Integrated Development and Management of water resources

A Case of Indrawati River Basin, Nepal

Proceedings of a Workshop held in Kathmandu, Nepal
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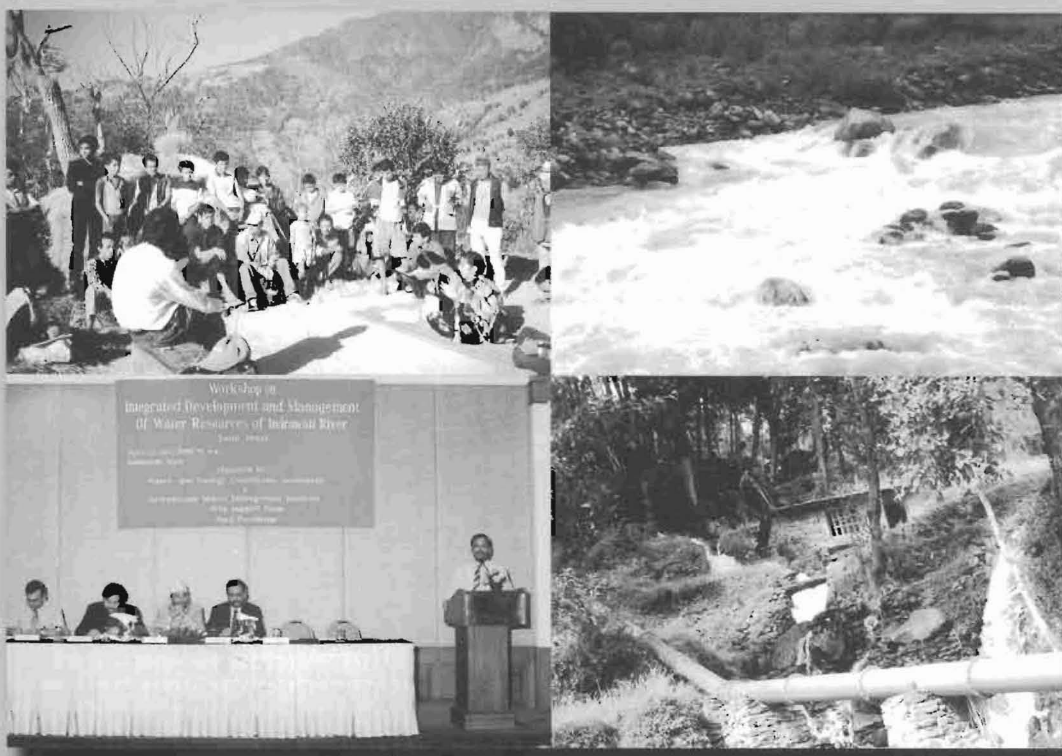

Organized by

Water and Energy Commission secretariat (WECS)

International Water Management Institute (IWMI)

Editors

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ACRONYMS

ADB	Asian Development Bank
ADB/M	Asian Development Bank/Manila
BDS	Bulk Distribution System
CBO	Community Based Organization/organizers
CBOs	Community Based Organization
d/s	Downstream
DDC	District Development Committee
DDWS	Department of Drinking Water and Sewerage
DIO	District Irrigation Office
DNI	Distribution Network Improvement
DWRC	District Water Resources Committee
Ghatta	Local water mills for grinding grains
HMG/N	His Majesty's Government of Nepal
I/NGO	International /Non-governmental Organization
IWMI	International Water Management Institute
JBIC	Japan Bank of International Cooperation
JICA	Japan International Cooperation Agency
Khola	Stream
Kulo	Canal
KV	Kathmandu Valley
kv	Kilo Volt
LGP	Local Governance Program
LPS	Liter per Second
MDS	Melamchi Diversion Scheme
MLD	Million Liter per Day
MOWR	Ministry of Water Resources
msl	Mean Sea Level

MWSDB	Melamchi Water Supply Development Board
MWSP	Melamchi Water Supply Project
NDF	Nordic Development Fund
NGOPP	NGO Participation Plan
NGOs	Non-governmental Organizations
NORAD	Norwegian Agency for Development Corporation
NWSC	Nepal Water Supply Corporation
PAP	Project Affected People
PDR	Process Documentation Research
Phant	Flat Irrigated Land in Hills
PHP	Public Hearing Program
RAP	Resettlement Action Plan
RCIW	Rural Community Infrastructure Works
REDP	Rural Energy Development Programme
RONAST	Royal Nepal Academy of Science and Technology
Sq. Km	*Square Kilometer*
SUP	Social Upliftment Program
u/s	Up stream
UNDP	United Nation Development Program
VDC	Village Development Committee
WECS	Water Energy Commission Secretariat
WT	Wastewater Treatment
WTP	Water Treatment Plant
WUA	Water Users Association

Preface and Acknowledgements

Along rivers of Nepal, dependable means of cooperation and water sharing mechanisms have evolved over centuries of trial and error. These traditional systems of cooperation and informal institutions provide a reliable base for future institutional development. In recent years, in addition to the increased demand for expanding agricultural sector to feed ever increasing population, demand for non-agriculture uses of water for domestic, industrial, hydropower generation and tourism, has increased considerably. These features present both opportunities and potential threats for the future management of available water resources and sustainable livelihoods in Nepal.

It is, then, important to recognize that the growing demand for water will lead to increasing water use conflicts between and among various sectors. Development and management of water resources should be based on an understanding of the existing formal and informal arrangements. The objectives of productivity and benefits for the poor, need equal consideration, while developing new institutional arrangements. All of these points to a clear need to take an integrated approach considering all the present, committed and futures uses of water resources.

On May 1999, the Ford Foundation approved grants to the Water and Energy Commission Secretariat (WECS) of His Majesty's Government of Nepal as well as to the International Water Management Institute (IWMI), for support for collaborative research on integrated development and management of Indrawati river basin resources for its production and equitable use.

This joint research between WECS and IWMI is explorative in nature, intended to identify key policy and strategic issues that can be addressed to (a) institutional continuity from the traditional systems of water management to higher levels of organization at basin level, (b) equal consideration to the objectives of water productivity and equity, especially protecting the rights and benefits of poor people and women and (c) resource conservation in terms of maintaining and improving the quality and quantity of water supplies to the various uses, including environmental services.

Consistent with the goal of the research/study to improve productivity of water resources in river basins, reduce poverty, increase equity in water use, and protect the environment through integrated water resources development and management strategies encompassing all the stakeholders in the context of increasing scarcity and competition of water, WECS and IWMI started the process of the study with inception report in December 1999. This was followed by field surveys, participatory rural appraisals and the stakeholders view in institutional mechanism for the river basin. Some professional consultants and researchers were also utilized to assist the study team. WECS in collaboration of IWMI organized a workshop in Kathmandu in April 25, 2001 to disseminate the research finding with the stakeholders and the professionals. Based upon the formal presentations and discussions at the workshop, this proceedings have been prepared, reorganizing the materials in a sequence that enables the reader to understand existing water accounting, formal and informal institutions, inclusion and expansion process of various users and the policy and strategy issues for increasing productivity of water resources in Indrawati river basin to reduce poverty, increase equity in water use.

We want to express our sincere appreciation to the Ford Foundation for their financial support for the whole study including this workshop and preparation of the workshop proceedings. Special thanks are due to Dr. Ujjwal Pradhan of the Ford Foundation for his help and support in guiding the study, beyond his call of duty. Ram Nath Kayastha, Project Manager, WRSF and Dr. Dhruba Pant have made this invaluable contribution not only for the report writing but for the whole study and deserve special thanks. Dr. David Molden, Dr. M. Samad, Mr. Krishna C. Prasad, Dr. Ian Making, Ms. Chaslottee De Frature, Ms. Jacobijn Van Etten have also made their contribution for this research and deserve special thanks. The Advisory Committee members also have helped through their guidance, comments and suggestions. Mr. Gautam Rajkarnikar, Mr. Sanju Upadhyay, Mr. R. Shilpakar, Mr. V.S. Mishra, Ms. Suku Pun, Mr. Matrika Koirala, Mr. Hari Devkota, Ms. Sanchita Sharma, Ms. Shyamu Thapa, Mr. Mohan Khadka, Mr. Roshan Shrestha and other members of the study team deserve special thanks for their contribution in the field study and preparing various reports. Sanjive Singh, Gokul P. Sharma, Rekha Sakya, Binod Neupane, Suden Lepcha, Pratap Lama, Sher Bahadur and other members of the study team deserve special mention for their contribution.

The users of various water use activities, local elected representatives, government officials, who shares their knowledge and experience deserve thanks as it was invaluable in the preparation of research reports.

The contributions from the authors of various reports general rapporteurs, session chairmen, general speakers, editors and those who offered discussion during the workshop are also gratefully acknowledged. Without their interest in the transfer of knowledge and full cooperation and contributions, it would have been impossible to have had a meaningful workshop and publish this proceedings.

1 Workshop Introduction

The freshwater system of the world is undergoing continuous natural changes in terms of quality, quantity and morphology. These changes are further accelerated due to increasing human exploitation of water resources caused by increasing population pressure demanding more water for several uses such as irrigation, drinking water, hydropower, and others. Environmental degradation has further increased pressure on water resources. In many areas increased demand for use of water resources has resulted into increased water use conflicts between water user groups and among various sectors: irrigated agriculture, tourism, industry, drinking water supply and new development projects. Increased competition for water resources among and within sectors has necessitated the need for an integrated approach in the management of water resources at basin level.

Although the concept of basin level management is emerging and has been a subject of discussion among water professionals in Nepal, until today it has not been used as a policy tool for the management of water resources. Recent study conducted by Water Energy Commission Secretariat (WECS) in formulating country's Water Resources Strategy has also recommended promotion of river basin concept to optimize water use benefits and minimize conflicts. Although many are aware of this need, in Nepal there is little practical experience and knowledge on how to operationalize such an approach.

Worldwide, International Water Management Institute (IWMI) is conducting researches on various aspects of water management. Of these aspects, research related to promotion of appropriate institution for water resources management at basin level is the one. In this context, in Nepal, Water and Energy Commission Secretariat (WECS) in collaboration with the IWMI initiated a study entitled "Integrated Development and Management of Water Resources in Indrawati River Basin" with the funding assistance from the Ford Foundation. The study intended to assess different ways and means of increasing and sustaining productivity of water through better management of multiple water uses in the river basin in a way that enhances equity, eradicates poverty, and conserves the environment. The specific objectives were as follows:

- Increased understanding and awareness of the existing formal and informal arrangements for managing water, and the many uses and stakeholders of water within river basins
- Preliminary assessment of proposed and committed development initiatives in terms of likely benefits derived from the water resources, and an understanding of the potential impact on present stakeholders
- Provision of key information and recommendations for developing integrated water resource development and management strategies that combine the objectives of productivity, equity and resource conservation
- Building the research and professional capacities of national scientists and practitioners in this area

1.1 Workshop Program

As part of the research activity, WECS and IWMI jointly organized a one-day workshop on 'Integrated Development and Management of Nepal's Water Resources –A case study of Indrawati River Basin' at Hotel Radisson, Kathmandu[1]. The followings were the objectives of the workshop:

- Disseminate the research results and identify issues for further studies.
- Provide a forum for discussion on various aspects of basin level management of water resources.
- Identify further research activities in the coming year

It was a one-day workshop, which had four sessions. These included one opening session, two presentation sessions, and one discussion/closing session. In the workshop, a total of seven papers were presented.

[1] The detailed workshop program and list of participant are given in the annex.

2 Opening Ceremony

Mr. R. N. Kayastha, Project Manager, Water Resources Strategy Formulation Project, WECS, formally opened the opening ceremony and welcomed all the participants in the workshop. Mr. P. B. Adiga, officiating Executive Secretary of the WECS chaired the opening ceremony. In the opening ceremony, representatives from various organizations also presented their views.

In addressing the opening ceremony, Mr. Kayastha, first, briefly introduced the research project entitled 'Integrated Development and Management of Nepal's Water Resources: A case study of Indrawati River Basin', which was carried out jointly by IWMI and WECS. Mr. Kayastha noted that the research on Indrawati River Basin, which was of explorative in nature, would be an example to help identify key issues and concerns related to integrated management of water resources. He further mentioned that the research would provide insights and guidance for developing future policies and integrated development strategies of water resources in Nepal. In introducing the research project, Mr. Kayastha also outlined the research questions, which relate to four major following issues.

- The need for integration of different water use sectors.
- The recognition of existing formal and informal arrangements of water resources management.
- The involvement of stakeholders at all levels and
- Equity issues.

While expressing his opinion, Mr. Kayastha said that the increasing pressure on scarce water resources for several uses of water, both from inside and outside the basin, calls for an integrated approach to water resources management to enhance productive, equitable and sustainable water use. In concluding his remarks, Mr. Kayastha hoped that the present research would also help in finalizing the country's water resources strategy, which is presently under discussion.

Finally, he hoped that the workshop would come forward with useful and valuable suggestions from the participants.

The next speaker Mr. S. P. Sharma, Joint Secretary of the Ministry of Water Resources (MOWR), first, thanked the organizers for providing him an opportunity to address the distinguished gathering. In his inaugural address, he hoped that the workshop on the Indrawati River Basin under a much wider umbrella of "Integrated Water resources Development and Management of Nepal's Water resources" would help in addressing several prominent issues on water resource management.

He argued that Indrawati basin is a small basin, and it may not, in many cases, be representative to draw a conclusion applicable to large basin. But he reasoned that the basin contains all the basic components of water resource uses that could be in general expected in the Nepalese context. The water resource uses include drinking water and domestic uses, irrigation, livestock and fisheries, hydropower, cottage industry, industrial enterprises and mining, navigation, recreational, and other uses. Thus, he appreciated WECS choosing Indrawati Basin for the study. He viewed that the diversified intra basin uses of water together with special reference to biophysical, geo-technical and socio-economic setting of the basin could provide the appropriate window to look on to the water resources sector. He hoped that deliberation of this workshop on the study conducted by expert would be able to draw fruitful lessons to direct the water resources sector in future.

Mr. Sharma in his address explained that the much debated and awaited Melamchi Water Supply Project is going to draw water from Melamchi, which is one of the tributaries of Indrawati River. In future stages, the Water Supply Project will further draw water from more tributaries of the basin. This has created a situation where a trans-basin transfer of water will take place. Socially, transfer of water would take place from a remote and relatively undeveloped area to most developed part of Nepal, the Capital. He cautioned that there are technical as well as social challenges lying ahead for all of us to face right at the doorstep. He further hoped that this workshop would provide a meaningful policy tool to meet the challenges.

He added that since the WECS is undertaking the formulation of National Water Resources Strategy, this study and outcome of today's workshop would be very useful for strategy formulation as well.

Dr. U. Pradhan, Program Officer, The Ford Foundation, expressed thanks to the organizers for the invitation in the workshop. In his deliberation he focused several issues that need to be taken into account in the studies of basin. He cited the possibility of collaborating activities with local level institutions for the studies. The important aspects that covered in his address include the issues on gender, natural resources management, role of line agencies, District Water Resources Development Committee (DWRC), decentralizations, community side, state vs. locality, enactment of law/legislative framework, large basin concept. The perspective of these issues may be quite different in water accounting/basin studies. He mentioned the importance of integrated management of natural resources such as soil, water and forest and implication of GIS maps showing formal and informal institutional set-ups. And also he focused on the need of understanding of dynamism of institutions.

Regarding collaborative studies he cited some cases of Indonesia. Further, he pointed out environmental effects, pollution, ground water as well as valuation of resources. How is water valued while taking water from one set of people to another. There is a challenge on basin approach, and political and social boundary. He hoped possibility of integration of series of thoughts. He dwelt on the development of India River Parliament, Rajasthan through the collaboration of Non-governmental Organizations (NGOs) and local community who have started construction of series of small dams. Its impact on surface flow, ground water recharge, sub-surface flow and overall eco-system balances are found positive. Thus, he suggested that construction of series of check-dams in the basin would be highly beneficial from environmental conservation point of view. In order to encourage local community he cited an example of Tamilnadu where supra local institution is functioning. The check and balance is very important in the democratic system. He was of the opinion that definitely the improvement can come from resource conservation.

Mr. M. Samad, of the International Water Management Institute (IWMI), presented IWMI's new program themes, which include:

- Integrated water resource management for agriculture
- Sustainable smallholder land and water management system

- Sustainable ground water management
- Water resources institutions and policies
- Water, health and environment

IWMI in Nepal

At the same time, he explained the objectives of IWMI in Nepal, and highlighted ongoing research projects which are as follows.

Development of effective water institutions for river basin management: a case study of East Rapti Basin. The project is funded by Asian Development Bank/Manila (ADB/M).

Assessment of process and performance of rehabilitation assistance to irrigation systems in Upper Andhi Khola Watershed area. The project is funded by Care International.

Integrated Development and Management of Nepal's Water Resources for Productive and Equitable Use: Indrawati Basin study. The project is funded by the Ford Foundation.

Collaborative study between IWMI and WECS. The project is funded by the Ford Foundation and Contribution of WECS is US$ 10,000. The total period of study is eighteen month (Oct 1999-April 2001).

Research Goal

The overall goal of this research is to improve productivity of water resources in Nepal's river basins, contribute to poverty alleviation, increase equity in water use, and protect the environment through integrated water resources development and management strategies encompassing all the stakeholders in the context of increasing scarcity and competition for water.

Research Objectives

The general objective of this study is to assess different ways and means of increasing and sustaining productivity of water through better management of multiple water uses in the river basin in a way that enhances equity, eradicates poverty, and conserve the environment.

The study will identify key policy and strategic issues that can be addressed in a follow up project dealing with water resources development, management systems and the development of basin level institutions in Nepal.

It is expected that some of results and recommendations can be translated into immediate actions and follow up, while other outputs will require further and more detailed studies.

Mr. P.B. Adiga, who chaired the session, made the remarks on the addresses of various persons as well as expressed his own views on the workshop. He highlighted this particular work carried out by the IWMI and WECS contribute to the His Majesty's Government of Nepal (HMGN) work, which relate to formulation of the National Water Resource Strategy, although National Water Resource Strategy formulation is for the overall country context. At the same time, the need of field level data immerged and the Indrawati basin was selected. He remarked that Indrawati basin work is more field investigation and data has been used in the draft strategy document. He further mentioned that most participants of this workshop had participated in the national workshop to discuss draft Water Resources Strategy Formulation paper that was held a month earlier. While preparing the draft report of National Water Resource strategy we had in mind the outcomes of the Indrawati basin study.

He noted that none of us could work within own group only and come out with recommendation for the nation. So it is of great importance to continuing the nature of this multidisciplinary approach with various disciplines working together. He emphasized the need to use water in a very simple way and make the best use of it for all kinds of human requirements. He cited an example of Mr. U. Pradhan who had mentioned that a lot of difficulties could be faced in implementation by ignoring the need and aspiration at the micro level and considering only the fulfillment of need at macro-level. The study on Integrated Water Resource Management, in which the science, technology aspects of social engineering, economics and environmental engineering are associated, was conducted by taking into consideration of this aspect also... Finally, he emphasized the important role of participants in critically analyzing these papers.

3 Outcome of the Workshop

This section first presents summary of the papers presented in the workshop, which is followed by summary of discussions on issues and concerns raised by the participants in the floor. The section ends with concluding remarks expressed by the chairperson and the organizer in the closing ceremony.

3.1 Summary of the Papers Presented in the Workshop

Water accounting study in Indrawati River Basin, Nepal
V.S. Mishra and R.L. Shilpakar

This paper defines, water accounting as a procedure to account for the use and productivity of water resources based on water balance approach. It classifies outflows from a water balance domain into various categories to provide information on the quantity of water depleted by various uses and the amount available for further uses.

It highlights on the present hydrological resource endowment in the Indrawati river basin and one of its sub-basin Melamchi as per IWMI's water accounting methodology. The basin contains a large range of land use patterns. The basin is also a part of National Park that has been an attraction of the tourists for trekking.

The paper is based on both secondary and primary information. The procedure of water accounting developed by Molden and Sakthivadivel (1999) is followed for data analysis. The study has taken into account of various components of water accounting. It has analyzed data from 1971-1990. For water accounting computation, three typical years (1985 wet year, 1981 average year and 1979 dry year) were selected. In the process of analysis, the paper defines several components that are used in the study such as net flow, available water, and depletion. It covers quantitative analysis of inflow to the basin, stream flow and storage change in the basin.

The paper first discusses the results of study and draws following conclusions:

- The Indrawati River Basin is an open basin, where as Melamchi is a close one.
- In the Indrawati River Basin, 23 per cent of water is depleted and remaining 77 per cent of utilizable outflow moves out of the basin.
- In the Indrawati River Basin, 4 per cent of available water is process consumed whereas non-beneficial depletion is about 3 per cent.
- In the Indrawati River Basin, the agricultural water productivity is NRs.10.9/m^3 (US$0.148/$m^3$) of water consumed, still there exist a great potential to increase water productivity.
- Drinking water use is minimal and mostly from spring sources.
- From Melamchi River a supply of 1.97m^3/sec is allocated to supplement the drinking water demand of Kathmandu City. Further withdrawal for irrigation and other purposes during dry season (December –January) may affect environment and other social needs. To justify this, detailed analysis of individual tributary is recommended.

Formal and informal institutions on water management in Indrawati River Basin
Dr. D.R. Pant

In farmer-managed water use systems, the Indrawati River Basin has a long history. This study was considered important to understand mechanisms developed by the users of different water uses that could provide a reliable basis for future institutional development while developing new systems. It focuses on formal and informal arrangements and means for conflict resolution within the selected tributaries.

The study was primarily based on the primary information that was obtained from field survey, which was exploratory in nature. The field study was conducted in two sub-basins of Indrawati River- Melamchi Khola and Handi/Mahadev Khola in Sindhupalchowk district. The basin was taken one of the research sites for studying the complexities of water use practices in the basin system.

The paper discusses that although the sources are perennial, the growing demand of water use creates water scarcity especially during dry season.

In the sub-basins, water allocation between irrigation and water mill with turbine users is arranged in close co-ordination.

The allocation of water between the irrigation system and the water mill suggest that the users were concerned for the maximum utilization of the water resources at the local level whenever there was an opportunity to do so. The study indicates that users have assigned priority of water use right for various uses, in which irrigation receives the first priority.

Increased number of irrigation systems has reduced disputes in water allocation among the users of irrigation, and between the irrigation systems and the *ghatta* in the sub-basin. But there is competition for water among the irrigation users and the *ghatta* owners. Although it is informal, the established rules of water allocation for *ghattas* assure right of the *ghatta* owners but they cannot exercise this right without co-operation from irrigation users. However, problem of water allocation between the *ghatta* owner and irrigation users arises during the daytime as the *ghattas* do not operate during the nighttime.

There exists conflict between the *ghatta* owner and irrigation users especially during the dry season. Some disputes occur occasionally when the irrigation users disrupt the water flow to the mill when there is reduced flow in the canal. However, these disputes are solved through negotiation between the users. The relevance of customary practice could be realized over here. The role of Village Development Committees (VDC)s was also found important in resolving the disputes.

The paper highlights the role of other local institutions in water management. In this respect, the view of District Development Committee (DDC) Chairman is that DDC should be central decision –making authority for the integrated water resource management in the district.

The major findings and conclusions of the paper are as follows:

- Users do not feel the need for formal organization because of use of customary practices in water allocation.
- Over time, development of the micro-hydro and new irrigation systems has increased competition for the use of water.

- The crop production receives priority over other users and users would not compromise on it. The water mill owner and the micro-hydro users had to take the maintenance responsibility since the irrigation is the oldest water use activity. Thus the irrigation users are not prepared to share their right unless they receive some benefit.
- The conflict among the water users is less pronounced at present, as the water availability for various uses is not a constraint.
- The up coming competition among various sectors indicates that there is a need of suitable institutional arrangement in the future.

Stakeholders' inclusion and exclusion process in the Indrawati River basin: A review
Sanju Upadhyay

Growing demand of water for its multi-sectoral uses has alarmed the need to study inclusion and exclusion processes of several users for sustainable management of a river basin. The paper focuses on the stakeholders' inclusion and exclusion processes under several scenarios in the Indrawati River basin area. These scenarios include growing competition of water, multiple uses of water, and new water use development program. The paper is the out come of a research project jointly managed by Water and Energy Commission Secretariat (WECS) and International water management Institute (IWMI).

The paper is based on the field study of a few sub-basins and water use systems in them, which were selected based on the multistage sampling procedure. For this purpose, sub-basins and water use systems in them were selected based on growing competition of water, multiple uses of water and new development program.

The primary data were collected in the field from the users of several water use systems that were visited. The respondents included households, key informants and user groups in community and personnel working at the district level offices and in other relevant organizations such as DDC, Rural Energy Development Programme (REDP), Department of Drinking Water and Sewerage (DDWS), and District Irrigation Office (DIO). The paper also depends on the secondary information, mainly from the agency records and various publications.

The paper examines the inclusion/exclusion process from several perspectives such as multi-sectoral uses of water, water rights and external intervention. The paper suggests that in the Indrawati River basin, demand of water has increasing over time, which in turn has increased competition over use of water within and across several water use sectors. It further notes that there are no water allocation rules across and within different water use sectors.

In such a situation, implementation of new development projects in the basin, which often did not take into account the interest of the prior appropriators, lead to both inclusion as well as exclusion of the stakeholder. The paper recommends developing effective mechanism for the protection of water rights of the prior appropriators otherwise implementation of new projects will result in exclusion of many poor families, which ultimately lead towards water related disputes. The paper finally suggests that integrated management of water resources through river basin approach may help to develop such institutions.

Process documentation research of Melamchi Water supply Project: A case study of trans-basin water diversion in Nepal
Hari Devkota

In the Kathmandu valley, the shortage of water supply has affected public health and economic activity. To meet the water demand of Kathmandu valley, the government carried out several studies related to sources of water and its supply. In 1973 the water supply master plan had identified the Melamchi Project as the potential source for water supply in the Kathmandu valley. In addition to this, a reconnaissance survey of possible sources outside the valley was also carried out in 1988. This survey had covered twenty possible sites including Melamchi Khola, Indrawati River and Roshi Khola. But Melamchi Water Supply Project has been considered most feasible and the government is taking steps for its implementation. The present study is the process documentation research of Melamchi Water Supply Project (MWSP). This paper examines degree of water scarcity in the Melamchi River Basin after Melamchi Diversion Scheme (MDS), involvement of various groups of stakeholders and institutions and their role in decision making process and implementation of MWSP.

This research was conducted in the Melamchi River basin area covering 8 VDCs in Sindhupalchowk district. This paper is based on previous studies conducted by various organizations and in-depth field survey. During field survey discussions were held with the concerned organizations` representatives at the VDC and district level institutions. Also long discussions were held with NGOs/Community Based Organization (CBOs) and User groups and stakeholders.

The paper first present the stages of project development, studies under taken for this purpose, physical characteristics of Melamchi River and MDS, and rationale for MWSP selection, water use pattern and possible effects due to MWSP, land use pattern and farming system. In the second part of the paper, summary of major issues and concern of the stakeholders and proposed programs and implementation processes are discussed.

It concludes that the likely impact of the project during and after completion on environment, farming system, socio-economy and socio-culture and climate could not be over looked. The project should take into account for compensation of this impact. The suggested packages are fixed allocation of about 5% of revenue for affected areas from water tariff; explanation on how much water would be left downstream of the dam; environmental and water rights; representation of local organization and elected bodies in the MWSDB; priority for employment; reasonable resettlement package; and other programs that include poverty alleviation, women empowerment and environmental conservation.

