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WORKING PAPER 41

Integrated Development and Management of Water Resources for Productive and Equitable Use in the Indrawati River Basin, Nepal



Madhusudan Bhattarai, Dhruba Pant, V. S. Mishra,
Hari Devkota, Shuku Pun, R. N. Kayastha and David Molden

Working Paper 41

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Acronyms

CDO	Chief District Officer
CPR	Common Property Resource
DDC	District Development Committee
DIO	District Irrigation Office
DOI	Department of Irrigation
DWRC	District Water Resources Committee
EIA	Environment Impact Assessment
ET	Evapotranspiration
HMG/N	His Majesty's Government of Nepal
ISP	Irrigation Sector Project
IUCN	World Conservation Union (formerly International Union for Conservation of Nature)
IWRM	Integrated Water Resource Management
MCM	Million Cubic Meters
MLD	Million Liters per Day
msl	mean sea level
MWSB	Melamchi Water Supply Board
MWSP	Melamchi Water Supply Project
NGO	Non Governmental Organization
NGOPP	NGO Participation Plan
NRs	Nepalese rupees
NWSC	Nepal Water Supply Corporation
PDR	Process Documentation Research
PHP	Public Hearing Program
PRA	Participatory Rural Appraisal
RAP	Resettlement Action Plan
RBDPM	River Basin Development Planning and Management
REDP	Rural Energy Development Program
SUP	Social Upliftment Program
UC	Users' Committee
UNDP	United Nations Development Program
VDC	Village Development Committee
WUA	Water Users' Association

Glossary

<i>ghatta:</i>	traditional water mill
<i>khola:</i>	river
<i>kulo:</i>	irrigation canal
<i>muhan:</i>	intake or source of water

Summary

Recently, the Government of Nepal launched a large-scale interbasin water transfer project, to divert water out of the Indrawati river basin (Melamchi river) to meet the drinking water needs of the capital Kathmandu city, located in the Bagmati river basin. The total cost of the water diversion project,¹ which is spread over 7 years, is US\$464 million. Recently, several case studies were conducted in the Indrawati river basin and one of its subbasins the Melamchi river, to assess potential local impacts of the bulk water transfer out of the basin, funded by the Ford Foundation/New Delhi. In view of concerns regarding the sustainability of the interbasin water transfer and its impacts on local water use, this study summarizes the preliminary assessment of the project impacts and the local water use in the basin. It also analyzes constraints and opportunities of managing the water resources, on the principle of Integrated Water Resources Management (IWRM). This involves an analysis of economic, financial, and productive uses of water resources, giving due consideration to social equity, environmental and ecosystem dimensions of the water use decisions, in relation to the water diversion project.

This paper has benefited by four detailed case studies² conducted in the Indrawati river basin by IWMI/Nepal and Water and Energy Commission Secretariat/Nepal (WECS/Nepal). It documents the major concerns in relation to Melamchi project on the Indrawati basin community, and illustrates the preliminary assessment of major project impacts in the basin. This paper particularly concentrates on, the likely impacts of the water diversion project on the economic and social fronts and local water use decisions, and also on the local environment. The major findings of the study in the Indrawati basin are summarized below.

A. Local Water Institutions

The existing water allocations across the sectors are mostly governed by customary water law, based on the informal traditions and need-based allocations. The local customary law provides priority to irrigation needs, because of the agricultural-based livelihoods of the communities. This is acceptable as long as the basin remains open with a low level of water use. However, as the development of other water uses increase, the demand for alternative water institutions and allocation practices would also increase. Minority water users, such as *ghatta* (traditional water mill), water mills, and micro-hydro owners, are already pressing for change in the existing informal arrangement. They want water allocations made more transparent and formal, which would protect their water rights during the water-scarce periods. The growing competition among various local users, and the need for bulk water transfer out of the basin, may provide enough incentives to all local stakeholders in the community, for institutionalization of appropriate and formal water-allocation mechanisms, for effective management of water resources in the basin.

¹ Details of the Melamchi project are provided in sections 3 and 4 of this paper.

²The four case studies conducted in the Indrawati basin were on the following topics: (1) Formal and Informal Water Institutions, (2) Water Accounting Status, (3) Social Exclusion and Inclusion and (4) Process Documentation Research (PDR) of the Melamchi Water Project. Details are provided in the reference.

There is a lack of coordination among various local institutional stakeholders, for managing the water resources in the basin. Some of the local-level formal stakeholders are the District Water Resources Committee (DWRC), the District Development Committee (DDC), the Village Development Committee (VDC), Non Governmental Organizations (NGOs), and other water user groups, and the Farmer Managed Irrigation Systems (FMIS). The statutory roles and functions of these local stakeholders on the allocation of water resources are not clearly defined in the National Water Resources Act (1993), resulting in conflicts among them. The National Water Resources Act (1993) has given the DWRC greater authority on decision making on water allocations. However, it is a virtually nonfunctional agency. Currently the DWRC is restructured with more representation from local water users and the DDC. Therefore, it could potentially also function as a coordination mechanism for intersectoral and interdistrict water allocation. It could also evolve as a rudimentary form of river basin (or subbasin) planning initiative in Nepal, without major changes in other administration and political institutions in the country.

The requirement of compulsory contributions of cash (and labor) to receive the services from new water use, has indirectly contributed to the exclusion of some of the poor households from using the services of new water projects, like micro-hydro and new irrigation systems. The service payment for the project can be adjusted from regular contributions, by providing a targeted subsidy from the DDC and the VDC, based on the need of the communities to set up the project without any additional burden. Thus, improved consultation of local stakeholders and the community-group decision-making process, would enable the marginal households to share the project benefits and water use activities.

The water rights (prior appropriation rights) of the first users are often encroached upon, without being compensated. This is particularly seen in the case of conflicts between the ghatta and the irrigation water users in the community. The water rights of the ghatta owners, who are usually marginal households in the community, are not as binding as the rights of others in the community.

B. Melamchi Project and Institutional Issues

The Melamchi Water Supply Project (MWSP) represents a situation prevalent worldwide, which is, meeting the increasing demand for drinking water and sanitation from cities, by diverting water from within and outside the local river basin areas, affecting the rural sector water uses. The existing water institutions in the Indrawati basin are mostly informal in nature, based on traditional or customary practices (customary law). They are not set up to deal with issues like formal water rights, river water reallocation, bulk intersectoral reallocation, and project-compensation-related negotiation with external agencies (the central government). However, these informal water institutions, may provide means to buffer the increasing stress brought about by the diversion of water out of the basin.

Bulk water transfer of this proportion out of the basin is likely to change some of the local water use practices, which may create some stress not only on traditionally practiced institutional mechanisms for water allocation but also on conflict resolution. Such water stress would be more pronounced immediately downstream of the project intake site, during the dry season

from January to May, when the river flow would only be about 10 percent of its peak flow level during the monsoon season. The question then is whether these existing community-level arrangements, can cope with the institutional crises brought about by external shocks. One of the major problems for effective use of water resources available in the basin, is the seasonal fluctuation of river flow.

The central-level government authorities that handled the formulation at the project planning stage of the MWSP, did not consult much with the local water institutions. However, consultation with local stakeholders, including the local institutional stakeholders, has been increased during the project implementation stage. As a result, several community level stakeholder consultation meetings were held recently, with the participation of local and national-level NGOs, representatives from international NGOs like IUCN, and from the UNDP functioning in the nearby areas.

C. Major Policy Implications

Planning such a bulk water transfer project requires building up local confidence, in order to avoid public skepticism of the project. In this respect, it would be helpful to hold local-level consultations and due sharing of project information with the local communities. Local-level consultations, even during the implementation stage, would greatly enhance their support for the project and ensure the success of the project on the long term.

There is a need to have detailed information of the river flow of the Melamchi river and its tributaries surrounding the proposed intake site publicly available. This is important, particularly for documenting the dry-season flow in the river when it is reduced substantially. The detailed water balance study in Melamchi could also help; a) to dispel the water-flow-related skepticism associated with the Melamchi project, and b) timely restructuring of the project compensation package if needed. Although, informal institutions are now capable of implementing water allocations for the present water uses in the basin, appropriate formal institutional mechanism of water allocation should evolve to manage the external stress caused by bulk water transfer out of the basin. These developments and dynamics of institutional evolution should nevertheless, be closely monitored.

The establishment of formal water rights for the existing water users in the basin community, even by provision to registration at VDC or at DDC, is necessary. It would help to a large extent to protect the minority water use rights, while implementing a new water project or reallocation of water to the community. This would also reduce the transaction costs involved in evolving a project compensation package and resettlement programs etc. This in turn would reduce the huge transaction cost involved in the compensation-negotiation process and encourage local as well as external community to invest in new water projects in the basin, like water mills, micro-hydro projects, etc. But, the process of setting up water rights at farmers and community level needs further investigation.

It is important, to have a proper assessment of the economic and societal benefits (costs) of water transferred out of the Melamchi subbasin to Kathmandu, including the social and environmental costs (benefits), attached to such an interbasin water transfer scheme. This

information will be useful for designing effective compensation packages and project benefit sharing mechanisms. This information will be useful not only for the Melamchi project, but also for future water infrastructure projects in Nepal, in particular for the estimation and quantification of the net social gain (attachment with cost) of such bulk water-transfer projects.

1. Introduction

This paper on the Melamchi water transfer project which is being carried out in the Indrawati river basin,³ is a summary and synthesis of four detailed case studies conducted earlier, in relation to the project. The case studies were conducted in Nepal by the IWMI and Water and Energy Commission Secretariat (WECS)/Nepal team, funded by the Ford Foundation/India. They are on the following topics:

- i. “Formal and informal water institutions (Pant and Bhattarai 2000),”
- ii. “Water accounting and water balance in the basin (Mishra 2000)”
- iii. “Process documentation research (Devkota and Bhattarai 2001)” and
- iv. “Exclusion and inclusion processes (Pun 2000)”.

The Indrawati river basin has recently been earmarked for several new water development projects, including the inter-basin Melamchi water diversion project which proposes to divert 1.97 m³/sec of water out of the basin, to meet the growing urban drinking water needs of the Kathmandu city. The project has provision to triple the original level of water transfer to Kathmandu as the city’s water demand rises. Details of the Melamchi water diversion project are given in section 4 of this paper. This scale of water diversion out of the basin may produce a wide range of external shocks to the locally managed water institutions, to social equity and to the water-related environment in the basin. In this context, this paper documents the existing institutions and water management practices, water use activities and water management in the river basin to promote appropriate planning steps and institutional arrangement for Integrated Water Resources Management (IWRM) at the basin level. This paper also assesses the anticipated impacts at local-level caused by the Melamchi interbasin water-transfer project, and how the present water institutions in the area can cope with the external shocks brought about by these large-scale water diversion projects. Indrawati river basin in Nepal is taken here as an example to illustrate key issues and concerns in initiating the IWRM approach in Nepal. This involves analyzing the anticipated impacts on the economic front, on social equity, on resources use, and on the freshwater ecosystem and other environmental fronts.

With growing population and improvements in living standards, the demand for water has been increasing rapidly over the past few decades. In many cases, this has led to increased conflicts between water user groups and also among various sectors, such as irrigated agriculture, urban water needs, tourism, and other new water-development projects. The need for an integrated approach to water resources management becomes more urgent with growing competition for water among these sectors. IWRM was recently recognized at the global policy level discussions as a necessary policy framework for efficient and equitable use of water resources. But in Nepal, there is little practical experience and knowledge on how to operationalize such an integrated approach to water-resources management. This paper and the policy research oriented case studies in the Indrawati basin, provide insights into developing future policy strategies for integrated development and management of water resources in Nepal.

³Details of these case studies are provided in recent IWMI/Nepal and WECS publications, as listed in the reference section.

The Indrawati basin is predominantly an agriculture-based system. Its upper basin, supplies water to more than 120 Farmer Managed Irrigation Schemes (FMIS), comprising about 2,100 hectares of agricultural land. Recently, the basin was selected for more complex and varied water uses, including hydropower plants and the Melamchi inter-basin water transfer scheme to provide water to Kathmandu (details on the Melamchi project are given in section 4). Moreover the demand for water in the river basin has been increasing, as a result of development of additional water-use activities, like water mills and ghatta; and the need for bringing more land under irrigation to sustain the food demand of the growing population. This increased pressure on scarce water resources, from inside as well as from outside the basin, calls for an integrated approach to water resources management, to enhance productive, social, equitable, and environmentally sustainable uses of the water resources.

This paper provides a preliminary assessment of the water use activities in the basin, to facilitate a more comprehensive and in-depth policy research in the future, i.e., in the second phase of the study in the river basin by WECS and IWMI. In this phase, issues considered will be: water resources development and management systems, economics of water transfer decision, development of basin-level institutions in Nepal; and detailed social and environmental costs associated with the water diversion scheme.

There are several variations operationalizing the IWRM concepts and the scale of hydraulic units to be considered that vary, based on the specific characteristics of the region. Within the IWRM concept, this project study explores the possibility and likely constraints on applying the river-basin management concept, to the existing water resources activities in the Indrawati river basin. Indrawati, a river basin where IWMI has been working since mid-1980s, has been selected by IWMI in Nepal for the long-term monitoring of changes in water-use activities, and sustainability of the river-basin systems.

Research Objectives

In the context of increasing scarcity and competition for water uses across the sectors, the overall objective of the study was to assess alternative means for increasing productivity of water, through better management of multiple water uses in the Indrawati river basin. This would enhance resources use efficiency; and social equity, eradicate poverty; and conserve the overall environment in the basin. Within this framework, the specific objectives of the case studies carried out in the basin were to:

1. Increase understanding and awareness of the existing formal and informal arrangements for managing water, and their many uses and identify stakeholders of water within the river basins.
2. Make preliminary assessment of proposed and committed development initiatives, in terms of likely benefits derived from the water resources, and an understanding of the potential impacts on present stakeholders.
3. Provide key information and recommendations for developing IWRM and management strategies that combine the objectives of resources use, productivity, equity, and conservation of natural resources.

Research Hypotheses and Framework of Case Study

It is expected that proper application of IWRM will enhance productive water use, equity and conservation of the local environment. The hypotheses and research questions of this study relate to four major issues in water resources. They are:

- Need for integration of different water use sectors,
- Recognition of existing formal and informal arrangements of water resources management,
- Involvement of stakeholders at all levels and
- Social equity issues involved in water use decisions.

Need for Integration

A major weakness in the water resource planning in Nepal, has been the lack of integration of various departments/agencies associated with a specific sector. Sectoral plans developed in isolation tend to ignore their inter-linkages as well as upstream and downstream effects of water uses. It is expected that ongoing as well as the new development projects in the basin (such as, the Melamchi water scheme, and three hydropower plants) will further increase competition for water, which will have a direct impact on the existing water use patterns in the basin. Knowledge of the existing water use patterns is important; to avoid or mitigate adverse impacts of increased competition for water. The discussions in this paper are within this context of better management of various local uses of water resources in the river basin.

Existing Formal and Informal Water Institutions

The Indrawati basin has a long history in farmer-managed irrigation schemes (FMIS). Over the years, dependable means of cooperation and water-sharing mechanisms have evolved by trial and error. New systems for developing and managing water resources must be based, on an understanding of the existing formal and informal arrangements. The new systems developed could otherwise be both ineffective and detrimental, to the interests of the present users.

Involvement of Stakeholders

Water development plans formulated at central level, often disregard the local water use patterns and informal institutional arrangements already in place. The local community is usually informed about the new development project plans, only after the major decisions have been taken at the central level. Whereas, it is the local population who directly benefit or bear the negative impacts; of new developments. Our research hypothesis is that within the local community, office bearers and community leaders are relatively well informed concerning development efforts, and consequently they have more opportunities to influence plans and benefit from them, than the majority of the basin population. Typically, poorer and more vulnerable groups have less access to this kind of information. Mechanisms to involve stakeholders at all levels, are an essential element in water resources development to enhance the social equity and better representation of local stakeholders in the resources use decisions.

Social Equity Issues

Not all people benefit equally from development efforts, especially the poorer and less-visible groups in society get excluded and are left out of the process. At the same time, it is likely that in an environment of growing competition and water scarcity, the poor and the marginal groups will lose more than others will. Well-organized sectors are likely to have better opportunities to claim water than the traditional farming sector. Insights on the “inclusion” and “exclusion” processes in water development would help avoid potential negative impacts of increased competition for water, on the already vulnerable groups. Such in-depth analyses would provide information, for designing appropriate benefit-sharing mechanisms among the stakeholders.

Research Questions for Case Studies

Considering the four key issues discussed earlier in the section on research hypotheses and objectives, the following research questions were formulated to carry out the detailed case studies in the Indrawati river basin. They are:

1. Who are the existing water users?
Are their patterns of water use differentiated by sector, public and private uses, gender, and income level?
Who is left out?
2. What is the degree of scarcity and competition for water resources among different users?
3. What are the formal and informal arrangements for managing water for different uses within the basin? What are the water rights arrangements and means for conflict resolution in the basin?
4. What are the possible impacts of proposed future developments on water use patterns and the degree of water scarcity? What sectors and/or water use groups in the basin will be affected? How do different user groups respond to this? Is there a difference in response between classes and gender?
5. What processes may lead to the “inclusion” or “exclusion” of different stakeholders with regard to recent and proposed development initiatives?
6. How can interests of disadvantaged groups be better protected and served?

River Basin Management in Nepal

This paper is a synthesis on the major findings from four separate case studies, in the Indrawati river basin. It also summarizes key policy and strategic issues, that should be addressed in relation to application of the IWRM framework, not only in the Indrawati river basin but also in general. This involves summarizing and putting together key recent worldwide literature on IWRM and Integrated River Basin Planning Management and Development (RBPMD), that are most pertinent to the issues in Nepal. In fact, RBPMD is the organizational function of IWRM, and the key element in operationalization of the IWRM principle. Considering the present water allocation problems in Nepal, the literature was synthesized in the framework of the country’s river basin management, its desirability and potential limitations prevailing in Nepal.

Research Methodology

The field study in Nepal adopted an exploratory case study approach, which could eventually lead to further research. Unavailability of detailed field-level data on water uses among various sectors, and the informal functioning of the local-level water institutions, compel us to adopt such explorative research methods. This is the first phase of a study to compile large sets of information on the river basins, to facilitate another in-depth study covering topics on water institutions, environmental and economic impacts of the water development projects, in the second stage of the project. Therefore, the scope of study and discussions in this paper have to be judged considering these limitations.

Study Activities

The detailed field study on the Indrawati river basin involved the following major exploratory activities:

1. Initial assessment of the present resources in the basin.
2. Assessment of water use patterns, the degree of water scarcity and competition.
3. Preparing an inventory of formal and informal water user organizations and their legal status regarding water rights. Assessment of arrangements and institutions related to water resources management and conflict resolution.
4. Making an inventory of new water development projects and assessment of possible impacts on present water use patterns. Gain insight on the inclusion and exclusion processes of the proposed and ongoing development efforts.
5. Assessments of existing water use and water balance, and carrying out a water accounting process in the basin.
6. Collection of the secondary level information available in Nepal on the Indrawati river basin.

These activities partially overlapped in time and scope. WECS and IWMI research teams jointly carried out the field studies and report preparation tasks. The information collected and compiled during the first phase of the project study will be very useful for any further study and strategic thinking on the river-basin planning exercises in Nepal.

Outline of the Study

This study provides answers to the specific objectives and research questions raised in the earlier sections. This paper has been designed such that each of the following sections provides answers to several related questions and the specific objectives stated earlier. Each section is based on the broad-level related issues of the case study, and avoids duplication of explanation. Hence, each section may provide answers to more than one question raised in the earlier section.

Section 2 of the paper describes the characteristics of the Indrawati river basin, which include physical, hydrological and socioeconomic factors, and water use activities. This section pro-

vides the broad-level overview of the Indrawati river basin, and its subbasin the Melamchi river, where the water diversion project work is going on.

Section 3 provides the water accounting results conducted at a major confluence of the Indrawati river basin. This section also provides answers to questions on the water availability and constraints in the basin. Further, it provides information on the present level of use and future development potentials of the water infrastructure.

Section 4 describes the Melamchi Water Supply Project (MWSP), an interbasin water transfer project designed to divert 1.97 m³/sec of water out of the Melamchi river to the Kathmandu city to meet the city's growing drinking water needs.

