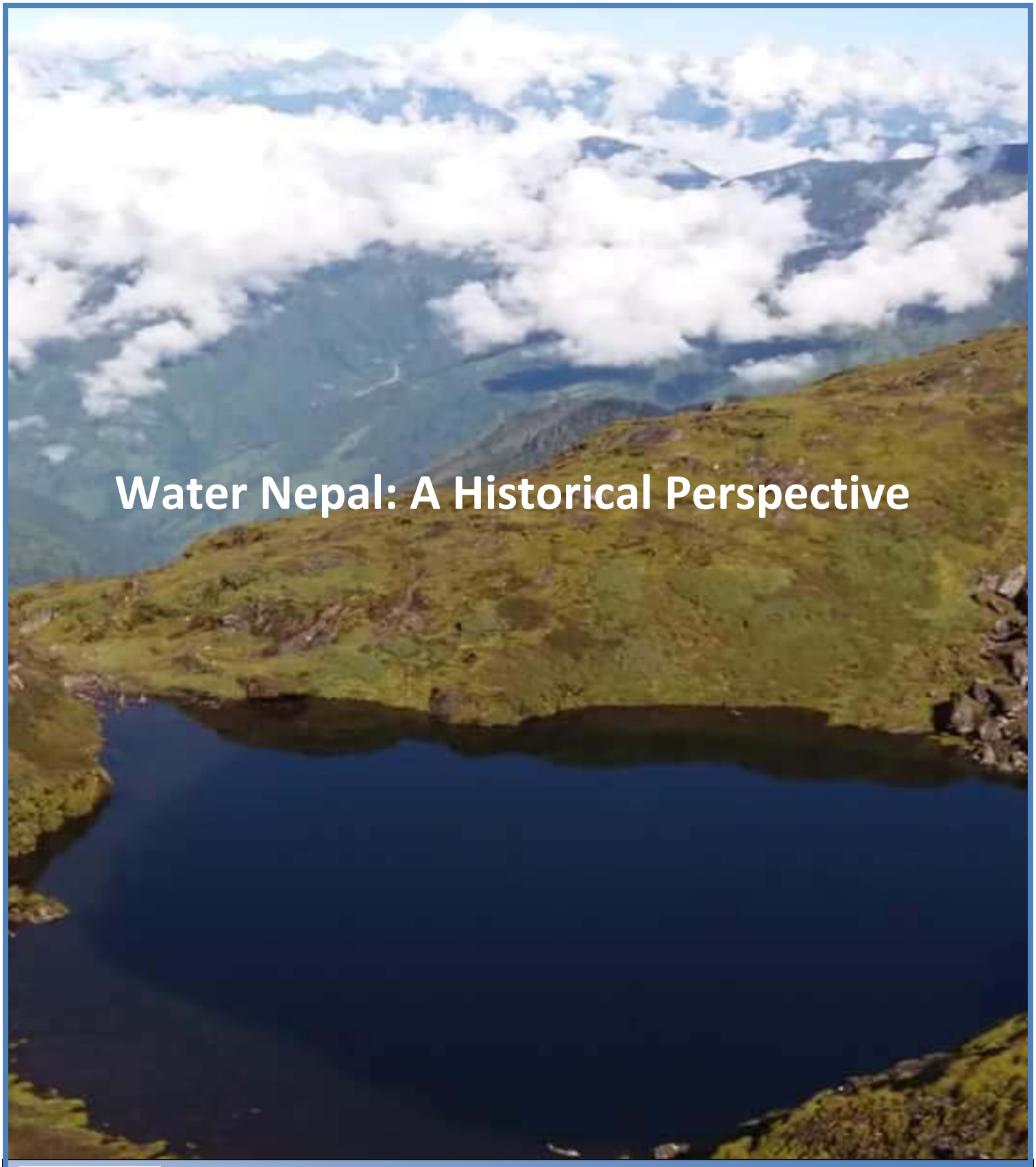

Water Nepal: A Historical Perspective

GWP Nepal

GWP Nepal/ Jalsrot Vikas Sanstha (JVS)
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Disclaimer

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Preface

Nepal is a landlocked country bordering with China to the north and India to the south, east and west. The climate of Nepal varies with topography from tropical hot and humid in the southern Terai to the alpine dry winter in the northern mountains. Water is one of the principal natural resources of the country playing significant role in socio-economic development. Nepal has more than 6,000 rivers that drain a total annual runoff of 224 billion cubic meters (BCM). These rivers are characterized by a wide seasonal variation of flow with maximum in the months of July and August and declining to their minimum flows in February and March. The groundwater is another major water resource which is available mainly in Terai regions and inner valleys.

Despite proud history of successful utilization of waters through the age-old community based water supply and irrigation systems and the symbolic Pharping Hydropower Plant, Nepal's overall scenario of water utilization is bleak. Irrigation is one of the major consumptive users with a total irrigated area of 1.37 million ha which is only about half of the cultivated land of 2.64 million ha. The total irrigated area also does not get the year round irrigation. In addition, about 28 percent irrigated lands in Terai is contributed from groundwater in the form of Shallow (STW) and Deep Tube Wells (DTW).

The existing coverage of drinking water supply is about 86 percent while the coverage of sanitation facility is about 82 percent. The main sources of drinking water are piped water, wells and open wells. The piped water is supplied only to 58 percent of urban population while only 41 percent of the rural population has access to piped water. By July 2019 the installed capacity of the electricity production would only reach 2300 MW despite country's potentiality of 83,000 MW. By virtue of steep topography and fragile geology coupled with intense monsoon rainfall Nepal frequently experiences floods, landslides and debris flows.

The water related institutional arrangement in Nepal can be categorized into four groups: i) institutions for planning, policy making and coordination, (ii) implementing institutions, (iii) operation-level institutions, and (iv) regulatory institutions. The institutions involved for planning, policy making and coordination are mainly councils, commissions and line ministries including Parliament and Council of Ministers. The implementing institutions are mainly departments, authority, boards and corporations under the organizational structure of line ministries. At the regional and local level several institutions are involved in the operation and management of the water related activities. At present there is no regulating authority for the water sector at the center.

The main policies related to water governance and management are Water Resources Strategy (WRS) 2002, National Water Plan 2005, Hydropower Development Policy 2001, Drinking Water

Supply and Sanitation Policy 2011, Irrigation Policy 2013, and Water Induced Disaster Management Policy 2015. Recognizing the importance of water sector in socio-economic development of the country, the Constitution of Nepal 2015 has made several provisions in its fundamental rights and directive principles, policies and obligations of the State. The main Acts relating to water are Water Resources Act 1992, Electricity Act 1992, and Foreign Investment and Technology Transfer Act 1992.

In Nepal financial resources for water sector are channeled through three types: water users through their own outlays, taxpayers through Government budget expenditure, and foreign aids. Human resource planning and management is one of the neglected aspects of development planning in Nepal. The specific planning of human resources for water sector governance and management are yet to be carried out in holistic manner.

The strengths of water governance in Nepal are availability of policies recognizing IWRM and river basin planning, huge hydropower potential, involvement of community in drinking water supply managements, age-old traditions of community irrigation, professional capacity of water institutions to plan, design and implement large water projects, climatic suitability to farm off-season vegetables, governmental efforts to deal with water induced disasters, and ample coverage of forest resources.

The weaknesses of water sector are the absence of central planning organization, constraints in implementing hydropower projects due to cost and time over run, low performance of existing irrigation systems, improper management of water supply systems and their sustainability, quality of drinking water, frequent water induced disasters, quality of data and information, and issues with riparian countries.

The opportunities of water sector are potential market for hydropower investment through Foreign Direct Investment (FDI), demand of cost effective small and medium hydropower projects, potential market of high value organic crops, possibility of year round irrigation utilizing large perennial rivers and ground water and commitment of the community in water supply and sanitation sector.

The main threats of the water governance are sustainability of hydropower projects without river basin planning and management, erosion and sedimentation of hydropower projects, decreasing water availability for irrigation and drinking water supply due to climate change, unplanned urbanization, transformation of fertile lands into residential areas, unavailability agriculture labor in rural areas, and inadequate knowledge on climate resilient and climate friendly socio-economic development.

The main gaps in water sector governance are resource constraints, regulatory framework, collaboration with academic institutions, highly skilled technical manpower, proper assessment of watersheds, drying water source after the Earth Quake 2015, and regular evaluation of existing irrigation systems. The support necessary for water governance sector are financial resources, establishment of functional water resources information system, and building climate-resilient communities.

In the context of the above situation and the challenge, it would be important to understand the basic construct of the water regime in its historical perspectives. The papers written by eminent experts in the respective fields of water utilization give a unique glimpse of the evolution of the regime from its start to the present situation. The attempt here is to make the reader aware of the past strides in all major areas of water resources they being hydro-power, irrigation, drinking water and sanitation and other uses like cultural and religious use and environmental uses. This is a unique attempt in itself. These papers do not give a highly sophisticated analysis yet they are a good source of information and recollection of the past strides. It is rightly said that "to understand the present one needs to look at the history". We hope that those researchers who want to do research on Nepalese water resources would be benefitted by this volume of write-ups. Jalshrot Vikas Sanstha/GWP Nepal feels proud in bringing out this volume in the light. JVS/GWP Nepal is deeply indebted to the experts who did produce voluntarily a revealing account of the developments in each sector of water use in the country. In bringing out this volume the laborious work done by JVS/GWP Nepal staffs particularly Tejendra GC the Manager and Neha Basnet the Program Officer have been highly helpful. They deserve high appreciation for that. Finally, JVS/ GWP Nepal would feel proud if this would be a modest help to the research fraternity in the field of water resources.

Thank you!

Surya Nath Upadhyay
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CHAPTER-I
HISTORY OF DRINKING WATER SYSTEM: TRADITION, DEVELOPMENT AND PARTNERS IN PROGRESS

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Acronyms

BCM	:	Billion Cubic Meters
STW	:	Shallow Tube Wells
DTW	:	Deep Tube Wells
MW	:	Mega Watts
WRS	:	Water Resources Strategy
IWRM	:	Integrated Water Resource Management
FDI	:	Foreign Direct Investment
WHO	:	World Health Organization
DWSS	:	Department of Water Supply and Sewerage
NGOs	:	Non-Governmental Organization
UNICEF	:	United Nations Children's Fund
VDC	:	Village Development Committee
DDC	:	District Development Committee
DWSO	:	District Water Supply Officer
PWD	:	Public Works Department
CWSS	:	Community Based Water Supply Sector
INGOs	:	International Non-Governmental Organization
VSO	:	Volunteer Service Overseas Nepal
ODA	:	Oversea Development Assistance
ADB	:	Asian Development Bank

UNDP	:	United Nations Development Programme
UK	:	United Kingdom
NEWAH	:	Nepal Water for Health
MoHPP	:	Ministry of Housing and Physical Planning
MPLD	:	Ministry of Panchayat and Local Development
FINNIDA	:	Finnish International Development Agency
JAKPAS	:	Janatako Afno Khanipani Ra Sarsafai
CBOs	:	Community Based Organizations
UWSSP	:	Urban Water Supply and Sanitation Policy
STWSSSP	:	Small Towns Water Supply and Sanitation sector Project
KVWSSSP	:	Kathmandu Valley Water Supply Sector Development Program
UEIP	:	Urban Environment Improvement Project
IUDP	:	Integrated Urban Development Projects
TYIP	:	Three Year Interim Plan
WASH	:	Water Sanitation and Hygiene
IDA	:	International Development Assistance
JICA	:	Japan International Cooperation Agency
MLD	:	Million Liter Day
NWSC	:	Nepal Water Supply Corporation
UFW	:	Unaccounted for Water
JBIC	:	Japan Bank for International Cooperation
SDR	:	Special Drawing Rights

SIDA	:	Swedish International Development Cooperation Agency
OEPC	:	Office of Environmental Policy & Compliance
NDF	:	Non-Deliverable Forward
KUKL	:	Kathmandu Upatyaka Khanepani Limited
FNCCI	:	Federation of Nepalese Chamber of Commerce and Industries
NCC	:	Nepal Chamber of Commerce
KVWSMB	:	Kathmandu Valley Water Supply Management Board
WASMIP	:	Water Supply and Sanitation Management Improvement Project
NRW	:	Non-Revenue Water
ENPHO	:	Environment and Public Health Organization
LISCU	:	Low Income Consumer Supply Unit
WUSCs	:	Water Users Supply Committee
NMIP	:	National Management Information Project
NRCS	:	Nepal Red Cross Society
CHRDU	:	Central Human Resource Development unit
STWSSP	:	Self Reliant Water Supply and Sanitation Support Programme
RWSSP	:	Rural Water Supply and Sanitation Project
DVI	:	Dutch Volunteer Agency
GWS	:	Gurkha Welfare Scheme
UN-HABITAT	:	United Nations Human Settlements Programme
WUC	:	Water Users Committe

INTRODUCTION

Water: Socio-Economic Culture

Access to a safe, reliable, affordable and easily accessible water supply is vital for good health, welfare and productivity of the people and country. Lack of access to safe drinking water leads to various avoidable diseases linked to organic and inorganic pollutants in drinking water. Poor public health conditions reduce human productivity and result in economic losses. Safe drinking water is, therefore, at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself.

Water is a finite natural resource which is renewable if well managed. Managed efficiently and equitably, water can play a key enabling role in strengthening the socio- economic development of a country as well as in increasing resilience of the environmental system of the country. Water has also a central place in the practices and beliefs of many religions. Water not only purifies objects for ritual use but also makes a person feel clean externally and spiritually. All religions insist on purification, physical and spiritual, in which water plays an important role.

Sanatan Hindu philosophy, mythology and culture treat water as one of the five elements 'Panchatatva' that constitute the form of universe, the other four being fire, air, earth and ether. Hindus believe water as a tangible manifestation of the Divine essence thus sacred. Nepalese believe that water has many Divine powers, among which the life-giving power is one of the most important. Sacred water is also believed to have the power to purify body and soul. In Nepal, there are several sources of sacred river and confluence of river, lakes i.e. Tribeni, Devghat, Kagbeni, Barahchhetra, Gosaikinda etc .Water used in Hindu rite, known as Abhisekh in which the images of Gods are washed, is particularly potent with power. Devotees drink this water and carry some home. Offering water to weary travelers to quench thirst and provision of water facilities for public/community is thought to bring ‘religious merit’/God’s blessings (Punya).

In Islam religion water is considered life-giver and purifier. Water is used both at home and mosque to achieve purification. Christianity also regards water as purifier of both the body and soul. As a symbol of purification, baptism is performed in which water plays an important role. Christians consider Jordan River sacred as River Ganga is for Hindus.

1. Drinking Water Harvesting and Management Tradition in Nepal

Traditional systems have provided drinking water in the mountain, hills, valleys and Terai over centuries. Difficult terrain, scattered settlement and abundance of water sources in the nearby settlement encourages/enables people to pool their resources and build and manage their own water facilities/supply systems i.e. stone spouts, spring, dug wells/wells and ponds for both

domestic and irrigation purposes. Ponds were important means to conserve precious water resources that provided water for domestic purposes including water for livestock, washing clothes, irrigations, protecting local environment and sustainable water resources.

Historical record/documents, inscriptions and writings amply indicate that in ancient Nepal the existence of community management of water resources used to be very much a community affair. Local autonomy was a characteristic feature of medieval Nepal. The villages of that period were self-governing. Until the middle of the last century and even years after the unification of Nepal, different parts of the kingdom had their own laws. The law and regulations then were mainly related with protection of water sources by not cutting trees, and rights regarding appropriation of water from the source for irrigation. Jung Bahadur, the first Prime Minister promulgated Ain (Law) known as Muluki Ain (National Code) in which, reference to water was limited to various aspects of irrigation-procurement, allocation and distribution. The1955 Act under the heading Essential Commodity Promotion also stressed: a) strict protection of drinking water and b) prohibition of unauthorized use or misuse, stealing, damaging etc. of drinking water. The 1992 Water Resources Act which specified priority uses of water allotted first priority to drinking water.

1.1 Kirat Period (200-800 B.C.)

Factual history of Nepal begins with the **Kirat people** believed to be the ancestors of modern Rai and Limbu ethnic groups of eastern Nepal. The emergence of Kirat rule marked the end of prehistoric period in ancient Nepal. Though very little is known about them, the Kirat administrative system was largely based on principles of local autonomy. This implies that community played an important role in the management of their socio-cultural and economic affairs though there are no references specific to water resources management. Drinking water may not have been a problem or a serious concern for the state/ the then rulers due to abundance of water sources in nearby settlement area, dense forest, rich vegetation and sparse population.

1.2 Lichhavi Period (300-800 AD)

The Kirat dynasty was followed by Lichhavi period. The Lichhavi rulers were also interested in the promotion of welfare of the people. Inscriptions found on stone spouts (Dhunge Dharas) and official documents show that stone spouts were started during Lichhavi period. The earliest stone spout for drinking water was constructed in 550 A.D.at Hadigaun, Kathmandu, while in Patan the oldest spout dates to 570 A.D. It is still in use and is known as **MANGA HITI**. There are many such stone spouts all over the country.

Stone spouts were then known as **PRANALI**. During Lichhavi time,'**Pranali Gosthi,'** which was created to make arrangement for supply of drinking water during festivals, was responsible for management of water resources including construction of drinking water and irrigation systems.

The tradition of providing drinking water to people during festivals by constructing 'Jal Dronis', which are stone water tanks built near temples, religious places and trails, is still in place in modern Nepal as well. The 'Jal Dronis' in Sankata Tebahal, Itumbahal and several Vihars in Kathmandu and Patan are still in existence. Apart from stone spouts, kunwa, kunda, pond, talau, pokhari, wells, etc. were constructed for supply of drinking water for household and agricultural uses both at individual and state level.

The 800-1200 A.D. period was a transitional period. Very little is known about this period except that it was a period of turmoil. However, despite the instability, religion, art and culture flourished in the valley and outside. Drinking water system was also developed: to name a few: the famous Sundhara spout in Patan (980 A.D.) and Sankhu stone spout were constructed in 1168 A.D. The Chakwa Hiti spout in Patan is known for architectural, cultural and historical significance.

1.3 Malla Period (1144-1768 A.D.)

The Lichhaviperiod is followed by the Malla period which lasted until Prithivi Narayan Shah; King of Gorkha principality conquered the Kathmandu Valley in 1768 A.D. and created the state of Nepal as it is known to-day. The Malla period is known as the Golden Era in development of water resources for both drinking and agricultural uses, and management of these resources/systems by the communities.

The construction of the famous **Raj Kulos** (irrigation canals) in Kathmandu and irrigation canals/painis/Nahar/Kulos in the hills are some of the well-known constructions of that period. Some of these are still in use and are being managed by the communities. More stone spouts, pokharies/ponds, wells, kuwas, Naulos and **Jal Dronis** were constructed to provide drinking water facilities in and outside Kathmandu valley. These systems/facilities are also well known for their architectural design and artistic beauty. Some of the most famous stone spouts of this period are Dhunge Dharas of Hanman Dhoka Palace, **Tusa Hiti** in Patan Durbar and **Thatu Hiti** in Bhkatapur Durbar.Water spouts of Balaju and Naulos (spring protection) of Baitatdi, Darchula, Dadeldhura and other districts of Far western region, which were constructed during this period, are still in current use. Naulos constructed by Khas Kings are well known for their architectural soundness and beauty.

During the Malla period, stone spouts began to be known as **Yitee or Hiti**. The office entrusted with the task of construction and maintenance of spouts, wells, canals, temples was called **Chebhandel** and the office in charge was known as **Dhalpa**.