Water accounting and water use institutions' study of Manusmara River basin

Hari P. Hemchuri, S. Sijapati & L.P. Bhattarai

With the increasing demand of water resource across and within different sectors of water use, there is a clear need to manage available water resources within a basin. This required accounting present and future demand of water for its sustainable allocation.

This paper focuses on the Manusmara River basin where consumptive use of water especially for agricultural purposes has increased considerably over the last few decades. As several new water use projects are being planned in the basin, it became essential to account its existing water use. In this context, this paper first examines the history of agricultural development of the Manusmara River basin and its interface with the efforts made by the beneficiary farmers to use the available water resource of the basin. The paper then tries to make an effort to analyze the basin characteristics with respect to the inflow and outflow scenarios from the perspective of water availability and water use pattern. The paper presents the interim findings of the study.

The paper suggests that use of water from the Manusmara River basin for the purpose of irrigation could have started since the early half of the nineteenths century. Since then several irrigation systems are developed, which are the main consumptive users of the basin water. Other uses of water (domestic purpose and animal husbandry) from the basin are negligible. Rainfall, ground water and irrigation supply from other irrigation systems located nearby (Bagmati Irrigation System) are the sources of inflow into the basin.

The paper notes that although some irrigation systems have Water Users' Associations for the management of water within the systems, no organization exist at the basin level for ensuring effective water use of the basin as a whole. Very little attention is being given to the issue of water right. Upstream diversions are constructed without any discussion or consensus from the downstream users.

Finally, the paper suggests that at present only 40 per cent of the available water (with respect to the year 1980, which was a dry year) are being used from the basin leaving a balance of 60 per cent of utilizable flow. As the utilizable outflow takes place throughout the year, the basin is an open basin. There is potential to harness this utilizable outflow and use it productively.

Existing arrangement for water management in East Rapti River Basin: Institutional issues
R.N. Kayastha and Dr. D.R. Pant

In the East Rapti River Basin, water resource is being used for various purposes. The natural resources of the basin are managed by the government as well as community organizations. The basin covers part of two administrative boundaries. In the basin, more than 200 farmer-managed irrigation systems (FMIS) are in operation accounting for about 90% of the irrigated area

This paper is mainly based on the review of previous studies of the basin. Field studies were also carried out for primary information.

It first presents growing seasonal water scarcity, effect of Hetauda Industrial Center's effluents on environment, and marginalization of indigenous tribes such as Bhote and Danuwar in the downstream. It also covers the conflicts between downstream and upstream users of irrigation that draw water from the same stream including increased practice of sand and gravel mining which is not only deteriorating the riverbed but also threatening Hetauda city.

Then it discusses use of water by a large number of agencies for various purposes owning the rights of utility and legal status of operator. Regarding water rights it has mentioned that it is tied up with land right. Further, the customary practice influences the water rights. However, the laws, rules and norms were evolved over the time on the basis of negotiation process between the users. The customary practices prevalent in the basin are water share based on investment, water right purchase from others and water rights proportionate to the land in irrigated area. It focuses the need of regulatory framework after rapid increase in the use of water especially for irrigation and drinking purposes.

Regarding disputes in water use, the paper indicates that there are disputes between agriculture and tourism/recreation use, irrigation and wildlife use and others include competition in water shortage areas. Such cases of disputes have been resolved by the various local and district level organization including the District Court. In most cases, issues on water use between drinking water and irrigation are more pronounced.

However, drinking water receives priority. Although a district level federation of Water Users Association (WUA)s in both the districts has recently been formed, but there are no institutional arrangements at the Rapti basin level for multiple water use management. There is a lack of policies on inter-sectoral water transfer or inter-basin water transfer.

It attempts to identify the major issues as the lack of estimates of sectoral water requirements, insufficient monitoring of ground water and several gaps in the present set up of the institutions. The implications are inability to manage allocation between institutions and comprehensive water resource planning, lack of resources development in an integrated and sustainable manner involving stakeholders in all water management initiatives. Thus there is a need of new organizations as well as redefining functions. The paper draws the following conclusions:

- Over time, scarcity of water in the basin has increased the conflict in water use.
- In the basin, the high industrial growth has raised water pollution problem.
- The indigenous ethnic groups such as Bhote and Danuwar are being marginalized in the basin areas.
- The sand minding practice in the riverbed has increased river cutting problem, which has threatened the Hetauda City.
- The cultivated land has increased converting forestland.
- The rights of water utility in the basin have owned by a multi sectoral group.
- The need of regulatory framework has increased after rapid increase in the use of water especially for irrigation and drinking purposes.
- The water rights are basically dependent on the customary rights, but there is no institutional set up in the basin level.
- The district level federation of WUAs in both the districts has recently been formed.

Institutional arrangements for river basin management: Some emerging issues

M. Samad

Although there has been considerable amount of investment in the development of water resources during the later half of the last century, development of appropriate institutions has been badly neglected. With the consensus of opinion among all major stakeholders in the water sector, it has been recognized that the river basin is the most appropriate unit for the effective management of water resources. With this consensus, need to develop effective water management institution at basin level is now well recognized.

In this context, one may raise question – what is the most appropriate institutional arrangement for the management of river basins? This paper attempts to address this question on the basis of the results of recent studies on institutional issues in river basin management carried out by the International Water Management Institute (IWMI).

The paper is based on studies conducted by IWMI on five river basins (East Rapti-Nepal, Ombilin-Indonesia, Upper Pampanga-Indonesia, Deduru Oya-Sri Lanka, Fuyang-China) with varying stages of development. The paper develops a perspective on the problems occurring in various stages as a river basin evolves.

The paper suggests that the "most appropriate" institutional arrangements depend on the stage of development of a particular river basin, which are categorized into following four stages.

- Development or construction stage,
- Supply management stage (in which management of water supply and water saving is the main focus) ,
- Integrated water management stage (in which management of water allocation within and across several sectors of water use is the main focus), and

- Demand management stage (as the river basin in this stage become "close", management of water under scarce condition is the main focus)

The paper further suggests that the institutional complexity increase with the stepping-up of the stage.

3.2 Summary of Discussion on Issues Raised During the Workshop

As noted above, during the workshop, participant raised several issues and concerns at the floor. These issues and concerns are grouped into three categories. They are physical (issues related to water accounting and basin concept), institutional, and about Melamchi basin. These issues and concerns are summarized and presented below.

Issues Related to Physical Aspects

Water Accounting

Most of the issues and concerns raised by the participants in relation to water accounting as an instrument for future planning of water resources are methodological. Participants raised concerns about several other external factors, which are not encompassed by the water accounting procedure, but can influence the availability/depletion of water resource in a basin. These include:

- Effect of global warming and change in climate in availability of water resources in a basin,
- Change in land use and vegetative cover in a watershed and its effect on availability of water resources in a basin, and
- Effect of subsoil flow and back flow in the availability of water in a basin in time and space.

Participants raised concerns that the above mentioned factors could substantially influence the availability of water resources in a basin in time and space in the context of changing global climate, increasing realization of integrated management of land and water resources, and patchy hydrological characteristics of mountains. Concerns were therefore raised about the need of appropriate methodology to account for the above mentioned factors.

Participant also raised concern about the need for long term time series data for prediction of water accounting results. Some participant suggested that while accounting water resources in a basin, several water use systems, which are under construction, should also be taken into account .

Some of the participant also raised concerns that in the context of depleting water resource in a basin as indicated by its water accounting, which considered only the run-off-the-river flows, viability of water storage project should also be examined for meeting the future demands of water resources.

Basin approach and existing political/geographical boundaries

Participant raised concern that in the context of present political/geographical boundaries of VDCs/DDCs, which may extend to more than one basin or one basin may contain several VDCs/DDCs, how can the basin approach as a planning tool for the management of water resources be effective? This is especially true in the context of present decentralization act, which has delegated authority to VDCs/DDCs for managing water resources within their area. Citing examples, participant raised concern that in a situation of scarce water resources, several VDCs/DDCs may compete for same water in a basin leading to conflict.

In this context, some participants highlighted the need of effective co-ordination among different water authorities (VDCs, DDCs, DWRCs and so on), while others argued for formation of basin authority for regulatory purpose.

Defining a Basin

A few participants raised question about the boundary of a basin, especially in the case of East Rapti River basin. In this context, question was also raised whether a basin should be defined from the supply or use perspectives. Technically, a basin is always defined from hydrological perspective, which considers only the supply side of waters into the basin. However, there are several areas, which may not fall within the hydrological boundary of a particular basin, but may depend on that basin for several uses of water[2]. Thus, the participant argued that in defining a basin from the supply (hydrological) perspective, water need of such dependent areas which is not included in the hydrological boundary might be omitted.

Issues Related to Institutional Aspects

Customary water rights/practices and prioritization of water use by water resources act.

In both the Indrawati and East Rapti river basins, the papers presented suggest that rights over the use of water are not based on actual need but based on their customary rights and practices. Several water use systems may be using more water than what is actually required. Further, rights over the use of water across different water use sectors (irrigation, drinking water, hydro power and so on) also follow the customary practices rater than their prioritization as stipulated by the Water Resources Act. For example, in the Indrawati river basin, irrigation water receives the first priority although the Water Resources Act gave the first priority to drinking water.

In this context, participants raised concerns regarding the recognition of customary water rights and future development of water resources. Although it is essential to recognize the customary water rights of the local community who are using water at present, such recognition may equally threaten future water demands of a growing population. These aspect raises question – how can we recognize the existing customary water rights of the local community and at the same time preserve the water demands of a growing population? Some argued that by initiating basin level planning of water resources, this discrepancy could be minimized. Others suggested that in order to avoid this discrepancy, prioritization of the use of water resources should be based on economic value of water rather than its social value.

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2 Examples are several *tar* in the mid-hills of Nepal. A *Tar* is terraces located in the hill slope much higher from the large (major or medium) rivers flowing through the bottom of the deeply incised valley. Due to higher differences in the elevation between these *tar* and the large rivers, in many of these *tar*, water from the tributaries of these large rivers located in a different sub-basin than that of such *tar* is tapped and conveyed for several uses of water.

Further, concerns were also raised regarding securing water rights of people belonging to different sector such as women, poor farmer, business man and so on.

Although several participants raised concern about the allocation of surface water, one participant highlighted the importance of rainwater allocation. In the context of growing realization of rain water harvesting in water deficit areas, allocation principals of rain water will also be equally important, especially in the context of integrated planning of water resources. Further, as irrigation consumes major portion of water resources concerns were also raised regarding optimization of the use of water resources as well as increasing agricultural productivity.

Local Organizations for Water Management

In a basin, different uses of water like irrigation, drinking water supply, hydropower, local industry (water mill) exist. Much of these uses are managed by informal organizations. In this context, concerns were raised whether these informal organizations would be able to manage water resources in future with the increase in water demands in the basin. Further, concerns were also raised about the need of integrating all these local organizations and linking them with several water authorities such as VDCs, DDCs, DIOs, DWSSs, and DWRCs for efficient management of water resources.

Basin Level Institutional Arrangement

As noted above several informal/formal organizations are managing water at local level and there is a need to link them with several water authorities in a basin. Further, coordination of these water authorities is also equally important. In this context, participants raised concern about the need of basin level institution for the purpose of regulation and co-ordination. But the question was how can such basin level institution be formed still remained unanswered. Nevertheless, the participant were in consensus that the regulative and planning function for the management of water resources should be distinguished and should be assigned to DWRC and DDC respectively.

Considering the importance of community participation in managing water resources, which calls for devolution of decision making power at local level, it was realized that formation of basin level institution with local representative with adequate authority is imperative.

At present, at the district level, the District Water Resources Committee (DWRC) headed by the Chief District Officer (CDO) manage some aspects of water resource development. These include issuing license for the development of water resource, registration of organizations for managing irrigation systems, and so on. Recognizing the importance of District Development Committee (DDC) in the development of water resources, some of the participants argued that the chairman of DDC should head the DWRC with member secretary from one of the HMGN water related line agency. They further argued that there should be adequate representation of actual water users in the DWRC, and the DWRC should be assigned for monitoring and regulating water resources for its sustainable development.

Irrespective of the above argument, concerns were also raised by the participants about the need of one single institution, with adequate technical manpower at basin/local level, for example River Basin Authority, for regulating and monitoring water resource for its sustainable development.

Issues Related to Melamchi Sub-basin

Considering the proposed diversion of 1.97 m^3/sec of water from the Melamchi River to the Kathmandu City, participant raised concerns about its likely effect in the Melamchi area, especially in the field of environment, agriculture and socio-economic. For assessing these effects, participants suggested to conduct adequate studies. Some participants, however, argued that a detailed Environmental Impact Assessment (EIA) should be able to quantify the likely effect of proposed diversion of water in the Melamchi area.

In this context, one participant argued that after the proposed diversion of water to the Kathmandu City, its value in the Kathmandu City increases considerably from that of its value in the Melamchi village area. He then raised question–how do we judge the value of water in these places, and how can we re-distribute some of these added value of water at

Kathmandu City to local population at the Melamchi village area?. In response to this question, other participant suggested that income-generating activities should be launched for the local community of the Melamchi village area.

In contrast to the above opinion, considering the proposed tariff of drinking water supply in the Kathmandu City after the Melamchi project, one participant raised question whether the local community of the Kathmandu City will be the loser or gainer of the proposed Melamchi project.

4 Closing Ceremony

Mr. B. K. Pradhan, former secretary of the Ministry of Water Resources chaired the closing ceremony.

The first speaker, Mr. P. B. Adiga, Officiating Executive Secretary of WECS, presented assessment of the entire workshop on behalf of the organizer. While expressing his opinion, Mr. Adiga mentioned that the workshop went well and met the expectation of the organizer. He further added that the workshop was not designed to seek some definite solutions, but was designed mainly to identify some of the relevant issues for further study.

Mr. Adiga congratulated all the researchers, especially the younger researchers, who involved themselves in the research and presented papers in this workshop. He further mentioned that for the younger researchers, this study could be an opportunity in which they could work with institutions like IWMI and The Ford Foundation. He further added that this study could also open up situations for further collaboration between WECS, IWMI and The Ford Foundation in number of other studies where people do not have common perception.

Citing one of the examples, Mr. Adiga mentioned that at present people talk about integrated management of water resources in holistic approach. But he raised the question what are those criteria for measuring the holistic approach. He further added that there are so many things to do, all of which will strengthened the national policy/strategy on water resource.

While expressing his opinion, Mr. Adiga added that there are so many questions, which need to be answered before initiating planning of water resources at the basin level. He believed that this workshop would be helpful in identifying some of these issues in this direction.

Finally, he expressed his satisfaction about the workshop and thanked the entire workshop participant.

The chairman, Mr. B. K. Pradhan, in his address in the closing ceremony first expressed his grateful thanks to the organizer for giving him opportunity to chair the session. Considering the focus of the present study on the Indrawati river basin, he recalled the previous studies (1983-87) conducted by the WECS in the same river area. He expressed his satisfaction that to day with the initiation of Melamchi Drinking Water Supply Project, WECS is again concentrating in the same river with the new concept of integrated management of water resources at basin level.

Mr. Pradhan mentioned that although not much of analysis has been done in issues like water accounting and institution, he expressed his satisfaction that they are identified as emerging issues. He further expressed that in future WECS may bring clear picture in these issues.

Referring to the papers presented in the workshop, Mr. Pradhan mentioned that most of papers could dig out the real status of the Indrawati River basin, which are essential for the integrated development of water resources at the basin level.

While expressing his opinion, Mr. Pradhan mentioned that realization of importance of basin approach in planning water resources helps in its sustainable development across all the water use sectors. He further added that in this aspect the country is in early stage of development and there is much to be learning in future for which hard work is needed.

Finally, he thanked all the participants for attending the workshop and providing valuable comments.

With the valuable remarks from the chairman Mr. B. K. Pradhan, Mr. R. N. Kayastha, Project Manager, Water Resources Strategy Formulation Project of WECS finally adjourned the workshop.

Papers

Paper 1: Water Accounting Study in Indrawati River Basin, Nepal

V. S. Mishra and R. L. Shilpakar

INTRODUCTION

Although Nepal is rich in water resources, the growing demand of water for multi-sectoral uses like in other many countries has alarmed the need to increase water productivity and judicious allocation of available water within and across sectoral uses. As a result of which IWMI and WECS have jointly managed a research project in Indrawati Basin of Nepal. Water accounting is a part of that collaborative research project.

Water accounting is a procedure to account for the use and productivity of water resources based on 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 and the amount available for further use.

This paper focuses on the present hydrological resource endowment in the Indrawati river basin and one of its sub-basins Melamchi as per IWMI's water accounting methodology.

BACKGROUND OF THE STUDY AREA

Indrawati River Basin

The Indrawati river basin is located in the central region of Nepal, in the Bagmati Zone (Figure 1).The river originates from Himalayan region of Mahabharat range (msl 5863 m). Snow and ice cover considerable area in the upper part of the river basin. The lowest confluence point of the basin lies in the middle mountain region. The land slopes vary from steep to mild comprising of very few plain lands. The basin area is at about 50-Km northeast of Kathmandu. From its origin, it flows southward and then confluence with Sunkoshi River, one of the major rivers in Nepal at msl of 626 m. The length of the main course of the river is about 59 Km. Some of the major tributaries of this river are: Larke Khola, Yangri Khola, Melamchi Khola, Jhyangri Khola, and Chaa Khola. The flow diagram of Indrawati river system is given in figure 2. The basin extends from Latitude 270 37' 11"N to 280 10' 12"N and Longitude 850 45' 21"E to 850 26' 36"E. The basin comes under sub-tropical to Alpine climatic zone and overlaps three districts of Nepal; Sindhupalchowk, Kavreplanchowk and Kathmandu. The catchment area of the basin is 124000 ha. The basin is covered by 40% of the forest area, as per district profile. Out of ten rain gauge stations in the basin, the average annual rainfall at higher elevation (Sarmathang) is 3874 mm, while it is about 1128 mm at Dolalghat, lower elevation Zone. The average annual potential evapotranspiration for the basin is 953.91 mm and the temperature ranges from 32.50 C to about 5o C. The average relative humidity is about 70% and varies from 60% in the dry season to 90% in the rainy season. Class-A pan daily evaporation averages 3.04 mm/day varying from 1.81 mm/day in January to 4.4 mm/day in August. The annual evaporation is estimated as 1110.75 mm. The daily sunshine hours average 6.23 hrs/day, varying from 3.3 hrs/day in July to 8.1 hrs/day in April. The wind velocity averages 3.21 km/hr or 0.9 m/s.

There are two water level gauging stations in Indrawati river basin, which are operated and maintained by Department of Hydrology and Meteorology. Between these two stations, discharge records of Dolalghat station have been taken into account for the water account analysis of Indrawati basin whereas river gauging station in Melamchi Khola at Helambu is considered for the analysis of Melamchi sub-basin. This Dolalghat station is located in Indrawati River at about 1km u/s of the confluence with Sunkoshi River while Helambu river gauging station is located in Melamchi Khola 23.5 km u/s of confluence with Indrawati River.

The population density of the basin in 1991 was 165/Km2 and the projected figure for 1998 is about 175/Km2. 96 percent of population is involved in agriculture. Farm-size per household is small (0.9 ha). Major crops grown in this basin are: wheat, rice, maize and millet. Their average yields are 2.3t/ha, 3.2t/ha, 2.45t/ha and 1.7t/ha respectively.

A major attraction of the basin is its National Park at the head of the basin covering sizable area and is one of the most tourist attractions for Trekking in Nepal.

Melamchi Sub-Basin

Melamchi River is one of the major tributaries of Indrawati River originating from Himalayan region (msl5863m) with Catchment area of 330 sq. km. The total population in the basin is 28182 and water used by this population is minimal usually from spring sources. Most of the water is consumed by the forest and agriculture. A water supply scheme is planned to divert water from Melamchi River at a distance of 20-km u/s of confluence with Indrawati to supplement the drinking water need of the capital town Kathmandu.

Figure 1: Location Map of Indrawati River Basin

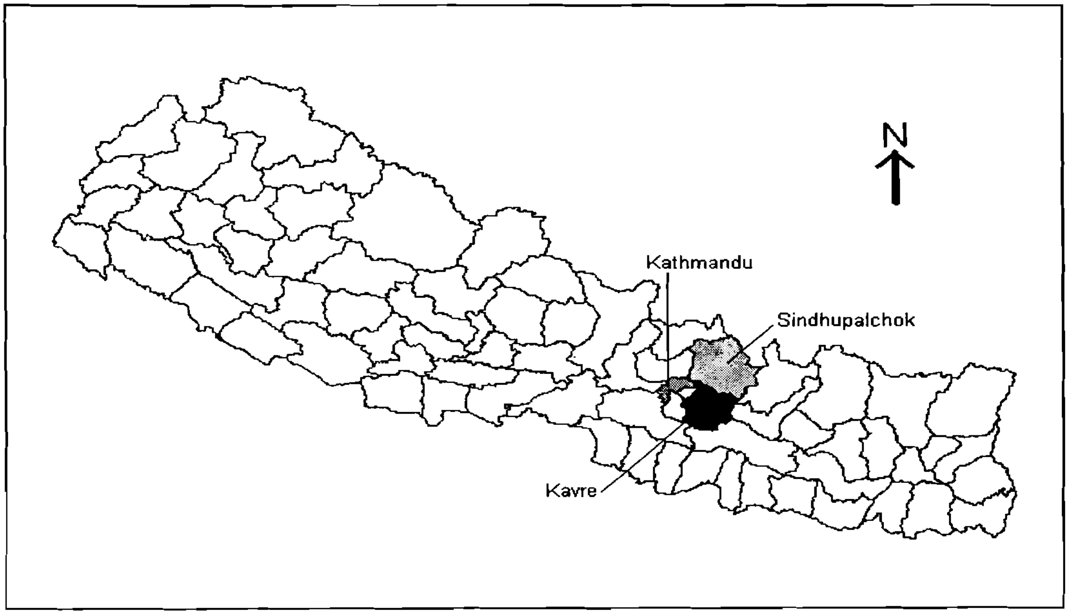


Figure 2: Map of Indrawati River Basin Showing River Network

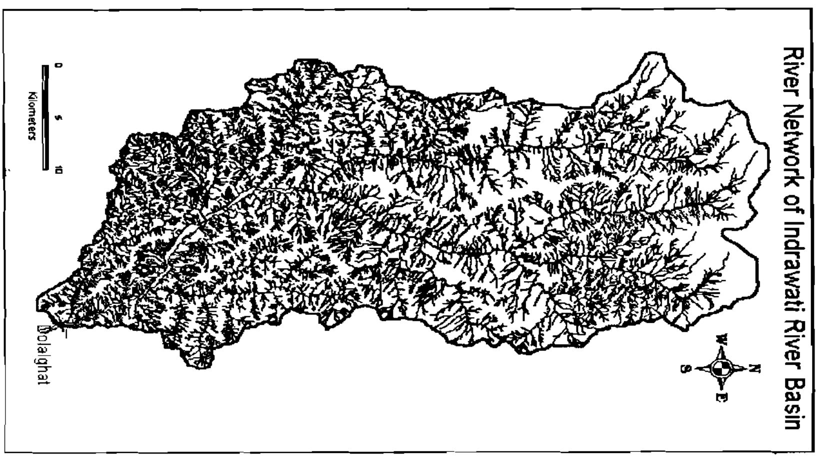
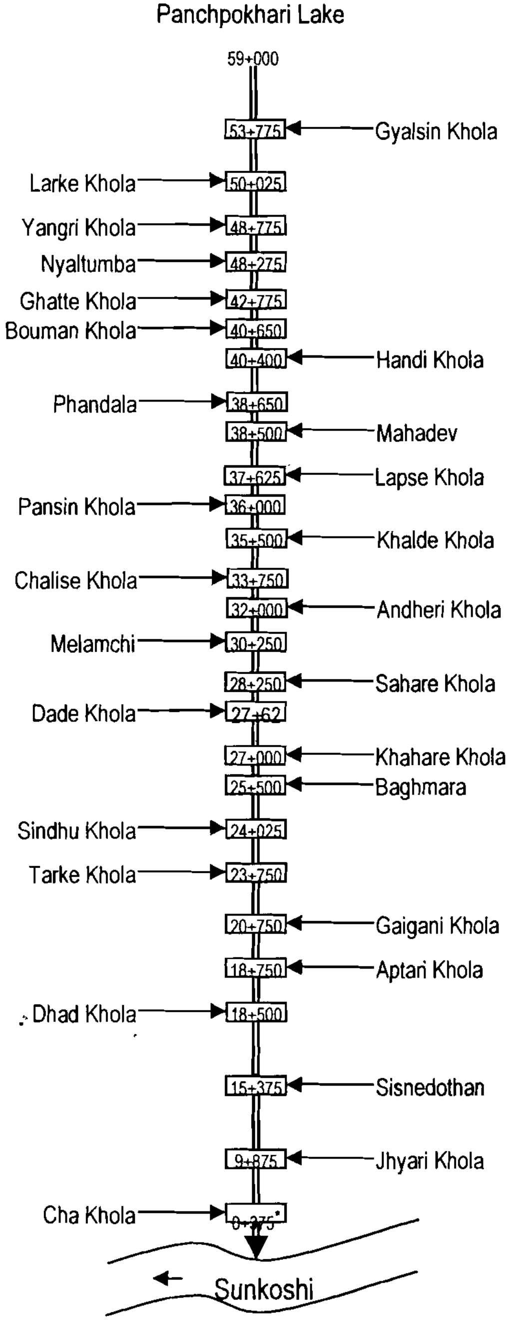


Figure 3: Flow Diagram of Indrawati River System



* Distance measured from confluence with Sunkoshi River in Km

WATER ACCOUNTING AND ANALYSIS

Water Accounting Procedure

The procedure of water accounting presented by Molden and Sakthivadivel (1999) was used in this study with minor modifications according to the data availability and practical conditions of Indrawati basin. The components of water accounting used in this study are described below:

Gross Inflow: The sum of rainfall and snowfall is considered as the gross inflow in the basin and sub-basin.

Storage: Surface reservoir and soil moisture storage is accounted for computation of water balance in the basin and sub-basin.

Outflows: Stream flows at the confluence of basin and sub-basin, accounted in this study were further sub divided as follows:

Committed outflow: The amount of water committed for environment protection, for downstream rights or for some other purposes either inside the basin or outside the basin is defined as committed flow. Here in this report the amount of water planned (1.97 m^3/sec) to be supplied from Melamchi Khola to Kathmandu city to supplement the need of drinking water is considered as committed flow. In total 62.1 million cubic meter of water is considered as committed flow.

Uncommitted flow: Though the utilizable flow have two values, one at the present level of technology and socioeconomic condition: and other at ultimate level of development, the amount of outflow excess of committed outflow is considered as uncommitted utilizable and non-utilizable outflow in this study.

Net Inflow

As defined by Molden and Sakthivadivel (1999), net inflow is the sum of gross inflow and storage change.

Available Water

Available water is defined as the amount of water available for use at the basin level without unsustainable withdrawals from storage. In this analysis available water is defined as the difference of net inflow and committed flow.

Depletion

Process Depletion: Process depletion considered in this analysis is the sum of agricultural crop depletion (evapotranspiration), domestic depletion, and animal depletion.

Non Process (Beneficial) Depletion: Forest, grazing land and homestead are beneficial for environment protection but intangible. So ET forest, ET grazing land and ET homestead are considered as non-process depletion in this report.

