Proceeding Report

Irrigation National Workshop

Irrigation in the Changing Context:

From Concepts to Actions

(April 27 - 28, 2008 / 15 – 16 Baishak, 2065 B.S.)

Editors
Suman Sijapati
Khem Raj Sharma

DoI / NEA / INPIM-Nepal / IWMI-Nepal
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TABLE OF CONTENTS

ACRONYMS

ADB/N	=	Agricultural Development Bank of Nepal
APP	=	Agriculture Perspective Plan
DDC	=	District Development Committee
DDG	=	Deputy Director General
DG	=	Director General
DHM	=	Department of Hydrology and Meteorology
DLGSP	=	Decentralized Local Governance Support Program
DoA	=	Department of Agriculture
DoI	=	Department of Irrigation
FAO	=	Food and Agriculture Organization of United Nation
GIS	=	Geographic Information System
ha	=	hectare
h.h.	=	households
IDA	=	International Development Association/The World Bank
IDP	=	Interim Development Plan
IDV	=	Irrigation Development Vision
IMD	=	Irrigation Management Division
IMT	=	Irrigation Management Transfer
INPIM	=	International Network on Participatory Irrigation Management
IPI	=	Irrigation Performance Indicator
ISF	=	Irrigation Service Fees
IWMI	=	International Water Management Institute
IWRM	=	Integrated Water Resource Management
IWRMP	=	Irrigation and Water Resources Management Project
MASSCOT	=	Mapping System and Services for Canal Operation Techniques
MoAC	=	Ministry of Agriculture and Cooperatives
MoLD	=	Ministry of Local Development
MoWR	=	Ministry of Water Resources
NFIWUAN	=	National Federation of Irrigation Water Users' Association
NG	=	Nepal Government
NGIIP	=	National Geographic Information Infrastructure Project
NITP	=	Non-conventional Irrigation Technology Project
NPC	=	National Planning Commission
NWP	=	National Water Plan
O & M	=	Operation and Maintenance
PRSP	=	Poverty Reduction Strategy Paper
RBM	=	Result Based Management
RD	=	Regional Directors
RID	=	Regional Irrigation Directorate
SDE	=	Senior Divisional Engineer
SIREN	=	Society of Irrigation Engineers, Nepal
SISP	=	Second Irrigation Sector Project
SMTP	=	System Management and Training Program
WB	=	World Bank
WECS	=	Water and Energy Commission Secretariat
WUA	=	Water User's Association
WUG	=	Water Users' Group
WUCC	=	Water Users' Coordination Committee

INTRODUCTION

1.1 Background

As a continuation of the national level workshop conducted in July 2007 in Godavari, System Management and Training Program (SMTP) had included conduction of another national level workshop in irrigation as one of the activities for the Fiscal Year 2064/65. The themes for the workshop were already outlined by the Godavari Workshop. However, some deviations were made in this workshop. First of all, in terms of organizing in order to make it more participatory, it was decided that the workshop should not be done by Department of Irrigation (DoI) alone and that it should collaborate with other organizations as well. Secondly, dissemination of information about the workshop should be made to a wider forum so that larger number and better quality papers can be received. Thirdly, a proficient committee should be formed in order to select the most appropriate papers and to guide the authors on their papers.

The workshop was conducted from April 27 to 29, 2008 (Baishak 15-16, 2065 B.S.) and was held in Mirabel Hotel Resort, Dhulikhel. It was jointly organized by four partners viz. Department of Irrigation (DoI), Nepal Engineers' Association (NEA), INPIM/Nepal and IWMI/Nepal. Representatives from all the four partner organizations and special invitees participated in the workshop. This proceeding report is a compilation of all the papers approved for the workshop. It also documents the activities conducted during the workshop and finally outlines the outcome from the workshop.

1.2 Rationale of the Workshop

Nepal is in the process of change. This process will not take a positive turn unless each sector embraces clear visions and outlines well defined road maps that match the aspirations and expectations of the people as well as the realities of the country. Agriculture being one of the major sectors that directly correlates with the major bulk of the people and irrigation being one of the major inputs for agriculture there is no doubt that irrigation has a significant stake in uplifting the livelihood of the majority in the country. Thus it was deemed necessary that irrigation sector should identify appropriate paths in the changing context.

The country is in the cross roads also in terms of the timeframe set by our major development plans. The tenth development plan has been completed and the 3-year Interim Plan with some major elements of change has just been introduced. Similarly, the short-term target period (2002 to 2007) of the National Water Plan has been completed and the medium target period (2008-2017) has begun. At this juncture it is considered appropriate to review what has been achieved so far and revise the activities proposed as medium term target for up to 2017.

Moreover, irrigation sector in Nepal has its own challenges. On one hand the sector faces many enduring issues like low social esteem to agriculture, low level of commitment to service delivery and irrigation cost recovery, construction focus of DoI professions, etc. which needs to be overcome. On the other, new concepts and tools like the application of Remote Sensing (RS) and Geographic Information System (GIS) are being introduced in the sector in developed countries with which there is a need for Nepal also

to catch up. This workshop aimed to both discuss about the new concepts and tools and also about the enduring issues of the irrigation sector.

Taking all these into consideration it was decided to organize the National Workshop in the overall theme of "change". It was considered important that the workshop should review the past achievements and to discuss on future path. In the changing context it was considered crucial that irrigation sector should identify and adopt the most appropriate concepts and ascertain suitable ways of converting the concepts to actions. Thus this national workshop on irrigation was entitled, "Irrigation in the Changing Context: From Concepts to Actions".

1.3 Workshop Objectives

The workshop brought together planners and policy makers, decision makers, professional irrigation engineers and users farmers to brainstorm in defining the most appropriate policy direction for the irrigation sector. The main objectives of the workshop were to:

i. Review the prevailing irrigation plans, policies and programs in the light of the changed context,
ii. Identify the necessary readjustments needed to align with the changed socio-political context and the expectations and aspirations of the people,
iii. Explore the developments in terms of new concepts and tools in the field of irrigation,
iv. Outline the future course of action that the irrigation sector should take in order to effectively contribute to the nation building process,
v. Explore the measures necessary to create a collective commitment and an enabling environment in the irrigation sector.

1.4 Workshop Design

The workshop was designed to adopt five sub-themes identified based on previously set concept paper and later refined based on the available papers. The five sub-themes were as follows:

- Integrated water resources management
- The way ahead for irrigation development and management in Nepal
- How to make irrigation more participatory and inclusive?
- Governance and gender equity concerns in irrigation
- Irrigation efficiency, service delivery and sustainability

These five sub-themes ranged from a broader outlook like IWRM to a more focused concept like irrigation efficiency. The sequencing of the presentations was done in the same logical order.

Unlike the last workshop, this workshop was designed to have discussions at the end of each session. Thus half an hour discussion on the topic of the sub-theme was provided to be guided by the session chair end of each session. For this the responsibility of chairing was given to people who were recognized to have good command over the topic. Towards the end of the workshop a wrap up discussion was designed to finalize the outcome and conclusions of the workshop.

1.5 Workshop Preparation

The workshop was conducted after almost six months of preparations. The concept note was prepared in the beginning of November 2007. During the month of December the partner organizations were

identified and several meetings were held with them regarding the role and contribution of each of partner. In order to ensure wide participation in the workshop the notice of the "call for papers" was published in the *Kantipur Daily* Newspaper on the 9th of January 2008. Besides mentioning the objective and sub-themes of the workshop, the planned dates of different activities were also mentioned in the notice.

Two committees were formed in January 15, 2008 through a meeting of all the four partners. The first was a Technical Committee for the screening and selection of papers and the second was a Management Committee for the management of the workshop event. The committee members were the representatives of the four organizing partners.

Seventeen abstracts were received by the set deadline of submission (i.e. 31st January). The Technical Committee held a meeting on 1st February and reviewed all the abstracts received. Papers were selected on the basis of their standards and relevance to the workshop theme. The authors of the selected papers were then requested to prepare full papers by following the technical guidelines prepared by the Technical Committee for the write up of the full papers. The deadline for the submission of the full papers was 2nd March 2008. These papers were again reviewed by the review committee in its meeting held on the 7th March.

The administrative and logistic arrangement of the workshop was carried out by the Management Committee during the month of April. A meeting of all partners held on 16th March finalized the list of participants. The workshop schedule was finalized and it was distributed along with the invitation card to all the participants few days in advance. Thus finally the workshop was held on the 27th and 28th of April after more than six months of homework.

1.6 Content of the Workshop

Five different sessions were included in the workshop. They were as follows:

Session 1: Integrated Water Resources Management: New Tools and Approaches
Session 2: Irrigation Development and the Vision for the Way Ahead
Session 3: Participation Modality and Inclusive Irrigation
Session 4: Governance and Gender Equity in Irrigation
Session 5: Irrigation Efficiency, Service Delivery and Sustainability

Three presentations were accommodated in each of the five sessions. Thus the total number of presentations made in the workshop was fifteen. The list of presentation along with the names of the presenter was as follows:

S.N.	Title:	Presenter(s):
1.	New Methods of Elevation Data Generation for IWRM	Dr. Raghunath Jha
2.	Rainwater Harvesting for Irrigating Small Lands	Dr. Indra Lal Kalu
3.	Adoption of National Water Plan for Irrigation	S. Dhungel & S. Sijapati
4.	Department of Irrigation and Irrigation Development	Rajendra P. Adhikari
5.	Groundwater Development: Status and Vision	N. R. Shrestha
6.	Can Electricity Infrastructure Induce STW Irrigation?	Dr. Dibya R. Kansakar
7.	Users' Participation in Irrigation	Gajhadhar Yadav
8.	Private Sector in Irrigation: Modalities of Participation	Basistha Raj Adhikari
9.	Well-being Ranking: A Tool for Inclusive Irrigation	Ram Prasad Bhandari

10. Gender Equity in Irrigation Management	Marina Lohani Sitaula
11. Inclusive and Gender Development Strategy	R. R. S. Neupane
12. Equitable Management of Common Resources	Padma P. Aryal
13. Enhancement of Irrigation Efficiency & Service Delivery	Dr. Khem Raj Sharma
14. Pond Irrigation: An Approach to Sustainable Livelihood	Susan Sakya
15. Technical Auditing for Efficient & Sustained Performance	Prakash Poudel

Each paper was given 20 minutes for the presentation and 10 minutes for question answer.

1.7 Participants

With the above mentioned approach this workshop was designed to have a core group discussion. This core group comprises of people both within and outside DOI. They were selected on the basis of the following categories:

- Paper Contribution
- Special Invitees
- Official Representation from DOI
- Official Representation from NEA
- Official Representation from INPIM/ Nepal
- Official Representation from IWMI/ Nepal
- Workshop Management Responsibilities

PROCEEDING

1.8 Registration and Opening Session

The Workshop began with the registration of the participants on Sunday morning (27th April 2008). Registration was carried out from 09:30 and completed by 10:00 a.m. The formal Opening Session started by requesting the chairperson, chief guests and special guests to take their seats in the stage at the front.

The first agenda of the Opening Session was the welcome address on behalf of all the four organizing partners. This was done by the President of Nepal Engineers' Association (NEA), Mr. Kishore Shakya. Mr. Shakya welcomed all the special invitee as well as the authors and general participants representing the four organizations to the workshop. He highlighted the importance of such workshops and of collaboration between government and professional organizations in the process. Mr Shakya also requested all the participants to feel at home and carry out the discussions in a free and open manner. Finally, he thanked all present for their time and effort in attending the workshop and expressed his confidence that, through their active participation, the workshop will attain the set objectives.

Then, with the objective of giving an overview of the workshop, the workshop coordinator, Mr. Suman Sijapati, gave a brief presentation on the workshop design and content. He explained the rationale behind the workshop and outlined its main objective and design. Mentioning "change" as the main theme of the workshop, Mr. Sijapati went on to highlight how this workshop was an example of the fact that DoI wants to collaborate with other professional organizations in the days ahead. He explained how sufficient homework and consorted effort was made to put to the workshop to bring it to the present form. He also mentioned how the workshop planned to discuss on the role and future prospects of irrigation sector in the changed context.

Next the officiating Secretary of Water and Energy Commission Secretariat (WECS), Mr. Shital Babu Regmee, was requested for a few words. In his speech Mr. Regmee opined that the national workshop on irrigation was very timely and relevant considering the growing threat of global food crisis. He also appreciated the theme of the workshop and opined that the theme also suggests that we need to come out of the mistakes that we have made in the past and transform ourselves to excel in the new context. Mr. Regmee however, stressed that the whole system needs to be transformed and expressed the opinion that until and unless there is a functional system of reward and punishment in place the whole system will not function properly. He concluded by stating that we all need to shape up to the change.

Then the chief guest of the Opening Session, Secretary of Ministry of Water Resources (MoWR) Mr. Shankar Koirala, was requested to express his opinions. Mr. Koirala first of all thanked the organizers for inviting him as the chief guest. He expressed his consent with the basic concept and need of the workshop and opined that this workshop can provide policy feedback and guidance for devising future programs of the MoWR. Expressing the opinion that change has to be led by economic upliftment, he stressed on the need to view all issues also from the perspective of how it will affect the economics of the livelihood of the majority of the people. Finally, the chief guest also highlighted the need to build all the discussions in the workshop on the foundations laid out by the principles of IWRM which has been accepted and adopted both at the national and international levels.

Finally the Opening Session was closed by the chairman, Mr. Madhu Sudhan Paudel, DG DOI. Before closing he also explained how the idea of workshop was conceived and expressed his optimism that the workshop will get useful feedbacks and a give clear roadmap for DOI to move ahead in the days to come.

1.9 Session 1: IWRM: New Tools and Approaches

This session was chaired by Mr. Bhuwanesh Kumar Pradhan, former Secretary of Water Resources and the repertoire was Tanka Prasad Kafle, Surface Division, DoI. Three technical presentations were covered in this session. These presentations, even though specific in their topic belonged to the broader framework of IWRM. Discussion on the specific topics and the overall topic of IWRM was carried out towards the end of the session.

1.9.1 New Methods of Elevation Data Generation for IWRM

The first presentation of the session as well as of the whole workshop was on new methods of elevation data generation. It was presented by Dr. Raghu Nath Jha. The main purpose of this paper was to describe how new methods are now available which have the process of generation of elevation data much easier compared to the conventional way of field survey. The paper presented clearly and concisely the different options and pointed out the merits and demerits of each of them. It was explained how these new methods could quickly and conveniently produce the elevation data of the area of interest e.g. an irrigation system and make it very convenient and cost-effective to do the planning and design and also to compare the different options.

Dr. Jha's presentation explained how terrain patterns play an important role in determining the nature of water resources and related hydrological model. He then discussed how Digital Elevation Models (DEMs) offers an efficient way of representing ground surface and extracting hydrological features and explained how it consequently derives the advantages of processing efficiency, cost effectiveness, and accuracy assessment, compared to traditional methods based on topographic maps, field surveys, or photographic interpretations. However, Dr. Jha cautioned that DEM quality and resolution affect the accuracy of the extracted hydrological features and hence must be clearly specified prior to its application.

Dr. Jha also explained how the technology of managing infrastructure using accurate land information displayed in three dimensions is gaining popularity. He mentioned that the data can be much easily understood when presented in three dimensions. He also cited management of water resources in terms of accurate alignment of irrigation canals and designation of command area and current floodplains as useful applications. Dr. Jha explained that in Nepal water resources planning are based on topomap of 1:25,000 and 1:50000 scale maps and contour interval 10m in Terai and 20m in hills. He stressed the point that even though considered for the planning purposes these do not suffice and 0.5m to 1m contour interval elevation data is required for detail planning and construction purposes. Dr. Jha pointed out that recently LIDAR (Light Detection and Ranging) technology has made it feasible to address the chronic lack of high resolution elevation data. He explained how this data can be used by different government organization for planning, design, construction and monitoring.

1.9.2 Rainwater Harvesting for Irrigating Smallholders' Non-irrigable Lands

Dr. Indra Lal Kalu of Kathmandu Engineering College made the second presentation. His presentation was on rainwater harvesting. He began by highlighting the importance of irrigation as the prime contributor to improving agricultural production and stabilizing agricultural production in the country.

He went on to explain how the use of water for irrigation needs to be converted into the overall framework of the principles of Integrated Water Resources Management (IWRMP) and what are the present challenges in doing so.

Dr. Kalu's presentation explained how reliable irrigation is necessary to motivate small farmers to shift from subsistence farming to high value agriculture. He pointed out that most of cultivated land in the mid hills and Bhabar area is non irrigable through conventional irrigation methods due to lack of ground water and sizeable surface water source and to bring home the fact that how rainwater is the only viable option.

Citing the study that he conducted using simulation method with 30 m^3 capacity low cost plastic lined tank made in 24 sq m coupled with low cost drip, Dr. Kalu mentioned that it could easily irrigate half Ropani winter vegetable. Simulation further showed that spring vegetable crops can also be cultivated providing irrigation in 5 out of 7 years using the stored water for irrigation. He then explained, how through this simple method, farmers can recover the investment cost of about Rs 18000 from the benefits obtained in 2 vegetable crops. His observation was that the farmers are willing to contribute local materials and labor work and they only need to be supported for procuring purchasable items. Thus he concluded that rain water harvesting technology should be promptly promoted to serve poor farmers and alleviate poverty.

1.9.3 Adoption of National Water Plan for Irrigation Sector

The third and final presentation of the first session was made by Mr. Suman Sijapati of the Water Management Branch of DoI and Mr. Sanjaya Dhungel of Water and Energy Commission Secretariat (WECS). At first, Mr. Sijapati gave the background of their paper by explaining how the National Water Plan (NWP) is a formally approved plan of the government and that it details out short (by 2007), medium (by 2017) and long-term (by 2027) water resources development activities for the country. He pointed out that presently NWP has completed its short-term targets period and entered into its medium-term period. The short-term target period coincided with the tenth five-year plan while the on-going three-year interim plan forms part of the medium-term target period. Mr. Sijapati pointed out that at this juncture it was felt relevant to make a comparative assessment of the achievements made so far with the short-term targets and also to assess to what extent the Interim Plan addresses the medium-term targets and what needs to be done in the remaining period of the medium-term. He then presented a gap analysis between the targets set, proposed activities, actually implemented activities and the achievements for the period up to 2007.

The second half of the presentation was made by Mr. Sanjaya Dhungel, who first of all highlighted the targets and programs of the Interim Plan. He then went on to present the analysis of the extent to which the Interim Plan is in line with the medium-term targets and proposed activities. Based on these analyses, he presented the conclusions drawn from the paper on the priorities for the remaining time of medium-term in order to meet the set targets.

1.9.4 Discussion on Integrated Water Resources Management

At the end of the first session a general discussion was carried out on the three papers and on IWRM in general. The discussion was facilitated by Mr. Bhuwanesh Kumar Pradhan. He began by briefly summarizing the content of the three papers. He then opened the floor for questions to the paper presenters.

Initiating the discussion Mr. Shital Babu Regmee suggested to Dr. Kalu, who presented the paper on rainwater harvesting that may be the benefits of pond irrigation can be further enhanced if aquaculture can be practiced in the storage tank. Dr Dhurba Pant of IWMI Nepal, pointing out to the limitations like investments, access to market, etc. of new technologies, suggested that first the infrastructure needs to be developed and then we can easily disseminate agricultural technology. Supplementing this point the chairperson Mr. Pradhan added that pilot project may be useful in disseminating such technologies.

Shifting to the topic to Irrigation Service Fees (ISF), Ms Indu Gurung spoke on behalf of the farmers and stated that if DoI can supply assured water supply, the farmers are willing to pay ISF. She stressed that there is close relationship between irrigation service and ISF.

Dr Dhurba Pant, commenting on the findings of paper on National Water Plan pointed out that the gap analysis indicates that much less was allocated compared to what was planed and much less was spent compared to what was allocated. This indicates that there is shortcoming both in allocation as well as in the absorptive capacity. He also expressed difference in opinion with NWP about first investing on the existing irrigation system and then only moving on to new schemes. He also pointed out the need to look into water productivity and the effect of irrigation in terms of poverty alleviation.

Finally, Mr. Mahendra Aryal added that indicators of NWP were identified after a lot of discussion and one of the purposes of these indicators is to discipline the irrigation administration within the periphery of set targets. He also added that in order to move towards integrated water resources management or river basin approach there is a need to strengthen WECS.

1.10 Session 2: Irrigation Development and the Vision for the Way Ahead

The second session of the workshop began after the lunch break. This session was chaired by Mr. Sarada Prasad Sharman the repertoire for the session was Mr. Pradeep Thapa. The session mainly aimed at bringing out the vision that DoI has for the future in terms of irrigation development. In this session also three presentations related to the topic were presented. The presentations made in this session have been briefly described one by one below.

1.10.1 Department of Irrigation and Irrigation Development

The first presentation of the second session was made by Mr. Rajendra Prasad Adhikari, SDE, Planning Division, DoI. Mr. Adhikari presented an overview of planned economic development of Nepal and pointed out that irrigation has always remained a priority of the government. Yet, he explained, that so far the available water resources have not been fully utilized for the common benefit of the Nepali people.

Mr Adhikari also pointed out that Integrated Water Resources Management has been adopted as one of the guiding principle while making the water utilization plan of Nepal. He stressed on the need to coordinate within and across the different sectors using water resources. Mr. Adhikari explained how Government of Nepal has emphasized round the year irrigation service and expansion of irrigation area with view of increasing agricultural production to feed the growing population. Under the guiding principle of National Water Plan and the National Water Strategy, he pointed out that DoI has several projects that reflect both the long and short term vision of the irrigation development. Management transfer to the beneficiary in decentralized community based manner and enhancing efficiency of irrigation water use by adopting integrated crop water management concept has been prime theme of the

irrigation development. Finally, Mr. Adhikari ended his presentation by drawing the attention of all towards the food security situation of the country and the challenging task in planning irrigation in the prevailing global food trade scenario.

1.10.2 Groundwater Irrigation: Status and Vision

The second presentation was made by Mr. Naba Raj Shrestha of Groundwater Division of DOI. At the onset he explained how annual precipitation is responsible for groundwater recharge to fractures of hard rocks and the sedimentary aquifer systems and that studies have shown that there is very high potential of rechargeable groundwater resource in the Terai plain and inner Terai valleys. He also added that this resource can be used for regular and reliable supply and is good for round the year irrigation facility. Mr. Shrestha pointed out that round-the-year irrigation facility development by the government of Nepal is taking place in Terai and inner Terai through Shallow Tube Well and Deep Tube Well irrigation and that the government is providing direct and indirect support to farmers to increase the tube well irrigation area. He also mentioned that new opportunities and challenges are also emerging. Numbers of farmers practicing cash crops in their farm land are increasing fast. Mr. Shrestha enumerated electricity distribution network, road access, market access, fertilizers, improved seeds, credit facility, government resource, etc. as some of the basic items in which improvements have to be made in order for groundwater development to pick up and went on to add that it is the reason why it is lagging behind despite its advantages and willingness of farmers. Finally, he ended his presentation suggesting that the government should be cautious to formulate policies and action plans so that they are farmer friendly and are able to provide favorable working environment.

1.10.3 Can Electricity Infrastructure Development Induce STW Expansion in Nepal Terai?

Dr. Dibya Ratna Kanshakar, Senior Hydro-geologist made the third presentation of this session. His presentation was based on the policy decision question on the implication of development of electricity infrastructure on shallow tube well expansion. He began by explaining how despite various policy measures by the government at different time periods, STW irrigation development had not been up to level that the country had planned; nor has it made any significant impact on the national poverty reduction goal. This, he pointed out was because of the fact that the tubewell is a highly divisible technology, and its users are either an individual or a very small group of farmers having their own distinct socio-economic character, which cannot be generalized for the purpose of policy formulation. He went on to discuss how the government has attempted to address the two issues – irrigation development and poverty alleviation – simultaneously by one uniform policy and critically analyzed the strategies for the two options.

Dr. Kansakar pointed out the fact that STW irrigation development has been slow in Nepal Terai compared to its neighboring countries like India, Bangladesh and China. The STW policies of Nepal government, since 1980, have addressed only the issues of finance and the capital costs involved in STW installation, but not the pump operating costs. He mentioned that with the fast rising market price of diesel fuel which constitutes the main chunk of the pumping cost, STW farmers are finding it increasingly difficult to earn profit from agriculture. However, he added with the availability of electric energy, as the rural electricity supply network improved in some parts of Terai, farmers are getting attracted to electric pumps for operating their STWs.

Citing the results of field studies carried out in Dangihat (Morang District), Arjundhara (Jhapa) and Hirminiya (Banke) VDCs in Nepal Terai, Dr. Kansakar demonstrated that groundwater extracted with an electric pump is at least 6.8 times cheaper than that with a diesel pump. This, he explained was mainly

because of the huge difference between the costs of diesel fuel and electricity and is going to lead to a rising trend in the use of electric pumps among STW irrigators in Terai in the coming years irrespective of the country's power generation capacity. Dr. Kansakar also concluded from his study that STW irrigation could be developed more rapidly, and also in private sector, if the network of electricity infrastructure is strengthened and expanded in rural parts of Terai. He concluded his presentation by suggesting that STW program should be integrated with rural electrification program in order to achieve a rapid growth rate but cautioned that it must be backed up adequately with the power sector development program.

1.10.4 Discussion on Irrigation Development and the Vision for the Way Ahead

General discussion on irrigation development and the vision for the way ahead was carried out at the end of the second session. At the onset of this discussion the chairman of the session, Mr. Sarada Prasad Sharma, shared some of his feeling based on his work experiences in irrigation. Firstly, he pointed out that the objective of the workshop is not to repent on the actions of the past but rather to be forward looking and update ourselves with the modern technologies and approaches. Secondly he pointed out that there is a need to define the functional limits of DoI. DoI through some new projects like CMAISP has been taking a broader outlook of trying to address the livelihood of the targeted community. Although in principle it is a good thing but he cautioned that there are limitations in terms of human and financial resources. Thus, Mr. Sharma opined that there should be functional limit to our activities and well defined priorities. He also suggested that DoI should keep the option of outsourcing open. Moreover, the organization should also be restructured as per the present needs. Finally he also added that since food security has been mentioned in the constitution as the basic right of the people there is a need to redefine irrigation as an extra benefit but a basic service over which people have right.

1.11 Session 3: Participation Modalities and Inclusive Irrigation

The third session was mainly devoted to modalities of participation and inclusive irrigation. Again three presentations were made during this session. This session was chaired by Mr. Mahendra Nath Aryal, ex-DG of DOI and Mr. Basu D. Lohani, SDE, IWRMP was the Repertoire.

1.11.1 Users' Participation in Irrigation Management

Mr. Gajadhar Yadav of NFIWUAN made the first presentation of this third session. His presentation was entitled User's Participation in Irrigation Management. Mr. Yadav first of explained the present context and prevailing scenario of users' participation in the country. He then went on to indicate that Nepal is the only country in Asia (probably the second or third in the World) where a national level federation of irrigation water users exists. The National Federation of Irrigation Water Users Association Nepal (NFIWUAN) was legally established in 1999. It is an autonomous institution of irrigation water users. It works for the benefit of Nepali irrigators. Mr. Yadav also pointed out that so far, NFIWUAN has established district level chapters in 66 districts, and it has affiliated to about 2139 irrigation water user's committee of the country. He also explained how NFIWUAN, as an umbrella body of irrigation users, is evolving.

Mr. Yadav also mentioned that NFIWUAN is willing to co-operate and coordinate with DoI. However, he pointed out that there is a need to clearly spell out users' roles in irrigation management. He concluded his presentation by mentioning that users' participation in irrigation management can be greatly enhanced if the WUAs are legally empowered, especially for activities like ISF collection.

1.11.2 Private Sector in Irrigation: Modalities of Participation

The second presentation of the session was made by Mr. Basistha Raj Adhikari. His presentation was on "Private Sector in Irrigation: Modalities of Participation". He began by giving a general background of the private sector involvement in irrigation activities. Citing the case studies for private sector involvement of three irrigation systems viz. Sunsari Morang Irrigation Project, Kankai Irrigation Project and Phalebas Irrigation System, Mr. Adhikari explained how all the irrigation functions (both in terms of operation and maintenance) in those irrigation systems were identified and analyzed one by one with the objective of exploring possibilities of private sector participation in irrigation with respect to the economic liberalization of irrigation governance. Finally he highlighted two modalities of private sector involvement in irrigation which, in his assessment, were functional in our context. He mentioned them as Management Contract Model and Community Private Partnership (CPP).

1.11.3 Well Being Ranking: A Tool for Inclusive Irrigation

The third presenter of this session was Mr. Ram Prasad Bhandari who presented on well being ranking. Explaining that this not a tool developed exclusively for irrigation, Mr. Bhandari pointed out that well being ranking is a tool that covers human position aspects besides the human condition, approach for community resource allocation ultimately leading to proper identification of the poor and their status. He pointed out that since it is often questioned whether irrigation can be pro-poor, as it serves those having land to irrigate. Similarly, the irrigation institutions are often controlled by socially elites rather than the 'real farmers' and access of poor farmers in such institutions is quite difficult. Thus, there is a strong need for an institution like DoI to make irrigation more inclusive. Mr. Bhandari also explained that the argument that irrigation sector is addressing the issue of poverty through employment generation for construction labor during construction period and agriculture labor afterwards is not able to convince those pleading for the rights-based approach of development.

Sharing his experiences with the application of the tool, Mr. Bhandari explained that participatory well-being ranking is a viable tool also for the identification of the poor households residing within the irrigation systems, existing or to be developed. Finally, he concluded his presentation by suggesting that even though irrigation vision and plans are aligned with the national agenda of poverty alleviation there is still the need to develop specific strategies, program interventions and monitoring of the changes imparted to the poor in order to realize the contribution of irrigation sector to poverty alleviation.

1.11.4 Group Discussion on Participation Modalities and Inclusive Irrigation

At the end of the first day a guided discussion was carried out on participation modalities and inclusive irrigation. This was facilitated by the session chairperson Mr. Mahendra Nath Aryal. At the onset he thanked all the four partners for organizing the workshop in an important topic. Regarding the theme of the session he mentioned that in his opinion proper representation was the key to inclusive irrigation. Mr. Aryal also opened the floor for questions to the three presenters and for general comments and ideas in the overall theme of participation modalities and inclusive irrigation. Taking this opportunity Mr. Sarada Prasad Sharma asked a question to Mr. Ram P. Bhandari regarding how the well-being ranking tool addresses the poor people. In response to this Mr. Bhandari explained that the tool helped in identifying and categorizing the poor but how they should be addressed was a separate issue. Then Dr. Dhurba Pant from IWMI Nepal made a suggestion on Mr. Gajadhar Yadav's paper. He pointed out that even though the presentation dealt on different aspects of users' participation it did not make specific recommendations as to what needs to be done. He suggested that it will be much better for implementing agencies if the users can make specific recommendations. To this Mr. B. K. Pradhan added that NFIWUAN should prepare a program for ISF collection. Ms. Indu Gurung from NFIWUA responded to

this saying the users have not denied collecting ISF but there were some constrains like complete and accurate data is not available, policy is ambiguous and regulations are not fully supportive. Also regarding poverty focused program she commented that most of those program conducted by NGOs were only benefiting the implementers not the real target group. Mr. Padma Aryal also made a point on the paper on private sector involvement saying that private sector involvement infers that the government is withdrawing. This may not be desirable rather the role of the WUA needs to be enhanced.

Finally, the chairperson closed the session mentioning that the papers are still generic and that they need to be more specific. He also pointed out that participation, decentralization and transparency are the three key principle to which we have to adhere if we want to make irrigation more inclusive and attract private sector involvement.

1.11.5 Review of the First Day

The second day of the workshop began early in the morning by reviewing the contents of the first day. This review was presented by the workshop coordinator Mr. Suman Sijapati. He recalled the workshop schedule of the previous day and presented the major points made by the papers one by one and also summarized the main recommendations made by each paper.

1.12 Session 4: Governance and Gender Equity in Irrigation

The fourth session was mainly devoted to governance and gender equity. This session was chaired by Dr. Prachanda Pradhan and repertoire was Mr. Ram Prasad Bhandari. The chairman requested each presenter to be brief and allow more time for discussion. He then asked each presenter to come to the front and present their paper one by one.

1.12.1 Gender Equity in Irrigation Management: A Case Study of 8 FMIS

The first presentation of the session was made by Ms. Merina Lohani Sitaula. Ms Merina expressed the opinion that the main purpose of her research paper was to assess gender equity with focus on information dissemination in irrigation management taking into account 8 FMIS districts in western Nepal. She described that showed that despite the mandatory 33% representation of women demanded by the Irrigation Policy, the gap still exists between its implementation as it still does not ensure qualitative and meaningful participation of women. Moreover, most WUAs have below 30% representation of women and they are hardly involved in decision making activities.

Ms. Merina enumerated the factors responsible for low representation and no active role of women in irrigation as:

- Link of WUA membership with the land holding;
- Weak information dissemination and communication with no especial effort on reaching out and addressing the female audiences;
- Lack of education, illiteracy and exposure, a hindrance in voicing their opinion and seeking information;
- The traditional roles of women and their exclusion from irrigation management by defining it as a ‘male domain; and
- Low socio-economic status

She concluded by stating that in order to promote gender sensitive development, it is crucial to identify the roles, problems and opportunities to ensure that the concerns of men and women are equitably

addressed and that the involvement should reflect and be guided by their actual interests, needs and present workload condition.

1.12.2 Inclusive and Gender Development Strategy: Experiences from SAGUN Irrigation

The second presentation of the session was made by Mr. Rishi Ram Sharma Neupane. He presented his opinion on inclusive and gender development strategy based on experiences of works carried out by SAGUN irrigation program in Nepal. He explained that his paper is about an experience on inclusion strategy implementation through SAGUN irrigation program in 14 WUAs of 11 irrigation projects under the management transfer program located in Saptari, Siraha, Dhanusa, Sarlahi, Chitawan, Nawalparasi, Kapilbastu and Kailali districts.

Mr. Neupane enumerated the six key drives of SAGUN-Irrigation program as: its goal and objectives, inclusion and gender development strategy, important field practices and achievements and key learning. Poor governance of WUA, low ISF collection efficiency, decreasing interest of water users in participation was explained as the basic drives for the second generation WUA capacity strengthening in SAGUN-Irrigation. He also explained the seven important strategies that were employed to achieve the objectives of inclusive water management and the best field practices that were documented during project operation. He also cited the impact of the project with production levels of rice, wheat and pulses increased to 3.89 mt/ha, 2.32mt/ha, 0.78 mt/ha respectively; Irrigation Service Fee (ISF) collected reached to Rs 2076137; a total of 1836 km of tertiary canals were cleaned by farmers; a total of 751 km of field channels were constructed by WUAs; intensive irrigation management area reached to 46260 ha in monsoon through the implementation of inclusion and gender development strategy in SAGUN Irrigation program. Finally, he opined that the strategies and activities of SAGUN-irrigation program are worth replicating to other programs as well.

1.12.3 Equitable Management of Common Resources at Andhi Khola

Mr. Padma Aryal made the third and last presentation of the session. He revealed the historical background of Andhi Khola Irrigation System and explained how innovative ideas were tried there by Andhi Khola Water User's Association (AKWUA). Mr. Aryal discussed in detail how land pulling from the larger landholders with their consent and distribution of land in accordance with the water right shares earned during the construction of the irrigation project has addressed the poverty to a larger extent. He highlighted that this indigenous practice of water right provided an opportunity to even the land less family (15 landless and 56 marginal farmers' family) of the command area to earn land by contributing labor during the construction of the project.

Explaining the provisions made, Mr. Aryal mentioned that water right shareholders can even sell their share of water to the person in need within the command area. The outcome of the strategic management and implementation of this irrigation project has not only resulted in the decrease of migration but it has improved the economic condition of the people. Increase in the crop production and economic activities has attracted establishment of boarding schools and mills for grain processing. He also explained how the water from the Andhi khola Irrigation system has not only been used for irrigation but also used for multiple purposes. Finally, he concluded by stating that Andhi Khola is a unique model of the integrated water resources management and has been successful to address the poverty with in the command area

1.12.4 Discussion on Governance and Gender Equity in Irrigation

After the three presentations of this session a general discussion was held facilitated by session chair, Dr. Prachanda Pradhan. He outlined the main points made by the three presentations and opened the floor for

questions to the three presenters and for general comments and ideas in the overall theme of governance and gender equity in irrigation.

At the end of the discussion session Dr. Pradhan made a few remarks based on his overall observations. First of all he mentioned that the papers carry much more weight when they are based on some research. He also opined that innovative ideas like those adopted by Andhi khola and SAGUN-irrigation program not only induce DoI to change but also affect national policy. He also raised a policy issue about how to perceive irrigation: is it the ultimate output or only a means of reaching to the output? Finally, he also made a suggestion that whatever knowledge we have learned through different projects needs to be well documented for future use.

1.13 Session 5: Irrigation Efficiency, Service Delivery and Sustainability

The fifth and final session was focused on identifying ways of improving irrigation efficiency, service delivery and sustainability. This session was chaired by Mr. Iswer Raj Onta, President of Nepal Engineering Council and repertoire was Dr. Bim Shrestha of Kathmandu University. The chairman requested each presenter to be brief and allow more time for discussion. He then asked each presenter to come to the front and present their paper one by one.

1.13.1 Enhanced Irrigation Efficiency and Service Delivery

The first presentation of the final session of the workshop was made by Dr. Khem Raj Sharma. Dr Sharma began his presentation by pointing out that since irrigation is the largest user of water it is quite obvious that concerns of low level of system efficiency and poor service delivery needs to be given due attention. He also explained that irrigation efficiency is dependent on system attributes including both hardware (irrigation and drainage infrastructure) and software (its management). He went on to add that in recent years physical system rehabilitation along with participatory management has been the principal mode of implementation but added that it has not been showing encouraging results. He also cautioned that although the new water strategy and plans have been advocating IWRM we need to be prepared for the new challenges that will emerge from it.

Dr. Sharma discussed in detail the issues of irrigation efficiency and service delivery both at system as well as farm level. He also mentioned about the close linkage between irrigation service and poverty and drew attention of all to the fact that irrigation must achieve higher efficiency and productivity in order to meet the increasing food requirements as both suitable land and available freshwater are decreasing day by day. He concluded stating that a paradigm shift is necessary in the working modality as well as in the attitude of the stakeholders in order to enhance irrigation efficiency and service delivery.

1.13.2 Pond Irrigation: An Approach for Sustainable Livelihood in Dry Hills Areas

The second presentation of the session was made by Mr. Susan Sakya, Engineer from LILI Project. He made his presentation based on the paper submitted by Rakesh Regmi, Siddhi Nath Jha and Bikesh Shrestha on pond irrigation implemented by LILI program as a means for sustaining livelihood in the dry hilly areas.

In his presentation Mr. Susan Sakya described how Helvetas-Nepal in 2004 initiated the program Demand based Rural Infrastructure at Local Level (DRILL) (currently called Local Infrastructure for Livelihood Improvement, LILI) with the objective of providing irrigation facilities to marginalized and disadvantaged group (DAG) in 6 hilly districts.

Mr. Sakya went on to explain how majority of the poor and lower caste people own sloppy terraces for farming which are not irrigable by conventional surface irrigation methods. Also, the performance of large and medium sized agency managed irrigation system have come into sharp criticism due to the failure in achieving the anticipated agricultural production and accomplishing the needed operation and maintenance cost recovery. That he explained is the reason why LILI decided to concentrate on cost effective, appropriate technology, local know-how impart, easy maintenance and optimum use of lean flow through pond irrigation, which will also act as a tool for optimization of irrigation in hilly areas. Going into the details of the design of pond irrigation that is being adopted by LILI he explained that the basic design concept of gravity flow is being followed except for the fact that Ferro Cement Tank has been replaced by Silpauline Plastic Pond. Per Ropani cost is NRs. 12,000.00 with command area having less than 25 hectares of land.

1.13.3 Technical Auditing for Efficient and Sustainable Performance of Irrigation

Mr. Prakash Paudel, RD of WRID made the final presentation of the last session. His presentation was on the topic of technical auditing. At the onset he highlighted the need and importance of technical auditing. He explained that in Nepal, Technical Audit was introduced as an important monitoring tool to assess the performance of infrastructure projects. He then went on to enumerate the main objectives of technical audit as: 1. check for quality assurance, 2. balance between functionality and life cycle cost, 3. value for money, and 4. project performance (overall need or expectations).