Section 5 of the study explains water institutions, both formal and informal, affecting the water allocation mechanisms of different sectors in the river basin.

Section 6 describes the water rights allocations and conflict-resolution mechanisms practiced in the communities, and the need to adjust some of these institutions and practices to suit the growing water uses, and the reallocation of the resources to productive uses. This section also provides information on existing water-related conflicts in the basin and the potential of cooperation.

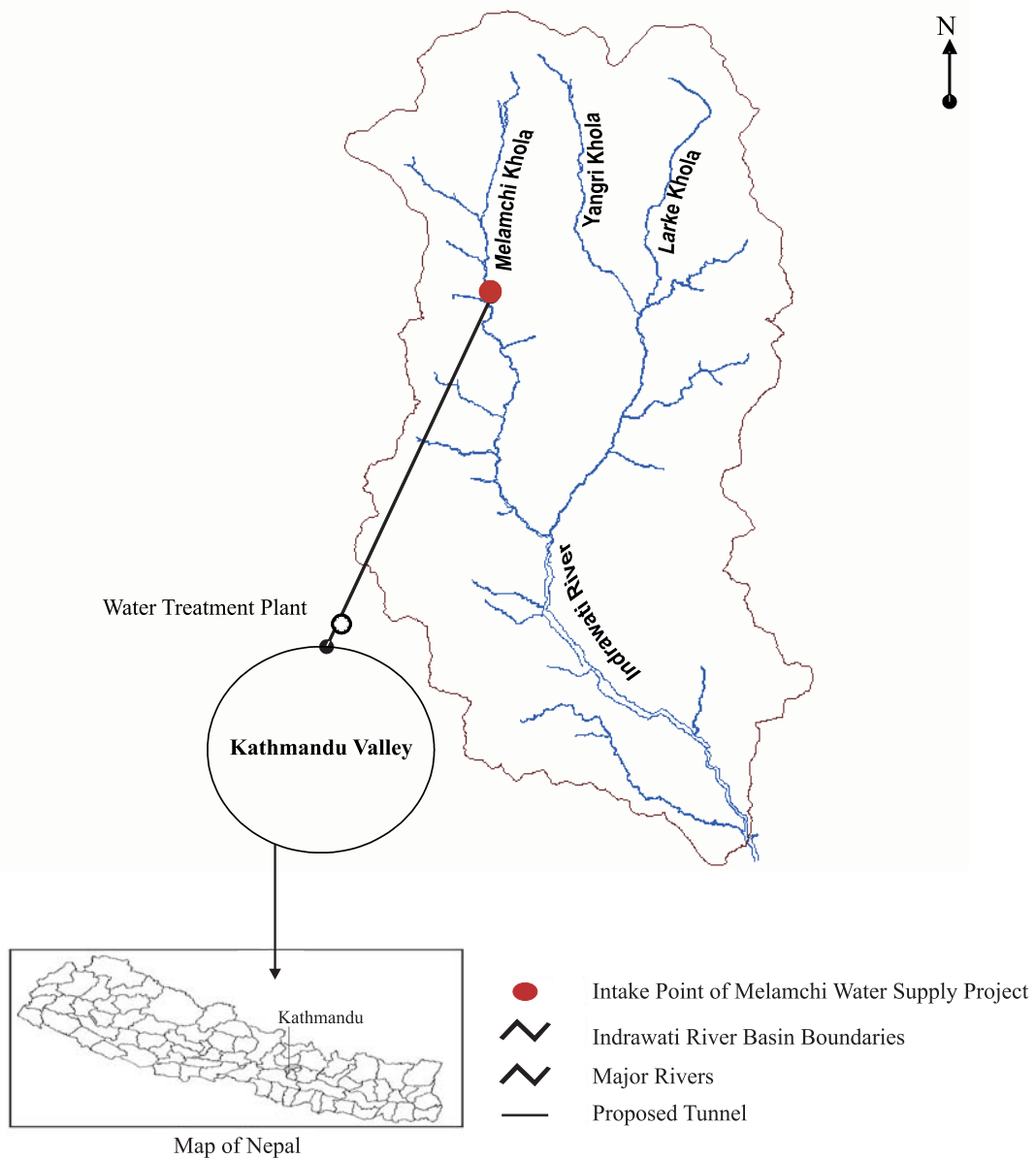
Section 7 provides an overview of the Integrated River-Basin Planning framework that could be applied in the context of both the Indrawati river basin and Nepal in general.

Section 8 is the concluding section of the paper. It provides a summary, conclusions, and the relevant policy implications inferred from these case studies and the need for future research in the Indrawati river basin.

2. Characteristics of the Indrawati River Basin

The Indrawati river basin is located in the mid-hill of the central region of Nepal, in the Bagmati zone, which originates from the higher snowy range of the Himalayas and joins downstream with Sun koshi (at 626 m msl). The Melamchi water diversion project site is in the Melamchi river in the Indrawati basin about 50 km northeast of the Kathmandu city. The map of the Indrawati river basin including its watershed area is given as figure 2.1. The landscape in the basin mostly covers rugged mountains, with occasional plateaus where farming is done. The length of the main course of the Indrawati river is about 59 km, covering 124,000 hectares of land. Some of the major tributaries of the Indrawati river basin are Larke *khola* (*khola* is the local term for river), Yangri *khola*, Melamchi *khola*, Jhyangri *khola*, Chaa *khola*, Handi *khola* and Mahadev *khola*, shown in the schematic diagram in appendix figure 2.

Figure 2.1. A sketch map showing the Indrawati River Basin and the Kathmandu valley.



Among the several basins of the Indrawati river, the Melamchi, Handi and Mahadev river basins are important in terms of water use practices. This section describes the salient features and selected characteristics of the Indrawati river basin and the Melamchi river, with focus on physical, hydrological, socioeconomic and current water-use activities. The detailed discussions on the Melamchi river basin along with the Melamchi water diversion project are reported in section 4.

2.1 Physical Characteristics of the Basin

The Indrawati river basin is located in the subtropical to alpine climatic zone in the Himalayan range, overlapping three central hill districts of Nepal namely: Sindhupalchowk, Kavreplanchok and Kathmandu. Out of the 124,000 hectares of the catchment area of the basin, the natural forest area covers nearly 40 percent of the basin. Less than 3 percent of the total basin area is currently utilized for farming. The population density of the basin was about 175/km² in 1998.

The average annual rainfall in the basin ranges from 3,874 mm at higher elevation (Sarmathang) to about 1,128 mm at Dolalghat, at the lower elevation zone, with an average annual potential evapotranspiration (ET) of about 954 mm (WECS/IWMI 2000). The average relative humidity is about 70 percent, which varies from 60 percent in the dry season to 90 percent in the rainy season. The daily average sunshine is 6.2 hours/day, varying from 3.3 hours/day in July to 8.1 hours/day in April.

2.2 Hydrological Features

Inflow to the Basin

Rainfall and snowfall in the upper catchment area are two major sources of inflow of precipitation into the basin. Annual rainfall in the basin varies from 3,172 mm in a wet year to 2,381 mm in a dry year with an average rainfall of 2,791 mm in an average year.⁴ The coefficient of variation of annual rainfall ranges from 10 percent to 22 percent at different stations. An analysis of data spanning 20 years (1971 to 1990) indicates that there is very little temporal variation in annual rainfall (Mishra 2000). However, there is a large spatial variation in annual rainfall from the head to the tail reach of the basin. The coefficient of variation of rainfall across the selected parts of the basin ranges from 23 to 43 percent, with higher rainfall received in the head reach of the basin (Mishra 2000). The average Class-A pan daily evaporation in the Indrawati river basin is 3 mm/day, varying from 1.8 mm/day in January to 4.4 mm/day in August. The annual evaporation is estimated at 1,110 mm in the basin.

The variations of the monthly average discharge of water in the three selected major subbasins of the Indrawati river basin are reported in table 2.1 below. It indicates that the river flow (discharge) is significantly higher in Melamchi during all seasons compared to the other two subbasins (on average, about five times higher than the Handi river, and 18 times higher than the Mahadev river). In addition, potential exists to expand the water diversion scheme in the future. A small modification of the existing intake structures will be sufficient for the additional diversion of water into the project tunnel from nearby tributaries.

⁴There is no gauging station in the upper catchment area (snow peak) of the basin above 4,000 m msl to measure either rainfall or snow pack. Hence, the inflow in the basin is averaged from the available hydrological data measured at downstream stations below 3,000 m msl.

Table 2.1. Mean monthly discharges of water in selected tributaries (m³/sec).

<i>Tributaries</i>	Jan.	Feb.	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg
Melamchi	4.17	3.55	3.23	3.42	4.74	16.07	47.70	57.01	43.57	19.09	8.56	5.55	18.06
Handi	0.69	0.59	0.52	0.50	0.64	2.83	8.65	10.65	8.37	3.60	1.74	1.13	3.33
Mahadev	0.23	0.19	0.17	0.15	0.18	0.74	2.35	2.91	2.27	1.0	0.44	0.29	0.91

Source: Rajkarnikar 2000.

Table 2.1 indicates significant seasonal variation of the water flows in the river, more than 90 percent of the total annual river flows occurring within 5 months of the monsoonal season (June to October). This has large-scale implications for the annual water use decisions and the proposed plans for the water development project.

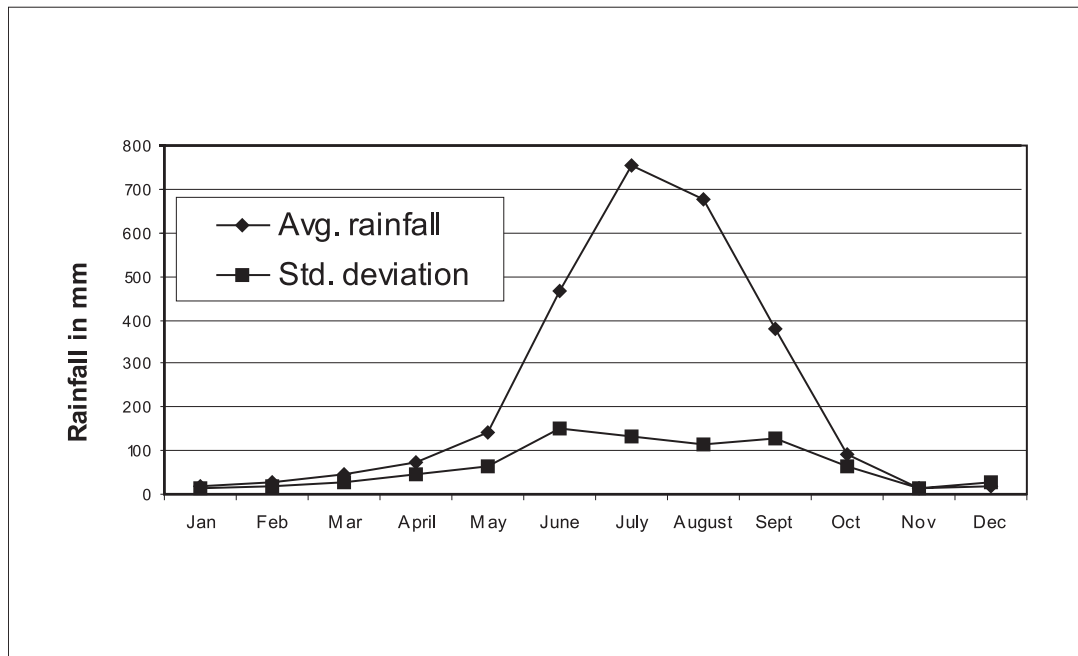
Rainfall

A plot of the average monthly rainfall over the last 20 years is shown in figure 2.2. The salient points revealed from the rainfall plot in figure 2.2 are as follows:

- Rainfall is concentrated mostly during 5 to 6 months of the monsoonal period, from the middle of May to the middle of October. Nearly half the rainfall is received in July and August. The rainfall pattern of these 2 months indicates whether a year is going to be wet, normal or dry. This is also the rough estimate adopted by the local community in the basin.
- Rainfall during the dry period of 6 months (November to end of April) is only about 7 percent of the annual rainfall, and does not vary much among wet, dry and average years.
- Monsoonal rainfall is the major source of inflow causing very high fluctuation in the river flow to the basin.
- The limited amount of water infrastructure limits use within the basin where a major portion of water flows out of the basin as runoff without much beneficial use in the basin.

A study of the rainfall and runoff pattern in the Indrawati river basin indicates that about 93 percent of rainfall is concentrated in 5 to 6 monsoonal months from mid-May to mid-October; consequently, there is considerable surface runoff and flooding during the monsoon. During the remaining 6 months of a year (November to April), there is very little rainfall but there is a sizable flow in the river due to the snow melting process in the head reach of the basin. The Indrawati river is a perennial type, so that a significant amount of water is available in the basin even during the dry season (detailed description in Mishra 2000). During the dry season, crops and vegetation in the basin use the soil water stored in the upper mantle, while the groundwater stored below the upper mantle contributes to the dry-weather flow in the river.

Figure 2.2. Twenty years' average monthly rainfall in the Indrawati River Basin, 1971–1990.



2.3 Socioeconomic Activities

The Indrawati river basin has been the location for several water development projects in the recent past. The Melamchi water diversion project and the Indrawati hydropower project are two of the major projects on the list. The Melamchi Water Diversion Project is a huge water diversion project. Kathmandu valley is a water-deficient area located nearby, and is the major reason for the initiation of such a large-scale water development project in the Indrawati basin. Agriculture is the predominant occupation, while other economic development activities in the basin are at a minimum level.

Landholding and Management Pattern

The case study revealed that an average farm-size holding in the area is 1 hectare in extent. The landholding patterns or the distribution of land, along the three major subbasins of Melamchi, Handi, Mahadev Khola in the Indrawati basin are summarized in table 2.2. The data table indicates a slightly higher proportion relatively big landowners in the Melamchi area, but this difference is not so wide between the two subbasins. The big landowners are mostly from the Sherpa community in the Melamchi river area, whereas Brahmin and Chhetri communities hold more land in the Handi and Mahadev khola subbasins. The tenant system of cultivation is commonly practiced in the region, with more than 90 percent of the cultivable land under tenancy in the Palchowk Beltar and Bhattar irrigation systems. Around 80 percent in the Taruki Besi and 70 percent in the Churetar irrigation systems practice the tenant system of cultivation, with mostly dual ownership type of land registration practices. This means, that the land is registered in the name of the landowner, but, the cultivator's name, with tenancy right on the land, is also mentioned on the landownership certificate. Such tenancy rights, legally binding

and transferable across generations, remain attached to the land even with changes in the land-ownership.

Table 2.2. Landholding patterns in study tributaries of Indrawati River Basin, 2000.

Tributaries	Large land owner (>1 ha)	Average landowner (0.5–1 ha)	Smallholders (<0.5 ha)	Landless family
Melamchi	12%	25%	60%	3%
Handi/Mahadev river	8%	35%	55%	2%

Source: Field survey 2000 (by local interpretations based on PRA data collection procedures).

Cropping Pattern/Productivity

Cereals like rice, wheat, maize and millet are the predominant crops in the river basin. The productivity of main paddy and spring paddy in the area is in the range of 2.5–3.0 metric tons per hectare (according to the PRA report), which is higher than the national average for paddy. The average productivity of maize and millet is 2.45 mt/ha and 1.7 mt/ha, respectively. The survey revealed, that there is no water scarcity for crop production in the basin, except occasionally in some areas of the tributaries, mainly due to the lack of adequate physical structures (intakes) or adequate water storage facilities.

Paddy is the main crop of the study area. If adequate irrigation is available some farmers grow even three crops per year, two seasons of paddy (summer and spring) followed by wheat as a winter crop. Wheat, maize and potato are other crops commonly grown in the basin area. The commonly prevailing cropping patterns in the Indrawati basin are presented in table 2.3.

Table 2.3. Cropping calendar followed in the Indrawati river basin area, 2000.

Crops	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Main paddy												
Wheat												
Potato+kitchen garden												
Spring paddy												
Maize												

Notes: 1. The bold line represents the cropping pattern for the low-altitude areas.
2. The thin line represents the cropping pattern for the high-altitude areas.

The cropping pattern followed in the lower altitude of the river basin area (1,200–1,400 m above mean sea level [msl]), is different from that followed in the higher altitude (1,400 m above msl). In the lower altitude farmers grow three crops a year including spring paddy, with 300 percent cropping intensity, due to access to year-round irrigation facility in the river and tributaries and also due to the sunshine in the valley delta. But the farmers in the higher altitude are at most able to grow only two crops a year, even if there is adequate irrigation, due to the cooler temperature. Farmers in the upper region cannot grow spring paddy; as it matures late due to the cold climate, which coincides with the plantation of the main season paddy. The cropping intensity is higher in the lower altitude valley deltas, as is the irrigation water demand compared to other places. Therefore the net-cropped area, and the water stress vary by altitude; as does the water sharing mechanism.

Water Use Activities

Commonly followed water use activities in the river basin are irrigation, drinking, animal husbandry, hydropower, water mills and also water use by forest and vegetation. All sectoral uses, other than hydropower and water mills deplete a certain percentage of water. Hydropower and water mills add economic value to water without any depletion, except in certain portions of the head-end. Spring water or water from relatively inaccessible tributaries, is used for drinking purposes. Therefore, river diversion will not have any impact on the drinking requirements of the community.

Figure 2.3. The Melamchi project intake site, in Sindhupalchowk district, Nepal.



3. Water Balance Situation in the Basin

This section provides a summary of water balance situations in the Indrawati river basin. Detailed water accounting and water balance estimations were carried out in the basin, to assess the hydrological consequence of the proposed water transfer out of the basin under the Melamchi project. Due to the limited availability of time series hydrological data, only a simulated water balance study could be conducted downstream at Melamchi river confluence in the Indrawati river basin. The detailed procedures followed and the results of the water balance analysis can be found in the IWMI/Nepal project report (Mishra 2000).

Water accounting is a procedure to account for the use and productivity of water resources, based on a water balance approach. It classifies outflows from a water balance domain (basin/irrigation project/irrigation field) into various categories to provide information on the quantity of water depleted by various uses (Molden and Sakthivadivel 1999). The results from the water accounting studies are summarized here, first for the Indrawati basin and then for its subbasin, the Melamchi river.

3.1 Indrawati River Basin

The major objectives of the water balance study in the Indrawati and the Melamchi river basins were:

- to assess whether there is sufficient water available in the basin for the water transfer out of the basin, and
- to analyze the likely hydrological impacts and other major consequences in the basin after the planned water diversion.

The water accounting study in the Indrawati river basin was conducted adopting the standard procedures, recommended by Molden and Sakthivadivel (1999) with some modifications as per data availability in the basin.

Hydrological data from 1971 to 1990 were analyzed for the water accounting task. Three typical years (1985, wet year; 1981, average year; and 1979, dry year) were selected for water accounting computation, where the average year relates to average rainfall in the basin. The selection of the typical year was based on the criteria that, the annual approximated rainfall values corresponded to frequencies 25 percent, 50 percent and 75 percent from the average rainfall for a dry year, average year and wet year, respectively. All other steps of water accounting like stream flow, storage changes, net flow, depletion and process consumption of water flow were estimated adopting the standard procedures provided by Molden and Sakthivadivel (1999).

The details of water accounting results in the Indrawati river basin for average year, wet year, and dry year are reported in a comparative setting in appendix table 3, and the major findings are summarized in table 3.1 and figures 3.1 and 3.2 below. In addition, the water balance findings are also reported in the standard water balance diagrams, as in figures 3.1 and 3.2. In an average year, nearly 90 percent of the utilizable water resources in the Indrawati river basin (upstream basin) flows out of the basin, as river runoff to the downstream reaches without any beneficial use to the community. This river run-off, was estimated to be nearly 3,100 million cubic meters (MCM) of water per annum in an average year, and 2,622 MCM per annum in the driest year. Even in the driest year (considered as 1979 over the 20-year period), the river outflow (runoff to downstream basin) was about 86 percent of the total intake into the basin.

Table 3. 1. Summary of water accounting results in the Indrawati river basin, for wet, average and dry years.