Non Process (non-Beneficial) Depletion: Since evaporation from barren land, flood plain and water body is not beneficial for society so the evapotranspiration or evaporation from these surfaces are considered as non-process but no-beneficial depletion.

Data Analysis

Period of Analysis

Data from 1971 to 1990 were analyzed. Three typical years (1985 – wet year; 1981 – average year and 1979 – dry year) were selected for water accounting computation as study years. Average year relates to average rainfall in the basin. The selection of typical years was based on following principle:

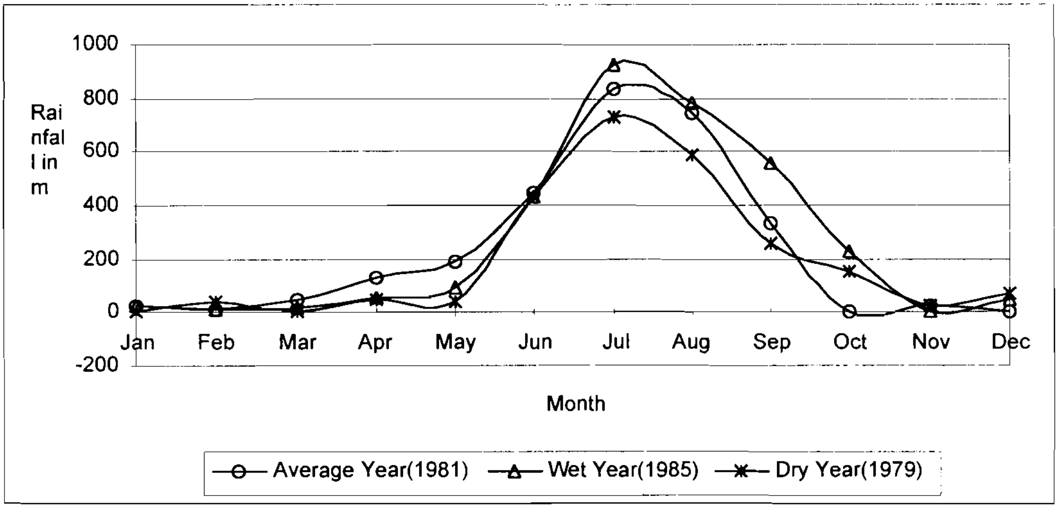
- The annual rainfall approximates rainfall values corresponding to frequencies of 25%, 50% and 75% for wet year, average year and dry year respectively.

Inflow to the Basin

Rainfall and Snowfall are the only sources of inflow to the basin. Since there is not any gauging station in the Himalayan region above msl of 4000 to measure either rainfall or snow pack the inflow in the basin is averaged from the available stations below msl of 3000 m. Annul rainfall inflow varies from 3172 mm in a wet year to 2381 mm in a dry year with average rainfall of 2,791 mm in an average year. The coefficient of variation of annual rainfall ranges from 10 percent to 22 percent at different stations. An analysis of 20 years of data (1971-1990) indicates that there is very little temporal variation in annual rainfall. However, there is a perceptible spatial variation in annual rainfall as one moves from head reach of the basin to the tail end. The coefficient of variation ranges from 23 to 43 percent receiving higher rainfall in head reach of the basin.

A plot of monthly rainfall for wet, average and dry years (Figure 4) indicates the following characteristics:

Figure 4: Comparison of Monthly Rainfall for Selected Study Years



- Rainfall is concentrated during six months of monsoon period from middle of May to end of October. July and August are the rainiest months receiving nearly half the annual rainfall. By looking at the rainfall of these two months, one can say whether a year is going to be wet, normal or dry year.
- Rainfall during the dry period of six months is only 7 percent of annual rainfall and do not vary much among wet, normal and dry years.
- As expected the coefficient of variation is very high during dry months and low during wet months.

Stream Flow

The stream flow record from 1975 to 1990 at Dolalghat river gauging station is considered for the calculation of basin runoff. The monthly mean discharges were compiled from the publication of Department Hydrology and Meteorology (DHM). About 84.4% of total runoff occurs during wet season from June to October. Yearly fluctuation of stream flow at Dolalghat is generally small with long term (16 years) average at confluence. A comparative analysis of rainfall and stream flow was done; the curve indicates inconsistency in flow records so stream flow is reprocessed to relate the series of observations on a statistical approach. In view of the fact that Indrawati River traverses over a large elevation change and the mean annual rainfall has a spatial variation of more than 2000 mm, the daily discharge at the confluence of Indrawati with Sunkoshi is computed using the following equation:

$$Q_c = Q_d * A_c/A_d * R_c/R_d * (S_c/S_d)^{0.5}$$

where, Q_c = discharge at confluence (m^3/sec)

- Q_d = discharge at Dolalghat (m^3/sec)
- A_c = catchment area up to confluence (km^2)
- A_d = catchment area up to Dolalghat (km^2)
- R_c = catchment rainfall up to confluence (mm)
- Rd = catchment rainfall up to Dolalghat (mm)
- S_c = average slope of catchment up to confluence
- S_d = average slope of catchment up to Dolalghat

Using the above equation daily discharges were generated at the basin confluence and from that monthly discharges were obtained. A typical plot of monthly discharges for selected study years and the long term average monthly discharges at the confluence are shown in figure 5 and 6 respectively:

Figure 5: Comparison of Monthly Discharges for Selected Study Years

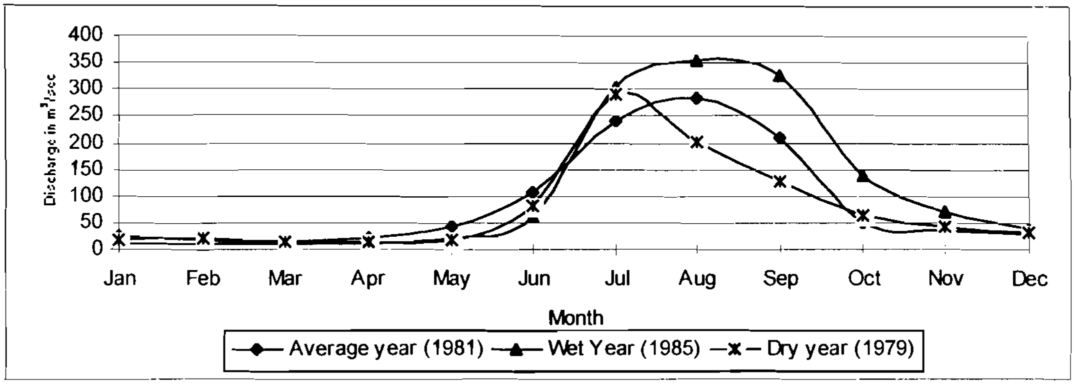
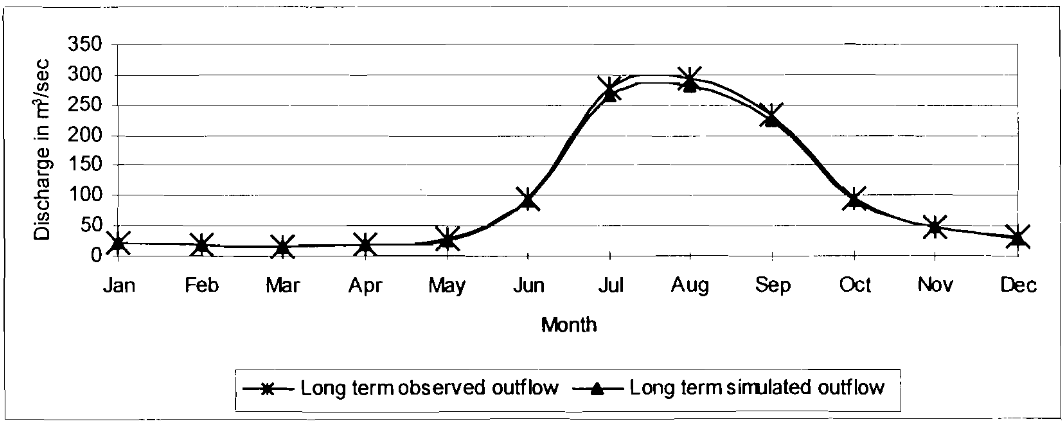


Figure 6: The Long Term Average Monthly Discharges at the Confluence Point



Storage Change

Storage change is mainly due to change in surface reservoir storage and change in soil moisture storage. Groundwater storage change was not accounted for, since groundwater is rarely used in this basin. Storage change is the difference between storage at the beginning of the year and at the end of the year. Since data is not available to compute both surface and soil moisture storage at the beginning and at the end of year, it is assumed that the storage at the beginning of a year is at full potential level of storage if the previous year is a wet year, at 75% of its potential storage if the previous year is a average year, and at 25% of its potential if the previous year is a dry year. As per this assumption the storage change for different combination of wet and dry year following one another is given in table below:

Table 1: Percentage Change in Storage

Previous Year	Current Year		
	Wet	Average	Dry
Wet	0.0	+25	+75
Average	-25	0.0	+50
Dry	-75	-50	0.0

The potential storage change is computed as follows:

For study period 1985 (wet year), previous year 1984 is a wet year so the both surface and soil moisture storage at the beginning of the year is estimated to be at 100% of its potential storage. Similarly for study period 1981 (average year) and 1979 (dry year), previous years are dry year and average year respectively. So the storage at the beginning of these years are at 25 % and 75% of potential storage respectively. Hence the change in storage considered for the wet year (1985) is 0% of potential storage. Similarly the change in storage considered for the average year (1981) is -50%, where - sign indicates the addition to the storage where as for the dry year (1979) storage change considered is +50 where + sign indicates the subtraction from the storage.

RESULTS AND DISCUSSIONS

Results

Indrawati Basin

The water account results for the study years are presented in table 2 and also presented in figures 6, 7 & 8. The basin performance indicators were computed for the dry year only, since yield data is available only for that year. The computed indicators are given in table 3.

Table 2: Water Account Result for Wet, Average and Dry Year

S. N.	Component	Sub-Component	Wet Year (PY – Wet)		Average Year (PY – Dry)		Dry Year (PY – Average)	
			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	3933.00		3461.00		2952.00	
2	Storage Changes	a) Surface Storage	0		-0.04		0.03825	
		b) Ground Storage	0		-81.15		88.15	
3	Net Inflow		**3933.00**		**3372.81**		**3040.2**	
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
		ET Millet	28.24	0.72	0.79	0.02	0.64	0.02
		ET Oil Seeds	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
		Sub-total	**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
		Sub-total	**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	Out-Flow	Run-off	**3512.53**	**89.31**	**3082.29**	**91.39**	**2621.63**	**86.23**
	Sum of depletion and surface run-off		4214.53		3824.93		3302.16	
	Sum of Net Inflow		3933.00		3372.81		3040.2	
	Calculation Error		-281.53		-452.11		-261.95	

Figure 7: Finger Diagrams Showing Water Account Results

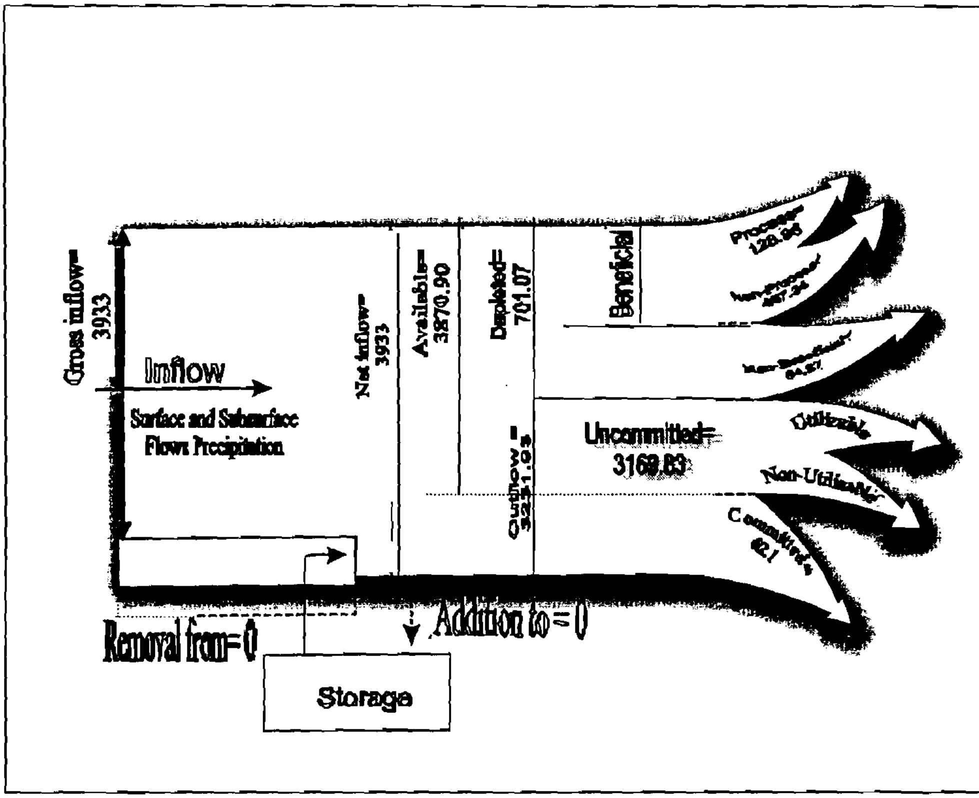


Table 3: Computed Indicators

S.N.	Indicators	Unit	Value	Remarks
1	Productivity of water in Agriculture	US$/m³	0.148	@1 US$ = 74 NPR
2	Depletion /Available water	%	23	
3	Beneficial Process Consumption/available water	%	4	
4	Beneficial Consumption/available water	%	20	
5	Utilizable Flow	%	77	

Melamchi Sub-Basin

An analysis was carried out to reflect the overall scenario of water use in the sub-basin with and without Melamchi water supply scheme. Twenty years (1971-1990) data of rainfall at three rain gauge stations were analyzed to evaluate the average inflow in the basin. Since the stream flow data for long term were not available so simulated data of 20 years (Hydroconsult) were considered to generate the outflow at intake point of water supply project and confluence point. Dry year is considered for the computation of water balance because this is the most crucial and most water short year so if there is no problem in this year then there will be no problem in other years. The water balance result for study year (1974-Dry year) is presented in table-4.

Table-4: Water balance result with and without Melamchi water supply project

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Before Project													
1. 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
2. Inflow in the basin (Rainfall) Million m^3	7.22	2.07	7.95	11.78	48.33	86.55	226.41	247.50	153.91	26.42	0.00	3.81	821.94
3. Inflow in the basin in m^3/sec	2.69	0.86	2.97	4.54	18.04	33.39	84.53	92.41	59.38	9.86	0.00	1.42	25.84
4. Outflow at confluence with Indrawati m^3/sec	6.57	4.61	5.17	5.51	6.16	14.32	57.92	77.37	50.96	17.48	10.79	7.70	22.05
5. Outflow at confluence in Million m^3	17.59	11.16	13.84	14.28	16.49	37.12	155.13	207.22	136.50	46.83	28.90	20.63	705.70
6. Process and Non-process depletion in Million m3	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
7. Out flow at Melamchi Intake m^3/sec	2.81	2.15	1.97	2.25	2.53	6.37	25.85	34.37	21.45	8.05	4.59	3.37	9.65
8. 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
9. 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
10. Diversion required for irrigated agriculture in m3/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
11. Balance runoff at confluence in 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													
12. Melamchi Project Supply m3/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
13. Outflow at confluence with Indrawati m3/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
14. Out flow at Melamchi Intake m3/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
15. Added flow from tributaries between Intake and confluence point m3/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
16. Process domestic requirement m3/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
17. Process depletion requirement (irrigated agriculture) m3/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
18. Irrigation diversion requirement m3/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
19. Outflow at confluence with irrigation system at full potential m3/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: 1. The drinking water requirements for 28,182 people will be about 0.013 m^3/s @ 40 lpd/capita, which is met from the nearby spring sources.

2. During dry period, whatever flow will be available at Melamchi Intake a minimum flow of 0.4 m3/s is supposed to be released d/s for aquatic life (As expressed by Melamchi Water Supply Project official during Technical Advisory Committee meeting).

Discussion of Results

Indrawati Basin (Basin Level)

A number of sectoral water uses were identified such as irrigation, drinking water, animal use, water use by forest and vegetation, hydropower and water mills etc. in the basin. All the sectoral uses deplete certain percent of water whereas hydropower and water mills add economic value for water without any depletion. Though it lose head and might not be able to use it at that certain location, indeed the water can be used further downstream in the basin.

Water accounting computations carried out for the Indrawati River Basin has demonstrated that only 23% of the basin available water resources is depleted in a dry year such as 1979 leaving a balance of 77% of utilizable outflow to move out of the basin (Table 3). As the utilizable outflow takes place throughout the year, the basin is an "Open Basin". There is a potential to harness this utilizable outflow and use it productively. Presently there are no major storage reservoirs in the basin.

Out of 23 percent of depleted water, only 4 percent is process consumption indicating that there is a great potential to increase beneficial process consumption. Also non-beneficial uses account for only 2.78 percent while bulk of the consumptive use is by forests, which is considered beneficial.

The water account balance sheets for the study years reflect that the sum of depletion and surface run-off is greater 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. It has already been discussed in the earlier section that there is high degree of spatial variation (33%) from north to south. That is higher in high elevation zone and lower in low elevation zone but unfortunately there is no rain gauge station above msl of 3000 m. Inflow in the basin is estimated on the basis of average rainfall below msl of 3000 m which might have resulted in lower inflow than considered in the above calculations. While preparing finger diagrams the out flow of different study periods is reduced by the quantity showing deficit to balance the inflow and assessing the quantity of utilizable flow more in safe side. This indicates following methodological limitations:

a. In steep terrain the variation of rainfall is high. So, if the rain gauge stations are not adequately spaced the average rainfall as calculated above may result in erroneous water accounts.

b. The precipitation is always considered as rainfall but snowfall may not yield same run-off as rainfall does.

A perusal of the rainfall and runoff pattern in the basin indicates that about 92.6 percent of rainfall is concentrated in six monsoon months from May to October and consequently there is considerable surface runoff. During the other six months of a year, there is very little rainfall, not contributing to surface runoff; however, there is sizable flow in the river because of significant coverage of snow in the head reach of the basin, which is an important and perennial source of water during the dry season. Beside, during the dry season, the soil water stored in the upper mantle is used by crops and vegetation present in the basin while the groundwater stored underneath the upper mantle contributes to dry weather flow to some extent.

Proposal for diverting water from this basin (Melamchi River) to supplement drinking water need of Kathmandu city is also considered in the present analysis. As per the plan at least 1.97 m^3/sec (62.1 Million m^3) is to be diverted. This quantum of water is considered as committed flow

The agricultural productivity of the basin works out to NRS 10.9/m^3 i.e. equivalent to US$ 0.148/m^3 of process consumed water (Table 3) that appears to be slightly high in view of the yields obtained for cereal and oilseed crops of the basin. We looked into the reason for such a slightly elevated figure. If one works out the water consumed per ha of cultivated crop, it works out to only 356 mm, which appears to be low. This low figure may be due to the way in which ET is computed in our calculation. In the ET computation for non-irrigated (rain-fed) crops, effective rainfall and potential evapotranspiration are computed for every 10 days of the crop growing season and if effective rainfall is less than potential ET computed, then 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 1.50 m. This may be one source for this apparently high water productivity of consumed water. Further investigation is needed to have a better understanding of this aspect.

Melamchi Sub-Basin (Sub-Basin level)

Water balance result (Table-4) of Melamchi sub-basin has reflected that the overall depletion (Process and Non-process) in the sub-basin area is only 208.88 Million m^3 (25.4%) out of total inflow of 821.9 Million m^3 remaining 705.7 Million m^3 of water is flowing out of the basin 613.02 Million m^3. This reflects the soil moisture depletion by an amount of 92.68 Million m^3 or the excess out flow may be due to increased flow from snow pack area inclusive of some estimation error. This result indicates that a minimum quantity of water is being used annually on the sub-basin level.

As discussed in previous section a water supply scheme is planned from Melamchi River to divert water at a flow rate of 1.97 m^3/sec in the Bagmati basin. From the balance sheet we see that the outflow d/s of intake after completion of project reduces significantly ranging from -0.003 m^3/sec in March to 1.4 m^3/sec in December with an average of 0.54m^3/sec during dry season from December to May. But during the meeting of Technical Advisory Committee, representative from the Melamchi Water Supply Project expressed that a minimum flow of 0.4 m^3/s will be released d/s for the aquatic life irrespective of the flow available at the Melamchi Intake. One can expect significant impact on d/s users with such low flow. Although a considerable volume of water is added through different tributaries, spatial variation in added flow may affect irrigated agriculture or other societal needs. This can be justified only after detail analysis of individual tributary.

Another area to be looked upon is the flow rate required for bathing and environment protection. From the table above we see that minimum flow in the river without project is 4.6 m^3/sec in the month of February but after potential use by irrigated agriculture the flow reduces to 4.35 m^3/sec. From local inquiry a flow rate of 2.3 m^3/sec that is 50% of present low flow is sufficient to meet requirements. But with Melamchi project this flow rate available during February to April will be 2.79 m^3/sec ranging from 2.38 m^3/sec in February to 3.13 m^3/sec in April slightly higher than required flow. This indicates that further abstraction from Melamchi sub-basin during these months may not be recommendable though the Indrawati river basin appears as an "Open Basin".

CONCLUDING REMARKS

The water accounting exercise of Indrawati River Basin and Melamchi Sub-basin indicates:

Indrawati River Basin

- It is an open basin; only 23% of water is depleted in the basin. The remaining 77% of utilizable outflow moves out of the basin.
- Only 4% of available water is process consumed. Forest occupying 40% of the basin area consumes a large chunk of water. Non-beneficial depletion is only 2.78%.
- The agricultural water productivity is NRs. 10.9/m^3 (US$ 0.148/m^3) of water consumed. Yields of cereal and oil seed crops are average. Still there is a great potential to increase water productivity.
- Drinking water use is minimal and mostly from spring sources.

Melamchi Sub-basin

- A supply of 1.97 m^3/sec is allocated to supplement the drinking water demand of Kathmandu city.
- Although Indrawati Basin is an open Basin, Melamchi Sub-Basin is closing one.
- Further withdrawal for irrigation and other purposes during dry season (December to January) may affect environment and other societal needs. To justify this, detail analysis of individual tributary is recommended.
- In spite of sufficient utilizable flow at basin level, spatial locations of feeder tributaries restrict the water use planning.
- During the dry season, there is considerable contribution of flow from snow pack area.
- Soil moisture depletion occurs during dry season.

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Paper 2: Formal and Informal Institutions on Water Management in Indrawati River Basin

Dhruba Pant

Background

The *Indrawati* river basin has a long history in farmer-managed water use systems. This river basin was one of the research sites for understanding the complexities of water use practices in a river basin. The study focus was to understand formal and informal arrangements for managing water in its different uses, water rights arrangements and means for conflict resolution within the selected tributaries. This study was important to understand mechanisms developed by the users of different water use that could provide a reliable basis for future institutional development while developing new systems. The study focused on two sub-basins of *Indrawati* River: *Melamchi Khola* and *Handi/Mahadev Khola* tributaries.

Water Use Activities, Water Availability and Scarcity

The *Melamchi, Handi /Mahadev Khola* is a perennial river. It has abundant supply of water and users have diverted water by constructing temporary intake at different places for various activities – irrigation, *Ghatta*, water mill with turbine and micro-hydro. The installation of micro-hydro is the recent (1999) development. These water use systems are operated throughout the year. Being a perennial source the water availability is abundant for various water uses. The users in some villages have been able to utilize water resource for more activities. This however, is determined by the availability of the external resources, ability to mobilize local resource and development of micro enterprises by private sector. The users reported that there is some water scarcity for winter and spring crop. Consequently, the cropped area in larger irrigation system decreases during winter and spring season. The water mill with turbine is also operated throughout the year but reported that they may have to run only one end-use at a time when water is used for irrigation also from mid-February to end of May because the available water is not sufficient both for irrigation and water mill operation. Some of the *Ghattas* are operated throughout the year, which face water scarcity during the dry season. This suggests that the available water have to be shared between irrigation system, water mills and the *Ghattas*. The competition for water use is growing due to implementation of new activities, which will be discussed in the following sections.

WATER ALLOCATION

Water allocation between irrigation and water mill with turbine

The canal for bringing water to the water mill with turbines is also used for irrigation. The mill owners have constructed the temporary headwork with earthen canal. The irrigation systems are at the upstream whereas the water mills with turbines are operated at the tail end of the canal. The mill owners have the right on the land on which the canal is constructed. An arrangement has been developed among the irrigation users and the mill owners that the irrigation users will have unhindered access to the water for irrigation. In that respect the mill owners share the water right with the irrigation users. The irrigation users used to divert water from small rivulets, which were not perennial before the construction of the canal by the mill owner. The allocation of water between these two water uses is not a problem due to the sufficient availability of water.

The users reported that the mill owners also do the operation and maintenance of the canal without the help of the irrigation users. This is because, the mill owners have more stake in the operation of the canal due to the investment they have made and also due to the fact that they are at the tail end. During the time of reduced flow (December to end of May) in the canal, the mill owners reported that they have to put in extra effort to check the leakage in order to augment more water (180 to 200 lps) in the canal since the canal is not lined. However, the irrigation users receive first priority for the use of water for planting and irrigation for spring paddy. There were occasions when the mill owners had to close the mill for 2-3 hours at the request of the irrigation users. Another arrangement is that the irrigation users irrigate their field during the night while leaving the water use to the mill in the daytime.

Water allocation between the irrigation, micro-hydro and the mill with water turbine

The mill owner negotiated with the irrigation users for establishing the mill upstream to the irrigation canal. The mill owner received the written consent from the irrigation users. The users gave the consent because they could get electricity; the users have easy access to the services from the mill and also travel time reduction. Beside, the mill owner took the responsibility of operation and maintenance of the canal from the intake up to the mill. The existing kinship relationship between the mill owner and the other irrigation users was also important in this respect as most of the irrigation users are from the same ethnic group and were related to each other. The allocation of water between the irrigation system and the mill suggests that the users were concerned for the maximum utilization of the water resources at the local level whenever there was an opportunity to do so.

A micro-hydro with a capacity of 21 kw with the support from UNDP at the down stream of the irrigation canal was installed in 1999. The micro-hydro is owned and managed by the community. The micro-hydro was constructed with the consent of the mill owner and with a written assurance that it will not disrupt the operation of the mill. An informal arrangement between the mill owner and the users was made that the mill will be operated during the day time and micro-hydro in the evening (5.30 pm to 11.00 pm), as the available water was not sufficient for the operation of both the micro-hydro and the mill. The important aspect in this respect is right of the irrigation users. The arrangement indicates that the irrigation users are the first to receive priority in water use. Then the mill owner has the right to use the water and only after that it comes the right of the hydro-power users. Some adjustment in future might be necessary if some of the villagers started micro-hydro end-uses in day time.

One of the implications of the micro-hydro operation was that the electricity generated by the mill has been stopped. The mill owner informed the study team that the REDP has promised to compensate by buying the turbine from him. Another important implication was that the operation and maintenance of the canal up to the micro-hydro is now the responsibility of the electricity users. The ownership was with the irrigation users when there was no mill, then after the ownership was divided between the irrigation users and the mill owner. Now all the electricity users have become the owners and most of them are also the irrigation users. This reflects the changes in the property relation due to the changes in the ownership pattern. This was due to the changes in the water uses for various purposes.