In Nepal, it has been the tradition to construct various types of water systems for people by kings and village chiefs while management and maintenance were the responsibility of the community.

There were also strict rules about irrigation, construction, maintenance and use of water resources. These were formalized in the form of decrees, ordinances like Mulki Sawal, Sanad Sawal etc. Such decrees and ordinances are also found in several historical documents and inscriptions. In ancient Nepal it was also decreed that water conflicts should be solved by the community itself. This is specifically mentioned in historical documents pertaining to the period of Gorkha King, Ram Shah.

Besides kings and village chiefs, individuals - rich and poor, of high and low caste, and men and women - also constructed water systems/ drinking water facilities in the community religious places, travel routes and resting places. In Nepalese culture, providing drinking water facilities for the people is considered one of the best ways to earn religious merit **Punya.** It is also our tradition to construct Dharas-spouts, wells as a tribute to our departed ancestors as well as give peace to their soul; i.e.,the famous **Ghansi Kuwa** (a well, constructed by a grass cutter) in Tanahu district, **Punla Dhara** constructed by a widow from her earnings by spinning thread in Byasi tole, Bhaktapur in 1643, and **Tripura Subndari Dhara** in 1468 etc. Though maintenance of such systems is the responsibility of the community, some individually constructed systems were maintained by the family or community Guthi (Trust).

Thus the tradition/ culture in the community to preserve, protect, maintain and manage their water systems dates back to several centuries. For this, general customary rules and festivals evolved such as **Sithi Nakha** which is still an annual affair in Kathmandu valley especially among Newar communities. On festivals such as **Sithi Nakha** the communities come together to clean spouts, wells, ponds etc. This ritual cleaning of the various water sources is then followed by a communal feast. This is just one sterling example of community participation, commitment and enthusiasm in management of water resources and sanitation.

Keeping in mind sanitation aspect it was often customary to install an idol of God and Goddesses in water places. In addition, the natural source of water is believed to be the abode of Snake God **Nag.** Thus source/place is thus kept clean. There were rules and special places designed for bathing and washing clothes away from stone spouts and wells. Washing dishes, pots and pans were not allowed in or around stone spouts, wells on ponds, thus, general sanitation was also given equal importance.

The Malla and Rana rulers promulgated decrees related to conservation, non-pollution and general cleanliness of the community environment and surroundings of water systems.

1.4 Shah and Rana Period (1768-1951 A.D)

The medieval period which started in 879 A.D. came to an end with the unification of Nepal by King Prithvi Narayan Shah in 1768. In 1846, the hereditary Shah King was relegated to a titular

head, and the Kingdom was ruled by Jung Bahadur Rana as Prime Minister. He founded the Rana dynasty which lasted until 1951.

During the Shah regime, the King was the supreme ruler. Accessibility and adequacy of water did not then pose serious problems because of limited population, abundant sources of water and dense forest which covered three-fourth of the land area. Kings and prominent people, as in the Malla period, continued building elaborate water places for the use of common people and passersby so as to earn merit/fame in the name of deceased family members.

Many dharas/spouts, wells and ponds were constructed during this period to meet the growing need of the people. The stone spouts came to be known as Dhunge Dharas. The most famous Dhunge Dhara of this period is the Sundhara in Kathmandu.

During the Rana period a number development and social welfare projects including piped water system and other water related projects were undertaken such as the installation of small hydro-electricity project at Pharping and Sundarijal in Kathmandu, construction of irrigation canal (Chandra-nahar) in Saptari destrict and Manusmara irrigation.

The first systematic water supply system was constructed by Bir Shumser under the name of Bir Dhara in 1895 which transported water from Shivapuri to a centrally located reservoir in Panipokhari and distributed water to select locations in the town through public stand pipes installed for the purpose. The first water treatment plant was constructed in Sundarijal , under the Indian aid assistance , which treated the tail race water flowing out of the Sundarijal Hydropower Station, that was built in during the regime of Chandra Shumsher. The treatment plant consist of sedimentation, coagulation, rapid sand filtration and chlorination facilities. Similarly, the pharping head pond constructed initially to operate the 500 kilowatt power station; the first hydropower station of Nepal also started to be used for water supply. These systems were followed by construction of Tri Bhim Dhara System which utilized water from Nagarjun hills and with a reservoir in Balaju.

1.5 Global Level Initiatives

At the global level, water related issues received attention as early as 1976 during the United Nation Conference on Human Settlement held in Vancouver, Canada. In 1977 the United Nation Water Conference in Mar del Plata recommended 1981-1990 decade to be declared the International Drinking Water Supply and Sanitation Decade with the objective of providing clean water and sanitation to a large number of people. The goals for the Decade proved to be too ambitious and the world fell short of achieving the objectives.

Fast growing population, rapid urbanization, prohibitive cost of developing water resources, lack of appropriate and technical capacities have greatly affected the optimum development of water

resources including drinking water supply. Sadly, the effects of these scarcities/problems are endured primarily by the most vulnerable groups in the developing countries especially by socially, culturally and economically disadvantaged groups living in rural hills, mountain and slum areas. Although, 89% of the global population now has access to an improved drinking water source, over 700 million people remain without access to safe water.

1.6 Piped Water Supply: Modern Nepal (Post -1950)

Piped water system was for the first time introduced in Kathmandu valley by the then Prime Minister Bir Shumser in late 1891. It was then available only to the ruling families. Piped water supply was then a status symbol. The first piped water scheme, which tapped the head water of the Bishnumati River in the Shivapuri hills north of the Kathmandu valley was constructed by the British engineers. Later on it was extended to Lalitpur, Bhaktapur and several other districts by other Rana Prime Ministers namely Chandra Shumser, Bhim Shumser, Padma Shumser, Dev Shumser and Judha Shumser. **Pani Goswaras** manned by a khardar and an overseer were created to design, construct and maintain the water systems.

With the introduction of piped water supply, the tradition of constructing stone spouts, wells and ponds gradually disappeared. Until 1950s, stone spouts, well, ponds, kuwas were the main sources of drinking water in the kingdom of Nepal.

In 1951 Nepal emerged from its self-imposed isolation from the world when it overthrew the centuries old autocratic rule. Until then piped water was available only to the autocratic rulers and some favored courtiers. Modern planning and development of public water supply and sanitation was initiated in Nepal during its First Five-Year Plan (1956-61). The Department of Water Supply and Sewerage was established in 1972 as the lead agency. Following the world declaration of 1981-1990 as the International Water Supply and Sanitation Decade, international donor agencies and Non-governmental organization supported Nepal's Water and Sanitation Program with generous financial help

It was only after 1972 that the Department of Water Supply and Sewerage (DWSS) was created and was entrusted with the responsibility of providing water facilities and sanitation services for people living in rural areas free of charge. The DWSS was given the management and maintenance responsibilities. For the urban sector, Nepal Water Supply Corporation is to provide and maintain drinking water supply system with nominal charges. Prior to that, Ministry of Panchayat was primarily responsible for providing piped water facilities in the rural communities.

Until the middle of last century, different parts of the kingdom (even after unification) had their own laws. The then regulations were mainly concerned with the protection of water resources by not cutting trees and rights regarding appropriating water for irrigation. Junga Bahadur Rana, the first Rana Prime minister promulgated first Muluki Ain National code 1854. Regarding water in the

National Code was limited to the various aspects of irrigation in terms of priority rights to acquire; allocation and distribution of water for irrigation. Next more comprehensive National code Muluki Ain was promulgated in 1963, which also limited to irrigation rights priorities.

The 1992 Water Resource Act vests ownership of water in the state and user right is to be obtained through licensing. Also priority on utilizing the water resources has been mentioned; Drinking Water having the first priority regarding utilization of water resources.

Thus community participation and management took a back seat for almost half-a-century. However, in the 1980s/late 1970s, NGOs, UNICEF and from 1993 onward DWSS made conscious efforts to revive and reintroduce community participation in construction and management of community water systems in rural areas. In recent times, community participation is **touted** as a new approach. Seen in the historical context, it is by now clear to us that community management of water resources-drinking water and irrigation canals is not a novel idea for Nepal as it has been in practice for centuries

2. Drinking Water Supply Sector Program Five year and Three year Development Plans:

2.1 Five Year Plan:

Plan development of the Water Supply and sanitation sector commenced with the advent of the Third Five Year Plan (1965-70). Until the Sixth Five Year Plan period (1980-85)there was no official mandate for DWSS to work with community/beneficiary groups in water supply sector. User/beneficiary participation was limited to labour contribution for the construction of Schemes. While selection and prioritization of the schemes/ projects took place at VDC and DDC level planning, feasibility, budgeting and construction became the DWSO's responsibility. Until the end of seventh Five Year Plan (1985-90) agreement between DWSO and potential beneficiary groups was neither practiced or was made mandatory.

2.1.1 First Five Year Plan Period (1956 - 1962)

Drinking Water and Irrigation was subsumed under the Public Works Department (PWD) under the Ministry of Agriculture, Transport and Construction. Drinking Water service was then limited to urban areas only.

The Sundarijal Water Treatment was constructed with the support of Government of India in 1957

2.1.2 Second Five Year Plan Period (1962 -1965)

Drinking water continued to be under the PWD and the focus was to provide water facilities to more urban areas.

2.1.3 Third Five Year Plan Period (1965- 1970)

Drinking Water Supply was still under PWD and the focus was again urban areas. Data suggest that by 1970, 3.7 percent of the total population had access to piped drinking water.

2.1.4 The Fourth Five Year Plan Period (1970-1975)

During this five year plan focus was given on

- Creation of Department of Water Supply and Sanitation (DWSS) in 1974
- Emphasis on providing drinking water facilities to urban centers.
- Outlying district head-quarter areas also began to receive water supply services under the new focus on basic needs.
- UNICEF under the Ministry of Panchayat and Local Development provided water supply facilities for Communities of less than 1500 people with an aim to reducing child mortality.
- DWSS services were limited to district headquarters and municipalities.
- World Bank (1973) also supported urban water supply sector with the formation of a water Supply and sewerage Board.
- From 1974 onwards World Bank assisted water supply and Sewerage Project Phase I in Kathmandu and Pokhara.
- By the end of the Fourth Plan Period about 7.5 percent of the total population had access to piped drinking water services.

2.1.5 The Fifth Five Year Plan Period (1975-1980)

- Drinking Water Sector for the first time developed its goals and aims to improve health and hygiene of people through supply of clean drinking water services to a maximum number of the population and initiate sewerage systems in urban areas.
- CWSS –UNICEF continued serving several communities.
- Formation of Khanipani Bikas Samiti to manage the completed drinking water systems.
- From 1976, HELVITAS (a Swiss NGO) came into the scene by expanding CWSS Programme in the Western Development Region.
- The World Bank continued funding to Urban Water Supply Programme and extended its Phase II support in Biratnagar and Birgunj with further expansion in Kathmandu and Pokhara (initiated in 1977).
- By the end of Fifth Plan Period 11 per cent of the population had access to pipe drinking water facilities.

2.1.6 The Sixth Five Year Plan Period (1980-1985)

- Was marked by Water and Sanitation Decade.
- Increased entry of trained/qualified overseers and engineers in the sector.

- Entry of NGOs, INGOs and Volunteer agencies like VSO, ODA, Peace Corps GVS, SNV etc. in the DWSS sector.
- From 1984 onwards foreign loan component in the sector began to exceed grants.
- First ADB loan project implemented
- Rural Water Supply Project (1985-1993) in 22 districts by DWSS (Mid -Western and Far Western Development Region)
- Other donors in the sector were UNDP, UNICEF and UK.
- Plan Period coverage reached 37 percent of population.

2.1.7 The Seven Five Year Plan Period (1985-1990)

- Second ADB Loan Rural Water Supply Sector Project implemented in 35 districts- Eastern, Mid -West and Far Western Development Region.
- DWSS adopted Community Oriented approach and developed guidelines for the same.
- A commission formed (1987) to review the water supply and sanitation situation in the Country, Pokhrel Commission was constituted with specific mandate to examine the achievements of the three projects implemented by the Water Supply and Sanitation Corporation (WSSC) with World Bank loan.
- Suggestions from the Commission were incorporated.
- Decentralized model with each town having its own WSSC
- Formation of Public Utility Commission to regulate tariff.
- Entry of Water Aid in 1987, Redd Barna in 1987, Dutch Volunteer in 1989, Lutheran World Service, and CARE Nepal in 1989.In the Rural Drinking Water and Sanitation Sector Nepali NGO - Nepal water for Health (NEWAH) - promoted by Water Aid appeared in the scene during this period.
- DWSS came under the umbrella of the Ministry of Housing and Physical Planning. The MoHPP has the overall responsibility for water supply sector which included sector planning, coordination of budgets and program of sector agencies and development sector policy.
- DWSS appointed the lead agency for the sector. DWSS is responsible for improving water supply system in rural and urban areas.
- UNICEF and HELVITAS supported CWSS Programmer was moved to DWSS from MPLD.
- DWSS approach changed from implementer to facilitator
- FINNIDA supported Rural Water Supply Sanitation Project implemented in the five district of Lumbini Zone.

2.1.8 The Eighth Five Year Plan Period (1992-1997)

- Preparation of a milestone document:
- Drinking Water Supply and Sanitation Sector Review and Development Plan (1991-2000).
- Based on the Sector Review Report target for the Plan Period was set to provide drinking water services to 72 percent of the population and extend the service to whole population in the next 10 years.
- From 1993 onwards DWSS changed its traditional role as provider or implementer to a facilitator role by making water supply and sanitation program participatory in terms of meaningful decision making demand for water supply scheme and cost sharing role by bringing operation and management responsibility under water users and sanitation committee.
- Sanitation made integral component of drinking water supply.
- Third Water Rural Supply Sector Project under the third ADB loan Project implemented.
- Continuation of the Finnish funded Rural Water Supply and Sanitation Project in Lumbini Zone
- Janatako Afno Khanipani Ra Sarsafai (JAKPAS_ initiated with World Bank Support.
- Established Rural Water Supply and Sanitation Fund Board with World Bank support through a formation order under the Development Board Act.
- Major implementing partners were ADB, Helvitas, Fund Board NEWAH and FINNIDA.

2.1.9 The Ninth Five Year Plan Period (1997-2002)

Some of the important features of the Ninth Plan are emphasis on:

- Sustainable development of drinking water and sanitation activities with meaningful involvement of the user groups/ communities and local government bodies by making them fully responsible at all stages of planning, implementation, execution, operation and maintenance of the system.
- Optimal mobilization of local resources as a part of minimal (10%) cost sharing, appreciation and use of relevant local skill and technology.
- NGOs and CBOs including private sector as partners in the development of the sector.
- Serving socially and economically disadvantaged groups with their active involvement.
- Gradual improvement of the service level of drinking water.
- Preparation of district profile for long term plans and programs of present status and coverage of drinking water and sanitation, existing water resources and potentiality of development.
- Reducing environmental impacts from programs of water supply and sanitation sector

2.1.10: The Tenth Five Year Plan (2002-2007)

- It is focused on providing basic drinking water to all regions by gradually upgrading the level of services also appropriate sanitation facilities both in urban and rural areas by increasing public awareness
- Reducing child mortality rate by controlling water borne and water induced diseases
- Involving private sector in overall management of urban water supply system/facilities

Development of Rural Water Supply and Sanitation National Policy 2060 (2004) and Rural Water Supply and Sanitation National Strategy 2060 (2004)

The principal objective of this policy were to set a new set of targets to provide safe, reliable and affordable water supply with basic sanitation facilities to 100 percent of the population on priority basis specially targeting the socially and economically disadvantaged people to reduce water borne diseases and save the time and labour of men, women and children form fetching the water. The policy focuses on renovation, rehabilitation, improvement and expansion works of the existing system and increase the quality of service. The policy has also provided guideline on water and sanitation service for urban communities also as it was partially relevant to the urban context, particularly around the integration of inputs and local capacity building.

2.1.11 Eleventh Three Year Interim Plan 2007-2010

The objective of this three year plan was to ensure sustainable water supply services and a healthy environment through institutionalization of socially inclusive development initiatives, gradually providing purified drinking water to the whole population, providing treatment facilities with an inclusive sewerage system in urban, semi-urban and emerging towns.

Development of Urban Water Supply and Sanitation Policy 2066 (2009)

The Urban Water Supply and Sanitation Policy (UWSSP) was formulated to address the complex operational issues of urban water supply and sanitation service delivery. It also addressed the need of an umbrella policy to achieve coherent, consistent and uniform approaches of development sector in urban areas by all effectiveness for improved service delivery in proper perspectives according to the need of the day.

The policy identified four major initiatives at the implementation level addressing Nation's, urban water supply and sanitation challenges and provides important insights for the development of the policy. Those were the Small Towns Water Supply and Sanitation sector Project (STWSSSP); the Kathmandu valley Water Supply Sector Development Program (KVWSSSP); the Urban Environment Improvement Project (UEIP) and the Integrated Urban Development Projects (IUDP).

This policy has provided a firm basis for the extension of the projects with additional resources made available.
The strategies to attain the above objectives, during the TYIP period, will include the following:

- Execute simple technology based water supply schemes for extending the basic drinking water supply services.
- Ensure sustainable water supply services through rehabilitation and extension of previously executed old and damaged water supply schemes.
- Gradually improve the quality of drinking water in accordance with the Drinking Water Standards, 2007.
- Gradually extend the service standards as per the Water Supply and Sanitation Policy, 2004
- Promote and extend Sanitation facilities through public awareness at the rural and urban areas with the participation and contribution of the local government and Users' communities.
- Introduce necessary policy, institutional and legal reforms for adopting the Sector Wide Approach through effective coordination between the stakeholder agencies.
- Strengthen Organizational capacity for effective and result oriented plan implementation, monitoring and evaluation.
- Update and arrange for the dissemination of data and information on population with or without having access to water supply services.

2.1.12 Twelfth Three year Plan (2010-2013)

The improvement of health and living standard focus was on development of sustainable and safe water supply and sanitation facilities. Selected strategies adopted to achieve above goals were:

- Gradual improvement on water quality and services
- Increased involvement of local communities in the planning, implementation and management including operation, maintenance of the completed projects/ systems.

2.1.13 Thirteenth Three year Plan (2013-2016)

The objective of the three year plan was to provide basic services of drinking water and sanitation to all people.
Strategies promulgated were:

- Enhance access to and the quality water and sanitation services as provided for in the National Drinking Water Standards (2005) and Action Plan
- Introduce technologies such as rainwater harvesting, solar and electric pumping, and hydraulic ramps as alternative sources of drinking water in dry areas
- Adopt a sector wide approach in drinking water and sanitation programmes, and

- Adopt environment-friendly and climate adaptive measures by using local resources in the construction of drinking water and sanitation structures.

2.1.14 Fourteenth Three Year Plan (2016-2018/19)

This three year plan also emphasized on:

- Providing basic level drinking water and sanitation facilities to all
- Gradual expansion of middle and higher level drinking water and sanitation facilities.

Major programs included were

- Provision of basic drinking water services
- Improved water quality level
- Rehabilitation of the non-functional systems
- Improved sanitation services/facilities

2.2 Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030)

Despite frequent changes in the political scenario leading to changes in development plan from 5 years to 3 years and various socio-economic barriers and a series of natural calamities, Nepal has made a commendable achievement in water supply and sanitation sector. Currently, 86 percent of the populations are served by basic water supply facilities while 81 % of the populations have access to toilet (DWSS, 2017). For the first time, after six decades of planned development process, the Nepal WASH sector has come up with a single long term development. The constitution of Nepal has envisaged complete decentralization of all aspects of planning, implementation, operation and maintenance of WASH projects to the Federal, Provincial and local tiers of Government. WASH sector long term development plan has focused on the eleven themes with detail breakdown on area, objective, outcome and cost. Major themes included are; Access and Utilization, Functionality and Sustainability, Innovation and Technology Adaptation, Ecosystem and water Production, WASH Governance, Institutional setup and Capacity Building, WASH Diplomacy, Monitoring and Evaluation, Continuous Quality and Service Improvement, Diversity and Inclusion, WASH in special situation and Sector Financing (Nepal water supply, Sanitation and Hygiene Sector Development Plan (2016-2030).