Referring to the experiences gained from technical auditing in Nepal, he mentioned that the quality of works and thus efficiency and sustainability of irrigation projects/systems has been found increase after the conduction of technical audit. He also revealed that the audit findings in irrigation projects have indicated that: technical guidelines and norms not followed seriously, contract documents not followed strictly, QAP / QCM not prepared / implemented as desired, detailed/working/as-built drawings not prepared or approved, quality of physical works found poor, and area irrigated is found 50% of the planned.

1.13.4 Discussion on Irrigation Efficiency, Service Delivery and Sustainability

At the end of the three presentations of this session before lunch a general discussion was held facilitated by Mr. Iswer Raj Onta. He outlined the main points made by the three presentations and opened the floor for questions to the three presenters.

Taking this opportunity Dr. Laxmi Prasad Devkota expressed the opinion that he was also in support of the idea that a paradigm shift is necessary to cater to the needs and aspirations of the people. He also cited the federal system that the country is in the process of adopting and can be one outlet for that. Regarding the policy question of whether irrigation should be perceived as an output or as a means of reaching to the output, he mentioned that he was of the opinion that it was only a means and needs to be treated in that way.

Then, Niranjan Dev Pandey, Project Manager of Non-conventional Irrigation Technology, referring to the presentation made by LILI mentioned that LILI also needs to collaborate and co-ordinate its activities with NITP. He also suggested that ponds function much better when combined with micro-irrigation systems like sprinkle and drip.

Catching up on the discussion on irrigation service fee, Mr. Uttam Timilsina mentioned that the Irrigation Management Division of DoI is working towards the preparation of the Irrigation Act which will try to properly address this issue.

At the end of the discussion session Mr. Iswer Onta made a few remarks in the overall theme of irrigation efficiency, service delivery and sustainability. First of all he highlighted that irrigation efficiency is an important topic and needs to be given more attention and the conclusions made in its regards have to be evidence based. Secondly he mentioned that not only irrigation efficiency but also agricultural and management efficiency also needs to be ascertained. Talking about pond irrigation, Mr. Onta pointed out that the 25 ha cutoff point that DoI has set is not applicable with other methods of irrigation like the pond irrigation. Finally, commenting on the paper on technical auditing he mentioned that the paper was well presented and that it also reflected the elements of governance that is in-build in it.

1.14 Conclusion and Workshop Closing

The workshop was concluded on the afternoon of second day (28th April 2008). Mr. Rama Kant Gauro, member of National Planning Commission was the Chief Guest and Mr. Madhu Sudhan Poudel, DG, DOI was the chair person of the session. First of all the chief of the Technical Committee for the workshop, Dr. Khem Raj Sharma, presented the summary and the key conclusions and recommendations of the workshop. The main conclusions and recommendations of the workshop have been presented in the third chapter of this Proceeding Report. Similarly, the full papers presented in the workshop are included in the Annexes.

After this, Dr. Dhurba Pant, Head of IWMI-Nepal was asked to express a few words on behalf of his organization. In his short speech Dr. Pant expressed he was glad to collaborate with DoI and the other partners for conducting this national workshop. He also expressed his willingness to provide any kind of intellectual support that DoI needs from his organization.

Next, on behalf of INPIM, Mr. Padma Aryal was requested to express a few words. Mr. Aryal expressed the opinion that the collaboration for this workshop was very successful and that this kind of collaboration needs to be even extended in the future.

Then, on a more formal note, the chief guest, Mr. Rama Kant Gauro, member of NPC, was requested to express his closing remarks. Mr. Gauro first of all congratulated all the four partners for organizing this event of the national workshop. He expressed satisfaction over what the workshop has been able to achieve. Adding his suggestions on the overall conclusions derived by the workshop, Mr. Gauro mentioned that geographic balance should also be one of the important considerations. He also highlighted the importance of monitoring of works and explained that even though it may involve some cost, measures like technical auditing is a worthwhile investment considering all the benefits that it can deliver.

Finally, the chairman of the closing ceremony, Mr. Madhu Sudhan Poudel, DG, DOI was requested to express his closing remarks and formally close the workshop. Discussing on the content of the workshop, Mr. Poudel expressed the opinion that the content of the workshop was very relevant at the present time. Referring to the conclusions and recommendations of the workshop, he expressed his commitment that he will try his level best to gradually incorporate them in the annual programs of DoI. Finally, Mr. Poudel was grateful to the paper writers and thanked all for the active participation and especially

thanked the chief guest for accepting the invitation and participating in the workshop. He also thanked all the organizers of the workshop for all their efforts.

Conclusion and Recommendations

The highlights of the presentations and the issues raised and the conclusions and recommendations made during the wrap up discussion at the end of the workshop have been presented in this part of the proceeding report. These were used to brief the honorable member of National Planning Commission for Water Resources during the Closing Session as the overall conclusions of the workshop. The highlights were prepared by Dr. Khem Raj Sharma and Mr. Mahendra Bahadur Gurung.

1.15 Highlights of the Different Presentations

Session 1: IWRM: New Tool and Approaches

New Methods of Elevation Data Generation for Integrated Water Resources Development by Raghunath Jha

- In hilly region, both DEM generated using Survey Department's topographic data and those from SRTM data produce nearly same catchment characteristics. However, in flat terrain, the features extracted from SRTM DEM having 100m resolution resembles better than those extracted from DEM generated using Survey Department contours of 10m interval.
- LiDAR can produce high resolution and highly accurate DEM in nearly 40% price of the traditional topographic survey ($20 per ha against $50 per ha). In addition to elevation data, it can also capture color orthophoto map of 1m resolution.
- The LiDAR generated DEM can be used for different activities including irrigation planning and construction.

Rainwater Harvesting for Irrigating Small Non-irrigable Land by Dr. Indra Lal Kalu

- Rainwater harvesting tank coupled with drip irrigation set is a potential technology to provide irrigation facility to otherwise non irrigable hill slopes and bhabar area where poor farmers are residing.
- Simulation of 7 years daily rainfall data showed that water collected in 30 m3 capacity tank can provide assured irrigation to vegetable crops cultivated in ½ ropani land during winter and spring.
- Cost for development of tank and drip irrigation set for ½ ropani is about NRs 18,000.00. The cost is recoverable from vegetable cultivation in 2 crop seasons.

Adoption of National Water Plan in Irrigation Sector by Sanjay Dhungel and Suman Sijapati

- Comparison made between NWP, 10th Plan and the 3-year Interim Plan on the basis of Target, Budget and Action programs/ activities.
- Revealed that only 40% of the NWP projection was allocated as annual budget and only 30% was actually spent (problem both in allocation and absorption).
- Budget allocations were not in conformity to NWP projections particularly for effective use of existing O&M irrigation projects.
- Not all the five activities cited by NWP, e.g. efficiency, year-round irrigation expansion, etc, have been effectively paid attention in annual programs.
- A challenge: Interim Plan’s budget projection is less for more coverage as compared to NWP’s more budget and less coverage.

Session 2: Irrigation Development Vision and the Way Ahead

Department of Irrigation and Irrigation Development by Rajendra Adhikari

- DoI has evolved over the years since its establishment in 2009 BS but it still faces many challenges.
- Corn is no more a food crop alone and has found its promising use as an alternative as bio fuel, the crop use in the years to come could be alarmingly high and scarce for the people.
- Whether irrigation/ agriculture is to be tied up with ISF collection or as self sufficiency indicator is debatable. Use remittance money to buy foods should be considered as it is the basic need.
- DoI has visioned to take initiatives for irrigation led storage projects (integrated approach) such as Kamala, Bagmati, Karnali Chisapani from where, in addition to irrigation, notable power can also be produced.

Groundwater Irrigation: Status and Vision by Nava Raj Shrestha and Jeevan Lal Shrestha

- Bhavar zone is the recharge area for groundwater reserve and 8,800 MCM of water as annual GW recharge.
- Nepal enjoys an alluvium thickness of up to 500m.
- The use so far is only around 1,100 MCM and the balance is still in the order of 7,700 MCM.
- The advantages of TW irrigation are: capable of providing irrigation round the year, quick completion and quick result, and quick input to food security, etc.
- Encouraging scenario of having a pipe line of more than 250 demands at hand with upfront cash deposition of more than NRs 1.2 million for deep tube wells (DTWs).

Can Electricity Infrastructure Development Induce Shallow Tube well Irrigation in Nepal? by Dr. Divya R. Kansakar

- Three case studies based on field survey in Dangihat (Morang), Arjundhara (Jhapa) and Hirminia (Banke) VDCs were presented to reveal the relationship between STW installation and electricity infrastuctures.
- Data showed that groundwater pumped out with an electric pump is 7 times cheaper than that pumped out with a diesel pump. The main cause was difference in the cost of diesel fuel and the cost of electricity consumed in the operation of STWs.
- The study results showed that availability of electricity infrastructures can significantly increase STW installation in rural Terai area. Such infrastructures also encourage private investment from the farmers. Therefore, a tie-up between rural electrification program and STW development program could significantly enhance STW irrigation development in Terai.
- Farmers are found to opt for electricity even though their wells are located as far as 250 m away from the low tension power distribution lines.
- Power supply points, i.e. electricity meters, need not be always located nearby the well location. For safety reasons, farmers prefer to site their electricity meters close to the settlement areas, or nearby busy village tracks or road.
- Farmers were found to prefer individual ownership in STWs where private sector development has taken place, as it was found in Hirminiya VDC, Banke district.

Session 3: Participation Modality and Inclusive Irrigation

User's Participation in Irrigation by Gajadhar Yadav

- Users are willing to co-operate and coordinate with the Department of Irrigation.
- Users' roles in irrigation management need to be clearly spilled out.

- WUA should be legally empowered, especially for ISF collection.

Private Sector in Irrigation: Modalities of Participation by Basistha Raj Adhikari
- Private sector involvement in irrigation is the policy prescription.
- Service agreement defining the responsibility of WUAs to manage lower level canals and to ensure water delivery should be enforced.
- Further studies are necessary to identify viable areas of private sector involvement in irrigation.

Well Being Ranking: A tool for Inclusive Irrigation by Ram Prasad Bhandari
- Irrigation vision and plans are aligned with the national agenda of poverty alleviation.
- Specific strategies, program interventions and monitoring of the changes imparted on poor from the irrigation are necessary in order to realize the contribution of irrigation sector to poverty alleviation.
- Participatory well-being ranking is a viable tool for the identification of the poor households residing within the irrigation systems, existing or to be developed.

Session 4: Governance and Gender Equity in Irrigation

Gender Equity in Irrigation Management: A Case Study of Seven FMIS in Western Regions of Nepal by Marina Lohani Sitaula
- It is essential to empower the female members of the WUA and to bring them into the mainstream of irrigation management.
- There is a need to disseminate extensive information targeting women, in particular.
- DoI needs to reorient and restructure its organization to address gender issues.
- All these seven cases of FMISs in which this study was carried out belong to IWRMP; hence the project should be used as an opportunity to push the policy of participation of women put it into action in its true sense.

Inclusive and Gender Development Strategy: Experience from SAGUN Irrigation by Rishi Ram Sharma Neupane
- SAGUN adopted good governance practices.
- Inclusive democratic process is essential for constitution formulation.
- Field channel is as an effective linkage for equity and reduced conflicts.
- Targeted program is necessary for disadvantaged (marginalized) groups.

Equitable Management of Common Resources at Andhi Khola Irrigation by Padam Prasad Aryal
- Andhi Khola is an exemplary multipurpose project.
- No landless in the project area after Andhikhola Project's conceptual intervention.
- Strong institutional arrangement has been made.

Session 5: Irrigation Efficiency, Service Delivery and Sustainability

Enhancement of Irrigation System Efficiency and Service Delivery by Dr. Khem Raj Sharma
- Irrigation development and management both are challenges
- DoI needs to adopt modernization rather than just rehabilitation
- Demand side management (modify demands, maximize efficiency) is also essential to enhance system efficiency based on NWP
- Transform existing regional and district entities in terms of river basin

- Needs a paradigm shift in DOI's working modality.

Pond Irrigation: an Approach to Sustainable Livelihood in the Dry Hilly areas by Susan Shakya
- LILI program is poverty focused.
- Specific criteria have been developed for addressing disadvantaged groups.
- Specific criteria (public hearing, public review and public audit) have been devised for attaining transparency.
- Group based works are more beneficial for pond irrigation.

Technical Auditing for Efficient and Sustained Performance of Irrigation Projects by Prakash Poudel
- Effective monitoring is a key to obtain quality assurance and achievement of set objective
- Basic training on technical auditing is necessary for DOI engineers
- NC Report submitted by the technical auditor has to be promptly implemented
- Attention needed for quality assurance and quality control.
- DoI should prepare a roaster of projects to be developed.
- Technical auditing should be a part and parcel of irrigation development and management.

1.16 Issues Raised

Session 1: IWRM: New Tool and Approaches

New Methods of Elevation Data Generation for Integrated Water Resources Development
- Should DoI stick to topographic map or move ahead making itself compatible with technological advancements like RS and GIS?

Rainwater Harvesting for Irrigating Small Non-irrigable Land
- How to help the poor farmers with small lands having no natural sources around?

Adoption of National Water Plan in Irrigation Sector
- How can the issue of deferred and low prioritization as compared to NWP be addressed?
- How to establish a system of tracking the indicators in order to monitor achievements of the targets set in the NWP?

Session 2: Irrigation Development Vision and the Way Ahead

Department of Irrigation and Irrigation Development
- What can be the alternative considering the fact that some food items like corn may become alarmingly scarce as it has alternative as bio fuel?
- Whether irrigation is to be considered a self sufficiency indicator or simply as any other economic investment?

Groundwater Irrigation: Status and Vision
- How to maximize groundwater development amidst a scenario of big demand but at the same time underutilization.

Can Electricity Infrastructure Development Induce Shallow Tube well Irrigation in Nepal?
- How to expand rural electrification and supply reliable power so that it can accelerate the expansion of STW development and use?

- How to ensure that planning on individual basis will benefit the 'have nots' and not only the 'haves'?

Session 3: Participation Modality and Inclusive Irrigation

User's Participation in Irrigation

- How to achieve meaningful users' participation (not just users' participation per say)?

Private Sector in Irrigation: Modalities of Participation

- What prerequisites have to be met in order for the WUA to manage the lower level canals and ensured water delivery?

Well Being Ranking: A tool for Inclusive Irrigation by Ram Prasad Bhandari

- How to develop and implement programs specifically focused to the poor and the disadvantaged groups?

Session 4: Governance and Gender Equity in Irrigation

Gender Equity in Irrigation Management

- How to overcome the issue of limited access to information and traditional behavior of institutions in order to maintain gender equity in irrigation?
- How to enhance the interaction of women with government functionaries so that they have better access to information and services.

Inclusive and Gender Development Strategy: Experience from SAGUN Irrigation

- How can the impact of Intensive programs like SAGUN be disseminated to a larger scale?
- How can the attention of DoI be directed also towards field channels and not be limited to main and branch canals?

Equitable Management of Common Resources at Andhi Khola Irrigation

- How to replicate the learning from Andhi Khola Irrigation Project to other projects with different settings?

Session 5: Irrigation Efficiency, Service Delivery and Sustainability

Enhancement of Irrigation System Efficiency and Service Delivery

- How can we materialize the river basin approach of the NWP?
- What can be the sustainable mode of irrigation modernization so that the recurring investments in the form of rehabilitation can be minimized?

Pond Irrigation: an Approach to Sustainable Livelihood in the Dry Hilly areas by Susan Shakya

- How to replicate the performance of the rather small sized projects like LILI to other larger (>25ha) ones?

Technical Auditing for Efficient and Sustained Performance of Irrigation Projects

- How to ensure quality in construction works of irrigation projects?
- How to orient DoI staff, especially engineers, to comply with technical auditing and ensure quality construction?

1.17 Recommendations

The recommendations made by the specific papers and plenary discussions at the end of each session have been enumerated in bullet form as follows:

- Application of GIS for cost-effective planning and design of irrigation systems should be explored.
- Management of water for irrigation should take into account the complete hydrological cycle, that is, both green and blue water and rainwater harvesting can provide irrigation benefits to targeted poor mass in water deficit areas and consequently serve the goal of poverty alleviation thus should be promoted.
- Tracking the achievements of the targets set by the National Water Plan is a must hence a system collecting, storing and analyzing data pertaining to those indicators highlighted in the plan must be established. IWRM contrasts with the sectoral approach that we are currently following. Lack of cross-sectoral linkages leads to uncoordinated water resource development and management, resulting in conflict, waste and unsustainable systems. Meeting the IWRM challenge will not be easy but it is vital that a start is made now to avert the burgeoning water crisis.
- DoI should prepare roster of large irrigation projects and take initiatives for irrigation led storage projects (integrated approach).
- Tubewell irrigation has considerable advantages e.g. capable of providing irrigation round the year, quick completion and quick result, quick input to food security, etc. and hence has to be promoted where feasible and demanded.
- Electricity infrastructure with metered pricing must be promoted for STW development.
- WUA's role in irrigation management must be fully defined and they should be legally empowered in order to achieve their fruitful participation, especially for ISF collection.
- Service agreements with WUAs should be prepared in large irrigation schemes for their sustainable management.
- Specific strategies and focused interventions and monitoring mechanisms should be developed for irrigation sector to contribute to poverty alleviation. Participatory well-being ranking can be used to identify the poor within an existing or proposed irrigation system.
- DOI personnel should be given training on gender issues and concerns to create environment for gender equity in irrigation management.
- The example of equitable management of common resources set up by Andhi Khola should be also replicated in similar cases elsewhere.
- DoI should go for modernization rather than rehabilitation of irrigation infrastructures.
- LILI's approach has found to significantly contribute to sustainable livelihood in the dry hilly areas and hence needs to be further disseminated and replicated by others as appropriate.
- Technical auditing should be a part and parcel of irrigation development and management.

The overall recommendations made during the wrap up discussion at the end of the workshop have been summarized as follows:

- DOI needs to be restructured and reoriented to be compatible with the changed context
- Encourage public private partnership
- Think innovative, work innovative
- Be inclusive considering aspects such as gender, disadvantaged and marginalized groups
- Encourage action research programs to get field based lessons to apply to better the DOI's performance
- Continue holding interactive workshops such as this to disseminate what have been done and to learn new horizons from findings from other actors

- Themes should be identified in advance so that more focused and research based papers will be available for the future workshops

Some of the themes identified for the next workshop are as follows:

- Scope of DoI involvement in livelihood improvement programs
- Private sector participation in irrigation
- Quality control in irrigation system construction
- Service oriented management in irrigation
- Irrigation development with gender equity
- Poverty focused irrigation

Annex – 1: Workshop Schedule

National Irrigation Workshop

"Irrigation in the Changing Context: From Concept to Action"

Venue: Mira Bell Hotel, Dhulikhel, Kavre
Duration: 15 – 16 Baishakh 2065 (27-28 April 2008)

Day One: Sunday 15th Baishakh 2064 (27th April 2008)

Duration	Activities	Resource Persons/ Responsibility
09:30-10:00	Registration of Participants	Workshop Management Committee
	Inaugural Session	Chairman: **DG, DOI** and Chief Guest: **Secretary of MoWR**
10:00-10:05	Welcome Address	Mr Kishor Shakya, Chairman, NEA
10:05-10:15	Introduction to the Workshop Design and Content	Mr. Suman Sijapati, Ws Co-ordinator
10:15-10:20	Few Words from WECS Secretary	Mr. Shital Babu Regmee, Act. Secretary, WECS
10:20-10:25	Few Words from Special Guest	Mr. Rama Kant Gauro, Member, NPC
10:25-10:35	Few Words from Chief Guest	Mr. Shankar Koirala, Secretary, MoWR
10:35-10:40	Few Words from Chairperson	Mr. Madhusudhan Paudel, DG, DOI
10:40-11:00	*Tea break*	
Session 1	**Integrated Water Resources Management: New Tools and Approaches**	Chairman: Mr. **B. K. Pradhan** and Repertoire: Mr. **Tanka P. Kafle**
11:00-11:30	New Methods for Elevation Data Generation for Integrated Water Resources Development	Dr. Raghunath Jha, IOE, Pulchok
11:30-12:00	Rainwater Harvesting for Irrigating Small Non-irrigable Land	Dr. Indra Lal Kalu, Freelance Consultant
12:00-12:30	Implementation Status and Projection of National Water Plan for Irrigation Sector	Mr. Sanjay Dhungel, SDE, WECS and Mr. Suman Sijapati, SDE, DOI
12:30-13:00	General Discussion on IWRM, NWP and IP	Guided by Session Chairman
13:00-14:00	*Lunch break*	
Session 2	**Irrigation Development and Monitoring: The Way Ahead**	Chairman: Mr. **Sarada P. Sharma** and Repertoire: Mr. **Pradeep Thapa**
14:00-14:30	Irrigation Status and Vision of DOI	Mr. Rajendra Adhikari and Dilip Karki, DOI
14:30-15:00	Groundwater Status and DOI's Vision on Groundwater Development	Mr. Jeevan Lal Shrestha and Mr. Nava Raj Shrestha, GRD, DOI
15:00-15:30	Can Electricity Infrastructure Development Induce Shallow Tubewell Irrigation in Nepal?	Dr. Dibya Ratna Kansakar, Senior Hydrogeologist, DoI
15:30-16:00	General Discussion on Efficiency, Service Delivery and Poverty	Guided by Session Chairman
16:00-16:20	*Tea Break*	
Session 3	**Participation Modalities and Inclusive Irrigation**	Chairman: Mr. **Mahendra N. Aryal**, Repertoire: Mr. **Bashu D. Lohani**
16:20-16:40	Users' Participation in Irrigation Management	Mr. Ram Prasad Meheta, NFIWUAN
16:40-17:20	Private Sector in Irrigation: Modalities of Participation	Mr. Basistha Raj Adhikari, SDE
17:20-17:40	Well-being Ranking: A Tool for Inclusive Irrigation	Mr. Ram Prasad Bhandari, Cosultant
17:40-18:20	General Discussion on Participation Modalities	Guided by Session Chairman
19:00-21:00	*Dinner*	

Day Two: Monday 16th Baishakh 2065 (28th April 2008)

Duration	Activities	Resource Persons/ Responsibility
07:30-08:30	*Breakfast*	
08:30-08:40	Review of Day 1	Ws Coordinator
Session 4	**Governance and Gender Equity in Irrigation**	Chairman: Dr **Prachanda Pradhan**. & Repertoire: Mr. **Ram P. Bhandari**
08:40-09:10	Gender Equity in Irrigation Management: A Case Study of Seven FMIS in Western Regions of Nepal	Ms. Marina Lohani Sitaula, CMS
09:10-09:40	Inclusive and Gender Development Strategy: Experience from SAGUN Irrigation	Mr. Rishi Ram Sharma Neupane, Freelance Consultant
09:40-10:10	Equitable Management of Common Resources Management at Adhikhola Irrigation System	Mr. Padma Aryal, NFIWUAN
10:10-10:40	General Discussion on Governance and Gender Equity in Irrigation	Guided by Session Chairman
10:40-11:00	*Tea Break*	
Session 5	**Irrigation Efficiency, Service Delivery and Poverty Focus**	Chairman: Mr. **Iswer Raj Onta** and Repertoire: Dr. **Bim Shrestha**
11:00-11:30	Enhancement of Irrigation System Efficiency and Service Delivery	Dr. Khem Raj Sharma, DOI
11:30-12:00	Pond Irrigation: An Approach to Sustainable Livelihood in the Dry Hilly Areas	Mr. Rakesh Regmi, Siddhi Nath Jha, and Bikesh Shrestha, Cemeca HRAP Ltd. and IDRS
12:00-12:30	Technical Auditing for Efficient and Sustained Performance of Irrigation Projects	Mr. Prakash Paudel, RD, WRID, DoI
12:30-13:00	General Discussion on Efficiency, Service Delivery and Poverty	Guided by Session Chairman
13:00-14:00	*Lunch break*	
14:00-15:00	**Rap-up Discussion** Key points raised during the workshop	Facilitated by Dr. **Khem R. Sharma** and Mr. **Mahendra B. Gurung**
	Closing Session	Chairman: **DG, DOI** and Chief Guest: **Secretary, MoWR**
15:00-15:15	Conclusions of the Workshop	Dr. Khem Raj Sharma, DOI
15:15-15:20	Few Words from IWMI/Nepal	Dr. Dhurba Pant, Head, IWMI Nepal
15:20-15:30	Few Words from INPIM/Nepal	Mr. Padma Aryal, Member
15:30-15:40	Few Words from NEA	Mr Kishor Shakya, Chairman, NEA
15:40-15:45	Few Words from Special Guest	Mr. Rama Kant Gauro, Member, NPC
15:45-15:55	Few Words from Chief Guest	Mr. Shankar Koirala, Secretary, MoWR
15:55-16:00	Thanking and Workshop Closing by Chairperson	Mr. Madhusudhan Paudel, DG, DOI
16:00-	*Final Tea and departure*	

Annex – 2: List of Participants

List of Participants

Special Invitees:

1. Mr. Shankar Koirala, Secretary, MoWR
2. Mr. Rama Kant Gauro, Member, NPC
3. Mr. Shital Babu Regmi, Act. Secretary, WECS

Paper Contributors:

4. Dr. Raghunath Jha, GIS and Water Resources Specialist
5. Dr. Indra Lal Kalu, Kathmandu Engineering College
6. Dr. Dibya Kansakar, Senior Hydro geologist
7. Mr. Sanjaya Dhungel, Senior Divisional Engineer
8. Mr. Basistha Raj Adhikari, Senior Divisional Engineer
9. Ms. Marina Lohani Sitaula, Social Development Specialist
10. Mr. Rishi Ram Sharma Neupane, Senior Agriculture Engineer
11. Mr. Gajhadhar Yadav, NFIWUAN
12. Mr. Ram Prasad Bhandari, Irrigation Engineer
13. Mr. Rajendra Prasad Adhikari, SDE, DoI Planning Division
14. Mr. Naba Raj Shrestha, Senior Hydro-geologist
15. Mr. Susan Sakya, LILI Engineer
16. Mr. Hari Thapa, Water Resources Scholar

Session Chairpersons and Repertoires:

17. Mr. B. K. Pradhan
18. Mr. Sharada Prasad Sharma
19. Mr. Mahendra Nath Aryal
20. Dr. Prachanda Pradhan
21. Mr. Iswer Raj Onta
22. Mr. Pradeep Thapa
23. Mr. Tanka Prasad Kafle
24. Mr. Bashu Dev Lohani
25. Dr. Bim Prasad Shrestha

Official Representation from **DOI**:

26. Mr. Madhu Sudhan Poudel, Director General
27. Mr. Sudhir Man Baisyet, DDG, Planning, Design, Monitoring and Evaluation Division
28. Mr. Jeevan Lal Shrestha, Deputy Director General, Groundwater Division
29. Mr. Uttam Raj Timilsina, Deputy Director General, Irrigation Management Division
30. Mr. Mahendra Bahadur Gurung, Director, CRID
31. Mr. Kamal Raj Regmi, Director, ERID
32. Mr. Prakash Poudel, Director, WRID
33. Mr. Siddhi Pratam Khan, Project Chief, GWDP
34. Mr. Purussotam Kumar Shahi, Project Coordinator, IWRMP
35. Mr. Niranjan Dev Pandey, Coordinator, NITP
36. Mr. Moti Bahadur Kunwor, CGISP
37. Mr. Bhuwon Prasad Ojha, SE, Surface Division
38. Mr. Ananta K. Gajurel, Coordinator, IIDS
39. Mr. Ram Babu Regmi, SDE, BIP

Official Representation from **NEA**:
40. Er. Kishore Shakya, President, NEA
41. Er. Dipendra Bahadur Bam, Deputy General Secretary
42. Er. Dev Raj Niraula, Executive Committee member
43. Er. Laxman K. C., Executive Committee member
44. Er. Dhurba Dhatta, Executive Committee member
45. Er. Ajay Lal Shrestha, member
46. Er. Laxmi Prasad Devkota, member
47. Er. Pradeep Chandra Pokhrel, member

Official Representation from **INPIM/Nepal**:
48. Dr. Khem Raj Sharma
49. Mr. Padma Prasad Aryal
50. Mr. Indu Gurung
51. Mr. Kumar Raj Shahi
52. Mr. Ram Hari Sharma
53. Mr. Shambu Prasad Dulal

Official Representation from **IWMI/Nepal**:
54. Mr. Dhurba Pant, Head

Official Representation from **Other Organizations**:
55. Mr. Suresh Upreti, WECS
56. Er. Mathura Dangol, MoWR
57. Er. Pradeep Raj Pandey, MoWR
58. Mr. Vijay Kumar Mallick, DDG, DoA

On the Basis of Management Responsibilities:
59. Mr. Suman Sijapati, Workshop Coordinator
60. Mr. Pradeep Manadhar, Co-ordinator, Workshop Management Committee
61. Mr. Pramod Shrestha, member, Workshop Management Committee
62. Mr. Rajendra R. Thapa, support staff, DoI

Annex – 3: Papers

New Methods for Elevation data Generation for Water Resources Development

Dr. Raghunath Jha
IOE, Pulchowk Campus
(rnjha@mail.com.np)

Abstract

In water resources planning, construction and management, DEM (Digital Elevation Model) has very important role. In Nepal presently two types of DEM are available one is derived from 1:25000 and 1:50000 scale topo maps with 20 m and 40 m contour interval respectively, another is SRTM DEM. It is found that topo map derived DEM has similar accuracy as of SRTM data sets in hills. However, SRTM DEM has higher accuracy in Terai. These two DEM can be used for planning of water resources, but cannot be used for construction due to low resolution of the DEM. LiDAR is a recent technology to create high resolution of with very high accuracy in moderate price, which can be used for planning, construction, and management of water resource, urban, road other infrastrure development projects

Introduction

Terrain patterns play an important role in determining the nature of water resources and related hydrological modeling. Digital Elevation Models (DEMs), offering an efficient way to represent ground surface, allow automated direct extraction of hydrological features. It thus brings advantages in terms of processing efficiency, cost effectiveness, and accuracy assessment, compared with traditional methods based on topographic maps, field surveys, or photographic interpretations. However, researchers have found that DEM quality and resolution affect the accuracy of any extracted hydrological features. Therefore, DEM quality and resolution must be specified according to the nature and application of the hydrological features.
In Nepal the water resources planning are based on topomap of 1:25,000 and 1:50000 scale maps and contour interval of 20m (supplementary contours of 10m in Terai) in hills and 40 m in Himalayan region. For the planning purposes these topo maps are perfect. However, for detail planning as well as the construction of water resources systems need 0.5m to 1m contour interval elevation data. The survey is done manually, which is intensive labor oriented, expensive, time consuming and there is probability of error occurrence. Recently, LIDAR (Light Detection and Ranging) technology has made it feasible to address the chronic lack of high resolution elevation data. This data can be used by different government organization for example: Road planning and construction work, Irrigation planning and construction, municipal planning and construction, agriculture planning and land consolidation and much more.

Available DEM in Nepal

SRTM data

The seamless data for SRTM can be downloaded from http://seamless.usgs.gov/ . The data is available in 5 degree by 5 degree quad. The data can be downloaded in different format. The best format of the data available is the GRID ASCII. If the gridascii data is downloaded, then grid can be converted using Arcgis or Arcview software. The SRTM data sets are available in WGS84 Datum and Degree Decimal (dd) format. The grid should be projected in Everest Datum and Modified Universal Transverse Macerator (MUTM) format. The data should be resampled to 100m grid resolution. The grid thus obtained is DEM of the study area.

Topo maps

The contour lines and spot elevations should either be digitized or digital map of contour lines and spot elevations of study area needs to be purchased from the Department of Survey. Using Arcview or Arcgis using 3D analyst, a TIN (Triangular Irregular Network) is created from

contour lines and spot elevation. From TIN, DEM of required grid resolution is created. In this study, to make same resolution map as SRTM DEM, a 100 m resolution is selected.

Application of DEMs

Two study areas, one in hills and the other in Terai are selected for application of DEM.

- Hill Study Area: Hill study area is in Kavre district. The map of location is shown in Figure 1. The catchment area is around 353 sq. km. The maximum and minimum elevation of this catchment is 300 and 2780 respectively and the average slope of the river is 48.9%. As the name itself suggests this catchment lies in hilly area.
- Terai Catchment: Terai catchment is situated in Mahottari district. This catchment area begins from Churiya hills. It partly lies in flat area and partly in hills. The average slope of the river is 3.6%. The catchment location is shown in Figure 1.

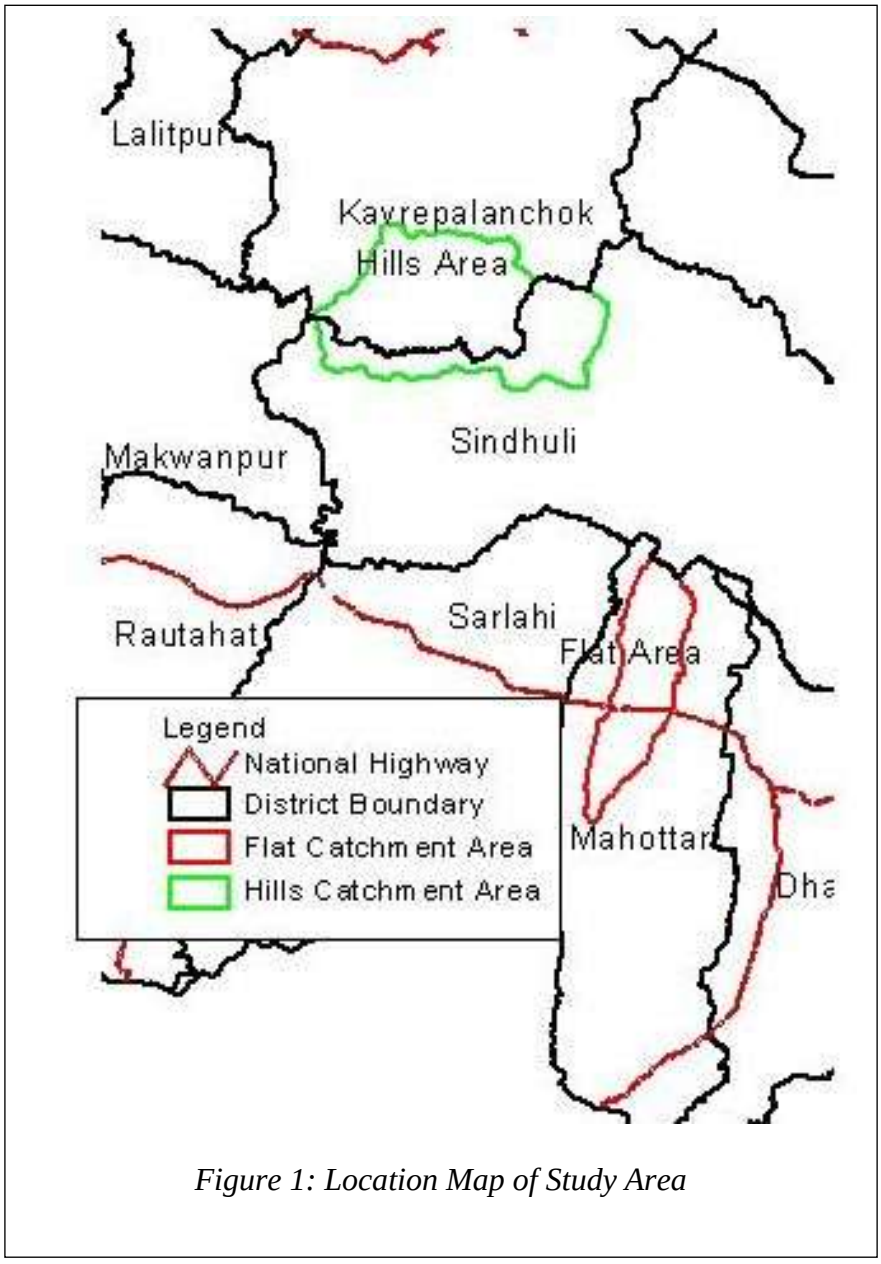


Figure 1: Location Map of Study Area

Results of DEM Applications

The following standard process were applied to generate river and catchment boundary

- Removal of sinks from DEM
- Creating flow direction from DEM
- Creating flow accumulation from flow direction
- Creating river network grid using threshold value of 250 grids
- Converting the river network grid to stream network
- Delineating the catchment boundary at known pore point for both DEM

Hilly Catchment

The comparison of river network generated with the real river and catchment boundary has been shown in Figure 2. It is clear from Figure 2 that both of the generated rivers are matching with the actual rivers. The other catchment characteristics such as area, perimeter, minimum slope and maximum slope are within one percent error. The comparison of other catchment characteristics is shown in Table 1.

Table -1: Comparison of Catchment Characteristics between SRTM and Topo DEM in Hilly area

Type of DEM	Area SQKM	Perimeter KM	Slope in %			Elevation in Meter				River Length	
			Min	Max	Average	Min	Max	Avg	SD	Maximum	Equivalent
Topo	353.6	90.7	0.0	143.3	48.9	300.0	2780.0	1154.5	481.4	48.1	35.4
SRTM	353.5	90.6	0.0	141.9	46.3	312.0	2791.0	1171.9	482.8	46.2	35.3
% Error	0.0	0.2	0.0	1.0	5.2	-4.0	-0.4	-1.5	-0.3	3.8	0.3

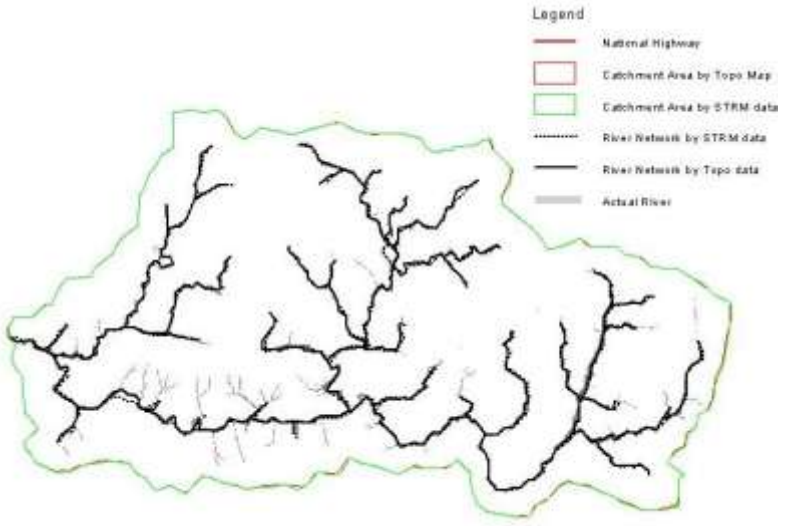


Figure 2: Comparison of Rivers and Catchment generated from SRTM and Topo DEM in Hilly Area

Flat Catchment

As previously described, the plain catchment is selected from southern part of east-central Nepal, Mahottari district. It was found that the river generated from SRTM more closely resembles the real river (digitized river) than the river generated from the Topo map as shown in Figure 3. The catchment area generated from Topo map does not match with the real river pattern. However the catchment generated from the SRTM are more close to the real catchment. There is an error of 77.7% in the delineating catchment by Topo DEM. Other basin characteristics are shown in Table 2.