In one case after the construction of micro-hydro it was realized that the power generated by the micro-hydro was not possible to extend to some of the settlement due to the transmission loss. Because of this it was agreed, in the presence of the VDC, that irrigation users would receive first priority for the use of water especially during February to May. The water from the tail race of micro-hydro flows to the irrigation canal at the down stream. The irrigation users at the tail end of this irrigation system had difficulty in receiving irrigation water before the construction of the micro-hydro according to the users. Therefore, there has been positive impact on the irrigation system at the down stream.

Water allocation between the irrigation systems and the Ghatta

There were four irrigation canals, parallel to each other, constructed in different times to provide irrigation water to different patches of land. The construction of these canals in different times was due to the constraint in the allocation of water within the irrigation systems, especially during planting season and for winter irrigation due to the expansion of the irrigated land. The allocation practice was to start irrigation at the head and the land at the middle and tail end received water only after finishing the irrigation at the head. The construction of new canals at the downstream has helped in reduction of disputes also. The availability of the water at the source was contributing to the construction of new construction.

There is competition for water among the irrigation users and the *Ghatta* owners also. There are 11 *Ghattas* operating along the riverside. Users informed that there are certain rules, although informal for the allocation of water to the *Ghattas*. According to their operation they are classified into four categories – up to three months, six months, nine months and one year and are registered with the VDCs. The owner can claim for the access to the water because they pay annual fee to the VDC according to the months of operation in a year. The fee is NRs. 5 per month. Therefore, other users cannot divert all the water by affecting the operation of the *Ghatta*. In this respect there is established right of the *Ghatta* owner as well. However there is no strict allocation rule between the *Ghatta* and the irrigation system. The problem for the allocation of water between the *Ghatta* owner and the irrigation users arises during the day time as the *Ghattas* do not operate during the night.

CONFLICT

The reported cases of conflict are between the *Ghatta* and the irrigation. The conflict is during the months from February to May when the water flow in the river decreases. The irrigation users however, claim that the *Ghatta* owner does not check the leakages in the canal, which would increase the flow to the need of both the users. During this period the irrigation users depute someone from among them for patrolling the canal to maintain continuous flow of water in the canal. He guards at the intake.

Some disputes occur occasionally when the irrigation users disrupt the water flow to the mill when there is reduced flow in the canal. However, these disputes are solved through the dialogue between the two parties either by increasing the water volume in the canal by the mill owner or by closing the mill for 1-2 hours when irrigation is required. The customary practice of maintaining at least 200 meter distance between the upstream and downstream intakes have reduced the conflict between the irrigation users. However, the users reported the conflicts in small tributaries for the spring crop (beginning of May) and planting season (beginning of July). The VDCs resolve the disputes by allocating the water between the upstream and downstream users, which is abided by both the upstream and downstream users.

INSTITUTIONAL AND ORGANISATIONAL ARRANGEMENTS

Except for the irrigation and the electricity, the other water use activities are privately owned. Some of the irrigation systems, which were rehabilitated by the IIMI/WECS had users' committee (UC) formed during the time of rehabilitation. These UCs are not functioning at present. The UC formed during irrigation intervention by DOI have also become dormant however this has not affected the functioning of these systems. The organization thus created for the interventions were functional during the time of construction only. The users' interests are represented collectively through the group. The group becomes active whenever there is a need to protect group's interest in protecting the water right. This was evidenced from the arrangement made by the group in patrolling the canal to ensure the allocation of the water and the initiative taken in construction of new irrigation systems. Besides, the users groups have been able to negotiate and develop appropriate mechanism for water allocation with other water use activities. Likewise, the users have negotiated with the private mill owner and the micro-hydro for the operation and maintenance of the canal, as they are responsible for operation and maintenance of the canal up to their water use activities. This was possible due to the leadership role of some of the users and also due to the fact that the irrigation users are also the users of other water uses activities in the village.

The users without the formal organizational structure have been able to represent the group in accessing external funding for the installation of the micro-hydro. The group is maintaining organization linkage with other institutions for the development of the water resources. For example they are mobilizing DDC and VDC resources also for the development of the micro-hydro. It shows that existence of formal organization is not a pre-condition for initiating development of the water system. But when it comes to the implementation and management of the water resources, formal organizations are required to mobilize resources and to protect the right of the users.

The REDP for the development of micro-hydro has formed users' committee of two tiers. Each of the settlement has one committee to co-ordinate the activities of the users and these committees have sent one representative each to form a main committee. The primary task of the main committee is to ensure proper functioning of the micro-hydro, mobilize resources through fee collection for the operation and maintenance of the system and to maintain linkage with the outside institution

The discussions on water allocation practices above indicate that the rules for the water use among various sectors are institutionalized through the agreement between the water users of various activities. However, customary practice is that the irrigation receives first priority according to the users. The development of new water use activity is also based on the informal arrangements among the users of different water use sectors. Therefore, rules are not formalized as observed in the form of constitution of water users. This is because the rules for defining the water rights among the users of various sectors are not required due to the absence of serious conflict among the user. Consequently, water users' organization is not in existence except for the irrigation systems and micro-hydro, which received the external assistance.

The role of VDC in water resource management is confined to providing occasional financial support for the construction of drinking water and maintenance of irrigation systems. Besides they register the *Ghatta* and collect fee from them. And also they play an important role in the resolution of conflict, as they are the people's representative body at local level. However, VDC is not proactive in the management of the water resources at local level. This may be because their role in the development of the water resources is not recognized at present.

THE ROLE OF OTHER INSTITUTIONS IN WATER MANAGEMENT

The role of District Water Resources Committee (DWRC) at present is confined to issuing license for water resource development, registration of the UC for the irrigation systems, request DDC/VDC to resolve the conflict if there are any complaint from the users and recommend DIO for the construction of the new irrigation systems at the request of the users. The activities of DWRC indicate that it is not involved in the integrated water resource planning for the district.

The DDCs role in the development of the water resources in the recent years is becoming important. This is largely due to their ability and willingness to contribute resources for water development. The DDC provided NRs. 178,000 and NRs. 150,000 for micro-hydro installation in two VDCs. Nevertheless, the DDC president of Sindhupalchowk opined that the co-ordination between various agencies for the development of water resources in the district is lacking. He was of the opinion that the government officials dominate DWRC. Therefore, the DDC has withdrawn its representative from the committee. Further, the DDC has filed court case challenging the authority of the DWRC with respect to registration of the Users Committee (UC) at DWRC, which is against the spirit of Local Governance Act. He argued that the government should seek DDC opinion before issuing license to private sector for water resources development. The chairman of the DWRC should be DDC president according to him. The chairman of DWRC at present is Chief District Officer of the district. He was also of the opinion that the government should specify private sector contribution to local development while issuing licenses for the development of water resources in the district. Beside, the local bodies should be empowered to tax the private sector development of water resources and the government should compensate for the negative effect created by the big water resource development projects according to him. In essence the DDC Chairman was not satisfied with the present arrangement for the development of water resources. The DDC should be central decision-making authority for the integrated water resource management in the district according to him.

SUMMARY AND CONCLUSIONS

The findings and the conclusions could be summarized as follows:

- The water allocation between the water use sectors is based on the customary practices, in which irrigation received first priority in water allocation. Therefore, users do not feel the need for formal organization.

- No strict allocation rules have been developed due to the sufficient water availability. However the competition for the use of water is increasing at recent time due to the development of the micro-hydro and new irrigation systems.

- The water rights between irrigation, micro-hydro and water mill with turbine are based on the negotiation and compromise for taking responsibility of maintenance. The arrangement indicates that the food production receives priority over other uses and users would not compromise on it. The water mill owner and the micro-hydro users had to take the maintenance responsibility since the irrigation is the oldest water use activity. Therefore, irrigation users are not prepared to share their right unless they receive some benefit.

- The conflict among the water users is less pronounced at present, as the water availability for various uses is not a constraint.

- The contribution of the VDC/DDC for the developments of water resources especially the micro-hydro is encouraging. However, DDC seeks bigger role in integrated water resources development at the district level.

- The growing competition among various sectors may encourage the users in future to develop suitable institutional arrangement.

MAIN ISSUES

1. Would the informal institutions be able to cope with the changes in the future water use practices in the river basin?

2. What role the local elected institutions and DWRC could play in the development of water resource planning in future?

3. Is there a need to develop river basin perspective for water resource development in the basin?

4. Is there a need for river basin authority for Integrated Water Resource Management (IWRM) in the river basin?

RECOMMENDATIONS

1. The competition for water resource use at the local level is increasing due to the increasing need for various uses. The river basin perspective in the development of water resource should be developed in order to fulfill existing and future needs for various water uses. Integrated water use planning for the river basin need to be developed before any intervention is made at local level in order to maximize the benefit from water use activities.

2. One single agency should be assigned to monitor the water uses activity at the local level. The DDC would be the appropriate agency for coordinating functions for the water resources from private, community and other agencies at the district level (when the activity covers more than one VDC). This is because the DDC are responsible for preparing periodic and annual District Development plan for various sectors in the district. Close co-ordination between the DDC and DWRC is required to prepare integrated water resources plan for the district. The DWRC need to as technical hand of the DDC needs to be made effective in this respect.

3. The users have to register to different agencies for water uses activities at present. For example, *Ghatta* is registered at VDC, Water mill with turbine at district office of cottage industry and UC for irrigation with DWRC. VDC would be the appropriate agency for the registration of the water uses activity at the VDC level and should be entitled to collect taxes for the development of water resources in the VDC. However, the VDC needs to be strengthened through proper orientation to its officials take up new challenges.

4. The users should be encouraged to keep the formal institution (UC) functional by explaining its advantages. The possibility of accessing resources from various sources for the operation and maintenance of the irrigation systems has contributed to the less interest among the users in this respect. Therefore, users need to be encouraged to develop appropriate mechanism for internal resource mobilization for the up keep of the systems. The NGOs, which are registered at the district nee to mobilized for this activity. The provision of internal resource generation for the operation of micro-hydro could be a good example in this regard.

Paper 3: Stakeholders' inclusion and exclusion process in the Indrawati River basin: a review

Sanju Upadhyay

INTRODUCTION

General

The growing demand of water for multi-sectoral uses has alarmed the need to study inclusion and exclusion processes of the stakeholders of the river basin. As a result of which Water and Energy Commission Secretariat (WECS) and International water management Institute (IWMI) have jointly managed a research project in the Indrawati river basin in Nepal. Stakeholders' inclusion exclusion process is part of this collaborative research project.

Background of the study area

The Indrawati river basin extends to the snowy mountains at the north till it meets the Sunkoshi River, one of the major river of Nepal at the south. The river originates from the Mahabharat range (msl 5863 m) the lowest confluence of the river basin lies at the middle mountainous region. The basin area lies at 50km north east from the Kathmandu valley. Length of the main course of the Indrawati River is 59km. Some of the major tributaries of the Indrawati River are Melamchi, Handi, Mahadev, Larke, Yangri, Jhangri and Chha Khola. The catchment area of the basin is 124,000ha. The basin covers sub-tropical to alpine climatic zone and overlaps three districts of Nepal: Sindhupalchowk, Kavreplanchowk and Kathmandu.

The population density of the basin in 1991 was 165 per km2 and the projected figure for 1998 is about 175/km2. 96% of the population is involved in agriculture. Farm size per household is small (0.9ha).Major crops grown in the basin are wheat, rice, maize and millet. The average yields are 2.3 t/ha.3.2t/ha.,2.45t/ha.,and 1.7t/ha. respectively.

About the Study

The Indrawati river basin has been targeted for many new water related projects inclusive of Melamchi Water Supply[3] and Indrawati Hydropower Projects. This study focuses on the stakeholders' inclusion and exclusion processes, which accompanied the implementation of water related projects in the Indrawati river basin area. Situations where water scarcity is leading to some group of water users to loose their claim on water and situations where new developments lead to more available water have been studied.

Objective of the study

Broadly objective of this study is to find out the inclusion/exclusion scenarios inside and across the system, Role of decision making of female gender/disadvantaged group/marginalized farmers/backward or downtrodden ethnic group. To be specific the objective of this study can be broken down into:

- To documents inclusion and exclusion processes in Indrawati sub watersheds,
- To analyses mechanisms of inclusion and exclusion of water-dependent stakeholders, and
- Recommend at the policy level if and how, the interest of disadvantaged groups can be better protected while preparing new water policies in the Nepali context.

Issues to be looked into

Both situations, where growing water competition leads to some group of water users to loose their claim on water and situations where new developments lead to more available water, have been studied. These are the issues looked into:

[3] The Melamchi project aims to divert water from one of the Indrawati tributaries, the Melamchi River, to Kathmandu valley for drinking water. Probably almost all dry water flow in the river will be diverted out of the basin, although information about the magnitude of diversion in comparison to the available flow is not consistent. Farmers, in response to the threat of loss of water, and hence loss of irrigated agriculture, formed pressure groups to ensure proper compensation of their felt losses. Meanwhile the government argues that the impacts of the Melamchi Project on downstream farming will be minimal.

- Initiation of the ideas of development of the project
- Identification of beneficiaries of the new development
- Identification of the excluded group of beneficiaries
  - Intra system exclusion
  - Inter system exclusion
- Inclusion –Exclusion of potential beneficiaries due to:
  - Economic class
  - Gender
  - Ethnicity
  - Kind of water users (Sectoral: Domestic, Agricultural, Entrepreneurial & Others)

RESEARCH METHODOLOGY

The study was carried out through the analysis of the secondary data and the primary data.

Secondary data collection

The secondary data was collected through the literature review of the Water Resource act (WRA) 2049 and various publications of previously undertaken studies of WECS and IIMI on Indrawati river basin.

Sample selection

For the selection of the sample multistage sampling procedure was followed in that first the tributaries to be studied was selected then the system in each of the tributaries were chosen. For selecting the development programs, following was the criteria set forth.

1. Growing competition of water
2. Multiple water uses
3. New development planned

Thus based on this three of the tributaries selected were

- Melamchi Khola
- Handi Khola
- Mahadev Khola

Primary data collection

For primary data collection, the following methods were adopted:

- Field observations, i.e. walkthru of the system was carried out. Visit to hydropower plants, water mills, ghattas and irrigation systems and canals to acquire the information related to the physical aspect of the system.

- Interview with key informants were carried out through the participatory rural appraisal (PRA) technique using checklist and questionnaires .The team interviews were however not based on the rigidly administered questionnaires and checklists generally used on the standard sample surveys but were flexible. Interviews were carried out through the guiding discussions with the informants. The questionnaires focused on issues of organizational pattern, management of the system, water allocation and distribution within the system or among the systems, water right and obligation, existing planned and ongoing water related projects, inclusion and exclusion processes related to new development. The draft questionnaires were modified after the first field visit of the selected tributaries (sites).

- Group discussions and interviews with the concern water users, the leaders of users and local political leaders and

- Cross checking of the field issues with District Development Committee (DDC) officials, Rural Energy Development Project (REDP) officials, district drinking water supply and district irrigation officials.

The key features of the selected systems for the study are as follows:

Table 1: Studied Irrigation Systems

Tributaries	Name of the system	Located VDC	Command area of the system	Beneficiaries households	Constructed/ rehabilitated	Length of the canal
Melamchi	Palchowk Beltar Bhattar	Palchowk	150 ha.	400	1996	4.6 KM
,,	Simbhandar	Kiul	7 ha.	55	1984	2 KM
,,	Chiuri Kharka Kiul Palchok (Nadi Ko Kulo)	Kiul/ Palchowk	220 ha.	650	1996	5.5 KM
Handi Khola	Subedardhap	Thangpaldhap	200	172	1997	4 KM
,,	Chhimti Muhan Ko Kulo	Thangpalkot	100	400	Rehab. 1987, 1993, 1998	7.7 KM
,,	Nayadhara	Thangpalkot	150	500	Rehab 1987	6.7
Mahadev Khola	Siran Ko Kulo	Thangpaldhap	25	71	Rehab. 1987	2.7
	Ghatta Muhan Ko Kulo	Thangpaldhap	33	108	Rehab. 1987	3.23
	Magar Ko Kulo	Bhotenamlang	143	650	Rehab.1987, 1997,1998, 2000	5.6 KM

Source: Field survey, 2000.

Table 2: Studied Hydropower Systems

Tributaries	Name of the system	Owner	VDC	Capacity	Beneficiaries household	Construction year
Melamchi	Dal Bahadur Jyoti Hydropower	Private	Kiul	10 KW	30	1989
Handi Khola	Handi Khola I Demonstration Micro Hydropower	Community	Thangpaldhap	27 KW	190	1999
Handi Khola	Handi Khola III Micro Hydropower	Community	Thangpalkot	20 KW	174	2000

Source: Field survey, 2000.

Table 3: Studied Drinking Water Supply Systems

Tributaries	Name of the systems	VDC	Beneficiaries	Total tap	Construction year
Melamchi	Ichowk drinking water supply	Ichowk (1-5 wards)	1700	300	1989
Melamchi	Nagi Danda drinking water supply	Palwhok ward-4, Kiul-1	48	32	Ongoing (2000)
Handi Khola	Nayadhara	Thangpalkot ward (2-3)	150	10	1996

Source: Field survey, 2000.

Table 4: Brief description on sectoral water uses in the selected tributaries

Tributaries	Length in (KM)	Catchment area in (KM^2)	Benefited VDCs	Uses of Water	Remarks
Melamchi	41	346.7	Helambu, Kiul, Ichowk, Palchowk, Mahankal, Dubachower, Talamarang, and Melamchi.	19 irrigation systems, several drinking water projects, one micro hydropower plant, ghattas and water mills	- Palchowk Beltar Bhattar (150 ha), Halade Taruki Besi (135 ha), Gure Besi (135 ha), Chiuri Kharka Kiul, Palchowk (220 ha, planned), Talamarang, Melamchi Tar (83 ha – ongoing) irrigation systems are the main users of Melamchi water. - As water is sufficiently available from the tributaries of Melamchi River, Malamchi water (from the river itself) is used only for irrigating dry season crops. - There is one existing micro hydropower project, of 10 KW capacity owned by individual. - None of drinking water project uses Melamchi water. - Most of ghattas and water mills run in winter season and about half of ghattas shut down during summer season due to the flood in Melamchi River. - The systems, which are fed by Melamchi, have adequate water available from the river. However, water shortage is faced in dry seasons mainly due to inappropriate maintenance and operation of the systems. - Among the selected systems in Melamchi tributary, only Simbhandar Kulo has multiple water use: irrigation, ghatta, water mill and micro hydropower.
Handi Khola	13.75	52	Thangpaldhap, Thangpalkot and Gunsa	12 irrigation systems, 2 existing and one planned micro hydropower projects, 10 ghattas and 2 water mills	- All system runs throughout the year.
Mahadev Khola	6	16	Thangpaltar, (Thangpaldhap) and Bhotanamlang	11 irrigation systems and 10 ghattas	- About half of ghattas do not get sufficient water throughout the year.

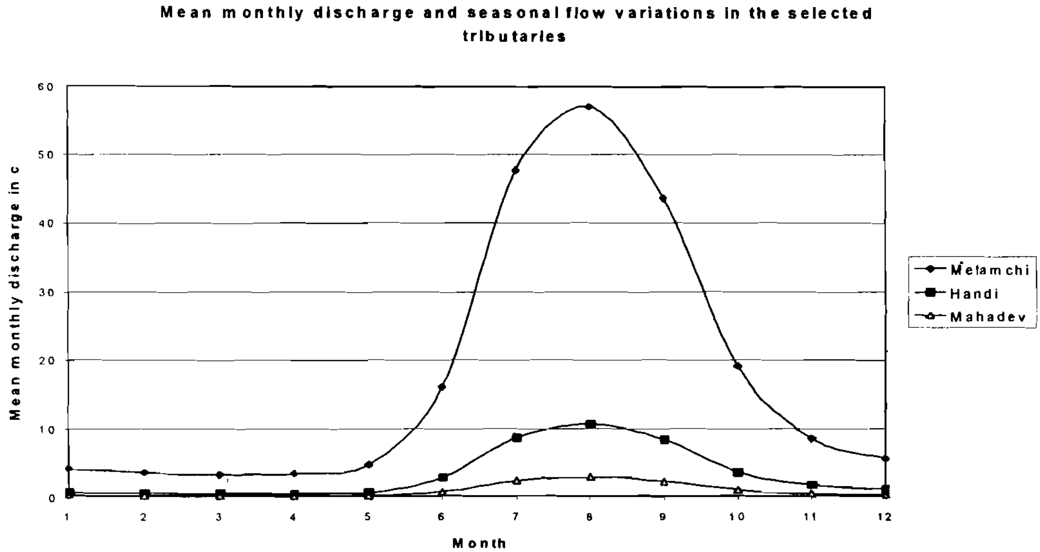
Source: Field survey 2000

In the selected tributaries, the reported discharges of water used in different sectors are as below.

Table 5: Mean monthly discharges of water in selected tributaries in M^3/sec

Tributaries	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
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
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
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

Source: G. Rajkarnikar, Initial Assessment of Resource Base in Indrawati River Basin, Nepal. May 2000.



SOCIO-ECONOMIC STATUS

Poor and marginalized groups

As per the local informants, the people are classified as "poor" if they do not own cultivable land and their shelters are built on the land of landowner. They fully depend on the land they till on, mostly as informal tenants. They have food security only for 6 months in a year. They are unable to send their children even for the primary level education. On an average 3% people are poor in study tributaries.

Marginal people, a little better off (considered as marginal for this study), own small plot of cultivable land but not sufficient for their families and have their own shelters. They are not- self-dependent either and have to cultivate others' land as tenants as well. Agriculture is the only source of income for their family. Food security for them is better but not enough for the entire year. They enroll their children in schools but most of them do not continue after primary level education.

Landholding/ management pattern

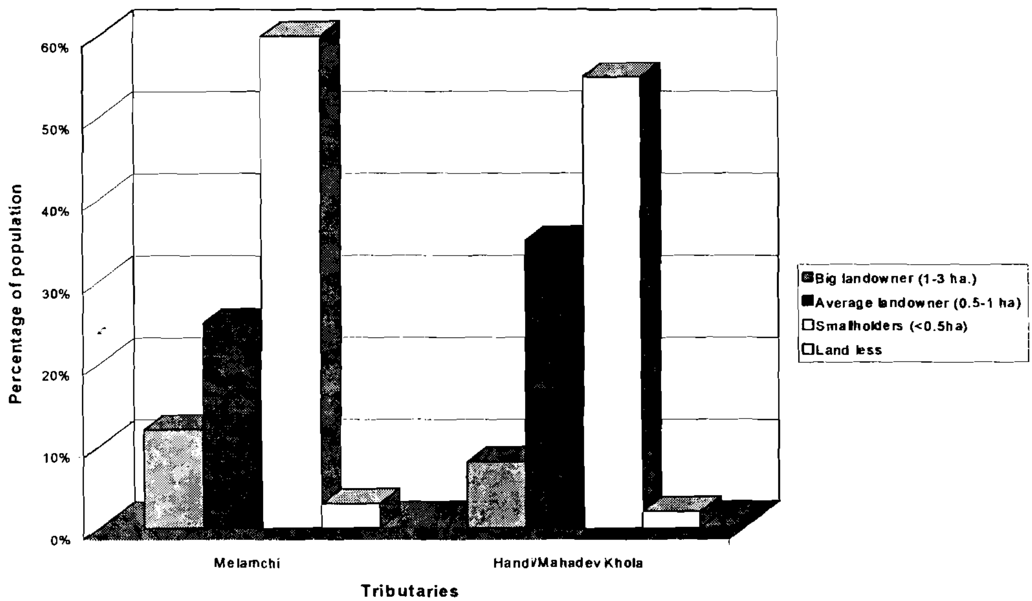
The distribution of land in the study area is summarized below:

Table 6: Landholding pattern in study tributaries

Tributaries	Big landowner (1-3 ha.)	Average landowner (0.5-1 ha)	Smallholders (<0.5ha)	Land less	Remark
Melamchi	12%	25%	60%	3%	Mostly the big landowners are Sherpa people in Melamchi tributary and Brahmin/Chhetri in Handi/Mahadev Khola.
Handi/Mahadev Khola	8%	35%	55%	2%	

Source: Field survey 2000 (by local interpretation)

Land holding pattern in the selected tributaries



The tenancy rate is much higher in Melamchi tributaries. The Palchok Beltar Bhattar Irrigation system, tenants are cultivating 90% of the cultivable land .The proportion is 80% and 70 % in Taruke besi and 70% in Churetar irrigation systems. Unlike Melamchi tributary, very small area of land is tenant cultivated in Handi Khola and Mahadev Khola tributaries.

Cropping pattern/productivity

The prevailing cropping patterns and productivity in the studied tributaries are summarized in the table below:

Table 7: Cropping pattern in study tributaries

Tributaries	Crops grown	Productivity in Mt/ha	Remarks
Melamchi	Paddy – Paddy wheat/lentil/potato	Paddy-3, Wheat-2, and Lentil-0.6	
Handi and Mahadev	Paddy – Wheat Maize/ Potato	Paddy-3, Wheat-2, and Maize-2	- Upper parts of these areas only have paddy and wheat (two crops in a season in a year). This is mainly due to coldness. - Limited parts of Subedardhap and Ghatta Muhan Ko Kulo, grow two paddy crops.

STAKEHOLDERS BY SECTORS

Various stakeholders using water along Melamchi tributaries include:

- Irrigation
- Hydro power
- Drinking water
- Ghattas and water mills
- Fishermen (only along Melamchi)

Among all the sectors as above irrigation stakeholders are in the majority.

Membership criteria

Irrespective of whether an individual is the land owner or the tenant, basic criteria of entitlement of the membership in an irrigation system is the contribution of labor in the construction or rehabilitation and for the regular maintenance.

In community-managed hydropower systems, labor contribution in construction is the basic criteria to get membership in the community level organization. To retain the membership one has to abide by the mandatory condition of payment of NRs.5.0 each week for the O&M of the system as reported in the Handi Khola-I and Handikhola-III hydropower system. Membership was found to be terminated in the case of three consecutive absence in the executive committee meeting as observed in the case of the Handikhola-I system. For instance, in *Thangpaldhap* the membership of two *Tamang* women was terminated because of their continuous absence in meetings. The beneficiaries with the low income group reported that the cost of electricity was beyond their affordability. Cases were observed when the 4 Tamang women were deprived of the electricity facility in the Handikhola-I hydropower project. In Handikhola-III system if an individual does not contribute labor for construction of the system and later seeks the membership then s/he has to pay double of what was required during the construction. In addition to the active committee members, there is also a provision of Manager, Operator and Assistant Operator in the hydropower committee. There are no committees in the private hydropower systems.

In drinking water supply project committees both, male and female, can become members. However, to be a member of the committee one should contribute labor in construction, pay cash for taps (NRS.1000.0 per stand post) as well as additional cost for operation and maintenance of the system. They have tried to balance the gender representation so there are 4 women in *Nagi Danda* and 2 women in *Nayadhara* drinking water supply committees. But, *Ichowk* drinking water supply committee has no woman as well as no members representing poor families.

In case of systems having multiple water uses (e.g. in *Thangpaldhap* and *Thangpalkŏt* areas), the members of the users' committee are from different sectors: irrigation, hydropower and drinking water supply etc. However, the members are more or less the same persons representing from different sectors. A dominating role is played by the hydropower committee because it is a gender-balanced, includes poor people and also because this committee is doing a great job in running the hydropower project. Hence disputes due to the competition of water use are not much pronounced.