3. Urban Water Supply and Sanitation Sector in Nepal: Growth and Development[1]

Water Supply and Sanitation Situation in urban centers vary a great degree by adequacy of supply, service, quantity and reliability, as well as cost recovery and management models.

Water supply in Kathmandu valley has remained a situation of chronic shortage since long time, particularly after urbanization started to grow in the 1980s. Situation in Kathmandu Valley, the largest urban center, is distinctly different from other areas. The Water Supply and Sewerage Board, was created in BS 2041 as a semi autonomous institution to initially over see water supply and sewerage systems in Kathmandu Valley and select 17 urban areas of the country. The Board was later graduated into a more autonomous, Nepal water Supply Corporation in 2047 BS through promulgation of Nepal Water Supply Corporation Act.

Several attempts were made, mainly through IDA assisted projects in the 1970s and 1980s, to improve the distribution network and augment the supply. It was for the first time that prospects of using ground water was explored, and several deep tube-wells were drilled to augment the supply. In 1990, JICA assisted a study to estimate the ground water potential of Kathmandu Valley, which concluded that the sustainable rate of groundwater in Kathmandu Valley was only to the order of 15 MLD. By late 90s, NWSC was already pumping out more than three times this amount in the dry season. The growing urbanization and resulting land use changes pose further constraints on ground water recharge in the Kathmandu Valley.

IDA also assisted a study to explore the possibility of augmenting supply in Kathmandu Valley on long term sustainable basis. The study was undertaken by Binnie and Partners, which identified 22 different options which ranged from pumping Trishuli River, building a medium high dam at Roshi, pumping water from Kulekhani reservoir, gravity flowing Trishuli river from Langtang, pumping from Indrawati river etc. This study identified Melamchi, Yangri and Markke river in sindhupalchowk , as potential sources to divert for supplying drinking water in Kathmandu Valley. Future studies established that each of these three rivers could provide Kathamndu Valley with of 170 MLD of water, bringing the total water available through Melamchi, Yngri and Larke rivers to 510 MLD.

The increasing shortfall on service delivery was not only accounted to lack of adequate supply of water but also to the dilapidated distribution system and inadequacy of management services which led to high UFW and revenue losses. Attempts were made to rehabilitate the distribution system inside the core urban area through IDA credit and to introduce an efficient management through hiring of an international private operator. But, two rounds of bids to recruit an operator, first under a lease contract and second time on an affermage / did not result in successful bid. As the works could not make good progress a bulk of the credit to the order of US$ 65 million was cancelled by IDA.

[1] Contributed by Suman Prasad Sharma, Former DG/DWSS secretary GoN

From amongst the 22 alternatives studied for augmenting water supply in Kathmandu Valley, the government focused on the option of Melamchi water project to provide a sustainable long term solution. It formed a Melamchi Water Limited, for the purpose of attracting private investment but after unsuccessful attempts, and construction of about 6 Kms of access road, the company was replaced by Melamchi Water Supply Development Board, which was formed in 2055BSunder the Development Board Act 2013 BS. Asian Development Bank provided an Engineering loan leading a consortium of development agencies comprising Norad and Sida, who funded the design of the 26 Km long diversion tunnel, headworks and the diversion scheme, JBIC funded the design of a Water Treatment Plant at Sundarijal.

From other parallel investments, Government of Japan supported some noteworthy activities, particularly construction of treatment plants constructed at Bansbari, Mahankalsthan etc. It also funded the Manohara Water Supply Project, through JICA funds, which included construction of infiltration wells in the banks of Manohara river and aimed at adding 22 MLD of supply to the system, which had a partial success. It also included construction of a treatment plant. Similarly, Asian Development Bank provided a Technical Assistance grant of an extensive study on water and Wastewater in Kathmandu Valley towards 1996-1998. The study primarily undertaken by Metcalf & Eddy has compiled and provided an integrated analysis of water and wastewater situation in Kathmandu valley.

3.1 Bagmati Basin Study

The first investment loan for the implementation of the Melamchi project was made available by ADB for an amount of US$ 120 million SDR, against the total projected cost of US$ 484 million, Norwegian grant, SIDA mixed credit, JBIC loan, OPEC fund loan, NDF loan were also availed. World Bank was however detached from the project and therefore a large portion of the fund required for Distribution system Rehabilitation (US$65 million) and Institutional Management (US$ 15 million) remained unfunded. Norwegian grant and SIDA mixed credit were also later withdrawn.

The project originally scheduled to be completed in 2007, is still ongoing with revised completion target of end 2017. In the meantime new funds have been made available for bulk distribution system, water distribution system improvement works and wastewater improvement, which are being executed by Project Implementation Directorate under the KUKL Board.

The part on sanitation has received much less formal attention as compared to water supply. Most of the sewer lines are laid to address local area problems and pose complex downstream challenges for network management. Sewage treatment ponds have been constructed in Sundarighat-Kritipur, Kodku-Balkumari Lalitpur, Sallaghari-Bhaktapur and Hanumante-Bhaktapur. They have a combined treatment capacity of about 19 MLD, but most of these plants remain largely dys-functional, resulting in open discharge of untreated sewers in Bagmati river and its tributaries like Bishnumati, Manohara, Rudramati, Ichchumati, Hanumante etc. Efforts are being made to rehabilitate these plants. Government initiated the construction of Guheshwori Wastewater Treatment Plant in 2055BS. It has a treatment capacity of 17 MLD. The plant was built under the institutional umbrella of High Powered Committee for Integrated Development of Bagmati Civilization. And was constructed with the primary objective of providing clean water in

the Pashupati, Aryaghat stretch of Bagmati river and consists of Activated Sludge Plant Technology. The committee has been subsequently entrusted with expanded scope of keeping Bagmati river clean, mainly by improving the river water quality from its origin in Dhap above Sundarijal to the outlet from Kathamandu in Chobhar. The activities mainly comprise of laying interceptor along the Bagmati river in Kathmandu.

3.2 Institutional Arrangements for water supply and sanitation

A thorough reform in the water supply and sanitation management was initiated together with the implementation of the Melamchi Water Supply Project. As a result, Water Supply Management Board Act, Water Supply Tariff Fixation Commission Act and revision to Nepal Water Supply Corporation Act were promulgated in 2064. The Nepal Water Supply Corporation was then split into in-valley and out-valley operations, and in the in-valley operations were transferred to a newly formed company Katmandu upatyaka Khanepani Limited (KUKL), established under Company Act. The company was established under a public- private Partnership approach with share holdings from the GoN, Kathmandu and Lalitpur Muncipalities, consortium of Bhaktapur, Kritipur and Madhyapur municipalities, Private Sector agencies Federation of Nepalese Chamber of Commerce and Industries (FNCCI), and Nepal Chamber of Commerce (NCC). The company has been awarded a thirty-year lease and operating license of the assets by Kathmandu Valley Water Supply Management Board (KVWSMB), who is now the official asset owner of water supply and sanitation facilities. Water Supply Tariff Commission is the tariff regulator.

3.2.1 Urban Water Supply outside the Kathmandu Valley

Nepal is undergoing a rapid urbanization. Old townships are seeing accelerated expansion and new townships are emerging, especially along the highways. This has created demand for water supply and sanitation services, which are not always commensurate with the resources for this sector.

Water supply in selected urban centers outside Kathmandu Valley are managed by Nepal Water Supply Corporation (list). Local water supply management boards have been credited in Bharatpur and Hetauda under the water Supply Management Board Act, to manage the upgraded utilities.

Major urban water supply projects undertaken in the past were those funded by Indian aid in the initial years, which contributed to building water systems in Rajbiraj, Japanese grant has been made available to construct water supply systems in Ilam, Gaushala (Mahottari), upgrading of Rajbiraj, Dhangadi, Mahendranagar and most uniquely in Tansen, Palpa amongst other places. The system in Tansen is unique for the multi stage pumping facility requiring large amount of electricity for its operation. Some amount of treatment and chlorination is provided in these townships. Lately the Japanese Assistance (JICA) has been to improve the systems in Dhulbari, Birtamod, Mangadh Projects, which are running in exemplary manners with characteristics of well managed utilities. JICA supported the management through two stages of WASMIP (Water Supply

and Sanitation Management Improvement Project), whereby new management tools were introduced into system operation and maintenance.

Some towns in eastern Terai were constructed using the British ODA funds in the 1980s. Damak, Kakarbhitta, Dhankuta, Birtamode, Budhabare are some of the such towns. Most of these systems have been expanded, upgraded and rehabilitated under the Japanese assistance or Asian Development Bank funded loans.

Water supply and basic sanitation services were expanded to 28 settlements in the first and further 21 settlements in the second Small Towns Water Supply and Sanitation project funded under the ADB loans. A fifteen year Small Towns Water Supply and Sanitation was prepared in 1998, which indentified around 200 small towns requiring installation of new services or upgrading of existing services. The implementation model is largely an extension on the rural water supply model, with much higher share and part in the system implementation process. The user's raise upfront cash to the order of 5 to 15% of the project cost, avail a loan for 35 to 40% f project cost, from the Town Development Fund, which administers the loan on-lent by Ministry of Finance and get an subsidy to the order of about 50% from the government of Nepal through budget appropriations channeled through DWSS, which has to be paid back in 20 years. The users take part in contractor evaluations, supervision and make payments to the contractor on their part of the loan. The project has shown mixed results for constructed facilities (Hemanata Gyawali, etal) with some towns achieving good results measured by reliability and quality of supply as well as loan repayment. Smart initiatives like daily water quality monitoring and results publication, SMS payment of monthly bills, controlled NRW have started to show up as indicators of good utility management.

As the demand for services is growing rapidly in other towns, the Government has launched a similar project called Sahalagani Karyakram (Joint Investment Program) under 50:50 cost sharing between local consumers and the government. A number of communities are availing this facility to improve their water supply and sanitation in their respective townships.

3.2.2 Issues in Urban Water Supply and Sanitation

Following are current issues in urban water and sanitation development

- Inadequate financial resources to address the fact growth in demand surfacing as combined effects of population growth, area expansion and change in quality of life.
- Service quality and demand responsiveness in newly declared municipalities, need of a national coverage plan and elaborate local WASH plan.
- Low service standards in many townships, lack of water quality assurance ,system continuity and reliability
- Lack of awareness leading to dependency on cheaper and easily available but potentially contaminated supply alternatives viz. shallow tube-well supply in Terai
- Power supply in Terai, leading to disruption in supply and high pumping costs.

- Lack of supply sources in hill towns to meet the demand by gravity supply, requiring high head and multi stage pumping, which are both difficult and expensive to maintain.
- Drying out of sources due to human activities and climate change, contamination of supply sources
- Affordability of consumers for higher quality of services

3.2.3 Water Quality

Government of Nepal has promulgated National Drinking water Quality Guidelines, 2004 which lays out plans to improve the water quality to make it safe for drinking under a phased approach. It includes guideline values for parameters. The targets have not been met but drinking water quality improvement. Programs are being undertaken, through several projects and programs. The Guidelines have to be revised and new targets have to be adopted.

Studies on water quality in Nepal are not very extensive. Very few systems/utilities conduct it on daily basis. Major identified problems till date are

- Occurrence of bacterial contamination including e-coli
- Arsenic contamination in 20 districts of Terai affecting thousands population.
- Arsenic is also spotted on some tube-well supplies in Kathmandu Valley
- Iron, manganese in ground water
- Calcium, TDS in water leading to calcinations and pipe incrustations, hardness

Some studies have been conducted for water samples in Kathmandu Valley and other major townships, including for the water from public water spouts and e-coli contamination has been noted including ENPHO, studies.

Spring water, which form the majority of water extraction sources in hills, are relatively free of human contamination for most part of the year, but the growing encroachment on water sources, accelerated development activities like road construction Sporadic outbreak of diarrhea and dysentery is still not ruled out although direct linkage with supply is not primary established in the absence of studies.

Water quality is definitely an area of importance for future pursuing in the water supply sector.

3.3.2 Water Supply and Sanitation for the urban poor

Water supply and sanitation for the urban poor has been an issue of much concern. Several studies have established that poor actual pay for higher cost of water as coping costs, than people who can afford a reliable piped supply. Lack of ample amount of clean water also adversely impacts on the health and productivity of residents of poor settlements, mainly due to poor hygienic conditions. This also creates pressure on river water quality as most of the squatter settlements lie close to streams and rivulets. A mapping of the urban poor settlements in Kathmandu and Lalitpur areas was conducted through a study funded by JICA and NGO Forum on Urban Water and Sanitation. The study has also identified that getting a connection is the first

step of solving the water and sanitation woes for a poor household, But, high connection costs, land entitlement issues and lack of awareness are major reasons for the poor remaining unconnected to the system.

A consumer education program was conducted in the past through the IDA assisted program, which focused more on water saving than on low income customers. A Low Income Customer Unit, LICSU is established inside KUKL to particularly address the concerns of the low income customers. Similarly, an Output Based Aid program focusing in end results is adopted in the ADB assisted second and Third Small Towns Water Supply and Sanitation Projects, which provides direct subsidy to utilities/WUSCs/operators for connecting poor households to the main system so that all families under a system area are covered by basic facilities of water and sanitation.

3.3.4 Service Standards and Functionality

Water Supply and Sanitation Policy 2004 classified water supply services into three categories basic, medium and high level based on quantity, quality, continuity and reliability of supply. Functionality of the existing systems is an emerging issue in drinking water and sanitation service delivery. NMIP survey of 2010 showed, only 18% of the systems were fully functional.

DWSS is undertaking National Management Information Project and the Ministry of Water Supply and Sanitation is undertaking a Rural Water Supply Management Information Program to update the status of water supply schemes all over Nepal.

4. Major Partners and Donors in the Water Supply and Sanitation Sector

4.1 UNICEF

UNICEF has been the most influential of all external agencies in this sector. In later years (in the 1980s), it was the leading advocate for the CWSS (Community Based water supply sector) programme. Initially UNICEF worked in collaboration with MPLD and later on with the DWSS. UNICEF also played as important role in developing local manufacturing capacity for the production of water supply construction materials including polythene pipes, brass fittings and suction hand pumps. It also provided extensive training to water and sanitation technicians. Most agencies active in this sector use methods pioneered by UNICEF staff or staff trained by the UNICEF.

Prior to 1997 UNICEF worked closely with the DWSS, the Nepal Red Cross Society (NRCS) and the Nepal Water for Health (NEWAH) for implementation of integrated water and sanitation projects in rural area. Following major changes in orientation and funding patterns in 1996-1997, it withdrew from the provision of drinking water and focused almost exclusively on the promotion of environmental sanitation, management information system (MIS) and central Human Resource Development unit (CHRDU)

4.2 HELVITAS

In 1975 HELVITAS (A Swiss NGO) entered the scene by expending DWSS programme in the Western Development Region. It has since then been active in this sector. It's Self Reliant Water Supply and Sanitation Support Programme (SRWSSP) currently operates within western Region and is headquartered in Pokhara. It works in partnership with CBO, NGOs and private sector.

In collaboration with UNICEF and MPLD, HELVITAS pioneered early participatory approach to community Standards to water supplies in Nepal, and played major role in developing technical standards for this sector. It is also the only INGO to have its programme agreement directly with DWSS.

HELVITAS has recently made two major decisions on the future of its programme. The first is to relocate to the Mid-Western Region in order to access to poorer and least well served communities. The second is to incorporate an integrated water management approach including working with VDCs to prepare water use master plans in all projects.

4.3 Asian Development Bank

ADB began to work in the rural water supply sector with the DWSS in 1984. ADB since 2000 has also involved with the Government of Nepal to improve water, sanitation and hygiene in the country's growing small urban centers through a services of Small Town Water Supply and Sanitation sector projects

4.4 FINNIDA

Since December 1989, FINNIDA began supporting Rural Water Supply and Sanitation Project (RWSSP) in six districts in Lumbini Zone. First phase of the project included grant aid, funding and technical support to MHPP-DWSS, which, through its District Water Supply Office implemented RWSSP. In keeping with the decentralization process FINNIDA changed its approach and partner in phase II. Consequently Ministry of Local Development became facilitator and DDCs direct partner for implementation of the project. The actual implemented were village communities, NGOs and CBOs. Phase III is a continuation of Phase II with a more emphatic support to decentralization planning. The estimated target of RWSSP was to serve a population of 216,000 by water supply facilities with special emphasis in the hills, and a population of 52,000 by sanitation facilities. Main distinguishing feature of the phase III was a stronger involvement from participatory districts in the form of monitoring contribution. Another important aspect of RWSSP was a Focus District Idea, meaning those districts which contribute 20 percent of their revenue for water supply and sanitation was to get more from the program. The program period was from July 1999 to July 2003.

The period of 1980-1990 also saw the entry of many international and national NGOs in the water and sanitation sector: Water Aid and Red Barna in 1987, Dutch Volunteer Agency (DVI), Lutheran World Service and Care Nepal in 1989, as well as a Nepali NGO, NEWAH (Nepal Water for Health)

4.5 DFID

DFID supports two NGOs, the Gurkha Welfare Scheme (GWS) and Nepal Water for Health (NEWAH). The GWS utilizes a network of retired Gurkha Soldiers (termed as sponsors) to help implement drinking water and sanitation schemes in key Gurkha recruiting areas. The working remit is generally confined to the hills of Eastern and Western Regions with a relatively smaller number of projects being undertaken in the Mid-West and Central Regions.

NEWAH, a Nepalese NGO, started with the help of Water Aid and registered with the Social Welfare Council, operates a nationwide programme of support through local NGOs. DFID finds are applied to its work in the Mid and Far Western Regions where access to safe water is ta its lowest. Water Aid, provides funding for projects in other Regions.

4.6 International and National NGOs

This organization has also been active in this sector supporting the government in expanding WASH services and capacity building for urban areas. UN-HABITAT primarily involved in sanitation & hygiene, urban WASH.

4.7 World Bank

The World Bank has been supporting the facilitation of urban water supply by assisting in the formation of Water Supply and Sewerage Board in 1973. The World Bank also began supporting phase-1 of the Water Supply and Sewerage project in Kathmandu and Pokhara.

During the Fifth Five Year Plan (1975-1980), Drinking water and sanitation sector for the first time attempted to detail its goals and strategy. It also initiated establishment of sewerage system in urban areas. The drinking Water Development Committee was also formed to manage the completed drinking water systems. The World Bank continued its assistance to urban Water Supply Program and extended its support to phase II of the Water Supply and Sewerage projects in Biratnagar and Birjung. World Bank funded Rural Water Supply and Sanitation project (2008-2013) to support the Government's efforts to improve rural water supply and sanitation sector performance and strengthen local water supply and sanitation users groups to plan, implement and operate drinking water and sanitation infrastructures.

5. Drinking Water Rights, Act and Regulations

Water is vital for life hence extremely valuable. There is a global recognition of the role of water: rights to water in ensuring better health, economy and environment of the people and community. Water as a basic human need was first formally recognized by the United Nations Water Conference in Mar del Plata, Argentine, in 1997. Subsequently an action plan was formulated confirming the right to access to drinking water in Agenda 21 adopted at the United Nations Conference on Environment and development in 1999.