SN.	Component	Subcomponent	Wet Year (1985)		Average Year (1981)		Dry Year (1979)	
			Volume (million m ³)	% of Net Flow	Volume (million m ³)	% of Net Flow	Volume (million m ³)	% of Net Flow
1	Gross inflow	a) Rainfall	3,933		3,461		2,952	
2	Storage changes	a) Surface storage	0		-0.05		0.04	
		b) Ground storage	0		-81.15		88.15	
3	Net inflow		3,933	100	3,373	100	3,040	100
4	Process depletion	ET of agricultural and related uses	130	3	128	4	132	4.5
5	Non-process depletion (beneficial)	a) ET forest, grazing lands, homestead, and others	4,87	13	527	15	466	15
6	Non-process depletion (non-beneficial)	ET barren land, flood plain and water body	85	2	88	3	83	3
7	Outflow	Runoff	3,513	89	3,082	92	2,622	86
	Sum of depletion and surface runoff		4,214		3,825		3,302	
	Sum of net inflow		3,933		3,373		3,040	
	Calculation error		-281		-452		-262	

Source: Mishra 2000. Notes: 1. Name of the basin: Indrawati. 2. Area of the Indrawati river basin: 124,000 hectares.

Out of an average annual net inflow of 3,373 MCM, only 39 percent of the available water in the basin (in 1981) was depleted. The remaining 91 percent of utilizable outflow (3082 MCM), moved out of the basin as river runoff (figure 3.1). Even in the driest year (1979), an average of 2,360 MCM of water flowed out of the basin without any of it being used in the Indrawati basin communities. The Indrawati river joins with the Sunkoshi river downstream, which itself is already a huge water surplus basin. The utilizable outflow takes place throughout the year, so it is identified as an “open basin.” This is of course the source of water to a large Ganga basin downstream. There is a potential to harness this utilizable outflow and use it productively in the basin area. But there are no major storage reservoirs in the Indrawati river basin, to utilize the available water resources. Within the selected area, an increase of even one percent at the present consumption, would probably not even be detected downstream. The other economic activities in the basin are also at a minimum level. Out of 23 percent of the depleted water in an average year, only 4 percent is process-consumed (for evapotranspiration [ET] requirements for agricultural needs), while the rest is for non-process depletion (for forests and barren land). But, it is not the water availability that is the binding constraint in the basin, but the availability of the cultivable land. The Indrawati river basin has a catchment area of 124,000 hectares, of which only less than 2,000 hectares are cultivable land (flat cropland). This means, the present cultivable area is less than 1.6 percent of the total catchment area of the Indrawati river basin. Thus, land factor restricts consumption of water.

Figure 3.1. Water account result in the Indrawati river basin for dry year (MCM).

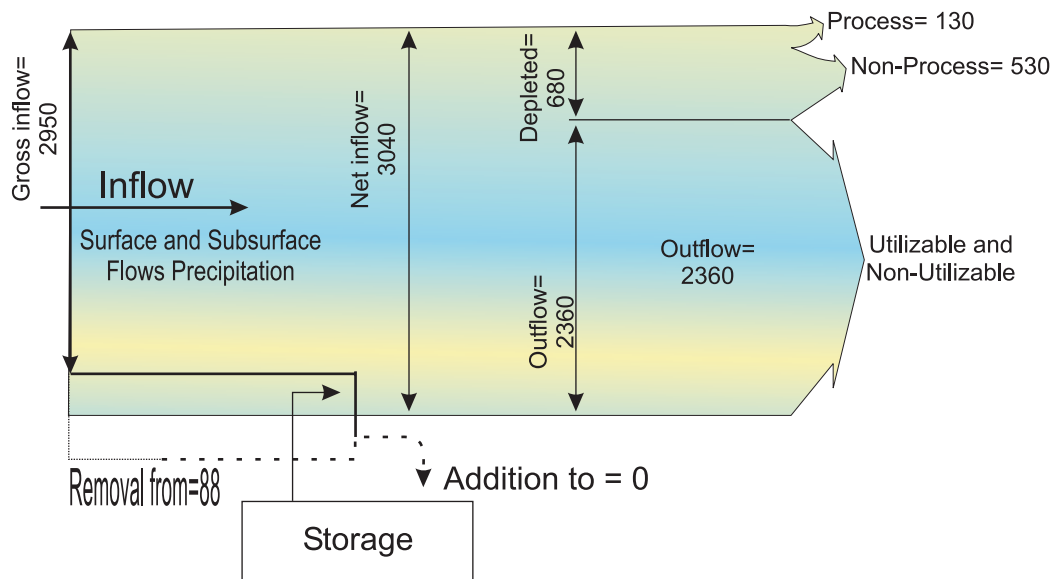
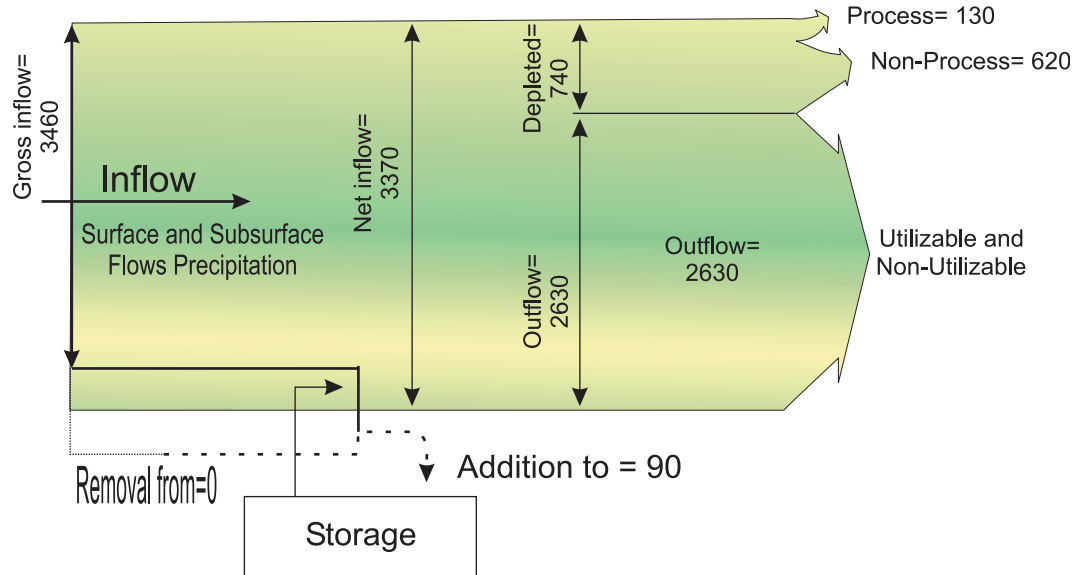


Figure 3.2. Water account result in the Indrawati river basin for average year (MCM).



The scenario of water diversion out of the basin, as proposed by the Melamchi project to supplement drinking water needs of the Kathmandu valley, is also considered in the present water accounting analysis. Considering the local water availability in the Indrawati river basin (2,622 MCM), the proposed water diversion scheme of 1.97 m³/sec (62 MCM per year) is negligible, compared to the total annual average river outflows from the basin even in the dry year (2,360 MCM). The planned water diversion is less than 2 percent of the total river outflows in the driest year. Therefore, in terms of average basin-wise hydrological consequence of the Melamchi water transfer project, there should not be any major felt impacts, except at the level of tributaries, where the seasonal variation of the water flow is higher, and the dry season river flow is substantially at low level.

The agricultural productivity of basin water use in a dry year works out to NRs 11/m³, (i.e. US\$0.15/m³) of process-consumed water. This appears to be slightly high considering the cereal and oilseed yields in the basin. But, the water productivity is based on the ET requirement of water. The water consumed per hectare of cultivated crop, works out to only 356 mm, which appears to be quite low. In the ET computation for nonirrigated (rain-fed) crops, effective rainfall and potential ET are computed for every 10 days of the crop-growing season. If the effective rainfall is less than the potential ET, computed actual ET is taken to be equal to effective rainfall. What is not accounted for in this type of computation is the depletion of soil moisture from the root zone, depth of about 0.5 to 1.5 m. This may be one reason for this apparently higher water productivity of consumed water. Considering the data limitation and the exploratory nature of the study, a simple form of water accounting analysis has been carried out. However, a further detailed investigation is needed to get a better understanding of the water uses and depletion in each sector, particularly in the Melamchi river, in relation to the proposed large-scale water diversion scheme.

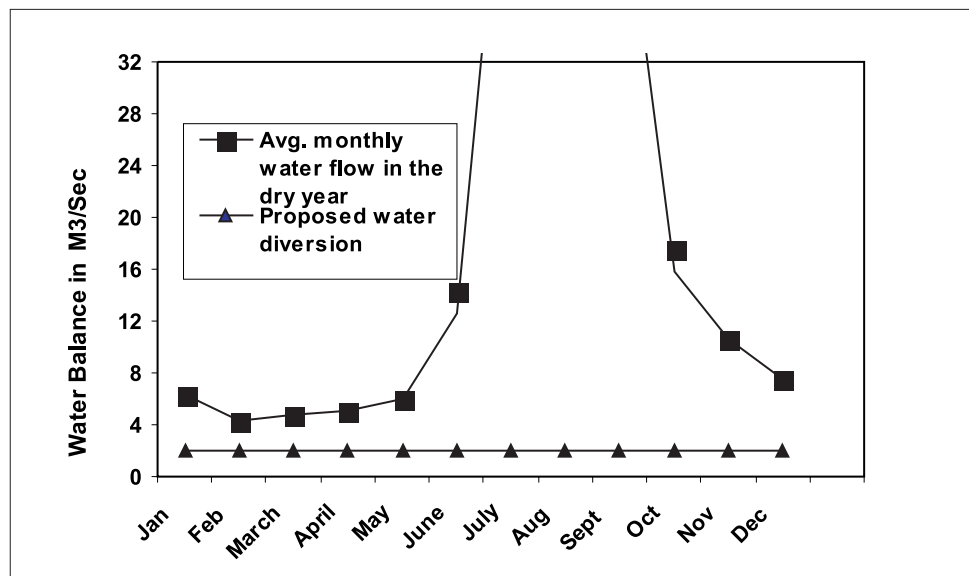
The water balance sheets for the study years reflect that the sum of depletion and surface runoff is slightly higher than the total inflow in the basin. This may be because of erroneous observations of stream flow and rainfall, or insufficient numbers and spacing of rain gauges in

the basin area, or it could be because of the difference in estimation of ET. There is a high degree of spatial variation of rainfall from north to south and a large variation of the snowmelt process within the seasons and the years. In addition, there is no rain gauge station or devices for measuring the river flow above 3,000 m msl (mean sea level). Therefore, inflow in the basin is estimated on the basis of average rainfall below 3,000 m msl, which might have resulted in lower inflow than considered in the above calculations. To be on the safe side while preparing the finger diagrams, the outflow of different study periods was reduced by the quantity showing a deficit, to balance the inflow and assess the quantity of utilizable flow.

3.2 Melamchi Subbasin

The water balance study is particularly important in the Melamchi river, considering the proposed water diversion scheme. Therefore, a simulated water balance analysis was carried out, to reflect the overall scenario of water uses in the subbasin, where a comparison was done of the scenario with and without the proposed Melamchi water supply scheme. The water balance was studied downstream of the Melamchi basin, where it joins the Indrawati river. Rainfall data collected over a period of 20 years (1971–1990), at three rain gauge stations were analyzed (detailed in Mishra 2000), to evaluate the average inflow into the basin. As long-term stream flow data was not available, simulated data, for a period of 20 years (Hydroconsult 1996) was considered, to generate the outflow at the intake point of the water supply project and at the confluence. A dry year is considered, for the computation of the water balance, because the water-scarce situation is most crucial. The water balance result, for the study year 1974 (dry year) is presented in appendix table 4, and the final results of the water balance study in the Melamchi river are summarized in figure 3.3.

Figure 3.3. Average monthly water availability in the Melamchi basin in the dry year, 1974.



Source: Based on Mishra 2000.

The water balance analysis in the Melamchi subbasin for a dry year showed, that the overall annual depletion (both process and non-process depletion) in the basin is only 209 MCM. This accounts for about 22 percent of the total inflow of 915 MCM into the basin. Nearly 706 MCM of water flowed out of the basin annually as river runoff without being utilized for any beneficial use upstream. Out of the total depletion, the process depletion component is much less than that of the non-process depletion, which is similar to the case of the Indrawati river basin presented earlier. These results indicate that a minimum quantity of water is now being used, at the Melamchi subbasin level and about 80 percent of the available water flows out of the basin (flowing downstream) as river runoff. However, during December to May a localized water scarcity is felt in some tributaries.

In this context, the planned diversion of 1.97 m³/sec of water out of the Melamchi subbasin by the project, accounts for only 62 MCM per annum compared to the average annual river runoff of 706 MCM downstream, even in a dry year. This is only about 9 percent of the average annual river outflow, from the Melamchi subbasin in the driest year. However, due to the higher seasonal fluctuations of the river runoff in the basin and also due to the monsoon-dependent river runoff, the average river flow is drastically reduced during the dry season from January to May, when the water scarcity situation would be mostly felt in the basin. Figure 3.3 also shows that the water availability in the basin during the dry season would reduce sharply after the planned water diversion. Nine months of the year, the monthly river flow in the Melamchi river is substantially higher than in the planned water diversion. The average river flow in Melamchi is more than 25 m³/sec during the peak monsoonal month. However, there is a sharp reduction in the river flow from January to May, with an average flow of 4 to 5 m³/sec. This is also the time when the water scarcity is mostly felt in the basin.

The most affected stretch of the Melamchi river is only 1–2 km immediately downstream of the project intake site. The contribution from the small tributaries downstream should be sufficient to cover any stress caused by the proposed water diversion. Although, the annual utilizable river flow at the basin (downstream) is sufficient, the water scarcity problems could be localized around the project intake site, especially during the 2 to 3 months (February to May) in a year. The spatial locations of feeder tributaries could still be a problem for the basin-level planning of water use activities.

A simulated water balance study was done downstream of the Melamchi river confluence with the Indrawati river. This was due to the unavailability of the long hydrological time series in the Melamchi river basin, particularly in its upper basin around the project intake construction site. Considering the nature and scale of the project, it is important that another detailed water accounting study is done at the Melamchi project intake site. Findings from such a detailed accounting study, will clarify some of the existing doubts and skepticism associated with the Melamchi project, particularly the present confusion regarding the water availability in the Melamchi river, downstream of the project.

4. Melamchi Water Transfer Project

This section provides an overview of the Melamchi Water Supply Project; the interbasin water diversion scheme, the local impacts of water transfer along with local initiatives, NGO involvement; and project compensation packages to the local communities. The Melamchi

Water Transfer Project is designed to transfer water from the upper mountain range to meet the urban water needs of the Kathmandu valley. This kind water transfer for commercial use is a pioneer project in Nepal. Therefore, this project has large-scale implications, for future water development projects in Nepal, as the urban demand for drinking water is growing in other parts of the country too. The total project cost is estimated to be US\$464 million, spread over a period of 7 years. The cost is almost half of the annual budget (GDP) of the Himalayan kingdom.

The current average water demand of the Kathmandu valley is about 180 million liters per day (MLD).⁵ The Nepal Water Supply Corporation (NWSC), a government-owned agency responsible for supplying drinking water, has a capacity to supply only 120 to 140 (MLD) (equivalent to 100 to 116 liters per capita per day) during the rainy season. The NWSC daily supply is reduced to 80-90 MLD (66 to 75 liters per capita per day) during the dry season. The water demand⁶ in the Kathmandu city is projected to increase to 510 MLD in 2018 (MWSB 2000). Thus, there is an urgency to identify a suitable alternative source of water for a continuous supply of drinking water to the city.

After studying several options, the Government of Nepal (HMG/N) decided to transfer water from the nearby Melamchi river basin to the Kathmandu valley. Details of the Melamchi Water Supply Project are summarized in table 4.1. The first stage of the project is designed to divert 170 MLD (1.97 m³/sec) of water from the Melamchi river to the Kathmandu city through a tunnel, 26.5 km long. In the second and third stages, according to the future water demands of Kathmandu, there is a proposal, to divert an additional 170 MLD of water by diverting it from Yangri and Larke tributaries of the Indrawati river. The Melamchi Water Supply Project is expected to meet the water demand of the Kathmandu city for the next 30 years or more.

The Melamchi Water Supply Project, involves the construction of a 26.5 km long tunnel in the upper mountain region. It is a complex and costly project. About 30 percent of the total financing is committed by multilateral and bilateral donors as a grant funding, about 45 percent by the World Bank and the Asian Development Bank as a loan, and the remaining 25 percent is to be financed by the Government of Nepal (table 4.1). There is clear provision for the involvement of the private sector, not only during the construction phase but also in the management of the water supply system in the Kathmandu city. This will be through privatization of the government-owned NWSC. There were also some preconditions for donor financing in the project. The Melamchi Water Supply Project is planned almost as a “full cost-recovery” type infrastructure project, through involvement of the private sectors in the water supply task in the Kathmandu city, which is an unprecedented practice in Nepal.

⁵This is based on the water needs of 150 liters per capita per day in the city. 1 million liter per day (MLD) = 11.5 liters per second.

⁶Based on the Kathmandu population of 1.2 million, which is growing at the rate of 3.5 percent per year.

Table 4.1. Salient features of the Melamchi Interbasin Water Transfer project.

S N	Features	Unit	Description
1	Project name		Melamchi Water Supply Project (MWSP)
2	Executing agency		Govt. of Nepal, Ministry of Physical Planning and Works Melamchi Water Supply Development Board (MWSDB)
3	Project duration	Years	7 (July 2001 to July 2008)
4	Estimated cost	US\$	464 million
5	FIRR (Financial Internal Rate of Return)	%	4.7 % This FIRR is estimated with full external debt service payment with soft interest rate, and with 50 % capital costs recovery project plan.
6	EIRR (Economic Internal Rate of Return)		15.2 % in the first phase, only with Melamchi water diversion 18 % in the second and third project phases with Melamchi/Yangri/Larke water diversion scheme implementation.
7	Financiers/Donors	No. 9	Asian Development Bank = US\$120 million World Bank = US\$80 million Other bilateral donors (grants plus soft loan)= US\$146 million Government of Nepal = US\$118 million. Thus, the project is designed as: External soft Loan = 62.5% External grant = 12.5 % Nepal government share = 12.5 %
8	Source of water	No. 3	Stage I: Melamchi river (perennial) in Helambu VDC of Sindupalchowk district located 40 km northeast of Kathmandu Stages II and III: Yangri and Larke (tributaries of the Indrawati)
9	Major components of the project	No. 5	Melamchi Diversion Scheme (MDS): Includes access road and tunnel adit, a diversion weir dam 5–7 m high, control system and sediment exclusion and 26.5-km long tunnel running from Ribarma to Mahankal, Sundarijal VDC in Kathmandu. Water Treatment Plant (WTP): Conventional gravity water treatment plant will treat the water for World Health Organization (WHO) drinking water standard through the process of chemical flocculation, sedimentation, filtration and chlorination. The plant will be located at Sundarijal VDC, on the outskirts of the Kathmandu city. Bulk Distribution System (BDS): Treated water will be conveyed by a network of peripheral distribution system of ductile iron pipes each with a diameter of 300–1,400 mm to the reservoirs built at high locations. Distribution Network Improvement (DNI): Distribution to the consumers by rehabilitated and extended network ensuring quality and equitable distribution, and reduction of leakage and wastage.

The supply of adequate drinking water to Kathmandu, has been an important issue in the political agenda of Nepali politics for a long time. The Melamchi project, was originally envisaged at the higher political and administrative level in the country, considering the water scarcity of the Kathmandu city. Negotiation with the prospective donors for funding; and coordinating with local stakeholders for a compensation package, was a major task for which high-level political (or government) commitment was required in the initial stages of the project.

Government mediation at a high level, facilitated the smooth resolving of local disputes at the project implementation site; and reallocation and resettlement programs, providing compensation packages, etc. Project implementation would not have been possible, without strong political commitment, as it involves not only a huge investment (nearly half a billion US\$) but also several institutional reforms in Nepal.

This water diversion project has contributed to several institutional changes in Nepal, particularly in the infrastructure development in related scale of project-financing sectors. Therefore, the experience gained during planning and implementation of the Melamchi project, and inclusion of wider range of stakeholders in the project decisions, are solid foundations upon which the future mega-scale water project planning in Nepal can be built. The experience gained by the government in negotiating together with several multilateral and bilateral donors in this project, which lasted more than a decade, could be a valuable information base, and a valuable experience for any future large-scale water resources project planning and development in Nepal.