Water rights by sector

Water rights by different sectors have been found to secure in the following three ways:

- **Prior appropriation (Customary practices):** In the case of the multipurpose projects it was observed that the irrigation is getting topmost priority. Drinking water supply system has less consumption and that too these systems are taking water from the small streams (sub tributaries). Therefore the most prevalent competition was observed between the hydropower/Ghatta system and the irrigation. A case was observed when the Chhimti Muhan ko Kulo farmers were deprived of irrigation from March to May due to Handi Khola-III hydropower system. However VDC intervened this case and irrigation users were allowed to apply water during flowering and transplanting period even at the cost of the hydropower. Ghatta owners are also have the perception that there would nothing be left to grind without irrigation. Hence issue of competition is generally found to be resolved with an understanding.
- **Physical situation (Priority to head-enders):** Due to the lack of an efficient water management practices in the system head enders are availing more water depriving tail enders from the irrigation facility. In the case of Subedardhap ko kulo in Handi Khola, influential farmers at the head reach never allowed tailenders to apply water from the channel stopping the operation of Ghatta.
- **Social norms (Social values):** In the basin areas there are some private ghattas also. These ghattas are constructed by individuals and are being maintained by themselves. The land along the feeder channels of ghattas are being irrigated however none of the land owners have contributed to the operation and maintenance of these channels. These ghattas have established their right of water use as they are registered before the DDC. In spite of their water use right ghatta owners allow the irrigation users to apply water during the flowering and transplanting period. These cases have been observed in the case of Simbhandar kulo in Melamchi, Maila Nagarkoti's ghatta in Handi Khola and Muhan ko kulo in Mahadev Khola.

Agency's Involved for the Water Resources Development

The development of irrigation systems in the basin area took its pace due to the advent of the Sinkalama program in 1984/85 and later through the WECS-IIMI action research program. Some of the irrigation systems were also developed after the introduction of ISP program funded by ADB. The ISP program in its new version is still ongoing till date.

ADBN is another agency to provide loan assistance to the individual (10kw) or community (20-27kw) to develop small scale hydropower system/Ghatta in the area.

REDP/UNDP, DDC, VDCs also have been found to contribute significantly towards the development of the small scale hydropower systems in the locality.

For the development of the Water Supply systems, District Water supply and sanitation office has constructed number of Water supply systems. DDC, VDCs, Action aid, Nepal Red Cross Society and Save the children (UK) are other agencies actively involved for the development of the water supply systems.

Role of local governing units

Local VDCs plays important roles in the water resources development. These local governing units were found to deliver the following key roles in the basin area.

- **Contribution**: *Palchowk* VDC contributed NRs. 120,000 for canal construction and NRs. 310,000 for the maintenance of *Palchowk Beltar Bhattar Phant* irrigation system in 1999 (Melamchi tributary).*Thangpalkot* VDC financially supported the *Chhimti* irrigation system for the system maintenance time to time. VDC contributed NRs. 280,000 in 1971, NRs. 150,000 in 1972 and NRs. 300,000 in 1974 (*Handi Khola* tributary). *Bhotenamlang* VDC also contributed cash for *Magar Ko Kulo* in different years such as NRs. 30,000 in 1997, NRs. 10,000 in 1998 and NRs.10, 000 in the year 2000.Bhotemanlang VDC provided NRs. 55,000 in 1993 to construct the *Yalmajung* Kulo (Mahadev Khola).For *Handi Khola-I*

Demonstration Micro Hydropower project, *Thangpaldhap* VDC contributed NRs.310,000 which is about 8% of the total project cost. Likewise, *Thangpalkot* VDC contributed 10% (e.g. NRs.310,000) for the construction of *Handi Khola-III Micro Hydropower Project.*

- **Securing Stake:** The role of the VDCs is significant in the development of drinking water supply sector too. New projects developed by the government require users to deposit cash for the stand post/tap. If 50% of the users cannot afford the required sum, concerned VDC pays the same to ensure drinking water facility to them. Drinking water and sanitation regulations restricts District Drinking Water Office to implement water supply system for the population less than 500. So, the concerned VDC has to provide drinking water facility to such communities. The scattered settlement areas are fully dependent on the VDC for drinking water facility.

- **Conflict resolution:** VDCs plays important role in resolving water-related conflicts. In the absence of institutionalized establishment for the water delivery, water use conflicts are more prone in the system. Such conflicts are generally resolved with the initiation of the VDCs. There are cases when inter-sectoral conflict issues have arisen in the systems having multiple use of water. Water allocation problem hence the competition of water use was more apparent in the systems like *Chhimti Muhan Ko Kulo* irrigation system and *Handi Khola-III Micro Hydropower system.* Users of the said irrigation and hydropower systems are not able to allocate water properly and proportionately. This led the *Thangpalkot* VDC to decide that the operation of the hydropower should be stopped during March to May. *Thangpalkot* VDC issued a written notice to *Nayadhara* water mill owner to stop the mill during paddy harvesting time because water seepage disturbed paddy harvesting.

Institutional strength of CBOs

Most of the organizations formed were found to be informal lacking adequate rules for resource mobilization, water delivery and operation and maintenance. These systems are institutionally weak and hence lack sustainability. Community organizations are not genuinely and equitably represented. Especially in the irrigation systems, rich and influential head-enders has the dominant role in the system management. Least care has been paid in making most of the organizations gender balanced.

Aspirations of some of the influential farmers of the community to derive undue benefit for their own resulted negative implications on the system development. Some new irrigation projects couldn't be completed because the members lost their interest not seeing any financial benefit from the project and remained inactive. For instance, *Falamesango* irrigation project (75 ha) could not be completed. Likewise, *Gunsa* irrigation project (82 ha, cost NRs. 4,300,000) could not run even for a single season.

In community owned hydropower projects, there are two tiers of organizations: community organization and main organization. Both the organizations are formed at the initial stage of such projects. In total there are 18 community organizations (9 of males and 9 of females) in *Handi Khola-I Demonstration Micro Hydropower Project*. The main hydropower committee comprises of one representative from each of the community organizations. Thus, it has 18 members in total on its Board. In *Handi Khola-III Micro Hydropower, Thangpalkot VDC*, there are 16 community organizations (8 of males and 8 of females) and there are 16 members in the board committee (main committee). The guidance of REDP in forming hydropower committees in each system has been very effective.

The main committee has the authority to decide on project related matters such as, to whom to give priority for the use of water, recruit project staff and fix their salary, service hours and electricity charges. The community organizations have the authority to include the excluded people in the system, collect membership fee and provide loan to the community members.

Drinking water supply projects form drinking water users committees in the beginning of the project. In *Ichowk* drinking water supply project there is no woman and poor man in its users committee. However, in *Nagi Danda* drinking water supply and *Nayadhara* drinking water projects there are 4 and 2 women respectively out of the 9 members of their respective committees. *Nagi Danda* and *Nayadhara* drinking projects' committees have been functioning properly. *Nayadhara* committee enjoys the authority to recruit an operator and technician and fix their salary and collect the water charge. But, the *Ichowk* drinking water system is defunct.

CASES OF INCLUSION AND EXCLUSION

Inclusion	Exclusion
1.Rehabilitation of Subedardhap ko kulo(Handi Khola) included 60 ha. of the rain fed area serving 40 households.	1.The left out farmers of Tarukebesi irrigation system(Melamchi) reported that the system could have served them as well, had the intake been located 20m. above of where it is constructed now. Though the argument of WUA seems justifiable as the alignment at the upper reach could have been more vulnerable due to land slides and these left out farmers are availing irrigation water from some other streams.
2. Rehabilitation of Nayadhara irrigation system (Handi Khola) included 30 ha. of land in ward no.8 and 9 of Thangpalkot VDC in its command area.	2. The extra efforts of the left out farmers of *Nadi Ko Kulo,* (20 ha) gave them a way to become part of the irrigation system. They had planned *Phalame Sangu Churetar Phant Projects* for 75 ha. this couldn't be completed due to lack of funds. Currently, a different project has been planned by the name of *Chiuri Kharka Churetar Phant Irrigation Project (Nadi Ko Kulo)* for 150 ha for the same users. So, their demand was included from the planning stage. However due to the possible vulnerability of the upper reach as was apparent, the alignment had to be fixed from the lower reach resulting in about 20 ha of land be left out.
3.Majh ko kulo rehabilitation in 1987(Mahadev Khola)included 100 ha of land in its command area.	3.Chimti Muhan ko kulo farmers were facing shortage of water due to Handi Khola-III. However VDC issued an order to stop hydropower project from March to May.
4.Magar ko kulo(Mahadev Khola) rehabilitation included 20ha. of land in the command area.	4. Some poor people were excluded from the electricity facility in Handi Khola-I due to un affordability to contribute and the CBOs have already assured them to include. Some potential beneficiaries of Handi Khola-III(all people of Thangpalkot-8,9 and some of 6 and 7) due to power shortage. However REDP has assured them to provide solar power.
5.Drinking water supply systems have brought in the sanitation programs in parallel hence stakeholders are included in the sanitation programs too.	5.Some beneficiaries of Nayadhara (Handi Khola) and Nagidanda(Melamchi) were excluded from the drinking water facility due to scattered settlement.
	6:The owner of Maila Nagarkoti's ghatta registered in 1895AD running through four generations reported that he is deprived from using full water use rights due to the persuasion of irrigation system.
	7.Purna Bahadur's ghatta could only grind 120kg in compared to 240 kgs per day before due to turn system with Ghatta Muhan irrigation system.

Protection or Compensation of the Excluded Stakeholders

The protection of water rights of excluded people of different sectors needs special and different actions. Here are some of the measures suggested to protect the stake of the people.

- Alternative arrangement need be done in Nadi ko Kulo in Phalamesangu for the left over command area if the intake could not be shifted to the upper reach due to technical unavailability.
- Water use rights of the tail end farmers of Subedardhap ko Kulo and Nayadhara-I need be protected with the practice of an efficient water management practices through strong rules and regulations for water delivery.
- Water use right of Chimti muhan ko kulo need be protected by shutting down the Handi Khola-III for March to May.
- Ambertar Chiuritar irrigation system need be repaired and the beneficiaries should be adequately compensated by Melamchi-Timbu road project.
- Beneficiaries unable to bear the cost need be considered in Handikhola-I and Handi Khola-III project and the excluded people of Handikhola-III need be provided alternative arrangements.
- Ichowk water supply system is in the defunct condition despite huge investment on it. This system need be properly maintained to prevent exclusion of the beneficiaries.
- VDCs should render support to avail drinking water to the people of scattered area in Nayadhara and Nagidanda water supply system where District water supply office cannot provide assistance due to the policy restrictions.
- Community based organizations need to be genuinely and equitably represented by marginalized and poor people to protect their stake within the system.

Discussions and Conclusions

In selected tributaries, the water sources are in use for multiple purposes: irrigation, hydropower, drinking water, *ghatta* and water mills. However, irrigation is accepted as the most important sector because irrigation systems have a long history and contribute substantially for reducing poverty by increasing production. The irrigation systems are being improved and their command areas are increasing. At the same time, the number of established and operated hydropower plants, drinking water supply projects, *ghattas* and water mills is burgeoning. Thus, the demand for water has been increasing in all the sectors and competition for the use of water between the systems as well as within the systems is growing up every year.

There are no established rules and regulations for water allocation, distribution, operation, maintenance, securing water rights and membership criteria in the studied systems. And, new water related projects are implemented utilizing the same source of water without taking into account the existing water rights of the prior appropriators and their rights are encroached without giving any compensation to them. The new initiators calculate the quantity of water available at the source for their project and hardly take into account the government's policy and interest of other users.

Thus, implementation of the new development projects, which often do not take into account the interest of the prior appropriators, leads to both e.g. inclusion as well as exclusion. Inclusion of new beneficiaries or lands in irrigation sector helps increase the agricultural production and reduce poverty of the included families. Inclusion of a family in an irrigation system may provide irrigation water rights to its many future generations. In the case of hydropower and drinking water along with sanitation facilities inclusion of a particular household means increase in facilities as well as possibility of increase in the family income. In many instances, inclusion in new development projects also means luxurious and comfortable life style to many of the local people.

On the other hand, exclusion from irrigation facilities results in decrease in crop production of the excluded families. And, food deficit problem may arise to those excluded families. The exclusion from hydropower, drinking water and sanitation facilities results in deprivation of basic services and the lives of the excluded people become harder. In the last, effective mechanism must be developed for the protection of the rights of the prior appropriators otherwise implementation of new projects will result in exclusion of many poor families and ultimately lead towards surfacing of many conflicts in future.

This paper definitely has the concern over the stake of prior appropriators in the Melamchi tributary as it is the most important tributary under the purview of this study. However it is premature to state that Melamchi will fall short of water in lean period if 170 MLD of water would be diverted to Kathmandu valley from the Melamchi tributary.

Like other studies in the Indrawati river basin, this study also has broader objective to look into the issues that would help formulating National Water Resources Strategy based on Integrated Water Resource Management with the holistic approach. And in doing so spirit of the local governance should always be entangled, as people are always the focal point of every development endeavor. At this point of time the question is how the Integrated Water Resources Management can be done? The most typical answer could be through the river basin approach of planning, development and management. At the same time the prominent role of local governing units also cannot be completely ignored.

Hence one should be able to identify the modality so that Integrated Water Resource Management and local governance can go hand in hand.

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Paper 4: Process Documentation Research of Melamchi Water Supply Project

A Case of Inter-Basin Water Diversion in Nepal

Hari Devkota

Introduction

The Melamchi River Basin is located in the central region of Nepal, 40-km northeast of Kathmandu valley. It originates from snowy mountain regions of *Mahabharat* range (5863 m from msl). Some upper parts of the river basin are covered by snow. The basin area is 330 Sq. Km, the length of the river is 41 km and it has 14 major tributaries. The basin is fully extended within 8 VDC of Sindhupalchowk district. The average annual rainfall at higher elevation *Sarmathang* is 3874mm and the temperature ranges between 5-32°C. The population density of the basin is 165 People/km^2. Ninety six percent of the population is involved in agriculture and average farm size per household is 0.9 ha. Major crops grown in this basin are Paddy, Wheat, Maize and Millet with the average yield of 3mt/ha, 2mt/ha, 2.45 mt/ha and 1.7 mt/ha respectively.

Objective of Study

- To determine the degree of water scarcity in the Melamchi River Basin after MDS[4].
- To explore and understand the mechanism adopted for negotiation by various groups of stakeholders and their involvement in decision-making process.
- To find out the involvement of various institutions in decision-making processes and implementation of MWSP.
- To find out the strategies applied by the locals to reduce any potential loss after the MWSP.

[4] MDS-Melamchi Diversion Scheme is one of the major five components of MWSP, includes- access road and tunnel adit, a diversion weir, control system and sediment exclusion and 26.5 Km long tunnel.

Melamchi Water Supply Project

Background

Kathmandu Valley (KV) has been suffering from the shortage of drinking water for a long time. At present, Nepal Water Supply Corporation (NWSC) can supply only 120-140 million-liters per day (MLD[5]) in the rainy season and 80-90 MLD in the dry season with the present available sources; where as the average daily demand of KV is 180 MLD. The population of KV is 1.2 million and the growth rate is about 3.3% per annum. The water demand is projected to increase to 510 MLD by 2018. The shortage of water supply has affected public health and economic activity in Kathmandu. The government carried out many studies to meet the water demand of KV. These studies formed the basis for the implementation of the MWSP, the dream of 24-hour water supply for Kathmanduites. The salient features of the MWSP are presented in Table 3 (HMGN/MWSDB, 2000)

Stages of Project Development

Initial stage:

The long awaited Melamchi project was identified during the preparation of the water supply master plan in 1973 as the potential water source for the Kathmandu valley.

Other studies:

Realizing the need to meet growing demands with the valley's scarce sources, a reconnaissance survey of possible water sources outside the valley was conducted in 1988. Studies on 20 possible sites including Melamchi Khola, Indrawati River, Rosi

Khola, Nepal Electric Authority Kulekhani reservoir (Indrasarobar) and Trishuli River were carried out by the HMG/N.

Some of the studies carried out in this respect are presented in Table 1 and the physical characteristics of Melamchi River and MDS intake are shown in Table 2.

[5] 1 million liter per day(MLD)=0.01157Cumecs

Table 1: Feasibility Studies of Melamchi

Organization	Focus of Study
Binnie and Partners, 1988	Water supply resource
SMEC, 1992	Feasibility study for Melamchi scheme
JICA, 1990	Kathmandu water Supply facilities improvement project
BPC, -Hydro consult, 1997	Bankable feasibility study for the Melamchi, diversion scheme
Binnie Thames, 1998	Water demand report

Source: MWSP Publication-2000

Figure 1: Location Map of Melamchi River Basin in Sindhupalchowk District

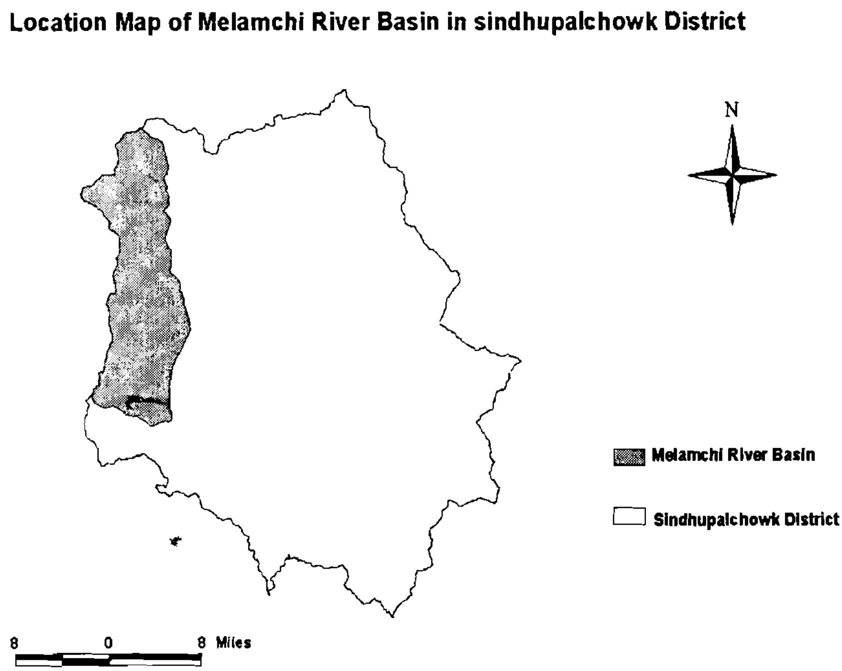


Table 2: The Physical Characteristics: Melamchi River and MDS

S.N.	Description	Unit	Quantity
1	Total Length of River: Main stream	Km	41.00
2	Catchment area of MDS intake	km^2	157.00
3	Catchment area of River	km^2	330.00
4	Catchment area of the nearest River gauge	km^2	122.00
5	Elevation at Intake from msl	M	1445.00
6	Elevation at tunnel end from msl	M	1410.00
7	Elevation at confluence (Melamchi and Indrawati)	M	820.00
8	Elevation of the river origin	M	5863.00
9	Elevation of River gauge at Sarmangthang	M	1700.00
10	Average monthly max flow at Intake	Cumecs	10.92
11	Average monthly min. flow at Intake (March)	Cumecs	2.55
12	Average monthly max. flow at confluence	Cumecs	76.00
13	Average monthly min. flow at confluence	Cumecs	5.62
14	Distance at Intake from Confluence	Km	20.00
15	Average annual rainfall in intake of catchment	Mm	3212.00
16	Average Annual rainfall in the Melamchi basin	Mm	3050.00

Source: Mishra's report, MWSP Publications

Table 3: Project Salient Features

S.N.	Features	Unit	Description
1	Project name		Melamchi Water Supply Project (MWSP)
2	Executing Agency		HMG/N, Ministry of Physical Planning and Works, Melamchi Water Supply Development Board (MWSDB)
3	Project Duration	Year	6 year (July,2001-July,2006)
4	Estimated cost	US$	464 Million
5	Internal Rate of return	%	13.5
6	Financiers/Donors	No:9	Asian Development Bank(120),World Bank-(80), NORAD-(28),SWE-(25),JBIC-(52),JICA-(18),OPEC-(14), NDF-(9) HMG/N-(118) **Total: 464 million**
7	International Consultant		Nippon Koei, NORPLAN AS, Lahmeyer/ MacDonald, Collaboration with Local consultants
8	Source of Water	No:3	Stage I: Melamchi River (perennial) in HELAMBU VDC of Sindhupalchowk District Stage II & III: Yangri and Larke (tributaries of Indrawati)

S.N.	Features	Unit	Description
9	Major Components of Project	No:5	• Melamchi Diversion Scheme (MDS)-Included access road and tunnel adit, a diversion weir dam 5-7 m high, control system and sediment exclusion and 26.5 Km long tunnel starting from Ribarma to Mahankal, Sundarijal VDC at Kathmandu. • Water Treatment Plant (WTP): Conventional gravity water treatment plant will treat the WHO drinking water standard through the process of chemical flocculation, sedimentation, filtration and chlorination, plant will be located at Mahankal in Sundarijal VDC at Kathmandu. • Bulk Distribution System (BDS): Treated water will be conveyed by network of peripheral distribution system of ductile iron pipe of dia.300-1400 mm to the reservoirs will be built at higher places. • Distribution Network Improvement (DNI): Distribution to the consumers by rehabilitated and extended network ensuring quality and equitable distribution, and reduction of leakage and wastage. • Wastewater Treatment (WT): Rehabilitation of existing sewer lines and wastewater treatment plants including construction of additional system in order to sewerage to unserved areas and control the pollution of river Bagmati and its tributes.

Source: MWSP Publication

Alternates to MWSP

- Pumping water from out of valley Rivers.
- Pumping Groundwater in the Kathmandu valley.
- Building a dam in the upper Bagmati River to store excess rainwater during the rainy season.
- Rainwater harvesting, recycling of wastewater, storage of wet season river water.

The Rationale for Selection of MWSP

The following were the reasons for the selection of MWSP for its implementation

Hydrological Reason: Perennial source originated from the Jugal Himalayan range at an elevation of 5,863m, which will have long-term dynamics of water available for the project.

Technical Reason: Technically feasible to bring water by gravity. Elevation at Melamchi Diversion Scheme intake is 1445m whereas elevation of tunnel end at Sundarijal, Kathmandu, is 1410 m from mean sea level (msl)

Social Reason: Socially highly desirable due to positive socio-cultural and environmental impact in the development of Kathmandu valley. It is possible to meet long-term future water demand by diverting water from Yangri and Larke (tributaries of Indrawati) to MDS intake through tunnel.

Environmental Reason: Environmentally acceptable due to limited adverse environmental impact through the basin transfer.

Economic Reason: Economically viable due to low unit cost of water production. It is financially affordable to the consumers.

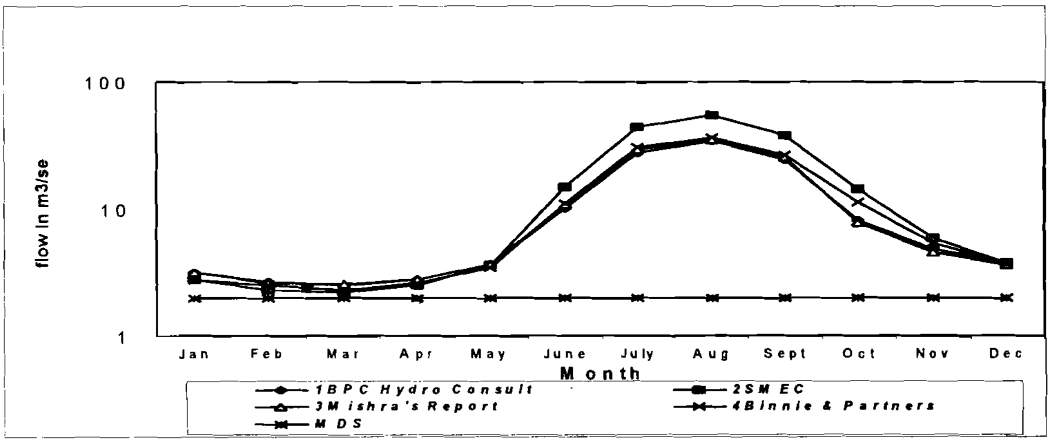
River Discharge at the MDS Intake: The annual average flow of Melamchi at intake is 933 MLD (10.79 cumecs) and the average discharge in the dry season (March/April) is 256 MLD (2.96 cumecs). The first stage of the project is designed to divert 170 MLD of water per day from Melamchi. In the second and third stages it is proposed to add 170 MLD of water each to the first stage by diverting water from Yangri and Larke rivers of Indrawati Tributaries. The MDS is designed to leave at least 35 MLD (0.4 cumecs) in the driest season in down stream of intake (HMGN/MWSDB, EIA report, 2000). Comparison of average monthly flows at MDS intake collected from different sources is presented below in Table 4.

Table 4: Comparison of Simulated Average Monthly Flow (m^3/sec) at MDS Intake

Month	SOURCES				
	[1]BPC Hydro Consult	[2]SMEC	[3]Mishra's Report	[4]Binnie & Partner	[5]Proposed MDS
Jan	3.2	2.8	3.19	2.8	1.97
Feb	2.7	2.3	2.64	2.5	1.97
Mar	2.5	2.2	2.55	2.3	1.97
Apr	2.8	2.5	2.81	2.6	1.97
May	3.7	3.6	3.67	3.5	1.97
Jun	10.2	14.8	10.77	11.0	1.97
Jul	27.4	44.4	29.29	30.5	1.97
Aug	34.4	55.3	34.79	36.7	1.97
Sep	24.4	38.0	25.3	26.6	1.97
Oct	8.2	14.1	7.85	11.3	1.97
Nov	4.9	5.9	4.56	5.4	1.97
Dec	3.7	3.8	3.65	3.7	1.97
Avg.	10.7	15.7	10.92	11.6	1.97

Note: (1) BPC – Butwal Power Company, Nepal (2) SMEC – Snowy Mountain Engineering Corporation, Australia. (3) Mishra – Researcher, IWMI Nepal (4) Binnie & Partners – Int. Consultant, United Kingdom (5) Proposed MDS

Figure 2: Comparison of Average Monthly Flows with Respect to Purposed MDS in m^3/s



The graph in Fig. 2 indicates that there is a high flow during the month of June-Sep whereas the low flow during Dec-May. March is the driest month in which the average flow at the MDS intake is 2.5 cumecs. However, MDS is proposed to divert 1.97 cumecs of water throughout the year, which will directly lead to the scarcity of water in the downstream of MDS in the month of Jan-May.

WATER USE PATTERN AND POSSIBLE EFFECTS DUE TO MWSP

The following types of water users are currently found in the Melamchi River basin:

- Ghattas and water mills
- Irrigation
- Drinking Water
- Fishing (Majhi)
- Hydropower

Ghattas and Water mills

A *Ghatta* is a water mill, which uses local technology for milling wheat, maize, and millet by using waterpower. *Ghattas* have been established in the Melamchi valley many years back, utilizing local resources and skills. At present, there are 22 *Ghattas* running from Melamchi River water, which are affected severely by floods in the rainy seasons (June-Oct). But some *Ghattas* operate the whole year round. *Ghatta* owners are usually from poor families whose agricultural production is not sufficient to feed their family and thus it provides an additional source of income.

Effect of MWSP on Ghattas and water mills

Ghatta Mill owners don't know how much water will be diverted and what will be the impact to their 12 *Ghattas* running simultaneously after MWSP. No government or any other private organizations have shown any interest in the possible impact on the living of these *Ghatta* owners, which is quite a serious issue. Locals fear that after the MWSP they might have to close down *Ghattas* and could result in their displacement from the present habitat.