The Committee on Economic, Social and Cultural Rights also adopted General Comment No 15 on the right to water in November 2002.The committee further defined the right to water of

everyone as 'sufficient' safe, acceptable, physically accessible and affordable water for personal and domestic uses. For the first time rights to water and sanitation were formally recognized in a UN resolution as fundamental elements protecting all human rights in July 2010. The resolution called on states and international agencies for increased financial investment, capacity building opportunities and technology transfer to support mainly developing countries in improving access to safe, clean, and affordable drinking water. 0n September 2010, the United Nations Human Rights Council adopted a resolution stating water and sanitation as human rights. This resolution required states to develop appropriate tools and mechanisms, which may encompass legislation and finance in a transparent manner, targeting more to vulnerable and marginalized groups to achieve the progressive realization of the human rights to safe drinking water and sanitation. In the South Asia Region, Delhi Declaration in November 2008 of the Third South Asian Conference on Sanitation recognized the rights to sanitation and water.

In Nepal, as early as 1955 (2012 BS) drinking water was conceived as essential commodity demanding strict protection of drinking water from unauthorized uses, stealing and damaging etc. National Water Supply Sector Policy 1998 declared drinking water as the basic minimum need of all human being and provision of convenient, safe and adequate drinking water in the commitment of the then government for enhanced socioeconomic benefit and public health improvements. For the first time drinking water as human rights is in the process of being included in the constitution under draft which reflects a political and financial commitment to increasing access to water in the country.

5.1 Acts and Regulations

1.	Muluki Ain 1953 (1910 BS)	▪ Ownership vested in the King of all resources including water and land. ▪ People had user right over water for domestic or religions purposes.
2.	Essential Commodity Protection Act 1955 (2012 BS)	▪ Drinking water conceived as essential commodity and strict protection of drinking water. ▪ Prohibition of unauthorized use or misuse, sterling, damaging etc. of drinking water.
3.	Muluki Ain 1963 (1963 BS)	▪ Spelled out the order of priority for use of water for irrigation only. Nothing on drinking water.
4.	Nepal Water Supply Corporation Act 1989 (2045 BS)	▪ Established the NWSC as the authority responsible for the supply of drinking water and sanitation.

5.	Water Resources Act 1992 (2049 BS)	Set the order of Priority of water use ▪ The use of water for drinking and domestic purposes given the first priority. ▪ Ownership of water vested in the state. ▪ Acknowledgement of the public right to drinking water and sanitation ▪ provision made for formation of Water Users Association ▪ Established a system of licensing ▪ Prohibited water pollution.
6.	Water Resources Regulation Act 1993 (2050 BS) Umbrella Regulation Governing Water Resources Management	▪ Devised procedure to Register Water User Association (WUC) and to obtain a license. ▪ District Water Resource Committee established. ▪ Spelled out the rights and obligations of WUCs and license holders. ▪ Dealt with the acquisition of house and land and compensation.
7.	Drinking Water Regulation 1998 (2055 BS)	▪ Regulated the use of water for drinking and domestic purpose and fixed priority for service connection. ▪ Also set out which consumers to be given priority for service connection by water suppliers. ▪ Provision for the formation of WUCs and detailed the procedure for registration. ▪ Dealt with limiting the use of drinking water. ▪ Control of water pollution and maintenance of quality standards for drinking water. ▪ Conditions of service utilization by consumers. ▪ Provision for the acquisition of house , land and compensation.
8.	Local Self Governance Act 1999	

	(2055 BS)	▪ Established a decentralized governance structure. ▪ Defined the power, functions and duties of the VDC, Municipality and DDC in relation to water and sanitation. ▪ Set out which natural resources are assets of local bodies and empowered local bodies to levy a natural resource tax.
9.	Local Self Governance Regulation 1999 (2056 BS)	▪ Detailed the powers, functions and duties of VDC, Municipality and DDC in relation to water and sanitation. ▪ Established the procedure for the formulation of water related plan and project implementation.

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CHAPTER II

HISTORY OF IRRIGATION DEVELOPMENT IN NEPAL

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Acronyms

Ha	:	Hectare
ICID	:	International Commission on Irrigation and Drainage
DoI	:	Department of Irrigation
FMIS	:	Farmers Managed Irrigation System
CUSEC	:	Cubic Foot per Second
ICM	:	Indian Co-operation Mission
FAO	:	Food and Agriculture Organization
USAID	:	United States Agency for International Development
GOI	:	Government of India
ADB/N	:	Agricultural Development Bank Nepal
CAD	:	Command Area Development
GON	:	Government of Nepal
GWRDB	:	Groundwater Resources Development Board
BLGWP	:	Bhairahawa Lumbini Ground Water Project
DTW	:	Deep Tube Wells
STW	:	Shallow Tube Wells
SIRDP	:	Sagarmatha Integrated Rural Development Project
IFAD	:	Integrated Fund for Agriculture Development
MIP	:	Mahakali Irrigation Project
WB	:	World Bank
UNCDF	:	United Nation Capital Development Fund
ISP	:	Irrigation Sector Project

ILC	:	Irrigation Line of Credit
IMP	:	Irrigation Master Plan
IMTP	:	Irrigation Management Transfer Project
NISP	:	Nepal Irrigation Sector Project
SISP	:	Second Irrigation Sector Project
APP	:	Agriculture Perspective Plan
CSITP	:	Community Shallow Tube-Well Irrigation Project
FY	:	Fiscal Year
CGISP	:	Community Groundwater Irrigation Sector Project
IDP	:	Irrigation Development Plan
EU	:	European Union
NWP	:	National Water Plan
CMIASP	:	Community Managed Irrigated Agriculture Sector Project
IWRMP	:	Irrigation Water Resources Management Project
CMIASP-AF	:	Community Managed Irrigated Agriculture Sector Project- Additional Fund
NITP	:	Non Conventional Irrigation Technology Project
LILI	:	Local Infrastructure Livelihood Improvement
SDC	:	Swiss Development Cooperation
RJKP	:	Rani Jamara Kularia Irrigation Project
BBDMP	:	Bheri Babai Diversion Multipurpose Project
CIP	:	Community Irrigation Project
WRPPF	:	Water Resources Project Preparatory Facility
BIP	:	Bagmati Irrigation Project
DIDW	:	Department of Irrigation and Drinking Water

DIHM	:	Department of Irrigation, Hydrology and Meteorology
KFAED	:	Kuwait Fund for Arab Economic Development
UNDP	:	United Nations Development Program
FAO	:	Food and Agriculture Organization
PMP	:	Pancheswor Multipurpose Project

1. Development of Irrigation

Historically, civilizations have been dependent on the development of irrigated agriculture to provide agrarian basis of the society and to enhance the security of the people. Archaeological investigations have identified evidences of irrigation in Mesopotamia and Egypt as far back to six millenniums BC. The irrigation in those days was introduced for growing barley and sesame oil seeds. In the "Zana" Valley of Andes Mountains in Peru, archaeologists found remains of three irrigation canals radio-carboned as far as 4 millennium BC. There are evidences in ancient Egyptian Pharaoh Amenemhet –III in the 12th dynasty (circa 1800 BC), the use of natural lake on the Fayum as a reservoir to store surpluses of water for the dry season irrigation, as the lake swelled due to annual flooding of the Nile. The Qanats developed in ancient Persia in about 800 BC, are among the oldest known irrigation systems, still prevailing. The system comprises a network of vertical wells and gently sloping tunnels driven into sides of cliffs and steep hills to tap groundwater. They are found in Asia, the Middle East and North Africa. The Noria-a system for water lifting, is a water wheel with clay pots around the rim powered by the flow of the stream or animal driven in case of still water resources. It is said that the technology was brought by the Roman settlers in North Africa in about 150 BC. Further, the pots were fitted with valves to allow smoother filling as they were forced into water (Shiristha , 2009)

The Indus Valley Civilization in Pakistan and North India also had an early canal irrigation system. Here, large scale agriculture was practiced and extensive network of canals were developed for the purpose of irrigation. In addition, reservoirs were also built for the storage at Girnar circa 3000 BC. The irrigation work of ancient Sri Lanka, the earliest dating circa 300 BC, in the reign of King Pandukabhaya and under continuous development for the next thousand years, were one of the most complex irrigation systems of the ancient world. Further the Sinhalese were the first to build the underground reservoir with the construction of underground canals. The system was restored and further extended in the reign of King Parakrama Bahu (1153-1186 AC). (Shiristha 2009)

Irrigation system was developed for the food security in Eastern Asia such as China and Korea. The Dujiangyan Irrigation System was built in 250 BC in the Szechwan region of China to irrigate a large area. This system is still in operation. The world's first water gauge (woo ryang gyae) was discovered in 1441 AC. The inventor was a Korean Engineer named Jang Young Sil of the Choson Dynasty under the direction of King, Sc. Jong. It was installed in irrigation tanks as a part of a nationwide system to measure and collect rainfall for agricultural applications. (Shiristha, 2009)

As of the 2018, situation of agriculture and irrigation in the world as a whole 1,224 million ha of land falls under rain-fed agriculture and only around300 million ha under irrigation. The world water use is estimated to be 4,500 billion cubic meters in 2018 and water requirement in future will increase to 6,430 billion cubic meters in 2030.Asia, the largest continent has 60% of the population of the world. About 70% of the world's irrigated area is in Asia and more than 80%of water withdrawals are used for irrigation. (ICID, 2018)

2. Historical Development of Irrigation Systems in Nepal

Irrigation development in Nepal originally was initiated either through the religious trust, individual initiative or community efforts. Though very little information regarding the development of irrigation in the past is available, study has indicated the existence of water management practices and water rights of the people in ancient days as well. Irrigation water served as both the spiritual and material foundations of Nepal's community civilization. The rich cultural tradition, arts, artifacts and architecture of Kathmandu valley are attributed for the network of irrigation systems supporting advanced and intensive agriculture activities. Spiritual mission, royalty and religious trust (known as Guthi) coupled with community initiative for irrigated agriculture was the main driving force in promoting local cooperative enterprises. The state encouraged the development of such trusts. These trusts allocated a portion of their income out of religious performance to assist irrigated agricultural activities on which livelihood of the trust's members was dependent. (Pradhan, 1988)

Importance of water resources has been recognized by Nepalese farmers and hence they have been constructing irrigation systems at their own initiative since long ago. It is rather fascinating to note that even in the ancient city planning, like that in the layout of Handigaun, the ancient capital of Nepal (Lichhavi Period), irrigated agriculture, as identified with the rural areas, was incorporated in the city landscape in the manner that the available land use was maximized by appropriate zoning of land for agricultural use, human settlement, Market place, water conservation ponds, pasture lands and religious sites.

Indigenous irrigation systems were developed in Nepal by using river water for agricultural purposes since the time immemorial. The need for construction of irrigation systems was mainly due to famine and hunger. Farmers used their own resources, skills and technologies to manage irrigation systems for agriculture at initial stage (DoI, 2009).

Historians divide the irrigation history of Nepal into three periods: Ancient Period (500 BC to 700 AD), the Medieval Period (750 AD to 1750AD), and the Modern Period (1750 AD onwards). These periods are briefly described below:

2.1 Ancient Period (500 BC to 750 AD)

Historical evidences show that there were disputes in irrigation water distribution with the development of irrigation systems. For example, there was dispute between Shakya and Kolya communities in the distribution of Rohini River water in Kapilvastu, and Gautam Buddha (500 - 600 BC) played a mediator role to settle the dispute. The traces of the irrigation infrastructure of that period have not been found so far (Poudel, 2003). However, after the development of brick manufacturing techniques in 5th century, the irrigation water control structures constructed in Lichhavi period (around 5th century) could be seen in Dhobi Khola and Tukucha in Kathmandu

Valley (Poudel, 2003). No government assistance was provided for the construction and maintenance of those irrigation systems constructed with compulsory labor contribution. The rulers or their officials built the irrigation systems in early days. Evidences show that irrigation development in Nepal is attached with taxation, land tenure and customary laws (Khanal, 2006).

2.2 Medieval Period (750AD to 1750AD)

In the beginning of first millennium, with the transfer of technology to construct irrigation systems from Kathmandu Valley to its surrounding areas, mainly rice cultivation started in the mid and high hills of Nepal. The value of cultivable and fertile agricultural land raised the jurisdiction of farmers' organizations. "To manage the irrigation system was within the work frame of farmers and community, and Government should not intervene into it" was announced by Ram Shah, King of Gorkha (Western Nepal) in 1674. Argheli canal, one of the Royal canals, lies in Palpa District of Western Nepal is still in operation. While evaluating the 18th century from irrigation point of view, it could be considered as the golden age for farmer, group and community built and managed irrigation Systems. Evidences show that rulers and their officials also supported in cash and kind to these Systems to some extent. Government motivated local communities to solve disputes themselves regarding irrigation water management.

The Royal canals (Raj Kulo) built by rulers in Malla Period (around 17th Century) in Kathmandu Valley are still in existence. In addition, multiuse of water from the one source had been a main theme in those days too. In developing Raj Kulos in Bhaktapur during the period of King Jitamitra Malla, irrigation canal (Raj Kulo) was constructed while diverting water from Mahadev Khola. This river was originated from Mahadev Danda, some 6 km far from Bhaktapur city. Further the same canal was the source for ponds and stone spouts (Dunge Dhara) in Bhaktapur. Kulo from Tika Bhairav in Lalitpur is another burning example for multi-use or followed the principle of Integrated Water Management. The tail end of the canal used to be at Lagankhel, Lalitpur. This canal had played great role in fulfilling the purposes of agriculture, domestic and holy cause. (Paudel 2010)

2.3 Modern Period (1750 AD- till date)

Before 1922, farmers developed, operated and maintained the irrigation systems called Farmers Managed Irrigation System. The modern irrigation system was started during the Rana regime in 1922. The Chandra Nahar was constructed in 1928 and the modern irrigation system started at that time. In 1943 Jagadishpur reservoir (Banganga) in Kapilbastu and Pardi dam in Pokhara were initiated. At that time foreign technicians helped to construct these irrigation systems. During Rana regime, there was no authorized central institution for the development of irrigation canals. The Chandra Nahar Division was entrusted for the irrigation development activities. The Canal Department was established in April 1952, under the Ministry of Construction and Communication (DOI, 2015).

Direct involvement of Government in construction and management of irrigation systems can be seen from the beginning of 20th century. It can be said that modern technology in irrigation system development started after the construction of Chandra Canal in Saptari District with the assistance of British India Government in 1922 (DoI, 2009). Jagadishpur Canal (1,000 ha) was constructed in 1942 in the Western Terai and later renamed as Banganga Irrigation System after being expanded in 1978. Judha Canal (2,000 ha) was built in 1946 in the Central Terai which became Manusmara Irrigation System after being expanded in 1979. Both of them were made by the then Public Works Department. (Paudel, 2010)

Historical Water Rights and Laws

"Water Right" in its connotation may be termed as "Right to Life". However the water right does not only entail right for consumption but also the right to use and discharge it. . It is said that Nepal was ruled by Gopal Vansh (Cowherds) and Aahir (buffaloherds) for about 500 years in the early stage. Actually no dynastic system in regards to water use is available. Though the dates of ruling by Karat, Lichhavi and Malla dynasties were confusing to some extent, they had established some forms of law for the use of water. Later on Prithvi Narayan Shah, Gorkha King unified the country and Shah Dynasty ruled the country for about 240 years. The provision of Mulki Ain (National Code), 1854 as mentioned in the chart, which could be regarded as the legal provisions being deeply rooted in the Nepalese society. The chronology of the water related laws in specific in Nepal are sketched as a Table below:

Table 1 : Chronology of water related laws in Nepal

SN	Ruling Dynasty	Duration/ Period	Prevailing Dharmashastra/ Law	Substantive Law	Concerned Authority	Jurisdiction	Remark
1	Kirat Dynasty	Before 464 AD	**"**Mundhum" (Chapter on "Khasem Kharon Theem" Rules for Administration of Justice)	No specific provision regarding water management found to date	Local Assemblies and Individuals	Water related conflicts as well as other issues	
2	Lichhavi Dynasty	464-782 AD	Manusmriti, Naradasmriti, Yangya Valka Smriti and other religious scriptures	As per customary practice and Dharmashastra	Panchali, Drang,Adhikaran Birtawala	Panchali was village level assembly of five adults like a trial court, all the cases within their jurisdiction. Drang was province level	

						or appeal level court • Adhikaran was central level court. • Birtawala had authority to hear local level water related cases within their Birta land area	Birtawalas were persons who receive land grant usually free from the state
3	Malla Dynasty	782-1768 AD	As above	Annual repair of canal by its users made mandatory and non-compliance was punishable. Everyone had right to use water irrespective of	• Pancha Samuchaya (Assembly of 5 local people) • Dwares (gateman) • Birtawala	• All village level disputes including water related. • All appointed	• In 1626 AD, Jitamitra Malla of Bhaktapur issued a royal order levy for the use of

				their caste on turn by turn basis.	(landlord) • Pundits (Priests)	by King, Princess or Ministers to hear petty cases including water related issues of their respective areas.	canal water. • Water related disputes not considered as important dispute of the society.
4 **a.**	Shah Dynasty Legal system before codification of law	Begins from the reign of Drabya Shah in Gorkha in 1559 to 1854 AD.	As above	• First come first service in drinking water & irrigation. • Petty cases relating to drinking water and irrigation was not heard by state agency or royal courts (Rules 6 & 8 of Ram Shah)	• Pancha • Dware • Thare • Mukhiya • Birtawala • Choudhary • Court of Bichari (Trial Court)		Jurisdiction of state agencies and the authorities overlap

b.	Legal system since the promulgation of codified law in 1854	1854 – 1963 AD	As above + National Code of 1854	• The person, who cut trees around drinking water taps was fined Rs. 5 (Rule 14) • Makers of the canal had first priority to use the water but traditional water sharing pattern was upheld. • Irrigation from top to bottom was recognized. • Canals were not allowed to be constructed upstream of			

				existing canals if that lessened water supply to the downstream canals.			
c.	Irrigation Act 1962 This Act replaced by Canal and Electricity & Related Water Resources Act 1968			• Focused on irrigation development for sustainability of food security all over the country • Coordination with agriculture • Better Institutional reforms • Enhance the system efficiency	• Department of Irrigation • District Panchayat • Village/Nagar Panchayat		
	Association Registration Act 2034			• Legal status for	• CDO office • Irrigation office		Ownership of water, water right, corporate character of

				WUA			WUA issues required to be defined
5	After Democracy Water Resource Act 1992 Water Resource Regulation 1993 Irrigation Regulation 2000	1990 – till date	As per National Code	• WR Regulation 1993 has prescribed District Water Resources Committee for registering WUA as a corporate and autonomous entity • Irrigation Regulation 2000 with 33% female members. This regulation has	• Department of Irrigation • District Water Resource Com. • CDO Office	• Court of Law • CDO Office	Confusion of appropriate procedure and place to accord legal personality to WUA

				made elaborate provision s regarding rights, responsibilities, dissolution procedure and record keeping etc.			