4.1 Hydrological Consequence of the Melamchi Project

The annual average flow of the Melamchi river at the intake is 933 MLD (10.79 m³/sec) and the average flow during the dry season (March/April) is 256 MLD (2.96 m³/sec). Comparison of average monthly flows at the Melamchi Project Diversion Site intake, collected from different sources, is presented in figure 4.1. However, there is no authentic water balance study done at the project intake site; all the previous studies on water availability in the river are based on some sort of assumptive or simulated set of results. Therefore, the detailed water balance in and around the project intake site is an important step to plan for any project-related environmental mitigation measures. The structure of environmental mitigation as well as compensation measures should be based on the level of adverse effects of the water stress in the basin, caused by diversion of water.

Figure 4.1. Average monthly river flows and the proposed water diversion plan (m³/s).

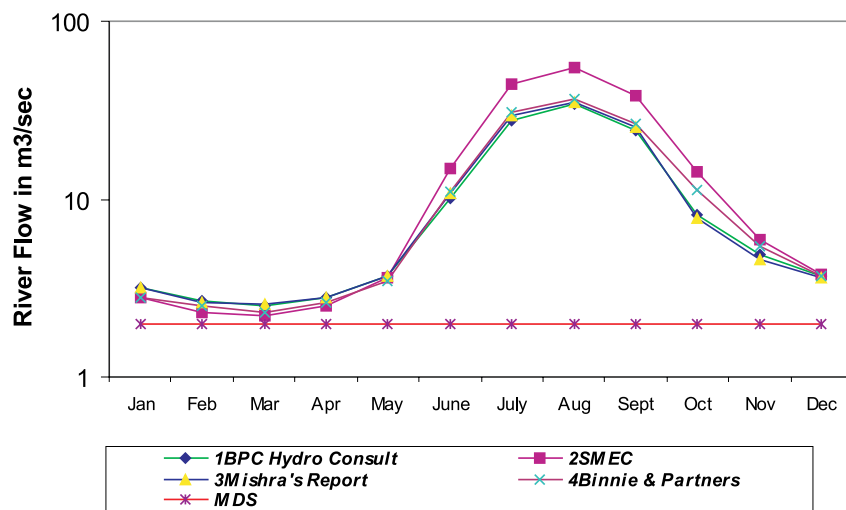


Figure 4.1 indicates that minimum flow in the river basin is in March as also shown in figure 3.3 in the preceding section. According to the Melamchi project authority, the water diversion project is designed to release at least 0.4 m³/s of water, as the “minimum environment flow” to maintain the environmental and aquatic ecosystem in the river. The minimum flow of water will be released even during the dry season (IUCN 1999, and Melamchi project document). The above graph on monthly river flow also indicates this fact. However, the local stakeholders are unaware about the minimum environmental flow, which will be available in the river even during the dry months. According to the project authority, this level of minimum flow is adequate for the survival of aquatic life and for maintaining the ecosystem in the river basin. This indicates that in the initial stage of the project planning due consideration has been given to the environmental issues.

The above figure suggests that unless properly planned, water stress could occur in the Melamchi river basin from February to May. Although on average, there is plenty of water available in the basin, peak river flows occur mostly during a few monsoonal months. The adverse effects of the water stress, occurring from February to May, would be mostly confined to within a 1–2 km stretch immediately downstream of the project intake site. Then there are other tributaries that join the Melamchi river, compensating for the planned diversion of water by the project. Due to the lack of extensive “long time-series reporting” and water balance study around the project intake site, there are several uncertainties on the future water balance situation in the river basins. Considering the scale of the project, there is a need to have a detailed water flow measuring at and around the project intake site.

4.2 Local Impacts of the Melamchi Water Supply Project

Considering the nature and scale of water diversion from the basin, and the level of physical construction works, it is likely that the project would produce both positive and negative impacts in the basin. Positive impacts could be on employment generation; and increased effective demand in the rural economy, whereas the project-related negative effects could be mostly in environmental aspects. Some of the Melamchi project-related impacts are summarized below.

Environmental Impacts and Mitigation Measures

The Langtang National park and the Helambu are famous eco-tourism trekking routes, and are located in the upper water catchment area of the Melamchi river basin. Several of the EIA studies of the project; and detailed feasibility studies conducted in the past, have not reported any major project-related adverse or irreversible environmental impacts either on tourism or on the basin in general. The small-scale environmental damage could be potentially mitigated with a little careful design of the project-compensation and project-mitigation package.

Soil excavations and quarrying of hillsides will have some adverse impacts on the local environment, particularly during construction of the project intake access road from the Arniko highway to the Melamchi Pulbazaar and Timbu (as shown in appendix figure1). Landslides and deforestation may increase in the project construction areas. However, this could be confined only to the construction period, and with careful planning this damage could also be

mitigated. The rocks extracted from the tunnel construction work can be used locally as construction material, for road construction and filling tracks, fencing, and building house foundations, and these rocks will be freely available to the local community.

Disposing the rubble and mud excavated from the adit through its portal is a problem. The waste material, which will mainly be rock wastes, is calculated to be 460,000 m³ (IUCN 1999). Another area of concern is the possible damage to the surrounding houses and other local constructions due to the blasting and resulting disturbance in the local environment.

However, the new access roads, will improve market access of more than 2,000 households in local communities along the Melamchi river. They will also benefit from the rural electrification in the project area with the extension of a 33 KV transmission line brought for the construction work. Several EIA studies have been conducted for the project, including IUCN/Nepal (Nippon Koei 2000; IUCN 1999). All, EIA studies have ranked the Melamchi project over other available alternate water supply projects to Kathmandu. The Melamchi project will produce the least social and environmental impacts in the basin, which can be mitigated.

Environmental Mitigating Measures

The project has planned to leave a flow of 0.4 m³/sec of water downstream, as minimum environmental flow: to minimize the potential damage to the freshwater ecosystem in the Melamchi river. In addition, there will be other small tributaries joining the Melamchi within 2 km downstream of the project intake site. Thus, the environmental stress will be confined only to this stretch.

The Melamchi Water Supply Project has also proposed various measures to mitigate the negative effects of the project construction work on the local environment. There is a requirement for a geologist to be present at the construction site, to monitor and minimize the potential landslides during the blasting and construction work of the project. There is provision for training construction workers on safe handling of explosives. The project compensates for deforestation caused during the construction period, through adequate re-forestation activities. This will be done in consultation with the Department of Forests and existing community forestry groups in the Melamchi valley. A mandatory provision exists for the project contractors to dispose of all the debris only at specific locations, so that the sediment load due to river runoff would be minimized. This is required to protect not only the water quality in the region, but also to have minimum adverse impacts on the aquatic life in the tributaries as well as in the Melamchi river basin.

Socioeconomic Impacts

The Indrawati basin, including the Melamchi subbasin, is a surplus basin. However, the water stress in the dry season from February to May, could be more at the immediate 2-km stretch downstream of the project intake site, before the confluence of two small tributaries with the river (as shown in figure 6.1). There are no major water uses within this 2-km stretch of the Melamchi river, mainly due to the rugged mountains and inaccessible places surrounded by steep mountains.

However, due to inadequate stakeholder consultations at the project planning stage, the information related to project activities, scale of its activities, water availability in the river

after the planned diversion, project compensation packages, etc. are not available to the local community (local stakeholders). This inadequate stakeholder consultation caused some confusion about the project impacts in the past; however, the local consultation process has improved recently. This was largely due to the complaints from the local pressure groups and may also be due to the donors' stringent requirements for local consultation for financing project.

There is a fear that after the planned diversion of water out of the basin, some of the minor water users like ghatta, or water mills may have to be completely closed down due to inadequate water availability in the river. Also, that they will be displaced from their present locations. The ghatta owners along with the other members of the community will get the least benefits from the project compensation package, which will be spent mostly for local public goods and infrastructures. By the time such infrastructure facilities are developed, these minority members will be already displaced from the communities. Therefore, provision of a targeted and direct compensation package to the project-affected communities maybe a better option.

The tenant farmers in the basin have been renting land for several generations, from the time when there was no irrigation facility from the Melamchi river. The main crop, paddy, is just enough to pay the land rent to the landowners, whereas the winter and spring season crops are kept by the tenants as a return for their labor and efforts on the farming land. Access to the irrigation systems allowed the community to harvest three crops a year. These tenant farmers fear that wheat production (dry season crop) in the basin might be adversely affected due to water diversion out of the basin. This could adversely affect the local household income, since winter and spring crops are the main sources of income for the tenant farmers. However, since the tenant farmers adversely affected are few, the project can compensate them.

4.3 Melamchi Project Implementation and Local Involvement

Local-level stakeholder consultations, by the project authority or from the concerned central-level water authority, were minimal during the early phase of project planning. This was one of the reasons for the widespread skepticism in the community about the project. It was reported that the first time local stakeholders were formally informed about the launching of the Melamchi project was only in 1998 at a Public Hearing Program (PHP) held at the Bhumeshwori High School (*Kiul*) and at the Timbu bazaar, close to the project intake site. The governmental officials assured the local community of providing enough water to the downstream stretch of the Melamchi Diversion Scheme, to fulfill the water demand of the local communities. They also pledged the construction of a 15-bed hospital, a higher secondary school and a metalled road from Lamidada to Timbu—providing direct access to the Kathmandu city, provision of employment opportunity to the local community in the project, and protection of the local environment of the Melamchi valley. There is also provision for giving priority to local communities for the project construction works.

Recently, several NGO coordination workshops were organized by the Melamchi project authority, with the concerned local NGOs and user groups, to identify issues and assess possible areas for their involvement in the project. The NGO Participation Plan (NGOPP) was one of the outcomes of the consultation meetings. The Melamchi project has assigned some of the

local NGOs as facilitators for implementation of various development and social upliftment activities in the project area. The experience thus gained by the government agencies from the project will be very useful for commissioning of any future water infrastructure projects in Nepal.

A proactive public campaign was recently conducted by Melamchi Water Supply Project to avoid public criticism, to highlight the project profile and to address some of the public concerns, which could potentially jeopardize project implementation. Realizing the need for a mechanism to bridge the gap between local stakeholders and the MWSP, the project recently hired a communication consultancy firm to develop public relations with the local stakeholders. Hence, the project authorities are now trying to reach the local communities and to avoid public criticism. Involvement of an international NGO like the UNDP in the project implementation phase, as practiced recently, may improve the transparency of the project operations in the future, particularly, implementing the project compensation activities in the communities.

4.4 Project Compensation Package

Unlike other infrastructural projects in Nepal, the process of local consultations has been recently increased in the case of the Melamchi project. The project implementation authority has developed a compensation package for the river basin (donor basin), as a mitigation measure for social and environmental impacts from the project.

Some of the major project compensation packages include land acquisition, resettlement of displaced communities, and provision of infrastructure in the local community affected by the project. Permanent land acquisition is expected for the main access roads, for project construction site in the Melamchi valley, certain portions along the tunnel construction sites, for a water treatment plant in the Kathmandu valley, and for improvements to pipeline route and sewerage system; also in the vicinity of Kathmandu. It is estimated that about 160 hectares of land will be affected in the main project sites, and 246 households will likely be affected either partially or entirely, including 25 households that will be permanently displaced.

In the absence of any formal rules and regulations for a bulk water-transfer project in Nepal, it is the central government agency that has to decide how to compensate the donor communities for any potential harm in the process of water transfer. The central government authority (Ministry of Physical Planning and Housing) concerned, has got a project compensation plan to spend about US\$18.5 million for the general welfare improvement activities in the communities, as a compensation package to mitigate some of the adverse environmental, social and economic effects imposed by the project. Considering the current development stage and socioeconomic activities there, this level of compensation package represents a considerable sum to the donor communities. Out of the total compensation package of US\$18.33, about US\$15 million is allocated for the Resettlement Action Plan (RAP) for a hospital, a road, and school services in the local communities. The remaining US\$3.5 million is allocated, for Social Upliftment Programs (SUPs) in the local communities (poverty reduction and equity related projects). The Melamchi water transfer project has also got a plan to provide rehabilitation assistance for the irrigation canals that would be damaged, during the construction of the access road.

The Melamchi project compensation package includes:

- Improved road access to Kathmandu and within the Melamchi valley
- Increased income through the expanded market infrastructure and the upgraded local skills
- Reduced workload for women and improved access to education in the communities
- Improved basic health and nutrition, especially for women and children

Based on an analysis of the ongoing project activities, and involvement of local NGOs even international agencies like the UNDP; for implementing some of the project-related mitigating activities, it is expected that the local community as a whole may get a fair share out of the total compensation package. However, intra-community distribution of the benefits from the project compensation package is not targeted to the actual project affected sector. Major portions of the mitigation expenditures are for the provision of public utilities like the construction of schools, roads and hospital buildings. The benefits of this local infrastructure are mostly realized by the permanent residents in the community, but not much by the displaced and project rehabilitated people (households) directly affected by the project. Since, these would be the project-displaced community; they might have already migrated from the community by the time these local infrastructures are built. Therefore, with a little more targeting of the project compensation, for the affected communities, particularly the minority water users like ghatta owners, immediately downstream of the project intake site, there will be more equitable distribution of the project compensation relief, and improvement of the basin community's social welfare.

4.5 Project Implementation and NGO Involvement

To address some of the environmental and social issues, the Melamchi Water Supply Board (MWSB); the governmental authority charged with the implementation of the project, has established a separate resettlement and social development division. The project authority has recently intensified its communication with the local community as local political leaders and communities raised voice on the negative effects of the water diversion scheme, and started demanding economic compensation packages for the donor basin. The NGOs and other interested groups formed at the local level also started to exert pressure on the board to address some of these local issues of project construction. Despite some uncertainty in project financing, and other local concerns, etc., the project work was commenced recently. The direct participation of the local people on the project, was elicited through the formation of a Local Consultative Group at the Melamchi valley consisting of a 15-member committee, representatives of line agencies, a high-school headmaster, social mobilizers (women) and project field officers in the subbasin.

There is a plan to mobilize NGOs to assist local government agencies in implementing the community-based project compensation package. The SUP (Social Upliftment Program) will take a participatory approach through direct participation of beneficiaries and utilize the institutional structure of the Local Governance Program, as this will ensure ownership and sustainability of the projects. Capacity building for DDCs and VDCs will also be conducted

through the program. The local community and the locally elected members of the community have opined that the SUP and RAP (Rehabilitation Action Plan) activities should also be assisted by additional royalties paid by the Kathmandu valley residents, as a drinking water fee, during the post-construction stage. Given the institutional structure of the water transfer scheme, it is less likely that this local demand will be fulfilled.

Unlike the RAP, which focuses on the construction of public utilities like a school, a road and a hospital, compensation under SUP activities are targeted more towards the project-affected communities. Those households that would lose their means of livelihoods and will be displaced by the project activities will receive direct compensation from the project. It is, however, not clear yet whether the SUP activities will be continued after commissioning of the project. One of the other demands of the local people was to levy an additional 5 percent tax for the Kathmandu water supply, with the proviso that the additional revenue from user fees in the Kathmandu city should be spent for local development activities in the Melamchi river basin. However, the project officials and the government central authority have not yet committed anything for such a revenue-sharing mechanism.

In terms of NGO involvement, the Melamchi project seems to be an entirely different type of infrastructural project compared to other development projects in Nepal, with the involvement of several local bodies and local NGOs; even during the project planning and construction stages. Nearly US\$18.5 million will be spent on the local communities (donor basin) under the project compensation and rehabilitation package. This level of project compensation was not seen in any other infrastructural project in Nepal in the recent past. However, it is not clear yet, whether existing institutions and the proposed institutional arrangement would be able to handle all these project-compensation and revenue sharing plans. Also unclear is, the ability of the existing institutions to cope with the changes brought about by the interbasin transfer project in water resources management at the local level.

5. Water Institutions in the Basin

Water institutions, institutional arrangements, and their functions in water management activities in the Indrawati basin are discussed in this section. Both formal and informal water institutions are functioning in the Indrawati basin for managing water uses. The informal institutions are effectively working at the local community level while the role of formal water institutions, i.e. the government institutions, is limited to the central and district-level decisions on water use. The role of the formal institutions on water management activities at the local level is limited to a great extent, for example, providing financial and technical support for the rehabilitation of irrigation systems, construction of drinking-water schemes, establishment of micro-hydro etc.

5.1 Formal Institutions

The formal institutions in relation to water allocation in the basin are:

- Central Level Institutions
- District Level Institutions
- District Development Committee
- Village Level Institutions

Central-Level Institutions

At present the Ministry of Water Resources and the Ministry of Housing and Physical Planning, are responsible for water-resources development in Nepal. The respective ministries, are represented at district level by the District Irrigation Office (DIO) and the District Water Supply and Sanitation Office. The DIO is responsible for new development and rehabilitation of irrigation systems, while the District Water Supply Office is responsible for the provision of drinking water and sanitation-related activities in the district. In addition, the Ministry of Water Resources is directly involved in granting licenses to the private sector, for large-scale water development projects like hydropower (Indrawati hydropower). The activities of the water-sector government institutions in the district are mostly based on the sectoral approach. But, they lack coordination with other sectoral agencies in the district.

The Government of Nepal formed the Melamchi Water Supply Board to look after the water transfer from the river to Kathmandu city. The Board is directly responsible for the overall supervision and implementation of the Melamchi Water Supply Project. The policy studies pertaining to development of an integrated water resources plan for the basin; are being done by the Water and Energy Commission Secretariat (WECS), a central-level water policy formulation and study center of His Majesty's Government of Nepal (HMG/N)

District-Level Water Institutions

The following are two key institutions at district level water allocation decisions:

- District Water Resources Committee (DWRC)
- District Development Committee (DDC)

District Water Resources Committee (DWRC)

The Water Resource Act of 1992 created DWRC, to coordinate all the water-related activities within the district and to avoid potential water-related disputes. The ex-officio secretary of the DWRC is the Chief District Officer (CDO) who additionally, is the chief administrative and security officer in the district; representing Ministry of Home Affairs, and also Chairman and Local Development Officer; Ministry of Local Development. The water users' sector is not represented in the DWRC; although most water-sector-related government agencies functioning in the district are represented.

The role of the DWRC at present in the Sindhupalchowk district, where the Melamchi project work is going on, is basically confined to the following areas:

- registration of water user committees for the irrigation systems
- advice and suggest DDC/VDC to resolve the water conflicts as per the water acts, if there are any complaints filed to the committee
- recommend and advice DIO for the construction of the new irrigation systems at the request of the users
- resolve any other water-related disputes between WUAs brought to its notice

Government officials dominate the executive committee of the WRC; there is no representation either by farmers (irrigation user associations) or any other local water user associations in the district. In reality, it was found that the DWRC of the Sindhupalchowk district had not met for more than a year, with the situation being similar in other districts. This was primarily due to the frequent changes of the Chief District Officer (CDO), who is also the ex-officio chairman of the DWRC. Besides, the CDO gives priority to administration and maintaining security in the district. Thus, water issues are at a low priority level to the CDO, compared to other administrative issues in the district.

During the field study, it was noticed that there was an increasing concern from different sectors even within the local government organizations, to modify the structure of the DWRC and accommodate more local stakeholders like the WUAs. It was found that the DDC was interested in altering the function of the DWRC to be consistent with the Local Governance Act (1998). However, adjustment of functions and jurisdictions of the DWRC and the DDC, requires a change in other national legislations and the Water Act (1992).

District Development Committee (DDC)

The DDC is an elected institution in Nepal, responsible for the coordination and implementation of all the local development activities within the district, which includes around 50 to 100 villages (VDC). Its role in the water sector is increasingly becoming important as it also provides financial subsidy to the water development project in the district. The DDC of Sindhupalchowk in 1999 provided NRs 178,000⁷ and NRs 150,000 for micro-hydro installation in Thangpaldhap and Thangpalkot VDCs, respectively. Nevertheless, the DDC president of Sindhupalchowk opined, that the coordination between various agencies in the district for the development of water resources was lacking, since the central government, does not recognize the role of the DDC, for the development of water resources in the district.

⁷US\$1.00 = NRs 73 the rate of conversion during the period of study (2000).