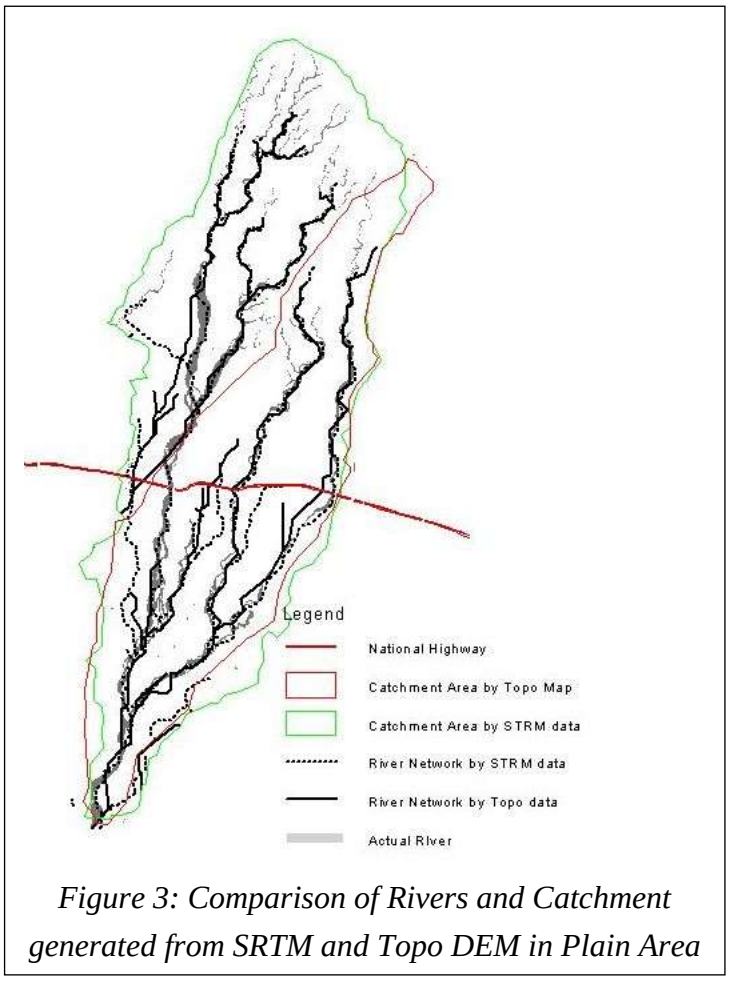


Figure 3: Comparison of Rivers and Catchment generated from SRTM and Topo DEM in Plain Area

Table - 2: Comparison of Catchment Characteristics between SRTM and Topo DEM in Plain area

Type of	Area	Perimeter	Slope in %			Elevation in Meter				River Length	
DEM	SQKM	KM	Min	Max	Average	Min	Max	Avg	SD	Maximum	Equivalent
Topo	93.1	56.5	0.0	55.4	3.7	105.0	660.0	218.4	100.1	30.6	24.5
SRTM	165.0	70.1	0.0	59.5	6.7	107.0	705.0	289.1	134.2	35.1	29.5
%Error	-77.4	-24.0	0.0	-7.6	-84.0	-1.9	-6.8	-32.4	-34.1	-14.6	-20.4

Flat Catchment with Stream Burning:

Stream burning is a process to correct the DEM hydrologically. As the name suggests, the real stream is burn on DEM, i.e., the elevation of DEM on river grid is depressed by 5 to 10 m as shown in the following formula. Correct DEM = DEM – 10 * (River_grid)

After stream burning on DEM, the generated river matches the real river.

After applying the stream burning on Topo DEM, the river and catchment boundary are regenerated. It is found that regenerated river network matches the real river and SRTM river as shown in Figure 4. The catchment boundary is more close to SRTM catchment boundary. The catchment area from SRTM and Topo maps are 165.0 and 146.1 sq. km. respectively. Other basin characteristics are shown in Table 3.

Table-3: Comparison of Catchment Characteristics between SRTM and Topo DEM in Plain area after Stream Burning to Topo DEM.

Type of DEM	Area SQKM	Perimeter KM	Slope in %			Elevation in Meter				River Length	
			Min	Max	Average	Min	Max	Avg	SD	Maximum	Equivalent
Topo	146.1	65.1	0.0	73.3	7.1	95.0	690.5	282.4	137.4	34.0	27.1
SRTM	165.0	70.1	0.0	59.5	6.7	107.0	705.0	289.1	134.2	35.1	29.5
%Error	-13.0	-7.8	0.0	18.7	5.2	-12.6	-2.1	-2.4	2.4	-3.2	-8.6

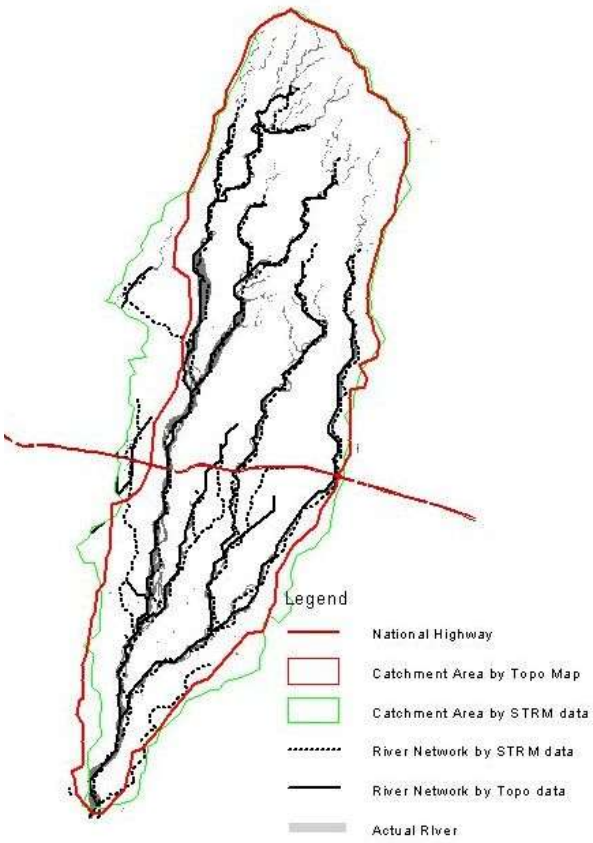


Figure - 4: Comparison of Rivers and Catchment generated from SRTM and Topo DEM in Plain Area after Stream Burning

LIDAR

LiDAR is a term that has been discussed, and researched since the early 1950's. It was not until the development of accurate positioning systems that LiDAR became to be considered as a viable imaging/mapping technology. Looking generally at how LiDAR works, there is typically a LiDAR laser sensor, which is precision mounted to the underside of an aircraft, and which transmits or pulses a narrow laser beam towards the earth as the aircraft flies. A receiver additionally affixed to the aircraft receives the reflection of these pulses as they bounce off the earth below, back to the aircraft. Most LiDAR systems use a scanning mirror to generate a swath of light pulses. Swath width depends on the mirror's angle of oscillation, and ground-point density depends on factors such as aircraft speed and mirror oscillation rate. The range is determined by computing the amount of time it takes light to leave an airplane, travel to the ground and return to the sensor. A sensing unit's precise position and attitude, instantaneous mirror angle and the collected ranges are used to calculate 3-D positions of terrain points. As many as 100,000 positions or "mass points" can be captured every second. The LiDAR sensor essentially record the difference in time between the signal being emitted and received from a given point, very much like a conventional survey instrument. The LiDAR data is coupled with additional precise positioning information gathered by on board Global Positioning Instruments (GPS) and other Inertial Navigation Systems (INS).

Once the total information volume is stored and processed, the resulting product is an extremely accurate "x.y.z." for every position scanned on the ground. Though, these results are varying, but it is generally agreed that there is a tremendous amount of accuracy with LiDAR, providing elevations to within 10cm in the vertical plane or even better and very similar in the horizontal plane. Advancements in the "associated technologies" – GPS, IMU and processing software – have led to a bigger market for LiDAR data. Airborne GPS will yield results in the 5-7 centimeter range – when all of these components are added together the real guaranteed accuracy will be around 15 centimeters.

LiDAR Derived DEM

The raw data from LiDAR system are three dimension cloud points with intensity values. Laser returns are recorded from no matter what target the laser happens to strike. The desired target for the generation of digital elevation model is the bare-earth. However, the LiDAR raw data includes everything on the ground such as buildings, telephone poles, power lines, and even birds. The post-processing of LiDAR data involves the removal of undesirable points by using filter algorithms. The final cloud points for DEM generation are those points which strike to the bare-earth ground. LiDAR data used for this project were classified into bare-earth and non-ground points by using different algorithms across the project area. Manual checking and editing of the data were also conducted to further improve the quality of the classification. Using GIS software, a regular 1m by 1 m grid DEM were created with the bare-earth points by means of the inverse distance weighted (IDW) interpolation method.

LiDAR data Types

There are five types of LiDAR data which is explain in Table 4

Table 4: Types of Datasets of LiDAR

Level	Name	Description
1	Basic or "all points"	All of the post-processed LiDAR data properly geo-referenced but with no additional filtering or analysis. Cheapest and fastest product
2	Low fidelity or "first pass"	The data provider will automatically filter the point cloud in to points on the ground, the "bare earth", and points that are not ground (buildings, trees, etc.)
3	High Fidelity or "cleaned"	A fully edited data set that has been extensively reviewed by an experienced data analyst to remove any artifacts created by the automatic classification routine and provides a "99%" clean terrain model.
4	Feature Layers	Further processing using a combination of automated and manual classification to identify features of interest such as power lines or building footprints. Usually more expensive product than high fidelity terrain model
5	Fused	A further refinement of the LiDAR data product achieved by the fusion of the lidar-derived dataset with information from other sensors. This can include digital imagery, hyperspectral data, thermal imagery, planimetric data or similar data sources. Generally the most information-rich product with the highest cost

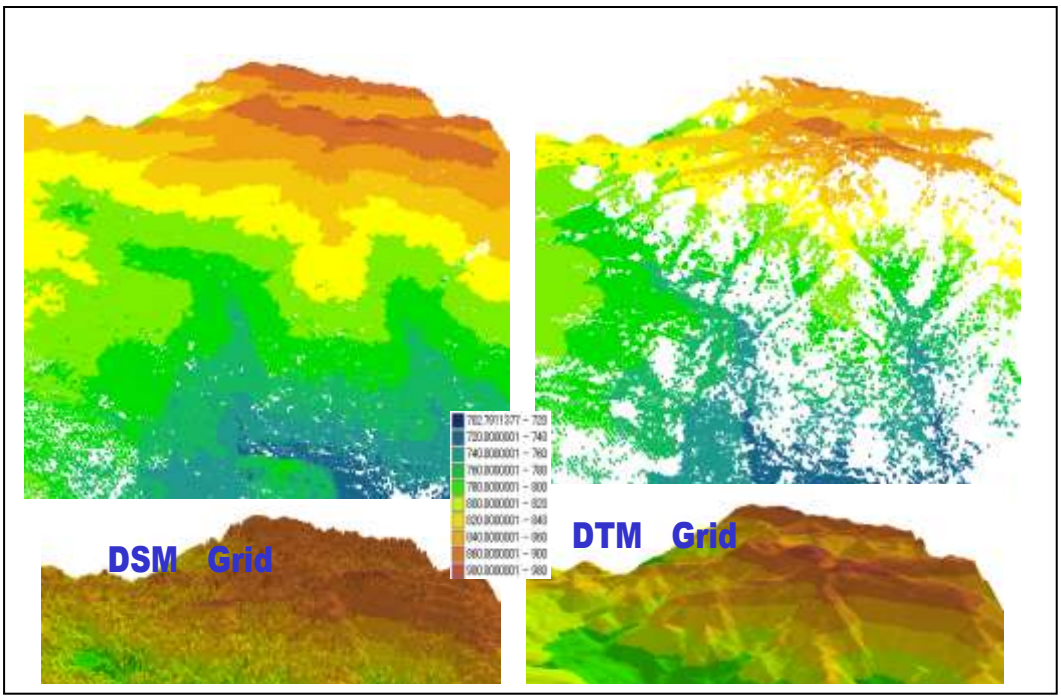
Application of LiDAR

LiDAR can be applied in a multitude of applications requiring large scale mapping with most of them related to infrastructure development or maintenance. The main application areas are: Irrigation Design and Management, Flood risk mapping, Hydropower projects, Forestry application, Geo-reference location structures, GIS and high tech aerial surveys, Large-scale civil engineering projects, Landslide risk mapping, Defense applications, Pipelines construction, Roadway corridor planning, Telecommunications, Topographic surveys, Transmission lines, Golf & resort planning station is used for the topo survey, which can increase the work flow and reduce the cost. The cost of the topo survey using total station is approximately NRS 3000 (US$ 50) per ha or US$ 5000 per sqkm. Approximately 400 points are collected per ha (25 sqm per points).

Table 5: Application of LiDAR Data

SN	Description	Typical Application
1	Topographic Surveys	High resolution DEMs
2	Irrigation Project	Canal layout and cut fill calculation, hydraulic structures levels, all types of irrigation planning, development and management
3	Hydropower	infrastructure development planning and design (Roads, pipelines, plant, well sites)
4	Civil Engineering	Infrastructure development planning and design – transportation, urban planning and mapping
5	Defense applications	Minefield mapping, simulated battlefield design
6	Roadway corridor Planning	Road network database development, road network extraction, 3D feature extraction
7	Pipelines construction	Corridor and vegetation mapping, 3D feature extraction along corridor
8	Transmission lines	Corridor and vegetation mapping, 3D feature extraction along corridor
9	Telecommunications	Corridor and vegetation mapping, 3D feature extraction along corridor
10	Forestry	Forest management Plan, It measures the height of the forest and volume of the wood

Cost Cost of Total Station Topo Survey



In recent days total

Cost of LiDAR

In recent days the price of LiDAR has been reduced drastically. The cost of LiDAR depends upon the terrain, size of the area and no. of points per square meter. However if the area of the project is around 500 sq.km and 2 to 3 points per sqm is collected then the price is approximately 2000US$ per sqkm or US$20 per ha. It includes DTM with LiDAR and color digital orthophoto with medium format camera. The area of the project may not be necessarily at one location. The cost is nearly 40% of the cost of traditional topo survey in Nepal

Conclusion

In hilly region both DEM (survey department and SRTM) generates nearly same catchment characteristics. However, in flat land the catchment characteristics are different in both DEM. Survey department contours are of 10m interval and in flat land these contours are separated by 10 km which creates a bad DEM. Nevertheless, SRTM data has grid value for 100m grid resolution and can generate better catchment characteristics.

LiDAR can produce high resolution and high accuracy DEM in nearly 40% price of the traditional topo survey. In addition to the contour lines, it can also capture color orthophoto map of 1m resolution which can be used for different purposes for the same price. The LiDAR generated DEM can be used by different government organization for different activities like Road planning and construction work, Irrigation planning and construction, municipal planning and construction, agriculture planning and land consolidation and much more

Acknowledgement: The Author is thankful to PASCO International and LEICA to provide LiDAR information.

Reference:

Jha Raghunath, 2006, Applicability of SRTM DEM in Nepal: Workshop on Flood Forecasting Management in Mountainous Areas 17-19 April 2006, Kathmandu

Rainwater harvesting for irrigating small holders' non irrigable land

Indra Lal Kalu
Kathmandu Engineering College
(indra_kalu@hotmail.com)

Abstract

Reliable irrigation is necessary to motivate small farmers to shift from subsistence farming to high value agriculture. But most of cultivated land in mid hill and Bhabar area is non irrigable for non-conventional irrigation method due to lack of ground water and sizeable surface water source. Rainwater harvesting is a possible option. The possibility of tank coupled with low cost drip irrigation for irrigation was studied using simulation method. Seven years daily rainfall data of Kathmandu airport was used to determine the field and the tank water balance situation. It showed that a 30 m^3 capacity low cost plastic lined tank made in 24 sq m can irrigate winter vegetable ½ ropani grown using drip irrigation system. Simulation further showed that spring vegetable crops can also be cultivated providing irrigation in 5 out of 7 years using the stored water for irrigation. Farmers can recover the investment cost of about Rs 18000 from the benefits obtained in 2 vegetable crops. Farmers are willing to contribute local materials and labor work and they need to be supported for procuring purchasable items. Hence rain water harvesting technology should be promoted promptly to serve poor farmers and alleviate poverty.

Background / Introduction

Poverty is the main problem of Nepal and so poverty alleviation is the prime goal of the country's development. And the past Tenth five year plan was also called as poverty reduction strategy paper. In agriculture based country where over 80% households are engaged in farming, alleviation of poverty will accrue naturally by improving the economic status of poor farmers. This necessitates increased farm production which shall be possible by increasing cropping intensity and production of high value crops both of which require reliable irrigation water supply. Poor farmers are small holders and their land size is small and so only option is to improve crop yields.

That is why all government agency as well as Non government agency emphasize on the development of irrigation for rural development. Reliable irrigation water is essential for growing multiple crops adopting improved practice and hence the farmers' first development priority in most rural community is irrigation. Reliable Irrigation facility permits to cultivate multiple crops year round increasing cropping intensity to 400 % at some warm places like Paanchkhal valley in Kavre.

Wherever water could be abstracted by means of canal simple excavation, farmers have developed inundation irrigation system. And government agencies have rehabilitated most of these systems as well as have developed new irrigation systems through surface irrigation and ground water development.
Currently irrigable area by canal irrigation and groundwater is 1.76 M ha in 2.25 M ha cultivable land, and at present irrigation facility has been developed for 1.17 M ha. Of the so called irrigated area, actual irrigated area in rainy season is only 70 % land, while that in the winter is 50 % and in spring season is 30 % only. Generally stream flow is reduced at source in dry months which causes scarcity of water, so the actual irrigation area is much less in dry season. Therefore year round irrigation from surface irrigation system is limited to small proportion. Year round irrigation is possible in ground water irrigation systems, but water has to be pumped

out. It is reported that these irrigation developments have taken place mostly in terai plains and river valleys of mid hill benefiting large and rich farmers.

And the poor farmers farming upper hill slopes including hilltops and the upland of Bhabar in terai are forced to cultivate under rain fed condition. Treadle pumps are benefiting farmers in terai belt where groundwater is at shallow depth. But this area is devoid of groundwater as well as sizeable surface water source to develop traditional irrigation system. So they are practicing traditional rain fed farming growing sorghum, maize followed by mustard, niger, sesame in hills and sweet potato, *gahat*, cowpea, etc producing low yields.

National Water Plan

Considering the apathy of such people, National Water Strategy and National Water Plan has proposed to develop non conventional irrigation technology considering the works of other agencies. Earlier Agriculture Development Bank of Nepal (ADBN) was mandated to provide loan along with government subsidy for developing micro irrigation and under that program different alternate irrigation technology namely lift, sprinkler, drip, hydraulic ram, dug well, shallow tube well, water harvesting tanks etc were promoted. This has provided micro irrigation facility to non irrigable area. One exemplary site is Madanpokhara of Palpa district. But now after the curtailment of subsidy in 1999, and also privatization, ADBN limited has virtually diminished irrigation promotion program. Now Department of Irrigation (DOI) has established 'Non conventional irrigation technology Project' (NITP) to promote these technologies. NITP is promoting various micro irrigation technology using available surface or ground water sources. But the area devoid of these water sources is still lying unattended. Therefore to address mass poor, irrigation technology appropriate to site should be explored. Rain water harvesting tank combined with water saving micro irrigation could be a potential option.

Potential option

Rainfall is the ultimate source of water and groundwater and spring water are the manifestation of rain water at different place and form. So if rain itself is collected (harvested) that could be used to supplement all water needs.

Rainfall in Nepal is generally high ranging from 1000 mm to 4000 mm. In the mid hills rainfall is around 1500 mm where as the annual evapo-transpiration is about 800 mm thus showing most area as humid on annual basis. But however due to occurrence of 3/4th rainfall within four months of rainy season beginning from June until October, water shortage is felt in other dry months. Therefore irrigation is needed for dry season cultivation. Moreover due to uneven distribution and erratic onset of monsoon rain in rainy season, irrigation may be needed in rainy season as well. The irrigation facility is needed to motivate farmers to adopt commercial farming.

In high rainfall area, rainwater harvesting tank could be a potential option to develop irrigation facility for such so called non irrigable land. Currently availability of economic plastic lining and low cost drip irrigation technology has produced favorable environment to explore the feasibility of the rainwater harvesting technology. In fact Rainwater harvesting is not a new concept in Nepal, villagers have already dug ponds and tanks to store rainwater for cattle, washing purpose, irrigation etc. Now government and donors have assisted to promote rainwater harvesting for water supply purpose in water scarce villages. And the rainwater harvesting has fared satisfactorily for water supply purpose.

So the viable option is to construct a water-harvesting tank coupled with low cost drip irrigation system. The plastic lined tanks will be made to store rainwater and that water shall be applied using drip irrigation sets. The purpose of rainwater harvesting tank is to grow vegetables in small scale by poor farmers, roof water as it will be clean, is proposed to be collected. And if one wants to do commercial farming in large scale, then runoff from upland can also be collected as is done in Madanpokhara village.

Rainwater harvesting for irrigation is still at initial stage in Nepal. Few NGOs and INGO like IDE/Nepal have tested various tanks like Thai jars, Ferro cement tanks, plastic lined tanks etc storing spring/canal water overnight or few days to irrigate later.

Design of Rainwater harvest tank

The design of rainwater harvest tank consists of fixing the size of tank, area to be irrigated based on the rain harvesting tank. The size of tank depends upon the rainfall pattern. If rainfall would have been evenly distributed, a small tank could serve large area and if it is unevenly distributed, then even large tank could irrigate naturally small area only. Basic task is to determine the size of tank and the irrigation area.

As the purpose of these tanks is to prompt poor farmers to grow vegetable cultivation, it is assumed that they will cultivate in ½ ropani land which shall be enough for household consumption and sale in the market. And they shall be collecting water from roof area of 50 sq m (10 m * 5 m) size which is a typical size.

Model Formulation

Model consists of determining the probable volume of water available at the end of rainy season and the period until which that water could be delivered for irrigation. It consists of two sub models

1) water balance of rainwater harvest tank
2) soil water balance model

Water Balance of rainwater harvesting tank

This sub model computes the water storage considering rainfall and evaporation from tank surface. As the plastic lining is proposed percolation loss is not considered. Daily rainfall in traces less than 1 mm is assumed to be non effective and of daily rainfall above 1 mm, 90 % is assumed to be collected in the tank. And water collected in excess of capacity will spill out.

$$Effrain = (Rain-1) * 90\ \%$$
$$Stor_{k+1} = stor_{k} + Effrain_{k} - ETO_{k} - Irr_{k} + runoff_{k}$$
$$Runoff_{k} = Effrain_{k} * catchment\ area$$

If $stor_{k+1} > stor_{max}$

$$spill = stor_{k+1} - stor_{max}$$
$$Stor_{k+1} = stor_{max}$$

If $stor\ stor_{max} < 0$ $stor_{k+1} = 0$

i.e. storage is non negative.

Soil water Balance Model

This model takes an account of soil moisture content. It computes the soil water balance considering effective rainfall as assumed earlier and the evapotranspiration in field. Irrigation shall be provided only when soil water content drops below management allowed deficit (MAD). The procedure can be stated as:

$SW_{k+1} = SW_k + Effrain_k - ETP_k + Irr_k$
$Irr_k = SW_k - MAD$ if ($SW_K < MAD$)
$= 0$ otherwise

Where, SW_{k+1} and SW_k are soil water content on k+1 and k th day
$Effrain_k$ is effective rain on kth day
ETP_k is potential crop evapotranspiration on k the day
Irr_k is irrigation demand.

Model Application

A computer program was developed for simulating the above water balance sub models. Seven years of daily rainfall data of Kathmandu airport from 1999 to 2005 was obtained from DHM and the Monthly Potential Evapotranspiration was computed by suing climwat data from CROPWAT. The climatic data is shown in Table 1.

Table 1 Climatological data and Evapotranspiration rate

Station: KATHMANDU AIRPORT Altitude: 1367 meter(s) above M.S.L.
Latitude: 27.42 Deg. (North) Longitude: 85.22 Deg. (East)

Month	Max Temp	Min Temp	Humidity	Wind Spd.	SunShine	Solar Rad.	ETo	ETP
	(deg.C)	(deg.C)	(%)	(Km/d)	(Hours)	(MJ/m2/d)	(mm/d)	mm/day
January	16.8	2.3	75	43	7.7	14	1.59	1.22
February	19	3.4	76	60	8.3	16.9	2.27	1.36
March	23.7	7.1	75	69	8.4	19.6	3.23	1.62
April	26.6	11.8	61	86	8.6	21.9	4.22	1.92
May	27.4	15.6	68	95	8	22	4.47	3.13
June	27.5	18.8	83	86	5.2	17.9	3.76	3.76
July	26.8	19.8	82	69	4.3	16.5	3.47	3.47
August	27.1	19.5	82	60	4.3	15.8	3.3	2.64
September	25.8	17.9	86	43	6	16.9	3.17	2.22
October	24.7	13.9	77	43	7.4	16.5	2.73	0.69
November	21.2	6.7	79	35	8.2	15	1.91	1.43
December	18.2	2	78	35	8	13.6	1.46	1.10
Average	23.7	11.6	76.8	60.3	7	17.2	2.97	

A typical upland field (bari) is situated near the village house with a roof area of 50 sq. m. And maize shall be grown from March-April to September as usual in the Kathmandu valley. Vegetable like Cauliflower / Cabbage shall be cultivated following maize. If water is available for irrigation, spring vegetable crops will be grown. In this case rainfall is the only source of water. As the purpose of rainwater harvesting is to provide service to mass poor, a small tank of 30 cubic meter capacity is chosen to irrigate half ropani (250 m^2).

Annual rainfall varied widely in these 7 years from 1200 mm to 1700 as shown in Table 2. Rainfall distribution is unimodal distributed in 5 months of June to October but its onset and closure is varying as shown in Figure 1. The winter and spring rain is less predictable. Median monthly rainfall has been computed as shown in Table 2.

Table 2 Monthly Rainfall and Median Rainfall (mm)

	Years							Median
Months	1,999	2,000	2,001	2,002	2,003	2,004	2,005	value
Jan	8	28	32	157	174	60	123	60
Feb	4	5	16	30	69	0	17	16
Mar	-	21	9	93	86	32	50	32
Apr	6	62	35	94	38	165	35	38
May	107	210	181	159	38	168	41	159
Jun	316	267	251	228	223	184	223	228
Jul	485	332	499	545	592	460	254	485
Aug	394	384	461	500	347	209	309	384
Sep	268	125	146	149	294	211	127	149
Oct	152	1	21	15	18	121	126	21
Nov	-	0	0	27	0	36	-	0
Dec	1	0	-	-	19	-	-	-
Total	1,739	1,410	1,625	1,874	1,743	1,612	1,239	1,625

Simulation model shows that the rainfall can fill tanks of 50 m^3 to 100 m^3 capacity depending upon the rainfall. In this case the proposed tank capacity of 30 m^3 is chosen which will be filled full each year in rainy season. Depending upon the last rainfall day, the tank will remain at full capacity until different date of October.

Design storage water is sufficient to provide 4 irrigations of almost about 30 mm and left over at an interval of 1 month roughly. Drip irrigation shall allow us to apply this water uniformly. Tentative recommended date for irrigation is shown in Table 3. Date varies slightly due to variation in monsoon closure date and occurrence of winter rainfall.

Table 3 Summary of Simulation Result

Crop Year	Last date of Tank remaining full	Recommended Irrigation dates				Depth of last irrigation
		first	Second	Third	Fourth	
1999-00	21-Oct	16-Nov	11-Dec	7-Jan	1-Feb	8 mm
2000-01	21-Sep	17-Oct	14-Nov	7-Dec	8-Jan	8 mm
2001-02	14-Sep	29-Sep	9-Nov	30-Nov	28-Dec	11 mm
2002-03	10-Oct	11-Nov	6-Dec	14-Jan	16-Jan	3 mm
2003-04	9-Oct	11-Nov	3-Dec	14-Jan	17-Feb	16 mm
2004-05	16-Oct	16-Nov	20-Dec	15-Jan	20-Feb	
2005-	24-Oct	18-Nov	12-Dec			

In general there is some soil moisture for crop growth. It lasted until late January in 2000 and mid February in 1999. In other years due to some rains in spring season, soil moisture was enough for crop cultivation throughout the spring. In 2004 irrigation was needed in July due to long term dry spell in June. It showed that the if rain water is collected, then in 5 out of 7 years, year round vegetable crops can be grown.

Financial Analysis

The cost of water harvesting tank and low cost drip irrigation system set for ½ ropani is about Rs 18000. And the benefit from cultivation of cauliflower/cabbage in ½ ropani is Rs 9000. Therefore the cost of investment is recoverable in 2 vegetable crop seasons which may take one or 2 years depending on the rainfall distribution in dry season. The earthwork is of about Rs 4000 and cost for purchasable items is Rs 12000. Farmers can contribute labor works and if government provides purchasable items, such small tanks can be spread to mass in short time. This way large number of farmers shall be served with irrigation with small amount spread to mass and support poverty alleviation.

CONCLUSION

Rainwater harvesting tank coupled to drip irrigation set is a potential technology to provide irrigation facility to otherwise non irrigable hill slopes and bhabar area where poor farmers are residing. Simulation using daily rainfall data of 7 years from 1999-2005 shows that water collected in 30 m3 capacity can provide assured irrigation to vegetable crops cultivated in ½ ropani land and it may provide irrigation in spring months in years when rainfall is fairly distributed.

Cost for development of tank and drip irrigation set for ½ ropani is Rs 18,000/. The cost is recoverable from vegetable cultivation in 2 crop season which may be same year or another year depending upon the rainfall distribution. Therefore to spread the benefits of irrigation to large mass in order to serve the goal of poverty alleviation, promotion of rainwater harvesting which has been concentrated in arid and semi arid area should be done promptly by providing subsidy to poor farmers.

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Adoption of National Water Plan in Irrigation Sector

Sanjaya Dhungel and Suman Sijapati
SDE,WECS and SDE, DOI
(sdhungel@wecs.gov.np) (suman@sijapati.wlink.com.np)

Abstract

National Water Plan that details out short (by 2007), medium (by 2017) and long-term (by 2027) water resources development activities for Nepal is a formally approved plan of the government. Presently, the plan has completed its short-term targets period and entered into its medium-term period. The short-term target period coincided with the tenth five-year plan while the on-going three-year interim plan forms part of the medium-term target period. At this juncture it is deemed necessary to make a comparative assessment of the achievements made so far with the short-term targets and also to assess to what extent the Interim Plan addresses the medium-term targets and what needs to be done in the remaining period of the medium-term. This paper focuses on the irrigation sector and presents a gap analysis between the targets set, proposed activities, actually implemented activities and the achievements for the period up to 2007. It also highlights the targets and programs of the Interim Plan and analyzes to what extent it is in line with the medium-term targets and proposed activities. Based on these analyses conclusions have been drawn as to what should be prioritised for the remaining time of medium-term in order to meet the set targets.

Introduction

National Water Plan (NWP) is the long-term plan formally approved and adopted by the Government of Nepal for the development of available water recourses in the country. It is based on the Water Resources Strategy prepared prior to it and adheres to the principles of Integrated Water Resources Management (IWRM). NWP has detailed out the activities for short-term (by 2007), medium-term (by 2017) and long-term (by 2027) stressing on the efficient but sustainable use of the resource.

The present period marks the transition between the completion of the short-term target period and the beginning of the medium-term target period. The Tenth Five Year Plan that covered the planned short-term target period has been completed and the Interim Development Plan, which reflects the new direction after the major political changes in the country, has recently been prepared. In this context it is considered very important that we review the past achievements and assess to what extent the currently proposed activities are in line with the long-term plan. This paper first presents the targets and the proposed activities for the period up to 2007 and then presents a gap analysis between the targets set, proposed activities, actually implemented activities and the achievements. The paper then goes on to present the targets and programs of the Interim Plan and analyzes to what extent it is in line with the medium-term targets and proposed activities.

NWP Short-term Targets and Review of the Tenth Five-Year Plan

Targets and the Proposed Activities for the Short-term Period of the NWP

The short-term purpose of NWP for the irrigation sub-sector was to establish a foundation towards the end of achieving appropriate and efficient irrigation that supports optimal and

sustainable use of irrigable land in the country and to provide tangible benefit to the people for the fulfillment of their basic needs. The main output at the end of the period was expressed as irrigation systems planned, developed and continued for sustainable management. The physical targets set for the period for the irrigation sector by the NWP were as follows:

- 71% of the total irrigable area will be developed to have irrigation facility
- 49% of the irrigated area will receive year-round irrigation
- 35% irrigation efficient will be attained
- 30% of the operation and maintenance cost will be recovered as ISF
- 140% cropping intensity will be achieved in year-round irrigation
- 160% and 126% cropping intensity will be achieved for all crops and cereals only respectively
- 15% increase in cereal production compared to 2001

For this target, the following five activities have been proposed by the NWP:

- Integrated Programme for Irrigated Programs
- Improved Management of Existing Irrigation Schemes
- Improved Planning and Implementation of New Irrigation Systems
- Capacity Building of Local Level Institutions
- National Capacity Building of Farmers

Gap Analysis

Gap analysis was carried out mainly in three regards. First the total expenditure proposed by the NWP was compared with the allocated and actual expenditure of the Tenth Plan. Then the action programmes proposed by the NWP were compared with the activities that were planned and actually implemented during the Tenth Plan. Finally, the targets set by the NWP were compared with the achievements made.

Budget Comparison

NWP has proposed a total expenditure of N. Rs. 20,185 Million for the short-term period, out of which N. Rs. 19,794 M is through structured means and the remaining N. Rs. 391 M through unstructured means. The expenditure through unstructured means has not been accounted for but the compilation of development expenditure in the different projects of irrigation has revealed that the total allocation and expenditure made during the tenth Plan were N. Rs. 10,697 M and N. Rs. 8,145 M respectively. Thus the actual expenditure through structured means during the Tenth Plan period was about one third.

Comparison of Action Programmes and Activities

Comparative analysis was also made between the actual programs and projects implemented during the tenth plan vis-à-vis the five action programmes and the various activities proposed by NWP for the short-term period.

Cost breakdown of the proposed action programmes and what was actually implemented has been presented in Table 1 below.

Table 1: Cost breakdown of Proposed, Allocated and Actually Implemented Action Programmes

	Action Programmes	**Proposed**	**Allocated**	**Actual Expenditure**

1	Integrated Programme for Irrigated Agriculture	5,906.1	3,216	2,084
2	Improved Management of Existing Irrigation Projects	11,425.6	2,304	2,024
3	Improved Planning and Management of New Irrigation Projects	4,292.3	3,039	2,415
4	Strengthening of Local Capacity of Planning, Implementation & Management	72.9	85	58
5	National Capacity Building of Farmers	0.0	176	69
	Grand Total	**21,697**	**8,819**	**6,650**

Source: Planning, Design and Monitoring and Evaluation Division, DOI.

The above table clearly shows that even though major thrust was given by NWP to improved management of existing irrigation projects the allocated budget for that action programme during the tenth plan period was not very significant. In relative terms emphasis is observed to have been given more on planning and management of new irrigation projects and on integrated programs. Similarly, compared to NWP proposal, high priority was given to software activities like strengthening of local capacity and capacity building of farmers. However, it is also observed that in software activities even though the allocation is higher than proposed, the actual expenditure is relatively low. This shows that the spending capacity on software activities of the concerned institutions is quite low.

Target Comparison

Gap analysis was also carried out to analyze the difference between targets set by the NWP, and the actual achievements made by the end of the tenth plan. Details of achievements in irrigated area by different projects and program until the end of 9th Development Plan and the end of the 10th Development Plan have been presented in Table 2 below.

Table 2. Achievements in Irrigation Area Expansion

S. N.	Program/Projects	**Total Irrigated area (ha)**, up to end of	
		9th Plan	10th Plan
1	Through government agencies		
a	Development of surface sources	6,14,947	6,54,749
b	Development of groundwater sources	2,05,559	2,86,637
2	Traditionally by the farmers	3,00,935	2,53,242
	Total	**11,21,441**	**11,94,628**

Source: Planning, Design and Monitoring and Evaluation Division, DOI.

Similarly, in terms of ISF Collection, Table 3 below shows the details:

Table 3: Target Analysis, Allocated and Actually Implemented Action Programmes

Fiscal years	**O&M Costs**	**ISF Collections**	**ISF / O&M Costs %**
059/60	110,713,741	1,548,000	1.4%
060/61	145,972,107	1,829,009	1.3%
061/62	166,704,880	2,144,975	1.3%
062/63	132,906,013	6,144,457	4.6%
063/64	132,976,000	6,044,553	4.5%

Source: SMTP, DOI

Slight improvements is observed in ISF collection during the recent years but still it is found to be far below the set targets.

Table 4 below presents the gap analysis between the overall set targets and the achievements also considering the scenario before the period.

Table 4: Target Analysis, Allocated and Actually Implemented Action Programmes

	Action Programmes	**Before**	**NWP Target**	**Achievement by end of 10th Plan**
1	Irrigable area with irrigation facility	64%	71%	68%
2	Irrigated area receiving year-round irrigation	45%	49%	? %
3	Irrigation efficiency	30%	35%	? %
4	Cropping intensity in year round irrigated area	220%	140%	
5	CI - of cereal crop only		126%	134%
	CI- of all crops	159%	160%	174%
6	Cereal production in irrigated area (datum yr 2001)	100%	115%	? %
7	Operation and maintenance cost recovered as ISF	2%	30%	4.5%

Source: DOI and MOAC

The above analysis indicates that the achievements made in the irrigation sector by the end of the 10th Plan are very much comparable to the targets set by the NWP for the short-term period. The following conclusions can be drawn from the overall analysis:

- Even though NWP has set very objective targets, it has been observed that there is no mechanism to monitor and evaluate some of the indicators.
- The achievements made in terms of expansion of irrigated area is found to be quite remarkable (about 57%) despite the fact that only 34% of the proposed budget was allocated.
- Some of the indicators used as targets do not seem to be very realistic. For example the target set for overall cropping intensity (160%) is higher than that of area receiving year-round irrigation (140%). (Generally, it would have been expected that the cropping intensity will increase with the availability of irrigation, even more so with year round irrigation).
- The achievements in terms of ISF collection is still much below target.

Three Years Interim Plan

The three-year interim plan (2007/08 – 2009/10) has taken Water Resources Strategy 2002 and National Water Plan 2005 as a basis for designing the programmes of the irrigation sector. Accordingly, the river basin approach in developing the irrigation systems, establishment of effective coordinating mechanism with stakeholders including women and deprived community in planning, implementing as well as operation and maintenance are incorporated in the planning document. The interim plan stresses on sustainability of the existing as well as planned irrigation projects through management transfer and capacity building of the farmers.

The target, action program and budget as allocated under the interim plan and NWP is briefly analysed.

Target

The three-year interim plan targets to extend the coverage of irrigated area by 119600 ha, in which surface irrigation projects covers 56,900 ha; groundwater projects 37,400 ha; new technology based irrigation program 1600 ha; and extension and improvement of farmer level canal 23,700 ha.

The NWP by 2007 targets to irrigate 71% of the potential area (17,66,000 ha.) i.e. 12,53,860 ha. By the end of tenth-plan period (2007), the total irrigated area is 11,94,628 ha i.e. 67 percent of the potential area. Thus, the area under irrigation as targeted is less by 59,232 ha.

The physical target of NWP by 2017 is to irrigate 80 percent of the potential area. This is an increase in 9% from the target of 2007 over ten years' period. Assuming an increase by 3% over three years' period, the NWP estimates to irrigate only 52,980 ha. This target is 44 percent less than the interim plan target.

Action Programmes

The action program of nwp focuses on extending the coverage of irrigated area, increasing the area of year-round irrigation, conjunctive use of surface and ground water, rehabilitation of farmers and agency managed irrigation system. the nwp has grouped the action program of irrigation sector under five broad categories, whereas, interim plan groups the irrigation sector activities in four categories. the interim plan in consideration of nwp, aims at extending the coverage of irrigated area by implementing shallow and deep tube well irrigation system. in order to increase the coverage, surkhet valley, bagmati, babai, mahakali, sikta, rani-jamara and non conventional irrigation technology projects are identified. further, rehabilitation of narayani, kamala and koshi pump irrigation system is planned. maintenance of the government and farmers' managed irrigation projects are also the program listed in the plan.

BUDGET

The budget allocated for the program in the three years interim plan is given in table below.

Table 5: Allocated Budget for Interim Plan

	Action Programmes	**Proposed (NRs. in Million)**
1	Increase in Irrigated Area	8,770.74
2	Operation, Maintenance and Rehabilitation	3,830.37
3	Institutional Development	150.18
4	Study and Research	380.71
	Grand Total	13,250.00

The NWP has considered five years time frame while estimating the budget in irrigation sector. As such, in this paper, sixty percent of the budget as allocated in NWP document is taken for reasonable comparison (Table 6).