(Source: S.Khadka ,1996; M. Belbas, 2010; SN Upadhyay, 2010)

The Mulki Ain was amended so as to carry legal provision in concerning water use, construction and maintenance of canals, distribution of water and collection of water charges provide further legal with regards to canal construction in 1952 AD. The country enacted the Irrigation Act 1962 AD (2018 BS). The enactment of the Village Panchayat Act 2019 BS empowered the Village Panchayats in the field of irrigation, water supply and fisheries in 1964. Further, the enactment of Town Panchayat Act 2019 make sure that the corresponding year is Bikram Smbat or AD and District Panchayat Act 2019 in 1964 provided the legal provisions for management and utilization of Water Resources within their jurisdiction. Irrigation Act 2018 was again introduced in 1962 with the Canal Operation Regulation in 1974. The then Government adopted a new Irrigation Policy 2045 in 1988 which was further enacted by Irrigation Regulation 2045 so as to provide legal provision for the formation of water users' groups, water distribution and realization of water charges, etc. Further the country with the promulgation of the Constitution of the Kingdom of Nepal in 2047, the Constitution provided some leading role in Water Resources and their utilization

"Water Right" is termed in one way as the "Right to Life". Keeping in view of protection of the irrigation system as well as related laws and policy were activated, which may be broadly grouped as below:

1. **Consumption Related Policy/Law**
   - Domestic Needs: National Code 1963 (Muluki Ain).
   - Irrigation: National Code 1963 (Chapter of Land Cultivation "Jagga Abadh Garneko")
   - Irrigation Policy 2049 and currently revised 2070
   - Irrigation Regulation 2056 (Revised 2056)

2. **Discharge Related Laws**
   - Solid Waste Management and Resource Mobilization Act, 1987
   - National Code, 1963

3. **Protection Related Laws**
   - Decentralization Act, 1982
   - Decentralization (Working Arrangement) Rules, 1982
   - Soil Conservation and Watershed Management Act 1982 and its regulation
   - Environment Protection Act 1997
   - Environment Protection Regulation 1998
   - Climate Change Policy 2010

4. **Umbrella Laws**
   - Water Resources Act 1992
   - Water Resources Rules 1993

The Mulki Ain is the oldest codified law of Nepal. In 1950, there was a successful popular political movement against the Rana rulers and the social, political and economic situation of the country was changed but the same law remained in existence till 1963. Then the revision in the law was made on 1963 to address these changes. Under the Chapter "Jagga Aawad Garneko (Land Cultivation)", one can construct irrigation canal upstream of the existing one subject to the condition that the water will not be lessened to the existing canal. Similarly, irrigation canal could be constructed through anyone's private land, whether fallow or cultivated. No one should prohibit in constructing the canal. Further, it has recognized the traditional system of irrigation infrastructure. The Mulki Ain will be no more active onwards August 16, 2018 whereas Civil Court and Criminal Court of Nepal will work as the replacement of the Mulki Ain. Accordingly, Devani Samhita has been made under Sub-clause 296 (1) of Constitution of Nepal Act 34. In other words, Devani Samhita has been constituted under the Legislative Power of the State. The construction and sharing of water from the irrigation channel has been described in Clauses 288-296 under the Article 4 of Land Utilization and Registration.

The acquisition of land required for the construction of canal has been supported from the Land Compensation Act 2034 (1977) as the land required for public utility could be taken over while paying reasonable compensation.

Accordingly, the summary of Agency developed irrigation area during each of the periodic planning is as given below:

Table 2: Irrigation Infrastructure Development in each planning period

Project Period	Surface (Ha)	Groundwater (Ha)	FMIS (Ha)
Before commencement of Five Year Plan	6,228	--	381,814
First Five Year Plan (1957/58-1961/62) to Seventh Five Year Plan (1986/87-1990/91) and Interim Plan (1990/91 – 1991/92)	352,076	109,098	
Eighth Five Year Plan (1992/93-1996/97)	146,178	60,223	
Ninth Five Year Plan (1997/98 -2001/02)	110,465	36,238	300,935
Tenth Five Year Plan (2002/03-2006/07)	39,802	47,683	286,637
Three Year Interim Plan (2007/08-2009/10)	23,828	46,454	274,203
Three Year Plan (2010/11-2012/13)	55,863	59,860	265,374
Thirteenth Plan (2013/14-2015/16)	46,425	49,457	202,299
Fourteenth Plan (2016/17-2018/19) Progress of First Fiscal Year 2016/17	31,282	35,272	176,925

Total	**812,147**	**444,285**	

Source: DOI, Jawalakhel

The area of irrigation infrastructures developed through surface and groundwater are 812,147 ha and 444,285 ha respectively in addition 176,925 ha falls under the FMIS. Out of total reported development of 1,433,357 ha, 56.7% is Surface water, 31% Ground Water and 12.3% FMIS. Actual irrigated area is substantially less than the reported figure besides the year-round irrigation is estimated to be less than one-fourth.

Before the beginning of the Periodic Planning, only Tri-Chandra Canal in Saptari completed in 1928, Juddah Canal in Sarlahi and Jagadishpur Reservoir in Kapilvastu District both in 1946, were built by the Government. These systems were operated by the Government. So far the Bi-lateral Agreement is concerned, water from the Sarada Barrage, constructed across Mahakali River by the then British Government, up to 1,000 cusec during the summer could be made available for irrigating Nepalese part as per the Memorandum of Understanding of 1920. Again irrigation infrastructure could be built for irrigating Nepalese part with the use of water from Koshi as per the amendment made in 1966 for Koshi Agreement made in 1954 between the Nepalese Government and Government of India. Again, the agreement permits for the use of water from any tributaries of Koshi River for any purpose including irrigation purpose. These systems however, were the ones which were developed by the government. Leaving these apart, most of the systems in operation in Nepal were FMISs without any support from the Government. Department of Irrigation was established in 2009 BS (1952 AD) for the development of irrigation infrastructure in the country. Periodic Planning was initiated in the country with the view of overall infrastructure development. Accordingly, the development in irrigation sector also initiated so as to support food security for the increasing population in the country.

4.1 First Five Year Plan (1957/58 – 1961/62)

With the initiation of First Five Year Plan, initially development of smaller irrigation schemes was practiced. Projects like Tika Bhairav, Gokarna, Mahadev Khola, Jhanj, Sirsia- Dudhaura, Tilawe, Phewa Tal, Lower Vijaypur and other few smaller irrigation schemes were implemented. Tika Bhairav and Phewa Tal Irrigation Schemes were originally implemented during the Malla Dynasty in Lalitpur and Kaski Raja in Kaski districts respectively. Indian Co-operation Mission (ICM) and US Aid joined hands in the implementation. Food and Agriculture Organization (FAO) also provided Technical Assistance for some of the schemes.

The 1959 Gandak agreement between Nepal and India had the provision for irrigation development of 42,000 ha in Narayani Zone (Bara, Parsa and Rautahat) from Don Branch of the

Gandak Eastern Main Canal (India) and 16,000 in Nawalparasi District from the Gandak Western Main Canal (Indian) and the Separate Western Gandak Canal built for Nepal only.

4.2 Second Three Year Plan (1962/63 – 1964/65)

The Second Three Year Plan was more ambitious. In addition to the maintenance of smaller irrigation schemes, projects like Pashupati, Bosan, Kotkhu, Godavari, Dunduwa, Tinau, Hardinath, Manusmara were implemented. One of the major irrigation system initiated during the period is Khageri Irrigation Project, which was implemented with the technical and financial resources of Nepal Government. In addition, Chatara Irrigation Project (Sunsari Morang Irrigation Project) was also initiated under the assistance of ICM as a part of obligation under the Koshi Agreement of 1954. Foundation stone of Kamala Irrigation Project also was laid. Further, the then Government planned to develop medium irrigation schemes like Khageri in Central Region and Mohana and Khutia in the Far West Region.

4.3 Third Five Year Plan (1965/66 – 1969/70):

Department of Irrigation in this period started implementation of large projects like Chatara Irrigation Project to irrigate around 68,000 ha of Sunsari and Morang districts under Indian assistance. This was followed by construction of Eastern and Western Main Canals respectively in Parsa, Bara districts and Nawalparasi district, which were the part of the obligation to build irrigation infrastructures by the Government of India under the Agreement of Gandak Irrigation and Power Project concluded in 1959. Patharaiya Irrigation Project in Far West Region was also initiated during this period.

Ground-water Development Program in Nepal started in 1969 in the name of “Ground water Resources Investigation in Nepal Terai” with the grant assistance of Unites States Agency for International Development (USAID). The investigation was limited to Western Terai from Nawalparasi to Kanchanpur.

4.4 Fourth Five Year Plan (1970/71 – 1974/75)

This Plan got the major breakthrough in co-partnering with two multi-donor agencies the Asian Development Bank and the World Bank for financing Kankai Irrigation Project and Narayani Irrigation Projects respectively. Further development of hill irrigation schemes like Ramgha Tar, Hande Tar in Lamjung, Chapakot in Syanja and Chaurjahari Tar Irrigation Project in Rukum were also initiated. Again, the Department initiated for the first ever lift irrigation scheme in Battar of Nuwakot district. In addition, Mahakali Irrigation Project in Kanchanpur and Kamala Irrigation Project so as to irrigate 25,000 ha of Dhanusha and Siraha districts were also implemented. Mahakali and Kamala Irrigation Projects were implemented with the Nepal Government resources while giving priority for establishing the water rights. Initiation for the implementation of Western Koshi Canal and Koshi Pump Canal Projects with command area

respectively of 11,000 ha and 13,000 ha were initiated through GOI as an obligation part of Koshi Agreement. In addition, GOI agreed for the rehabilitation and extension of the Chandra Canal System with command area of 10,500 ha.

Agricultural Development Bank Nepal (ADB/N) was the first pioneer organization to develop Shallow Tubewells (STWs) in Nepal. The development of STWs started since 1970's with some subsidy.

4.5 Fifth Five Year Plan (1975/76 – 1979/80)

Some differences in this Plan have been observed as this plan has focused on implementation of the Command Area Development (CAD) so as to facilitate for management of water in the field.GON with the cooperation of multi-lateral development partners initiated the irrigating through development of groundwater too. In this respect, the Sunsari Morang, Kankai and Narayani were the exemplary Projects. In these Projects more focus was given in command area development. The Chatara Irrigation Project was handed over to Nepal in 1975 by the Indian Government in 1975. The system was renamed as the Sunsari Morang Irrigation Project and GON initiated the Stage-I development of around 12,000 ha of command area with the World Bank financial assistance initiated. Construction of second lift irrigation scheme so as to irrigate around 8,000 ha in Chitwan District was also started with the assistance of ADB. The Rasuwa-Nuwakot, Rapti, Sagarmatha and Mahakali Integrated Development Programs were also launched during this period with the cooperation of multi-lateral development partners.

The investigation and development of groundwater took place under Groundwater Resources Development Board (GWRDB) through Groundwater Resources Development Project (GWRDP). The feasibility study of Rupandehi District was carried out with loan assistance of the World Bank in 1976. On the basis of the study Bhairahawa Lumbini Ground Water Project (BLGWP) was launched. First phase of BLGWP with command area of 7,600 ha through groundwater in Rupandehi District with 60 deep tube-wells (DTW) also started during the period. Since 1975 GWRDP started the investigation in the whole of Nepal Terai.

Sagarmatha Integrated Development Program was launched under co-operation of ADB and European Economic Commission so as to irrigate 9,000 ha of land through 1800 shallow tube wells and 20 nos. of deep tube wells. Japan International Cooperation Agency (JICA) also joined in groundwater irrigation development in Mahottari, Dhanusha, Sarlahi, Rautahat, Bara and other few districts to irrigate around 30,000 ha of land through DTW and STW.

4.6 Sixth Five Year Plan (1980/81 – 1984/85)

With the confidence in the implementation of Kamala Irrigation Project, implementation of Bagmati Irrigation Project was initiated so as to irrigate 68,000 ha of Sarlahi, Rautahat and Bara with the GON resources. During the period, implementation of Sunsari Morang Irrigation

Project as well as Chandra Canal and Koshi West Irrigation systems also were set in implementation. Further, the command area development of Manusmara, West Gandak and Banganga Irrigation Projects were initiated so as to give required attention in water management and productivity of the crops to be grown.

Prospects of food deficit in general in hill areas was recognized by the then Government, so the priority for the implementation of irrigation systems in hill areas through Hill Irrigation Project was given. Accordingly, the irrigation schemes such as Rampurtar, Atrauliputar, Bijaypur, Hyangja, Pokhara Water Conservation etc. were initiated. The intensive development of command area would result generating productivity. Accordingly such works were initiated for Manusmara, West Gandak and Banganga Irrigation Projects under Command Area Development Project

To irrigate around 1,700 ha of land in Siraha, Saptari and Udaipur districts through DTW and STW was launched under Sagarmatha Integrated Rural Development Project (SIRDP). SIRDP was implemented with the assistance of ADB and Integrated Fund for Agriculture Development (IFAD). In addition, the irrigation with groundwater development was implemented in Kailali-Kanchanpur through STW and Mahottari as well as Kapilvastu through DTW. The provision of subsidy for STW lending programme was started by ADB/N in 1982/83 with the subsidy in drilling cost only which was up to a maximum of Rs. 3000 per tubewell. These tubewells were installed with the requirement of collateral. Government of Nepal made distinctive subsidy rate separately for individual and group-owned STW.

4.7 Seventh Five Year Plan (1985/86 -1989/90)

Intensive program in existing and future projects need to be provided so as to benefit large numbers of people and increased food production with effective irrigation. Accordingly, approach of intensive farmer's involvement would have been the key for success and failure of the irrigation systems. Thus, priority for completing the ongoing systems with its full utilization whether it is hill or Terai was considered to be the right approach. Mahakali Irrigation Project (MIP) I with World Bank (WB) (give full form) cooperation completed during the period and Phase II initiated so as to increase 6,800 ha in Kanchanpur. Similarly Phase II in Sunsari Morang Irrigation Project with the completion of Phase I was also initiated. Kankai Irrigation Project II 3000 ha also completed during the period. Development of irrigation infrastructure surface irrigation in Bagmati Irrigation Project continued whereas Koshi and Chandra Canal systems were almost completed. Saudi Fund Development joined in the development of Bagmati Irrigation Project. Completion of Marchawar Lift Irrigation System in Rupandehi the cooperation of UNCDF had been another break during the plan period. In addition, Phase II of BLGWP came into implementation so as to provide additional 4,400 ha of land in Rupandehi

with 31 DTWs. Further the development of tubewells in Mahottari, Kapilvastu and Kailali-Kanchanpur continued as usual.

Another milestone was added in this period so as to keep eye on medium scale irrigation schemes in the country. ADB as well as WB joined the hands in the implementation respectively in Eastern and Central Regions by the name Irrigation Sector Project (ISP) as well as Western, Mid Western and Far Western Regions by the name Irrigation Line of Credit (ILC).
Water management after the construction of irrigation infrastructure plays a major role in increasing the cropping intensity, diversification and management of cropping pattern for enhanced productivity. Accordingly Irrigation Management Project under the assistance of US Aid was launched so as to launch this program.
One of the major jobs completed during the period is the preparation of Irrigation Master Plan (IMP) and preparation of Irrigation Design Manual. The main purpose of the IMP was for the future planning and development of irrigation in Nepal.

Interim Plan (1990/91 – 1991/1992)

As the country entered into new era with democratic rule, these two years were almost without new plans in irrigation development. As a continued effort in the past plan periods, implementation of MIP, Phase II and BLGWP Phase III so as to irrigate 6,800 ha in Kanchanpur and 8,300 ha with the construction of 78 DTW systems in Rupandehi district. Department of Irrigation paved another milestone in this period with the initiation for Irrigation Management Transfer Project (IMTP) the construction of headworks in Babai river so as to provide assured water in Babai Irrigation System previously managed by the farmers.
Following the feasibility study of BLGWP, UNDP had provided grant for conducting shallow aquifer investigation of the terai in 1987 which was completed in 1992.

4.8 Eighth Five Year Plan (1992/93 – 1996/97)

The irrigation systems such as Bagmati, Babai, MIP II as well as sector projects were continued. Preparation for Second Phase of ILC and ISP were initiated naming Nepal Irrigation Sector Project (NISP) and Second Irrigation Sector Project (SISP) respectively. Command Area Development of Stage I of Phase III Sunsari Morang Irrigation Project commenced during the period. In addition, the rehabilitation Farmer managed Irrigation Scheme (FMIS) such as Rajapur Irrigation Project of around 12,000 ha in Kailali district was commenced. In the mean time, special program was launched in developing the main as well as distribution systems of Babai Irrigation Project completely with the GON fund. Further the due preparation for improvement another FMIS Praganna Irrigation System of around 5,600 ha in Dang through OPEC Fund was initiated.

The then Government of Nepal approved 20-year Agriculture Perspective Plan (APP) in 1995. The plan envisaged the use of vast available groundwater resources of the country for round the year irrigation system for increasing the productivity to meet the food security for the growing population in the country. Consumptive use of surface and groundwater irrigation has been the main focus with the involvement of the beneficiaries.

Community Shallow Tube-well Irrigation Project (CSTIP) started in FY 1994/95 under the loan assistance of International Fund for Agriculture Development (IFAD) in Eastern & Central Development Region. Ground Water Resources Development Project/DOI implemented this project in the then draught and flood affected five districts of Terai namely Sunsari, Saptari, Siraha, Sarlahi & Rautahat.

4.9 Ninth Five Year Plan (1997/98 – 2001/02):

The then Government withdrew the subsidy provided for chemical fertilizer and the shallow tube well. This decision definitely retarded the groundwater development in irrigation sector. A program named Community Groundwater Irrigation Sector Project (CGISP) was launched with the cooperation of ADB so as to provide irrigation Jhapa to Chitwan through STW. This is a special program to address the APP too. BLGWP Phase I- III completed during this period while enabling to provide irrigation facility through DTW in 20,000 ha of Rupandehi.

SISP was completed during the period whereas NISP continued. Rajapur Irrigation Project rehabilitation program completed during the period. Irrigation Development Plan (IDP) under the assistance of European Union (EU) was launched so as to provide irrigation for 3,500 ha in Banke, Surkhet, Bajhang, Dailekh etc.

Water Resources Strategy (2002-27) was prepared so as to develop water sector projects through Integrated Water Resources Management principle. The strategic planning is prepared with the aim to attain a higher level goal within a given timeframe through water resources of the country. With this preparation National Water Plan was initiated so as to implement strategy under this framework. As the irrigation sector requirement of water is around 70 percentage of the national requirement, this framework would play a vital role in the irrigation development.

4.10 Tenth Five Year Plan (2002/03 – 2006/07)

National Water Plan (NWP) preparation was completed and the document was approved by the then Government on 2005. NWP targeted for the irrigation sub-sector with the objective for attaining food security during the plan period. Accordingly, following targets were assumed:

- 49% of total area to be provided irrigation service with cropping intensity of minimum 160% by 2007

- 64% of total area to be provided irrigation service with cropping intensity of minimum 170% by 2017
- 67% of total area to be provided irrigation service with cropping intensity of minimum 193% by 2027.

The design of Sikta Irrigation Project was initiated under IDP so as to provide irrigation facility to 34,000 ha of Banke. Community Managed Irrigated Agriculture Sector Project (CMIASP) and IWRMP (Irrigation Water Resources Management Project) started with the completion of due procedure respectively with the cooperation of ADB and WB.

Further a program to address the APP was initiated immediately to complement the CGIASP. In addition, preparation also started to execute the program under Indian AID too.

Non Conventional Irrigation Technology Project (NITP) was launched during the period to irrigate the cultivable lands, which are not irrigated by the conventional or traditional method. Similar type of project by the name of Local Infrastructure Livelihood Improvement (LILI) program in eight remote districts of the country was also implemented under Swiss Development Cooperation (SDC).

4.11 Three Year (Eleventh) Plan (2007/08 – 2009/10)

The main thrust provided during the period is the implementation of Sikta Irrigation Project to irrigate 34,000 ha of land in Banke district. CMIASP and IWRMP also commenced during the period. It is a fact that food security needs to be addressed for poverty alleviation. As the thousands of mid level irrigation systems need to be implemented for improving the FMISs or dry lands available scattered in the country, a project by name Mid Irrigation Project (MIP) was launched by the Government. As usual MIP also handled area of 25 to 500 ha in hill and 200 to 2,000 ha in terai.