Conflicting Role of DWRC and DDC

On principle, the DDC does not have any statutory role in the formation and registration of UC for irrigation and other water use activities in the district. The District Irrigation Office (DOI) plays a key role in the formation and registration of such irrigation user associations in the district. However, the DDC is more or less directly responsible for water-sector and agricultural development, and the overall development planning in the district. Some local officials had very critical views on the structure and functioning of the District Water Resources Committee (DWRC) in that district. He criticized the existing Water Act (1992). He is of opinion that there is overrepresentation and dominance of government officials in the DWRC. Despite the confusion and conflicts of interests, the DDC of Sindhupalchowk has been assigned by the Melamchi Project Authority to play an active role in coordinating the activities of the local NGOs, known as the NGO Participation Plan (NGOPP), in the district.

The local officials think that the Chairman of the DWRC should be the DDC President, so that the DDC will have a greater role on the development of water resources in the district. He was also of the opinion that the government should specify private sector contribution to local development and royalty sharing in the district, while issuing a water license for new water development projects (like hydropower) in the district. A local body (like the DDC or VDC) should be empowered to tax; the private-sector development of water resources in their jurisdictions, and the government authority concerned should compensate any local-level negative impacts caused by large-scale water resources development projects. The local DDC Chairman also thinks that the DDC should be an authoritative decision-making body in Nepal, for integrated water resources management and development in the district.

Recently, the DDC representative was recalled from the DWRC on the grounds of overrepresentation and dominance of the government representatives in the DWRC. On the same issue, the local DDC chairman has recently filed a court case at the Supreme Court challenging the authority of the DWRC with respect to registration of the Users Committee (UC) at the DWRC, which he thinks is against the spirit of the Local Governance Act (1998). The Supreme Court verdict on this case would have much larger bearing on the structure and functioning of the DWRC countrywide. This could bring about a large-scale institutional change in the functioning of the water sector in Nepal.

Village-Level Institutions

The following are important village level formal water institutions

- Village Development Committees (VDC)
- Non governmental organizations (NGO)
- Water User Associations (WUA)

Village development committee (VDC)

The VDC role in the water sector is mostly confined to providing occasional financial support (grant) for the construction of the irrigation systems (FMIS), and investment for micro-hydro development, construction of access roads, and financing other small scale infrastructure development projects in the district. For example, the two concerned VDCs in Sindhupalchowk, under the governmental annual assistance program, jointly provided NRs310,000 for the installation of the micro-hydro in Thangpaldhap and Thangpalkot VDCs. The local VDCs also provided financial and material (polythene pipes, cement, etc.) support on a small scale, for the construction of the drinking water supply of the community. Occasionally, ghatta and water mills are also registered at the VDC level; and the registration fee is levied from these enterprises. Sometimes the VDC resolves some of the water-related disputes, especially between irrigation systems and either ghatta or water mills. However, the VDC has got a minimal role in the day-to-day management of the water use activities, since its role in the development of the water resources is not yet officially recognized in the existing Water Act (1992).

The Melamchi project authority has given responsibility to the concerned VDCs for coordinating and monitoring, in their respective jurisdictions, the activities implemented by the NGOs under the MWSP (the Melamchi Water Supply Project).⁸ These activities involve project rehabilitation and resettlement, and other project compensation related projects. Unlike other water infrastructure projects in Nepal, the MWSP has given due consideration to involvement of locally elected institutions in implementing the project activities in the basin communities.

Non Governmental Organizations (NGOs.)

Altogether 65 NGOs have been officially registered in the district; many are directly concerned with the Melamchi project. The sudden increase in the number of NGOs in the project area was mainly due to anticipation of involvement in the Melamchi project activities. The emergence of so many NGOs and local pressure groups in the Melamchi project area, is one of the important developments and marked institutional changes seen in the project area. However, not all of these NGOs are equally effective in looking after the interest of the local communities. Most of these NGOs have been focusing mainly on their activities in implementation of economic packages under the project compensation programs, rather than looking at the needs of the local community. Nevertheless, these NGOs have recently played an important role in raising awareness and concern among local people about the Melamchi project, and its likely impact on the livelihood of the local communities. The awareness campaign conducted by the NGOs included a poster campaign in the local communities, as shown in figure 5.1. Certain points raised here were, about alerting the local community to pay special attention to some of the project's likely impacts in the community, for example: What impact will the project have on the cultural systems and traditional values of the community? How can the local community be more involved in project activities? Who will implement the project in the community? What will be the project impact on community forestry, local environment and community tourism sector?

⁸A detailed description of the Melamchi Water Supply Project was provided in section 4.

Figure 5.1. Posters used in the public awareness campaign conducted by local NGOs.



Water User Associations (WUA)

There is a certain advantage of creating formal organizations, to efficiently mobilize resources and to protect the legal right of the resource users. Particularly, for managing common property resources like irrigation services. Some of the irrigation systems in the basin, which were rehabilitated by the IIMI/WECS project earlier in late 1980s had formed a users committee (UC) during the time of rehabilitation for regular O&M of the systems, except for some informal mechanisms. These WUAs were formally registered. However, they are not functioning actively as they were during the construction period. They were actively functional during the construction and rehabilitation phase and whenever they had to obtain resources from outside, a strong stimulus for organizing collective action. Occasionally, the local community members, even without a formal organizational structure, are able to mobilize the needed collective actions and get external funding for small-scale repair and maintenance work, for example, traditional operation of FMIS. Such external assistance is specially required for new construction, or rehabilitation of physical structures of water resources. For example, the Gorebesi *kulo* (*kulo* is the local term for irrigation canal) has mobilized labor contribution equivalent to NRs 122,000 for rehabilitation of the irrigation system. The UC members also deposited a cash fund of NRs 65,000 for the system rehabilitation.

There is a general trend seen in such WUA action that, the anticipated additional benefits generated out of those efforts should be higher than the cost of the collective action. It was noticed that some members of the UC became active only when they had to mobilize the external resources from the VDC, international NGOs, and governmental agencies for construction or O&M of irrigation systems.

It seems that the existence of formal organizations, is not a prerequisite for initiating small-scale activities, and for collective action in the communities. However, in a larger water resources project, it is better to have in place, a formal organization to mobilize external resources and to protect the legal rights of the users. Formal registration of a UC, is one of the conditions, often set for providing financial support and construction-material support by most

of the intervening agencies. This is also important, to legally protect the water rights of each member in the community.

This type of organizational behavior is consistent with Common Property Resource (CPR) management, and collective action theories (North 1990; Ostrom 1993). The marginal benefits out of project rehabilitation work are substantially higher than the day-to-day managing of the canal later on. The collective action is not “a cost-free adventure;” some strongly felt impetus is required to overcome the transaction costs of community actions; and coming together for negotiation costs.

The local community also mobilizes DDC and VDC resources for the development of micro-hydro in the area, for which the two tiers of formal water UC were formed for micro-hydro projects, under the Rural Energy Development Program (REDP) of UNDP. Each of the settlements has one committee to coordinate the activities of the users at the community level, each of these committees, sent a representative to form a main committee at a higher tier. The primary task of the main committee is, to ensure proper functioning of the micro-hydro by mobilizing resources; through the collection of a service use fee, timely O&M of the system, and also to maintain linkage with the outside institutions. At present, REDP is also providing necessary technical and managerial support to the UC. Two such water UCs have been recently formed in the study area of the Indrawati basin, but it is too early to judge their performance. It would be interesting to look at the performance of these micro-hydro committees in future vis-à-vis the performance of the committees formed for irrigation management (FMIS).

5.2 Informal Institutions

Basically, informal institutions comprise local traditions and customs that set norms for almost all water allocation practices in the basin. The water allocation among different sectors is based on the mutual agreements and customary laws. No formal rules for water-allocation have yet been developed at the local level, maybe due to the relative abundance of the water resources in the basin. The available water in the Melamchi, Handi, and Mahadev khola, which are major tributaries of the Indrawati river basin systems are shared among the irrigation systems — the water-turbine-operated mills, ghatta, and the micro-hydro. The water mills are usually privately owned, whereas the irrigation systems and the micro-hydro are usually community-owned resources, and are managed as Common Property Resources (CPR).

Informal institutions are steeped in the social customs and cultural traditions, as such, it is difficult to isolate and pinpoint all the informal norms precisely while working in one sector of resources use. Rather, they all function within a web-like structure — one affecting the other and the last affected, in turn, being affected by rest of the community practices. Among these informal water rules and institutions, the water allocation mechanism between farmers (usually upstream) and the water mill (downstream) and/or ghatta is particularly interesting and fascinating in the case of the Indrawati river basin.

The mill owner or the micro-hydro committee does the construction and operation and seasonal maintenance of the irrigation canal. Water in the canal is shared with the farmers free of cost. The irrigation is provided to the adjacent field plots, as a secondary benefit from the water mill. Farmers do not contribute to the O&M of the field channel, but they get irrigation benefits, mainly for sharing their prior water rights, and for providing the land for a field

channel to deliver water up to the water mill at the downstream. Viewed from outside, it seems an undue burden on the mill owners, but it is a social-cost minimizing norm, serving to minimize the transaction costs of the collective action of the community. The mill owners, since they have a larger stake in the operation, perform timely maintenance of the field channel than the smallholder farmers each with less than half or quarter hectare of landholding.

The mill owners and irrigators have adapted an effective O&M system for the canal networks. Informal water rights and enforcement mechanisms have evolved to match the local situation. Locally derived O&M procedures exist and are fairly well adapted to the rugged mountains, which are prone to frequent landslides. In case of multiple water use, the ownership is shared between the owners of various uses and a written agreement is made to guarantee the rights of users.

The institutionalization of the water allocation arrangements for various uses, which has provided a kind of water rights to the present users, has not encouraged them enough to form a formal organization. At present, the users' interests are represented collectively through the group, which relatively becomes active whenever there is a need to protect the group's interest in protecting the water rights and whenever there is a need for collective action. This was evidenced from the arrangement made by the community in night patrolling the canal to ensure the allocation of the water equally to all members, and the initiative taken in the construction of a new irrigation system. Besides, the user groups have been able to negotiate and develop an appropriate mechanism for water allocation with other water use activities. Likewise, the farmers have informally negotiated with the private mill owners and with the micro-hydro committee for the O&M of the canal in exchange for sharing the water rights. Mill owners and micro-hydro committees are responsible for the O&M of the canal up to where their water use activities are.

The customary law practiced in the basin gives priority of water use to irrigation service over various other activities. This could be primarily due to agriculture-based development activity in the basin. Besides, activities of all other sectors including the water mill and ghatta operations directly depend upon the success of the agricultural crops grown in the community. The informal water allocation rules are institutionalized through mutual agreement and informal negotiations among the various water use activities. They are also known as customary law based on cultural tradition.

Consent from the prior water users is necessary for developing any new water use activity in the area. Water allocation rules are not formalized in the basin in the form of a constitution of WUAs, as seen in other parts of Nepal. The water rights are not required in the Indrawati basin, perhaps due to the absence of any serious water disputes, except in isolated cases. A formal WUA is not a common practice here, except for the irrigation system, which usually receives external assistance, and the establishment of such formal WUAs is sometimes a prerequisite for receiving any form of external assistance from the government or international NGOs.

In summary, it can be said that the institutional framework in the river basin has evolved ingeniously to manage local water supplies. However, it is uncertain whether institutions evolved for managing at local-level, can also cope with the external impacts caused by huge water development projects like the Melamchi water diversion project. Fortunately, there is ample water available in the river except in a few dry months that help to ease conflicts. Along the Indrawati river system, there is little need for upstream-downstream coordination because of the

sufficient availability of water in the river. But, there have been cases where local institutions have evolved to resolve such issues in the case of small tributaries, where the water flow substantially reduces during the dry season. The question then is whether such informal institutions will be adequate, to resolve the issues on bulk water transfer outside of the basin.

6. Water Rights, Allocations and Conflict Resolution

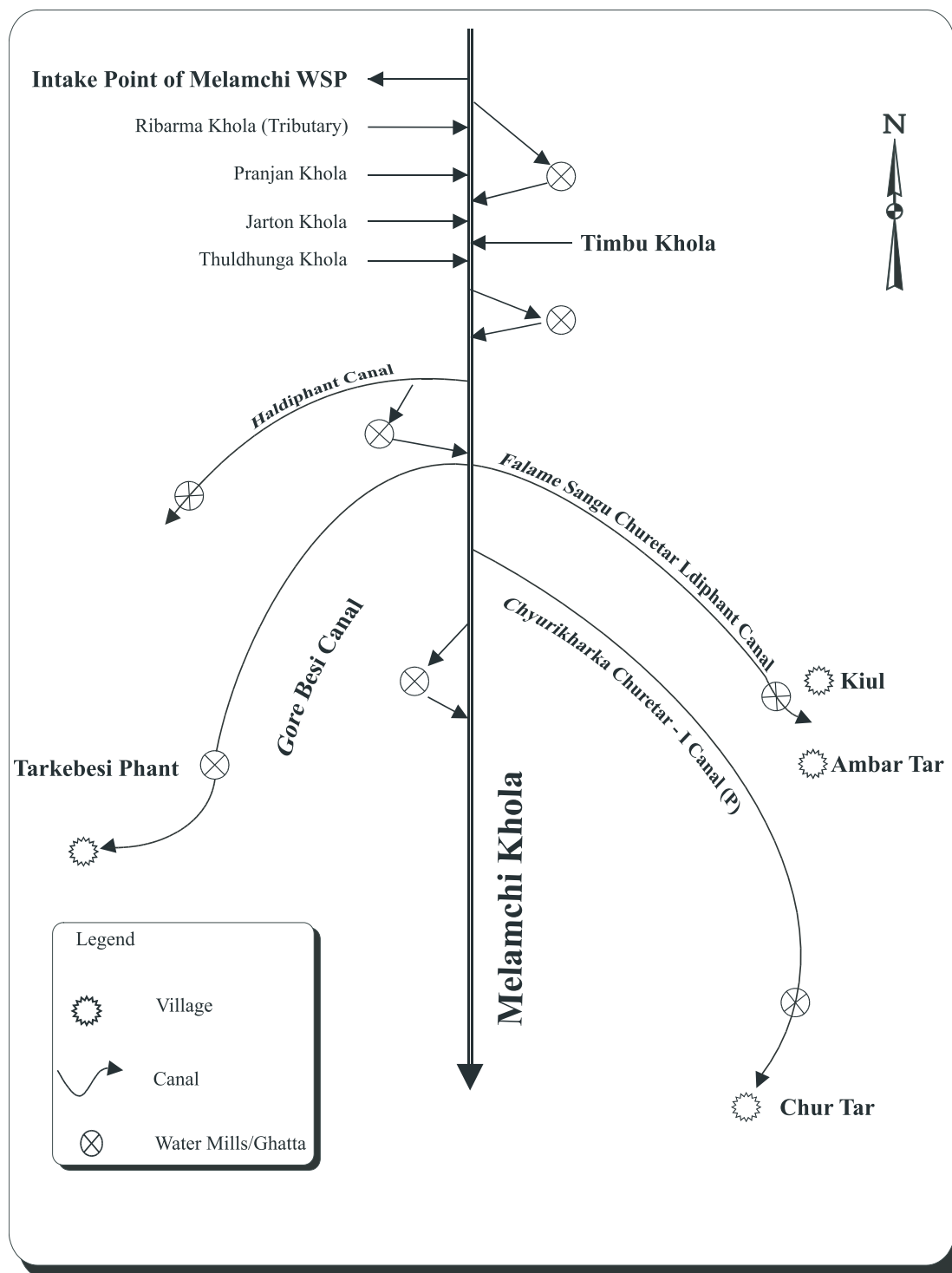
This section summarizes the water use activities, water allocation practices and water-related disputes in the Indrawati basin. The discussions here are not exclusively related to the Melamchi project and its activities but provides an overview of the water use activities in the local community as a whole, an understating of which will provide a reference basis for analyzing the impacts related to the Melamchi project and in turn, provide a solid foundation for designing the Melamchi project compensation package. Therefore, it is expected that the information provided here would be very useful to the project officials and to others, for improved management of the water resources in the basin, within the framework of IWRM.

In Nepal, the Water Resources Act of 1992, and its by-laws in 1993, were introduced to regulate the use of water resources in the country. According to the 1992 Water Resource Act, the ownership of all the water resources is vested in the Government of Nepal. A government license is required for the development of the water resources, other than for small-scale water resources development on private land, and for individual and collective use for drinking water and irrigation. The law has also prioritized the use of water, according to which drinking water and irrigation, and agricultural uses (animal husbandry) have received priority over other uses of water in the community. At the same time, the *Muluki Ain* (civil code of Nepal) of 1963 has guaranteed the customary use right and prior appropriation right of water users.

6.1 Major Stakeholders and Water Rights

Irrigation and micro-hydro users and also ghatta and water mill owners are the major stakeholders in these three tributaries. The typical water use activities are shown in figure 6.1. The irrigation use association (FMIS and other committees) and the newly established micro-hydro committees, are relatively organized stakeholders. The community consultations and stakeholder participation for service use and cost sharing, are the basic features of FMIS. During recent developments of several new water projects in the basin, the roles of these traditional stakeholders are undergoing a changing process. Now, the DDC and the VDC are in the process of becoming major local-level institutional stakeholders of water resources.

Figure 6.1. Water use practices in the Melamchi WSP intake in the Melamchi river subbasin, Nepal (not to scale).



According to customary law the existing water users have got first rights, to use water over the newcomers. Hence, any proposed diversion of water from the river basin should not negatively affect the present water use practices, unless adequately compensated for. As adequate information on how much water will be left in the river after diversion is lacking, it cannot be guaranteed whether the customary use right of the present users will be protected. As sufficient water is available in the basin and the stage of economic development is low, it is anticipated that the potential adverse effects of the water diversion project at the donor basin (Melamchi) will be at a minimum level. However, the situation may change in the future depending on the development activities of the basin.

Traditionally, drinking water needs and irrigation get priority over other uses, followed by ghatta and water mill or hydropower. Water rights of all sectors are secured as follows:

- according to customary practice, where first user gets priority (a kind of appropriation rights)
- physical situation—priority to head enders over others, (i.e., riparian rights), and
- registration at VDC, or at DDC, or contribution for the establishment of private enterprises and communal property viz. ghatta, water mill, micro-hydro, etc.

Some ghatta owners have secured their water rights either by registration at VDC or by location at the upstream of the other irrigation systems. However, the irrigation system even at the downstream, gets priority over other uses during transplantation and flowering stages of paddy. This is logical, considering that agriculture is the predominant occupation in the society, and that the community well-being in a year; largely depends upon the success of the agricultural production in that year.

The water-turbine-operated mill owner usually gets secured water rights through the consent of users of other activities, for taking on responsibility for the O&M of the field channel. That is, approval of prior users is important in the community for securing new water rights, or altering the existing water rights.

In many irrigation systems, the water rights of the poor and marginalized groups of farmers are not secure as those of the others. For example, in the Subedardhap irrigation system, the hydropower main committee dominates in the allocation of water among different water users, viz. irrigation, hydropower, water mills, and *ghattas*. The majority of the UC members of the micro-hydro community are head-reach farmers who belong to the affluent groups of communities. There are complaints that, it is often hard to get a committee decision in favor of the poor and marginalized people. Some of the ghattas have even secured water rights by paying an annual fee to the VDC. However, when it comes to allocation of water during the water-scarce period, the decision of the farmers (irrigation users) always prevails over the other water users (ghattas). Therefore, despite the fact that some have got formal water rights, inequity in enforcement of water rights and water allocations occurs. This is also due to lack of an equal participatory decision-making process at the local level. In the case of the irrigation system and the arbitration of any dispute by the VDC (local elected body), the inclusion of tail-end farmers in the UC, would potentially reduce inequity and help ensure protection of water rights of all the users.

6.2 Processes of Inclusion and Exclusion in Water Use Services

The processes of inclusion and exclusion of the users (communities), in water use activities are largely determined by the process of new investment in water resource projects by the government, community, or by the private sector. The negotiation and the compromise reached among the concerned parties, affect the process of inclusion or exclusion of certain groups or communities in the use of future water project services. Those who are able to influence the decision-making process are usually included as project beneficiaries and benefit from the development of new water use activities. Understanding the needs of various water users and providing an opportunity for their participation in new water use activities, are crucial for the inclusion of large number of users, especially the poor and marginal users who are generally excluded from receiving the development-project benefits.

Irrigation

In selected tributaries of the Indrawati basin, rehabilitation of irrigation systems enabled the inclusion of some new areas as well as new users. For instance, rehabilitating the Subedardhap Ko kulo, irrigation systems enabled it to be expanded to include an additional 60 hectares of rain-fed upland of 40 households into the command area. Likewise, the rehabilitation of Nayadhara irrigation brought an additional 30 hectares of land into the command area in the Thangpalkot VDC.