Table 6: Proposed budget for the 3 year Interim Period

	Action Programmes	**Proposed (NRs. in Million)**
1	Integrated Programme for Irrigated Agriculture	7,065.30
2	Improved Management of Existing Irrigation Projects	11,492.22
3	Improved Planning and Management of New Irrigation Projects	13,202.58
4	Strengthening of Local Capacity of Planning, Implementation & Management	125.70
5	National Capacity Building of Farmers	165.36
	Grand Total	32,051.16

The budget allocated in Interim Plan document is nearly 59 percent less than the estimated budget of NWP for irrigation sector.

1.18 Challenges

Different analyses presented in this paper show that there are many challenges in meeting the objectives and goals set by the NWP. Some of the most pertinent ones have been enumerated below:

- Mechanism needs to be developed for the monitoring and evaluating the indicators set by the NWP. Moreover, some of the indicators need to be reviewed and refined.
- Need has felt to reflect the priorities set by the NWP and master plans of irrigation also in the projects and program.
- Major thrust in terms of ISF collection is needed if we are to move towards the targets set by NWP.
- The interim plan in the planning document mandates the adaptation of River Basin Approach and IWRM principles; however, the action programs are not specific in addressing the approach and principles.
- The target to increase the coverage of irrigated area in Interim Plan is higher than NWP. It is found that over five years (tenth plan period), 87,485 ha. of potential area is irrigated. Considering this achievement, the target to irrigate 1,19,600 ha. over three years period looks ambitious.
- There is already a shortfall of 59,232 ha. at the end of tenth plan period. It is assumed that this backlog has been incorporated in the interim plan target of 1,19,600 ha. Clarity in this regard will help in implementation process.
- The NWP specifically recognises the need to increase year round irrigated area where as the interim plan is silent to mention this program.
- The action program under interim plan document covers all the specific activities such as increasing cropping intensity, efficiency of irrigation system, increasing irrigation services fees, etc. as mentioned in the NWP. The challenge is not only to extend the irrigated areas but also to carry out the above mentioned activities in order to sustain the system and provide benefit to the water users.

- The budgetary allocation in Interim plan varies from that of NWP. It is seen that NWP estimated a larger amount to achieve a relatively smaller target.

Meeting the Challenges

The following recommendation has been suggested for meeting the above mentioned challenges in the irrigation sector:

- There is still a pressing need to enhance the level of understanding of the beneficiaries and stakeholders in order to internalise the concept of IWRM in different levels of program/project formulation implementation and management of irrigation sector.
- The database of year round irrigated areas, irrigation efficiency, cropping intensity and diversification needs to be established and updated. Capacity development program of the related agencies need to be undertaken in coordination with the agriculture sector. This will help in appropriate prioritization of programs and projects.
- Operating modality for optimum benefits and sustainable use has to be derived and roles/responsibilities of the stakeholders have to be defined through participatory process. The beneficiaries need to be involved in all the phases of irrigation development.
- The budgetary provision made under the interim plan be reviewed and adjusted as per the requirement taking into confidence the related stakeholders.

Conclusion

There are some clear discrepancies between NWP and the Tenth Development Plan both in terms of the proposed activities and what was actually implement and in terms of targets and achievement. The approach has to be to minimize these differences and to adhere to the principles of IWRM while developing and implementing programs and project in the future. The policy of three-year interim plan attempted to adopt the doctrines of NWP that are integration, coordination, decentralization, participation and equity in irrigation sector. However, these doctrines also need to be addressed in formulating the implementation mechanism of the designed program. The formulated program is silent on increasing year round irrigation and efficiency of the irrigation system which is equally important as extension of coverage of irrigated area.

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Department of Irrigation and Irrigation Development

Rajendra Prasad Adhikary, SDE, DoI
rpadhikary108@yahoo.com

Abstract

Nepal commenced its program of planned economic development from the mid fifties with the launching of First Five Year Plan in 1956. The government has expressed a strong commitment to achieve optimum growth of national production and its equitable distribution. Nepal is considered as one of the richest countries in the world in terms of available water resources. Its immense water resources can be the biggest source of national wealth. So far the available water resources have not been fully utilized for the common benefit of the people of Nepal. Agriculture being the backbone of Nepalese economy with over 80 % of rural population actively engaged in agriculture for their living, irrigation can play a vital role in increasing agriculture productivity. Therefore, government has been making substantial budgetary allocation in irrigation development to enable surplus production to meet food deficit, increase income of rural farmers, and subsequently enhance their quality of life. Integrated Water Resources Management (IWRM) has been adopted as one of the guiding principal while making the water utilization plan of Nepal. Different sectoral use of water resources must be coordinated within and across the sectors. Government of Nepal have emphasized round the year irrigation service and expansion of irrigation area with view of increasing agricultural production to feed the growing population. Department of Irrigation (DoI) is a sole Government agency responsible for the entire irrigation projects in the country. Under the guiding principle of National Water Plan and the National Water Strategy, DoI has several projects that reflect both the long and short term vision of the irrigation development. Management transfer to the beneficiary in decentralized community based manner and enhancing efficiency of irrigation water use by adopting integrated crop water management concept has been prime theme of the irrigation development. Food security for Nepalese people and the global food trade scenario has become a new challenging task in planning irrigation development.

Introduction

Nepal is considered as one of the richest countries in the world in terms of available water resources. Its immense water resources, if properly utilized, can be the biggest source of national wealth. Tremendous volume of water flows through hundreds of big and small rivers throughout the country. During the rainy season they create serious threats of high floods and inundation. Minimizing these adverse effects require large amount of technical and financial resources. So far, neither have these rivers been properly trained to minimize their adverse effects nor have their water resources been fully utilized.

Agriculture is the backbone of Nepalese economy with over 80% of rural population actively engaged in agriculture for their living. It is well understood that irrigation can play a catalytic role in increasing agricultural productivity. Irrigation enables to cultivate multiple crops, reduces the risk of crop failure due to drought and stabilizes the food production by minimizing rainfall induced fluctuation. Therefore, government has been making substantial budgetary allocations in irrigation development to enable surplus production to meet food deficit, increase income of rural farmers, and subsequently enhance their quality of life.

Water Resources of Nepal

There are six thousand rivers in Nepal flowing from north to south of the country. Rivers of Nepal can be classified based on their origin, age, topography and character. There are some very old rivers like the Koshi, Gandaki, Narayani and Karnali. These rivers have definite regime flow with deep cut and vertically sharp gorges. In fact, their genesis is believed to be from as early as that of the northern Himalayas.

On the basis of the place of origin, rivers of Nepal can be grouped in four categories as follows:

i) Rivers originated from higher Himalayas, perennial rivers
ii) Rivers originated from Mahabharat and inner terai, perennial rivers
iii) Rivers originated from Churiya Hills, ephemeral rivers
iv) Rivers originated from the Terai, the southern rivers

Himalayan rivers are snow fed rivers having very large discharge. Extraction of water from these rivers requires high level of technical and hydraulic analysis. These rivers are well known in the world for their huge discharge and the extent of damage they frequently cause.

Rivers originating from the Mahabharat range are the medium size rivers. Discharge of these rivers reaches as high as 8000 to 10000 cumec. While passing through the hilly regions of Nepal they transport a huge quantity of the sediments including fertile soil.

There are large numbers of small, relatively very young rivers originating in the Churiya hill in the sourthen flat plain of the terai. These rivers originate from the southern face of the Churia range. Length of these rivers, from their origin up to the Indian border, ranges from 25 to 40 Kilometers. Their catchments areas are between 30 square Km to 200 square Km. Run off of rivers of this type occurs within 2-3 months of the monsoon seasons between July and September and they are completely dry during the rest of the year. Most of the runoff occurs in the form of short and high flash flood lasting only 1 to 2 hours. The yearly flood ranges from 100 - 300 cumecs. Hundred year flood in some rivers may reach 1000 cumecs.

Rivers originating from high altitude regions carry heavy sediment loads. On one hand, steep slope gradient, intense precipitation and sparse forest cover have made hills very vulnerable to erosion. On the other, these rivers cause heavy seasonal flooding damaging agricultural land and properties in the hills and terai every year. Weak and fragile geology of Nepalese hills associated with intense rainfall during the monsoon season often results in debris torrent laden with boulders causing threats to lives and property. Most of the rivers acquire very high gradient before entering into terai, forcing them to transport heavy sediment load. As they enter the Gangetic plain of India, the rivers spread out and their gradients decrease abruptly. This results in a decrease in sediment transportation capacity. Such obstruction produces deposition of bed loading causing the rivers to spread out inundating vast areas of cultivated land.

Integrated Water Resources Management

Integrated Water Resources Management (IWRM) has been adopted as one of the guiding principles while making the water utilization plan in Nepal. This mode of water management principle professes that the water must be viewed from a holistic perspective. The different sectoral use of water resources, i.e. domestic, agriculture, hydropower, industrial, cultural and environmental, etc, must be coordinated within and across the sectors. The delivery mechanism of the water service distribution shall be done in a decentralized manner involving local autonomous and accountable agencies. These could be public, private or the community and users based agencies. Participation and consultation with all the stakeholders both in the local and the regional level will make a reliable basis for the water sector development and management. IWRM mainly

focuses on sustainable utilization of the existing water ensuring that the natural resources are conserved and that the environment is protected.

IWRM also adopts the river basin as the basic unit for management and thus the entire country has been hydrologically divided into the numbers of basins and the sub basins. All the basins of Nepal constitute a part of the greater Ganga basin.

Round the Year Irrigation

The policy documents of the Government of Nepal have emphasized that the area under year round irrigation needs to be increased with the view of increasing agricultural production to feed the growing population. There are two possible ways of achieving year round irrigation, particularly in the terai area where the most of the irrigation land is located: firstly, through conjunctive use of ground and surface water and, secondly, through the construction of storage reservoirs. Groundwater irrigation through shallow tubewells is however, not going to provide a long term solution to the problem. Therefore, we have to construct reservoir projects to provide the year round irrigation in the future. The irrigation policy, 2060 has also mandated DoI to develop multipurpose projects with irrigation as the primary benefit.

Expansion of Irrigation Area

More than half of the population of the country is living in hills and mountains. Majority of the marginal farmers farm in sloppy terraces not irrigable by conventional irrigation method and hence considered non irrigable land. Using the database of Land Resources Mapping Project 1986 and water use inventory of various districts carried out by WECS, irrigation master plan (1990) had made an estimation of irrigable land in Nepal. In general, the irrigable land in hills is limited. The total irrigable land in hills and mountains is estimated 429000 ha out of which irrigation facilities is available in 215,000 ha of cultivated land and year round irrigation facilities is available only in 84, 000ha of irrigated land (WRS Nepal, 2002). About 50% of the irrigable land in hills and mountains and about 30% of irrigable land in the terai still remains to be developed with irrigation facilities.

Rehabilitation and Modernization of Existing Systems

Possibilities of expanding the cropped area both in hills and terai are limited. Hence, physical system rehabilitation and improvement of management of irrigation systems with appropriate modern technologies is the way ahead for increasing the reliability and efficiency of the irrigation systems. Therefore modernization of the existing irrigation systems is a priority for DoI.

Presently, DoI and few other organizations are working in this area of irrigation development. The main objective of the above works is to provide round the year irrigation facilities to the irrigation suitable land by effective utilization of the available water resources of the country (Irrigation policy 2060). To meet this objective irrigation projects should be designed in such a way that water can be delivered and utilized in harmonized, effective and sustainable manner.

Mountains and hills of Nepal are very fragile. Whole Himalayas comprise a geologically active zone where instability due to tectonic activity and continuous on going erosions everywhere. Active degradation of upper mountain slopes and valley slides generate vast quantity of sediments in the rivers. Moreover, land slides, mass wasting, erosions, are the major threats to the stability of the canal systems especially in the hills and mountains. Nepalese rivers are very dynamic and

violent. The fragile geomorphology of the mountains has been a key cause of destruction of the irrigation infrastructures both in the mountain and the terai regions requiring large rehabilitation. Rehabilitation and modernization with the latest irrigation technologies not only makes the irrigation system efficient but also makes the infrastructure tolerant against the adverse effect of soil movement.

Irrigation Development Vision

Water resources potential of Nepal is estimated to be 225 billion cubic meters of surface water and 9 billion cubic meters of groundwater on an annual basis of which only about 8% has been tapped for irrigation use. However, there is considerable seasonal and spatial variation in water availability, and potential for irrigation varies across ecological zones. More than three quarters of the total irrigable land lies in the flat plain of terai where the quality of irrigation in terms of water quantity, timeliness, year-round availability is likely to be better, especially given the potential for ground water.

Recognizing irrigation as a major input to agricultural productivity and growth, Irrigation Development Vision (IDV) has been prepared to achieve the medium and long term goal of the irrigation sector. It also tries to present clearly and concisely the strategies, polices and key program activities on the basis of past implementation experiences. The Irrigation Development Vision begins with the government vision for the irrigation sector. It lists out key strategies and polices followed by proposed irrigation development program.

IDV formulates following long term vision for the development of irrigation sector in the country and institutional reform of the DoI:

- Provide sustainable services to users for improved agriculture and livelihood support through the development of controlled and year round irrigation facilities that could be managed by stable partnership of users, Government, local bodies and private sectors through the mobilization of local resources, a major source of which comes from the users.
- Reorganize DOI to become a genuine service oriented institution that promotes stakeholders participation and water users' association empowerment, and provides effective services in response to the needs of the diverse stakeholders including the socially disadvantaged groups to facilitate the achievements of their development objectives.

In recognition of this vision, for the first five years, the Water Resources Strategy for the irrigation sector emphasizes on implementation and promotion of sustainable effective irrigation systems, based on opportunities to intensify and diversify agriculture production and to establish new sustainable conditions of improved prosperity for individual farmers and the rural community they support. It also emphasizes the importance of sustained opportunities for farmers in commercialized agriculture and increased productivity from land.

In the following ten years, the vision is to focus activities on achieving reliable irrigation services and expansion of these services based on sustainability and the creation of wealth. By the end of 25 years, the sector will strive to provide appropriate and efficient irrigation for the optimal use of irrigable land in a sustainable manner. Point wise they are as follows:

- Provide irrigation services to 90 % of irrigable lands.
- Increase cropping intensity to exceed 250%.
- Increase irrigation system efficiency of large surface irrigation systems to 60%.
- Establish and strengthen Water Users Association that are capable of managing irrigation systems up to 5000 ha.
- Provide year round irrigation to two thirds of irrigated areas.

Department of Irrigation and Irrigation Development

DoI is the leading government agency responsible for the entire irrigation projects in the country. It is one of the departments under the Ministry of Water Resources whose prime goal is to take a leading role for developing all round irrigation facilities and for generating economical activities and employment opportunities by utilizing the available water resources of the country. Control and regulation facilities on water resources facilitate the delivery of round the year irrigation service to the users. This not only increases the agricultural productivity of the country but also makes the livelihood of the people better. Food production and the environmental conservation have been considered simultaneously so that water resources can be utilized in a sustainable manner. DOI is putting consorted effort in bringing out all the potentially irrigable area under irrigation coverage. Under the guiding principle of National Water Plan and the National Water Resources Strategy, DoI has the following projects in progress.

Irrigation and Water Resource Management Project (IWRMP)

Irrigation and water resource management is a new modality of irrigation project in which productivity of water and land use has been considered together. It is being implemented through World Bank grant assistance. The project will be implemented in the selected farmer managed irrigation systems in all the 40 districts of western, mid-western and far-western regions and in selected agency managed irrigation systems from throughout the country.

During the time of the project formulation the main theme of the project was to expedite the agricultural growth to ensure the food security of the nation in order to reduce poverty of the Nepalese people. This could only be achieved by the expanded growth of the irrigated agriculture area. Adequate amount of quality water at the time of irrigation should be made available in the agriculture field together with other input such as seed and fertilizers. The increment in cropping intensities which ultimately raise crop yield increases the farm income of the farmers. The following are the main project objectives:

i) Service delivery of the irrigation system would be improved so that the water users get the required amount of water at the time of need. Adequate and reliable delivery of irrigation water has been considered as prime criteria of the irrigation service delivery.
ii) Most of the irrigation systems of Nepal are running with very low efficiency. Under this project, the efficiency of the irrigation system selected would be improved so that the irrigation system as whole can operate in a sustainable manner.

In order to achieve the above objectives the following programs have been proposed for implementation:

i) New irrigation infrastructures development and the improvement of the old ones.
ii) Completion and consolidation of Irrigation Management Transfer program.
iii) Institutional and policy support for better water management and productivity.

The IWRMP has the following four components:

A. Rehabilitation and Modernization of Irrigation Infrastructures:
Both the agency managed and the farmers managed irrigation system lacks proper maintenance so that the irrigation system as such is running with very low efficiency. This results in very low output unit input of the irrigation water. The productivity capacity of the unit volume of water should be increased in an effective manner in order to bring the large stretch of the command area under irrigation. Realizing this, IWRMP has got rehabilitation of

the old and defunct irrigation systems. Rehabilitation and modernization shall be carried out simultaneously so as to increase the water use efficiency of the systems. Modern technologies of irrigation such as drip and sprinkler methods would be adopted in water delivery as and when suitable.

B. Irrigation Institutional Reform:

An irrigation management transfer to the beneficiary farmers has been the prime goal as per the national water resource strategy. The management of the irrigation systems will be simultaneously transferred to the capable stakeholder farmers of the irrigation projects. This not only decreases the annual operation and maintenance budget of DoI but also helps to generate resources from the system in decentralized manner. IWRMP strengthens the capability of the stakeholder farmers in order to run the Irrigation system effectively after the management transfer. Under this program the regional and the unit irrigation offices under the DoI would be institutionally equipped with trained manpower and the logistics.

C Integrated Crop and Water Management Component:

This component of the project emphasizes on enhancing the efficiency of irrigation water use. In most of the irrigation systems the irrigation water has been guided by the concept of water supply. Proportionate amount of water per crop has not been considered so far in a large scale. This could be because of the availability of abundant water in many irrigation systems. Over the years, versatile use of fresh water in many sectors has made the fresh water scare. Similarly more agriculture land has to be brought under irrigation in order to cope up with the ever growing population of the country .It would seek to enhance productivity and profitability of agriculture by promoting improved water management and agro-economic practices. The non conventional or the modern irrigation technologies such as drip and sprinkler would be brought under use for promotion of better water use and water management. Farmers' Field School and farmers to farmers' extension linkage of agronomics practices would be established as site specific, local needs and market opportunities. This component also covers a support program for pre and post production activities such as rural access infrastructures , improved availability of hybrid seeds, strengthening of the supply chain, improved storage structures, improved crop handling practices.

Community-Managed Irrigated Agriculture Sector Project (CMIASP)

This project has been introduced to improve the economic status of the rural people in order to decrease the rural poverty. It has been conducted under the loan agreement with the Asian Development Bank and the OPEC Fund. All the 35 districts of central and eastern development regions come under this project. Several programs, such as empowerment of water users associations, development and extension of irrigation services, agriculture extension and capacity building of the traditionally deprived farmers' communities in the rural areas, improvement of the economic status of rural population are presently being implemented under this project. Following are the important specialties of the project:

i) The sub project gets support from CMISP when the group request from the organized water users committee come forward.
ii) Fund is available to the subproject as per predetermined procedure and specified share of the total sub project cost should be borne by the user farmers.
iii) Separate working provision has been made for the opportunity deprived community. This approach has been formulated in order to address the poverty mitigation issue.
iv) The project will be implemented with the collaboration among Government, Private and the Non Governmental organizations.

v) The project will be implemented in such a way that the progress in the district level shall be measured with respect to the Agricultural strategy where as in the sub project level the progress shall be measured in reference to the formulation of practical agricultural development projects.

Decentralized Community Based Water management Project

Proposed Decentralized Community based Water Management Project (DCBWMP) aims to enhancing irrigation productivity through sustainable and decentralized irrigation development and management focusing to the needs of small land holders and the marginalized farmers thus by increasing the role and control of users in the development and management of irrigation infrastructures, water distribution and water utilization. The project has been conceived to include four interrelated components to complement the ongoing initiatives of DoI in improving the performance of irrigation and irrigated agriculture. They are:

i) Irrigation Management transfer (IMT) of total of eight DOI managed surface and ground water irrigation schemes comprising 45,700 ha;
ii) Ground water development through shallow tube wells in 12 terai districts in the central and eastern development regions comprising total of 5,400 ha;
iii) Promotion of non conventional irrigation technologies (NITs) catering to the irrigation needs of small and marginal farmers, comprising total of 10, 000 ha; and
iv) Integrated Crop and Water Management Program (ICWMP) to enhance the productivity of irrigated agriculture in surface (FMIS and DOI managed) and groundwater irrigation schemes comprising total of 4,168 ha.

Summary and Conclusion

DoI as the lead government agency responsible for irrigation development and management through the country is presently making several efforts towards the end of achieving year-round irrigation facilities. Its recent endeavors like CMIASP, IWRMP, DCWMP, are based on an integrated approach to irrigation development and work within the framework of IWRM. For the way ahead, DOI should consider the use of modern technology like RS and GIS and it should focus on the development of multipurpose storage projects which not only help in establishing year-round irrigation but also help in harnessing the country's water resources.

Groundwater Irrigation: Status and Vision

Naba Raj Shrestha, Senior Divisional Hydro-geologist, DOI
Jeevan Lal Shrestha, Deputy Director General, DOI

Abstract

Nepal is rich in water resource. From the river systems of Nepal, annually about 200 billion cubic meters of water flow to river Ganges. The annual precipitation is the main source for annual groundwater recharge into the fractures of hard rocks and the sedimentary aquifer systems. Studies to this effect have shown that there is very high potential of rechargeable groundwater resource in the Terai plain and inner Terai valleys. This resource can be used for regular and reliable supply for round the year irrigation facility. This is reflected in the policy and development plan documents of the Government especially APP document and National Water Plan etc., which have given high priority to use this resource for the economic development through agriculture.

Round the Year irrigation facility development by the government of Nepal is taking place in Terai and inner Terai through Shallow Tube Well and Deep Tube Well Irrigation. Government is providing direct and indirect support to farmers to increase the tube well irrigation areas. But new opportunities and challenges are also emerging for the farmers to cultivate cash crops such as vegetables etc. as there is assured source of irrigation facilities. Electricity distribution network, road access, market access, fertilizers, improved seeds, credit facility, government resource etc. are some of the items, which need to be improved a lot. Hence, despite the remarkable advantages and willingness of farmers in using this resource the progress has not been encouraging. Government needs to be cautious to formulate policies and action plans so that they are farmer friendly and are able to provide favorable working environment.

Introduction

The average annual rainfall in Nepal range from 1,500 mm to 2,000 mm. Small part of it is held in the fractures of hard rocks, some part infiltrate to sedimentary aquifer and some part is retained as snow in the high mountains. Substantial part runs off and drains out through river system of Nepal. Annually some 200 billion cubic meters flow out of Nepal to river Ganges. The rainfall pattern is such that about 75% of rainfall occurs during the monsoon period i.e. June to September.

Annual precipitation is the main source for recharging the aquifers. It is estimated that about 20% of the annual precipitation infiltrate to the shallow and deep seated aquifers in the alluvial terrain in the Terai plain. The Bhabar zone lies in the northern part of the Terai plain and extends in the east-west direction. It exists almost in the entire Terai districts. This part is the main infiltrating area as the subsurface is composed of more porous materials like gravels, pebbles and even boulders.

The terai plain is the northern extension of large Indo-Gangetic Plain. The average width of the Terai is about 30 km and extend east west, except in Chitwan, north-west part of Kapilvastu and Deokhuri where it is missing. It is very fertile and plain area, which is very good for agriculture development. It consists of one of the very productive aquifer system in the south-east Asia.

Groundwater Investigations

Groundwater investigation works in Terai started in 1967 through US Aide mission. Over 100 deep tube wells were constructed in western Terai districts for evaluating the groundwater potential. Study in Kathmandu valley was made under Indian Cooperation Mission in 1967 by constructing numbers of deep tube well and geological survey. Afterwards, many studies in Kathmandu valley and Terai areas were conducted by various national and international agencies to assess the ground water potential for irrigation and other uses.

Groundwater Development Potential

Various studies carried out so far concluded that the Terai is a part of large Indo-Gangetic Plain and it constitutes very thick layers of alluvial sediments that have developed a system of multiple aquifers. Thickness of alluvial sediment may reach well over 500m. Both confined and unconfined aquifers are present in this section. The aquifers are highly favorable for GW development.

There are many tectonic and river valleys like Panchkhal, Kolphu, Trisuli, Bhakunde Besi etc. where groundwater seems to be favorable but no studies have been done so far. Due to ever increasing demand of irrigation in these areas for intensive agricultural practices, there is increasing pressure to find out the possibility of groundwater.

The total area of Terai plain and Bhabar area of Nepal is 3.61 Mha. Out of this only 1.356 Mha is irrigable. The ground water investigation suggests that there is good potential for shallow tube well irrigation development in 0.726 Mha lands and marginal shallow tube well irrigation development in only 0.305 Mha. The deep tube well irrigation development is good in 0.19 Mha in the whole Terai region. The potential annual recharge is 8,800 MCM, which can be used without adverse effect on environment.

Subsidy Scenario in Groundwater Irrigation

There is different scenario of cost sharing in tube well irrigation. In deep tube well irrigation farmer's share was fixed at 16% of the cost of project either in cash or in kind or combination of both. Now it is fixed at 15%. Government bears 85% of the total project cost.

In shallow tube well irrigation the scenario is little more complex. The subsidy was 60%, 30% and 0% in F. Y. 055/56, 056/57 and 057/58 respectively. In the zero subsidy regime the demand for STW construction reduced significantly. However, the ADB funded Community Groundwater Irrigation Sector Project, which was designed without subsidy but with lots of Farmer's Support Services to attract farmers for STW installation, has gained popularity. So in APP STW project also this system was adopted but with limited support services. In this new system, farmer have to construct the STW on their own cost, government provide services (bears the cost for), which includes electrification of STWs, minor repair and maintenance of approach road, distribution of one pump for every two STW's etc. One package of services is provided for each cluster of 50 ha. The government cost for support for each cluster is limited by budget. Farmer decide on the items (from the prior approved list of items) to be included for the government's support.

Tube Well Irrigation Development

In some parts of Terai, where surface water is not available, Groundwater is the only source of water for irrigation. Farmers constructed dug wells and shallow tube wells in such areas for drinking and irrigation purposes.

In Terai, groundwater irrigation is expanded with government's own resource and with assistance from various donors. The World Bank assisted Bhairahawa Lumbini Ground Water Project in Rupendehi district is one of the major groundwater irrigation project. Also many other groundwater projects were implemented afterwards. Major projects are Irrigation Line of Credit and Nepal Irrigation Sector Project with the loan assistance of The World Bank covering districts from Nawalparasi to Kanchanpur, Community Shallow Tubewell Irrigation Project under the loan assistance of IFAD, ADB funded Community Groundwater Irrigation Sector Project and various government funded projects. The list of the completed & ongoing groundwater irrigation projects are presented in Table 1.

Table 1: Tube Well Irrigation Command area

S. No.	Project	District	Command area (ha)	Remarks
1	Baise Bichuwa STW Irrigation Project	Kanchanpur	150	STW
2	Mohana Irrigation Project	Kailali	37	STW, conjunctive
3	Irrigation Line of Credit (ILC)	Nawalparasi to Kanchanpur	4,328	STW and DTW
4	Nepal Irrigation Sector Project (NISP)	"	5,336	"
5	Sagarmatha Integrated Rural Development Project (SIRDP)	Siraha and Saptari	12,175	"
6	Seti Integrated Rural Development Project	Kailali	1,100	"
7	Community Shallow Tubewell Irrigation Project	Sunsari, Saptari, Siraha, Sarlahi and Rautahat	4,855	STW
8	Arjun Khola Irrigation Project	Deokhuri valley	180	Conjunctive
9	Narayani Zone Irrigation Development Project	Bara and Parsa	700	DTW, Conjunctive
10	Kapilvastu Tube well Project	Kapilvastu	60	DTW
11	Aparesota, Satbariya Tube Well Project	Dang	290	DTW
12	Kailali-Kanchanpur Tube Well Project	Kailali & Kanchanpur	538	DTW
13	Irrigation Development Project (IDP)	Banke	680	DTW
14	Mahottari Tube well Project	Mahottari	823	DTW
15	Community Groundwater Irrigation Sector Project	Chitwan to Jhapa	37,685	STW
16	Bhairaha Lumbini Groundwater Project	Rupandehi	20,309	DTW

17	Agriculture Perspective Plan	All Terai Districts	20,846	STW & DTW
18	Ground Water Irrigation Project	Siraha to Jhapa Siraha & Mahottari	240	DTW STW

Agriculture Development Bank (ADB/N) also contributed significantly in increasing the command area mainly from shallow tube well Irrigation. ADB/N was the pioneer agency for STW development. ADB/N had developed STWs since 1978 with various subsidy rates and so far it had developed 1,67,943 ha of command area. After the removal of subsidy the STW installation by ADB/N had decreased considerably.

Janakpur Agriculture Development Project (ADP/J) under Ministry of Agriculture and Cooperatives is also developing DTWs for irrigation. It has developed so far 16,405 ha command area.

Ongoing Tube well Irrigation Projects

Ground water is reliable source to maintain regular supply of water, which is of prime importance for the agriculture development. Hence demand for ground water irrigation is ever increasing. Government has also increased investment in the development of shallow tube well irrigation to fulfill the demand.

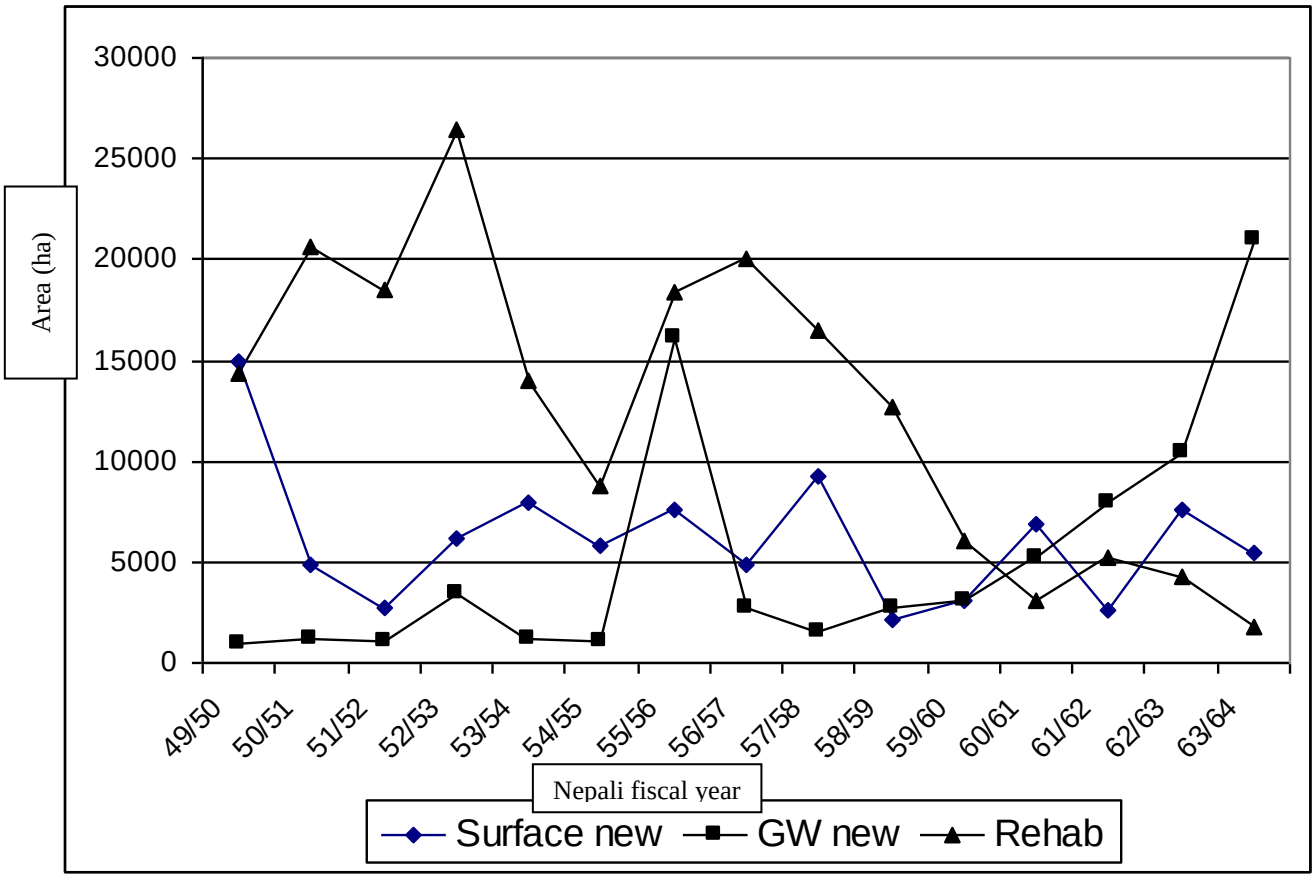
In case of deep tube well irrigation also farmer's demand is high but government approach is to go only in areas where shallow tube well irrigation potential is low or nil but the DTW potential exists. Such areas exist in northern parts of Terai bordering the Churia hill i.e. Bhabar zone. Such areas also exist in some parts in the southern parts of Terai. The farmers have submitted demand forms for over 250 deep tube well systems and deposited NRs. 1.2 million as upfront cash to government as per Irrigation Regulation 1992, and waiting since long for their turn.

At present, government is implementing a number of tube well irrigation projects targeted in Terai districts.

- Agriculture Perspective Plan - STW & DTW Irrigation in all Terai districts under government's own resource
- Ground Water Irrigation Project - STW & DTW irrigation under Indian grant assistance in some eastern terai districts
- Irrigation Water Resource Management Project for STW & DTW Irrigation under World Bank assistance in Nawalparasi to Kanchanpur districts
- Janakpur Agriculture Development Project/ Ministry of Agriculture and Cooperatives mainly implementing DTW Irrigation in Terai.

The achievement made by the Department of Irrigation in year wise command area development since 8th five year to Tenth Five Year Plan (1992 to 2007) in surface and groundwater irrigation is presented in the following table.

Fig No. 1: Development of Command area by Department of Irrigation (F. Y. 049/50 -063/64)



The graph shows that general trend of development of surface irrigation is more compared to tube well irrigation up to the end of Ninth Five Year Plan (July 2002). Afterwards, the contribution of tube well irrigation has increased significantly in fulfilling the annual target of area expansion under irrigation. The tube well irrigation command area is from Terai districts only, whereas the surface irrigation command area is from the whole country.

There are many river valleys in the mountain areas, like Paanchkhal, Bhakundebesi, etc. Such valleys are very fertile and demands for agricultural activities are high. These valleys can be good source of agriculture products for neighboring market centers like Kathmandu. Such valleys can be very effective alternative to our increasing dependency in Terai. But surface water source is exhausted and round the year and reliable irrigation facility is a great problem in the valleys. Hence ground water investigation and development has to be extended in such areas as well.

Studies for pipe line projects

Ground water studies for large projects were carried out in Rupandehi, Parsa, Jhapa, Mahottari, Banke districts, etc. Apart from these large sized projects, many feasibility studies of smaller clusters (over 250 ha each) had also been completed in different Terai districts under government resource. The list of these pipe line projects are tabulated below.

Table 2: Pipe line projects and command area

S. No.	Project	District	CA (ha)	STW/DTW	Remarks
1	Terai Groundwater Irrigation	Rupandehi	4,480	DTW	Study under WB assistance
2	"	Parsa	7,250	STW+DTW	"
3	Terai Groundwater for irrigation	Jhapa	17,000	DTW	Study under JICA assistance
4	"	Mahottari	7,000	DTW	"
5	"	Banke	8,000	DTW	"
6	DTW feasible clusters	Different districts	> 6,000	DTW	Study under government resource

The investigation works conducted so far have also shown that there is large area in Terai where shallow tube well irrigation is feasible. But in some places there is hard bouldery formation present at shallow depth, under which exists good aquifer. In such areas, though the tube well depth is limited (less than 50m), it is difficult and hence the expensive to drill upper hard layer. This has been big financial gamble to farmers in these areas. Government need to formulate suitable policy to help farmers in such difficult areas.

Plans, Policy and Legal aspects in GW irrigation development

There exist many documents approved by the Government regarding the groundwater resource development for irrigation. The aspects related to groundwater resource are dealt with in the following sections.

a) Water Resources Act (1992) and Water Resources Regulation (1993)
This is the basic legislation for regulating the exploitation, utilization, and management of water resources in the country. It has established the order of priority in water use. Irrigation is in second priority after drinking water and domestic use.

b) Agriculture Perspective Plan (APP) (1995)
It is a 20 years multi sectoral plan (1995-2015) to accelerate agricultural growth. It has envisaged subsidy in shallow tube well irrigation and fertilizer etc. It has emphasized on the development of year round irrigation in Terai using ground water, as there is very good potential. Its annual target is to develop command area at the rate of 22,000 ha by shallow tube well and 2,000 ha by deep well irrigation for 20 years.

c) Irrigation Policy (2003) and Irrigation Regulation (1999) (and amendments)
These documents have emphasized for increasing year round irrigation by effective utilization of surface as well as groundwater. It states that there will not be any discrimination regarding government treatment of source of surface water and groundwater. It has fixed subsidy rate as the following:
Government investment according to type of irrigation is as the following

- 95-97% in surface irrigation scheme
- 85% in DTW irrigation scheme
- zero in STW irrigation scheme

In the case of shallow tube well irrigation farmer has to construct the tube well on their own cost. Government provide support service as mentioned in Section 11 (h) below, like

electrification, minor road maintenance, distribution of pump sets (one unit per two stw's) etc.

The irrigation schemes are transferred to users group/association after construction/ rehabilitation. The operation, repair and maintenance is the responsibility of the farmers after transfer.

d) National Water Resource Strategy (NWRS, 2002)

It has given holistic approach to manage country's water resources. It also has set the short, medium and long term targets in the development of water resources. It states that for sustainable management there is need of groundwater regulatory body to regulate its abstraction and that existing Ground Water Resources Development Board (GWRDB) be converted as regulatory authority.

e) National Water Plan (2005)

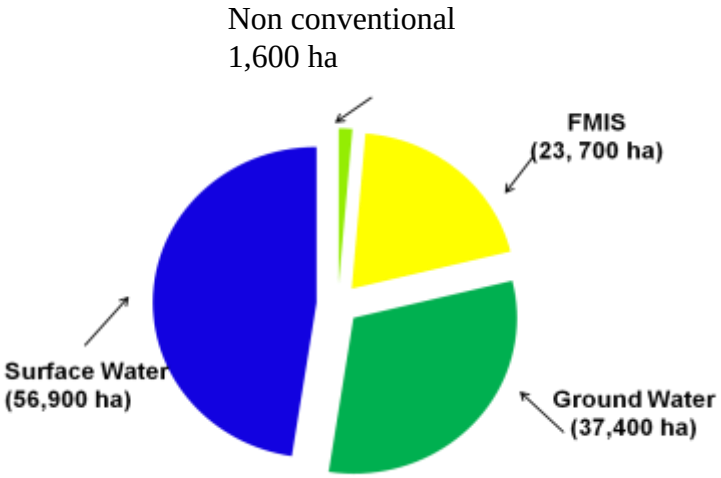
It has set irrigation targets as guided by the NWRS, 2002. The main features regarding ground water development is to launch groundwater projects in new areas, take regulatory measures and increase year round irrigation by conjunctive use of surface and groundwater resource.

f) Irrigation Development Vision (IDV, 2005)

The IDV has outlined the strategy, plans and the programs for achieving stated goals of NWP. It has set target for physical development for first ten years of the NWP period, i.e. up to 2012 AD. The target for surface irrigation is 1,08,701 ha (54%) and for groundwater irrigation is 92,172 ha (46%) of which STW irrigation in 82,172ha and DTW irrigation in 10,000 ha.

g) Periodic Development Plans

The periodic plans like five year plans also depict the total target of irrigation. Instead of regular five year plan, Interim three year plan is running now since FY 2064/65. The target set for the interim plan period is to develop surface irrigation in 56,900 ha (59%) and groundwater irrigation in 37,400 ha (39%) and non irrigation Non Conventional Irrigation in 1,600 ha (2%). Department must also rehabilitate Farmer Managed Irrigation Systems (FMIS) covering a total of 23,700 ha.



h) STW Implementation procedure, 2005

Shallow tube well irrigation got set back after cancellation of subsidy in 2056. The government developed concept of helping farmer by providing other support services they need instead of direct subsidy. It took some time to finalize the items to be included in the support service. The support service included tube well electrification in the first year (2057). Later on it was extended to include to electrification, maintenance of approach road, distribution of pump sets etc. It was necessary to regularize the shallow tube well irrigation development in the situation of no subsidy and inclusion of support services. Hence the shallow tube well irrigation procedural guidelines was prepared and approved by the Department of Irrigation in line with the Irrigation Procedural Guidelines of the department. The shallow tube well irrigation development is implemented as per the shallow tube well irrigation guideline. It is updated regularly to make it more farmer friendly.