The water diversion from surplus basin to deficit basin would contribute irrigation facility in larger areas in the country. Accordingly, the study to divert water from the Bheri to Babai basin initiated so as to provide year round irrigation facility in 60,000 ha of Bardia district.

The food security in remote is equally important and looking after the migration from these areas Government initiated separate irrigation development programs by name Seti Mahakali Irrigation Development Program and Karnali Zone Irrigation Development Program.

4.12 Three Year (Twelfth) Plan (2010/11 –2012/13)

Besides the continuation of the on-going projects, improvement of Rani Jamara Kularia Irrigation System (RJK), one of the large FMIS, was initiated. Further additional 16,000 ha in Kailali district also would be irrigated totaling around 38,000 ha from RJK. A good momentum

was given to enhance Bheri Babai Diversion Multipurpose Project (BBDMP) as to provide round the year irrigation in 60,000 ha of Bardia district. BBMP would generate around 48 MW of electricity too.

To address the small irrigation systems, Government initiated Community Irrigation Project (CIP) under the grant assistance of ADB. CIP was implemented in 4 districts in Terai and 8 in hill and mountains to facilitate around 15,000 ha with irrigation. In addition, due procedure was initiated to implement Water Resources Project Preparatory Facility (WRPPF), CMIASP Additional Fund (CMIASP-AF), and IWRMP Additional Fund (IWRMP-AF).

4.13 Thirteenth Plan (2013/14 – 2015/16)

The implementation of CMIASP-AF and IWRMP-AF went on full swing in addition to RJK and BBDMP. In addition to ADB funding, Kuwait fund also became active for improvement of FMIS for medium sized irrigation schemes in Eastern and Central Regions. The needs of the smaller systems are equally important to address food security especially in remote areas. Accordingly, Small Irrigation Project (SIP) was launched under the assistance of SDC. Implementation of SIP would be carried in hill and mountain areas only.

As the irrigation is main input for the productivity and so as the poverty alleviation with dependable food security, irrigating round the year as well as all over the country is important. Accordingly, implementation of WRPPF was launched for updating the Irrigation Master Plan and study of irrigate of systems different from the traditional technology was initiated.

Detail study of Sunkoshi Marin Diversion Multipurpose was initiated. As Marin is a tributary of Bagmati river, the additional water from Sunkoshi to Bagmati river via Marin would assist round the year irrigation of Bagmati Irrigation Project (BIP). This would further assist to implement the Phase II that is, extending the total area to 120,000 ha.

4.14 Fourteenth Plan (2016/17 – 2018/19): First Year 2016/17

Construction of BBMP started with the contract execution for the tunnel with Tunnel Boring Machine, which is first time in Nepal. It is expected that 12 km long tunnel will completed within this plan period.

WRPPF under the grant assistance of ADB has initiated the updating of the Irrigation Master Plan as per the basin plan. In addition, innovative project studies such as solarized groundwater irrigation for 40,000 ha in Rautahat and Sarlahi districts, lift irrigation in Kali Gandaki, Marsyangdi and Daraudi corridor and Budhi Kulo Protection of Rajapur Irrigation Project options.

Initiation of Enhanced Terai Irrigation Development Program with the rehabilitation and construction of ponds, wells as well as shallow and deep tube-wells was taken up. Further plan

has been made for rehabilitation of few existing irrigation system. This program would facilitate to irrigate around 115,000 ha of 18 Terai and 4 inner Terai.

5. Institutional Development

Department of Irrigation (DOI) is mandated to plan, develop, maintain, operate and monitor different modes of environmentally sustainable and socially acceptable from small to larger surface irrigation systems as well as community to individual groundwater schemes.
Irrigation institution in Nepal has passed many Institutional changes in the past. In the past there was no separate central institution for looking after irrigation development. With the starting of democracy in Nepal in 1951 irrigation development got priority from the government.

i. Nahar (Canal) Division under Ministry of Construction and Communication was established in 1952 as a separate office to deal with the irrigation activities. It was headed by the Chief Engineer and was renamed 'Nahar Bibagh' (Canal Department). The Chandra Canal divisional chief Mr. Kartar Singh Garcha-an Indian National was assigned as the first Chief Engineer of the Department. After five years only in 1957 Mr. Medini Prasad Bhattarai- a Nepali Engineer was the second chief of the Department.
ii. In 1961 with the advent of Panchayati Raj Mr. Karna Dhoj Adhikary took over the Chief Engineer's post.
iii. In 1967 Department of Irrigation and Drinking Water (DIDW)was established under Ministry of Water and Electricity.In addition, in 1968 a Minor Irrigation Department was established under the Ministry of Agriculture. Engineer Mr. Nanda Kishore Agrawal was the Chief Engineer of the Department. It aimed at developing irrigated agriculture in close coordination with the Agriculture Department and the motto was the community participation in the development. The Department was merged with DIDW in 1971 as it could not achieve its targeted goals. Peoples Participation was the prime motive but high level of political intervention and corruption was the main cause of demise of the Department.
iv. For addressing decentralization and to develop irrigation in coordinated manner Department of Irrigation, Hydrology and Meteorology (DIHM) under Ministry of Food Agriculture and Irrigation was established in 1971. In 1972 Mr. K. D. Adhikary was promoted to Secretary of the Ministry and Mr. B. K. Pradhan took his position. The Water Supply and Sanitation Department was separated from DIHM. Four regional Directorates for Eastern, Central, Western and Far- western region were

also established. In 1981 one more directorate was added in Far-west region covering Seti and Mahakali Zone.

v. In 1980 the department was put under newly reformed Ministry of Water Resources.

vi. In 1987 the name Department of Irrigation (earlier Canal Department) was reestablished. Department of Hydrology and Meteorology was made a separate department, detaching it from DIHM.

vii. In 1988, District Irrigation Offices were formed in all the 75 districts instead of existing Division and Sub-division offices.

viii. Existing District Irrigation Offices were restructured into 26Division and20 Sub-division offices as well as 8 nos. of Irrigation Management Divisions in 2002. Further the River Training and Management Division was separated from the DOI.

ix. In 2008 a separate ministry, Ministry of Irrigation, to look after irrigation development was established and the Department of Irrigation was put under the ministry.

x. Institutional reforms have been made with the addition of Groundwater and Irrigation Management Directorates in addition to five Regional Irrigation Directorates in 2015. In addition, the existing divisions have been reformed with 57 nos. of Irrigation Development Divisions, 16 nos. of Irrigation Development Sub-divisions, 11 Groundwater Divisions, 13 nos. of Irrigation Management Divisions and 3 nos. of Mechanical Division offices.

xi. DoI is presently renamed as Department of Water Resources and Irrigation with the merger of DWIDM under newly merged Ministry of Energy, Water Resources and Irrigation.

6. Irrigation Infrastructure under Development Projects

Department of Irrigation as a lead agency to look after the overall development of irrigation in the country, efforts have been made so as to develop, maintain and operate the irrigation infrastructure so that productivity in agriculture sector would be enhanced for the food security from east to west as well as north to southern part of the country. In addition, feasibility study, research, training to the beneficiaries and technical personnel as well as mechanical equipment management for emergency use have also been induced at the present stage. Apart from the new irrigation projects under construction or the rehabilitation program, importance for operation and maintenance of the existing systems has been provided. Accordingly, following projects and the programs for the development of irrigation schemes are undertaken:

I. Irrigation Projects

- Sikta Irrigation Project
- Babai Irrigation Project
- Bagmati Irrigation Project
- Sunsari Morang Irrigation Project (Phase III)
- Mahakali Irrigation Project (Phase III)
- Praganna and Badkapath Irrigation Project
- Rani Jamara Kularia Irrigation Project (Including modernization of the system)
- Irrigation and Water Resources Management Project (IWRMP-AF)
- Community Managed Irrigated Agriculture Sector Project (CMIASP-AF)
- Medium Irrigation Project (MIP)
- Irrigation Systems Rehabilitation Project (KFAED)
- Bheri Babai Diversion Multipurpose Project
- Enhanced Terai Madhesh Irrigation Special Program
- Sunkoshi Marin Diversion Multipurpose Project

II. Projects under Operation as Program

- Groundwater Shallow and Deep Tubewell Irrigation Project
- Operation and Maintenance Project
- Irrigation Management Transfer of Big Agency Managed Irrigation Projects
- Irrigation Systems under Non Conventional Technology
- Daraundi Palungtar Irrigation (River Training) Project
- Karnali Zone Irrigation Development Program
- Seti Mahakali Irrigation Development Program

III. Study, Research and Other Programs

- Irrigation Feasibility Study and Quality Construction Program
- System Management and Training Program
- Irrigation Institution Development Project
- Mechanical Management Program
- Water Resources Project Preparation Facility (WRPPF)

7. Prospective Programs in Irrigation Development

Irrigation infrastructures development for the whole cultivable land in the country is not possible with the traditional mode of development such as run of the river and groundwater. Irrigating all the cultivable land with round the year irrigation facilities would be the preferred option for the food security in the country. Storage, Inter-basin Transfer, Conjunctive Use and

Non-conventional could be an instrumental for achieving the envisaged prospect. Following multipurpose projects have been envisaged for the future development. . Some of the projects are mutually exclusive.

i. Kankai Multipurpose Project

This project could irrigate around 67,000 ha in Jhapa district with the construction of an 85 m high dam across Kankai River in Chula-Chuli around 6 km upstream of East West Highway. In addition, there is a possibility of generation of 60 MW hydropower electricity.

ii. Koshi High Dam Multipurpose Project

The high dam of 270 m high across Koshi River in Baraha Chhetra area was proposed during the British reign in India primarily for the flood protection purposes. Around 20,000 ha of land would be submerged by the reservoir in Nepal with the potential of irrigating around 700,000 ha in Nepal and 2 million ha in India and power generation of 5,000 MW. In addition, it has been envisaged to develop river navigation canal facilities to connect Chatara of Koshi River to River Ganga in India. Eventually Nepal will have approach to the international waters. The Detailed Project Report is jointly prepared under the grant assistance of India. However, this project has no priority becaue of the submersion of a huge land, property and settlements in Nepal.

iii. Kamala Multipurpose Project

This is an alternately envisaged project of Sunkoshi Kamala Diversion Project with the construction of a high dam across Kamala River. This project would have the potential of irrigating around 96,000 ha in Dhanusha, Mahottari and Siraha districts with the production of 40 MW electricity. Economic and financial viability of this project is still a matter of question.

iv. Sunkoshi Kamala Diversion Project

Water from Sunkoshi River would be diverted to Kamala River through the construction of 16.6 km long tunnel. This could irrigate around 175,000 ha of land in Siraha, Mahottari, Dhanusha and would assist water scarce Bagmati Irrigation Project. Prefeasibility of this project was carried out in 1968-1972 by the Japanese Consultant Nippon Coei under the grant assistance of UNDP/FAO. Presently Detailed Project Report is under preparation through the grant assistance of the Government of India. At present the study has been halted due the dispute with the Consultants.

v. Sunkoshi Marin Diversion Project

This is also an alternate project of Sunkoshi Kamala Diversion Project. Water from Sunkoshi with the construction of 13 km long tunnel would be diverted through Marin Khola to Bagmati River. This would assist the extension of Bagmati Irrigation Project including the water demand in dry season and generate 38 MW of electricity. This project is under detail design level.

vi. Bagmati Multipurpose Project

The high dam of around 110 m was envisaged so as to irrigate 120,000 ha of land of Sarlahi, Mahottari, Rautahat and Bara districts, that is, Phase I & II of Bagmati Irrigation Project. Further the project has potentiality of 140 MW power productions. As the proposed dam inundate 12,000 ha of land including Marin Valley. This scheme is almost abandoned at the present stage.

vii. Sapta Gandaki Multipurpose Project

This consists of construction of 60 m high dam across Narayani River so as to irrigate around 40,000 ha of land in Chitwan district. This project further has a potential of generating 225 MW of electricity. This project has been almost abandoned as it would inundate the holy place like Dev Ghat too. The Feasibility Study was completed in 1981 under the grant assistance of Japanese Government.

viii. West Rapti Multipurpose Project

This project would assist for augmentation of water in dry season to Sikta Irrigation Project of around 36,000 ha in Banke district followed by water scarce area of around 40,000 in Dang and Kapilvastu districts. It has a potential of around 200 MW of power production.

ix. Bheri Babai Diversion Multipurpose Project

Water from Bheri River to Babai would be diverted with the construction of around 12 km long tunnel. Presently, the tunnel is under construction with the use of tunnel boring machine for the first time in Nepal. The additional water in Babai River would irrigate around 60,000 ha of land of Bardia district with the production of 48 MW of electricity.

x. Karnali Multipurpose Project

The feasibility study of this multipurpose project was completed under the World Bank assistance on 1990. It has a potential of irrigating around 200,000 ha of land in Nepal and 3.2 million ha of land in India. The power potential of this project is 10,800 MW.

xi. Pancheshwor Multipurpose Project

After a long period of study and negotiations a comprehensive agreement of the Project was signed between Nepal and India in 1996.This is an integrated multipurpose project consisting of Sharada Barrage, Tanakpur and Pancheshwor high dam. As per the agreement before the execution of 310 m Pancheshwor high dam project Nepal would receive additional 28.3 $m^3$of water from Tanakpur Barrage for irrigating Kanchanpur and Kailali districts of Nepal as well as 70 million KWH of free electricity. In addition, 10.0 m^3capacity canal for Chadani-Dodhara area is set to release from the Sharada Main Canal of India. The committed facilities are yet to be materialized. The Detailed Project Report of PMP of this Project is yet to be jointly finalized and the benefit sharing mechanism to be agreed.

xii. Innovative Irrigation Project (Conjunctive Use as well as Lift Scheme)

This project is under detail design stage with the principle of conjunctive so as to facilitate round the year irrigation of 40,000 ha of land in Rautahat and Sarlahi districts with the construction of 1000 no. of deep tube wells. Solarized yard would be used for the lifting of the groundwater. In addition around 1,440 ha land would be irrigated in Daraudi, Kali Gandaki and Marsyangdi corridor with lifting technology. This would be an example for further implementation in other area of the country.

xiii. Non Conventional Irrigation Technology Project

These technologies consist of drip, sprinkler, pond, rainwater harvesting etc. for irrigating the areas especially in mountain and hills of the country. These technologies would be used for the disadvantage, low income group and water scarce areas. Extensive implementation of these types of projects would bring the food security in the hills and mountains as well as stop large migration of people from these areas in search of food and job.

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CHAPTER III

HISTORIC PERSPECTIVE OF HYDROPOWER DEVELOPMENT IN NEPAL

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Acronyms

NEA	:	Nepal Electricity Authority
MW	:	Mega Watt
BOOT	:	Build, Operate, Own and Transfer
FDI	:	Foreign Direct Investment
NPC	:	National Planning Commission
SMEC	:	Snowy Mountain Engineering Corporation
PRoR	:	Runoff River Project
INPS	:	Integrated Nepalese Power System

1. History of Water mill:

The technology to take advantage of falling water and get useful mechanic energy is old. The history of hydropower started with the development of water mills over 2000 years ago. Earliest watermills were gristmills. Originally, grain was pounded and then milled by hand in a pestle and mortar, the invention of the millstone was important and animals were used to turn them. The only other energy source was water, and when this was harnessed the mill became a water mill. Wind was not exploited until several centuries later. The water mill required either a swift flowing current, or a head of water. The kinetic energy of flowing water and the potential energy of a head of water was converted into rotational energy by a water wheel. Rotational energy was used to grind the grain and soon other uses were found for this energy.

First water wheels were put in use by the ancient Greeks to grind grain. The earliest evidence of a water-driven wheel is probably the Perachora wheel (3rd century BC), in Greece. It was not until the Middle Ages that the technology was spread to Europe.
The invention of the horizontal-wheeled mill is believed to be in the Greek colony of Byzantium in the first half of 3rd century BC, and that of the vertical-wheeled mill to Ptolemaic Alexandria around 240 BC.

The waterwheel was found in China from 30 AD onwards. Water-powered millstone could have existed in Han China by the 1st century AD; there is no sufficient literary evidence for it until the 5th century. In 488 AD, the mathematician and engineer Zu Chongzhi had a watermill erected. The engineer Yang Su of the Sui Dynasty (581–618 AD) was said to operate hundreds of them by the beginning of the 6th century. By 610 or 670 AD, the water mill was introduced to Japan via Korean Peninsula. It also became known in Tibet by at least 641 AD. India received water-mills from the Roman Empire in the early 4th century AD.

Historic evidences of exact time period and the location of Water mills in Nepal, locally known as *Pani Ghattas*, is not known but they have been in use in mountainous regions of Nepal for centuries for grinding grains. By the early 20th century, availability of cheap electrical energy made the watermill obsolete in developed countries although, in developing country like Nepal, rural mills continued to operate and many of them were upgraded by replacing wooden parts with better-designed metal ones to increase efficiency and to couple it with mini hydropower generating units to generate low quality electricity and to illuminate isolated rural cluster of households. It is believed that there are some 25,000 *Pani Ghattas* operating in Nepal.

2. Water Resources and Hydro potential: *from GHATTA to BIJULI*

2.1 Basics of Hydropower scheme:

Flowing water contains energy. Water when allowed to drop or flow from a height, energy contained in it could be used to drive a motor (mechanical energy) and to rotate the rotor of a generator to generate electrical energy.

Typically a hydropower scheme would contain a barricade across the river to store or maintain the water level. Water is carried to topographically suitable location in a gently sloping power canal (or a headrace tunnel) and is allowed to fall through a height. The force of the high speed water drives the blades of a wheel or turbine, which in turn rotates an axle and coupled machinery. Thus, the potential energy contained in water at height is converted to kinetic energy. The core of generator coupled with the turbine rotation rotates in the magnetic field of the generator to generate electricity. Thus, the kinetic energy is converted to electrical energy. Water after releasing energy is safely drained through a tail race to the natural river waterway.

The most important event in the development of hydropower happened in 1831 when the first electric generator was invented by Michael Faraday. This laid the foundation for generating electricity with hydropower almost half a century later, in 1878.

Technological advances had moved the open water wheel into an enclosed turbine or water motor. In 1848 James B. Francis improved on these designs to create a turbine. The Francis reaction turbine is still in wide use today. In the 1870s, Lester Allan Pelton developed the high efficiency Pelton wheel impulse turbine, which utilized hydropower from the high head streams.
The first hydroelectric power plant, located in Appleton, Wisconsin, began to generate electricity in 1882. The power output was at about 12.5 kW. By 1890, the total number of hydroelectric power plant in the US alone had exceeded 200.

In the 19th century these power plants got an increased amount of commercial attention and were built rapidly all over the world.
During the first half of the 1900's hydropower became the world's most important source of electricity.

These days, Hydropower is considered as a matured technology and its contribution in global electricity generation is about 16%. Its share in total electricity generation will continue to grow in the future.

3. History of Hydropower development in Nepal

3.1 Hydro-Potential:

There is no doubt that Nepal has abundant water resources. Monsoon system brings in ample moisture laden clouds to Nepalese Himalayas and when it hits the high barricade causes to precipitate in various forms. It is estimated that the total annual water outflow from Nepal to Ganga Basin is 225 Billion cubic meters. This high water flow coupled with high gradient gives high hydropower potentiality.