Irrigation

Water flowing from the Melamchi River is being used for operating irrigation systems. There are 19 irrigation systems in the basin, which cover a minimum of 2.5 ha to maximum of 150 ha at present. About 508ha of land is using this water for irrigation at present. The irrigation system under construction will provide irrigation to 83ha of land and the planned irrigation scheme will cover 125ha

Effect of MWSP

The water availability in the canal is not sufficient during the dry season for irrigation at present due to temporary intake and poor management. Beside, the water level will be low in winter and that has caused difficulties in diverting water for irrigation. Plantation of spring paddy will be stopped if there will not be sufficient water in the River during the dry season after MWSP.

Drinking Water

None of the locals were fully dependent on the Melamchi River for drinking water purpose. The Danuwar families living in the lower region of the basin depend on this River for the driest months of the year. This situation occurs when the existing five taps constructed from local springs by Women Development Program, ACTION AID and VDC dries out during the dry season (Mar-May). In upper and lower region dwellers don't use the Melamchi River for drinking purpose in any season.

Effect of MWSP

Danuwar women will be affected by MWSP because they use the Melamchi River water for drinking purpose in the dry season. After the MWSP, there will be less water flow in the river and at the same time water will not be drinkable due to pollution from upper part of the basin. This could cause many serious health hazards for this community. This fact was revealed from a group discussion with women groups in Melamchi VDC. It was also found that people dwelling near basin are using Melamchi River for domestic use i.e. washing clothes, and for livestock as well.

Fishing (Majhi)

Fishing is not the main occupation of any of the people living in the basin However, most of the Danuwars and *Ghatta* owners were involved in fishing in their spare time, which is one of the major sources of income for them. The appropriate time for fishing is Nov-Jan. During this time they earn up to NRs. 500/day. Also few local farmers from Ichowk, Kiul, Talamarang, Mahankal, Dubachour and Melamchi VDC are also involved in fishing occasionally.

Effect of MWSP

These fishermen opined that they might not have enough fish collection due to less water flow after MWSP and might loose good income from this alternate source

Hydropower

There are two water mills, which also generate 5–10 kW of electricity and is distributed to the local villages. In the dry season, these water mills will be severely affected due to less water flow in the basin after the MWSP.

FARMING ACTIVITIES/LAND USE

Farmers harvest three crops a year in the Melamchi River basin. The major crops in this area are main paddy, wheat and spring paddy and the water intensive crops are main paddy and spring paddy. Melamchi Valley is considered to be one of the most fertile lands lying in the hilly region of Nepal. National average production of paddy (main) is 2.5-3 Mt/ha where as that of Melamchi Valley is 3 Mt/ha. Similarly, national average production of wheat and spring paddy is 3, 2.5-3Mt/ha respectively whereas that of Melamchi valley is 2 and 3Mt/ha respectively. This indicates that productivity of crops in the basin is quite encouraging, except for wheat, in comparison to that of other hilly regions of Nepal.

Anticipated Effect of MWSP on Farming Activities

In earlier times, the farmers had to depend on rainwater for the paddy. According to the tenant farmers, they were paying Kut (rent of land) since the last 4-5 generations when there was no irrigation from Melamchi River. Initially these tenants did not have had enough crops to give Kut. Main paddy was just enough to pay Kut to landowners. As a result they even thought of giving back the land to the landowner. They overcome this problem by diverting water from Melamchi River and were able to plant three crops. Farmers fear that wheat production will be affected and growing spring crops will have to be stopped immediately after the MWSP. This will affect their household income, since their main source of income is winter and spring crop.

Anticipated change in cropping pattern after MWSP

The cropping pattern is likely to change in the basin after MWSP. The farmers may switch over to crops that require less water. Potato farming has become one of the attractive options to the locals and some of the farmers are planting it at present also. Potato requires less water and is quite profitable in comparison to other crops. It can be grown in small areas as well, so it might be better alternative to the poor farmers who own small piece of land.

SUMMARY OF MAJOR ISSUES AND CONCERN OF THE STAKEHOLDERS

NGOs/CBOs and User groups, on behalf of the locals, raised many issues that were likely to affect the local stakeholders during and after the project completion.

Issues

Environmental concerns:

- Deforestation, soil erosion & landslide and various other environmental degradation due to infrastructure construction.
- Disposal problem of stones, mud, sands that come out of the tunnel during construction.
- Natural springs will be endangered during the tunnel construction.
- Increasing pollution in the water sources due to less and contaminated water flow in the rivers.
- Drying of the small rivers in the lower region.

Impact on agriculture:

- Irrigation problem in dry season due to less water in the river.
- Decrease food production due to lack of water for irrigation. Spring crops will not be grown due to lack of water.
- Scarcity of drinking water in the local area.

Socio-economic:

- Displacement of watermills and *Ghattas* due to insufficient water flow in the dry season.
- Displacement of fishermen due to which they will loose extra income
- Possible damage to houses due to blasting, disturbance to the wild life.
- Price of the goods and commodities will be increased due to influx of people for employment in the project.
- Land acquisition due to temporary and permanent infrastructure building during the construction of MDS.

Socio-cultural:

- Negative impact on the local culture due to flow of workers from other places.
- Disturbances in children education, as they will be attracted to the project construction work for earning money.
- Tourism and natural environment will be endangered.
- Displacement of people and their household due to construction work i.e. Resettlement and rehabilitation.

Climatic:

- Climatic change/increase in humidity in and around the Melamchi valley due to the water diversion scheme.

Demands

The local stakeholders made following demands:

- There should be a fixed allocation of about 5% of revenue for affected areas from water tariff generated from the consumers of the Kathmandu valley for the integrated development of Melamchi valley.
- The project should explain how much water would be left downstream of the dam after diverting 170 million-liters of water per day for the Melamchi water supply project.
- The natural rights like water rights and environmental rights of the local people will have to be ensured. The local stakeholders demand protection of these rights in written form.
- The locals are demanding adequate insurance of the human and other properties for possible loss before the construction works.
- There should be representation of local organization and elected bodies in the MWSDB.
- The local people should receive first priority for employment and contracts in project works.
- Reasonable compensation and resettlement package for the project affected people.
- Implementation of the following programs in the Project Affected Area.
    - Poverty alleviation
    - Health and sanitation
    - Plantation, forest conservation
    - Public awareness
    - Tourism development
    - Drinking water
    - Woman empowerment
    - Fisherman uplift
    - Control of girl trafficking and prostitution control

- Training should be provided to the locals to develop specific skills for construction work.
- Formation of appropriate co-ordination mechanism from village level to government level for the monitoring and evaluation of the project.
- Flood protection measures will have to be adopted on both sides of river. This demand was made to ensure the safety of locals in case of break down of MDS.

NEGOTIATION PROCESSES AND OUTCOMES

Local Stakeholders were informed formally for the first time about the launching of Melamchi Project in 1998 in a Public Hearing Program (PHP) held at Bhumeshwori High School (Kiul) and at Timbu Bazar.

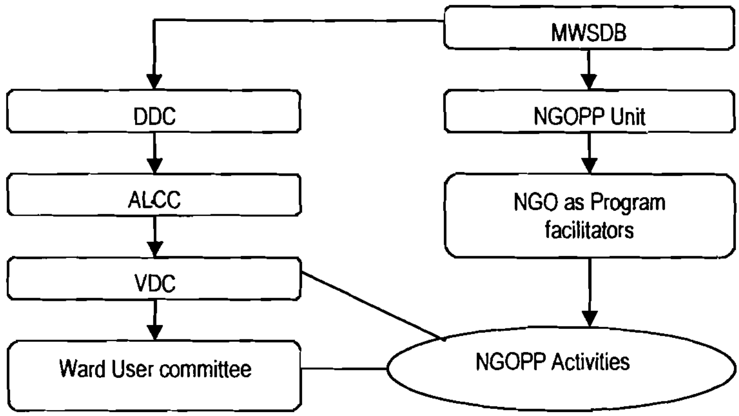
Then later in four NGO Co-ordination workshops were organized by MWSP with NGOs/CBOs and user groups to identify issues and work out possible areas of their involvement in the future. Altogether 65 NGOs/CBOs and user groups were identified who were concerned about the MWSP activities. The NGO Participation Plan (NGOPP) is the end result of this process. This shows that the locals were able to voice their concern and force the implementation authority to develop a package of programs for implementation in the area.

Table 8: Major Events on NGO Co-ordination Activities

Workshop	Main them	Date Organized
First NGO Co-ordination Workshops (NGOCW)	Identification of the projects issues	August 9,1999
Second NGOCW	Information collection on concerned NGOs	October 6,1999
Third NGOCW	Classification of issues/prepare short list	December 17,1999
Forth NGOCW	Collect information on program issues	February 22,2000

Source: MWSP Publications, 2000.

Figure 3: Implementation Structure of NGOPP in Melamchi Valley



Source: MWSP publication, 2000

NGOPP is based on policies and implementation strategies specified in the Ninth Plan of His Majesty's government of Nepal (HMGN). It is a support program of MWSP. The plan aims at improving and sustaining the socio-economic and environmental conditions of the MWSP affected area though NGO participation so that the negative impacts of the project can be minimized to a greater extent and the project affected people will have an improvement in their living in future. The program will be implemented through the local governance bodies with NGOs as facilitators. Agreement between the collaborating NGOs and the local governing institution will be, made outlining the roles and responsibilities of different stakeholders.

PROPOSED PROGRAMS AND IMPLEMENTATION PROCESSES

Resettlement and Land Acquisition

One of the major components of this project is MDS construction. For this purpose there will be acquisition of land for infrastructure construction either temporarily or permanently. Altogether 160 ha land will be affected. Temporary land acquisition of 142 ha is also expected for the construction for camps, burrow pits and construction related areas. 246 households will be affected either partially or entirely, including 25 households that will be displaced.

Irrigation channel and community forestry will also be affected. MWSP will compensate and provide rehabilitation assistance for the severely affected people for loss of income i.e. loss of crops due to project. A resettlement action plan (RAP) has been developed for the MWSP and its policy framework is already prepared by MWSDB and ADB and also approved by Ministry of Physical Planning and works. The overall estimated cost of RAP is $15 million.

SUP Program

MWSP will cause adverse impact on socioeconomic life of the PAP (Project Affected People). To reduce this impact, a program called SUP (Social Uplift Program) and infrastructure construction, which is the component of MWSP, will be implemented in consultation with local communities, leaders and NGOs. It will work in the field of poverty alleviation in the affected areas. This program will directly help to:

- improve access to Kathmandu and within the Melamchi Valley
- increased income through the expanded market and the upgraded skills for the locals which will be a direct help in improving the living condition of the PAP.
- reduce the work load for women
- increase gender awareness in the community
- increase adult /child literacy rate
- improve health and family planning especially for women and children
- reduce trafficking of girls for improvement in the socio-cultural environment at the local level.

Implementation arrangements

A proactive public relation campaign will be conducted by MWSP to highlight the project high profile and potential public concerns, which could jeopardize implementation. To address this problem environmental resettlement, social development division has already been established by MWSDB. NGOs will be mobilized to assist local government agencies in implementing community-based activities. To ensure ownership and sustainability, the SUP will (I) take a participatory approach through direct participation of beneficiaries (II) utilize the institutional structure of the ongoing Local Governance Program, whereby capacity building for DDCs and VDCs will be conducted through the programs, assisted by experts, (III) be run by royalties paid by the Kathmandu Valley water users in the post construction stage

Realizing the need of a mechanism to bridge the gap between local stakeholders and the MWSP, a Public Relation Team (PRT) is in act. For these activities a NGO is already nominated. Its field office is planned to be at Melamchi Pulbazar.

The major objectives of this local consultative group will be as follows:

- To help in developing social upliftment programs.
- To help in planning and implementing land remuneration program.

THE ROLE OF LOCAL INSTITUTIONS

Many organizations and institution are working at local level in the Sindhupalchowk district. The Melamchi valley is situated at the western part of the district covering 8 VDCs. Some of the institutions have direct or indirect involvement in MWSP activities. Their roles are explained below.

District Development Committee (DDC)

DDC is the highest-level local government institution, responsible for coordination of all the government's development activities and also for implementing development programs through its own resources in the district. An agreement for the project implementation will be prepared by the NGOPP on behalf of MWSDB and jointly signed by the DDC and MWSP. Respective DDCs will implement the program with the authority prescribed by the Local governance act and regulations.

Village Development Committee (VDC)

As a member of NGOPP implementation board, VDC is responsible for implementation and coordination of the projects in their respective areas. VDC will monitor the programs on quarterly basis and provide regular feedback to the collaborating NGOs and NGOPP units.

Others

There were no defined roles played by the District Water Resource Committee, District Drinking Water Supply Office, District Irrigation Office and District Forest Office during the decision making process of Melamchi project. It is based on the IWMI field research team's interview with the concerned organizations' representatives. There is lack of co-ordination between MWSP and the DIO though both of them are concerned with Melamchi River Water.

LEARNINGS

- Lack of coordination and communication between different institutions involved in Melamchi River Basin.
- The importance of local involvement in the decision making process.
- Water right issue of the locals should be prioritized.

CONCLUSION

The Melamchi Water Supply Project is a large scale ($464 Million) water project in Nepal. Melamchi scored over the other entire similar proposed water project justifying its selection as the best scheme to meet the long-term water supply demands of the Kathmandu Valley as people are facing water scarcity. However, The locals feel that they were not informed about the Melamchi Project in the planning phase and their involvement was completely neglected.

Several compensation packages like SUP, NGOPP, RAP, and EMP are planned for implementation in the project-affected area. It will work in areas of poverty alleviation, vocational training, awareness, education, environment and rural tourism, which will be a real asset for the locals. This type of compensation package is provided for the first time in Nepal in case of water supply project. This is expected to reduce some of the grievances of the local people. Nevertheless, it entirely depends on how these programs will be implemented and how successful it would be to help local people in minimizing the adverse effects. There is no doubt that the inhabitants of Sindhupalchowk, more particularly in the project area are living in the miserable poverty. Therefore, they should be compensated according to the use of resources in their area.

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Paper 5: Water Accounting and Water Use Institutions' Study of Manusmara River Basin

Hari P. Hemchuri, S. Sijapati & L.P. Bhattarai

ABSTRACT

Manusmara River Basin, a sub-basin of the Bagmati River Basin, lies in the terai of Nepal. With a very gentle slope towards the south it lies in the sub-tropical climatic zone. Up to mid 1960s, a large portion, especially of the northern part of the basin, was covered by dense forest. However, at present only 6% of the area is occupied by forest. Over the last few decades the process of consumption of water especially for agricultural purposes has increased tremendously. This paper at first draws out the history of agricultural development of the basin and its interface with the efforts made by the beneficiary farmers to use the available water resource of the basin. And then it tries to make an effort to analyze the basin characteristics with respect to the inflow and outflow scenarios and with the perspective of water availability and water use pattern.

INTRODUCTION: PHYSICAL AND SOCIAL SETTING

Manusmara River is a rain and spring fed perennial river originating from the forest area in the south of East-West Highway in Sarlahi district. From its origin, the river runs southward parallel to Bagmati River and then confluences with it at Hathiul. The length of the mainstream is 53.7 km and its average slope is 1:2200. Laldiyar, Soti and Sother are its three main and only tributaries.

The River Basin is a sub-basin of the Bagmati River Basin. The whole basin lies in Sarlahi district in the terai of Nepal. The basin extends from Latitude 27° 03' to 26° 46' N and Longitude 85° 20'to 85° 29' E (See Figure 1 for the Location Map of the Basin). Total basin area is 156 Km^2. The topography is almost flat with the highest point and lowest points at 107.8 and 74.6 m above mean sea level respectively. The deep surface soil varies from loam to fine loam.

The climate of the river basin is sub-tropical. The mean annual air temperature, as observed in Basworiya[6] station, is 25°C, with the mean annual maximum of 31°C and mean annual minimum of 19°C. On the basis of characterization of thermal regime, the study area lies in the verge of double rice based cropping system as the critical temperature duration of more than 20 and 15 degrees in more than 210 and 270 days respectively. The average relative humidity is about 75% and varies from 50% in the dry season to 90% in the rainy season. The daily sunshine hours averages 7 hrs/day, varying from 4 hrs/day in July to 8 hrs/day in April. The wind velocity averages 1.6 km/hrs.

The Average annual precipitation is 1427 mm. Computed by the WECS method, 80% reliable rainfall has been found to be 1054 mm. Rainfall has been found to occur mainly from middle of May to the end of October. It is concentrated during the monsoon, which has been found to begin from the second week of June to the third week of September. Average monthly precipitation varies from a minimum of 6mm in the month of November to a maximum of 422mm during the month of July. Considering 1979 to 2000 as the period of analysis, 1980 has been found to be the driest year while 1987 has been found to be the wettest year and 1993 an average year.

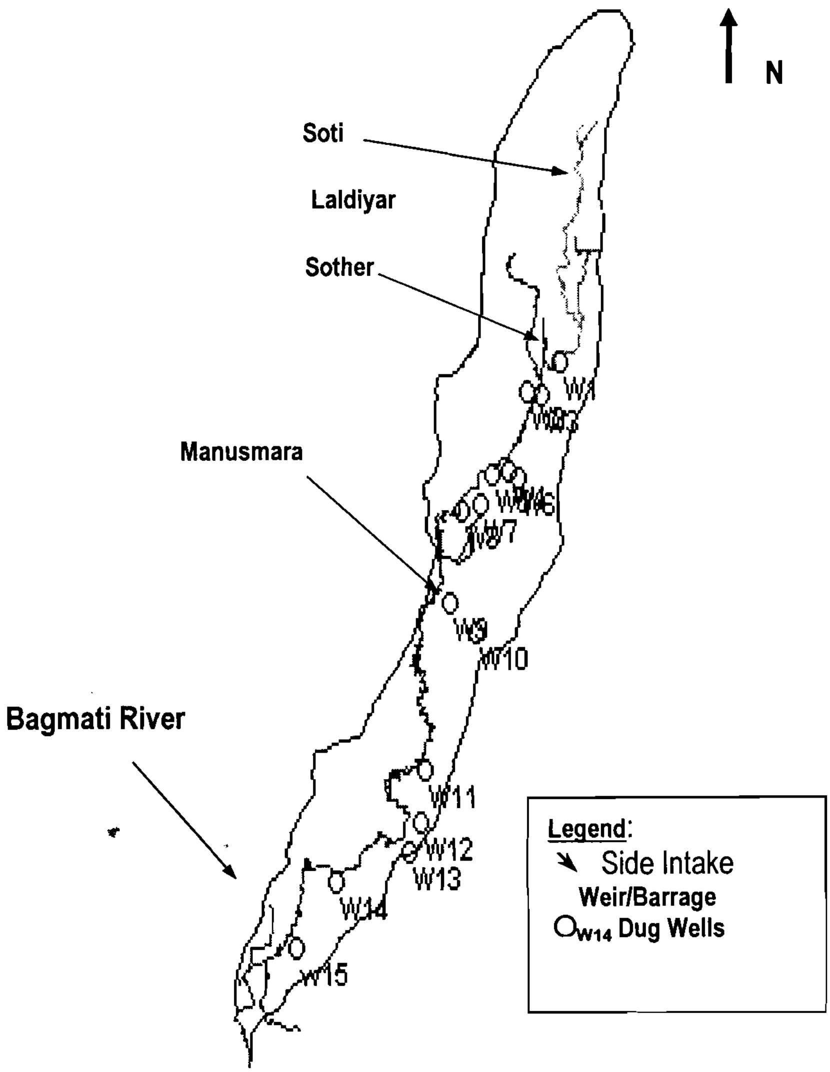
Up to mid 1960s, a large portion, especially of the northern part of the basin, was covered by dense forest. However, with the inflow of people into the basin during the 1950s and 60s, the forest was converted to agricultural land and at present it has been estimated that the forest occupies only 6% of the basin area. Even though the cropping pattern and cropping intensity varies significantly within the basin, the prevailing major crops grown in the area are: rice, sugarcane and wheat.

Except for Barhathawa, which is gradually moving towards urbanization, the basin area is mainly covered by rural settlement. The area, fully or partially, encompasses 24 VDCs of Sarlahi district. The present population density of the basin is estimated to be 480/Km^2. Average family size of household is about 6. More than eighty percent of the population is involved in agriculture. Average farm-size per household is small (about 1 ha). However, land is not uniformly distributed and a small minority of rich

[6] Basworiya is located almost at the center of the basin. Considering the small size of the basin, climatic data of this station has been considered to be representative of the whole basin.

farmers own most of the land while the majority of the poor farmers have very small land holding.

Figure 1: Layout Map of Manushmara River Basin



Natural and Socio-Economic Landscape Changes

Sufficient evidences can be found to state that the history of human existence in the basin goes back more than 200 years. Archeological evidences of settlement ruins and legends of ethno history assure this fact. Huge and seemingly old *Pipal* trees are found every few hundred meters runs in the locality standing alone or accompanied with Mango or *Sami* tree[7] amidst intensive agricultural land. Weather they were protected from the very beginning or grown by people; they signal the historicity of the people that resided there.

Orallore of local people of the *Yadav* community has ratified their historical presence in this locality. It is believed that their livelihood depended on cow herding for a long period of history. Thus, it is quite logical to believe that they might have been here far before agriculture was practiced in the locality during which period the area was mainly covered by dense forest. The population density was very low and the sense of possession of land was not developed. The people then are believed to have practiced subsistence farming with shifting cultivation of rainfed crops like *Aluwa* (Sweden Root), *Maduwa* (millet), *Kagono* (Barley), etc.

Rice is believed to have been introduced in this area sometimes during the early half of the nineteenth century. With rice, came the need of irrigation. Through the individual effort of the local farmers several *kulos* (indigenous irrigation systems)[8] were constructed. These simply consisted of an inundation earthen canal network dug from an appropriate location in the river. During the monsoon, the water level in the river would rise and the water would flow through these canals to irrigate the paddy fields. There was no mechanism to regulate the flow and only limited land could be irrigated. However, since the population density was low and rice initially was produced only for self-consumption, this technology was sufficient for the time. The coverage of rice is reported to have gradually increased towards the end of the nineteenth century as the produce got its

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[7] These trees are celebrated trees in the Hindu religious life.

[8] Among them several including *"Hakrai kulo"* (*kulo* having many branches) constructed by Harkatawa people is still functional till date.

market in the nearby Indian villages. With the expansion of the coverage of rice, the tradition of shifting cultivation gradually came to an end. People started to settle down in small clusters in slightly elevated areas in the vicinity of these paddy fields. Wells were dug in each village to fulfill their domestic water requirements.

Significant increase in crop coverage is found to have occurred during the Rana Regime[9]. During that period more cultivation was encouraged by the state to generate more revenue. Hence, *Jimmidars* (local landlords who functioned as politico-administrative agents of the state for revenue collection from the peasants) were deputed for each village. In this period cultivators were attracted from everywhere and dominantly from the Indian plain. *Jimmidars* either encouraged peasants to cultivate more land or cultivated in their own land to yield more in order to pay the high revenue levied by the state which was then led by the Ranas.

Increase in crop coverage resulted in the need to irrigate more land. Thus the technology of inundation canals was considered insufficient and the technology of earthen dams[10] was introduced. The main objective of these earthen dams was to fulfill the critical requirements of rice especially during land preparation stage. Through initiative of local *Jimmidars*, earthen dams were constructed at appropriate locations of the river. Small tenants also paid voluntary labor and grains. Dam construction works were taken as a religious ritual. They found an auspicious day to initiate the dam construction work every year and performed worships to Gods and local spirits. Each year these dams would be constructed before the monsoon sometimes during the month of May and would survive until a major flood in the river would destroy them. Thus dam construction was a continuous process.

The first attempt to construct a permanent structure to divert water in the river took place during the 1940s. In the petition of influential landlords of

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[9] The Rana Regime prevailed in Nepal from 1846 to 1950.

[10] The tradition of earthen dam construction does not prevail at present. It was very prevalent up to two decades ago. Among the earthen dams at that time the one near Mahinathpur and that near Hirapur which used to be made by the landlords and peasants of Gadaiya and Harkathwa respectively, were reported to be the most pertinent.

the area a permanent dam was constructed by the grace of Rana Prime Minister Juddha Samsher Rana in Manusmara River, south of Hirapur. Juddha Canal (its ruins now-a-days known as Choruwa Kottha) was constructed between 1945 to 1947. Later, this dam was completely destroyed by the terror some flood of 1954. Construction of Juddha Canal opened the door for cultivation boom in the locality.

Infrastructure development works in the locality during and after the 1950s[11] like irrigation and road attracted the population from hills too. Construction of the east west highway, eradication of Malaria, and the effort of Land Distribution Commission became instrumental to immigrant boom in the northern part of the basin after 1965 AD. All these developments rendered pressure to the demand of land in the basin. The land holding size became smaller. The gross area of rice cropping reduced as small tenants and peasants only cultivated part of their land for rice crop and the rest for other staple crops, pulses, vegetables and fruits. Gradually winter crop like wheat was also introduced. Crop diversification was also augmented by the introduction of high yielding varieties of cereals requiring stricter water management than traditional varieties.

This shift in agriculture system resulted in the need to have more control over water. Thus in the year 1965 the first modern diversion (barrage) with steel gates allowing regulation of flow was constructed at Hirapur upstream of the old destroyed dam. It became functional from 1968. About a decade later, another permanent diversion was constructed 6 km downstream of the first in the form of a concrete barrage at Manpur. This diversion became functional from 1982. Under the Irrigation Sector Project another diversion was constructed further d/s at Sudama to irrigate 1630 ha. Then in the year 1996/97 under SISP, Laukat Irrigation System irrigating 375 ha was constructed 3-km upstream of Hirapur. Thus, a series of diversions have been (and still are being) constructed in the river.

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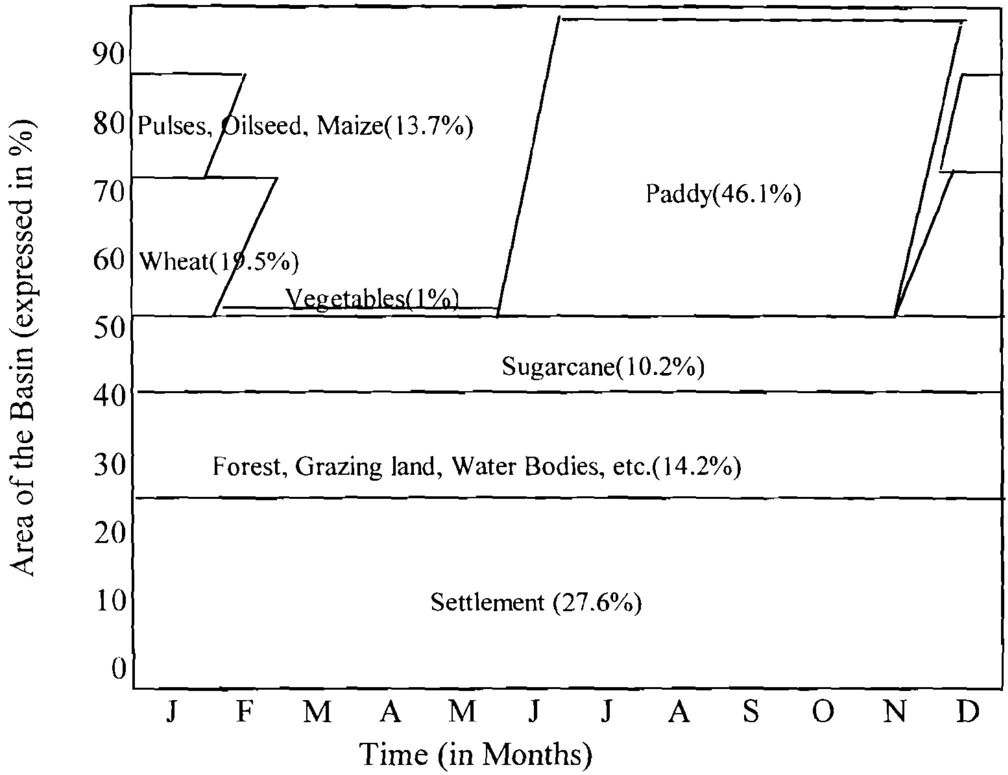
[11] Elderly key informants of the basin have reported that the northern settlement from Basworiya Camp only grew up after 1950. It is said that only Gadaiya, Dumariya, Bakainiya, Sissautiya, Dhangara, and Dhankaul were in existence during the early half of the last century.