Ground Water Irrigation Development Vision

APP has given high priority to shallow tube well irrigation mainly because there is large chunk of land where STW is feasible in Terai, it is fast and return is quick, it is the reliable and regular source etc. All these reasons are even more relevant now due to development of infrastructures and when the world and Nepal are facing acute food security problem. Food items need to be produced in larger quantity and short duration. This is the area where STW irrigation is playing very important role. This was the main reason that tube well irrigation has been treated as important item in all policy and program documents of government and non government organizations.

The demand for agriculture products are increasing every day. Hence there is need to increase irrigated land in one hand and productivity in the other. Tube well irrigation has potentiality to increase fast the irrigated land. Construction period of tube well irrigation system is comparatively short; there is less environmental effect, small system hence manageable by farmers etc. By this time we have long experienced farmers, managers and policy makers to handle effectively the ground water irrigation.

Construction of infrastructures like road, market places, electrification, agriculture support services etc. which are major components for agriculture development are increasing fast in Terai as the area is favorable.

Conclusion

To attain faster growth rate of tube well irrigation, government should address the following points:

- Attain a faster growth rate of STW in feasible areas. Promote small electric pump instead of diesel pumps
- Limit DTW development to those areas only, where STW is not feasible.
- Plan for intensive development in well defined and larger clusters or blocks, for both STW and DTW irrigation.
- Develop and implement farmer friendly credit facility for tube well installation, operation, agricultural inputs etc.
- Integrate agricultural, electricity distribution network and other support programs in a project package
- Promote community based rural electrification program
- Focus on agricultural extension support services, market development

- Targeted programs to high poverty incidence area
- Regular monitoring for water balance, arsenic content
- Extend GW irrigation in inner and river valleys as well
- Project manages O/M of Electrical installations, as these items need specialized knowledge and huge amounts for repair and maintenance.

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Can Electricity Infrastructure Development Induce Shallow Tubewell Irrigation Expansion in Nepal Terai?

Dibya Ratna Kansakar
Department of Irrigation

1.18.1.1 Abstract

Shallow tubewell (STW) irrigation development rate has been slow in Nepal Terai compared to its neighboring countries like India, Bangladesh and China. The STW policies of Nepal government, since 1980, have addressed only the issues of finance in the capital costs involved in STW installation, but not the pump operating costs. However, with the fast rising market price of diesel fuel, STW farmers are finding it increasingly difficult to earn profit from agriculture, because their groundwater pumping cost is rising. The cost of diesel fuel or energy cost in pump operation constitutes the main chunk of the cost of STW irrigation. However, with the availability of electric energy, as the rural electricity supply network improved in some parts of Terai, farmers are getting attracted to electric pumps for operating their STWs.

Based on the field studies carried out in Dangihat (Morang District), Arjundhara (Jhapa) and Hirminiya (Banke) VDCs in Nepal Terai, the present study demonstrates that groundwater extracted with an electric pump is at least 6.8 times cheaper than that with a diesel pump. This is mainly because of the huge difference between the costs of diesel fuel and electricity. This single factor is leading to rising trend in the use of electric pumps among STW irrigators in Terai, whether there is adequate power generation capacity in the country or not. Again, the study also shows that STW irrigation could be developed more rapidly, and that too in private sector, if the network of electricity infrastructure is strengthened and expanded in rural parts of Terai. Therefore, there is a need to integrate STW program with rural electrification program in order to achieve the targeted growth rate in STW irrigation in Terai, as perceived in Agriculture Perspective Plan and the National Water Plan of Nepal Government. This, however, must also be backed up adequately by well-thought power sector development and management plan.

1.19 Introduction

Agricultural growth is essential for assuring food security, poverty alleviation, and overall economic growth in Nepal. For this, irrigation development is important. Nepalese government has assigned high priority to irrigation development since the very beginning of planned development effort in Nepal, but their achievements have so far lagged behind the targeted levels.

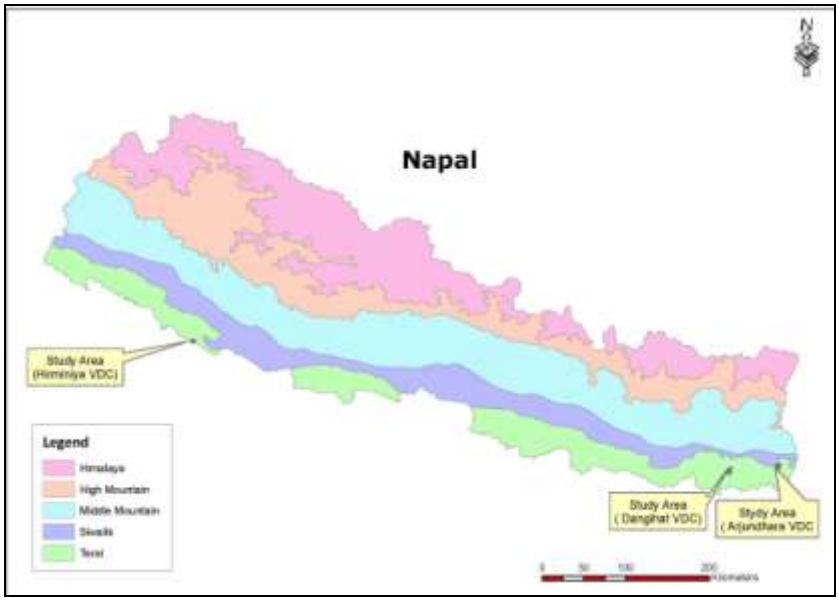
For rapid economic growth in agriculture in Terai, Agriculture Perspective Plan (APP, 1995) and National Water Plan (NWP, 2005) have prioritized shallow tubewell development, albeit as a short-term means. The government policies on STW development – direct capital subsidy from 1980 to 2000 AD, and the current policy of persuading farmers to install shallow tubewells through support in providing credit, agriculture extension and training, and improvements in rural road infra-structures in Community Groundwater Irrigation Sector Project and later on in Shallow Tubewell Irrigation Project (APP special program) of Department of Irrigation (DOI) and Groundwater Resources Development Project (GWRDP) since 2000 AD – have addressed only the capital investment issue of the farmers, but not the issue of energy cost in operating shallow tubewells, which is even more critical for the farmers.

Until very recently, all the government STW programs have promoted only the use of diesel pumps, because the electricity infrastructure development was limited in Terai. Therefore, most of the STWs are operated with diesel pumps in Nepal Terai. However, due to steeply rising trend in diesel fuel price, STW irrigation is becoming increasingly costly to these farmers. In response to this situation, these STW owners minimize their pump use hours, even though their farm productivity is affected adversely. On the other hand, farmers are discouraged to invest in new wells. However, this situation is changing gradually in the areas, where farmers could access to electricity supply network.

The present study compares the cost of energy involved in STW operation by diesel pumps in Dangihat VDC, Morang district, with that in Arjundhara VDC of Jhapa district, where all the STWs are operated with electric pumps. It also compares the impact of energy mode on STW development pattern under Community Groundwater Irrigation Sector Project (CGISP) in these two areas. Again, based on the evidences from Hirminiya VDC in Banke districts, the present paper argues that intensive STW development can take place, that too from private sector, if the electricity infrastructure is developed adequately. The field surveys in Dangihat and Arjundhara areas were carried out during 2007, and the Hirminiya area was studied in late 2007 and early 2008.

1.20 The Study Areas

Dangihat and Arjundhara VDCs are the two among numerous VDCs where CGISP program was implemented. In Dangihat, diesel pumps are dominantly in use, while in Arjundhara area, all the STWs are operated with electric motors. All project supported STWs in these two VDCs are entirely owned in groups by the farmers. In contrast, all the shallow tubewells in Hirminiya VDC are owned by individual farmers. The locations of the study areas are shown in Fig.1.



1.20.1.1.1 Figure 1. Location Map of the Study Sites

COST OF GROUNDWATER PUMPING IN STWS

Besides the capital cost investment in STW, cost of energy or fuel consumed in pump operation is the single most important element that determines the cost of irrigation. For diesel pump operators, the cost of diesel fuel is very high. In 1994, the market price of diesel fuel used to be Rs.12.00/liter, but the same was Rs.52.50 in 2006. At present, it has risen to Rs 67.00/liter. This is an increase by 516% in 14 years. Again, because the divisibility in diesel engine technology is low, farmers generally use 5 to 8 HP engines. Field survey in Dangihat VDC shows that these pumps consumes between 1.0 and 1.5 liters of diesel fuel for an hour of operation. At 2006 market price, the cost of fuel alone was between Rs. 52.50 to Rs. 78.75 per hour. On the other hand, the electricity is much cheaper because electricity tariff rate for irrigators is only Rs. 3.5/kWh. Again, the electric motor technology is highly divisible. Electric motors are available from a small capacity of 0.5 HP to very high capacities. A 2 HP electric pumpset consumes only 1.54 kWh of electric energy per hour, but it can deliver water discharge that is comparable to that from a 5 or even 8 HP diesel pump. At the prevailing electricity tariff rate, their energy cost is only Rs.5.39/hour, which is just 10.3% to 6.8% of the fuel cost in a diesel pump.

The operation and maintenance costs (for the crop year 2005-06) of the twenty-seven diesel pump operators in Dangihat VDC and 33 electric pump operators in Arjundhara were obtained by field survey. The tubewell discharges of all these wells were also measured. The total annual pump operation costs were calculated and the results for the two areas are shown in Figures 2 and 3 respectively.

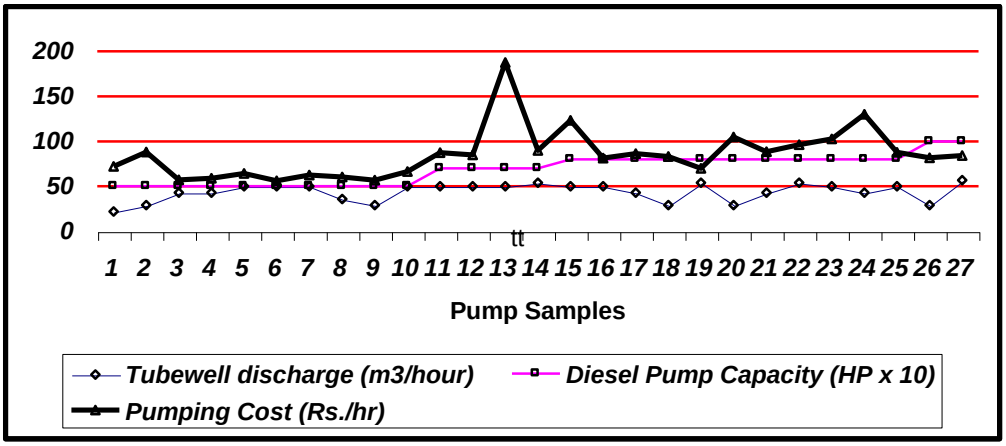


Figure 2. Tubewell Discharge, Pump Capacity and Operation Cost among Diesel Pump Owners in Dangihat VDC, Morang District. (Source: Field Survey, 2007)

For diesel pump operators in Dangihat VDC, the pump operation costs ranged from Rs 56.07 per hour to Rs 187.62 per hour in the year 2005-06 (@ Rs 52.50/liter). A case of extreme high cost reported by one respondent farmer was due to poor condition of his equipment and lower use rate. The average of pumping costs of all diesel pump operators in Dangihat VDC was Rs 85.63 per hour (Figure 2), but among the 5 HP pumps operators (37% of the samples), the average was only Rs 64.27/hour; among 8 HP pump operators (41% of the samples), it was much higher at Rs 95.77/hr. It may be noted that all the 5 HP pumps in the survey sample were relatively new as they were purchased under the CGISP project, whereas many of the 8 HP and 10 HP pumps were older and hence their maintenance costs were also higher.

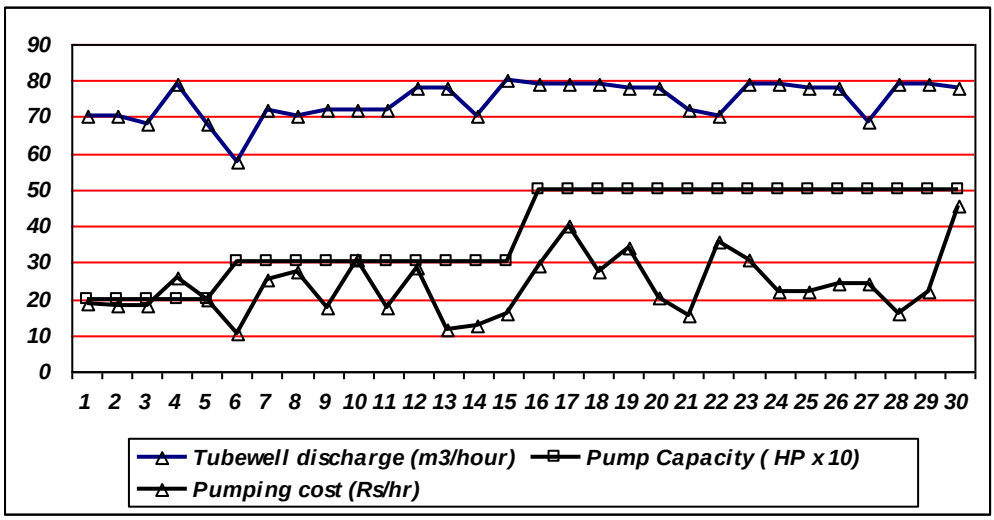


Figure 3. *Tubewell Discharge, Pump Capacity, and Operation Cost among Electric Pump Owners in Arjundhara VDC, Jhapa District. (Source: Field Survey, 2007)*

As already mentioned earlier, although entire STWs in Arjundhara VDC are run with electric pumps, 52% of the pumps in use have 5 HP capacity; only 35% have 3 HP and 15% have 2 HP capacity. With no significant variation in well discharges, these pumps had their operating costs ranging from Rs 10.28 to Rs 139.23 per hour (Figure 3). The average of pumping costs of all the sample pumps was found to be Rs 38.51/hr. Among the 2 HP pump operators, the average cost of pumping was Rs 20.09 per hour only.

In Dangihat VDC, the average cost of groundwater pumped from a diesel pump was Rs 2.06/m^3. It ranged from Rs 1.76/m^3 in 5 HP to Rs2.27/m^3 in 8 HP pumps. In contrast, the average cost of groundwater pumped from a electric pump in Arjundhara was only Rs 0.30/m^3; this is nearly 7

times cheaper that the average cost in Dangihat. These results clearly show why farmers prefer electric mode of STW operation to a diesel fuel mode.

1.21 Electricity Infrastructure and STW Installation Rates

A comparison of STW development patterns in the three study areas are presented here. In the two study sites, namely Dangihat and Arjundhara VDCs, Government of Nepal implemented the Community Groundwater Irrigation Sector Project (CGISP) very recently, whereas in the third study site, i.e. Hirminiya VDC, although the Agricultural Development Bank of Nepal (ADBN) introduced the STW technology in early 1980's, private sector has mainly been responsible for its intensive development recently.

1.21.1 Dangihat VDC, Morang District

This VDC was one of the pilot sites of CGISP, which launched the STW program in its beginning year of 1998. According to the project design, only diesel pumps were installed in the wells, and 19 STWs were installed during its initial five years. The project prescribed the use of 5 HP diesel engines, which were the only smallest capacity pump engines available in the market at that time. But, many of the farmers preferred 7 or 8 HP engines, because they trusted larger capacity pumps. Only 10 out of 19 owners (i.e. 52% samples), purchased 5 HP pumps. The project did not support the use of electric pumps initially, even though electricity supply lines were available in the area. The project faced great difficulty in increasing the number of STW installations. After the project relaxed its policy and allowed electric pumps, 3 more STWs were installed in this VDC after 2004 *(Annual Progress Repost, CGISP, 2007).*

1.21.2 Arjundhara VDC

In Arjundhara VDC, the CGISP program was implemented much later, in 2001 only. When the project was launched, the farmers first demanded for the provision of financing in electric pumps. Interestingly, there was no electricity supply network in the area at that time. Because of similar demand from numerous other project areas, the project changed its policy in 2003 and accommodated the farmers' demand. While the farmers were negotiating for policy change with the project management, the villagers organized themselves and built the electricity infrastructure under the Community Based Rural Electrification (CBRE) program. The CBRE is a cost-sharing program of the government that required the community to share 20% of the project cost. In a short period of two year between 2004 and 2006, the villagers installed 72 STWs under the CGISP *(Annual Progress Report, CGISP, 2007).* All of these wells are fitted with electric pumps. This VDC is one among the few others where the project could achieve such high numbers of STWs installations.

Hirminiya VDC, Banke District

In Hirminiya VDC, Banke district, the Agricultural Development Bank introduced STW technology in 1985. However, there were very few shallow tubewells then. Later on, treadle pump technology became popular because most of the farmers here were small sized farm operators. When electricity supply lines became available, there was a sudden increase in STW numbers. The diesel pumps as well as treadle were replaced with electric pumps. At present, there are 673 shallow tubewells in operation in this VDC. With the help of a hand-held GPS instrument, the STW locations were mapped in parts of the VDC to show the relationship between STW density and the availability electricity infrastructure. The sites were (i) the Bhanghotna village block in ward no. 1, where electricity supply network was good, and (ii) the Koryanpurwa-Jungalisingpurwa block in ward nos, 6 & 7, where electricity infrastructure was poor. The electricity transmission and distribution lines were also mapped (Figure 4).

In Bhanghotna village block (Figure 4), which has an area of 220 ha, 121 mechanized STWs were recorded. Except for the two, which were located far away from electricity line, all the mechanized STWs were run with electric pumps. This shows a density of one shallow tubewell for every 1.8 ha land. In addition, there were 26 treadle pumps, which were located far from electricity line. There were 9 dug wells of earlier times, some of which were now used with electric pumps. Overall, the density of groundwater extraction wells was 0.71 per hectare in this block. In other words, there is one well for every 1.4 ha of land.

In Koryanpurwa-Jungalisingpurwa block, on the other hand, 101 mechanized STWs and 2 dug wells were recorded in an area of 553 ha. Among these STWs also, many were found to be clustered around and along the electricity supply lines. In this block, 37 STWs were operated with diesel pumps, and the rest with electric pumps. Here, the density of groundwater extraction wells is 0.18 per hectare, i.e. there is one well for 5.37 ha land only.

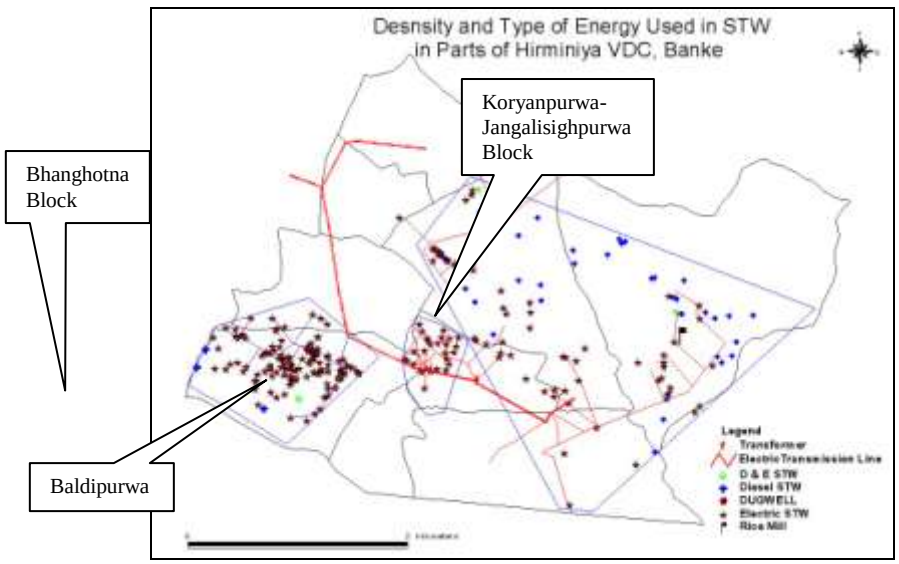


Figure 4. Electricity Line and STW Locations in Hirminiya VDC, Banke. *(Source: Field Survey 2008)*

A detailed map of the Baldipurwa village in ward no.4 shows the tubewell locations and their respective command plots, and distances between the electricity supply line and the electricity supply points, (Figure 5). It may be seen that electricity meters (electricity supply points) are not always sited next to the tubewell site, but closer to the village or a busy trail or a road, for protection from burglary or vandalism. It was found that electricity meters may be as far as up to 100 m away from low-tension electricity line, and tubewell may be even 200 to 300 m far from the electricity meter. Common house-wires were used to bring electricity line from the meter to the pumping (well) site. Again, the commanding plots are not always contiguous, and some plots are quite far away (max. distance 625 m) from the well site. This has become possible because of the availability of low-cost portable polythene pipes in the local market (Figure 5).

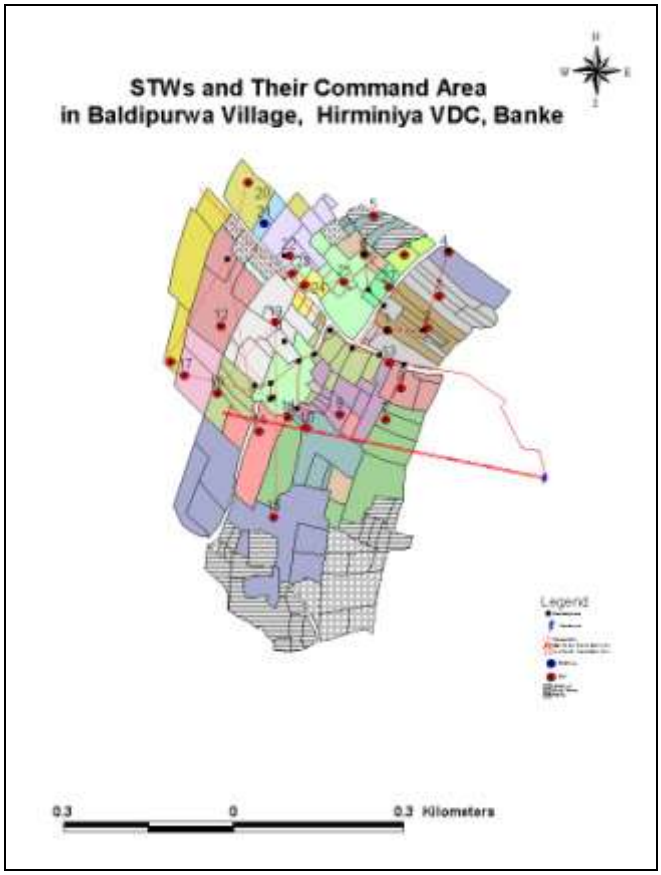


Figure 5. A detailed map of Baldipurwa village, ward no. 4 in Hirminiya VDC, showing locations of shallow tubewells and their respective command areas, electricity meters, and transmission line. (Source: Field Survey, 2008)

In Hirminiya VDC, the most commonly used pumps have 1 HP or 2 HP motors. The pump outlets are commonly 3 inches in diameter, even when the tubewell diameter is 4 inches. Some tubewells have 3-inch diameter. In spite of high well density in the area, farmers had not observed the problem of well interference. This may be explained by the fact that such small pumps

extracts water at a slower rate and the overall water requirement of an individual farmer is also small, because their landholding sizes and the farm plots are small.

Tubewell Ownership and Water Market in Hirminiya VDC

In Hirminiya VDC, all the STWs are privately owned. Except for a few ADBN funded wells, all the STWs and all the electric pumps are financed by the farmers themselves, without any external or project support.

Sharing of shallow tubewells is commonly practiced here, and the water sharing takes place in various forms. There was no charge at all, if only the borewell was shared, but Rs 15 per hour was charged if a 1 HP electric pump along with the electricity supply was also rented out. In case of 2 or 3 HP electric pump, the rate was Rs 50 per hour. Some farmers even rent out just the electricity meter, which means the sale of electric energy only, the charge for which ranged from Rs 10 to Rs 15 per hour. In this case, the farmers make a profit out of selling just the electric energy. In case of the diesel pumps, the rental charge was found to range from Rs.100 to Rs.125 per hour. Thus, even for water buyers, an electric pump is significantly more attractive than a diesel pump.

Figure 6. Low-cost, portable polythene pipes in use to deliver water to far away fields in Hirminiya VDC, Banke.

Discussion and Conclusions

The present study clearly shows that electric energy is already a very important issue for the STW irrigators in Nepal Terai, because diesel fuel is becoming economically not viable due to exorbitant market price. The cases of STW development in Arjundhara and Hirminiya VDCs shows that farmers are very much aware of this fact. It also shows that new STW installations can take place much faster if electricity infrastructure is made available. If government could support in developing electricity infrastructure, as Shallow

Tubewell Irrigation Project of Department of Irrigation (also commonly known as APP-Special program) has started recently, STW irrigation could expand much faster. It was reported that 2,880 STWs were installed for operation with electric pumps in 144 cluster areas in the eight western Terai districts in the year 2006/07, but it could develop only 765 STWs in those same districts in the previous two years when electricity infrastructure development component was provided *(DOI, Internal Reports).*

The cases of STW development in Hirminiya VDC, Banke district, amply suggest that farmers are willing to invest in electric pumps on their own, irrespective of their landholding sizes and their economic status, because it makes farming highly profitable. The two contrasting case sites in the VDC also suggest that STW numbers can grow tremendously, even without external support program, when electricity infrastructure is available, and therefore, the number of electric pump operated STWs will go on increasing in Terai where electricity infrastructure is already available. Conversely, it also demonstrates that STW growth may be seriously hindered in the absence of electricity infrastructure even if other infrastructures such as market opportunities and access roads are available. Therefore, from the present study, it may be concluded that the planned national targets in STW irrigation development could be achieved much rapidly if rural electrification network is strengthened and expanded in Terai. For this, STW development programs should be tied up with rural electrification programs. But, at present, power generation capacity in the country is much lower compared to its existing peak-hour energy demand. Therefore, Nepal needs to prepare itself by increasing its power generation capacity, and manage its available energy production, in order to meet the demand from the increasing number of tubewell irrigators, which will grow even faster in the coming years as the diesel fuel price increases further.

Private sector has played key roles in shallow tubewell irrigation development in other countries also, e.g. in India, Bangladesh and China. The expansion of STW was possible in India only because of the huge investments made by the government in rural electrification infrastructures and aggressive promotion of tubewell electrification during the 1960s and 1970s. India's 'Green Revolution' actually followed closely the 'Tubewell Revolution', with a time lag of 3-5 years (Repertto, 1994). By 1990, groundwater irrigation in India had far surpassed the surface irrigation in terms of area served as well as proportion of agricultural output supported by it (Debroy and Shah, 2003). Official estimate is that 60% of India's irrigated lands are served by groundwater, while independent surveys put this figure to 75% (Shah et al., 2004). However, India has fallen into a trap of groundwater-energy nexus due to its flawed energy policy.

State governments in India provide heavy subsidy on electricity supplied to the tubewell farmers. Again, citing the high cost of transaction in individual electric meter reading system, many states charge a highly subsidized and flat annual tariff rate to the farmers. This policy has caused heavy loss on revenue to the state power boards, leading them to near bankruptcy situations. To worsen the matter, this policy has also encouraged farmers to excessively use groundwater for irrigation, causing depletion in groundwater reserves to

threatening levels in many of its states. Some states likes West Bengal is now reverting to the system of metering electric pump lines, whereas in Gujarat state, dedicated electricity lines separated from domestic and industrial supply lines have been erected for supplying electricity to the irrigators, so that the industrial and domestic sector could also be protected from serious power cuts (Shah et al., 2007).

At present, only a small percentage of the STW pumps are run with electricity in Nepal Terai, but, the cases in Hirminiya VDC clearly shows that this number is certain to grow very quickly in the coming years as the diesel fuel price rises further. It will grow also as the rural electricity network expands further in the Terai. As of now, all the electric pump operated STWs are metered individually. But, it may become difficult to manage when their numbers become large. Therefore, learning from the experiences of India and other neighboring countries, it is now already a time that Nepal government starts considering appropriate policy measures to develop and manage its groundwater irrigation and energy sectors simultaneously.

Acknowledgement

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सहभागितात्मक सिंचाई ब्यवस्थापन
र
उपभोक्ता सहभागिता

गजाधर यादव
राष्ट्रिय सिंचाई जल उपभोक्ता महासंघ नेपाल

१. नेपालमा कृषिको भूमिका

कृषि क्षेत्रको विकासले कुल ग्राहश्त उत्पादनको लगभग ४० प्रतिशत भन्दा बढि देशको अर्थतन्त्रलाई प्रत्येक्ष सहयोग गर्दछ । देशको कुल जनसंख्या मध्ये ८० प्रतिशत कृषि पेशामा नै निर्भर रहेको पाईन्छ भने ६५.६ प्रतिशत जनसंख्या यस पेशामा आहालित छन् । कृषि उत्पादनको लागि भूमिको प्रयोग, सिचांई ब्यवस्थापन, किसानको सकृय सहभागिताको साथै सकारात्मक नीति, नियम अपरिहार्य हुन्छ । उपभोक्ता किसानहरुको पहिचान, सिंचाई प्रणालीहरुको लेखाजोखा यस सम्बन्धित क्षेत्रमा कार्यरत सरोकारवालाहरु संगको सम्बन्ध सहकार्य र समलग्नता जस्ता कृयाकलापले ब्यवस्थापनमा दिर्घकालिन प्रभाव पार्दछ ।

प्रभावकारी कृषि प्रणालीको लागि सिंचाईसंग समलग्न संस्थाहरु एवं समुदायमा आधारित सिंचाई सम्बन्धि सिकाई ज्ञान र पद्धतिहरु अत्यन्त महत्वपूर्ण पूर्वाधार हुन् । त्यसैले दिगो र प्रभावकारी सिंचाई प्रणालीको विकास विना उन्नत कृषि प्रणाली सम्भव छैन । त्यसैले जनता र राष्ट्रको स्थानीय एवं राष्ट्रिय अर्थतन्त्र दरिलो बनाउन प्रभावकारी कृषि प्रणाली नै भरपर्दो माध्यम हो । त्यसो नभएमा सिचाई संस्था एवं समुदायमा आधारित प्रभावकारी सिंचाई पद्धति विना अन्तरिम संविधानमा उल्लेखित खाद्य सम्प्रभुत्ता सम्बन्धी मौलिक हक र किसानको समाजिक न्याय एवं समाजिक सुरक्षा सम्बन्धी मौलिक हकहरु समेत निश्प्रभावी बन्न पुग्दछन् ।

नेपालमा योजनाबद्ध सिंचाई विकासको ५२ वर्षको उमेर पार भईसकेको छ । यस अवधिमा मुलुकमा विकासका प्रयासहरुका धेरै नमुनाहरुको परिक्षण भइसकेको पनि छ । यसबीच प्रयोग भएका विकासका नमुनाहरुले जलश्रोतको धनी देशका कृषकहरुको अन्न उत्पादनको मुख्य आधार सिंचाई क्षेत्रलाई आफ्नो परिक्षेत्र भन्दा बाहिर राखेको छैन । बाहिरबाट सहयोग अनुदान र विशेषज्ञसहित आउने विकास प्रकृयाको परिक्षेत्रको ५२ वर्ष उमेर बिताएको सिंचाई क्षेत्र प्रायजसो सम्बन्धित निकायहरु र उपभोक्ताको सीप जांगर र परिश्रममा निर्भर रहदै आएको पाईन्छ । राज्यले चाहे जस्तो उपलब्धि हासिल गर्न सकेको छैन ।

२. सहभागितात्मक सिंचाई विकासको अभ्यास

नेपालमा सिंचाई प्रणालीहरुमा उपभोक्ताहरुले शताब्दिऔ देखिनै स्वतस्फूर्त रुपमा सिंचाई ब्यवस्थापनको विकास, प्रबद्धन र संस्थागत गर्दै संचालन गरि आए पनि देशब्यापि रुपमा उपभोक्ता संस्थाहरुको लेखाजोखा अभिलेखिय रुपमा प्राप्त गर्न सम्भव थिएन तर पनि समुदायमा आधारित सहभागितात्मक सिंचाई ब्यवस्थापन समुदायका मानिसहरुमा आत्मिय अभ्यास भईसकेको थियो र एउटा संस्थागत आकार सहभागितात्मक सिंचाई ब्यवस्थापन लाई अगाडि ल्याउन यत्रतत्र प्रयास भने भइरहेका थिए ।

नेपालको सिंचाई प्रणालीहरु अध्यवधिक ७० प्रतिशत किसान उपभोक्ताहरु आफैले निर्माण गरेका मध्ये पर्दछन् भने ३० प्रतिशत सरकार वा दातृ संस्थाहरुद्धारा निर्माण गरिका भित्र पर्दछन् । जब–जब सरकारको लागानी द्धारा सिंचाई प्रणालीको विकास प्रकृया शुरुभयो तव देखि सरकार, उपभोक्ताहरु र निर्माण गर्ने पक्ष विचको समन्वय र सहकार्यको विचमा खाडलको श्रृंखलाको शुरुवात भयो । सरकारद्धारा निर्मित सिंचाई प्रणाली उपभोक्ता किसानहरुको कम सहभागिताको देखासिकिमा स्वयंम उपभोक्ताहरु द्धारा संचालित सिंचाई प्रणालीमा असर पर्न गयो । जसको कारण सरोकारवाला पक्ष अनुपस्थितिमा विभिन्न प्रविधिक कमि कमजोरिका बाबजुद संरचनाहरु गुणस्तर युक्त हुन सकेनन् । जसले गर्दा अपेक्षित उपलब्धि प्राप्त गर्न सकिने सम्भावना रहेनन् । त्यसैले उपभोक्ताहरुले परम्परागत रुपमा विकास गरि आएका सहभागितात्मक पद्धतीको सहअस्तित्व कायम गरि संचलन गरेका सिंचाई प्रणालीहरुको नमूना, मार्गदर्शक सिद्धान्त र व्यवहारलाई अंगिकार गर्दै २०४६ साल तिरबाट सहभागितात्मक सिंचाई ब्यवस्थापनको विकास एवं प्रर्वद्धन गर्ने अवधारणा अघि सारिएको थियो ।

सोहि अनुरुप प्रजातन्त्रको पूनर्वहाली पश्चात २०४९ सालमा राष्ट्रिय रुपमा पहिलो सिंचाइ नीतिको तर्जुमा भयो । नेपालमा सिंचाइ नीतिको तर्जुमा भए पश्चात सहभागितात्मक सिंचाइ व्यवस्थापनको विकास एवं प्रवर्द्धन प्रकृयलाई अगाडि सारिएको थियो । सोहि नीति अनुरुप सहभागितात्मक सिंचाई प्रणाली व्यवस्थापन र विकास गर्नको लागि सरकारद्धारा विकास गरिएका सिंचाइ प्रणाली समेत जल उपभोक्ता संस्थालाई क्रमिक रुपमा हस्तान्तरण गर्न शुरु गरियो । यस्ता प्रणालीहरु संचालन गर्दै आएका संस्थाहरुको बिचमा पनि एक आपसमा संगठित भई आफ्ना समस्या र सवालहरुको बारेमा अनुभव आदान प्रदान गर्ने प्रयाप्त अवसरहरु प्राप्त हुन सकेका थिएनन् । उक्त खांचो पुरा गर्नुको साथै नेपालको अपार जलश्रोत व्यवस्थापनमा उपभोक्ता सम्मको चासोलाई सम्बोधन गरी क्रमिक रुपमा पहुंच, नियन्त्रण र स्वामीत्व सुनिश्चित गर्नका लागी सिंचाई जल उपभोक्ताहरुलाई संगठित गरी उनीहरुको एकत्रित आवाज लागि विभिन्न सरोकारवालाहरुको सहयोगमा विभिन्न चरणहरु पार गर्दै २०५५ साल कार्तिकमा तर्दथ समिति गठन गरि २०५६ साल श्रावण २७ गते विधिवत रुपमा काठमाण्डौ जिल्ला प्रशासन कार्यलयमा राष्ट्रिय सिंचाइ जल उपभोक्ता महासंघ विधिवत रुपमा दर्ता गरियो । तत्तपश्चात महासंघले उपभोक्ताहरुको अधिकार सुनिश्चितताका लागि सहभागितात्मक सिंचाई व्यवस्थापनलाई समन्वयकारि प्रवर्द्धन गर्दै अघि बढिरहेको विद्यामान अवस्था छ ।

३. महासंघको उदेश्य

- नेपाल भरिका जल उपभोक्ताहरुलाईं संगठित गर्दै नेपाल सरकारका संम्बन्धित निकाय र जल उपभोक्ता संस्थाहरु बीच समन्वय कायम गराउदै जल उपभोक्ताहरुको नेतृत्व र संस्थागत क्षमताको विकास गर्ने ।
- जल उपभोक्ताहरुलाई आफ्नो अधिकार र दायित्वप्रति सचेत तुल्याउन जलश्रोत सम्बन्धि राष्ट्रिय, अन्तराष्ट्रिय कानून र नीतिसंग सम्बन्धित तालिम,गोष्ठि,सेमिनार छलफल आदी आयोजना गर्ने गराउने,
- सरकारको सहभागितामुलक सिंचाइ नीति अनुरुप सबै किसिमका सिंचाइ प्रणालीहरुको निर्माण र संरचना अन्तरगत रहेका सबै प्राकृतिक एवं अन्य श्रोतहरुको दिगो व्यवस्थापनका लागि जल उपभोक्ता संस्थाहरुको निर्णायक सहभागिता अभिबृद्धि गर्न उनिहरुलाई सक्षम बनाइ सो श्रोतहरु सदुपयोग गर्न लगाउने कार्य गर्ने गराउने ।
- जलश्रोतको बहु–उदेशीय उपयोगको लागि जलश्रोतसंग सम्बन्धित सवालहरुलाई एकिकृत रुपमा समाधान गर्न जल उपभोक्ता संस्थाहरुलाई उत्प्रेरित गर्ने ।
- जल उपभोक्ता संस्था तथा महासंघको सांगठनिक इकाई र कार्यक्रमहरुमा महिलाहरुको सहभागिता र प्रतिनिधित्व गराउन उत्प्रेति गराउने,
- जल उपभोक्ता संस्था तथा महासंघको सांगठनिक इकाई र कार्यक्रमहरुमा विपन्न, दलित, आदिवासि, जनजातिहरुको समातामुलक सहभागिता गराउन उत्प्रेरित गर्ने, गराउने,
- जल उपभोक्ता संस्थाहरुको प्रतिनीधिमुलक संस्थाको रुपमा वकालत गर्दै सिंचाइ र जल श्रोत सम्बन्धि कानुन, नीति, योजना तथा कार्यक्रमका सम्बन्धमा सरकार र अन्य सरोकारवालाहरुलाई आवशयक सल्लाह एवं सुझावहरु उपलब्ध गराउने ।
- जलश्रोतको दिगो व्यवस्थापन एवं लाभदायि उपयोग र जल उपभोक्ता सस्थाहरु एवं कृषि सम्बन्धि विविध पक्षहरुको बारेमा आवश्यक अध्ययन अनुसन्धान र प्रकाशन गर्ने गराउने ।
- क्षेत्रिय समन्वय समिति र जिल्ला कार्य समितिहरुको संस्थागत क्षमता अभिबृद्धि गर्न आवश्यक पर्ने कार्यहरु गर्ने ।
- गरिव तथा सिमान्तकृत वर्गको क्षमता विकासमा सहयोग पुर्याई उत्पादनका साधन (जलश्रोत माथि) मा पहुचको लागि सक्षम बनाउने ।