In 1966, Dr. Hari Man Shrestha assessed the total hydropower potential in Nepal as 83,290 MW. He did so during the research work for his Ph.D. Thesis (1966) from Moscow Power Institute, USSR on—Cadastre of potential water power resources of less studied high mountainous regions, with special reference to Nepal. The finding seems to have been accepted as full and final to date. No credible study has been taken so far to re-evaluate or re-ascertain the findings of Dr. Shrestha by utilizing presently available advanced evaluating technology and the study approaches.

3.2 The first power Plant:

The first hydropower plant in Nepal did not come with indigenous technical evolvement. The first hydropower plant in Nepal came soon after the technology developed somewhere else.

The then Prime Minister Chandra Shamsher Rana while visiting Britain was impressed by the use of electricity decided to build power plant and initiated it. Colonel Kishore Narsingh Rana designed the 500 kW Pharping project. Waters from Sheshnarayan Basuki Kunda and from Satamul were to be brought to Sokhel Bhanjyang and dropped to Power house at Kutuli Faant. Project Engineer Mr Barnau Puwante, an Electrical Engineer was in charge of the Power house and Mr Linzale from General Electric Co. was responsible for Erection and installation of the power house equipments. A total of 950,000 Man-Days was used to complete the plant. A 10 Km transmission line from Pharping to Tundikhel was constructed. The equipments for the project were granted by the British Government. The cost of the project, excluding equipments was the then Indian Rs. 713,274.

The first hydropower generation plant the Pharping Hydropower Plant (named as Chandra Jyoti) was commissioned at 6:30 pm on Monday May 22, 1911 (BS 9 Jestha 1968) by lighting light bulbs by the King Prithvi Bir Bikram Shah in presence of the Prime Minister Chandra Shamsher Rana. The plant was used to light 2407 light bulbs which included 260 street lamps. Basically the purpose of the plant was to illuminate the residences of the Rulers of Nepal.

The plant has been in operation from 1911 to 1981; for 70 years. At that time since electricity was in surplus, spare parts for the plant became difficult to supply and since growing population of Lalitpur demanded water, the plant went out of operation. The plant was rehabilitated in 2006 with water sharing arrangement with drinking uses and to produce power during peak hours.

3.3 Hydro Electricity Development

Hydropower development after construction of Pharping went into dormant stage for about 25 years until the development of Sundarijal Hydropower Plant was initiated.

It was just for the sake of competition with the elder brother Prime Minister Chandra Shamsher Rana, the then Prime Minister Dev Shamsher Rana initiated 640 kW Sundarijal Hydropower Plant. The project was commissioned in 1936.

After commissioning of Sundarijal power plant, hydro electricity development in Nepal was, once again, stalled for decades. Untill 50s, hydroprojects were developed considering electricity requirement of the Ruler's families.

After the downfall of Rana Dynasty, democracy was established and the development of the country was addressed through periodic development plans. Development of Electricity sector was included as a priority agenda rigtht from the first Five year plan in 1956.

3.4 Development of Hydropower in the Periodic Development Plans

3.4.1 First Five-Year Plan (1956-1961)

In the first five-year plan period, electricity development was fourth in the priority list. It occupied a prominent place amongst the infrastructures. The main objective of this plan was to generate 20 MW of electricity, which included both diesel and hydroelectricity. Nepal signed agreements with the USSR and India to construct hydroelectric projects like Panauti and Trisuli respectively. For meeting the surplus demand, diesel plants were also set up to generate power.

3.4.2 Second Three-Year Plan (1962-1965)

The generation of electricity received high priority and planned with the objective of producing 30 MW electricity from hydropower and diesel plants. The plan gave more emphasis on the establishment of diesel plants for meeting the immediate needs of residential and industrial areas in Kathmandu, Birgunj, Hetauda and Biratnagar. The development of transmission lines in various places started from this periodic plan. In order to produce more power to meet the domestic and industrial needs and for effective management of the distribution of power, a separate organization called Electricity Corporation was established in 1964 as a government enterprise.

3.4.3 Third Five-Year Plan (1965-1970)

This plan had given high priority to hydroelectricity generation. The total budget allocated for electricity development in this period was NRs. 60 million. However, only 19 MW of electricity was generated during this plan period combining both hydroelectricity and diesel. This includes Trishuli (9 MW) and Phewa (1.088 MW) in Pokhara. Both of these projects were constructed

with the assistance of India. The transmission lines from Kahtmandu to Birgunj (66 kV) were fully completed and Dharan-Dhankuta, transmission line was under construction in this period.

3.4.4 Fourth-Five Year Plan (1970-1975)

The fourth plan had given more emphasis on transmission and network improvement, fixation of power tariffs, power purchase from India, setting up diesel plants to meet the demands of Bagmati and Narayani zones etc. Similarly, efforts were made to electrify at least one city in 12 zones out of 14 in the country. During the plan period, the total electricity generation from hydropower projects was 26.040 MW and from the diesel was 5.256 MW. Transmission line of 152.2 km length was also constructed during this period

3.4.5 Fifth Five Year Plan (1975-1980)

In the fifth plan, policies were formulated to fulfill the short term and long term demands within the country first and to export surplus power to India. A policy was adopted, whereby, the government would produce electricity and handover the operation and distribution of electricity to other entities making them capable in business activities.

Until late 1980s, hydro projects were built with excessive assistance of foreign donor countries. During 80s, donor agencies' policy shifted from infrastructure likes electricity to other sectors of development. Grant assistance and soft loans became scarce for electricity sector.

3.4.6 Sixth Five Year Plan (1980-1985)

The sixth plan had also given emphasis on hydropower development. There was power crisis in the first two years of the plan period. Private sector was encouraged to invest in power because the growth in population and economic activities had led to growing demand for power. Due to lack of sufficient funds and other constraints, it was understood that the supply side of electricity would not increase with government's sole efforts. On the third year of the plan period, the addition of Kulekhani I power project (60 MW) and the addition of Devighat project (14.1 MW) eased the power crisis to a large extent. However, only 60percent of the demand was met and the effect of energy crisis was badly felt.

Amid this, Jhimruk Khola project was started by Butwal Power Company in Pyuthan and other 24 small projects were also initiated in this plan period.

In addition to this, the Water and Energy Commission provided valuable assistance in research and standardization, determination of existing manpower, preparation of project profiles, study on the allocation of investment and other various aspects of project development. These activities were conducted with the help of Nepal and Canadian government

3.4.7 Seventh Five Year Plan (1985-1990)

The seventh plan period considered development of multipurpose projects along with electricity based transportation to substitute import of petroleum. The plan had encouraged

the private sector in the establishment and operation of micro hydropower plant, particularly in the rural areas. In the plan period, 720 km of transmission lines with a capacity of 132 kV was set up. Many projects faced financial difficulties as they relied on more than one source of bilateral or multilateral financing and most bilateral or multilateral financing were strategic and not commercial.

3.4.8 Eighth Five Year Plan (1992- 1997)

This was the first plan by the democratic government which was formed after restoration of democracy in 1990. The plan emphasized on development of hydropower. Considering the inadequate government funding for electricity development the government formulated a comprehensive set of policies for hydropower and energy development. Hydropower Development Policy 1992, Water Resources Act 1992, Electricity Act 1992 and Foreign Investment and One Window Policy 1992 were formulated to attract foreign as well as domestic investment from private sectors during this period.

The idea was to utilize indigenous skills and resources as well as foreign capital and technology which the earlier plans failed to do. Efforts were also made to diversify the use of electricity, control the leakage and ensure reliable supply of electricity. Tariff rates were also changed to make them more realistic. The NEA (Nepal Electricity Authority) was made responsible for making arrangements for the purchase of electricity from the private plants and transmission and distribution lines required for the purpose was set up.

Nepal and India signed an agreement on Mahakali River Integrated Development Project which paved the way for foreign investment in large hydropower projects such as Pancheswar.

There was also a power trade agreement with India following which Nepal imported more than 60 MW of electricity to reduce severe energy crisis.

In power generation, the 12.5 MW Jhimruk hydroelectricity project was completed and construction of 144 MW Kali Gandaki 'A' was started. By operating and strengthening of Trishuli-Devighat hydropower project, another 11 MW was added (NPC, 1992).

Despite these achievements, the biggest setback in the hydropower sector was the failure to initiate Arun III (402 MW) hydropower project due to environmental and political issues.

3.4.9 Hydropower Development Policy 1992 and electricity Act 1992

The major objectives of the Hydropower Development Policy 1992 was to supply electricity as per the demands in urban and rural areas and meet the energy needs required for industrial development in the country. The rationale of this policy was (a) to make alternative arrangement to meet the interim demand, (b) to meet demand of hilly and remote Himalayan regions which are deprived of electricity from national grid, and (c) to extend distribution

system in rural areas. The policy intended to limit private sector participation in hydropower projects to 100 MW and favored public sector for projects bigger than 100 MW.

The Hydropower Development Policy 1992 and Electricity Act 1992 were very progressive as they provided excellent incentives to develop hydropower in Nepal. The power developer could get generation license validity of 50 years, income tax holiday of 15 years, income tax (when applicable after 15 years) at the rate of 10% below prevailing corporate income tax, energy rate to allow 25% return on invested share capital, 1% customs duty only on imported goods for the project, exemption on import license and exemption on sales tax.

Two major projects with foreign investment (Khimti - 60 MW, Bhotekoshi - 36 MW) and few projects with local finance such as Indrawati Project were able to reap the benefits of this progressive policy. But this Act was formulated mainly for small hydropower projects and could not address various issues related to export oriented large hydropower projects.

An open and liberal policy formulated after restoration of the democracy in 1990 had started giving positive results in hydropower development. Foreign as well as domestic investors were attracted to the sector after enactment of Electricity Act 1992.

3.4.10 Ninth Five Year Plan (1997- 2002)

The plan enunciated a long term policy with a target of augmenting electric energy consumption from 1 percent to 3.5 percent in the next 20 years. The plan also laid emphasis on development of multipurpose projects like Koshi 4,700 MW, Karnali 10,800 MW and Mahakali 4,680 MW for domestic use as well as for export.

As Nepal adopted reforms in electricity sector and private sectors investment. Projects like Khimti, Bhotekoshi, Indrawati-4, Chilime were constructed with pure commercial investments.

The major policy thrust of the plan included institutional reforms to attract private sector in power generation and distribution, and various programs such as generation and supply of electricity, power transmission; system strengthening, feasibility study and design for rural electrification were carried out in this regard.

3.4.11 Hydropower Development Policy, 2001

New Hydropower Development Policy was developed in 2001 and also National Water Plan was developed and adopted. These plan and policy were prepared with the aim to develop hydropower sector in a sustainable way.

The Hydropower Development Policy 2001 was introduced to give continuity to the trend with following objectives:

- To generate electricity at low cost,
- To provide reliable and quality electricity at a reasonable price,
- To link electrification with the economic activities,
- To extend rural electrification, and

- To develop hydropower as an export commodity

In order to fulfill these objectives, for the first time, the planners came up with the concept of BOOT (Build, Operate, Own and Transfer) in developing infrastructure projects. The concept provides adequate incentives to the developers of big infrastructure projects and has successfully been implemented in other parts of the world.

The new policy proposed various new incentives and amended a few provisions of the earlier one. It proposed comprehensive hydropower generation license validity depending upon the type of project, a new rational royalty regime, and significant changes in tax and customs policy.

The policy also made institutional arrangements for the development of hydropower. The existing Electricity Tariff Fixation Commission was developed as a regulatory body whose main functions was to act as the regulator of the sector and responsibility would include regulating the transactions of electricity at every stage of transaction, fix electricity tariffs, monitor and supervise the safety of the electric system, prepare grid codes, and to protect the interest of consumers.

The government prepared new bills for the Electricity Act and the Nepal Electricity Regulatory Commission Act. But both the acts have been pending approval and the new policy could not be implemented due to the country's more than decade's political transformation

3.4.12 Tenth Five Year Plan Period (2002-2007)

The tenth plan laid emphasis on the construction of small, medium, large and reservoir type hydropower projects. The plan intended to promote integrated development of water resources involving private and public sector with emphasis on rural electrification and control of unauthorized leakage of electricity. Rural electrification has an important role to play in accelerating, agricultural growth and rural development. According to tenth five year plan, it required a huge investment to provide electricity services to the rural areas from the national grid system; therefore a decentralized renewable energy program was launched to benefit rural community.

By the end of the plan period, Nepal was generating 527.5 MW of electricity out of which 412.5 MW was generated from public sector, including the largest hydropower project; Kaligandaki A (144 MW), and 115 MW was produced by private sector. The Electricity Act, 1992 could not be amended to revise the royalty that the government received as per the Hydroelectricity Development Policy, 2001. Similarly, the private sector of Nepal was not able to invest such a large amount of capital in one project for a long period and Foreign Direct Investment (FDI) remained low.

3.4.13 Three Year Interim Plan (2007-2010)

During three year interim plan, the production target was 105 MW including private and public sector. The total contribution from the private sector was estimated to be 20 MW while

developing remaining 85 MW from public entities. The micro-hydro projects were also given special emphasis as its contribution was expected to be around 20 MW.

The failure to arrange investments in West-Seti project by Australian multinational, the Snowy Mountain Engineering Corporation (SMEC) was another setback for Nepal's hydropower development.

10,000 MW of Hydropower in 10 Years

An Action Plan formulated by an experts group was adopted by the Government in 2009 to execute 10,000 MW hydropower plant in next 10 years i.e. by 2020. The action plan identified the projects and the implementation plan for the execution of the projects. However, in coming days the Action Plan was taken as a political propaganda.

Three Year Plan (2010/11-2012/13)

The second three year plan had set a target of generating 282 MW of hydroelectricity to reduce power cuts to 12 hours. It has given special encouragement to not only public and private sectors but combination of both as Public-Private Partnership model. (NPC, 2010).

3.4.14 Thirteenth Plan (2013/14-2015/16)

The thirteenth plan laid emphasis on the development of reservoir type hydropower projects. Focus was put on reservoir protects. Construction of Tanahun (140 MW) reservoir project is proposed to be started. Other reservoir projects such as Budhigandaki (1200 MW), Nalgad (410 MW), West Seti (750 MW) were to be initiated, but none could be taken up as planned.

Although, Kulekhani-III (14 MW), Chamelia(30 MW), Trishuli 3A (60 MW) and Rahughat (32 MW) are to be completed by the public Sector, none could be completed. Trishuli 3B (40 MW) and U. Modi (42 MW) are proposed to be developed in PPP model. Private sector is proposed to complete a number of projects of a total capacity of about 1000 MW; which includes U. Tamakoshi (456 MW).

The country was struck by a powerful 7.8 magnitude mega-earthquake on 25 April 2015. The epicenter was about 80 km North West of the capital Kathmandu. The main shock and several aftershocks, notably 6.6 and 6.7 magnitude aftershocks within a period of two weeks, have impacted the progress of ongoing infrastructure projects including hydropower projects.

Mazaffarpur-Dhalkebar 400 kV Indo-Nepal cross border Power Transmission line Project was completed at the Thirteenth plan. This facility could not be used at its full capacity due to constrain in sub-station and transmission capacity.

However, two major export oriented large PRoR projects; namely U. Karnali (900 MW) and Arun-3 (900 MW) projects have been awarded under BOOT principles to Indian companies for development through a process of competition.

3.4.14 Fourteenth Plan (2016/17-2018/19)

During this period, long awaited public sector Chamelia (30 MW) was completed. In addition to this, private developers completed many sizable projects such as Upper Marsyangdi A (50 MW),

Madi A (25 MW), Hewa Khola A (14.9 MW), Madkyu (13 MW), Thapa Khola A (11.2 MW) and some other smaller projects.

With completion of Mazaffarpur-Dhalkebar 400 kV Transmission line Project and synchronizing the Nepalese power system (INPS) with Indian system, bulk electricity was possible to be injected to the INPS and as much as 50 % of the total demand of the system during peak demand could be imported and the load shedding during peak hours could be eliminated.

With the expectation that a large hydropower project; Upper Tamakoshi (456 MW) with daily peaking capacity would be completed by end of 2018, it is expected that the demand of the INPS system during wet months could be met from the hydropower plants in the country.

The plan expected that by the end of this plan (i.e., July 2019), the hydro installed capacity in the country is expected to be in the range of 2300 MW and many of them will have daily peaking capacity.

4. Analysis of development of Hydropower projects

In the history of one century of hydro electricity development in Nepal, a huge number of projects has been built; especially, after the Hydropower Development Policy in 1991. The list of projects that have been constructed is given in the Following Table:

Table 3: The list of constructed hydropower projects.

Hydropower projects constructed by the Government/Public sector			
Project	Capacity MW	Operation Year	Remarks
Pharping	0.5	1911	The first power plant of Nepal
Sundarijal	0.6	1934	Hydropower and Water supply project
Panauti	2.4	1965	Hydropower, Irrigation and Water supply project
Trishuli	21.0	1967	Refurbished to 24 MW in 1995
Phewa-Pokhara	1.0	1969	
Sunkoshi	10.1	1972	
Gandak	15.0	1979	Weir regulated by Bihar; generation tied with irrigation in India
Kulekhani-I	60.0	1982	The first Reservoir project with seasonal peaking
Devighat	14.1	1984	Refurbished to 15 MW from 14.1 MW in 2011
Seti (Pokhara)	1.5	1985	Hydropower and Irrigation Project
Kulekhani-II	32.0	1986	Cascade to Kulekhani-I
Marsyangdi	69.0	1989	
Chatara	3.2	1996	

Puwa	6.2	1999	
Modi Khola	14.8	2000	
Kali Gandaki A	144.0	2002	Largest Hydropower project, daily peaking capacity
Tatopani	2.0	2004	Not in operation; Mistri to bypass river flows
Madhya Marsyangdi	70.0	2008	Daily Peaking plant
Chamelia	30.0	2018	Daily Peaking plant
TOTAL	497.4		

Hydropower projects constructed by the Private sector		
Project	**Capacity MW**	**Year**
Andhi Khola	9.4	1991
Khimti -I	60.0	2000
Upper Bhotekoshi	45.0	2000
Tinau	1.0	1982
Tadi Khola (thaprek)	5.0	2002
Indrawati -III	7.5	2002
Jhimruk Khola	12.3	1994
Piluwa Khola	3.0	2003
Sunkoshi Small	2.6	2005
Chaku Khola	3.0	2005
Khudi Khola	4.0	2006
Thoppal Khola	1.7	2007
Mai Khola	4.5	2008
Chilime	22.1	2003
Ridi Khola	2.4	2009
Mardi Khola	4.8	2010
Hewa khola	4.5	2010
Bijayapur-1	4.5	2011

Siuri Khola	5.0	2011
Lower Modi -1	10.0	2011
Sipring Khola	10.0	2012
Middle Chaku Khola	1.8	2013
Charnawati Khola Hydroelectric Project	3.5	2013
Lower Chaku Khola	1.8	2013
Ankhu Khola - 1	7.0	2013
Radhi Small	4.4	2014
Bhairab Kund Khola	3.0	2014
Mailung Khola	5.0	2014
Upper Puwa-1	3.0	2015
Mai	22.0	2015
Jiri Khola SHP	2.4	2015
Upper Hugdi	5.0	2015
Baramchi Khola HPP	4.2	2015
Nau Gad Khola	8.5	2015
Chhyangdi Khola	2.0	2016
Mai Cascade	7.0	2016
Upper Mai Hydropower Project	12.0	2016
Daram Khola-A	2.5	2016
Jhyari Khola	2.0	2016
Upper Marsyangdi A	50.0	2016
Khani Khola	2.0	2016
Tungun - Thosne Khola	4.4	2016
Daraundi A	6.0	2016
Upper Madi	25.0	2017
Hewa Khola A	14.9	2017

Jogmai Khola	7.6	2017
Dwari Khola SHP	3.8	2017
Upper Mai -C	6.1	2017
Sabha Khola	3.3	2017
Phawa khola Hydropower Project	5.0	2017
Puwa Khola-1	4.0	2017
Thapa Khola	11.2	2017
Sardi Khola	4.0	2017
Chake Khola	2.8	2017
Midim Khola	3.0	2018
Chameliya Khola	30.0	2018
Molun Khola SHP	7.0	2018
Madkyu Khola	13.0	2018
Mai Cascade HPP	8.0	2018
14 Projects < 1MW	10.2	Various
TOTAL	**540.6**	

In less than three decades of the hydropower technology came into practice elsewhere, the first power plant of Nepal; Pharping hydropower Plant came into operation in May 1911. This can be considered as fast. But for next five and half decades, the development was insignificant. Until 1965 AD, installed capacity was not more than 1.1 MW. By 1980 AD, the installed capacity of hydropower plants reached only 50 MW. Till 80s the plants were constructed mainly with grant assistance of friendly countries. In 80s, electricity was gradually started to be considered more as commodity and grant assistance was not available. The plants were built basically on government funding and/or loan assistance with bilateral and multilateral funding assistance. With democracy restored in 1990 AD and new policy to develop hydropower in BOOT model in early 90s, hydropower plants were built with involvement of the domestic and international private sector. By 2000 AD, installed capacity of hydro plants had reached to about 400 MW. But, by 2000 AD, the country was in civil war/political instability and no infrastructure constructed activity was taking place. It was only after 2007/2008 AD, when country started to move towards political stability, private investment, basically from domestic investors, was

coming to hydropower plants. By 2017/18 AD the installed capacity was above 1000 MW. Installed capacity wise, contribution of private sector surpassed that of public sector.