The present cropping pattern is a mixture of many crops. See figure 2 for the existing land use pattern of the basin.

Figure 2: Landuse Pattern of the Basin



The intensity of sugarcane cultivation is presently in the incline. This is thought to be a risk minimizing strategy of farmers against the potential failure of rice crop (for subsistence) and market risk of sugarcane. Hence, almost all the farmers regardless of their social and economic strata now a days grow cane in about one third of their land and other crops in the rest including rice and wheat. This type of agricultural system also allows poor farmers to go to Punjab as off farm migrant labor in winter.

Cropping intensity has been found to decrease as we move down from north to south. The major reasons for this has been observed to be higher coverage of short term crops like maize and vegetable in the northern side while the increase in coverage of long term crops like sugarcane in the southern side. Moreover, differences in the size of landholding and the problem of absentee landowner are more prevalent in the southern side. Farmers cultivate land in *Hunda* (contract) or *Bataiya* (share cropping) basis.

WATER AVAILABILITY SCENARIO: INFLOWS AND STEAMFLOW

Inflow to the basin occurs from 3 sources: rainfall, ground water and irrigation supply from Bagmati Irrigation System.

Rainfall in the basin area has been found to be concentrated from the second week of June to the third week of September. Considering 1979 to 2000 as the period of analysis, 1980 has been found to be the driest year while 1987 has been found to be the wettest year and 1993 an normal year. Average monthly precipitation varies from a minimum of 6mm in the month of November to a maximum of 422mm during the month of July. On the basis of analysis of daily rainfall data from 1997 to 2000, the maximum 24-hr daily rainfall has been recorded to be up to 159mm on 21 June 1998.

Ground water is the second source of inflow to the basin. Inflow from the ground water table is observed to occur by three ways: firstly through recharge of the river and secondly through capillary rise into the root zone depth and thirdly through extraction by hand pumps. The ground water table over the basin area was observed through 15 representative dug wells and the observed data was interpolated over the whole area. In general, the ground water table of the basin area is found to be quite high. On an average in a normal year, it was found to be about 2m below average ground level. Seasonal fluctuation was observed to be of the order of 1.8m. During the non-monsoon period i.e. from October to May the water table of almost the whole basin is below average root zone level[12]. However, during the monsoon period i.e. from June to September, on the basis of water table the basin can be divided into 4 parts. The first part comprising of 20% of the area of the basin is the part where the ground water table never reaches up to the root zone level. The second part comprising of 54 % of the basin is the part where the ground water table reaches on an average 0.1m for about 12 days. The third and forth part comprising of 13 % each is the part where the ground water table reaches on an average 0.6m and 1m for 50 days and 82 days respectively.

Irrigation supply from Bagmati Irrigation System is the third source of inflow into the basin. The design discharge of the secondary canal entering the basin is 1.2 m^3/s. Considering the operational schedule of the irrigation system, operational period is estimated as 70% under normal conditions. Thus for a normal year, the annual inflow is 26.5 Mm^3. Ten percent increase in the dry year and 10% decrease in the wet year in this value has been assumed.

Study of river morphology has revealed that the river can be divided into three stages. From the origin up to Manpurgoth (13km stretch), the river has an average slope of 1:1000 and is quite straight and the alignment of the river is significantly far away from Bagmati River. The 27.5 km stretch from Manpurgoth to Khairwa is very flat (average slope: 1:3300) and has a lot of meanders with representative meander ratio as 5.45. Then finally the stretch (13.2km) from Khairwa to Hathiul (the confluence point) with an average slope of 1:4200 is relatively straight. It appears that the first stretch gets its recharge from the spring line of the Bhabar zone, the second stretch get recharge from the seepage water of Bagmati river and the third stretch gets surplus discharge by the flooding of Bagmati River.

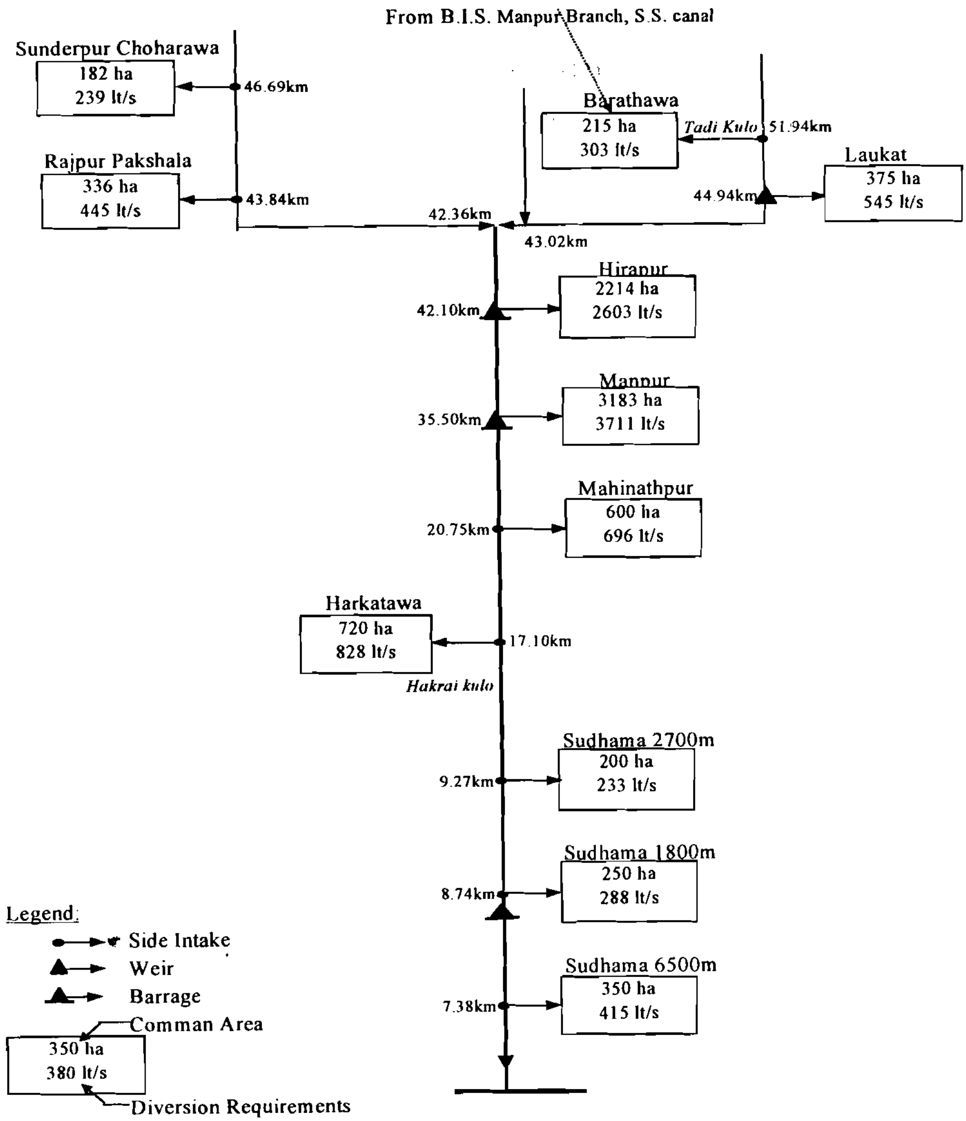
[12] Considering the prevailing crops average root zone depth of 1.2 has been used here.

WATER USE SCENERIO OF THE BASIN

Water in the basin is being used for irrigation, domestic purposes and for animal husbandry. These uses have been considered as the process depletion of the basin. No industry exists within the basin. Among the various uses, irrigation is the most pertinent in terms of volume. At present a series of diversions exist in the river in order to divert water for irrigation purposes. These diversions can be broadly categorized into two types: permanent diversions and side intakes. Permanent diversions are concrete structures (barrage or weir) which divert water as per the requirements of the farmers while side intakes are off takes where water flows through inundation when the water reaches a certain level. For details of the diversions see figure 3. As significant differences exists in the cropping pattern and cropping intensity within the basin each irrigation command area has been treated differently for crop water requirement computations within the basin. Penman Montheith method has been used for the computations. The diverted water is not only used within the basin but also goes beyond the basin boundary. This part has been accounted as trans-basin transfer.

For domestic purposes no water supply system exits except for the shallow tubewells (hand pumps). Previously dugwells were used to fulfill the domestic water requirement. Shallow tubewells were introduced in this area from the early 1970s. These were considered superior by the farmers as they occupied less space, were less prone to contamination and were easier to operate. Thus, hand pumps slowly replaced the dugwells and their number is gradually increasing. Well to do families own up to 3 hand pumps while in poor communities 3 to 5 families share one hand pump. Even though some tubewells go as deep as 20m, most tube wells in the area are 8 to 12m deep. A total of about 2400 tubewells exits in the whole basin area.

Figure 3: Schematic Diagram of Manusmara River



WATER INSTITUTIONS

Institutional analysis of the basin including both the rules as well as the organizations governed by such rules has also been carried out in detail. Water use institutions of the basin have been found to evolve through time and their role has been found to change through time. In the olden times as no permanent structure existed for the diversion of the water. Thus the main difficulty for the farmers was to mobilize resources for the acquisition and allocation of water. Thus the farmer got organized. Even though no formal organization existed, the social structure and norms were instrumental for such resource mobilization.

At present Water Users' Associations (WUAs) have been formed and legally recognized in all command areas where permanent diversions have been constructed by the government. These associations mainly targeted towards distribution of water within their command area. Analysis of the decisions and actions taken by these associations also clearly reflect the fact that their major concern is water management and resource mobilization for operation and maintenance of the irrigation system. No association exists for command areas irrigated through inundation canals.

At the basin level, no organization is found to exist for ensuring effective water use of the basin as a whole. Even though it is understood to be the task of the government, the mechanism for its achievement is found to be ineffective. Very little attention is being given to the issue of water right. Upstream diversions are constructed without any discussion or consensus from the downstream users.

FINDINGS FROM THE WATER ACCOUNTING ANALYSIS:

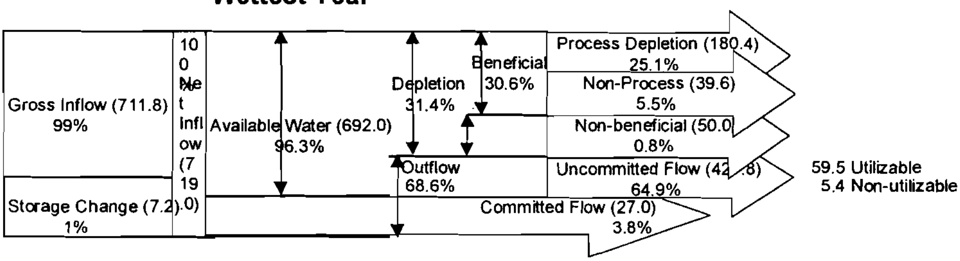
Table 1: Water Account Result

		Year Considered:	Wettest Year (1987)		Normal Year (1993)		Driest Year (1980)	
		Previous Year:	Normal		Dry		Normal	
S.N	Component	Sub-component	Volume $10^6 m^3$	% of Net Flow	Volume $10^6 m^3$	% of Net Flow	Volume $10^6 m^3$	% of Net Flow
1	Gross Inflow	a Rainfall	387.8	60.4	221.8	46.8	156.6	39.8
		b Bagmati	24.1	3.8	26.5	5.6	29.2	7.4
		c Subsurface	222.8	34.7	218.4	46.1	214.0	54.4
		Sub Total	634.7	98.9	466.7	98.5	399.8	101.5
2	Storage Changes	a Surface Storage	0.9	0.1	0.7	0.1	0.2	0.1
		b Ground Storage	6.3	1.0	6.3	1.3	-6.3	-1.6
		Sub Total	7.2	1.1	7.0	1.5	-6.0	-1.5
3	Net Inflow		**641.9**	100	**473.7**	100	**393.7**	100
4a	Process Depletion (within basin)	a ET of Paddy	43.6	6.8	43.6	9.2	43.6	11.1
		b ET of Wheat	13.9	2.2	13.9	2.9	13.9	3.5
		c ET of Sugarcane	16.0	2.5	16.0	3.4	16.0	4.1
		d ET of Pulses	6.5	1.0	6.5	1.4	6.5	1.7
		e ET of Maize	2.7	0.4	2.7	0.6	2.7	0.7
		f ET of Oilseed	1.5	0.2	1.5	0.3	1.5	0.4
		g ET of Vegetables	1.1	0.2	1.1	0.2	1.1	0.3
		h Domestic uses	0.8	0.1	0.8	0.2	0.8	0.2
		I Animal uses	0.3	0.0	0.3	0.1	0.3	0.1
4b	Process Depletion (trans-basin)	j Agricultural uses	22.1	3.4	20.1	4.2	18.1	4.6
		Sub Total	**108.5**	**16.9**	**106.5**	**22.5**	**104.5**	**26.5**
5	Non Process Depletion (Beneficial)	a ET Forest	6.6	1.0	6.2	1.3	5.9	1.5
		b ET Canal Forest	0.2	0.0	0.2	0.0	0.2	0.1
		c ET Grazing land	2.8	0.4	2.6	0.5	2.5	0.6
		d ET Homestead	30.0	4.7	28.2	6.0	27.1	6.9
		Sub Total	39.6	6.2	37.2	7.9	35.7	9.1
6	Non Process Depletion (Non-beneficial)	ET Barren land, flood plain and water body	5.6	0.9	5.2	1.1	5.0	1.3
7	Out-flow	Runoff	461.0	71.8	316.0	66.7	242.0	61.5
		Sum of depletion and surface run-off	**614.7**	95.8	**464.9**	98.1	**387.2**	98.3
		Deep percolation	27.2	4.2	8.8	1.9	6.6	1.7

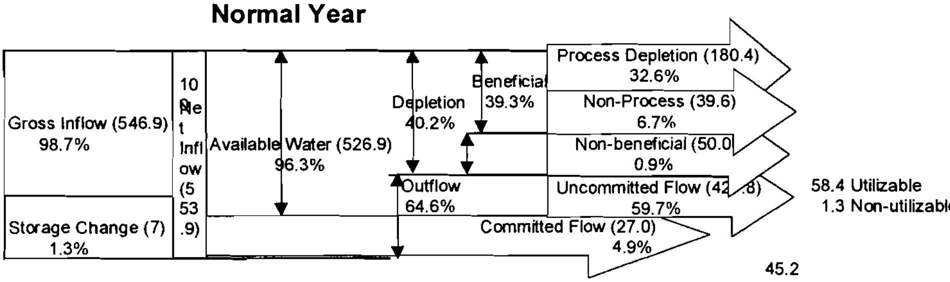
Finger Diagrams:

	Dry	Normal	Wet
Process	25.1	32.6	37.8
Non-Process Beneficial	5.5	6.7	7.5
Non Beneficial	0.8	0.9	1.0
Utilizable	59.5	53.5	47.2
Non-utilizable	5.4	1.3	0.7
Committed	3.8	4.9	5.7

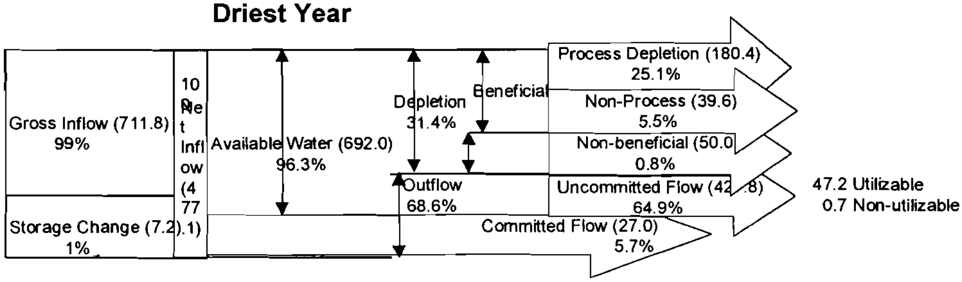
Wettest Year



Normal Year



Driest Year



Available Flow	614.9	446.7	366.7
Depletion	153.7	148.9	145.2
Depletion/Available	25%	33%	40%
Beneficial Process/Available	18%	24%	28%
Beneficial Consumption/Available	24%	32%	38%
Utilizable flow	406.8	280.2	208.4
	66%	63%	57%
	9%	4%	3.6%

Discussion of Results:

Table 1: Computed Indicators

S.N.	Indicators	Value
1.	Depletion/Available water	43%
2.	Beneficial Process/Available water	28%
3.	Beneficial Consumption/Available water	38%
4.	Utilizable flow	57%

Water accounting computations carried out for the Manusmara River Basin has roughly demonstrated that only 40% is depleted in a dry year (such as year 1980) leaving a balance of 60% of utilizable flow to move out of the basin (Table 1). As the utilizable outflow takes place throughout the year, the basin is an open basin. There is potential to harness this utilizable outflow and use it productively.

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Paper 6: Existing Arrangement for Water Management In East Rapti River Basin: Institutional Issues

R. N. Kayastha & Dhruba Pant

PHYSICAL CHARACTERISTICS

The river basin has a catchment area of about 3,200 sq. km. The East Rapti River course starts with a very steep slope in mountainous area and flattens on the way out to meet the Narayani River. The lower reach of the river has mild slopes and larger discharges as many tributaries join in its course. Consequently, it has relatively higher velocities of water in the upper reaches than in the downstream.

The water accounting computations indicate that the basin is an "open basin." In a typical dry year, only 53% of the available flow in the basin gets depleted, allowing the rest (47%) utilizable flow to move out of the basin. This indicates a potential to harness this utilizable outflow. Also, as only 6% of the depleted water is process consumed, there is a potential to further increase the process consumption. The study also pointed out that there are substantial spatial variations in water availability compared to temporal variations within the basin.

There is an inflow into the basin at upstream through the tailrace of Kulekhani Hydropower plant built into adjacent Bagmati River basin. Kulekhani-I and II hydroelectric power plants are located in the upstream catchment area of the basin near *Bhainse* in the *Makawanpur* district with the installed capacity of 60 and 32 MW electricity respectively. This is the sole large water storage hydroelectric power station with the catchment and reservoir areas of 126 and 2.2 square kilometers respectively. One 114m high rock-fill dam has been constructed in the Kulekhani River to store a gross volume of 85.3 x 10^6 cu. m., which ultimately drains to this basin via I and II hydroelectric plants[13]. However, the water of Manu river of this basin is also added to the drain from the first hydroelectric plant while diverting to second power plant. Consequently, water of Mandu River downstream from the diversion point became insufficient for running the privately run about 10 water mills for which the compensation was paid by the power plant.

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[13] It recently, for the purpose of catchment area protection, has launched the "Kulekhani Disaster Prevention Project."

The population density is 145 per sq. km. and it has been increasing at the rate of more than 2.8% every year due to people's influx into this area (Ghimire, et. al. 2000). The basin has been experiencing population influx from different parts of the country from 1950s with a state-supported resettlement program and the trend is continued. Promising farming land is still available in basin area and people like to come and settle. Accordingly, the rate of urbanization is relatively higher here and about 23% people live in urban areas compared to 15% national average. Literacy rate is about 40%. Forty two percent people are below the poverty line (Making less than NRs. 2,500/capita/year) and only about 36% people have piped water supplies.

The land use pattern in the basin indicates an extensive presence of forest (39%) followed by agricultural land (27%) and National Park (27%). The basin has a diverse biophysical environment by gradients, altitudes, landforms, and soil types.

The average farm holding is 0.9ha per household and above 75% people are engaged in agricultural activities. More females (87%) are found engaged in agriculture than their male counterparts (67%). The land distribution pattern in the basin is highly skewed (Ghimire, et. al., 2000). About 46% farmers own less than 0.5ha (only 16% of the total cultivable land where as 6% households own more than 2ha (2%). It was found that significant number of people (above 75 percent of people engaged in agricultural activities) have either no access or have access to small size of land ownership. Therefore, land tenancy arrangements are very commonly practiced in the basin area.

Also mentioned before, about 27% of the basin area is under agricultural cultivation (Adhikari, et. al, 2000; RTDB, IAAS and IWMI, 2000; and Ghimire, et. al., 2000). It is estimated that still only 45% of the total cultivated area (about 86,000ha) in the basin is irrigated and only about half of it receives year round irrigation service (Ibid.).
The irrigation systems that divert water directly from the East Rapti River have adequate water supplies (as per the farmers' need) whereas almost all the irrigation systems diverting water from its tributaries have less–assured and limited water supplies (below the farmers' need) (Adhikari, et. al, 2000). Consequently, river-fed irrigation systems have better productivity in all cereal crops (rice, maize, and wheat).

Emerging Trends

Growing Seasonal Water Scarcity

The basin experiences seasonal water scarcity for agricultural purposes. Surface irrigation systems are being stressed for required water supplies during the dry season. Consequently, many irrigation water users' groups are making extra efforts for augmenting water supplies from alternative surface sources and ground water. The stress has increased also because of growing water demands from other sectors.

In addition, high spatial and temporal variations in water availability are forcing farmers of some areas to look for alternative cropping patterns. Although rice has low water use efficiency, it is cultivated as the main crop for a variety of reasons including in dry areas and by poor people. Despite numerous irrigation infrastructures, lack of dependable sources and unreliable supply has in many cases resulted to failure of maize crop particularly during spring season in dry areas. Due to low ET requirements of winter crops and substantial efforts to manage water for rice during monsoon season, farmers of relatively dry areas experience more water scarcity during spring than in other seasons.

Marginalization of Fishermen

As mentioned earlier, *Bhote* and *Danuwar* heavily depend on fishing. However, the number of fishes has been decreasing over time (Ghimire, et. al., 2000). Main reasons for this are pointed as floods, dam construction in Narayani at Triveni, use of gelatins and poisons for fishing by other communities, and lack of moss (plankton and the essential flora deposition in the riverbeds for fish food). The fishermen opine that the industrial effluent has a major role in reducing the moss. The decreasing number of fishes in the river streams can largely marginalize these most unprivileged and predominantly illiterate tribes who hardly have any access to agricultural land and other alternative jobs. Not only the availability of fishes is declining but also the means of catching them such as bringing woods required for making fishing boats are restricted after the establishment of National Park.

Water Conflicts

Conflicts are emerging between upstream and down stream water users, mainly between irrigation systems that draw water from the same stream. Some inter-sectoral conflicts are also observed although they are very few. For example, Bhandara water supply system has started facing the problem of water shortage because of recent water diversions at the upstream of its intake. By its intake, about 2 km. downstream of Kusum Khola, flood victims of 1993 are settled. They are being accused of stealing water for irrigating their kitchen gardens and polluting it at the source itself. Conflicts have been so fierce that people have started thinking about removing the new settlers or shifting the intake further upstream.

Similarly, incidents of conflicts were reported between Machan Hotel located near Lothar River and irrigators of Pratappur Mau Irrigation System over the use of water during winter months in East Rapti River. The hotel wants water to flow downstream for sailing tourists in boats, whereas farmers want water for irrigating their crops.

Sand Mining

The riverbeds of East Rapti river and its major tributaries have been good source for getting sand, gravel and aggregates for construction purposes in this rapidly urbanizing basin. As the quality of these materials in this basin is perceived to be superior, the rate of sand mining is increasing over time. Further, it has become a source of income for the District Development Committees as they tax for sand mining. The collection of these materials, however, is not done in a regulated manner. Both the individual collectors and licensed agencies are neither aware of nor serious about the interests of other stakeholders. The haphazard digging of the riverbanks for collecting these materials has not only caused riverbank cuttings and landslides but also disturbed the river's regime flows causing, at some places, overflowing of river water into the agricultural fields as floods during rainy seasons has raised river beds at some locations. The raised riverbed near *Hetauda* is being perceived to be dangerous to the city itself. By the intake point of Padampokhari Irrigation System (just about 2 km. downstream of *Hetauda*) the riverbed is reportedly lowered and it has made it difficult and expensive to divert water to its permanent intake.

Increase in Cultivated Area

Over the last twenty years, the cultivated area in the basin has increased from 83,448 ha to 85,578ha whereas the forest cover has decreased by 73,255ha indicating that part of the forest has been converted into agricultural lands.

Water pollution

The pollution of water in the river basin is reported due to disposal of industrial wastes by some of the industries as reported by the users and also confirmed by the District Officials. The brewery, soft drink and paper mill is reported to have disposed the industrial waster in the river in the Chitwan District. For example the irrigation users from ward no 8 and 9 of Birendranagar Municipality in Chitwan has complained of the pollution in the irrigation water due to the waste disposal by the brewery and soft drink industries. The people have lodged complaint officially at the ministry level (Ministry of Population and Environment (MOPE) and to the Ministry of water resources). The district officials told that this matter will be are investigated. Likewise, People complained about the waste disposal by the industries in Hetauda Industrial District in Makawanpur. During the discussion the Chief District Officer told that the industries have been asked to dispose of industrial waste after its treatment and they have agreed to that. However, it remains to be seen whether they will comply with the decision reached between the local people, administration and the industries. The cases of water pollution are reported to the local authorities however they lack technical capability to investigate the matter and the MOPE does not have its office at district level. Therefore, the problem is not addressed immediately. The users in the river basin reported no other form of pollution. This is because that most of the water in the river basin is used for irrigation.

Adverse activities (fish poisoning, use of explosives etc) for the well beings of aquatic flora and fauna should be stopped. Safe disposal of industrial effluent should be sought. This not only kills fish in the Rapti River but also is hazardous to wildlife in RCNP.

In relation to water pollution, downstream stakeholders particularly the livestock farmers' complaint against the polluted water drained out of the industrial area of Hetauda where number of industries (71 at present) are on the rise. Severe complains and conflicts are not occurring, not because of unpolluted outflow, but because of the ignorance of downstream stakeholders about the degree of pollution and its adverse effects. Nevertheless, there is a growing concern about the pollution and effects of polluted water on the life and property of the concerned people downstream. Because of this concern, perhaps, the government is planning to establish a Common Water Treatment Plant.

In the case of rural water supply system, the intake area at the water source is being protected through fencing against the external pollution in the vicinity only. Pollution is in rampage from industries and municipalities in the case of urban area. Hetauda Industrial area and Hetauda Cement Factory have polluted the Karra Khola, that joins east Rapti in Hetauda and East Rapti river itself both in the Sandstone quarry site nearby Bhainse and from the effluent from the cement factory in Hetauda.

It has been come to notice that Hetauda Industrial district is planning to minimize the pollutants from the industrial area.

INSTITUTIONAL CHARACTERISTICS

District boundaries encompassing several villages development committees, traditionally and legally, form the main basis for state's instruments of administration and governance. The hydrological boundary of the basin passes over two administrative districts. This indicates a need for cross-district arrangement for managing river basin water.