Despite increases in the irrigation command area after the rehabilitation of the irrigation systems, some of the households that were interested in joining the irrigation system could not be included due to technical and other factors. For example, in the Taruki Besi irrigation rehabilitation project, some farmers were left out of the command area due to the construction of a new intake/canal upstream of the existing temporary intake because of topographical and geographical constraints. The excluded farmers did not protest, as the change in the intake site was due to a genuine technical reason. The previous intake site was vulnerable to landslide and erosion.

Micro Hydropower

The poor and marginal households are usually excluded from the service of electricity generated from a privately owned micro-hydropower because of their inability to provide the required financial contribution for its construction. Some of them are not in a position to pay the monthly minimum electricity charge (about NRs 25.00 per month). The case is, however, different in the community-owned hydropower projects, where the users have to contribute labor in construction works to get access to the electricity services. There is however a provision to include these households again by charging them twice as much as that of the others, if the concerned community organization permits it to do so. In the case of the electricity from a private owner, it is distributed only to those people who are able to pay the electricity charges, which is a natural way to encourage private operation in the sector. To avoid this economic exclusion, the DDC contribution of the micro-hydro should be targeted, to the service provision to those vulnerable households. Besides exclusion related to economic factors, no cases related to social exclusion were noticed in the use of micro-hydro service in the studied areas.

Drinking Water

In the selected drinking-water supply projects, some people were excluded from the drinking water facility due to technical problems (such as scattered settlement patterns and costly fixed expenditure for establishment of the facility). For example, eight poor *Tamang* (a hill tribal community) households of the Nayadhara drinking-water supply project and two households of *Giri* (a hill tribal community) people of the Nagi Danda drinking-water project, were excluded from the drinking-water facility because the cost of fixing separate tap-stands was comparatively higher due to the scattered nature of the settlement. Thus, inability to bear the high fixed cost was the major reason for their exclusion.

Fishing

Some of the *Danuwar*s (a hill tribal community) and the traditional water mill owners engage in fishing activities in the basin during their spare time. This is a major source of their income. These fishermen feared that due to reduced river flow in the Melamchi after the water is transferred out of the river, there may not be enough fish in the river and they may lose one of their major sources of income. There are only a few households that depend on fishing, downstream of the project.

Multiple Uses of Water and Exclusion of the Ghatta

Development of new irrigation systems and rehabilitation programs of old systems, have gradually excluded ghatta owners from their water rights, mostly during the dry season. In the Thangpalkot VDC the water rights of Handi khola ghatta were encroached by new users without any compensation given to the ghatta owners. This type of encroachment on water rights frequently occurs during the dry season, when the river flow is at minimum level and also during the paddy planting seasons. The traditional system of giving priority to the irrigation water use and rotation system introduced for allocation of water between irrigation and ghatta has led to this situation. The farmers (irrigation users) are in a majority and are relatively better off in the communities; hence they usually set the rules for the water allocations for various sectors, which usually marginalizes the *ghattas* and other minority water-rights holders in the communities. Besides, the ghatta owners reported that they are usually not consulted when new water use activities are implemented in the village. Thus, their requirement is not properly addressed even if there are any village-level consultations (a kind of social exclusion). Hence, the development of new water use activities has had a negative effect on the prior use right of the ghatta owners, for example the new water allocation norms introduced after the construction of the irrigation system in the area. Some of the ghatta owners immediately downstream of the project intake are likely to also be affected from the water diversion. Therefore, the project compensation package should address these issues carefully so that appropriate compensation can be made, targeted to the project-affected communities, and more to the adversely affected households.

6.3 Impact of the Inclusion and Exclusion

The processes of inclusion and exclusion in the irrigation sector bear considerable impact on the livelihoods of local people (households). The newly included farmers in an irrigation system have been able to harvest three crops a year, paddy in the spring and summer, and wheat in the winter. Access to irrigation ensures a permanent income to the households compared to those excluded from such facilities.

The damage to the canal in Kiul VDC by Melamchi-Timbu road, constructed by the MWSP has excluded several households from the irrigation facility, electricity supply and water mill services. Therefore, the Ambar Tar Churitar Ko kulo people face more hardships due to the exclusion from the irrigation and mill operation. This is, however, expected to be temporary until completion of the project construction work. On the other hand, this road has facilitated the people of Palchowk Beltar Bhattar villages to send locally produced milk and the crops to the Kathmandu valley market throughout the year. The road infrastructures have given different types of impacts depending upon their locations.

It was noticed, when initiating a new water project in the communities, that the prior water use rights of the minority community were commonly encroached. This is due to lack of not only formal water rights but also of a proper enforcement mechanism on water rights. There is a need to have an adequate benefit-sharing mechanism; and provision for compensation, to those excluded from the new water service facilities. The exclusion of the poor and marginal groups in the use of hydropower services; due to their inability to pay monthly bills, could be addressed through additional income-generating activities in the villages. This can also be addressed through DDC-targeted subsidy to the selected group using their labor force as a contribution for the rehabilitation and maintenance of the project. This would not only enhance their capability to pay for the services but also will not suppress the private entrepreneurship in the village to further invest in the micro-hydro project or water mill.

Special attention needs to be paid for the water rights of the different sectors to avoid the social exclusion in water uses. The encroachment of the water rights of the minority community members is commonly seen more than that of the majority community (farmers), which is one of the reasons for the inequity of water uses across the members and sectors. In the irrigation sector, additional funds for construction of the intake structures will resolve most of the water crises in the basin. However, the economic scarcity on managing water is problematic. The Indrawati river basin is still an open basin and water availability for irrigation is not a constraint, but the financial resources required for the development of the physical structures and intake construction are limited. Likewise, careful planning, and inclusion of the tail enders in the UC could ensure protection of their rights to derive benefit from the water uses.

6.4 Water Disputes and Cooperation

The discussions in earlier sections showed that the present water use is at a minimum level in the basin; and that customary practices and informal arrangements of water allocations, are working satisfactorily to resolve any disputes among the users. No serious cases of water disputes have been noticed in the basin, perhaps because it is an open basin. Some of the

selected characteristics of the basin in relation to water disputes within a sector, or across sectors, are as follows:

- Abundance of water availability in the river basin, since Indrawati is still an open basin.
- Almost all the water-turbine mills are located downstream. Therefore, the mill owners spend for the annual O&M of the canal and the farmers get free irrigation services for providing access to the land for the construction of field channels for water mills. This level of extra benefits to farmers may be a compensation for sharing their prior water rights with the new water users (water mill) in the community.
- There is a customary practice, of maintaining a distance of at least 200 meters between the upstream and downstream intakes along the river. This has helped reduce conflicts between the two irrigation systems (ghatta, and/or mills intake). A new intake at the upstream should maintain a distance at least 200 meters from the existing intake. The downstream users would not allow a new construction if the upstream user does not follow this practice, unless there is sufficient river flow year-round.⁹

Nevertheless, some water-related disputes do occur in the basin community, occasionally when the irrigation users disrupt the water flow to the ghatta and the water mill without informing the owner. This happens especially during the winter and spring when the water flow in the canal is reduced.

Water-Related Disputes between Ghatta and the Farmers

The reported cases of water disputes between the ghatta and the farmers occur mainly during February to May, when the water flow in the river decreases substantially. The irrigation users claim that the ghatta owner does not check the leakages in the field channel, which would otherwise increase the flow adequately to meet the need of both users. Unlike the water disputes in the irrigation use and the water mills, no appropriate mechanism exists for resolving the disputes between the farmers (irrigation users) and the ghatta owners. The farmers, who are in a large majority, usually ensure adequate flow in the canal for their fields even by disrupting the ghatta operation, and closing its operation for a few days during acute water-scarcity. During this period, the farmers depute someone to patrol the canal and guard against the intake side to maintain the continuous flow of water. However, the VDC could intervene in this sector and effectively resolve some of the disputes. VDC membership is a little more representative of all the community in the area, as the electorate provision for VDC gives the suppressed community at least a chance to exercise its voting power in every 5-year rotation.

Conflicts between Irrigation and the Water Mill

Occasionally disputes occur between irrigation users and water mills, mostly in small tributaries, and mainly for the spring crop (beginning of May) and in the main season paddy planting season (beginning of July). One of the VDCs in the basin resolved such disputes in the past by

⁹In reality, 200 meters distance varies by locations, considering the mountain, topography, etc. This distance will avoid the potential conflict among water users in the river areas. But, customary law suggests maintaining the distance, to prevent any potential disputes.

proportionately allocating the water between the upstream and downstream users, which is abided by both disputing parties.

Sometimes, water-related disputes are also seen during paddy harvesting when there is leakage from the canal, mainly due to lack of timely maintenance of the field canal. In the past, a case had also been filed at the VDC. Occasionally, there are also cases when farmers have disrupted the water flow to the ghattas and water mills. Likewise, the mill owners complain that the irrigation users do not contribute anything—neither labor nor capital costs—for the O&M of the field channel. Also, that the farmers do not even share costs for augmenting water in the canal. However, they receive almost a free-rider benefit from the present set up. The mill owners in the area favor a cost-sharing mechanism with the benefiting farmers (irrigation users), specifically for O&M of the field channel. Although some VDC officials agree, the farmers (the irrigation users) do not like the idea of contributing to the O&M of the channel since they think they have got the first right for irrigation by providing the land for the field channel. The local water institutions are in the evolving process, and such frequent frictions may ultimately provide an incentive for better local-level institutions in the future, and the establishment of formal water rights or a formal cost-sharing mechanism.

There are some cases of disputes between the irrigation users and the mill owners regarding construction of new water uses.

Resolution Mechanisms for Water Disputes

Until now, the disputes between the irrigation users and the mill owners were usually resolved through dialogue and mutual understanding between the two parties. It is usually the mill owner who puts extra effort to increase the water volume in the field channel, and he is also responsible for O&M costs of the canal. In a situation when it is not possible to increase the water in the canal, the mill owner closes the mill for 1—2 hours when irrigation is required. As water supply gets scarce, this type of customary law; which allocates costs unequally among the water users, with norms designed for a plentiful water-available situation may create further conflicts among the users, unless there is timely evolution of better institutions. Therefore, occasional disputes between farmers and water mill owners may assist to establish some sort of formal water right negotiation, or a water-sharing mechanism.

The customary practice of maintaining at least a 200-meter distance between the upstream and downstream intakes, to some extent, has helped reduce conflicts between members of the two irrigation systems, and other users. Occasionally, the VDCs also intervene to resolve the water-related disputes between the irrigation systems; for example, in one of the tributaries of the Melamchi khola, the VDC intervened to enforce water use based on proportionate allocation between the upstream and downstream users. The water allocation was proportionate to the landholding in which the Jageswor kulo (upstream FMIS) was allocated to use water for 4 days and Tarshera phant kulo (downstream FMIS) for 3 days. Both the upstream and downstream irrigation users agreed to this ruling. This arrangement was only meant for the spring crop (beginning of May) and the planting season (beginning of July), when water scarcity is largely felt. Both the upstream users and the downstream users have abided with the above decision of the VDC.

In relation to the water disputes, the local-level elected institutions (DDC and VDC) lack authority and also technical and managerial capability to effectively plan for water resources

development in the district. The DWRC, which could have played a key role in resolving such large-scale water disputes within the district, is underutilized. Its role is confined to the registration of the WUA, which can even be done at the District Irrigation Office.

With respect to managing the water resources on the principles of IWRM, the local communities are managing the water resources using centuries-old informal institutional mechanism. However, with the growing demands and increasing number of large-scale water projects such informal institutions designed to resolve small-scale water disputes might not be able to tackle all the complex water disputes, and the water allocations for large sectoral uses. To protect the welfare and water rights of the minority users, and to enhance the equity of resource uses, it may be time to introduce formal water rights by allowing registration of the local water rights at the DDC at the district level, and at VDC at the village level. In that respect, the role of the formal organization, particularly of the DWRC, is crucial for resolving any of these major water use conflicts in the district.

In principle, the DWRC can also take a leading role to initiate coordinating different district-level agencies in the water sector, and the various water use activities. It can potentially provide a forum for dispute resolution even across the districts, and coordinating the water use activities. Due to the administrative setup and the structural weakness, the role of the DWRC until now has not been up to the spirit of the Water Act of 1992, under which it was created. A few changes in the present Water Act (1993) can make the DWRC body active in conflict resolution, intersectoral planning and water use activities in the district and across the district. For example, increased role of several other local stakeholders like the DDC and district irrigation and water supply agencies, and increased representation from local WUAs like the FMIS and local water supply organizations in the set up of DWRC.

7. Integrated River-Basin Management

This section assesses the possibility of the adopting Integrated Water Resources Management (IWRM) in the Indrawati river basin, and also the complexities involved in the adoption of the IWRM framework in Nepal. There is no uniform set of standard IWRM framework, which can be applied to each and every country; rather the designing institutions under IWRM are flexible to suit the local context. How to design appropriate water institutions for a country based on IWRM principles is still a tricky question in the literature of water resources.

This section assesses some of the IWRM issues in the context of integrated River Basin Development Planning and Management (RBDPM). The application of IWRM in the river basin results in the improved management of the river basin. This section also reviews some of the international literature on RBDPM applicability and some of its concepts and framework in Nepal.

Water sector professionals in Nepal have shown a high-level of interest to have such a review of international literature on the topic in the context of applicability of the IWRM concept, which would assist in process of water-sector institutional-reform in Nepal. Therefore, it is expected that this review of literature on IWRM and RBDPM will be particularly useful to the water-sector agencies and researchers in Nepal to assist them in initiating the institutional-development process in Nepal.

7.1 Basic Concept and Framework for River Basin Planning

RBDPM, is a widely accepted framework for sustainable development of water resources worldwide, particularly more so after the Dublin Conference (1992) on Water and Environment, and the Earth Summit (1992) on Environment and Development (chapter 18 of Agenda 21). Comprehensive management of the water resources using RBDPM is one of the four key principles adopted by the Dublin Conference in 1992, a significant milestone in managing water resources, for the sustainable use of global water resources

The river basin is basically the catchment area of a particular river, thus it is a geophysical (hydrological) unit, with a high degree of functional integrity and a large number of interrelationships (with the socioeconomic, institutional and other environments of the catchment area). It is a relatively homogenous system even when upper, middle and lower sections have different conditions and human activities (Barrow 1998; Betlem 1998). Thus, a river basin is a hydrologically and ecologically functional unit. It is a focal point for development and planning of a region and has a sustainable area development goal of resources management and planning. The need for integrated management of water resources is increasingly felt worldwide. Especially as the competition for water, among the different sectors is increasing, which results in conflicts due to water scarcity.

In this context, RBDPM broadly consists of the major activities planning, management, and conflict resolution.

The operationalization of the RBDPM largely varies by countries and regions because it is an “integrated theme” and “development tool” for social, economic, institutional and environmental (ecosystem based) well-being of a river basin catchment area. Hence, its concepts are much broader than the traditional sectoral approach of water development.

The RBDPM seeks to integrate three separately evolved concepts which are interrelated, i.e. a) multipurpose development, b) integrated role for the drainage basin unit, and c) acceptance of intervention to promote development, typically seen to be improvement of social welfare in a regional context (Barrow 1998).

Moreover, the basic concept and meaning of RBDPM has been changed over time, from orderly marshalling of water resources of a river basin to promote human welfare (by UN) in 1970, to a much broader concept, and as a planning tool for achieving a sustainable development goal in the mid-nineties. The present thinking on RBDPM is a much broader concept, which includes integration of watershed, groundwater, land use, river regulation, human-welfare improvement, health care and most aspects of development (Barrow 1998). The present thinking on RBDPM is, that a river-basin resource can be best described as common property resource (CPR). Hence, there is a strong proposition that the RBDPM should be largely undertaken by the public sector since the *laissez-faire* type of market mechanism, always underprovides such common property nature of services available from the river basin.

A variety of RBDPM models have been observed in practice. According to Barrow (1998), some of the major kinds of river basins can be grouped into the following six categories:

- | | |
|------------------|--------------|
| i single purpose | v integrated |
| ii dual purpose | vi holistic |
| iii multipurpose | |
| iv comprehensive | |

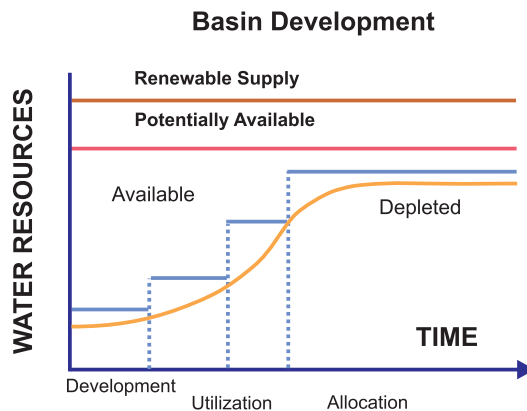
The first four terms above are fairly straightforward and self-explanatory, and therefore, only the last two terms of RBDPM are discussed here. *Integrated RBDPM* goes further than comprehensive management of water resources, and it advocates using water as a “tool” for social and economic development and environment purposes. It provides a solid framework for integrating water planning and management with the environmental, social and economic development (Barrow 1998). The traditional concept of RBM, which focuses on the single sectoral use of the water resources, has also been in the process of being refined in recent years. The integrated RBDPM includes the application of the sustainable development approach including ecological consideration, broader-scale stakeholders’ participation, and increased public consultation during development and uses of water resources. The *holistic* approach of RBDPM is a much broader approach than the integrated approach, and it encompasses more on the region and ecology approach and focuses on the river-basin management in the principle of chaotic complexity (of ecological function) in the region. The concept of chaotic complexities is based on the belief that everything on earth is interconnected, and the whole is always greater than the sum of its parts. However, operational setting of the holistic approach is a complex task, and rarely has it been practiced anywhere.

7.2 RBDPM — Operationalization

The framework of RBDPM provides satisfactory coordination of diverse interests of stakeholders within the basin. In practice, RBDPM bodies have varying goals, jurisdictions and authorities. The variety of roles and several kinds of institutional innovations of RBDPM depends upon the relative scarcity of resources (water) in the locality, whether the river basin is already closed, nearly closed or an open basin, upon the level of technology available, and upon the level of economic development in the region.

What is the most appropriate institutional arrangement for management of the river basins? Certainly, there is no “one-size-cut-fits-for-all” type of answer available for the above question. The most appropriate institutional arrangement depends on the level of economic development, level of water scarcity, and the technology available in the river basin. The institutional arrangements of any place are not static at any moment, but are dynamic and they change over time with factors like level of scarcity of the water resources, and level of technological changes (North 1990). In fact river basin management institutions evolve and change over time, in relation to the changes in biophysical factors (hydrological changes), socioeconomic factors, and level of technologies available, the increasing scarcities of water (rising water demand), and increased value of water induced technical and institutional changes, also called induced technological innovation.

Figure 7.1. Different stages of the river basin development, based on the level of water scarcity.



Original source: Molden, et al. 2001

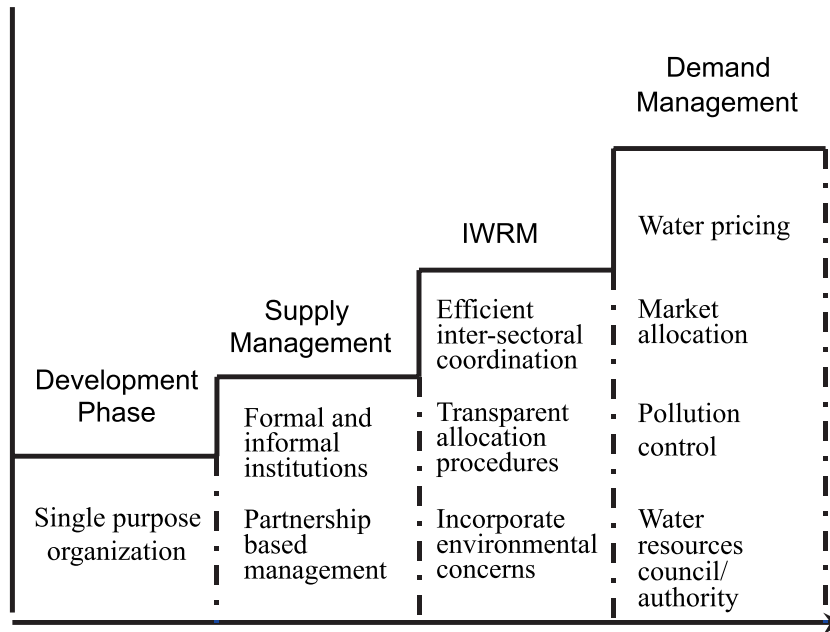
A recent IWMI study on variation of institutional arrangements of RBDPM across five selected countries has tried to explain some of the factors affecting the changes in the selected river basin institutions. The study identified four distinct stages in the development of river-basin water resources:

- i. development or construction stage;
- ii. supply management, where the emphasis is on managing supplies and water savings;
- iii. integrated water management stage in which there is growing intersectoral competition the dominant task is setting priorities for the allocation of water among sectors—irrigation, domestic, industry, environment; and
- iv. demand management stage in which the river basin has become “closed,” i.e., all available water has been allocated to various uses and scarcity management becomes a paramount task.