5. Conclusion

Nepal has abundant hydropower resources; more than what it needs for internal consumption. Although the first hydropower plant came too early, the pace of development of hydropower in Nepal is not satisfactory. Since, the country lacks the availability of other conventional sources of energy/electricity, the development of the country, more specifically the development of the economic sectors where the country has the edge e.g. agri/herb-culture, tourism and replacement of petroleum products for household consumption and transport is not possible without generation of ample electricity. Hydropower is capital intensive and requires long gestation period requiring huge upfront investment.

The trend analysis shows that during recent time have seriously failed to meet the targets. The capacity of electricity power generation was not sufficient to meet even the internal demand. One of the major causes for the failure is that the government has neither been able to invest in development of hydropower potential nor been able to attract required amount of investments in this sector. The domestic private sectors have relatively low capital base to invest in large and storage-type reservoir projects. Foreign investors mainly from India and China have shown interest in hydropower development, but the lack of political stability, unsatisfactory “single window system” and ambiguities in foreign direct investment policy, red tape-ism, and unclear labor laws has hindered private investments in Nepal and foreign private sectors investors, although ready to invest in Nepal, remained on “wait and see” mode.

However, with country moving to political stability and the private investors are ready for the investment in the development of hydropower plants, adequate investment can be mobilized from the private sector. Already numerous hydropower projects has commitment for investment from domestic and international investors, projects totaling 3000MW installed capacity is at different stages of implementation, among which projects of some 2000 MW installed capacity is in active construction. By 2020, the country should be energy sufficient from hydro generation but capacity sufficiency might take some time as it will be possible only with construction of mega reservoir project.

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CHAPTER- IV
OTHER USES OF WATER

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Background:

Nepal is in the process of amending and formulating existing and new policy, legislation, strategy, plan and master plan on water resources based on evidence and scientific analysis among various uses and users. This was created in order to achieve optimum benefits from available water resources for domestic water-including sanitation and hygiene, irrigation, agriculture and animal husbandry, hydropower, industrial uses, recreation and tourism, inland navigation, aquaculture, religious, cultural and environmental uses etc. Existing three major uses --- irrigation, water supply sanitation and hydropower have been discussed in the previous three chapters.

Other remaining uses or users will be discussed in brief in this chapter. In addition, increasing challenges are to be confronted in maintaining water quality by controlling pollution of water bodies. This and water-induced disaster management issues will be briefly discussed below.

1. Industrial Use

There are no compiled and published articles containing authentic information on the industrial water use in Nepal. A feasibility study conducted by a Thai study team in 1993 on the Kotkhu Water Supply Project estimated that the industrial consumption (including commercial and institutional) for the urban valley of Kathmandu represented about 5 percent of the domestic demand. Although this data is of over two decades old, an estimate was made based on this to provide an indicative idea of aggregated water use in industrial, commercial and institutional sectors. The World Data Atlas states the annual quantity of water withdrawal for industrial uses as 40 million cubic meters per year (2000). This includes renewable water resources as well as a potential over-abstraction of renewable ground water or withdrawal of fossil ground water and potential use of desalinated water or treated wastewater. This quantity refers to self-supplied industries which are not connected to the public distribution network. The ratio between the net consumption and withdrawal is estimated at about 5 percent. This includes water for the cooling of thermo-electric plants, omitting hydroelectric plants.

Water abstraction is mainly carried out for four main industrial sectors: i) mining and quarrying, ii) manufacturing, iii) production of electricity, and iv) construction and other industrial activities. Developed countries have water use records in each of these sectors. Nepal is yet to create a new data base for the nation. In developed countries manufacturing and energy production together accounts for over 70 percent of total water use (majority of water is used for cooling purposes). Water use in these sectors is briefly described below.

I. Mining and quarrying: this industry use self-supply and quantitative records of use is seldom maintained.

i) Manufacturing: Self and other supply is the main water source in the manufacturing.

- Manufacturing food products
- Manufacturing textiles
- Manufacturing paper and paper products
- Manufacturing refined petroleum products, chemical and chemical products
- Manufacturing of basic metals, manufacturing of motor vehicles, tractors and other equipment.

ii) Production of electricity: Both thermal as well as hydroelectric plants use water for cooling purposes. Self-supply is the main source in these industries.

iii) Construction and other industrial activities: Self and other supply is the main water source for these industries.

On average industrial, commercial and institutional sectors use an estimated 1 percent of total water.

2. Inland Navigation

Historically, inland waterways were recognized as vital arteries for trade, transport and communication. In Nepal, this is a neglected sector and the government handles it carelessly. In recent years, India has developed an inland waterway terminal at Varanasi to connect it with the Indian Ocean at Haldia Seaport. Indian cargo vessels are running from Varanasi to Haldia where two major river systems of Nepal—the Kosi and Gandaki—meet. In addition, India has also extended the waterway further west along the Ganges. The operational existing waterway in this river from Allahabad to Haldia is 1620 km long. Nepal has to develop the connectivity with this existing and well-functioning navigational system. Nepal has a long-cherished dream to have unhindered access to the nearest Indian seaport, Haldia in Kolkotta, connecting its three large river systems Kosi, Gandaki and Karnali to the existing waterway in the Ganges River through the development of inland navigation and navigation terminals in the national territory. If this dream project of Nepal is realized it will be a great breakthrough in river navigation which possesses the potential for not only transforming the economic life of north India but also offers the possibility of freeing Nepal from the captivity of its land-locked geography.

Unfortunately, so far, Indian and Nepalese politicians wanted to brush it aside citing as an unfeasible proposition. The Inland Navigational Studies conducted in the Koshi and the Gandaki Rivers by the Indian consultants together with the Nepalese counterpart are not consistent with the development aspiration of Nepalese people. Benefit of this development will last for generations for both the countries.

Also, the Government of Nepal for many years had completely neglected the inland water transport sector. Earlier in late 1960s under the initiative of the King Mahendra inland

navigation section was established under the then Ministry of Transport and Communication and now it is almost defunct. In larger rivers private sector contractor are running the small boats and ferries for transport of goods, people and services across the rivers and along as well in few stretches. The Local Authorities are entitled to collect taxes from the Contractors. There is no government initiative to the development of river transport. Private sector is developing boating facilities for recreational uses in the public lakes and ponds.

Recent development in new connectivity between India and Nepal through inland waterways will be discussed below:

The following includes information extracted from the joint statement during the state visit of prime minister of Nepal to India on 6-8 April 2018.

1. The Prime Ministers of India and Nepal recognize the untapped potential of inland waterways to contribute towards the overall development of the region. Taking cognition of their geographies and noting the development of inland waterways in both countries, the two prime ministers took a landmark decision to develop inland waterways for the movement of cargo, within the framework of trade and transit arrangements, providing additional access to sea for Nepal. (April 7, 2018 - Ministry of External Affairs, Government of India Media Centre)

2. This new initiative will enable cost effective and efficient movement of cargo. The Prime Minister of Nepal noted the enormous impact this additional connectivity will have on the growth of business and economy of Nepal. To facilitate the movement of traffic in transit the two leaders directed their respective officials to formulate and mutually agree upon the requisite procedures and modalities for including inland waterways as additional means of transport in the protocol of the treaty of transit between India and Nepal.

3. India is developing its first modern inland water transport fairways on the Ganga river between Varanasi and the sea port of Haldia Kolkata with the assistance of World Bank. Nepal could establish connectivity with this Indian waterway.

The two sides discussed the benefits of incorporating waterway connectivity as part of the transit treaty between the two countries at the IGC (Intergovernmental Committee) meeting. Kathmandu Post 11-04-2018

This initiative should not remain within the political niceties only. Nepal's dream has to be materialized as early as possible.

3. Recreation and Tourism

Nature-based recreation and tourism highlights Nepal's biodiversity and natural features and is increasingly becoming a powerful economic sector. It has a substantial scope to grow much larger, but also has the potential to undermine its own foundation by insensitive development, pollution and overcrowding. The Water Resources Management Policies need to include and regulate ecotourism and recreational sectors/facilities in water bodies. If developed correctly this can be a tool to promote nature conservation. It should be integrated with social development through community-based natural resources management and the involvement of traditional life-ways.

The water-based recreation and tourism has become a growing industry. It relies mostly on publicly owned and managed rivers, lakes, ponds, parks and lands for many of the recreational activities. There is low sensitization and awareness creation on sustainable use of rivers and water bodies for tourism and recreational purposes.

Rafting Companies in Nepal offer the following services: mountain rafting, kayaking, canoeing, whitewater rafting adventure, paragliding, bungee jumping, hiking and other types of tours and travels. Whitewater Rafting Adventure is negotiating river rapids and obstacles in inflatable rubber boats. The rivers are graded from easy to near impossible according to their size and intensity of rapids and the difficulties that may affect rescue attempts. Following five rivers are basically allocated for this purpose: a) Sun Kosi, b) Kali Gandaki, c) Marsyangdi, d) Bhote Kosi and Trisuli. Other rivers like Karnali, Bheri, Mahakali etc. are not yet developed for the purpose.

4. Aquaculture Uses

The aquatic ecosystems of Nepal offer excellent habitats to more than 168 indigenous and of exotic species of high economic, environmental and academic significance. Among the total of 186 fish species, about 60 have been considered as cold-water fish. The most important indigenous cold-water fish species are Sahar (*Tor spp*), Katle (*Neolissocheilus hexagonolepis*) and snow Trout (*Schizothoraichthys spp* and *Schizothorax spp*). They are excellent from the economic and sport fishery point of view, but many other species are fished for subsistence. Cold water fisheries offer a great opportunity for self-employment and income generation among poor people living along rivers, lakes and other natural water bodies. Normally they are widely scattered and not organized. About 400,000 beneficiaries are engaged in this subsector. As the watersheds inhabited by important species are shared by a number of nations, a regional cooperative effort is necessary to share experiences and initiate collective actions to conserve and manage these shared aquatic resources (Swar).

The capture fisheries are widely scattered throughout Terai, mid-hill valleys, high hills and mountains of the country. They are not concentrated, and fishing is not organized, hence the fish production has been assessed as small scale industry.

Table 4. Estimated Fish Production from Water Bodies in Nepal (Capture Fisheries)

Water body	Surface Area (ha)	Production in metric tons	Remarks
Rivers	395,000	5,000	Kosi, Gandaki, Karnali and others
Lakes	5,000	1,000	Pokhara lakes, Rara & others
Reservoirs	1,500	500	Indrasarober & others
Irrigated paddy fields	398,000	6,000	Mostly in Terai and Inner Terai
Swamps/ditches	11,500	5,000	Fish cultured in about 1,000 ha.
Total	811,200	17,500	

Aquatic habitats and fish species can be viewed as prospects for fisheries and aquaculture activities in Nepal. Fishing is traditional in Nepal but modern aquaculture techniques for fish production started with the introduction of exotic carps in the early 1950s. To utilize fish resources about fourteen State-owned fish farms were established in different parts of the country during 1960-1965, where spawning and seed production technologies of carps were successfully developed in the warm southern region. At present, technology of commercial carp farming in ponds has been widely disseminated in the warmer part of southern Nepal. Over the years, pond aquaculture has developed as the most viable and popular aquaculture production system and accounted for over 90 percent of the total production. It is estimated that about 50,000 hector of fish ponds have been already developed in the rural areas. A major part of the pond fish production takes place in the Terai plain where more than 90 percent of fish ponds are located.

Carp and rainbow trout fish culture with supplementary cage feeding in lakes and reservoirs has substantially enhanced fish farming with the yield of about 6kg/m^3. At present about 50,000 metric tons of fish are produced from water bodies of Nepal.

Rainbow trout was bred for the first time in Nepal in 1990 and its culture was initiated experimentally in 1993. Present trout production is more than 10 metric tons annually from two government stations (Godavari and Trisuli) and about 10-15 tons from the private sector. Private sector was started in Kakani, Nuwakot in 1998 and is now rapidly expanding in other districts (Makawanpur, Parbat, Dolakha, Dhading, Sindhupalchowk etc.) as well.

5. Religious and Cultural Uses

Great milestones of human history took place by the banks of rivers and water bodies. The rivers in our Indian Sub-continent are wrapped in many myths, epic tales and religious significance. Religious texts mention that all sins are washed away by bathing in sacred rivers like Ganga, Yamuna, Narbada, Sarasvati, Sindhu, Kaveri and their tributaries in India. The sacred

Mansarover Lake at the western Tibetan plateau and adjoining Kailash Mountain is the origin of great rivers, Indus, Yamuna, Ganga and Brahmaputra. This area has been declared as the residence and play ground of Lord Shiva and goddess Parvati.

In Nepal Rivers and water bodies are precious lifelines with rich cultural heritage. Bagmati, Koshi, Gandaki and other rivers of Nepal are considered sacred. Holy places are usually located on the banks of these rivers. Sites of convergence, between land and rivers carry special significance and are especially sacred. Sacred rivers are thought to be a great equalizer. Funeral grounds are always located near the bank at the confluence point of two or more rivers.

In Hindu tradition, rivers with cultural and religious importance are revered. There are various festivals and functions marking the importance of rivers and water bodies and as a result various articles are dumped into the water bodies which have effects like, a) Organic effluents (discharges) and b) Inorganic wastes such as plastic and various chemicals. These are highly negative wastes and pollute the ecosystem for generations to come.

On the other hand, religion and culture tend to preserve the river. This aspect necessitates the use of better and more efficient sewage treatment plants, since the concern is not only environmental but also religious.

In recent decades, the Sacred Bagmati River and its tributaries in the Kathmandu Valley were extremely polluted beyond recognition and could be considered biologically 'dead rivers'. To rectify the situation the Government and Public Sector have initiated integrated activities. Every Saturday for last three years eminent and patriotic people of Kathmandu valley are cleaning the river banks and river beds and removing detrimental wastes. The Government of Nepal has developed a Bagmati Action Plan. The Plan is being implemented by the High-Powered Committee for Integrated Development of the Bagmati Civilization with support from the Asian Development. This Project has been laying sewerage pipelines the banks of rivers and an efficient sewerage Treatment Plant will be built at Sanepa on the other side of Chovar Hillock. For the storage of flood water, two small dams are to be constructed at Shivpuri hill in Dhap area.

In the Plan Rainwater Harvesting, structures are also to be built for the purpose of maintaining water security in the Kathmandu valley. This will provide safe water supply to 25,000 households and recharge the ground water of the area. Finally, the plan is to substantially improve the river bank environment.

Nepali people observe several religious and cultural events on the bank of major rivers. Some of them are Chatara of Koshi River, Devghat at Gandaki River, Kagbeni and Ridi at Kali Gandaki River (a tributary of Gandaki River) and so on. Hindus consider them holy rivers and places and visit such religious sites.

The Karnali River which originates from Rakchas (Devil) Lake nearby the Sacred Mansarover Lake in Tibetan highland has been degraded in a diminutive form in a religious sense merely due to its origin. After the River crosses Nepal’s border, it becomes Ghagra in India. Once it

meets Saryu again its name is perceived as a great sacred river at Ayodya the birth place of Lord Rama.

There are many sacred lakes and ponds scattered all over the Nepal.

6. Environmental Uses[2]

Human civilization was and is dependent on the rational use of water. Such civilizations were and are on the banks of the river, indicating the need for water right from the birth to the death, and to maintain and improve livelihoods. Human beings, like other living organisms, contain larger portions of water in their bodies. It is well understood that water, as a natural resource, is the most important element to maintain and sustain life and increase productivity of life and life-supporting systems such as ecosystems. In other words, water is used for several purposes, and has multi-fold impacts on human beings. In recent years, people engage in dialogue about environmental flow which is related to the release of water to maintain downstream life. Water diversion from one to another basin has further urged for promoting and ensuring environmental flow.

Nepal's Hydropower Development Policy (2001) has provisioned for releasing such quantum of water which is higher of either at least ten percent of the minimum monthly average discharge of the river/stream or the minimum required quantum as mentioned in the Environmental Impact Assessment (EIA) report. The Irrigation Policy (2014) urges to maintain minimum required water flow in rivers and rivulets while diverting or utilizing water for irrigation. Nepal does not have evidence-based data and information on the requirement of water for specific use of an organism or for life-supporting systems. It is difficult to know the quantum of water flow required to maintain downstream ecosystem functioning as science-based research in this area is 'low' to 'none'. The following questions arise; how much water is required to maintain life of a fish species in the river water which should be diverted to generate hydroelectricity or for irrigation purposes. In recent years, institutions having regulatory or research and academic functions and environmentalists have raised concerns on 'environmental flow' to ensure the biological functioning of the downstream areas.

The Brisbane Declaration (2007) mentions environmental flow as the quantity, quality and timing of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems. This flow is also considered as the flow that is left in, or released into, a river system with specific purpose of managing some aspects of its condition. It means, environmental flows are urgently required to make the riverine ecosystem 'healthy' and productive.

As per the policy provisions of Nepal, some of environmental assessment reports include indicative provision for environmental flow in order to maintain downstream ecosystem,

[2] Contributed by Batu Krishna Uprety, Former Joint Secretary (MoEST)

mostly in hydroelectricity generation projects. In most cases, 10 percent of the average monthly flow of river water is proposed without clearly knowing the requirement of recipient of water users – drinking for human beings and wildlife or livestock, or fish or other aquatic life. In other words, it is not clear where this quantum of water is sufficient to meet the objective of 'releasing' water. In many of the hydroelectricity generation projects, downstream release is not maintained as this policy provision is not implemented during the dry season.

Inter-relationship, inter-action and inter-dependence between biotic and abiotic factors is well understood, at least, among the professionals, and practitioners. Few studies have recently been started to document the state of compliance on 'environmental flow', to establish its need to maintain downstream life, and to propose the sustainable amount to meet the needs of the upstream and downstream users. This is a new area of research and study. More research on the water requirement of terrestrial and aquatic species of plants and animals will help in enhancing our understanding on the environmental uses of water.

References

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