लक्ष्य

जल उपभोक्ता संस्था तथा समुह (सरकाद्धारा निर्मित, सहअस्त्विमा संचालि वा किसान व्यवस्थित) लाई संगठित गर्दै समावेशि आमसहभागिताको माध्यामबाट,प्रगति र अन्तरनिर्भरताका लागि निर्णय प्रकृया सम्म उपभोक्तालाई समावेश गराउनु महासंघको लक्ष्य रहेको छ ।

- जमिन र जलको बहुउपयोग गरि उन्नत कृषि प्रविधि अपनाउदै उत्पादनमा बृद्धि गर्ने ।
- महासंघलाई राष्ट्रिय रुपमा जनवकालत गर्ने संस्थाको रुपमा स्थापित गराउने ।
- देशभरि छरएर रहेका जल उपभोक्ता सस्थाहरुलाई सार्थक सहभागिताको आधारमा निर्णय प्रकृयामा सरिक गराउने ।

ध्यये

- जमिन र जलको बहुउपयोग गराई बैज्ञानिक प्रबृधि अपनाई उत्पादकत्वमा बृद्धि गरिने छ ।
- राज्य र सम्बन्धित निकायलाई जल उपभोक्ताका पक्षमा नीति निर्माण परिमार्जन र कार्यन्वयनको लागि पैरवि गरिनेछ ।
- महासंघ जल उपभोक्ताहरुको साझा,सुशासित र सुदृढ संस्थाको रुपमा स्थापित भएको हुनेछ ।
- उपलब्ध जलश्रोत तथा जलाधार क्षेत्रको संरक्षण संवर्द्धन गर्दै न्यायचित लाभांश वितरणमा नैसर्गिक अधिकारको सुनिश्चितता प्रदान गरिने छ ।

महासंघको परिकल्पना र दुरदृष्टि

उपभोक्ताको क्षमता अभिबृद्धि गर्दै साधन श्रोत ब्यवस्थापनमा उपभोक्ताको सहभागिता बृद्धि गरि श्रोत साधन माथि उपभोक्ता अधिकार स्थापित गर्दै, गरिबी निवार गर्न सहयोग गर्ने गरि महासंघले आफ्नो परिकल्पना निम्नानुशार तयार गरेको छ ।

“गरिवी निवारण हाम्रो सरोकार जलश्रोतमा पूर्ण अधिकार”

महांघले संचालन गरेका उपभोक्ता सहभागिता बृद्धि गर्ने कृयाकलाप

१) क्षमता अभिवृद्धि गोष्ठि,तालीम,
२) महिला जागरण कार्यक्रम,
३) उपभोक्ता जागरण कार्यक्रम,
४) लैगिक समता कार्यक्रम,
५) जल प्रदुशण न्यूनिकरण कार्यक्रम,
६) संगठन, विकाश, विस्तार तथा सुदृढिकरण,
७) विधान निर्माण एवं, प्रकृयागत ढंगले समुह गठन,
८) जिल्ला स्तरिय तथ्यांक संकलन,
९) नेतृत्व बिकाश कार्यक्रम,
१०) प्रशिक्षक प्रशिक्षण कार्यक्रम,
११) सिंचाई सेवा शुल्क उठाउनेबारे अन्तरकृया,
१२) मर्मत संभार सम्बन्धि सहभागिता मुलक कार्यक्रम,
१३) श्रोत पहिचान तथा ब्यावस्थापन कार्यक्रम,
१४) गरिवी न्यूनिकरण सहयोग कार्यक्रम ,
१५) अध्ययन भ्रमण,
१६) विभिन्न सरकारी,गैरसरकारी, संघ संस्थाहरुसंग सम्बन्ध कायम गर्ने,

उपलब्धि तथा सकारात्मक प्रभाव

- उपभोक्ताको साझा आंगनका रुपमा महासंघ स्थापित भएको छ ।
- उपभोक्ताहरु एक आपसमा संगठित हुने बातावरणको श्रृजना भएको छ ।
- उपभोक्तामा जल प्रदुषण र यसले कृषिमा पार्ने प्रभावको बारेमा ज्ञान हासिल भएको छ साथै सिंचाई तथा जलमा रहको समस्या समाधानमा उपभोक्ता संगठित हुने क्रम बढ्दो छ ।
- महासंघको उपलब्धिको रुपमा सिचाई नीति तथा नीयमावलीमा उपभोक्ता हितका प्रवधान स्थापितको शुरुवात भएको छ ।
- सिंचाई सेवा शुल्क, सिंचाई नीति, नियामावली,उपभोक्ताको अधिकार र दायित्वको बारेमा उपभोक्तामा ज्ञान बढ्दो छ ।
- सिंचाई तथा कृषिसंग सम्बन्धित सरकारि कार्यलय सम्म उपभोक्ताको पहुच पुग्न सक्ने बातावरण श्रृजना भएको छ ।
- ज.उ.स.तथा सिंचाई संग सम्बन्धित कार्यमा उल्लेखनिय मात्रामा महिला सहभागिता बृद्धि भएको छ ।

४. नीतिगत रुपमा सहभागितात्मक ब्यवस्था

४.१ राष्ट्रिय जल योजनामा जनसहभागिता सम्बन्धि ब्यवस्था

सहभागिता मुलक ब्यवस्थाले गर्दा सबै संलग्न सरोकारवालाहरु बीच जलको महत्व बारे बोध हुने मात्र नभै जलश्रोतको अधिकतम उपयोग र सर्वाङ्गिण विकास प्रतिको अवधारणामा समेत सर्वसम्मती कायम गर्न सकिने हुन्छ । यसले स्थानीय स्तरमा विकास कृयाकलापहरु प्रति स्वामित्व भएको महशुस गराई दिगो विकास निश्चित गराउंछ । प्रत्येक उपक्षेत्रिय कृयाकलापहरु तथा उपबेसिन समितिहरुमा उपभोक्ताहरुको समुह गठन गर्नु राष्ट्रिय जल योजनाको एक अभिन्न अंश हो, जसले एकिकृत जलश्रोत विकास तथा ब्यवस्थापनमा ब्यापक जनसहभागिता निश्चित गर्दछ ।

४.२ तीन वर्षे अन्तरिम योजना

जलाधार क्षेत्रको अवधारणा, उपभोक्ता सहभागिता, निर्णया प्रकृया र तहमा समानुपातिक, लैगिक प्रतिनिधित्व, सिंचाई क्षेत्रसंग सरोकारवालाहरु सबैको समन्वय अर्थात एकिकृत जलश्रोत ब्यवस्थापनको आधारमा जलश्रोतको क्षेत्रगत विकास गरिनेछ ।

४.३ सिंचाइ नीति २०६०

सिंचाइ नीतिले पनि आयोजना कार्यान्वयन तथा मर्मत संभारको जिम्मेवारी स्थानीय निकाय तथा उपभोक्तालाई हस्तान्तरण गर्ने लगायतका किसान हितका कुराहरुलाई नै जोड दिएको छ ।

नीति तथा कार्यक्रम राम्रो हुनु सकारात्मक पक्ष हो, तर नीतिलाई ब्यवहारमा लागू गर्न गरिएका प्रतिवद्धतालाई कार्यन्वयन चरणमा आवश्यक ध्यान पुर्याईनु जरुरि छ । अर्को तर्फ सिंचाई नीतिमा समेट्नै पर्ने विषय समेट्न नसक्नु आफैमा एउटा सवाल हो । उपभोक्ताको संस्थागत विकास भनिएको छ तर संस्था/समूह दर्ता प्रकृया नाफा कमाउन गठित प्राईभेट फर्म दर्ता प्रकृयाभन्दा कम जटिल छैन । किसानद्वारा स्वयं विकसित गरी संचालित कुलो समुहहरुको विधान दर्ता गर्ने र नविकरण गर्ने काम झन्झटिलो त छदैछ दर्ता गर्ने ठाउंको एकरुपता समेत छैन । जिल्ला प्रशासन, जिल्ला विकास समिति र विभागीय कार्यलय डिभिजन मध्ये कहां दर्ता गर्ने हो भन्नेमा उपभोक्ता अझै दुबिधामा भएको पाईन्छ । यसैले सिंचाई विकासका सबै प्रकृयामा सहजरुपमा उपभोक्तालाई संगठित हुने प्रकृयालाई अवलम्बन गर्न जरुरि देखिन्छ ।

६. सहभागिता मुलक सिंचाइ व्यवस्थापनका चुनौतिहरु

- चालु सिंचाई नीति र सिंचाई क्षेत्रमा संचालित कार्यक्रममा उपभोक्ताको महत्वपूर्ण (अर्थपूर्ण) भूमिकाकालाई अंगिकार गर्नु ।
- नीति नियाममम्मा उल्लेख गरे बमोजिमको उपभोक्ताको सहभागिता,सिंचाई सेवा शुल्क लगायतका कार्यक्रममा प्रभावकारिता र कार्यक्रम उपभोक्ताका पक्षमा संस्थागत रुपमा अघि बढाउनु ।
- जन स्तरवाट वनेका उपभोक्ता समूहलाई एकिकृत गरि, सस्थागत क्षमता अभिबृद्धि गरि दिगो व्यवस्थापनमा सहयोग पुर्याउनु ।
- राज्य पूर्नसंरचना अनुशार सिँचाइ प्रणालीहरुको कार्यमूलक अनुसन्धान गरि उपभोक्ता महासंघलाई अझ सशक्त वनाई यसको छातामा देशभरीका सिंचाई जल उपभोक्ता समुहको एकिकृत संजाल निर्माण गरी हरेक कार्यमा सहभागितामूलक प्रकृया अवलम्बनको वातावरण श्रृजना गर्नु ।
- जनतासंग प्रत्यक्ष सरोकार राख्ने योजनाहरु निर्माणमा अर्थपूर्ण सहभागिताका लागि उपभोक्ताको पहुंच स्थापित गराउनु, उपभोक्ताको क्षमता अभिबृद्धि गर्नु ।
- सम्बद्ध ऐन नियमहरुको एकिकृत अध्ययन गरी उपभोक्ता हितका विरुद्धमा भएका प्रावधान परिमार्जन तथा संशोधन गरी जन–अधिकार मुखी ऐन नियमहरु निर्माण गर्नु गराउनु ।
- सिंचाइ तथा कृषि विकासमा राष्ट्रिय, अन्तराष्ट्रिय स्तर सम्म भएका गतिविधि, ज्ञान, सिप तथा नयाँ प्रबिधिको जानकारिको लागि उपभोक्ताको पहुंच पुर्याउनु ।
- सिंचाइ जल उपभोक्ता संस्था एवं स्थानीय समुदायको क्षमता अभिवृद्धि गरी नेपालका सम्पूर्ण सिचाइ प्रणालीहरु, सिंचाइ संस्था एवं समुदायलाई हस्तान्तरण गरिने कुरालाई राज्यको महत्वपूर्ण दायित्वको रुपमा बोध गराई समुदायमा आधारित सिंचाइ प्रणालीलाई नेपालको प्राथमिकता प्राप्त सिंचाई प्रणालीको रुपमा स्थापित गराउनु को साथै ठूला सिंचाई प्रणालीका मुलनहर भन्दा तलका शाखा–प्रशाखा जल उपभोक्ता संस्थालाई हस्तान्तरण गर्नु ।
- जलस्रोत सम्बन्धी सबै बहूउद्देशीय परियोजनाद्वारा विकसित सबै सिंचाइ प्रणालीहरु सिंचाई जल उपभोक्ता संस्थाहरुको संचालनमा क्षमता विकास गराई हस्तान्तरणको लागि पहल गर्दै, नेपालको कुनै पनि सिंचाइ प्रणाली निजीकरण वा निजी क्षेत्रलाई हस्तान्तरण नगरिने संबैधानिक नीतिको लागी पैरवि गर्नु ।

६. सिंचाई विकासमा उपभोक्ता सहभागिता बृद्धि गर्न चालिनु पर्ने पाइलाहरु

१) जन स्तरवाट वनेका उपभोक्ता समूहलाई एकिकृत गर्न, सस्थागत क्षमता अभिबृद्धि गर्न र कृषक सहभागितामूलक अवधारणा अनुरुप बिकसित सिँचाई प्रणालीहरुको दिगो व्यवस्थापन गर्न, सिँचाई प्रणालीहरुको कार्यमूलक अनुसन्धान गर्न, उपभोक्ता महासंघलाई अझ सशक्त वनाई यसको छातामा देशभरीका सिंचाई जल उपभोक्ता संस्थाहरुलाई आबद्ध गरी हरेक कार्यमा सहभागितामूलक प्रकृया अवलम्बन गर्न आवश्यक छ ।

२) योजना तर्जुमा गर्दा सिंचाई संम्बन्धित सरोकारवालाहरुको अर्थपूर्ण सहभागितामा उनिहरुसंग भएको ज्ञान, अनुभव र सिकाइका पाठहरुलाई समेटि योजना निर्माण गर्नु आवश्यक छ ।

३) आम जन–समुदायको पहुँच पुग्न सक्ने खालका योजनालाई प्राथमिकता दिई जन–समुदाय समेतको सक्रिय सहभागिता र स्वामित्वमा कार्यक्रम संचालन गरिनुपर्छ ।

४) ऐन, नियम निती र जल योजनामा उल्लेख भए अनुरुप उपभोक्ता समुहको क्षमता अभिवृद्धि गर्न र पहुंच बढाउन यथोचित तालिम, प्रकाशन, प्रचार, प्रसार गरिनुपर्ने ।

५) योजना तर्जुमा गर्दा प्रभावित क्षेत्रका जनताको हक,अधिकार र फाईदाको उचित वाँडफाँडको प्रश्नलाई केन्द्रमा राखेर सम्बोधन गरिनु पर्ने ।

५) वजेटको विनियोजन, खर्च र खर्चको पारदर्शीता हुनु पर्ने, सरोकारवालाले चाहेको वेला त्यस सम्बन्धमा सुचना पाउनु पर्ने ।

६) हरेक तहका सरंचनामा जनसंख्याको आधारमा प्रतिनिधित्व गराउनका लागि उपभोक्ता किसानको क्षमता अभिबृद्धि र शसक्तीकरणका लागि तालिम, गोष्ठि, सेमिनारको, उचित व्यवस्था गरिनु पर्ने ।

७) अर्न्तराष्ट्रिय स्तरका आधुनिक सिचाई प्रविधि खेती प्रणाली आदिका वारेमा ज्ञान दिन र यि प्रविधिमा सरोकार वाला किसानको पहुँच बृद्धि गर्न विशेष कार्यक्रम संचालन गरिनु पर्ने ।

८) कतिपय समुदाय व्यवस्थित सिचाई प्रणाली र सरकारद्धारा निर्मित सिचाई प्रणालीको मुहान सुक्दै गईरहेकोले श्रोत संरक्षण गरी पानी उपयोग माथिको पहुच कायम राख्नु पर्छ ।

९) वालीहरुमा पानी मापन यन्त्र वा पानी कति वेला चहिने यन्त्र खेतहरुमा जडान गरी कति पानी र कुन वेला चहिने उपभोक्ताहरुलाई विश्वस्त पारी पानीको उचित उपयोग गर्न वानी वसाल्ने ।

७. निष्कर्ष

देशको तिब्र आर्थिक विकासका लागि कृषिलाई आधुनिकिरण गर्नु व्यापक जनतालाई आर्थिक क्रान्तिमा समाहित गर्नु पर्ने चुनौतीको साथै नेपालको माटो सुहाउदो, नेपालको आर्थिक अवस्था सुहाउंदो साना–साना जल सिँचाई आयोजनाहरुलाई प्राथमिकताका साथ लैजानु र भैरहेका साना ठूला सिँचाई योजना व्यवस्थित गर्नु अर्को चुनौती छ । यसका लागि देशभरि छरिएर रहेका आम किसान उपभोक्ता समुह गैंरसरकारी संघ संस्था र सरकार समेतको एकिकृत प्रयासले आम जनताका हक अधिकारको प्रश्नलाई केन्द्रमा राखेर कार्य गर्नु नितान्त आवश्यक बनीसकेको छ ।

हालका सिंचाई व्यवस्थापनका प्रायजसो योजनाहरुमा उपभोक्ताको अर्थपुर्ण सहभागितालाई ध्यान दिईएको देखिदैन। विकाशको अवधारणा भनेको सहभागितात्मक हो, विकासका लागि साझेदारि हो । सिंचाई प्रणाली, योजना तर्जुमा नीति निर्माणको साथै कार्यन्वयन र मुल्यांकनमा सरोकारवाला किसानको आधिकारिक पहुंच विना व्यावस्थित सिंचाई प्रणाली सम्भव हुदैन ।

विश्वव्यपी रुपमै आजको खाद्य सुरक्षाको स्थितिलाई हेर्दा समेत गरिबीको चपेटामा परेका र कृषि प्रधान मुलकुको नामले परिचित हरेक देशमा कृषि उत्पादनको बृद्धि नै खाद्य सुरक्षाको प्रत्याभूति दिने प्रमुख मापदण्ड हो र यसको अस्तित्व कायम राख्ने अपरिहार्य माध्यम सिंचाई प्रणाली हो । जल, जंगल र जमिन आधारभूत रुपमै किसान - उपभोक्ता)को जीवनसंग जोडिएर आउने विषयहरु हुन् । यिनीहरुको परिचालनमा राज्यले दायित्व र गरिबी निबारण आधारको रुपमा मनन् गरि कार्यक्रम बनाई सहभागीतात्मक व्यवस्थापन र परिचालन गरी वास्तविक उपभोक्ता किसानहरुको पहुंच विस्तार तथा क्षमता अभिबृद्धि गरी उपभोक्ताकै सकृयता र स्वामित्वमा कार्यक्रम संचालन नगरेसम्म देशले विकास गर्न सक्दैन भन्ने मान्यतामा रहेर सिंचाई व्यवस्थापनमा सहभागितात्मक अवधारणालाई आत्मसाथ गर्दै अघि बढ्नु पर्छ भन्ने महासंघको मान्यता रहेको छ ।

॥ धन्यवाद ॥

PRIVATE SECTOR IN IRRIGATION: MODALITIES OF PARTICIPATION

Basistha Raj Adhikari
SDE, DWIDP
(basistha@wlink.com.np)

Abstract

Irrigation is one of the major components of the agricultural based economy of Nepal. Private landowners and the state sponsored agencies had developed irrigation systems to irrigate the cultivated land aiming to grow more crops. Development of Rajkulos and their operation with the promulgation of appropriate sanad and sawals provides insights on the successful story of irrigation development and management. Several irrigation systems have been constructed to irrigate large chunk of land in Terai as well as in the Hills providing modern irrigation facility up to small land parcels. In addition to the development of surface irrigation network, groundwater irrigation has also been implemented where surface water sources are deficient.

Despite the continuous efforts of more than 50 years irrigation coverage accounts only for two-third of its potential area and reliability of irrigation water is below the expectation of the farmers. It is high time to improve the management aspects of irrigation through the involvement of private sector in all aspects of project planning and management. This paper tries to identify possibilities of private sector participation in irrigation with respect to the economic liberalization of irrigation governance. The paper also presents case studies of three irrigation systems as potential for private sector involvement: Sunsari Morang Irrigation Project, Kankai Irrigation Project and Phalebas Irrigation System. It highlights the modalities of private sector involvement in irrigation as Management Contract Model and Community Private Partnership (CPP).

Introduction

Historic evidences show that irrigation is being practiced in Nepal since *Lichchhabi* era. Private landowners and the state sponsored agencies have developed irrigation systems to irrigate the cultivated land aiming to grow more crops. Development of *Raj Kulo* and enactment of Civil Code in 1854 had established legal framework for development and management of state sponsored irrigation systems (Pradhan, 2000). Irrigation canals constructed with the initiation of *Birta* and *Jagir* owners (Regmi, 1978) has demonstrated one of the best practices of community participation in irrigation management. Construction of Chandra Canal in 1928 and promulgation of *Sanad Sawal* for its operation and maintenance has proved the then Government's commitments towards modern irrigation management. Establishment of Department of Irrigation (DOI) in 1952 had opened new horizons in the irrigation sector, which was further expanded systematically during the planned development periods. Many irrigation systems have been constructed to irrigate large chunks of land in the Terai as well as in the Hills providing modern irrigation facility up to small land parcels. Similarly, many community managed irrigation systems (CMIS) have been rehabilitated aiming to increase cropped area and production. In addition, groundwater has also been exploited for irrigation where surface water sources are deficient. With the promulgation of the Irrigation Policy in 1992, the involvement of water users became mandatory in project development and management. Formation of Water Users Associations (WUA) at various levels of canal hierarchy and their participation in irrigation activities has improved water management tasks at the field level. To enhance the role

of WUA in irrigation governance the Irrigation Management Transfer Project (IMTP) has been implemented in some of the systems. Despite continuous efforts of more than 50 years irrigation coverage accounts only for two-thirds of its potential area and productivity of irrigated agriculture is not encouraging (Shah and Singh, 2001). On the one hand the annual growth of irrigated area coverage can not replicate the strategic targets and on the other hand the utilization of developed infrastructure is reported to have an overall efficiency of only 32 percent. The end result is less area coverage in year round irrigation and marginal increase in cropping intensity after rehabilitation. The average collection of Irrigation Service Fee (ISF) is as low as 10 percent of the targets and covers less than 2 percent of operation and maintenance (O and M) expenditure of the irrigation systems (Timilsena, 2007). Hence, it is essential to think about the change in management aspects of the irrigation sector and the involvement of private sector is one of the options for the improvement of management. This article tries to identify the modalities of private sector participation in irrigation with respect to the economic liberalization of irrigation governance.

Concept of Private Sector Participation

Liberal economic policy of the country is conducive towards involvement of private entrepreneurs in various sectors of economic development including water infrastructure. Involvement of private sector in irrigation means attracting private investment under contractual arrangement for the development and management of a whole or part of an irrigation system. In contrast to other segments of economic infrastructure like energy, transportation and communication, services related to irrigation water supply are managed at the local level. Considering the complexities of irrigation services and their low financial viability, it is unlikely that private entrepreneurs will come forward in the development of the irrigation systems. Management contract model is a widely practiced model for the efficiency improvement of public companies. Nepal Bank Limited and Rastriya Banijya Bank are the best examples of efficiency improvement through management contract. Involvement of private entity in infrastructure development and management has shown steady improvements in Kathmandu Municipality such as road crossing bridges, construction and management of public utilities etc. Adaptation of Public Private Partnership (PPP) in hydropower development is worth mentioning in enhancing power sector development and management. In the perspective of commercial agriculture, the role of private sector will provide new horizons in socio-economic context of the country.

Proper operation and adequate maintenance of an irrigation system is the prerequisite for attaining targeted irrigation benefits. Operation and maintenance not only seek resource allocation but also require skill and knowledge in order to keep the system intact and get expected benefits from irrigated agriculture. Of the total completed irrigation systems, 29 systems are still under the resource allocation of the Government for operation and routine maintenance. Considering the present austerity of the national budget, the resources for system operation and maintenance are not only inadequate to fulfill the basic operational requirements but also, in some cases, allocated resources are not utilized properly. In such a condition, the efficiency of resource allocation and its utilisation is in diminishing order and the irrigation systems, like other public property, are deteriorating. To best allocate the available resources and utilize it in reaping agricultural benefits, involvement of the private sector is seen as the most appropriate alternative for sustainable management of agency managed irrigation systems. Sustainable management here refers to the operation of irrigation system or its part, and to distribute water as per accepted norms and practices, and maintain the system or its part to best meet the operational requirements. Operation and routine maintenance of headwork, main canal, secondary canals and other canal network may be the possible options for involving the private sector as a management partner of the Government.

Management contract model is the involvement of private entity in irrigation infrastructure operation and maintenance in contract basis while community private partnership model is the involvement of private entity in close in joint liability with community water users. But involvement of the private sector would be limited to the system specific conditions. Prior to identifying the areas of private sector involvement, it is important to spell out the policy provisions of private sector involvement in irrigation management.

Policy and Legal Provisions

The **Water Resources Strategy-2002** identifies potential role of the private sector in achieving irrigation efficiency and cost recovery goals. It further enunciates the possibility of private participation operation and management of large surface irrigation systems, collection of ISF, tube well installation, and in promoting micro-irrigation.

The **Irrigation Policy-2060** also states policy principles on promoting the private sector involvement in construction, operation, and management of irrigation systems. Moreover, the responsibility of operation and maintenance of part of the irrigation system or system as a whole, which is presently being managed either jointly or by the government alone, may be given to private or non-governmental sector on the basis of competition through agreements.

To provide efficient and reliable services to the beneficiaries, **Private Sector Involvement in Infrastructure Development and Management Act 2060** provides legal framework to involve private sector in infrastructure construction, operation and transfer. The Act enumerates the seven modalities of private sector involvement in infrastructure development and management, which are Built and Transfer (BT), Built, Operate and Transfer (BOT), Built, Own, Operate and Transfer (BOOT), Built, Transfer and Operate (BTO), Lease, Operate and Transfer (LOT), Lease, Built, Operate and Transfer (LBOT), Develop, Operate and Transfer (DOT).

Scope of Private Sector Involvement in Irrigation

Main objective of private sector involvement in irrigation as stated in Irrigation Policy is to enhance the irrigation efficiency and water productivity. The specific objectives of the private sector involvement in irrigation may be to make cost recovery of investment, to commercialize irrigated agriculture and enhance its productivity, to strengthen role of the private sector in agricultural economy, to reduce the liability of the Government in system management, to open technological innovations, to provide reliable and efficient water services to the farmers, and to enhance WUA as a new form of water governance. In order to identify the areas of private sector involvement, a study had been carried out by DOI in 2006 and forthcoming headings brief these case studies.

Case Studies

Sunsari Morang Irrigation Project

Management Overview

In Sunsari Morang Irrigation Project (SMIP) having irrigated area of 58,000 ha, the system operation and management is being carried out under Joint Management (JM) practice since 1995, when the formation of all WUAs were completed. According to the provisions of joint management, headwork, main canal, and secondary canals would be maintained by the Project, while the operation and maintenance of sub-secondary, tertiary and watercourses was to be the responsibility of WUAs. Major management responsibility of different stakeholders is illustrated in tabular form (Table 1).

Table 1 Management Responsibility in SMIP

SN	Irrigation system component	Management responsibilities			Remarks
		Operation	Maintenance	Resource mobilization	

1	Head works	Project office		Government	
2	Dredging machines	Project office		Government	
3	Hydropower station	Nepal Electricity Authority		NEA	
4	Chatra main canal	Project office		Government	
5	Secondary canals	Project office		Government	WUAs also assist
6	Sub-secondary and tertiary canals	No major operation is needed	Minor desilting by users, other maintenance by GON	Mostly GON, but some times users	Users do mobilize some labours
7	Watercourses	Users	Users	Users fund or labour mobilisation	
8	Service roads	Mostly irrigation agency, no defined mechanism exists			
9	Buildings, equipment	Irrigation agency			
10	Drainage	Virtually, no maintenance			

SMIP is built on the proportional (structured) system of water distribution and there are no gates for operation below the secondary level canals. The main operational activities are monitoring the flow, monitoring the illegal outlets and actualization of equitable distribution of water. Major maintenance tasks at lower level canals are desilting the canals, upkeep the canal banks, and closing illegal outlets. It is observed that Water Users Committees (WUC) formed at the sub-secondary level can manage the lower level management of the system as stipulated in joint management provisions.

1.22 System Performance

The operation and maintenance within the structured block is the responsibility of WUC while SMIP is responsible to provide scheduled delivery of water at the head of structuring level. Water Users Group (WUG) at watercourse level is responsible for organizing and paying for, operation and maintenance costs on the watercourse and managing water distribution within the watercourse. Most water users organize themselves to clean watercourses. Water users consider that on the tertiary and sub-secondary canals, desilting, and repairs should be managed by WUC. Based on the existing practices of system operation and maintenance, the physical point of division of responsibility for joint management is critical to define and hence, the performance of handed over sub-systems is less satisfactory with respect to self-management of WUCs. In many instances, maintenance within the handed over blocks are carried out by the Project and WUCs are dependent on annual budget allocations. However, feeling of ownership and community participation, labor mobilization at watercourse level, and reduction of the Government liability at lower level maintenance are some positive aspects of participatory irrigation management.

Identification of areas of private sector involvement
Based on the performance of existing management practices the following would be the areas of private sector involvement in SMIP.

- Operation and maintenance of dredging machines: Based on the annual silt exclusion performance of the past ten years and its positive impact on system operation, it is essential to make efficient management of the dredging machines in annual management contract.
- The operation and maintenance of secondary canal: Operation and minor maintenance on an annual basis may also be possible option for private sector involvement,
- Collection of ISF in each structured block may also be given to the private sector,

1.23 Kankai Irrigation Project

Management Overview
Kankai irrigation Project (KIP) with an irrigated area of 7,000 ha, is under joint management with the WUA since 1992. The Irrigation Division Office is managing headwork and main canal while secondary and tertiary canals are managed by respective WUCs. Table 2 outlines present management arrangements.

Table 2 Management Arrangements of KIP

SN	Irrigation system component	Management responsibilities			Remarks
		Operation	Maintenance	Resource mobilization	
1	Head works and main canal	Irrigation agency in consultation with MC		Government	
2	Secondary and tertiary canals that are not handed over to users	Usually done by SCC and WUC	Minor desilting by users, other maintenance by SSC/WUC with GON resource	Mainly GON	Users do mobilize some labours.
2	Secondary that are handed over to users	SCC	SCC	SCC	
3	Service roads	No defined mechanism exists. Maintenance is poor.			
4	Buildings, equipment	Irrigation agency			
5	Drainage	Virtually, no maintenance			

System Performance
In the KIP, five secondary and a few tertiary canals were handed over to the concerned SCC during late 1990s. Discussions with farmers, irrigation agency personnel, and committee members suggest that in handed over secondary canals, management is sustainable, maintenance is taken care by the respective SCC/WUC, ISF is collected by SCC/WUC, water distribution is better managed, and canals are better protected through livestock control. There is a growing feeling among the users that the handed over systems belongs to them, and it is primarily for their benefit. Thus, it is fostering a sense of collective responsibility in the users. The magnitude of direct financial burden of the agency in terms of O and M costs, salaries and wages of O and M staff has been reduced.

Identification of areas of private sector involvement
KIP has 18 secondary canals, of these canals, four secondary canals namely S1, S5, S8, and S14 have areas varying between 633 and 798 ha, and each of the remaining secondary canals has area less than 500 ha. As per the policy provisions, except these large secondary canals, all the remaining secondary canals can be handed over to the users. In reality even some of the large secondary canals namely S5 and S14 are already handed over to respective SCC and they are performing well. Thus, recognizing the better performance of secondary canals by the concerned SCC, it is feasible to involve private sector in operation and maintenance of the head works and main canals through management contract agreements.

1.24 Phalebas Irrigation System

Management Overview

1.25 Phalebas Irrigation System (PIS) is a small irrigation system having an irrigated area of 340 ha. In this system users are directly involved in its management since the completion of the project in 1990. The system management in PIS refers to the operation of two head regulator gates at the headwork, operation of direct outlets and other regulator gates in the main canal, distribution of water as per share system and maintenance of main canal. WUA was formed as early as 1992 and is performing well. The existing practices of O and M reveal that the users with their elected WUA are actively involved in water management practices (Table 3).

Table 3 Management Arrangements of PIS

SN	Irrigation system component	Management responsibilities			Remarks
		Operation	Maintenance	Resource mobilisation	
1	Head works and main canal	Agency Chaukidars	Agency and users	Agency and users mobilisation	
2	Branch canals	WUAs	Users	Labour mobilisation	
3	Tertiary canals and field channels	WUA	Users	Labour mobilisation	

1.26

1.27 From the table it is clear that users involvement in system operation and maintenance is quite encouraging. The Government through its local irrigation offices (presently Western Irrigation Sub-division No 1, Kushma), is allocating annual budget for system O and M. But the allocated budget is always insufficient to cope with the demand of the system management. And users are involved not only in day to day operation but also provide labour for main canal and branch canal maintenance.

1.28 System Performance

1.29 Users of the PIS are quite active in reaping agricultural benefits of the system especially users of Matedewal and Khanigaun are more benefited than those of Devisthan area as the previous areas were rain fed prior to system operation. With the formulation of WUA and other activities carried out for sustainable development of irrigated agriculture, users are positive on the following aspects.

- Ownership feeling of the system is the prime concern of the users to motivate them for operation and maintenance,
- Water distribution on the basis of share system on Devisthan branch with the help of Sancho is the fundamental aspect of equitable water distribution and sustainable management,
- Transparent accounting and public auditing is another essence of FMIS, which is being practiced in PIS,
- Community participation is the main motive of the PIS, which encouraged all users to work together and reap the benefit collectively,
- With the active involvement of WUA the role of the Government is diminishing not only in administrative aspects but also in financial responsibility.

1.30 Identification of areas of private sector involvement

Considering the positive role of WUA and active participation of users in system operation and maintenance, it is feasible to hand over the system to WUA.

In the original design of PIS there was plan of developing hydropower of 80 kW capacity from the available canal water. The available drop of more than 25 m at ch 7+500, which is now chute drop could be utilised for power generation. The revenue to be collected from the power generation could be used for irrigation system operation and maintenance. In addition, users of irrigation water may also be the shareholders of the proposed micro hydropower as per Community Private Partnership (CPP).

Conclusions

Policies to involve private sector in irrigation represent a significant shift towards the approach to commercialize irrigated agriculture. For this to succeed, it is essential to better understand the factors that facilitate and constrain private participation in irrigation.

The case studies in SMIP. KIP and PIS indicate that there are active formal institutions (WUA) for water management at the local level, although they are in the process of strengthening institutional capability. Farmers are also engaged in collective actions for maintenance of lower order canals, and quite active in collective lobbying efforts. In case of KIP, SCC performs maintenance of secondary and tertiary canals as per government budget allocation. Results of these case studies suggest that the existing institutions are successful in undertaking irrigation related activities at lower level canal networks and the involvement of private sector is possible at the management of higher level system operation and maintenance. Despite the policy

provisions to raise ISF through WUA, the rate of collection and cost recovery for system operation and maintenance is too low to justify the activities of WUA.

Based on above conclusions following are the possible areas of private sector involvement in irrigation development and management.

- Repair and maintenance - desilting and minor maintenance of canals, gravel roads etc (like DOR)
- Operation and Maintenance of plants and equipments- pump houses, lifting arrangements, dredging machines, gates etc,
- Canal operation- rather than hiring daily wage operators and chaukidars, management contract for canal operation including minor maintenance,
- Collection of ISF- part or whole of the system (during Rana regime land tax collection was given to private party),
- Leasing part of infrastructure for associated development and management like hydropower, tourism, small water mills etc,
- Institutional strengthening activities- based on experience these activities may be given to local Community Based Organization,

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Well Being Ranking: A Tool for Inclusive Irrigation

Ram Prasad Bhandari
Senior Training Officer cum Administrator, SMES Project JICA/NPCS
bhandariram9@gmail.com

Abstract

It is often questioned that whether irrigation can be pro-poor, as it serves those having land to irrigate. Similarly, the irrigation institutions are often controlled by socially elites rather than the 'real farmers'; the access of poor farmers in such institutions is much far to their reach. Then how can we address the issue of poverty reduction of a nation with agriculture base and make it inclusive in a diverse society, like Nepal. Irrigation project can plead that it is addressing the issue of poverty through employment generation for construction labor during construction period and agriculture labor for the rest part of the irrigation project. But, these considerations had become too classical and are not able to convince those pleading for the rights-based approach of development. In this background, this paper tries to discuss on the application of well-being ranking, which covers human position aspects besides the human condition, approach for community resource allocation ultimately making the irrigation a truly inclusive and pro-poor.

Background

Poverty alleviation is the national development agenda of Nepal. Incorporating the learning from the past periodic plans, the Tenth Five Year Plan (Poverty Reduction Strategy Paper – PRSP) clearly spelled out that the goal of poverty alleviation can not be achieved only by achieving the targets of overall economic indicators. With this realization the PRSP defined the poverty from three dimensions viz: income poverty, human poverty, and social exclusion (Three Year Interim Plan – TYIP). This definition of poverty supports the element of "human position" i.e. the societal status of an individual besides the "human condition", which covers the physical assets and income level of the individual.

Agriculture is still the mainstay of the majority of Nepali people, especially of those living below the poverty line. National Water Plan (NWP) states that around 80 percent of the poor work in the agriculture sector. It further says that these poor generally work on small and dispersed plots of low quality land. Nepal Living Standard Survey (NLSS) mentions that 78 percent of the people living below the poverty line have been receiving main employment from the agriculture sector. Further, baseline survey conducted in 422 poor households from four districts also revealed that 83 percent of the total households mentioned that their main occupation is agriculture (Sharma, 2006).

Water Resources Strategy (WRS) has set the goal that living condition of Nepalese people significantly improved in a sustainable manner. Supporting the WRS goal NWP states that the water sector development is expected to contribute appreciably towards sustainable growth in the agriculture sector, thereby reducing the level of absolute poverty in line with the national goal. But, the NWP also mentions that the number of absolute poor has nearly doubled over the past twenty years. TYIP puts the alarming note that despite the reduction of the population living below absolute poverty line from 42 percent to 31 percent, the income distribution gap has been further widened. The Gini Coefficient that shows the disparity in income distribution has been increased to 0.41 from 0.34 (TYIP). This reality puts a big question mark before the development planners, implementers and result monitors whether our past efforts were effectively aligned towards achieving the goal of poverty alleviation. Were not there some missing linkages between the overall sectoral goals and programs to contribute on those goal; between the programs and projects; between the projects and project activities; between the

project activities and actual implementation? Are not our programs and projects merely following the classical economic growth centered analysis in justifying the rationale of the development interventions?

Reiterating the national goal of poverty alleviation, TYIP has set its vision of building a well-off, modern and just Nepal where the nation will be out of the absolute poverty line and the gap between the rich and poor will be smaller. The TYIP sets forth the strategy of increasing access of excluded people in social and economic service delivery. Involving the excluded people into development process and ensuring the fruits of development results to the excluded have been underlined a challenge of development by the Interim Plan. To address the challenge the Interim Plan highlights identification of the people living below the absolute poverty line and focusing the development intervention for poverty alleviation as one the key policy.

This context clearly spells out the necessity of an appropriate tool to locate the poor in order to facilitate programming for appropriate intervention, delivery of the development intervention to the targeted poor, and monitor the changes brought by the development intervention. For which, Participatory Well Being Ranking (PWBR) could be considered as an appropriate tool.

The Irrigation Sector

As briefly discussed in the background the Water Resources Strategy as well as the National Water Plan had tried to align the irrigation objectives to the broader national goal of alleviating poverty. On the positive side, one of the specific objectives of NWP is to help reduce the incidence of poverty. Supporting the notion of NWP the Interim Plan states its expected outcome as the contributing to poverty reduction through enhanced food security, generation of employment and increase in income. The Plan, under its monitoring and evaluation provision, states that it will monitor whether or not the program generated employment opportunity and brought changes in the human development index (HDI). The NWP has mentioned that it has performed poverty analysis by taking the poverty index of different districts. It further says that a project falling in a particular category of districts is assumed to benefit the percentage of the poor living in the district as estimated from the poverty analysis. The NWP also claims that its targets are based on the objectives of the food security and livelihood improvement during the NWP period. But, the targets (see box 1) of irrigation sector do not have direct targets of livelihood improvement of the poor. These targets again follow the conventional way of rationalizing the irrigation projects contributing for poverty alleviation. The TYIP has outlined in its working policy that the non-conventional technology based irrigation projects such as drip, sprinkler, pond, etc. will be implemented targeting the marginalized farmers. This also reveals that the conventional technology based irrigation projects hardly serve the marginalized farmers, the poor strata.