Details of some of these issues are found in Samad 2001 and other IWMI publications on river-basin management.

The hypothetical development path of a river basin and the recent issues on river-basin management challenges are also illustrated in figure 7.1 and table 7.1. The figure provides the different stages of the development path in river basin management, and how the operational policy varies from the development path. Likewise, table 7.1 highlights some of their salient features and factors affecting the variation of river-basin institutions. These issues and operational strategies on RBDPM as shown in table 7.1 are not mutually exclusive, rather there is considerable overlap in the management challenges and the strategies adopted at any particular stage. For example, when the basin is closed or almost at the closing level then it will require altogether, an integrated approach to water resources management, components of supply management and investment in infrastructure development. Basically, water then becomes one of the critical binding factors on the production system, and its allocation needs top priority for sustaining the development process, as seen in some of the closing river basins, for example, the Yellow river in China and the Jordan river valley in the Middle East. In this context, some of the suggestions for the institutional arrangements appropriate as per the different development stages of river basins are given in figure 7.2 below.

Figure 7.2. Basin development stage and institutional complexities involved.



Original Source: Samad, (2001); and Keller, et al. (1998)

Table 7.1. Different operationalization issues and strategies of river basin management in a country, based on the development stage.

Development stage	Supply management	IWRM	Demand management
Infrastructure development	Managing supply distribution	Increases in intersectoral competition	Physical water scarcity
Low value of water	Investing and improving O&M	Intersectoral water conflicts	Water conservation
Economic scarcity	Efficiency in water use	Holistic view on water	High value of water
Low intersectoral competition	Modernization and rehabilitation of infrastructure	Conjunctive management	Shift to high-value use
Simple technology	Diluting pollution	Increasing value of water	Regulating groundwater
Inclusion of poor in the development facilities	Localized/intra-sectoral conflicts	Prioritize allocations	Pollution control
	Emerging pollution/salinity	Greater environmental concerns	Best possible overall use -- basin efficiency
		Safeguarding the interest of the poor and disadvantaged	

Source: Sakthivadivel and Molden 2001; Samad 2001; and Keller, et al. (1998).

7.3 RBDPM Application in the Context of Nepal

The RBDPM approach could provide several more advantages than the single purpose planning of the river, such as better management of the ecosystem, or economic use of resources, or minimizing the conflicts over water and effective use of resources. Considering the complexities of the geophysical settings and lower level of development stages, mostly dominated by lower-value water uses, the operationalization of the RBDPM framework in the case of Nepal may need some adjustments and tailoring of framework as per specific needs of the economy.

Despite having a common framework, the operational rules and procedures of RBDPM vary by country-specific situations and by regional factors. There are no river basin management operational activities in two nations that are exactly similar. Hence, the application of the RBDPM concepts in Nepal has also to be understood in the same context. In Nepal due considerations are needed, on the following specific factors to tailor the RBDPM framework:

- a. *Geophysical complexity of the river-basin setting*: Almost all major river basins in Nepal originate in the Tibet region of China, and become tributaries of selected four or five major river basins, which are all again basically subbasins of the Greater Gangatic basin downstream in India. In this context, how to clearly delineate the hydrological boundary of a river basin within Nepal is a complicated task, which needs to be analyzed thoroughly. River basin management in Nepal would be different from that of a large nation, such as India, Australia, USA, and China, where the originating point and ending (lower-end confluence) of the river are basically confined within the geographical boundary of a nation. While designing operational policy of the RBDPM in Nepal, this factor needs to be considered well in advance and modification of the framework should be done accordingly.
- b. *Large variation of the basin hydrology*: In Nepal, the geophysiological and hydrology of the river basin in high mountain areas is vastly different from the southern plains (*Terai*) of Nepal. This causes a large variation in regional and local environment and other related factors within a short distance (within few kilometers) in a basin. Due to the rugged geography and complex hydrology, the variation of some of these characteristics within the basin, north to south, is much higher than the interbasin variation.
- c. *Monsoon dependence and high inter-seasonal variation of river flow*: Large variation of inter-seasonal river flow creates a major hurdle and several other complications on river water uses, and high level of uncertainty. More than 90 percent of the annual river flow occurs within 4 to 5 months of the monsoon seasons (June to October), and the annual river flow substantially decreases during the remaining months. In addition, there are less reservoirs and physical control structures in place to facilitate the smooth and controlled allocation of water within and among the sectors. All these factors lead to ineffective monitoring of the river-basin activities, which could further complicate the coordinating process among different agencies involved in the water sector, even if they are all brought under one umbrella of the RBDPM planning process.

- d. *Open basins and low level of water withdrawal*: In the basin context, there is less than 5 percent of annual net withdrawal (Mishra 2000) out of the total available water in the river basin. All water flows out of the basin (and in Nepal) within 4 to 5 months of the monsoonal season. The Indrawati water accounting report also suggests that the annual total withdrawal rate in the basin is less than 4 percent of the total water available in the river basin. As shown in figure 7.1 and table 7.1 when the river basin is at open stage there will be little incentives among the stakeholders to participate in the basin planning process and overcome the transaction costs of the river-basin management process. Besides, the lower economic development level in the basin may not provide enough incentives (economic rewards), for involvement and creation of new water institutions including those of RBDPM.

At the lower stage of economic development, the amount of water withdrawal is at a minimum level compared to the available water resources in the basin. At that stage of development, the amount of the naturally available water is also not a constraint to the society, with the exception of some of the arid and semiarid regions. In the initial stage of the development, there may not be any incentive for having river-basin management institutions, since the water is not a binding factor in the economy, and is rather easily available to all, if the needed infrastructures are in place. But as the economy starts on the development path, there will be a need for more organized water infrastructure, as the demand for water withdrawal (either for agriculture or industry) will increase. When, the economy moves to the transitional stage, then there will be some water-related infrastructure in place, and the competition for water uses will also expand further, so the demands for water will also rise further. This leads to the need for the allocation management. Detailed discussions on these issues can be found in Sakthivadivel and Molden 2001 and Shah et al. 2001.

What will be the sort of institutional mechanism suitable for the RBDPM in Nepal? The answer depends upon several underlying factors and it needs a careful evaluation. As figures 7.1 and 7.2 and table 7.1 show that there are four broad stages of development in the case of a river basin.

- development (infrastructural)
- transitional (supply management)
- IWRM
- allocation (demand management)

Each development stage of the river basin requires a different strategy, details of which can be found in Sakthivadivel and Molden 2001 and in Samad 2001. Hence, Nepal's present situation of demand and supply of water in a basin is at the developmental stage. Therefore, the framework of RBDPM in the context of Nepal should match the need for water management at this stage.

Small-scale basin studies like the studies done in the Indrawati river basin can provide information on micro-level water uses, the local water institutions, the water conflicts and the water-sharing mechanism at the local level. However, such a micro-level study may not be able to provide a broad-scale picture of the complexities involved in creating regional institutions with such wide implications, authorities, and activities involved. For this, a separate

study will be required along with assessment of all the macro and meso level factors affecting river-basin planning and management in Nepal.

In the case of Nepal, the DWRC, in cooperation with the DDC, would currently be the best available institutional setting to initiate interaction among different stakeholders within a district (subbasin) and provide intersectoral linkage. This union could potentially start implementing some of the RBDPM principles at the subbasin or basin context. This can be done by coordinating among the different water-sector agencies by slightly altering the present structure of the DWRC in line with river-basin management. The representation of other major local stakeholders in water-sector decision making, within the DWRC, may provide a first step in initiating the concept of river-basin planning, or subbasin level planning in Nepal. In fact, the Government of Nepal can potentially assess the complexities of the river-basin framework by approaching the planning framework for the Bagmati river basin in the Kathmandu valley, where the water is already scarce and river flow almost closed in some of the months in the dry season.

Some sections of the selected river basins in Nepal are at closing level, for example, Bagmati river basin, particularly, the portion within the 20-km stretch of the Kathmandu valley. Therefore, operationalization and pilot-testing on some of the concepts and principles of RBDPM in Nepal would be very relevant for some portions of the Bagmati river basin, particularly in the Kathmandu valley region. The Bagmati river basin as a whole is an open basin when it flows out 10 km downstream of the Kathmandu valley, and 10 km upstream of the valley range, but it is almost closed within the range of the Kathmandu valley. Therefore, the Bagmati river basin provides a perfect pilot site for testing the viability of river basin planning and implementing approach in the context of Nepal.

8. Conclusions and Policy Recommendations

8.1 Conclusion

This section provides conclusions and policy recommendations from the discussions reported in earlier sections. The focus of the discussions and policy recommendations here will be more in respect of the Melamchi water project and its likely impacts in the Indrawati river basin, and the institutional, hydrological and other social issues affecting the process.

Complex sets of water use practices with a long history of water use prevail in the Indrawati river basin. However, as the water-use activities grow by the day, the pressure to establish formal and transparent water allocation rules and procedures to replace the mostly informal water allocations, are also mounting in the local communities. The various mechanisms developed for local-level water use, and long traditions of relying on FMIS institutions in Nepal, could provide a reliable and a solid foundation for developing an Integrated Water Resource Management (IWRM) framework at the basin level. This also assists in the operationalization of the Integrated River Basin Development Planning and Management (IRBDPM) framework for managing the river resources in the basin.

Melamchi Water Project

There was some skepticism among some of the local stakeholders, including local institutional stakeholders, about the water availability in Melamchi after the planned diversion of water to the Kathmandu valley, even though the Melamchi project has got a plan to release of 0.4 m³/s of water in the dry season, as a minimum environmental flow requirement of the project. These different perceptions and skepticism of the local stakeholders about the project could be mainly because of inadequate interactions between project officials and local stakeholders, and inadequate sharing of information by the project officials. Other than that, the case studies revealed that the local communities were not very much aware of the proposed the Melamchi Inter Basin Water Transfer (IBWT) Project, and its likely other impacts on their livelihoods in the basin. The minimal involvement of the local communities in the decision-making process of the project could be one of the reasons for this lack of awareness.

Considering the sufficient availability of water in the Indrawati river basin, the proposed water diversion project could have a minimum level of adverse effects on the local agricultural practices, except the immediate downstream reaches of the Melamchi project intake site. However, this could not be substantiated much due to the unavailability of adequate data. The Melamchi project has proposed various compensation packages worth more than US\$18 million to mitigate some of these negative environment and social impacts on the livelihood of the local population. Considering the previous water-infrastructure projects, this level of compensation is considered to be fairly high, particularly considering the level of economic development in the area.

The other major implications of MWSP could be on the existing institutional practices of water management at the local level. Removing a large volume of water is likely to change some of the hydrologic characteristics and river ecology, and may create additional stress on the present institutions responsible for water allocations and conflict resolutions. It is doubtful whether the existing traditional community-level institutional arrangements can effectively cope with the institutional crisis brought about by this level of external shock, as they were basically designed only for small-scale water allocations. However, much can be learned from the existing local-level institutions (formal and informal), to design any advanced set of institutional mechanism in the basin.

Water Balance Situation

The water balance study in the Indrawati river basin shows that it is an open basin; however, the subbasin may be near to being closed during the dry months, when water stress is more pronounced in the subbasin and its tributaries. The present process consumption level of water in the Indrawati river basin is at minimal level, and about 90 percent of the utilizable water, moves out of the basin as river outflow. Therefore, the proposed water diversion plan will have little impact on the Indrawati basin hydrology, except for some water scarcity felt in the 1-or 2-km reaches of the Melamchi river immediately downstream of the project intake site, particularly during the dry months from February to May. The planned water diversion is merely 2 percent of the average annual river outflow from the basin (even in the driest year). Additionally, in managing the environmental aspect, the Melamchi project has got a plan to maintain at least a 0.4 m³/s of water flow at the downstream of the project intake site, as a minimum environmental

flow for aquatic ecosystem, even in the driest season. This will potentially minimize the water transfer impacts on the local aquatic environment. However, it is not clear whether this minimum flow would be sufficient to sustain the other water use activities in the downstream reaches. The water use planning in this subbasin is constrained due to the spatial location of the feeder tributaries and therefore, all these factors need to be considered in the development of future water-use activities in the Melamchi subbasin, after the planned diversion of water out of the basin.

Water Institutions and Allocations

In the Indrawati basin, the present water allocation among various water sectors is at a minimum level compared to the water availability in the basin. Allocation is mostly governed by the customary practices. Formal water allocation rules have not yet been developed in the basin, mainly due to sufficient water availability, and the low level of economic development in the basin areas. Some of the major water use sectors are irrigation systems, the water turbine mills, the ghatta and the micro-hydro. However, the competition for the use of water is increasing mainly due to the development of the micro-hydro, new irrigation systems, and water mills, etc.

The traditional practice of water allocation provides priority to irrigation over other uses. Therefore, farmers are in favor of keeping these water allocations rather than introducing any other allocation mechanism (formal water rights), which is likely to equally favor all competing water users in the basin. During the study it was revealed that some of the large farmers (local elite) do not want effective UC functioning in the locality, as it may hinder their self-interest, and as it could increase the collective bargaining power of the small farmers and other minority community members in the society.

The conflict among the water users is less pronounced, as the water availability for various uses is not a binding constraint, except for occasional water-related disputes seen in the communities mainly in the dry season (January to May). Water-related disputes have been reported from some tributaries, which are usually settled by community-level mutual understanding and informal negotiation. Likewise, the dispute on water uses between irrigation and water-turbine-operated mills and/or the micro-hydro sector is particularly contained, due to the informal arrangement in scheduling of the operation of the water mill in the day and irrigation schedule in the night, respectively.

The existing informal institutions may not be able to cope with the external shocks brought about by mega-projects like the MWSP, and other hydroelectric projects. Therefore, increasing water activities in the basin may, in the future, encourage the users to develop a formal water-allocation mechanism and a new institutional arrangement. Although identified as an open basin, the water availability across the basin is not evenly distributed to fulfill the needs of all the users in all seasons. Some changes may be required in the existing water allocation procedure, flexible enough to adjust for the average flow and the minimum flow.

The VDCs and DDCs contribute to the development of water resources at their jurisdictions especially for the construction of the micro-hydro, irrigation systems, etc. Considering its role in other development sectors in the district, the DDC is already playing a significant role in water resources development in the district, which is more than what is provided by the existing national legislation on water (1992).

At the moment, the DWRC is not playing an effective role in planning for local water use activities in the district, despite a larger role envisaged by the existing Water Act (1992). The local DDC, particularly the Sindhupalchowk district, is interested in playing a bigger role in development of the water resources sector in the district, in spite of its minimum statutory role in the water sector. It is likely that such conflicts and friction in the systems and in the rules and regulations, and the ongoing court cases between the local DDC and the central government, may positively assist in the evolution of better and efficient water institutions in Nepal.

Social Exclusion and Equity in Water Uses

There are no established rules and regulations at the local level for securing water rights in relation to the development of new water projects, and water use activities in the basin. New water-related projects are implemented in the basin, utilizing the same source of water, without adequately taking into account the existing water use rights of the prior appropriators. The first users' water rights are encroached upon without giving any compensation to them. This is already a problem in the competition for water between farmers and ghatta owners and mill owners. The mill owners are resourceful persons in the community, who can exercise their social influence and negotiate their interest. The ghatta owners are usually from the marginal section of the society and they are usually the victims of such informal water rights and water allocation practices. The Melamchi project should also provide direct and targeted compensation package to the ghatta owners and other minor water users, and those who are likely to be displaced from the Melamchi project activities in the basin.

The need for a compulsory contribution of cash during the development of new water projects has also become a source of exclusion of households in the project's service-use activities later on; particularly the poor and marginal households that cannot contribute cash for the project activities. Inclusion in the irrigation sector has helped increase the agricultural production and reduce poverty of the included families and helped them secure water rights. In the case of hydropower, drinking water and sanitation facilities, inclusion of a particular household means access to better facilities as well as increased income and a more comfortable life style. This creates a positive impact to one group of households over the other group, who is excluded from these services.

8.2 Policy Recommendations

The major policy recommendations forwarded from this study are grouped into the following subheadings below, to cover the nature and scope of the case studies done in the basin earlier.

Melamchi Project

- The project should conduct more local-level consultations and information sharing with the local stakeholders in the basin. There are still certain levels of skepticism about the project among the local community members and local stakeholders, despite the fact that the project has a comprehensive compensation package, including the maintaining of a minimum environment flow (0.4 m³/sec) immediately downstream of the project intake

site. Frequent consultations and improved information sharing among the local stakeholders will promote awareness and avoid criticism.

- The project compensation package should be more targeted to the communities and households directly and adversely affected by the project activities, and this includes some of the ghatta owners and the FMIS groups immediately downstream of the project intake site.
- There is a need for a study on costs and benefits of water uses in various sectors, in the donor as well as in the recipient basin (Kathmandu), especially in relation to inter-basin water transfer. This deserves special merit for improved quantification of social and economic values (costs) of the interbasin water transfer decision, and sharing of the social benefits (costs) across the sectors. This information will be particularly useful for the effective management of the water resources and the efficient utilization of the other resources in the donor basin as well in the recipient basin.
- There is a need to continue an effective process documentation research (PDR) of the Melamchi project, particularly of implementation of the project compensation package to provide timely feedback to the project authority. The government experiences in dealing with the project compensation package and rehabilitation, task under the Melamchi project will also be equally useful for implementing other water infrastructure projects in the country. The national workshop discussions of this project in Kathmandu also concluded that the PDR should be continued in the Indrawati basin to understand the complexities involved in large-scale interbasin water transfer out of the basin. Particularly focussing on, its other impacts on social, economic and environmental aspects at regional as well as micro levels, and the local communities' strategies to cope with the changed situations.
- There is a need for further detailed socioeconomic research on quantifying the costs and benefits associated with the water transfer project, including quantifying some of the environmental costs and the total benefits to the society, which would help to improve understanding of impacts of the water transfer project. These include the impact analysis of the economic activities, environment, livelihood of the local people, and social and welfare gain in the recipient basin (Kathmandu). This will assist the negotiation process of the local community in securing the project-related compensation benefits and protecting their water rights. The improved understanding of these factors will also assist the Government of Nepal to properly design other water resource projects in Nepal. It would also help in understanding the institutional arrangement that may emerge to cope with the changes brought about by the project.

Water Accounting

- A detailed water balance study should be conducted at and around the Melamchi project intake site, to draw a precise picture of the local-level impacts of the project in the basin. This will provide an accurate estimate of the water available immediately downstream of the project intake site. The study will facilitate the development of appropriate institutions to cope with the impacts. Besides, it would assist in learning the precise impact of interbasin water transfer on the economic, social and environmental aspects of the local community, which is still confusing in Nepal.