People in the basin have had a long tradition of making collective efforts to manage natural resources including agricultural water. Traditionally, there have been several beneficiaries' organizations at individual system level. They have been locally taking care of operation and maintenance (O&M) activities through collective efforts. Going beyond the tradition, recently, 134 irrigation systems in Chitwan area have been registered with the District Water Resources Development Committee. The registration provides them a legitimate status. Also in the past, farmer-managed irrigation systems of eastern Chitwan part had formed a separate federation for consolidating regional efforts to adopt pertinent irrigated agricultural development strategy and accordingly approach the related agencies for assistance.

Historically, surface irrigation systems were initially developed and managed by indigenous and tribal community organizations and the systems concentrated more in the central plains of the basin than in the hills. Later, with the state-supported resettlement programs in the basin area following disastrous floods and landslides in the surrounding hills, numerous immigrants received land entitlements (on forest cleared lands) in the basin and irrigation development and management practices started becoming a concern of mixed communities. Presently, there are more than 200 farmer-managed irrigation systems in the basin and they account for about 90% of the irrigated area (RTDB and IWMI, June 2000). The state initiated supporting irrigation developments in this area only from 1960s.

Evolution and use of water laws, rules and norms in ERRB

The DWRCs in Chitwan and Makawanpur districts, have been registering WUAs in their respective districts but the issuance of licenses to use water resources have not been so much operationalized. The DWRCs are not properly organized due to lack of budget and manpower. A workable mechanism for allocating, reallocating and monitoring uses of water resources hence yet to be developed. The DWRC Chairman and the member secretary are not so much aware of the existing as well as emerging issues in the basin and sub-basins. Scarcity of and competition of water uses are increasing. District Irrigation Offices and District Water Supply and Sanitation Offices are facing increasing number of cases on the conflicts concerning different uses of water resources. Most of the conflicts are resolved at the local level by the users association and/or concerned village development committee. District Irrigation and/or water supply offices have resolved some of the disputes but there are few conflicts that have reached the appellate court. Jiudi-Chipleti Irrigation System in Chitwan is one of the examples where conflicts were registered for sharing of water from the same river sub-basin of Pampa Khola.

The Tharus and Darais were the original settlers in the Rapti basin area until 1953. They developed the irrigation systems before 1953. The need for irrigation water was less, as the settlement in the area was very small and scattered. The villages contributed their resources for the development irrigation as per their need. With the implementation of the state sponsored resettlement programme since 1953, a large numbers of people, mostly from western Nepal, settled in the area after clearing the forest. Initially, they took management contract of the irrigation systems developed by Thaurs and Darais (A. Shukla et al, 1997). In course of time they started the development of new irrigation systems. An informal user group was formed to initiate the irrigation development. The users reported that in the beginning the distance between the headworks used to be 1.6 km. The users developed the necessary rules with respect to the system development, resource mobilization, water allocation and distribution and operation and maintenance. These informal rules constituted the working rules of the operation of the system. With the development of new irrigation systems there was a rise in conflict among the users which required appropriate mechanism for resolving the disputes. Another, reason for the conflict was due to the change in the water course by the river during high flood, which washed away the intakes and that required construction of new intake in different location. However, prior appropriation right was recognized. The mechanism adopted by the users to solve the disputes and in defining the water right was through the negotiation among the users. Therefore, the downstream users have to negotiate with the upstream users if there was objection from them. However, there was an understanding between the user that the need of every users should be addressed as far as practicable.

In some cases arbitration by government functionaries at the local, district and zonal level and a written agreement is signed between the disputing parties (A. Shukla et al, 1997). That served as basis for rules and norms for the development and management of irrigation systems. The development of rules and norms was further reinforced, when government started various intervention programmes to support the development and rehabilitation of irrigation systems. One of the conditions for government interventions was the requirement for official registration with a constitution of WUA. Consequently, the informal water users group became WUA and their informal rules were formalized through the constitution of WUA. The users reported that almost all the WUA in river basin are legally registered, as they received government support. The water laws and rules, as it is practiced in the river basin at present, evolved through various negotiation processes between the users as the history of irrigation development took place since 1953. The formalization of these rules however took place when external support was provided to these irrigation systems.

Land right and water right

The Water users' Association (WUA) represents the collective interest of the respective users in the basin. In the absence of male members, women can also represent the male members in water users associations or assembly and related decision making process as de facto members (Ghimire, et. al, 2000).

Water rights are also associated with land rights. In irrigated lands, this means that the rights to use water are automatically transferred to the offspring as land ownership is inherited. Similar is the case when land buyers acquire land ownership after purchase. In general, the access to irrigation water rights is tied up with the access to land rights. Water rights are also related to tenure system. Different kinds of tenure arrangements operate in the basin, e.g., owner-operator, share-cropping, mortgage, lease, contract farming, etc. Share-cropping is quite common practice after owner-operators. All operators hold possessions of water rights as they are required to contribute resource in terms of kind, cash or labor for the system development, acquisition, distribution and use of water resource for irrigation.

To sum up, the prevailing practices of customary rights in the river basin are: water share based on investment, water right purchase from others (Pradhan, 1989) and water rights proportionate to the land in irrigated area (Pradhan, 1989). The availability of irrigation water for area expansion, the users' willingness to invest in its development, external resources obtained for the development of the irrigation has influence in defining the water right of the users in the river basin.

Dispute management

The inter-system conflict is mainly between agricultural use, National Park and hotels and resorts for tourism due to the existence of many diversion structures in the river, which has become obstacles for boating for tourists who are the guests of several Hotels and Resorts. Besides, the consumption of water by several irrigation systems, especially towards the upper section of the National Park has seriously decreased the amount of water in the river during summer season.

External factors like high floods associated with catchment degradation due to encroachment upstream that damage diversions structures and changes in stream-course has been a potential cause of conflicts across the systems. In some cases, intervention by external agency has also displaced the years-old structures and obstructed water distribution pattern among users. Thus, construction of new intake invites conflict when existing intake point and canal lining are lost, as none of the users want to lose claim on water. Conflicts are also due to those who have not sometimes participated or paid cash or required labor for repair-works. Although settled by the users themselves, more conflicts do occur due to water competition in water limited/deficit areas.

Depending upon the nature and severity of conflict, a range of mechanisms is used to resolve conflicts. These include both formal and informal mechanisms. Although not frequent, there are cases resolved by simple informal negotiations and arbitration. Agreement was signed between the disputing parties in the mediation of VDC and local *Panchabhaladmi* (group of local people accepted by the disputing parties). In some other cases, the VDCs have forwarded the cases to the Chief District Officer (CDO). Although informal mechanism is most common, users approach legal and quasi-legal institutions when informal mechanisms fail to resolve conflicts adequately (Shukla et al., 1996). Some of the cases have traveled from the district Court even up to the Supreme Court for final resolution of the problems (Shukla et al. 1997). Different water rotation schedules are used to minimize conflicts within the system. Therefore, the conflict between and within irrigation systems is less pronounced in the river basin area.

There was conflict between supply of drinking water of Pithuwa VDC and irrigation water of neighboring Chainpur VDC, as both have same water source on Kair stream. It is natural that both desire water supply according to their own convenience. Since drinking water is more critical issue than irrigation and due to high water demand during daytime, the conflict was resolved by a mutual written agreement whereby Chainpur would divert water only at night for irrigation so that high demand for drinking water of Pithuwa residents is met during daytime.

Inter Sectoral Water Transfer and Organizational Linkages

Important actors for managing the catchment area at national level have been identified as: Ministry of Water Resources (MOWR) and National Planning Commission (NPC), whereas at district level actors include: Forest, Water Supply and Sewerage, District Development Committee, Electricity, Irrigation Offices and concerned municipalities. Resource users, both as individuals and organizations, Village Development Committees (VDCs), industries, etc is responsible for managing the catchment area at the local level. Makawanpur Industrial District is the authority to manage water in Makawanpur district.

A brief review of the water uses in the ERRB and its legal status is presented in following Table 1.

Table 1: Water Utilities in East Rapti River Basin

Type of Utility	Number	Who Owns Utility	Who Operates the Utility	Legal Status of Operator
Surface irrigation systems	214	Government and farmers both collectively and individually	WUAs = 208 Jointly by the government and farmers – 6	Govt. Department Local WUAs – Some recognized by law and some informal
Groundwater Schemes	STW = 589 Dug Well = 1,809 Treadle Pumps = 47	Mostly by individual farmers and some in groups	Mostly by individual farmers and some in groups	Some recognized by law and some informal
Domestic water supply schemes	45	Municipality level schemes (3 schemes) by the government and village level schemes by users' groups	Municipality level schemes by Water Supply Corporation and village level schemes by users' groups	Majority of user groups are legally recognized
Hydropower plants	One	The government	Nepal Electricity Authority	Government body
Waste water Treatment plants	None	Not applicable	Not applicable	Not applicable
Wetlands and other water bodies	Numerous – exact number yet to be ascertained	Royal Chitwan National Park	Park Officials and local people in buffer zone	Buffer zone peoples' committees are legally recognized
Hand pumps	Numerous – exact number not available	Individual farmers	Individual farmers	Informal and private
Industries	126	Public and private	Government and private sectors	Legally recognized

There are no institutional arrangements at Rapti basin level to cope up with multiple use of water. However, a district level federation of WUAs in both districts (Chitwan & Makawanpur) under East-Rapti Basin and a separate federation of WUAs in East Chitwan have recently been formed.

Precise policies lack with respect to inter-sectoral water transfers or inter-basin transfers of water. The natural resources in the country are owned by the state and only use rights are given out. The central government level agencies have the sole decision making authority and accordingly command the influence. Recently, some initiatives have been made for delegating some authority over to the district level water resources committees. Subsequently, these district level committees are expected to be primarily involved in river water management tasks at the district level.

For inter-sectoral water allocation, only informal arrangements exist, for example, between water mills and irrigation. The same is the case for intra-sectoral water allocation and distribution, e.g. between irrigation and irrigation.

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Informal arrangements (customary practices) for inter-sectoral water allocation and distribution in study area

Except Narayani Lift and Khageri irrigation systems, which are jointly managed by government and users associations, farmers themselves manage all others. Most of the irrigation systems acquire water from series of headworks along the streams. An arrangement for water allocation between these systems is based primarily on mutual consensus among upstream and downstream users especially during dry seasons. Usual tradition is that the downstream systems approach the upstream system through functionaries to make an informal request for sharing water. Also, there are systems among which a formal legal right of access to water is also found. While in some others, water is allocated proportionately into a number of shares depending upon the labor contribution to O&M to maintain the common intake.

In the case of intra-system water allocation, boundary rules are used to define who users are and who are not. Each farmer within the rule is allocated water based on his labor contribution to O&M of the system. Stringent rules are implemented during water deficit periods to ensure equity in allocation. Systems switch from continuous mode of supply to rotational pattern of water distribution method as canal supply decreases towards lean season. In most of the systems, opportunistic users' behaviors like shirking and water pilferage is controlled by pay-off rules for graduated sanctions.

One embankment (18km long) and a number of spurs are built along the river course for flood protection in the downstream. But no storage facility that can control or distribute the flow of units from the river to other places or sectors is developed. No explicit allocation of uncontrolled river water is found among various sectors. As mentioned earlier, conflicts between tourism and irrigation sectors indicated that although national government has high priority to tourism and National Parks, exclusion of water use from the river for irrigation appears impossible unless options are developed negotiable to both sectors. This brings an issue of little or no water allocation across sectors and protection of riparian property rights.

All but one of the industries is supplied with water from Hetauda Industrial District (HID) in upstream. Using an intake channel, they extract from both Karra stream and from a well. Hetauda Textiles has its own well and only a minor part of the consumption is supplied by the HID. Water allocation and supply within industries is demand based and does not seem to be a problem since revenue is collected from the use of power.

Paper 7: Institutional Arrangements for River Basin Management: Some Emerging Issues

M. Samad

Outline

During latter half of the last century or so, throughout Asia, there has been substantial investments in the water resources development, particularly in expanding the areas under irrigated agriculture. But with very few exceptions the development of appropriate institutions has been badly neglected. The need to develop effective water management institutions is now well recognized. Consensus of opinion among all major stakeholders in the water sector that suggest that the river basin is the most appropriate unit for the effective management of water resources. This stems from the fact that focusing on river basins greatly helps in the better understanding of the environmental, social and economic influences that impinge on the productivity of agricultural water management. In a basin context, inter-related issues on both quantity and quality of surface and groundwater, and the extraction, use and disposal of water resources can be more easily and comprehensively analyzed. Participation of a larger number of stakeholders can be sought, and water resources planning can be more effectively carried out.

In terms of institutional change, a basin perspective may bring about a much needed balance between the need for decentralization and the continued responsibilities of the center. This is particularly relevant in water scarce situations where complex interplay between declines in water quality, reductions in agricultural production, threats to human health, inequitable water allocation and reduced access to water by resource-poor people pose profound institutional and political challenges (Wester, 1999). As pointed out by Vermillion and Merrey (1998):

"Once basins become closed, where water is the prize in what is in essence a zero-sum game, the institutional and management issues become enormously complex, and solutions that seem optimal from a 'systems' perspective (which in practice means an economic perspective) are unsatisfactory from the perspective of particular water users. What is required are effective institutional arrangements for providing the diverse water services demanded by users."

A question often asked is what is the most appropriate institutional arrangement for the management of river basins? This paper attempts to address this question on the basis of the results of recent studies on institutional issues in river basin management carried out by the International Water Management Institute (IWMI). Those who have worked on institutional issues are well aware that institutional arrangements are not static but are dynamic entities that change over time with varying requirements. River basins evolve and change over time from both a bio-physical and socio-economic perspective. The growing demand for water and rising value induces technical and institutional changes. The paper argues that the "most appropriate" institutional arrangements depends on the stage of development of a particular river basin.

The paper draws on empirical evidence from five river basins (East Rapti-Nepal, Ombilin-Indonesia, Upper Pampanga-Indonesia, Deduru Oya-Sri Lanka, Fuyang-China) reflecting the full range of stages in the development of river-basin water resources and develops a perspective on the problems occurring in various stages as a river basin evolves.

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 inter-sectoral and the dominant task is setting priorities for the allocation of water among sectors - irrigation, domestic, industry, environment, (iv) Demand Management stage in which the river basin has become "closed" in the sense that all available water has been allocated to various uses and scarcity management becomes paramount.

Figure 1 illustrates the hypothetical development path of a river basin and the management challenges and Figure 2 categorizes the five selected river basins in terms of their development stages and highlights some of their salient features

Figure 1: Basin Development

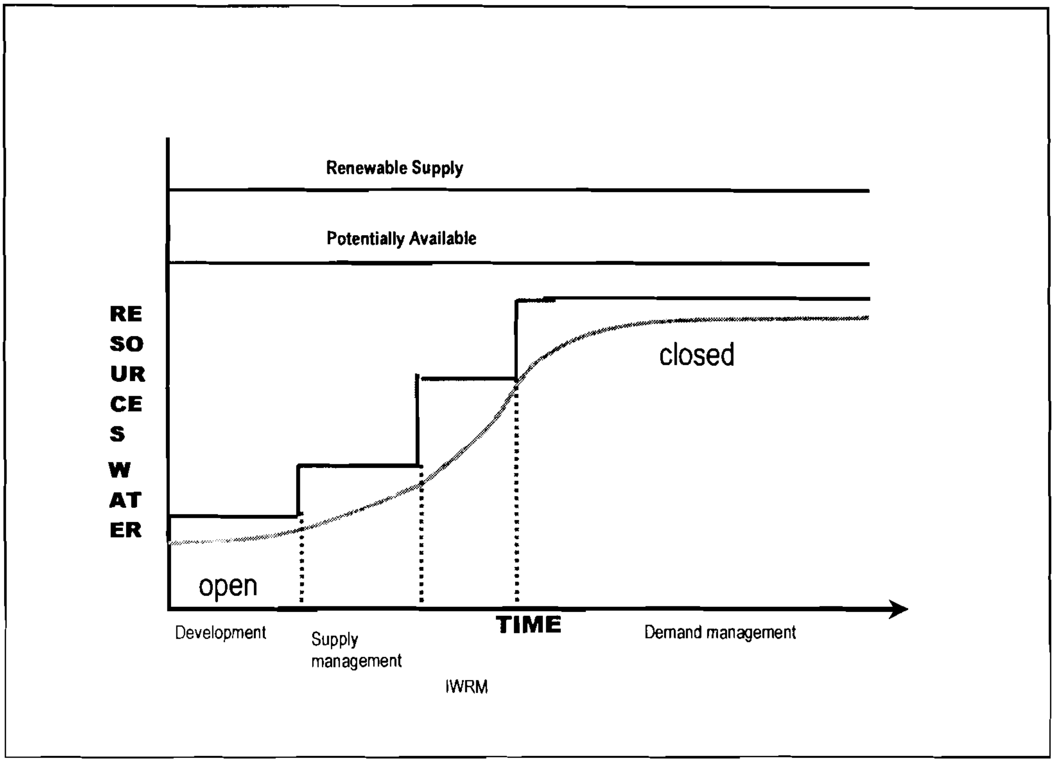


Figure 2: Basin Water Use and Development Potential

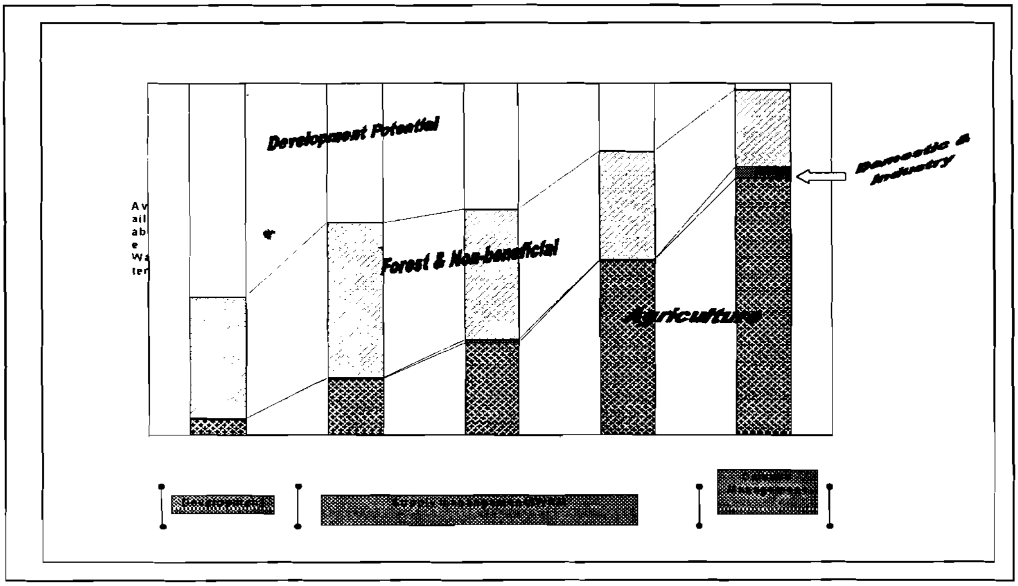


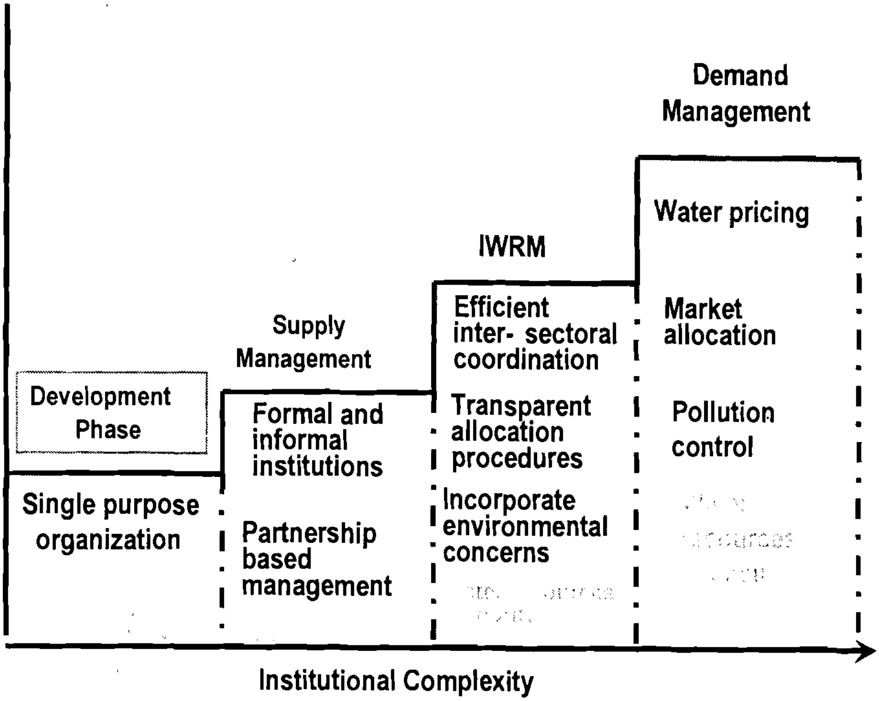
Table 1: Identifies the specific issues at each stage:

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

These are not mutually exclusive categories. There is considerable overlap in the management challenges. For example, demand management will require an integrated approach to water resources management, components of supply management and investment infrastructure development.

Figure 3 contains some suggestion s for institutional arrangements appropriate for the different development stages of river basins.

Figure 3: Basin Development Stage and Institutional Needs



ANNEXES

Annex 1: Program for the Workshop on Integrated Development and Management of Nepal Water Resources – A Case of Indrawati River Basin, Nepal

Venue: Hotel Radisson, Kathmandu

Date: Wednesday, 25 April 2001 (Baisakh 12, 2058)

Activity	Time From	Time To
Registration	8:45	9:00
Opening Session: 9:00 – 10:10 Chairperson: Mr. Purna Bhadra Adiga, Officiating Executive Secretary, WECS		
Introduction on workshop and welcome – R.N. Kayastha, WECS	9:00	9:10
Few words – S.P. Sharma, Joint Secretary, MOWR	9:10	9:20
Few words – Dr. U. Pradhan, Ford Foundation	9:20	9:30
Background on the research project – M. Samad, IWMI	9:30	9:50
Remarks by Chairperson	9:50	10:00
Tea Break: 10:00 – 10:30		
Presentation Session I: 10:30 – 12:30 Chairperson: Dr. R.P. Yadav		
1. Paper on Water Accounting Study of Indrawati River Basin – V. S. Mishra	10:30	10:50
2. Paper on Institutional Analysis – D. R. Pant	10:50	11:10
3. Paper on Stakeholders Inclusion and Exclusion – Sanju Upadhyay	11:10	11:30
4. Paper on PDR Research on Melamchi Water Supply Project – H. Devkota	11:30	11:50
Discussions	11:50	12:10
Summing up by the Chairperson	12:10	12:20
Lunch: 12:20 – 13:30		
Presentation Session II: 13:30 – 15:00 Chairperson: Dr. Prachanda Pradhan		
5. Paper on Water Accounting and Water Use Institutions' Study of Manushmara River Basin, Nepal – H. Hemchuri and L. P. Bhattarai	13:30	13:50
6. Paper on Institutional Analysis of East Rapti River Basin – R. N. Kayastha/D.R. Pant	13:50	14:10
7. International Arrangements for River Basin Management: Some Emerging Issues – M. Samad	14:10	14:30
Discussions	14:30	14:50
Summing up by Chairperson	14:50	15:00
Tea Break: 15:00 – 15:30		
Discussion Session III: 15:30 – 17:45 Chairperson: Mr. B. K. Pradhan		
Presentation of Main Issues	15:30	15:50
General Discussions	15:50	17:20
Comments by the Executive Secretary, WECS	17:20	17:30
Summing up by Chairperson and Workshop Adjournment	17:30	17:45
Dinner	18:30	

Annex 2: List of Participants

1. Mr. A. N. Baidya, Department of Agriculture
2. Mr. Ajay Bista, Agri. Economist, Ministry of Agriculture and Cooperative
3. Mr. B. Baniya, Section Officer, WECS
4. Mr. B. R. Adhikari, Senior Divisional Engineer, WECS
5. B. R. Kaini, Deputy Director General, Department of Agriculture
6. Mr. Bharat Purasaini, Project Coordinator, Department of Soil Conservation and Watershed Management
7. Mr. Bhubanesh K. Pradhan, Chairperson, ARMS
8. Ms. Bimala Pradhan, Social Service Officer, WECS
9. Mr. Chiranjivi Sharma, SISP Consultant
10. Chitra Dev Bhatta, Advisor, NPC
11. Mr. D. D. Baral, Engineer, DOI
12. D. P. Kharal, Engineer, DOI
13. Mr. D. R. Regmi, Joint Secretary, MOWR
14. Mr. Daman Thapa, Executive Director, MRMG
15. Mr. Dambar Aryal, Vice Chairman, DDC Sindhupalchowk
16. Mr. Dhirendra Bhattarai, Engineer, WRSF/WECS
17. Dr. Dhruba Pant, IWMI Nepal
18. Dr. Divas B. Basnet, WRSF Consultant
19. Mr. Ganesh B. Khatri, Local Dev. Officer, Sindhupalchowk
20. Mr. Gautam Rajkarnikar, WECS
21. Mr. Gokul P. Sharma, Project Coordinator, WIDP
22. Mr. Govinda D. Shrestha, WRSF Consultants
23. Mr. Hari Devkota, IWMI Nepal
24. Mr. Hari Hemchuri, Engineer, Department of Irrigation
25. Dr. Indra L. Kalu, Ex. Director, RITI Consultants
26. Mr. Iswor R. Onta, WRSF Consultants
27. Mr. J. R. Sharma, Coordinator, IMTP, Department of Irrigation
28. Mr. Janak L. Maharjan, Draft person, WECS

29. Mr. Ms. Janaki Karmacharya, Librarian, WECS
30. Dr. K. B. Aryal, Executive Director, WECS
31 Mr. K. B. Bhurtel, Executive Director, WECS
32. Dr. K. R. Sharma, Coordinator, NISP, Department of Irrigation (DOI)
33. Mr. K. Sharma, Director, CRID
34. Mr. Keshav R. Adhikari, Coordinator WMSG/IAAS
35. Mr. Kiran P. Giri, Economist, WECS
36. Mr. L. P. Bhattarai, Sociologist, DOI
37. Mr. Laxman Kharel, Engineer, MWSDB
38. Mr. Laxmi N. Chaudhari, Nepal Engineering College
39. Mr. M. L. Shrestha, Senior Divisional Engineer, DIO Sindhupalchowk
40. Dr. Madar Samad, IWMI-HQ
41. Dr. Madhusudan Bhattarai, IWMI-HQ
42. Ms. Mandira S. Shrestha, Senior Hydrologist, Tahal Consultants
43. Mr. Mukti N. Manandhar, Project Manager, RTP/Department of Irrigation
44. Mr. N. K. Agarwal, WRSF Consultant
45. Mr. N. N. Vaidya, DDG, Department of Irrigation
46. Mr. Narayan P. Bhattarai, Deputy Director General, DOI
47. Mr. P. B. Adiga, Executive Director, WECS
48. Mr. Padam P. Aryal, WUA Federation Nepal
49. Mr. Prabhat Kumar, Engineer, Melamchi WSDB
50. Dr. Prachanda Pradhan, FMIS Trust
51. Mr. Prem Raj Purkoli, WIDP/WECS
52. Mr. R. C. Arya, Senior Divisional Engineer, WECS
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70. Dr. Ujjwal Pradhan, Ford Foundation
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