Box 1: Targets of Irrigation Sub-sector

- Year-round irrigation is provided to 49% of the total irrigated area (present level estimated at below 30%).
- Average cereal yield in irrigated area increases by 15% over the 2001 level.
- Average cropping intensity exceeds 140% in year-round irrigated areas.
- Average cropping intensity of cereal crops exceeds 126% and overall cropping intensity, including that of other crops, exceeds 160%.
- Seventy-one per cent of the potential area is served by irrigation systems.
- Irrigation efficiency increases to 35%.
- Irrigation service contribution collection increases by 30% of the O&M cost.

The Interim Plan also put emphasis on capable and strong water users associations to realize inclusive governance. It spells out in its working policy that participation of women, differently-able people, senior citizen and other excluded groups will be ensured while forming the water users' associations (WUAs). To effectively implement the policy statement in the real field also needs specific program interventions to locate the excluded people, ways to involve them into the WUAs, and monitor the level of their meaningful participation.

Participatory Well Being Ranking

It is a community based participatory tool that stratifies the individual households within the given geographical boundary at various ranks based on their self-developed ranking criteria. It is the modified version of wealth ranking tool. The Participatory Well Being Ranking (PWBR) tool encompasses both the human condition aspects such as the income, physical assets, sanitation, etc. as well as human position aspects such as societal status, participation in community level decision making process, participation in political process, education, etc. The tool shows basically the relative poverty level among the households within the area of consideration.

Broad Steps of PWBR

- Preparation of households list within the targeted geographical boundary.
- Identification of heterogeneous group of informants such as social leaders, village leaders, elites, local merchants, local money lenders, teachers, tailors, butchers, etc. representing all clusters of the targeted area.
- Verification of households list by the informants.
- Preparation of separate name cards for the individual households.
- Preparation of well being ranking criteria and its finalization (table 1 shows one real example of the ranking criteria).
- Grouping the households name cards into different categories.
- Preparation of individual ranking within the stratified groups.

Table 1: Real Case Example of Ranking Criteria

Criteria	Ka	Kha	Ga	Gha
Source of income	Service, pension, good fixed assets from the ancestor	Lower level permanent service, some ancestral assets	Temporary service, only the land for housing from ancestor	Wage labor
Education	BA or equivalent	SLC pass	Eight grade or test pass	Just literate or illiterate
Land	Land producing food for the whole year	Nine months food producing	Six months food producing	Less than 3 months food producing or landless
Family members	Small	Up to six	Up to eight	Uncontrolled
Type of housing	Reinforced Cement Concrete	Galvanized Iron Sheets or slate covered roof	Thatched roof	Jhupadi (hut) or katero
Livestock	Pair of oxen, milking buffalo, 5 goats or capable of	One ox and one milking buffalo	Tharo buffalo and 2 goats	None

	purchasing all			
Participation in community groups	At the leadership level, involved in social works and implementing the known matter	Participates, but do not implement	Name listed in the groups, but does not cares	Not able to participate in the community groups

(Source: Shrikrishna et. al)

The whole process needs to be facilitated by a community level facilitator having received a maximum of 3 day orientation course. The output of the whole process looks like as shown in the conceptual sketch table 2.

Table 2: Conceptual Sketch of PWBR Output

Category Ka	Category Kha	Category Ga	Category Gha
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Case Study

Real case of the Participatory Well Being Ranking results has been presented here in order to test its validity for targeting the poor strata. PWBR was administered in 19 Village Development Committees (VDCs) of four districts namely Ramechhap, Dolakha, Lamjung and Kaski to implement income generating program for the lowest strata i.e. the worse-off. All together 422 households were selected for program intervention based on the result of the PWBR. A detailed baseline survey was conducted covering all of the 422 households in order to know their real benchmark status of poverty. The baseline survey questionnaire and checklist covered all dimensions of poverty such as economic, social status, community participation, health, sanitation, education, access to development interventions, etc. The survey data was analyzed using compute software namely SPSS. Results generated were thus compared with the gross poverty classifications criteria that are being used by Nepal Rastra Bank and Nepal Living Standard Survey. Table 3 presents the highlights of key findings from the baseline survey.

Table 3: Highlights of Baseline Survey Findings

Indicators	Percentage of total households
Agriculture as the main occupation	83
Having no land	21
Having land less than 6.5 ropani	82
Having land less than 10.2 ropani	92
Food sufficiency for less than 3 months a year	34
Food sufficiency for less than 6 months a year	88

Participating in community level activities	60
Participating in decision-making or planning level (among those participating in community level activities)	3

Nepal Rastra Bank has classified poverty levels of households on the basis of land and categorized as - the land holding less than 6.5 ropani are considered in ultra poor category, while those with less than 10.2 ropani regarded as poor and those with more than 10.2 ropani as non poor (Sharma, 2006). Following this classification the 92 percent of households identified as poor from the PWBR fall under the category of poor.

The Nepal Living Standard Survey 2003/04 had set the poverty line for Lamjung and Kaski districts as Rs. 8901.5 per person and for Ramechhap and Dolakha districts Rs.8069.6 per person (Sharma, 2006). The baseline survey result shows that 63 percent of Lamjung and Kaski district and 96 percent of Ramechhap and Dolakha districts households fall under the poverty line as compared with the NLSS scale.

Conclusion

From the above discussion following conclusions can be drawn.

- The Water Resources Strategy, Nepal Water Plan and Three Year Interim Plan had clearly spelled out their commitments on contributing to the broader national goal of poverty alleviation through irrigation sub-sector. But, are lacking to specifically pin pointing out the strategies, action programs and targets to convince the development partners that the irrigation sub-sector is pro-poor.
- Participatory Well Being Ranking tool, although developed to trace the "relative poverty" within the boundary of its administration has also been found a well representing tool for tracing the "absolute poverty".
- Being simple and locally owned tool the PWBR can be administered as a tool to locate people under multidimensional poverty level, a tool of sensitization for project prioritization, and a tool for monitoring the change status of the poor.

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GENDER EQUITY IN IRRIGATION MANAGEMENT: A CASE STUDY OF 8 FMIS IN WESTERN REGIONS OF NEPAL

Merina Lohani Sitoeula
Social Development Specialist
CMS Nepal (P) Ltd.
merinalohani@hotmail.com

Abstract

The purpose of this paper is to assess gender equity with focus on information dissemination in irrigation management taking into account 8 FMIS districts in western Nepal.

The study results show that despite the mandatory 33% representation of women demanded by the Irrigation Policy, the gap still exists between its implementation as it still does not ensure qualitative and meaningful participation of women. Most of the WUAs have below 30% representation of women and they are not involved in decision making activities.

The responsible factors identified for low representation and no active participation of women in participatory irrigation management are as under:

- *Link of WUA membership with the land holding;*
- *Weak information dissemination and communication with no especial effort on reaching out and addressing the female audiences;*
- *Lack of education, illiteracy and exposure a hindrance in voicing their opinion and seeking information;*
- *The traditional roles of women and their exclusion from irrigation management by defining it as a 'male domain; and*
- *Low socio-economic status*

Hence, to promote gender sensitive development, it is crucial to identify the roles, problems and opportunities to ensure that the concerns of men and women are equitably addressed. The development initiatives to encourage and facilitate involvement of women in irrigation management should reflect and be guided by their actual interests, needs and present workload condition.

Introduction

This paper explores gender equity in irrigation with focus on the roles women in irrigation management and their access to information. This study is divided into two sections: first section reviews the status of women in participatory irrigation management from the review of past projects as well as national and international write ups. And the second part draws empirical evidence on the aspect from the case studies of 8 surface FMIS in the western regions of Nepal.

Background

When discussing gender equity, it is essential to understand the concept of social equity first. The literatures of social science define social equity as "social justice in benefit sharing" or the "fair distribution of benefits". Fair distribution of benefits can be ensured only if there is an active participation of the representatives from all the interest groups and a wide spectrum for decision making to correspond to their common interest and this vision is shared by the 'Community of Interest Theory', one of the modern theories of water right (Singh, 1991).This is

significant for utilizing the common property resource which in this context is water for irrigation. The social equity can be achieved in any context only if there is sufficient access to resources; economic prospect, decision-making opportunity and justice (Carol et.al, 2001).

To understand gender equity it is essential to assess gender relation which in true sense is a power relation and is basically concerned with the access and control over resources. While addressing gender equity, it is necessary to assess the equality of access to and distribution of resources between male and female. In certain societies, the balance in equity is disturbed when women have access to resources but the control over resources lie in the hands of men.

Women, both rural and urban have a multidisciplinary role to play but the opportunities given to them are comparatively very less than men. The Nepalese women are found engaged in productive, reproductive as well as community services work while men undertake only productive and community role. The needs and interest of men and women may vary. There are two types of gender needs of women - practical gender needs and strategic gender needs which must be recognized and addressed while formulating policies that aim to strengthen women's role in society.

Like in many agrarian societies, the division of labor in Nepal is also fixed according to gender. However, in the situation of a decade long conflict going on in the country and the out-migration of men-folk to the labor demanding industrial cities of the world, the agricultural workload on women multiplies and the customs of what is considered male and female work do not always correspond with the actual practice. Women have an extensive involvement in a key sector of the economy with over 90% involved in some way with agriculture. Gender roles have an important impact on how irrigation is managed, and on who does or does not benefit from efforts to improve participation in irrigation management. With 75% of irrigated agriculture commanded by FMIS, besides their household drudgery, the active female beneficiaries are also burdened with the responsibility of operating, maintaining and managing small irrigation systems.

For irrigation management to be successful, the participation of the users play crucial role. Hence ensuring WUA competency in equitable, efficient and sustainable O&M and in facilitating highly productive irrigated agriculture is a critical requirement for successful FMIS interventions. Organizationally, they need to be represented by all users across the command area including women. Realizing this, the irrigation policy, 1992 (first amendment, 1997) states that *'Women participation in the WUA will be encouraged and it would be intended to increase by at least 20% in executive board of the WUA.'* The revised Irrigation Policy 2003 has increased the percentage of women representation in WUAs to 33% and also made it mandatory. The irrigation regulation, 2000 states that the executive committee of the WUA should have at least two women members out of nine members thereby further making women's participation mandatory.

This regulation intends to provide the opportunity to improve women farmers' social status, their skills and provide them space to voice their opinion in water management. Tenth Plan has also ensured the continuation of women's involvement in WUA formation as mandated by Irrigation Policy, First Amendment (2053). Less membership of women in the WUA usually corresponds with land ownership. Since many daughters renounce their rights to inherit land in favor of their brothers, there are few women land owners.

Despite specific policies related to women's rights and opportunities in several significant Government plans and initiatives, the position of women in Nepal (taking into account most

social indicators) remains poor compared to men. Social indicators, reflecting the quality of life in Nepal also indicate a poor situation showing women and children more affected by poverty than men in both the rural and urban areas of the country. A gender indicator in Nepal (0.452) reflects the disparity between males and females in terms of levels of subsistence lifestyles, health statistics, education, employment and advancement opportunities, legal rights over physical assets, and the environment for independent mobilization and socio-cultural aspects as a whole. Low levels of adult literacy among women (35.4%) compared to men (64.8%) and low levels of overall literacy (24%) compared to men (52%) are particularly significant statistics (CMIASP, 2004).Poverty alleviation has been the focus of all the FYPs and the need for gender balance has been duly considered in this pursuit in the Tenth Plan.

If women become the WUC members they can act towards safeguarding their water rights. Representation of women in WUC addresses the larger strategic needs of women - the practical gender needs which if met would assist women in their current activities; and strategic gender needs, which if met would enable women to transform existing imbalances of power between women and men.

Also the traditional roles of women and their exclusion from irrigation management by defining it as a 'male domain' have failed to gather their contribution. Hence it is crucial to identify most important roles, problems and opportunities for providing foundation to ensure that the concerns of men and women are equitably addressed by a program/project. This requires, besides looking at water distribution and infrastructure improvement, also assessing how rights to land, participation in community decision-making and access to information, credit and other resources can help promote gender equitable development. The development initiatives to enhance their involvement in irrigation management should reflect and be guided by their actual interests, needs and present workload condition.

Methodology

The sample households were selected using the simple random sampling under the probability sampling framework. Then, a proportionate stratified random sampling was used to ensure the fair representation of various farm sizes in the three different locations of the command area. The PRA tools formed the basis of the field work which included key informant interview, focus group discussion, group meetings and informal discussions the purpose of collecting field level information. A separate checklist for each set of tools was developed and administered.

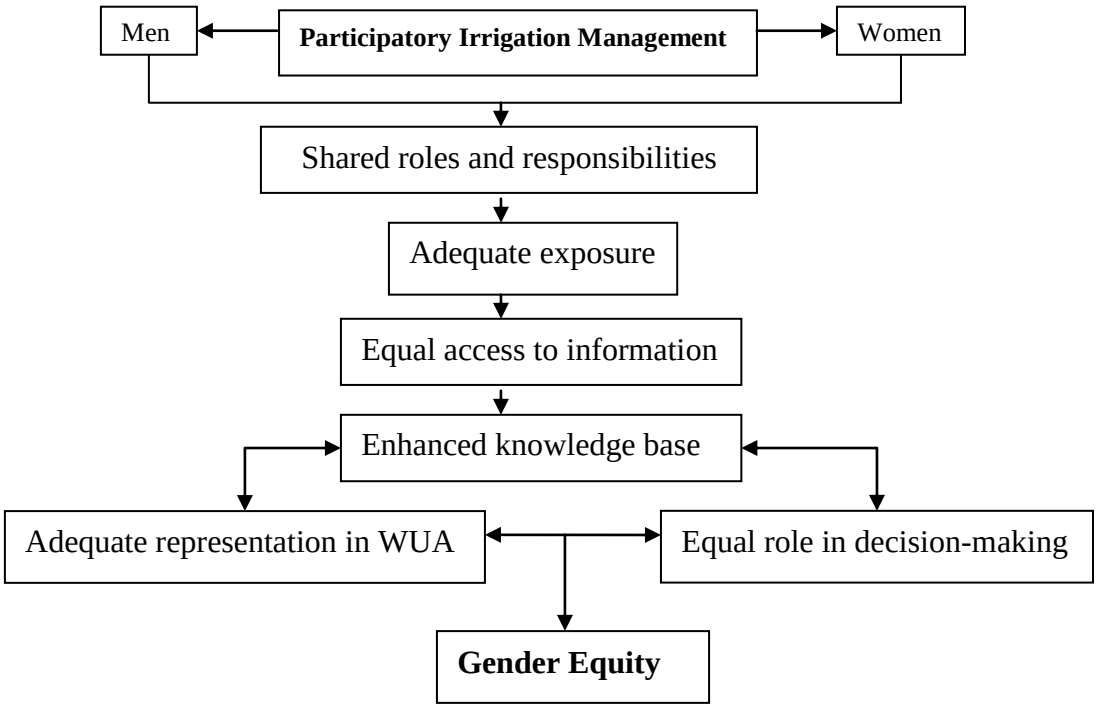

Fig.1: Gender equity in participatory irrigation management-A Conceptual Framework

This framework represents the link between participatory irrigation management and gender equity and suggests ways to make irrigation management participatory in its true sense of term.

Case Study Findings

1. Overall Socio-economic Status of Women

Regarding the socio-economic status of women in the sampled FMIS districts, Surkhet and Bardiya had the indigenous *Tharus* as dominant population. Darchula and Doti had majority of Chettris with substantial *Dalit* population while in Syangja Brahmins were the pre-dominant castes. Lamjung had Brahmins as dominant castes with some Gurung population. In Dailekh there were large population of *Dalits* and Chettris while Rupandehi had the majority of *Terai* high caste groups and few indigenous groups like Tharus, Gurungs and Magars and some *Dalits*.

Looking at the overall socio-economic status of women in the sample districts, the scenario was not very different from the rest of Nepal with some variations in the urbanized districts. Like every where else in Nepal, the socio-economic status of women was poor. Women were involved in productive, reproductive and community works without true recognition of their endeavor both socially and financially. Women from *Dalits*, disadvantaged groups and marginal/landless category were the ones who were the most deprived. Women from high castes were not much involved in productive works but were rather engrossed in playing reproductive role confined inside their households. In several sample districts where the indigenous *Tharu* were the majority of the population, the situation was a little different because *Tharu* women were relatively empowered and their socio-economic status was also comparatively better-off.

Table 1: Educational Status among Female in FMIS districts

FMIS District	Literate (%)	Literate Male (%)	Literate Female (%)	Illiterate (%)
Surkhet	36	52.9	47.2	32

Bardiya	30.3	58	41.2	28.8
Darchula	20	60	40	13.3
Doti	15.4	52.1	47.9	23.1
Syangja	15	53.8	46.2	10.5
Lamjung	17	50	50	3.3
Rupandehi	17.4			47.1
Dailekh	35	56.3	43.8	25

Looking at the educational status of women in these districts in **Table 1**, it was found that only a handful of women had completed higher secondary education and a significant dropout at primary and secondary level was seen primarily due to high work load and less time left for studying.

2. General Irrigation Organization Pattern

Generally water for irrigation is managed by the user groups of the community. The general pattern of organizing the users' group is through the formation of a Water Users' Association (WUA) which has also been recognized to play a pivotal role in sustainable irrigation development and management by Irrigation Policy. They are basically task-based organizations and are primarily engaged in resource mobilization system operation and maintenance and allocation/distribution of water. The policy further recognizes WUA as a legally registered organization.

Assessment of WUAs in the sample sub-projects informs that there are WUAs in variable status: i) Ad hoc, ii) registered and non-registered, iii) relatively new and old. In four of the sample districts namely- Surkhet, Bardiya, Doti and Rupandehi there were formal Water Users' Association (WUA) while in Dailekh it was in the process of being legally registered. Darchula, Syangja and Lamjung did not have a formal WUA.

3. Women's Institutional Representation and their Role in Decision-making

Table 2: Representation and Role in WUA

S.N.	FMIS District	Total Numbers of Members	No. of Women Representatives	Involvement of Women
1	Surkhet	11	3	Attend meetings, not involved in decision-making/management related activities
2	Bardiya	15	2 (Tharu)	Attend meetings, not involved in decision-making/management related activities
3	Darchula	-	-	-
4	Doti	11	4 (Vice-chairperson is a women)	Actively involved in meetings, repair and maintenance, irrigation water distribution, and irrigation service fee collection
5	Syangja	-	-	-
6	Lamjung	-	-	-
7	Rupandehi	13	5 (two *Dalit* women, one is	Attend meetings, not involved in decision-making/management related

			treasurer)	activities
8	Dailekh	11	2	Attend meetings, not involved in decision-making/management related activities

Most WUAs have below 30% representation of women except for Doti and Rupandehi where it was 36% and 38%, respectively. One of the reasons for low representation of women in WUA has been linked with the land holding which is mostly under men's name. In WUAs with women's representation, actual participation in the irrigation management was negligible because except for attending the meetings spasmodically, women were not involved in decision-making and other management related activities.

In Doti the position of vice chairperson was entitled to a woman. Here, women actively participated in irrigation management as advocated by their involvement in the meetings, repair and maintenance, irrigation water distribution, and irrigation service fee collection. In Rupandehi the treasurer of the WUA was a woman but her activity was limited to attending meetings and she was not given authority to take decisions.

Since it is a woman who does most of the farm activities, it is essential that she attends meetings where issues such as irrigation scheduling and improvement of on-farm irrigation practices are to be discussed because such meetings are informative and hence women can understand what is happening. Ironically, as confided by female members, they were always sidelined when it came to taking decisions which were always taken by male members without any concern for their viewpoint.

4. Role of Women in Irrigation Management and their Access to Information

Despite major role played by women in agriculture, it is actually taken to be the extension of their household chores and is not counted as a productive activity. The theoretical division of labor in agriculture does not agree with the actual practice where 90% of the agricultural activities are undertaken by women. Men are mostly involved in land preparing activities while rest of the works are burdened on the shoulders of women.

Regarding access to information, in most cases, no gender parity was seen. Men were the ones to get firsthand information while women mostly got information indirectly either through the women leaders in their community or through their male counterparts. One of the major findings from the field was that while circulating information, no special effort was put on addressing and reaching out to the audiences on the basis of literacy status, gender, language, identity (such as Indigenous People) and disadvantaged/vulnerable groups (such as *Dalits*, and landless depending more on the local common property resources). There was no practice of using selective tool for disseminating information among women. Information was given to all following a common set of tools and mechanisms. Men in the WUA did not properly communicate about the agendas and proceedings to the women members. Not being fully aware of what is happening, women said that they did not feel inclined to attend the WUA general meetings; when they did attend the WUA general meetings, they were usually hesitant to speak out their irrigation needs and problems.

The case was a little different in Tharu dominated areas where female leaders of the community were actively involved in the process of disseminating information especially among the women folks and indigenous groups. Females in this community have a strong hold over decision making. They have adequate exposure compared to the females in the other regions. However,

lack of adequate education was predominant and has also been cited as one of the major barriers to their active participation in the WUA and in decision-making. Contrary to this, in other non-Tharu parts, especially the Far Western Development Region (Darchula, Kanchanpur and Doti), scenario was different with women who had literally no access or very poor access to information. The low socio-economic status ascribed to women in these regions has been the primary reason for this discrepancy. As revealed by the female informants, since they were confined to their house and farm only, lacked exposure and had no access to information, their representation in WUA was negligible.

5. Interaction of Women with Government Functionaries

In majority of the sample districts, women were not found to have a direct relation with the government functionaries, who were mostly men. The task of visiting the government offices or directly interacting with the officials during the site visit was usually done by the male members hence women seldom got opportunity to interact with the government functionaries.

6. Factors Affecting Low Level of Participation and Equity

The reasons for minimal involvement of women as active members of the WUA as obtained from the field study are as follows:

a) Patriarchy: Women are discouraged to be a part of activities that have been separated as a 'male domain' which in this context is participation in public activities. True in every case, women have a huge work load with reproductive role to play, on-farm and off-farm activities and household chores leaving them with very little time to get involved in other activities beyond these.

b) Lack of education and exposure: Huge work load, very less time for community involvements and their confinement within the domestic sphere, resulting in the lack of exposure adds to their limited knowledge of things. As realized by women themselves, the lack of/inadequate education has hindered their understanding of things and stunted their self-confidence. Due to this factor a gap in their knowledge, understanding and their ability to respond to different things is created. Because of this they cannot voice their opinion clearly and confidently leaving them simply as a meek audience and listener.

c) Low economic status: One of the major factors for empowering women besides education is their economic condition. An economically sound woman is empowered to think and take her own decisions to certain extent in comparison to those women who are poor and have no financial security. In the sample districts, majority of women are economically disadvantaged with no land holding or any other properties at their disposal and no other source of income. A puppet in the hands of male members in the house they hardly get any chance to express their views and desires.

d) Poor access to information: Poor access to information is found to play a critical role in the involvement and participation of women in irrigation management. Due to lack of exposure and education, women do not have equal access to information like men. It is this gap in information that results in their low participation. Women are not taken as a primary recipient while disseminating information. This gap in information and communication has also resulted in their decreased interest and hence low participation in irrigation management.

e) Policy gaps: Although the existing policy in the context of equity in irrigation system management has defined mechanism to ensure inclusion for women, it still does not ascertain qualitative and meaningful participation of women.

Conclusion

Despite the quota for women in the WUA, their actual representation in participatory irrigation management and their involvement in the decision-making is minimal. Mere policy reform cannot bring women into the irrigation management mainstream because policy needs to be put into action. This requires extensive information dissemination to women in the rural areas. It is due to this gap in information and effective communication that irrigation management has still not succeeded in generating interest among women. The needs and priorities of men and women may vary because women have different concerns and responsibilities. In the current scenario where women are bound to do all the agricultural works as a household head they need information for taking day to day decisions. These are some of the practical reasons requiring gender equity in irrigation so as to achieve a sustainable irrigation development and management. With equal participation of men and women in irrigation and water management, equal access to information and equal role in decision making, irrigation management can become participatory in true sense of the term.

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Inclusive and Gender Development Strategy: Experience from SAGUN- Irrigation

Rishi Ram Sharma Neupane
Land and water Management Expert
(samirne@enet.com.np

Abstract

This paper is about an experience on inclusion strategy implementation through SAGUN irrigation program in 14 WUAs of 11 irrigation projects located in Saptari, Siraha, Dhanusa, Sarlahi, Chitawan, Nawalparasi, Kapilbastu and Kailali. This paper is organized into six ideas such as, key drives to SAGUN-Irrigation program, its goal and objectives, inclusion and gender development strategy, important field practices and achievements and key learning. Poor governance of WUA, low ISF collection efficiency, decreasing attitude of water users in participation have been explained as the basic drives for the second generation WUA capacity strengthening in SAGUN-Irrigation. Seven important strategies that were employed to achieve the objectives of inclusive water management approach have been explained in this paper. The important and effective field practices that were documented as best practices during project operation have been included. Agricultural yield of rice, wheat and pulses increased to 3.89 mt/ha, 2.32mt/ha, 0.78 mt/ha respectively; Irrigation Service Fee (ISF) collected reached to Rs 2076137; a total of 1836 km of tertiary canals were cleaned by farmers; a total of 751 km of field channels were constructed by WUAs; intensive irrigation management area reached to 46260 ha in monsoon through the implementation of inclusion and gender development strategy in SAGUN Irrigation program.. Finally, the paper shares key learning useful for policies and act re-visit, and program replication

Introduction

Even after the completion of Irrigation Management Transfer Project jointly financed by ADB/USAID/HMGN/WUA, some aspects of capacity development part of Water Users Associations (WUAs) still remained incomplete due to which management decision taken by WUA executives in the absence of appropriate knowledge and skills, resulted in various organizational issues that became primary inputs to second generation capacity development of SAGUN-Irrigation program. These issues were as bellow:

- poor governance of WUA functioning,
- continuous reduction in ISF collection efficiency,
- gradual decrease in people participation in canal cleaning and maintenance,
- gradual exclusion of lower level WUA comities in decision making, and
- gradual exclusion of women participation and poor and small farmers in WUA membership s and key positions.

To solve above primary issues, Strengthened Action for Governance in Utilization of Natural Resources (SAGUN-Irrigation) program financed by USAID and implemented by DOI/CARE/RITI consultancy P.(LTD)/WUA was carried over during 2002 November-2006 September in Saptari(Chandra canal), Siraha(Kamala East), Dhanusa(Hardinath East and West), Sarlahi(Manusmara I &II), Chitawan(Khageri and Panchakanya), Nawalparasi(West Gandak and Piperpati), Kapilbastu(Banaganga), and Kailali(Pathraiya and Mohana) districts covering 14 WUAS,77247 households,191VDCs served by 1080 tertiary irrigation canals. The program had the set goal and objectives with detailed strategy and activities.

Vision, Goal and Purpose

Vision: "Water Users Organizations are managing and maintaining the irrigation systems, collecting membership and irrigation service fees and the system is functioning properly and sustainable. Proper functioning includes institutionalization of good governance practice regarding participation, transparency, accountability and equity within the water user's organization".

Goal: To evolve self-enduring and self-governing sustainable water user's organization for increase water productivity and irrigated area under WUA management.

Purpose: To contribute to increased irrigation area coverage for increase irrigation revenue through effective and efficient WUAs functioning democratically.

1.30.1 Objectives

The overall and the specific objectives of SAGUN-Irrigation were as listed below:

Overall objective: The overall objective of the SAGUN-Irrigation program was 'to ensure that Nepal's natural resource are managed in a democratic way; that the performance of selected institutions is improved to meet the principle of good governance and participation; and in particular that the benefits derived from water resources are dispersed in accountable and other earned revenues are equitably distributed among beneficiaries'.

Specific Objectives

- Strengthened WUAs with enhanced organizational, managerial, technical and governance capacities.
- Increased active participation of women, poor farmer/small-holders, dalits in WUAs including leadership position.
- A limited number of weak WUAs strengthened.
- Financial accountability and Advocacy functions of WUAs strengthened.
- DOI capacities strengthened.
- Strengthened capacity of the Water User's Federation, NIWUAN..
- Improved communications between all stakeholders in irrigation, sharing lessons learned, issues and problems.
- Lessons learned and best practices documented and disseminated for replication.

Inclusion and Gender Development Strategy of the Program

The notable strategy feature of SAGUN Irrigation was to involve landless, dalit, women, small land holders and big owners from the very beginning of project implementation making WUAs as partner of program execution to achieve the set targets. Remarkable results and impacts such as increase in agricultural yields-rice from 2.5 mt/ha to 3.89 mt/ha, wheat from 1.5 mt/ha to 2.32 mt/ha, pulse from 0.5 mt/ha to 0.78 mt/ha; intensively managed irrigated area increased from 25000 ha to 46260 ha in monsoon and from 14000 ha to 24286 ha in winter; Irrigation Service Fee (ISF) collection increased from Rs 830000 to Rs 20716137. While achieving above results two pronged approaches- preparatory and operational was implemented during project. Preparatory approach consisted of sharing vision, objectives, and annual plan and budget to all project staff and stake holders with the development of necessary skills, knowledge and logistics needed to implement the program. The operational approach that seemed very critical and important in meeting program objectives were:

- identification and analysis of stake holders,
- inclusion of dalits, women, and small land holders in decision making with active participation,
- partnership with WUA in program implementation,

- establishment of linkage and net works with district based line agencies,
- practice of good governance in managing irrigation water,
- development and use of local resource persons, and
- application of equity principles in water distribution and labor contribution

Field Practices and Achievements

Implementation practices and processes were closely monitored and modified according to field situation as the national political imbalance considerably influenced the peace of the local communities at that time. Delay in program operation schedule, hardships in program monitoring, fears of looting logistics and resources were the critical features of insurgency period at that time. Several blockades (Bandhas), strikes, threaten by rebels and prohibition to project sites, obstructed smooth operation of the project activities as planned. However, the best practices applied to achieve the following planned strategy aspects and the corresponding results during project period are briefed bellow:

Increasing stake holder's participation: Two levels of stakeholders were identified - service provider groups and service receiving groups. Identified service providing groups consisted of Divisional offices of Irrigation Department , District Agricultural Office, District Office of Forestry, Soil Conservation, Fishery, Animal Husbandry , Banks and local level agencies-NGOs and Co-operatives. Among service receiving groups (farmers) further classification was made as benefited farmers, partially benefited farmers and non-benefited farmers (land less groups , widows and single women, and dalit farmers). All identified stake holders were invited and involved during program design, orientation, implementation and monitoring and evaluation. The average percentage of women representation in Main, Branch and Tertiary committees of WUAs were 15%, 30% and 19% respectively.

The annual plan and progress were reviewed annually in a workshops attended by stake holders representatives. At field, user level participation of women, dalit, poor farmers were promoted through branch canal committee meetings.

Promoting inclusion of dalit and women: For hearing voices of marginal {partially benefited or non benefited) water users, women, and dalits, WUA constitutions were modified for reserving key positions for women and dalits. At tertiary level, standard committees which consisted of 7 members in which one dalit and 3 women were encouraged to be formed. About 4% of dalits occupied key positions in WUAs. Women and dalits were empowered through trainings, exposure visits and income generation activities.

Table 1: Active Participation of Women in WUA (Target -20 % of total WUA members)

Items	Base data (%)	Year 1		Year 2		Year 3		Year 4	
		Target	Progress	Target	Progress	Target	Progress	Target	Progress
% participation	5	5	7.76	10	17	14	19	20	20

Note: Figures are cumulative.

Some important issues which appeared during program initiation period were::

- non –inclusion attitude of some WUA executives for landless, dalits and single women,
- Landless and dalits showing less interest in the program unless tangible benefits were clear,

Income Expenditure in WUA, HISW

Before SAGUN program, program implementation budget and expenditure used be centrally controlled by projects and non-transparent. The users were unaware of the programs and they did not have access on decision. After SAGUN program every activity, budget, expenditure is made transparent through public auditing and hearing. At present WUA has maintained records as taught in training provided by SAGUN. Maintained records are advance ledger, labor contribution and passbook, ISF records, membership records. With this transparent behavior of WUAs users have paid ISF meeting 100% target of Hardinath West Irrigation System.
-Bujhawan Thakur, Chariman, Branch 5, Hardinath West

Program implementation through partnership with WUA: For strengthening program ownership attitude of WUAs executives; for making them more responsive and accountable; and for strengthening their program management capacity, 14 WUAs offices at main, branch and some tertiary canal levels were established and supported with office support kits(furnitures, stationeries, bicycles, office documents); project training field staff were kept in WUA offices; technical and managerial skill supports were provided to WUA field staff(motivators and secretaries); and budget was transferred to WUA accounts quarterly after submission of future budget plan and previous expenditure details.

Partnership approach was experienced as very effective ways of canalizing project programs to achieve target results because of self respect, decentralized accountability and due recognition of their working capability.

However, some important issues as mentioned below were noted while working together with WUAs:

- very low existing financial management capacity of WUAs to begin the program,
- inadequate seed money in WUA for necessary logistic operation, employing minimum office staff, and hiring WUA office,

Promoting net workings and linkage: To provide line agency program supports and services to WUA for sustainability of the benefit obtained from the program, district level meetings were organized with line agency offices (agriculture, agriculture bank, forest, veterinary etc) providing membership to WUA in District Agriculture Development Committee (DADC).

Followings were the observed issues for effective and continuous service support from line agencies:

- very limited flexibility with line agencies in program adjustment to be compatible to users need,
- line agencies obliged to follow central policy for program formulation despite the local needs, and
- inadequate infra structure to under take dealership of fertilizer, seeds, and pesticides.

Development and utilization of local resource persons: For sustaining imparted skills and knowledge required for qualitative irrigation services within local community, WUAs were advised to recruit and train resource persons from their own locality. After recruitment these resource people were trained with training skills and subject matters .With inbuilt capacity these persons conducted trainings on awareness generation of ISF and labor contribution to their fellow farmers using project budget.

The important issues observed during project implementation were as following:

- difficulty to retain educated recourse persons in WUAs,
- WUA could not give employment to these trained resource persons permanently, and
- Local level development agencies showing inability to use these persons.

Application of equity principles in resource allocation and labor contribution: To maximize users participation in water management and to reduce water related conflicts, the basic principle of equitable water distribution –flow duration (almost same stream size /discharge) based on location and area irrigated; and participation in labor /cash /kind contribution based on irrigation land holding size, were strengthened and practiced in the user committee. A total of 1836 km of tertiary canals were cleaned and 751 km of field channels were constructed by WUAs. Almost all WUAs established their own norms for labor contribution separately in different projects as shown in table

Table2 : Different standards of norms for TC cleaning

Projects	CIS (Rs.)	KISE (Pers)	KISW (Pers)	HISE (Pers)	HISW (Pers)	MIS-I (Kg)	MIS-II (Kg)	PIS (Rs.)	KgIS (Rs.)	WGIS (Rs.)	PPIS (Pers)	BIS (Pers)	PtIS (Pers)	MOIS (Pers)
Standards per ha.	90	3	3	3	3	30	30	300	750	120	3	3	3	3

Note :CIS-Chandra canal ,KIS- Kamala, HIS- Hardinath, MIS-Manusmara, PIS-panchkanya , Kgi-Khageri, WGIS-West gandak,PPIS-Piperpati paursauni, BIS-Banganga ,PtLS-Pathlaiya, MOI-Mohana

Table3: Labor mobilization for cleaning Tertiary Canals

Items	**Base data**	**Year 1**		**Year 2**		**Year 3**		**Year 4**	
		Target	**Progress**	**Target**	**Progress**	**Target**	**Progress**	**Target**	**Progress**
# of TCC	N/A	100	200	400	398	630	676	630	1028
Persons/day	N/A	1296	16776	5184	84012	8165	140682	8165	179624

Note: Figures are cumulative. N/A=not available as established norms.

Encountered important issues in equity concept implantation in water distribution and labor mobilization were as given bellow:

- farmers' resistances to field canal expansion for fear land contribution,
- inadequate and inappropriate tertiary level water control and division structures, and
- farmers' poor attitude of non- declaration of their actual irrigated land.

Practice of good governance: To promote and strengthen good governance characteristics –transparency, participation, equity, accountability, rule of law, and predictability, all level WUA members, executives and tertiary level water users were made aware of the advantage of implementation of good governance characteristics through WUA management functions. The remarkable impacts of good governance were observed in the increase efficiency of ISF collection, regular annual auditing and public auditing by 12 WUAs as well as public auditing followed even by Divisional offices of Saptari, Dhanusa, Sarlahi and Nawalparasi districts. Establishing rules of ISF collection, WUAs increased annual amount of irrigation service fee as given in the following table.

Table 4: ISF Collection by WUAs (Target ISF – Rs. 1920000)

Items	**Base data (Rs.)**	**Year 1**		**Year 2**		**Year 3**		**Year 4**	
		Target	**Progress**	**Target**	**Progress**	**Target**	**Progress**	**Target**	**Progress**
ISF collected	830000	960000	965229	1535000	1487678	1728000	1571051	1920000	2076137
% collected	43%	50%	50%	80%	77%	90%	82%	100%	108%

Note: Figures are annual.

A few issues that were encountered during implementation of good governance characteristics were as written bellow:

- prevailing local corruption attitude resisted chairperson of WUA to follow good governance,
- WUA executives could not implement good governance practices in the absence of rules and policy of WUA, and
- lack of national policy and act on good governance de-motivated service providing groups to be transparent and accountable to users.

Key Learning's

Learning on different aspects such as constitution development, inclusion approached, women empowerment were documented during the strategy implementation period of SAGUN-Irrigation program. A few of these learning worth for program replication are briefed below:

Inclusion of stake holders: Recipient stake holders such as single women/widow, land less farmers, marginal water utilizes need to be identified before implementation of the irrigation program. Development program should target with program to these stake holders after assessment of well being ranking.

Need of WUA constitution, rules and policy: Advantage of Inclusion and participation of marginal users in irrigation development can be anticipated when constitution, rules and policy exist in WUA and include principle process of inclusion.

Inclusive democratic process for constitution development: For having sound constitution of WUA, equitable representation/ participation of all types of water users of the command area, regional (head, middle, tail) representatives consisting of proportionally selected users by cast and gender, was considered. For this one general assembly was formed taking one representative from 10 house holds. Then, main assembly was formed taking 5% members from general assembly. After then, an ad-hoc working committee was formed taking 25% members from main assembly and 2% experts from outside. Such representation of constitution was fully honored by all users and local elites.

Member representation regionally in constitutional assembly: Constitution development assembly members should represent regionally (branch canal wise), with the representation of poor and rich farmers, women and dalits (farmers) and political parties proportionally.

Need of Women empowerment: Women members of WUA can be more successful agent in mobilization of labor resources for canal maintenance and women farmer participation in WUA activities..

Field channel as an effective linkage for equity and reduced conflicts: Field channel to field irrigation practice ensures access to all marginalized water users reducing conflicts and promoting more and more equitable water scheduling and labor contribution.

Practice of good governance characteristics: Implementation of transparency, participation, accountability, equity and rules of law behavior in organizational functions of WUA promotes irrigation service fee collection efficiency and labor contribution to canal cleaning.

Initiation of a true spirit 0f inclusion: A shared vision of the program, objective, goal and a shared responsibility of managing financial resources (budgeting and expenditure) develops a partnership sprit among the WUA executives and members in undertaking responsibilities for achieving program objectives and goal.

Specific program needs to marginalized groups: The over all irrigation development or management project should consists adequate program and budget in addressing the development needs of the marginalized group (land less, poorest group having less than 2 ropani or 5 katha land), single women etc).It demands program diversification such as literacy, income generation, local agro-enterprise development, agricultural equipment development, diversified agriculture and even local tourism.

Inclusion strategy promote conflict mitigation: When program, budget, expenditure, program and issues are shared among all level of stake holders, minimum conflicts occurs during irrigation planning implementation, commissioning and benefit sharing, because every project action becomes transparent to members. Mutual supports for field channel construction, canal cleaning, water distribution, capacity building trainings and decision implementation reduces community conflicts and misunderstandings on irrigation water use and labor contribution.

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Abstract

Equitable Distribution and Common Resources Management at Andhi Khola Irrigation System

1). PADMA PRASAD ARYAL

2). DINESH RAJOURIA

Water resources being one of the major natural resources of Nepal, culturally, economically as well as geographically it plays an integral and vital role in the agriculture based economy that supports 40% of the GDP with more than 80% people's involvement in the sector. Land fragmentation coupled with small land holdings, and uncertainties in land tenure regulations are identified as some of the confronting factors in the process of agriculture development in the country.