Water Institution

- Given the present administrative and organizational setup in Nepal, there is a need to make a distinction between the regulative and planning function of government organizations at the district level, to facilitate improved management of the water resources and intersectoral coordination at the local level.
- At present, the functions of the DWRC are more regulative (legislative) in nature and, therefore, its structural setup needs to be reorganized to discharge an effective coordination across the sectors in the district. This can be altered by involving some of the local water-sector stakeholders in the DWRC committee, and representatives from FMIS and other water users. It may be better if the ex-officio chairperson and secretary of the DWRC are from the developmental agency (DDC and DOI), and not from the administrative sector. The existing structure of the DWRC needs to be tailored to fit the water-sector acts as well as other sectoral acts in the country. Moreover, all of these adjustments also need to be consistent with the decentralization in decision making and participation of local stakeholders in the water-sector decision-making process, which is also the core objective of implementing the IWRM framework in managing the water resource.
- The DDC could be the appropriate agency for the planning function of water resources, in particular, coordinating the development of water resources from private, community and other agencies at the district level when the activity covers several VDCs. In addition, in principle, the DDC is also responsible for preparing the periodic and annual District Development Plans for various other development sectors for the district.
- Close coordination between the DDC and the DWRC is required to prepare an integrated water resources plan for the district. It may be better, if the DWRC would work as a technical body of the DDC. Because of the conflicting nature of the two national acts, Water Act (1992) and Decentralization Act (1995), at present there is essentially a functional-level confusion between the DDC and the DWRC.
- If the functions of the DWRC in the legal framework are modified and strengthened according to the Decentralization Act (1995), it would facilitate better coordination of water-sector agencies and water-use activities within and across the adjacent districts. In turn, the success of functioning of the DWRC may lead to the evolution of the river basin planning process in Nepal.
- The role of local-level elected bodies (VDC and DDC) in the water sectors should be strengthened for better participation of the local stakeholders in the district. The VDC would be the appropriate agency for registration of the small-scale water-use activities at its jurisdiction, like ghatta and water mill, etc. The VDC should even be authorized to collect some level of taxes (as a registration fee) from some of these water projects within their jurisdiction. For a relatively medium-scale water project, like micro-hydro or small-scale hydropower (up to 5 or 10 MW), and water mills, the DDC may be an appropriate agency to coordinate at the district level as well as with the concerned sectoral agencies at the center. Then, the central government can better concentrate its efforts on the development of large-scale water projects.
- The centuries-old community-developed and practiced-innovative water use institutions could somewhat buffer the extent of the shock, and could also provide a sound basis for developing the IWRM at the basin level. Therefore, the process of building a new institutional

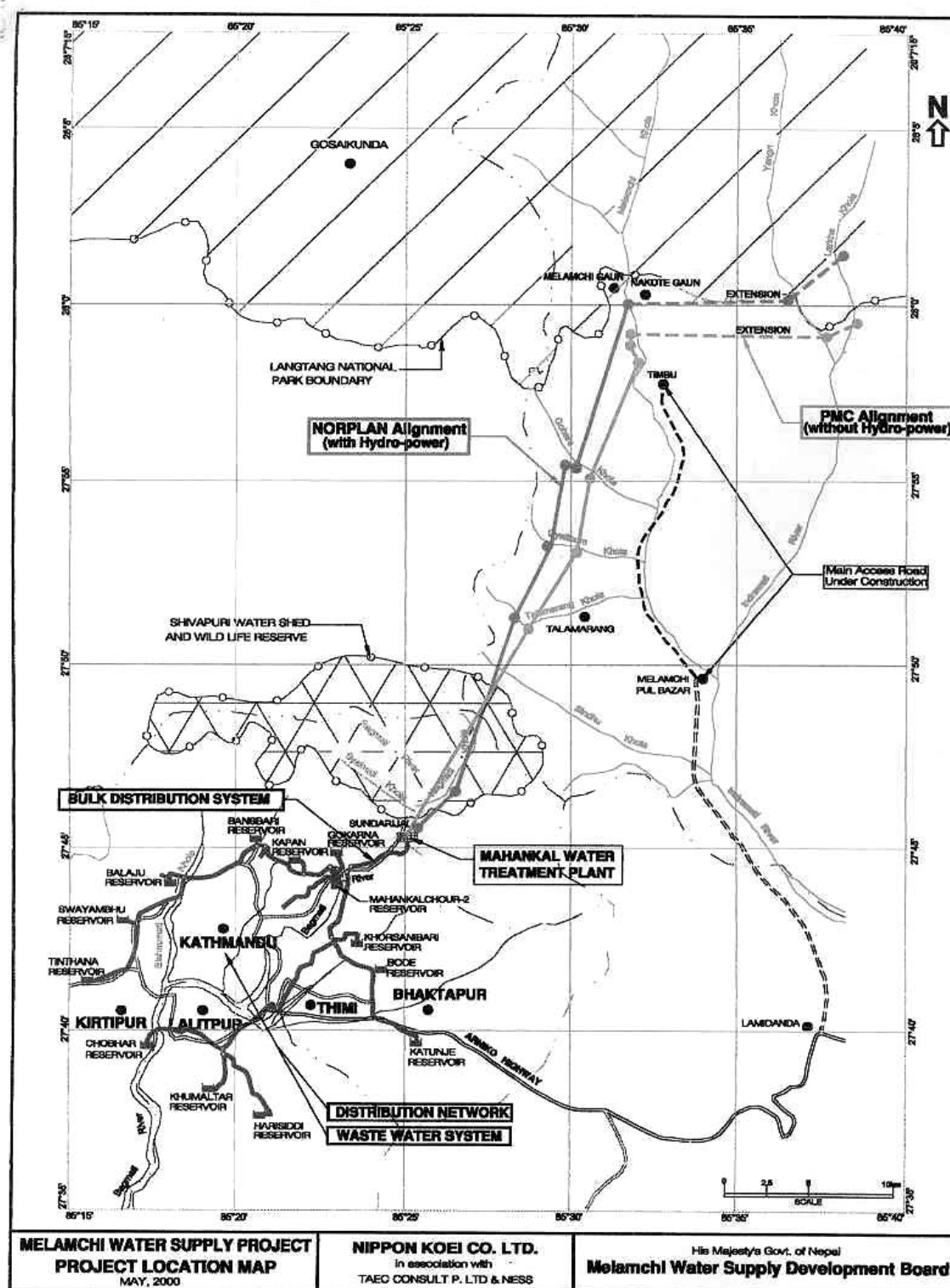
arrangement, if based on existing institutions, will ensure its success in advance. Therefore, there is a need for further exploration on how the community success in FMIS type of water-resources development process in Nepal can also be made effective at the higher tier resources management there, including managing the water and other natural resources.

Exclusion and Inequity in Water Uses

- There is a need to develop an effective mechanism for the protection of the water rights of the prior appropriators (first users) and to address the need of the poor and marginal groups while developing new water use activities, especially considering the dry-season water availability. The important aspect is to develop the capacity of the minority community to enable its members to participate in the decision-making process in water resources use. Strengthening of the institutional and negotiation procedures should be done so that the voice of the marginal water users is properly heard in the decision-making process.
- There is a need to have a formal registration on water rights of the local-level minority use (like ghatta owners) at local-level agency, like the VDC. This would greatly assist in designing a proper compensation mechanism during the intersectoral water transfer as in the case of the Melamchi project, or implementing any new water project in the basin. This would provide a formal basis for negotiation between the existing water users and the new (potential) users and designing an effective benefit-sharing mechanism and project-compensation package. This would allow movement of the resources from lower-value to higher-value use and pave the way for the development process, with due consideration to the equity dimension of the resource uses. The fear of inequity over future resources use is the usual skepticism on any water development project everywhere. In that sense, the securing of entitlement of water users, even of the minority users, would greatly increase their bargaining power during the negotiations over the project-compensation package.

Appendix

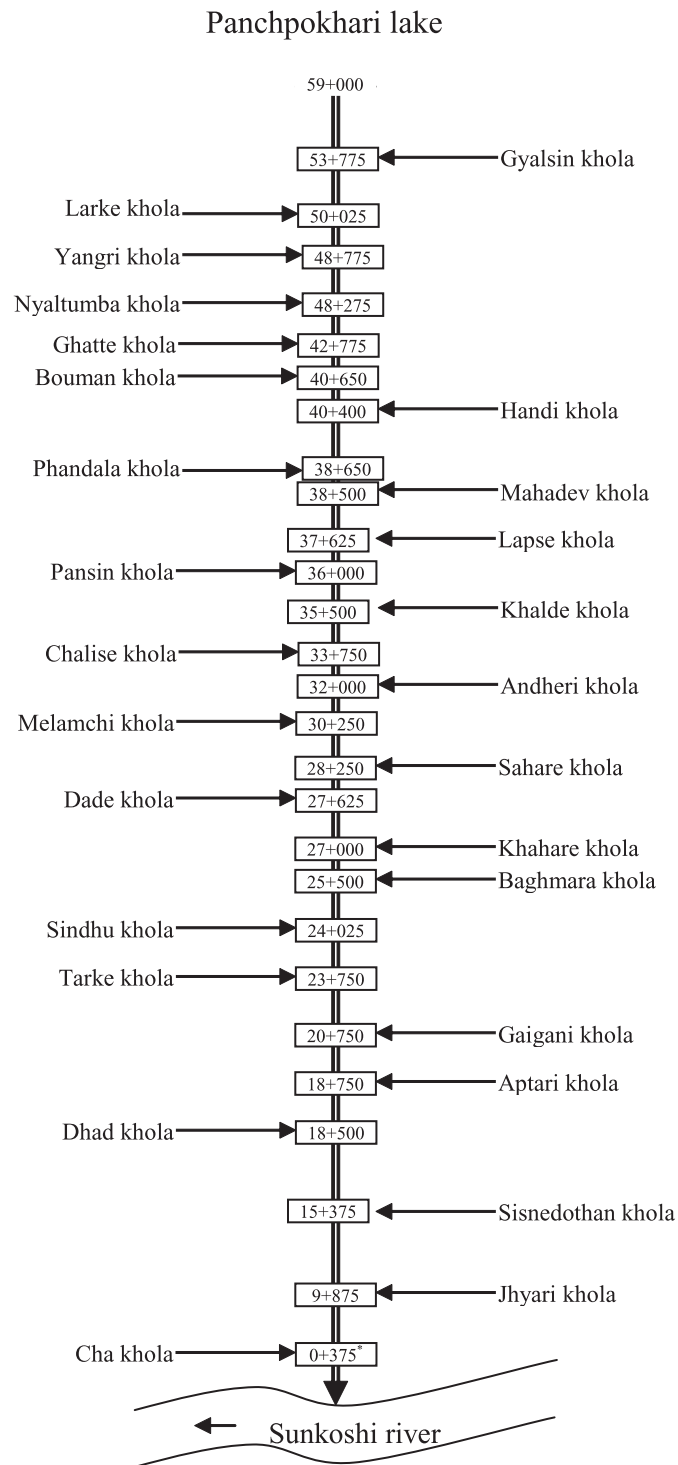
Appendix figure 1. Melamchi diversion scheme, engineering sketch.



Source: NIPPON KOEI Co. Ltd. 2000.

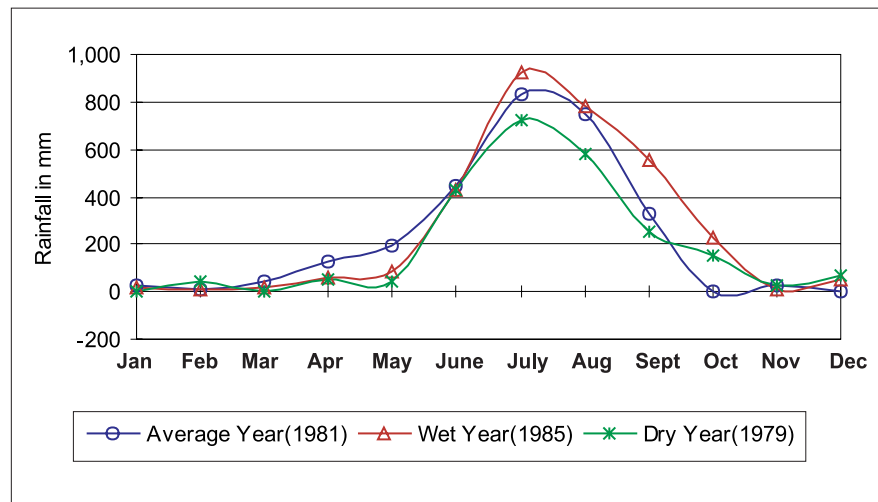
Note: The final approved Project plan in 2001 is without hydropower plant, so the Norplan alignment scheme as shown in the figure is dropped from the official approved project plan in 2001.

Appendix figure 2. The Indrawati



*Distance measured from confluence with Sunkoshi river (distance measured in km)

Appendix figure 3. Comparison of monthly rainfall for selected study years.



Appendix table 1. Brief description on sectoral water uses in the selected tributaries.

Source: Field survey 2000; and findings of case studies in the Indrawati river basin.

Appendix table 2. Average monthly and yearly discharge (in m³/sec) at the Dolalghat station no. 629.1.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly
1975	22.2	18.7	13.8	18.3	23.5	74.9	248.0	279.0	284.0	140.0	52.3	30.7	100.45
1976	23.4	17.8	12.1	13.5	29.1	118.0	144.0	232.0	190.0	68.5	36.4	23.2	75.7
1977	18.4	14.3	11.7	16.7	20.6	102.0	171.0	150.0	122.0	81.9	47.7	25.5	65.2
1978	25.7	20.1	20.7	25.6	37.4	93.5	265.0	366.0	227.0	120.0	59.8	29.8	107.6
1979	16.5	21.8	14.6	15.4	15.7	79.7	282.0	194.0	125.0	61.5	39.8	32.6	74.9
1980	18.5	12.3	12.8	13.6	14.3	103.0	237.0	260.0	194.0	88.8	53.6	35.2	86.9
1981	24.9	17.4	14.0	20.5	40.3	104.0	235.0	276.0	205.0	48.8	33.3	21.4	86.7
1982	19.2	28.9	36.2	42.0	42.5	112.0	205.0	233.0	172.0	82.0	35.3	21.5	85.8
1983	26.7	23.2	22.6	19.0	35.8	49.2	225.0	233.0	217.0	62.8	39.1	24.7	81.5
1984	18.5	14.0	11.1	10.4	17.3	57.9	462.0	440.0	364.0	71.9	33.0	24.2	127.0
1985	11.6	11.2	10.5	8.9	19.7	59.0	296.0	345.0	319.0	134.0	69.7	39.1	110.3
1986	22.0	15.0	10.0	12.0	11.0	64.0	219.0	237.0	284.0	135.0	51.0	30.0	91.0
1987	21.0	17.0	15.0	18.0	24.0	79.0	297.0	309.0	253.0	92.0	45.0	27.0	100.0
1988	19.0	18.0	20.0	18.0	29.0	146.0	360.0	282.0	222.0	77.0	44.0	32.0	106.0
1989	29.0	21.0	20.0	17.0	27.0	81.0	273.0	326.0	164.0	90.0	35.0	19.0	92.0
1990	14.0	12.0	10.0	11.0	24.0	92.0	222.0	215.0	151.0	69.0	33.0	23.0	73.0
Average	20.6	17.7	16.0	17.5	25.7	88.4	258.8	273.6	218.3	88.9	44.3	27.5	91.4

Appendix table 3. Details of Water Account result for wet, average and dry year in the Indrawati River Basin.

S. N.	Component	Subcomponent	Wet Year (1985)		Average Year (1979)		Dry Year (1981)	
			Volume (million m ³)	% of Net Flow	Volume (million m ³)	% of Net Flow	Volume (million m ³)	% of Net Flow
1	Gross inflow	a) Rainfall	3,933.00		3,461.00		2,952.00	
2	Storage changes	a) Surface storage	0		-0.04		0.03825	
		b) Ground storage	0		-81.15		88.15	
3	Net inflow		3,933.00		3372.81		3,040.2	
4	Process Depletion	ET of paddy	32.50	0.83	27.40	0.81	31.70	1.04
		ET of paddy (spring)	4.60	0.12	9.30	0.28	4.07	0.13
		ET maize (winter)	19.53	0.50	17.40	0.52	26.85	0.88
		ET maize (summer)	18.70	0.48	20.50	0.61	17.99	0.59
		ET wheat	8.80	0.22	12.89	0.38	8.35	0.27
		ET potato	1.60	0.04	4.20	0.12	1.30	0.04
		ET pulses	3.50	0.09	1.10	0.03	1.60	0.05
		ET vegetables	1.27	0.03	1.20	0.04	1.20	0.04
		ETmillet	28.24	0.72	0.79	0.02	0.64	0.02
		ET oilseeds	0.73	0.02	22.90	0.68	28.20	0.93
		ET fruits	8.00	0.20	8.10	0.24	7.50	0.25
		Domestic uses	1.49	0.04	1.49	0.04	1.49	0.05
		Animal uses	0.93	0.02	0.93	0.03	0.93	0.03
		Subtotal	129.89	3.30	128.20	3.80	131.82	4.34
5	Non-process depletion (beneficial)	a) ET forest	325.21	8.27	355.81	10.55	310.71	10.22
		c) ET grazing land	54.73	1.39	56.22	1.67	53.15	1.75
		d) ET homestead and Others	107.30	2.73	114.42	3.39	102.14	3.36
		Subtotal	487.24	12.39	526.45	15.61	466.01	15.33
6	Non-process depletion (non-beneficial)	ET barren land, flood plain and water body	84.87	2.16	87.98	2.61	82.70	2.72
7	Outflow	Runoff	3,512.53	89.31	3,082.29	91.39	2,621.63	86.23
	Sum of depletion and surface runoff		4,214.53		3,824.93		3,302.16	
	Sum of net inflow		3,933.00		3,372.81		3,040.2	
	Calculation error		-281.53		-452.11		-261.95	

Source: Mishra 2000.

Appendix table 4. Water balance result with and without the Melamchi water supply project.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Before Project													
Inflow in the basin (rainfall) mm	21.9	6.3	24.1	35.7	146.5	262.3	686.1	750.0	466.4	80.1	0.0	11.5	2490.7
Inflow in the basin (rainfall) million m ³	7.2	2.1	7.9	11.8	48.3	86.5	226.4	247.5	153.9	26.4	0.0	3.8	821.9
Inflow in the basin (m ³ /sec)	2.7	0.9	3.0	4.5	18.0	33.4	84.5	92.4	59.4	9.9	0.0	1.4	25.8
Outflow at confluence with Indrawati (m ³ /sec)	6.6	4.6	5.2	5.5	6.2	14.3	57.9	77.4	51.0	17.5	10.8	7.7	22.0
Outflow at confluence (million m ³)	17.6	11.2	13.8	14.3	16.5	37.1	155.1	207.2	136.5	46.8	28.9	20.6	705.7
Process and non-process depletion in million m ³	4.11	0.96	7.06	14.76	33.73	38.03	35.11	30.73	24.33	19.02	0.03	1.02	208.88
Outflow at Melamchi intake (m ³ /sec)	2.8	2.2	2.0	2.2	2.5	6.4	25.8	34.4	21.4	8.1	4.6	3.4	9.6
Added flow from tributaries between intake and confluence point (m ³ /sec)	3.8	2.5	3.2	3.3	3.6	8.0	32.1	43.0	29.5	9.4	6.2	4.3	12.4
Process domestic requirement (m ³ /s)	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Diversion required for irrigated agriculture (m ³ /sec)	0.20	0.25	0.33	0.40	0.18	0.00	0.00	0.00	0.00	0.00	0.15	0.17	0.14
Balance runoff at confluence (m ³ /sec)	6.36	4.35	4.83	5.10	5.97	14.31	57.91	77.35	50.95	17.47	10.63	7.52	21.90
After Project													
Melamchi project supply (m ³ /sec)	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
Outflow at confluence with Indrawati (m ³ /sec)	4.60	2.64	3.20	3.54	4.19	12.35	55.95	75.40	48.99	15.51	8.82	5.73	20.08
Outflow at Melamchi intake (m ³ /sec)	0.84	0.18	0.00	0.28	0.56	4.40	23.88	32.40	19.48	6.08	2.62	1.40	7.68
Added flow from tributaries between intake and confluence point (m ³ /sec)	3.76	2.46	3.20	3.26	3.63	7.95	32.07	43.00	29.52	9.43	6.20	4.33	12.40
Process domestic requirement (m ³ /sec)	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Process depletion requirement (irrigated agriculture- m ³ /sec)	0.15	0.15	0.24	0.34	0.37	0.34	0.30	0.26	0.21	0.15	0.09	0.11	0.23
Irrigation diversion requirement (m ³ /sec)	0.20	0.25	0.33	0.40	0.18	0.00	0.00	0.00	0.00	0.00	0.15	0.17	0.14
Outflow at confluence with irrigation system at full potential (m ³ /s)	4.39	2.38	2.86	3.13	4.00	12.34	55.94	75.38	48.98	15.50	8.66	5.56	19.94

Note: The drinking water requirements for 28,182 persons in the basin is estimated to be about 0.13 m³/sec, or at 40 liters per day per capita, which are met from the nearby spring sources.

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