Land pulling from the larger landholders with their consent and distribution of land in accordance with the water right shares earned during the construction of the irrigation project has addressed the poverty to a larger extent and the effort made by Andhi Khola Water User's Association (AKWUA) is commendable. This indigenous practice of water right provided an opportunity to even the land less family of the command area to earn land by contributing labor during the construction of the project. This indigenous practice has provided land to the 15 landless and 56 marginal farmers' family.

The water right shareholders can even sell their share of water to the person in need with in the command area. The out come of the strategic management and implementation of this irrigation project has not only resulted in the decrease of migration but it has improved the economic condition of the people. Increase in the crop production and economic activities has attracted establishment of boarding schools and mills for grain processing. The water from the Andhi khola Irrigation system has not only been used for irrigation but it is used in multiple purposes. This system is a unique model of the integrated water resources management and has been successful to address the poverty with in the command area.[i]

[1] 1)Executive Member- National Federation of Irrigation Water User Association Nepal
2) Irrigation Engineer – Department of Irrigation
Phone: 0097715530244, e-mail: akwuas@yahoo.com

Equitable Distribution and Common Resources Management at Andhi Khola Irrigation System

Part I

Introduction

Although UMN had been planning a water resources development program in the Andhi-khola basin (Andhi is the name of the river and Khola means river in Nepalese language) since 1963, it could not be materialized till 1980 due to lack of resources both financial and humane. In 1980, it exerted its effort to undertake a multipurpose and integrated rural development project targeted for overall development of the region. Under this project, a 5.1 MW hydro-electric project was formulated with the objective of availing electricity for rural electrification, ropeways, lift irrigation and small agro-based industries.

In 1981, an agreement was signed between the then His Majesty's Government of Nepal and the UMN for the implementation of the program. Initially, the Norwegian Agency for Development Cooperation (NORAD) provided the fund through UMN for hydro-power construction and rural electrification component only. Later following a request, the NORAD agreed to provide additional fund needed for irrigation development activities too. In 1985, the NORAD through Norwegian Himal-Asia Mission made available the fund for irrigation component. This irrigation project is called Andhikhola Irrigation Project (AKIP) that provides irrigation facility to about 282 hectares of lands. The total cost of the project at its completion was 31.8 million rupees (US $ 0.45 million). This paper now onwards will focus only on the different aspects of Irrigation development and related impacts on the socio-economic condition and its functioning mechanisms.

The Andhi Khola Irrigation Project

The Water Source

The arrangement for the distribution of water for both hydropower and irrigation is made in such a way that a 60 m. long and 6 m. high Ogee type weir is constructed across the Andhi-Kholal that in turn diverts water through 1284 m long head race tunnel that opens up to a surge tank. This surge tank has two out lets- one for the hydropower and another for the irrigation channel.

The Irrigation System

This irrigation system comprises of 9.4 km of main canals (3.4 km extended after hand over), 13 branch canals totaling to a length of 21.6 km with a network of pipelines to cater irrigation water to different patches of agricultural lands scattered around the sloping and incised topography.

The construction of this system was started in 1989 and handed over to the water user's organization, Andhi Khola Water Users Association (AKWUA) on 27th June, 1997.

Formation of Andhi Khola Water Users Association (AKWUA)

In line with one of the prominent objectives of the project, which was the uplifting of the poor and landless farmers in the command area through active participation in the development of the project a representative body of the affected farmers was formed as early as in 1984 and registered under the association registration act. There are three committees under AKWUA that are legally tied up with the AKWUA statute. There major responsibilities and extent of works are described below:

1. AKWUA Executive Board:

This board is comprised of 13 members with at least 33% of women members. This board is chosen through the direct election from the share holders. The election is held every year, however, the each election replaces only the 50% of the members that have completed 2 years tenure. This arrangement is made in order to make cohesion with the newly elected members and make sustainable governance. The executive body is not only responsible for the daily activities of the AKWUA office and its employees at the same time, it is the main body that looks after the over all operation and maintenance, service fee collection, budget allocation, water distribution and resource mobilization with in the system. This committee is mandated to take all the major decisions and is responsible to make cooperation and coordination with the major stakeholders and funding agencies both governmental and non-governmental. Regular monthly meeting is held of the executive body.

2. Evaluation and Monitoring Committee

This committee is comprised of one chairperson and 10 members elected directed from the share holders. The election for this committee is held every year for its all 11 members. This committee is mandated to monitor and evaluate the activities carried out by the executive committee and make suggestions and recommends for further betterment. This committee submits the report of its evolution and findings to the executive board every six months.

3. Land purchasing and Redistribution Committee

This committee is comprised of one chairperson and 6 members. All the 6 members and the chairperson are nominated by the executive body. This committee is mandated to keep the records of the land and water share of the individual. The trading of the water share can only take place after the recommendation this committee to the executive body.

Formation of Andhikhola Multipurpose Association (AMA)

With the main objective of providing sustainable support to AKWUA a new organization in 2005 has been registered. This organization is comprised of AKIP shareholders and representative from Butwal power Company (BPC) that owns the hydropower. This organization has 500 general members. It also has an executive body comprised of 5 elected members out of water shareholders and 2 representative nominated by BPC. BPC has agreed to provide Rs. 250000.00 per annum to AKWUA through this organization for institutional development of AKWUA. After formation of this organization BPC has waved the share of the cost (20%) that AKWUA used to pay to BPC towards the maintenance to head works and headrace tunnel. This organization is active in attracting fund from donors. So far the fund collected by this organization amounts to rupees 577774. It releases the fund to AKWUA as and when requested.

Role Played By the AKWUA and Modality of Implementation

The AKWUA has worked closely with AKP/ UMN staff in implementation of the irrigation project. It has been much instrumental specifically in mobilizing local human resources during construction, and executing necessary task of land purchasing and redistribution program of the project. Fig. 1 presents the external and internal support mechanism that the AKWUA has established. Some of the prominent areas wherein the AKWUA has contributed are discussed below:

Share Earning:

As stated earlier, any person residing in project area could earn a share by contributing 5 days labor contribution (worth Rupees 165 equivalent to US $ 2.32). A person was entitled to earn a maximum of 4 shares. There was a provision of 25000 shares to be distributed to the beneficiaries. Possession of the single share would give the owner a water right of 1/ 25000 part of the water flow available at the head (which would mean 688 lit/sec divided by 25000, equals to 0.027 lit/sec). Calculating at the rate of Rupees 165 per share the total contribution that was expected from the beneficiaries farmers was worth rupees 4,125,000. However, by the end of the project i.e. hand over date the shares earned by the beneficiaries were only 17739 worth rupees 2926935. Since the UMN had spent money in lieu of labors for rest of the contribution the UMN kept rest of shares, 7,261 within it self. However, in year 2000 the share kept by UMN was handed over to the AKWUA. So far AKWUA has sold 1056 shares out of 7261 and remaining 6205 shares are still in the possession of AKWUA. In order to sell the remaining share AKWUA is thinking of revising the quantity of water per share.

Assessment of Water Need

The AKWUA notifies to the user farmers register their shares with in certain date before each cropping season. They share holders are required to mention the canal from where he /she needs water. Based on such registration, the AKWUA calculates the discharge needed and it requests the Hydro power to release water for irrigation from the surge tank. The AKWUA also determines the discharge required to each canal (Main, branches and tertiary) based on the prior registration.

Land re-distribution

One of the major objectives of this project was to collect some lands from the rich farmers and then distribute to the land less. The basis for determining and optimum land requirement for livelihood was based on the assumption (postulated by Joy Poppe, 1982, Socio-Economic Survey) that a family with 7 members would need a land area of 5 Ropanis (0.25 hectares). This would mean that one person would need approximately 11.5 anna (0.036 hectares). As a result of this, the project made criteria that farmers having more than 0.036 hectares per person would require to sell 10% of their extra land to the AKWUA. Such purchased land pieces would then be distributed to the poor or landless farmers at the same pre irrigation price.

To date, AKWUA has been successful to purchase 232 Ropani (11.6 hectares) of land and also has already distributed this land to 71 poor/landless and marginal farmers. The rate for buying and selling of the land by the AKWUA was decided according to land category which is shown in table 1. While the money was fully paid to the seller, the eligible buyers were allowed to pay in installment basis of five years with out any interest. For this purpose of land pulling and subsequent payment to the seller, UMN had provided a refundable fund to the AKWUA which later on waved by the UMN to the AKWUA for its institutional development.

S.No.	Price (Rupees/ropani)		
	Land Slope	Before 1990	After 1990
1	0º- 10 º	2000	3000
2	10º -20º	1800	2800
3	20º - 30º	1600	2600

Table: 1. Land Price

Irrigation Service Fee

Each shareholder or beneficiary farmers are paying rupees 6.0/share/year for office expenditure of AKWUA. Besides this the shareholders are paying rupees 4/share/year for maintenance and operation of the canal system. The shareholders are also shouldering a portion of maintenance expenditure of headwork and tunnel (20%) to the hydropower company. At present 15000

shares are active and utilizing water for irrigation and paying the O& M as well as office expenditures. Besides the above the AKWUA also mobilizes some labor contribution from each shareholder for canal cleaning and reshaping. There are some prior agreed rules and procedures for such labor contribution. Therefore, the canals are generally cleaned twice in a year that is before paddy transplantation and wheat sowing.

Conflict Management

The AKWUA board has been successful to resolve conflict so far. There has been no conspicuous related to water allocation and distribution. The AKWUA has rules whereby any person or shareholder who does not abide by the rule are normally penalized by depriving him of irrigation water or requiring him to pay fine of some amount.

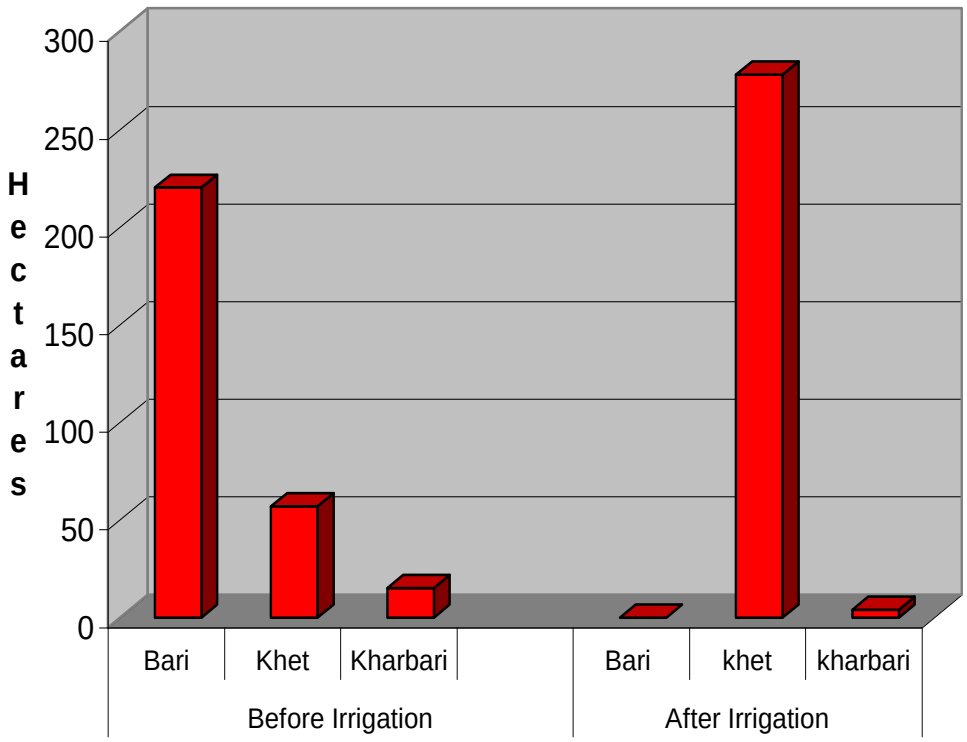
Part II

The comparative Study

Land Type of the Command Area

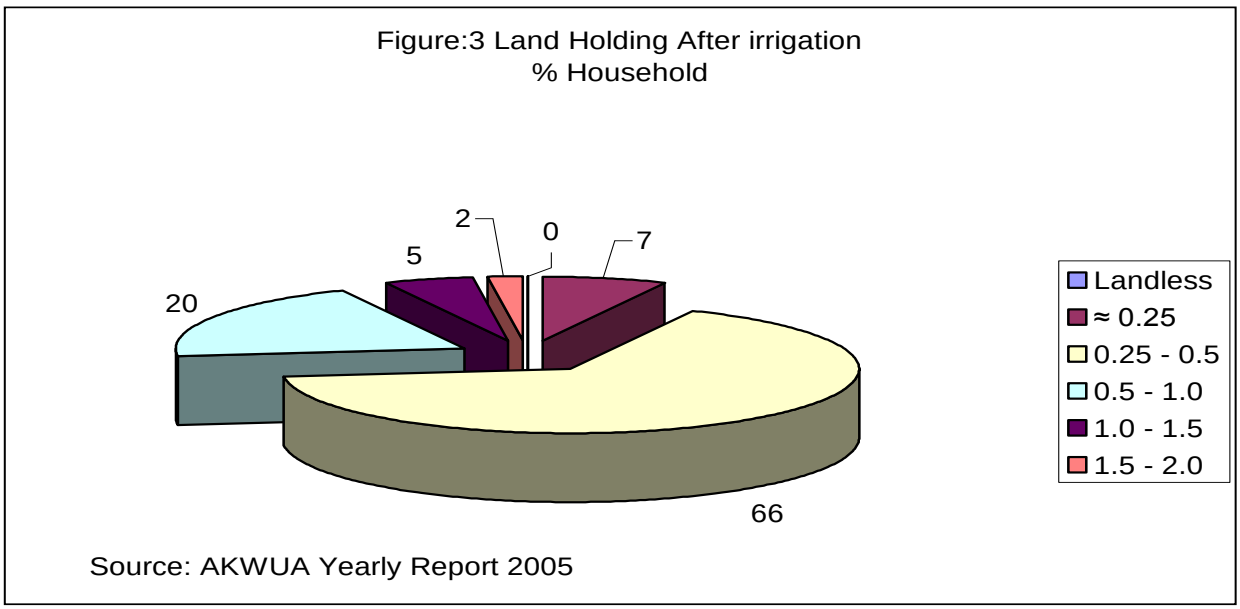
Basically the land in hills is classified into three types- "Khet" – terraced, irrigated land; "Bari" – unirrigated land that is sometimes terraced; "Kharbari" – an area of seemingly waste land which is cut for fodder. The Figure 1, below shows the comparative status of land type with in the command area. It is note worthy that the farmers have worked hard to convert their sloping land into terraced land in order to grow rice and take full advantage of irrigation. This terracing of land has not only added value to their property but also the soil erosion has been checked to a larger extent.

figure:1 Land Type



Land Holding

There has been a significant change in the pattern of land holding as a result of land pulling from the larger land holders and redistribution to the land less and marginal farmers. The figure 2 and 3 show the comparative pattern of land holding.



Source: Joy Poppe, 1982 Socio-economic Survey

Food Suf

Rain fed paddy and maize were the dominant crops grown in the area. After the irrigation facility, farmers are producing more paddies, wheat and the vegetables such as tomatoes, potatoes, cauliflower, cabbage, onion, garlic and green leafy vegetables. Generally, maize and millet are grown in unirrigated "bari" land. After the availability of irrigation, major part of the bari and meadow has been converted into rice fields and thus the production of maize and millets has gone down considerably. More and more farmers are attracted towards the vegetable farming due to availability of agricultural inputs in the local market and the agriculture extension service nearby. Tables below show the comparative production status of different crops:

Comparative Crop production

Before Project		In year 2005	
Crops (Rainfed)	**% of Gross Production**	**Crops (Irrigated)**	**% of Gross Production**
Paddy	38.70	Paddy	60.77
Maize	30.77	Maize	10.90
Millet	16.90	Millet	0.85
Wheat	7.28	Wheat	15.37
Potato/Vegetables	3.16	Potato/Vegetables	9.37
Pulses	2.33	Pulses	1.51

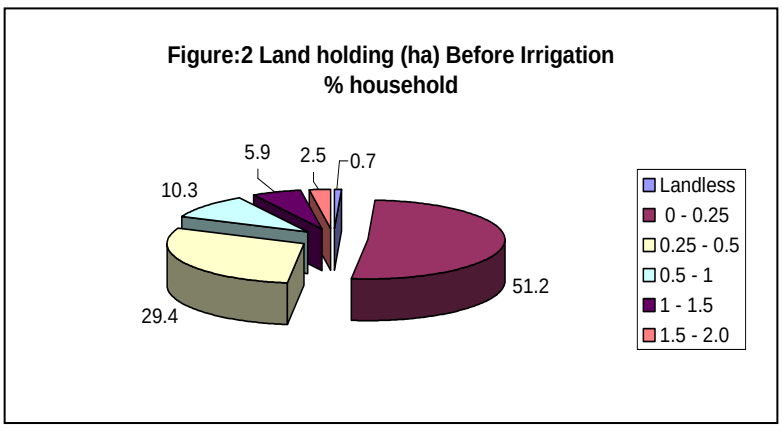
The average grain production per person per annum has increased from 3.83 muri (Approx 268 kg) to 5.64 muri (Approx. 395kg).

Cropping Intensity

Due to the non availability of irrigation water only the long duration crops were grown as a result of which, farmers were able to grow only two crops per year. The average cropping intensity then reported was merely 150%. However, due to availability of short duration and quick yielding varieties most of the farmers are harvesting 3 crops a year resulting into the 288.8% of cropping intensity in the year 2005.

Crop Yield

No large increase in crop yield was reported in the earlier years and it is believed that this might have happened due to the loss of fertile top soil while converting the bari (sloping land) into Khet (terraced land). However, in the recent years the average yield of summer paddy is 3.1 mt/ha and spring paddy (cultivated only from last year) is 4.4 mt/ha. The average yields of wheat and maize are 1.8 and 1.5 mt/ha



Ecological Balance

The previously rugged terrain of high slope was prone to land slide and land degradation. Deforestation of the marginal land for fodder and fuel was its peak. However, after up coming of the multipurpose project these adverse activities have been checked to a great extent. Efforts have been made towards plantation of suitable plants to minimize the threat of land slide and sheet flow of top soil. The area that looked deserted before the implementation of the project now surrounds with green vegetation giving a picturesque view. As result of this effort the project has owned the prestigious "Blue planet Award 2005". A good effort towards biodiversity and ecosystem conservation with in the project area has been made to over come the threat of land degradation.

Conclusion

The AKIP is a unique irrigation project in the history of irrigation development in Nepal. The modalities of design and construction, water right share distribution; land pulling and redistribution are very well thought and very appropriate ones. The project has been successful in meeting the objectives up to large extent. The unique concept of share distribution has not only instilled much farmer's contribution in the system construction but has become one of the example of equitable distribution of common resources and its management. It has helped to establish an equitable water distribution mechanism. The major success of this project lies in getting some portion of land from comparatively large land-holders and distribution of these land to land less and marginal farmers. The project has been successful in alleviating the poverty in the region. The trend of migration of the family members from the region has gone down considerably. The establishment of health centre and educational institution has provided the opportunity to the population for better health care and education. The establishment of strong and powerful water user Association is another remarkable achievement of this project towards decision making for the betterment of the farmers and functioning of project as well. This project is not only a very good example of successful integrated water resources management but also a very good coordination and cooperation exists between the management of Irrigation system and Hydropower Company.

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[i] 1)Executive Member- National Federation of Irrigation Water User Association Nepal
2) Irrigation Engineer – Department of Irrigation
Phone: 0097715530244, e-mail: akwuas@yahoo.com

To Enhancement of Irrigation System Efficiency and Service Delivery

Khem Raj Sharma
Department of Irrigation, Jawalakhel, Lalitpur
(khemraj.sharma@gmail.com)

Abstract

Concerns about low level of system efficiency and poor service delivery have asked for attention on irrigation, the largest water use sector. Irrigation system attributes such as physical infrastructures (irrigation and drainage) and management have pronounced impacts on system efficiency, service delivery, crop production and the income of the farmers. Over the recent years, physical system rehabilitation and participatory irrigation management (PIM) has been the implementation framework to improve the system attributes. The outcomes of this modality have not been very encouraging.

Provision of adequate, equitable, flexible, reliable and timely irrigation service to the farmers' fields to enable them achieve gains in agricultural productivity and poverty reduction is still a challenge. Formation and capacity development of farmer organizations has proved to be a difficult task. With the formulation of the new water strategy advocating the concept of integrated water resources management, additional set of challenges are likely to emerge.

In a bid to deal with irrigation sector, the paper has attempted to highlight the issue of irrigation efficiency and service delivery both at the system and the farm levels. Irrigated agriculture in Nepal is predominantly rice-based and therefore the discussion is based on the improvements of the rice-based crop production systems which include the rice and also non-rice corps.

Introduction

Nepal's current 25 million populations are predicted to reach 41 million by 2025, implying a increasing demand for food. This would have to be produced from the same or even less land available for cultivation, suggesting increasing need for irrigation. Current statistics suggest that about 45% of the cultivated land is brought under some form of irrigation and contributes 60% to total agricultural production. This percentage is expected to increase. However, investment in irrigation is perceived to be a poor investment by the funding community. Over the past two decades the number of large scale irrigation projects financed by the external sources is decreasing. Small and medium scale irrigation schemes are believed to be more attractive and hence relatively there is more support for such schemes.

The evidence from government managed systems or farmer-managed schemes under irrigation sector programs suggest that the potential advantages have not been realized. In majority cases, productivity has been less than originally planned owing to inefficient water use, low cropping intensities, very low cost recovery, poor system maintenance and mismatch in water delivery service. In many cases, small or medium scale irrigation is just treated as a miniature version of traditional large scale schemes.

It is clear that irrigation sector must achieve higher irrigation efficiency, equity and productivity to better system performance in order to be able to meet increasing food requirements and help alleviate the rural poverty.

Trends in irrigation development and management

Over the years, growth rate in irrigated area in the country has declined. In the tenth plan (2002-2007), though the additional area targeted on the part of Department of Irrigation was 193,600 ha, the achievement was only 87,485ha (45% %). In almost all the development plans of the country, the achievements in terms of expansion of irrigated area, the crop productivity and cropping intensity have been less than the projected figures.

The aging of the irrigation systems and the issue of rehabilitation, which is related to those of O&M and modernization, is becoming increasingly important. Although extension of irrigated area still represents an important part of our irrigation program, system rehabilitation (in both jointly managed and farmer managed systems) are getting an increasing importance. There is need to adopt to water scarcity, chiefly by demand management strategy. This calls for a deep transformation of the irrigation sub-sector by the adoption of measures to modify water demands and maximize efficiency in water use, first and foremost to consume less water and to improve the economic, technical and environmental performance. Diversification of produce and cropping patterns along with changes in management systems and structures will be essential for financial sustainability.

On the other hand, more efficient and decentralized administrations, and new management models, constitute as many favorable conditions for an improvement of performance of the irrigation sector and modernization of irrigation systems.

Short, Medium and Long term Scenarios

The National Water Plan (NWP), 2005 has set short medium and long term targets over specified time periods. Irrigation sustainability, food security and livelihood improvement are the basic aims in setting the targets presented in Table 1.

Table 1 NWP targets

Indicators	Short term, by (2007)	Medium term, by (2017)	Long term, by (2027)
Year round irrigation*	49%	64%	67%
Cropping intensity	140%	164%	193%
Increase in agricultural yield**	15%	28%	44%
Irrigation coverage***	77%	85%	97%
Irrigation efficiency****	35%	45%	50%
Irrigation service fee collection (percentage of O&M costs)	30%	45%	75%

*of cumulative total irrigated area
** over 2001 level
*** of the potential area
**** of large scale surface schemes

Integrated program for irrigated agriculture, improved management of existing irrigation systems, improved planning and management of new irrigation systems, capacity building of local level institutions in project planning and implementation and capacity enhancement of farmers are the programs set to achieve the target outputs.

Looking into the figures of above table, it is clear that the targets are hard, if not impossible, to achieve within the specified time frame. Several constraints (e.g. inadequate

capacity of WUA, over ambitious targets, poor security and political instability, inadequate financial supports, low ISF collection resulting into poor system O&M, unavailability of agricultural inputs, poor service delivery, market constraints, etc) are encountered during program implementation and as it stands at the moment, the efforts being put are not sufficient in attaining the set targets.

IWRM Challenges

With these existing problems that still remain to be sufficiently addressed, a set of new challenges are emerging.

IWRM principles are to be adopted in the water sector development planning and program implementation. Under this prescription of the National Water Resources Strategy, the irrigation sector must move from the traditional supply-side orientation towards proactive demand management. In operationalizing the IWRM framework, the usual blue print package includes (i) a national water policy (ii) a water law and regulatory framework (iii) recognition of river basin as the appropriate unit of water and land resources planning and management (iv) treating water as an economic good, and (v) participatory water resource management.

It is clear that the pursuance of IWRM requires a significant shift from current paradigms and though this is an opportunity, it will also create a new set of challenges.

Research results on IWRM in developing countries have indicated that enforcing new water laws are more difficult than enacting them (IWMI, undated). Managing water resource at basin level is not that easy as compared to establishing or renaming the regional or division level organizations as basin organizations. Declaring water as an economic good is simple, but using price mechanisms to direct water to high value uses is complex. As a consequence, the IWRM initiative in many developing countries has not been that effective, if not counterproductive. With this scenario the targets as given in Table1 will be hard to realize. However, it is also true that some developed countries have made significant achievements through IWRM. For this more attention should be paid to defining the boundaries of intervention and for this adequacy of information for proper planning need to be ensured.

Water Delivery Service

The primary goal of irrigation is to deliver a reliable supply of water. Service is qualified in terms of equity, reliability, flexibility and adequacy. The degree of flexibility in frequency, rate and duration is what distinguishes and characterizes classes of service quality from rotation to on-demand. The level of irrigation service is closely related to improvements in agriculture performance, crop diversification, etc.

Participatory irrigation management (PIM) has been central in our program implementation and the role of Department of Irrigation (DOI) and Water User Associations (WUA) is crucial in the improvement of service delivery. However, the performance evaluation of the irrigation sector programs and the irrigation management transfer projects indicate that improved service remains a problem area.

Organizing effective WUAs is both the greatest need and the greatest opportunity. But it is also the greatest difficulty. The service definition needs to specify the responsibilities of DOI, the WUAs and the farmers in operating and maintaining all elements of irrigation system. The decision on the level of service against the cost for providing this service should be expressed in 'service agreements', which are the foundation of an asset management strategy (Facon, 2005). Service agreements could be a modality to define the service levels including the enhancement of irrigation water use efficiency, the area to be irrigated, the anticipated production levels, the scope for crop diversification, the provision for irrigation service fee collection, so on and so forth.

As noted above an approach to improve system performance has been the system rehabilitation and participatory management. The results, however, have not been very encouraging in many cases. The main constraint on achieving the full benefits of farmer participation is the lack of delineating the roles and responsibilities between the DOI and the WUAs. Conflicts of priorities between these institutions along with restrictive administrative provisions and politicization of WUAs are also the areas hindering effective farmer participation.

Some other pertinent features of irrigation systems, especially those where systems were rehabilitated under irrigation management transfer program are as follows:

- A dependable water supply is not commonly available
- Water measurement at the diversion canal inlets and outlets is hardly done and/or analyzed
- Elevation of the water surface and the bottom of the canal do not provide adequate elevation control to command the irrigation of adjacent fields
- Outlets are provided at intervals as opening in the walls, but no regulation of the discharge or the water level for the off-takes is provided.
- Branch canals have limited ability for flow regulation at the branch off take and very limited or no flow measurement capabilities.
- The water measurement process involves lowering the regulating structure gate to raise the level in the main canal and to obtain the target discharge for the branch canal
- In general systems are operated but not managed.
- Illegal outlets are provided as and when deemed necessary. This is a contributing factor why water does not reach to tail end farmers.
- Tail enders have no dependable water supply
- Irrigation system efficiency has not improved to the potential level.
- Drainage component is overly neglected.

The illegal outlets create the condition for an undependable water supply caused by inequitable distribution of water. As a result, the irrigation systems perform with varying but low degrees of efficiency depending on the degree of control implemented through the physical components of the system and through management of such system. Inadequate and inequitable water supply has been a common phenomenon in most of the systems.

Irrigation Service and Poverty

The elements of service provision from irrigation infrastructure and its management has been presented in Figure1. The provision of physical infrastructure (should include both irrigation and drainage) and the system management provide the irrigation water supply and the drainage of excess water. The infrastructure and the management components along with other production inputs and the type of crop cultivar support crop production. The agricultural produce with market facilities and pricing mechanisms contribute to increased farmer income. This in turn leads to the ability to pay the irrigation service fee, which supports the management and the maintenance of the infrastructures. For this process control systems are required to deliver water, manage maintenance and account for finances (Molden et.al, 2007). Improved water adequacy and the right timing of water supply guarantee farmers a good irrigation service. Proper asset management leads to a functioning system which is possible only when there is accountable and transparent fee collection leading to adequate O&M cost recovery. This is possible only when there is a strong institutional base and the will to cooperate between the farmers and the supporting agencies.

Inequitable distribution and head-tail problems are often the result of poor irrigation service. Problems of inequitable distribution have been found to be directly related to poverty in irrigation systems (Hussain, 2005). Small land holding (57% of farmer households in Nepal own less than 0.5ha) coupled with no irrigation or poor irrigation service resulting into inefficient water use, low crop intensity and productivity are the prominent factors of poverty incidence in the farming communities. Development of new irrigation should target the poorest segments of the society.

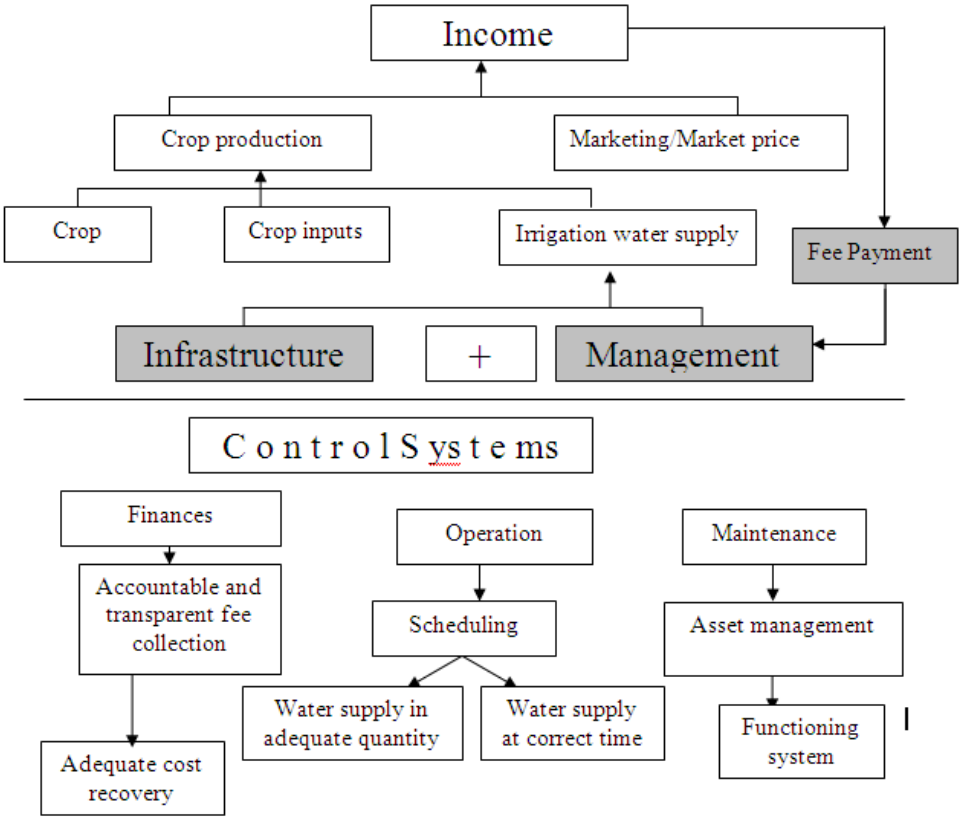

Figure1. Elements of service provision (adapted from Molden et.al, 2007)

Irrigation Water Management at Farm Level

1. Rice Irrigation

Our irrigation systems are designed to supplement unevenly distributed rainfall for mainly rice areas. The present need for intensification has set to design new schemes for year round irrigation. Since evapotranspiration (ET) must be maintained at the potential rate to achieve high yields and percolation process should be allowed to continue throughout the rice growing season for ensuring adequate nutrient supplies to the crop roots, the practically desirable opportunities to economize on water use are to: (1) control runoff from the farm, (ii) control deep percolation to minimize water movement to depths below the root zone, and (iii) minimize water loss by seepage from the farm.

The three processes are often interactive, such that by controlling water loss by one, the losses through the others can also be reduced. The key points of actions toward achieving higher irrigation efficiency are indicated below:

- While applying irrigation water, adjust flow rate and period to control water movement and accumulation on the plot such that surface runoff out of the farm is minimized. This will also improve top-dressed fertilizer retention in the field.
- Conserve and utilize rainfall to minimize irrigation requirement. Apply irrigation water in smaller amounts more frequently and leave sufficient freeboard for rainwater storage in fields, if rainfall is expected.
- During land preparation, puddle soil to reduce soil porosity and help develop plow pan, in order to cut down water loss by percolation. To reduce percolation loss during crop growth period, irrigate to saturate soil to provide a shallow submergence of rice field, this assists in providing greater availability of nutrients, suppression of weeds, elimination of moisture as a limiting factor for crop growth and micro-climate favorable to the rice plant. This is possible because rice is highly adaptable to the reductive condition of the soil brought about by partial submergence.
- Maintain field bunds to create as much as possible sealed barriers, with special care given to farm boundary fields, to minimize seepage through bunds. Water application to boundary adjacent to deep drainage are minimized to reduce seepage losses.

Most of the water saving techniques that both farmers and researchers have attempted can be classified under the following categories:

1. Continuous soil saturation maintaining soil always saturated but without ponding water on surface.
2. Continuous shallow submergence (with various depths of water).
3. Combination of 1 and 2.
4. Intermittent water application (creating alternate wet and dry cycles).
5. Combination of 2 and 4.
6. System of rice intensification (SRI)

Land Preparation Period

In rice irrigation systems, water used by farmers to complete land preparation is much greater than the absolute requirement because the activity is stretched over long period during which much water is lost by evaporation and deep percolation. This can be reduced by increasing the flow rate of irrigation water and timely preparedness of farmers.

Direct seeding of rice instead of conventional method of transplanting has resulted in an significant saving of water.

The management actions needed to practically minimize irrigation water requirements for rice-land preparation are the following:

- Manage soil during the post harvest period to prevent deep cracking, so that percolation losses during the land-soaking period for the subsequent crop are not excessive.
- Apply irrigation water in relatively large rates over a short period, rather than in a long period, to reduce excessive evaporation loss during the land-soaking period.
- Make advance preparations with tillage, labor, seedlings, inputs etc. So that the completion of land preparation and subsequent crop establishment are not delayed by lack of these inputs once water for land preparation is available.
- At the beginning of the season, attend to and strengthen paddy dikes and farm boundaries to seal cracks, holes, low spots and breaches in order to minimize loss of water by run off and seepage through them and to better retain water applied from irrigation source or rainfall.
- As far as possible rice lands should be leveled, allowing only a small slope (0to0.2%) for water movement within a plot, so that more or less uniform water depths can be applied.

Non-rice Crops

Farmers grow non-rice crops in both irrigated and residual soil moisture conditions. Excessive moisture in the soil at the critical crop establishment time and water stress during the vegetative and reproductive grain-filling periods are often encountered in areas planted after harvesting rice. Soil type and rainfall largely dictate the status of soil moisture in relation to non-rice crop establishment after monsoon rice.

Sometimes, because of post-rice rains, non-rice crop establishment has to wait until the top soil dries up. As water evaporates from the surface of heavy clay soil, which have very slow internal drainage, they become hardned surface and difficult to prepare for non-rice crop establishment although the soil may remain wet few centimeters below. An effective way of managing such soils is to allow them to dry up to about 20cm depth below field capacity water content, apply irrigation water lightly to quickly soak the top soil and bring the land to good tilth and prepare it for seeding. If rainfall is not excessive, applying the irrigation water or draining the rice field timely before crop harvest, the soil tilth for the succeeding non-rice crop can be achieved earlier.

Tillage techniques, seed zone and root zone management and the time of seeding of non-rice crops after irrigated rice should get utmost considerations. For example, in Bhairahawa area wheat crop planted in the week of 15-22 November without any tillage produced higher yield than those from conventional tillage with time delay.

Certain crop growth stages are more responsive to irrigation water application. For example, maize yields are very low when ET is severely restricted during the tasseling stage, compared to other stages. Methods of irrigation (e.g. applying water on alternate furrows) and mulching practices are some of the techniques used by farmers to reduce crop water requirements. The saved water can make a major income difference to fellow farmers who have to keep their land fallow in dry season due to scarcity of water. Non-rice crops are also hand-watered using indigenous means to lift shallow ground water or to carry water from a nearby source and applying it directly on the field. Waste water utilization is also commonly observed. Technically these methods are highly water efficient, but most labor intensive.

Farmers also construct small reservoirs to store rainwater or water from springs or a rivulet. Some features of increasing water productivity are highlighted in the following section.

Increasing water productivity

Developing improved verities. High yielding varieties (HYVs) have allowed to more than double rice water productivity (against T) over the last decades. Hybrid rice has successfully been introduced in transplanted systems. However, the direct seeding method which is gaining increased acceptance is limiting the adoption rate of the hybrid rice technology since the process requires the use of much more of the costly seeds of hybrid rice per hectare than does the alternative method of transplanting rice. Direct seeding of hybrid rice is not economical with current hybrid seed production technologies.

The New plant Type (NPT) has been developed by IRRI scientists with the goal of raising the yield potential of conventional rice varieties to about 12-15 tones/ha. NPTs are targeted *for direct seeding conditions in irrigated ecology*.

Improving agronomic management. Improving pest control and nutrient management and other technologies that enhance yields increase output per unit of water (T). It should be noted that IPM techniques were developed in the context of large schemes where water supply was considered a constraint. Efforts have been made to integrate on-farm water management, IPM, nutrient management with the improvement of crop management.

Changing the crop planting date and making more effective use of rainfall. Both these strategies require changes in water resources or reservoir and farm management strategies and good cooperation between system operators and farmers.

Reducing water use for land preparation. Practices include land leveling (which contributes to better utilization of variable rainfall early in the season, reducing weeds, reducing S&P, improving fertilizer application efficiencies and improving the timeliness of land preparation etc), reducing the land preparation period, pudding, management of cracked soils (losses can be reduced by measures that minimize crack development during the soil drying period through straw mulching and dry shallow surface tillage on crack formation during the fallow period, or by impeding the flow of water through these cracks), dry tillage.

Supplementary irrigation of rainfed low-land rice. Supplementary irrigation either for crop establishment or at critical growth stages, particularly flowering, can prevent yield depressions of up to 40% or even crop failure one year out of five for T.Aman (monsoon season) rice in Bangladesh.

Water distribution strategies. Reducing inequities in water distribution among tertiary canals or within tertiary canal blocks through various systems of rotation should contribute to achieving a more even distribution, reduces losses and provide water to large areas. However, rotation systems are difficult to establish in practice.

Water recycling and conjunctive use. Conjunctive use was developed on the Indian sub-continent principally to compensate for the lack of reliability, inequities in distribution, and rigidity of canal water distribution systems, which constitute as many obstacles to the development of productive irrigated agricultural systems. It allows flexibility in availability of irrigation water and secures against failures in water delivery. It enables farmers to reuse seepage and percolation losses from canals and fields. However, conjunctive use and recycling of drainage water were not developed primarily to enhance water productivity or overall system efficiency and are usually not considered in design manual of most irrigation agencies.

Conclusion

The challenge to produce more crops with less water, economically and in ways that will be adopted by farmers in a context of the current water strategies and integrated water resources management is vital for the food security of the country. This will require a paradigm shift in the working modality and the stakeholders attitude.

A range of options are available for increasing the efficiency and productivity of irrigated agriculture. In the years to come, in view of decreased availability of irrigation water and suitability of land, irrigation must achieve higher efficiency and productivity in order to meet increasing food requirements. The pace of construction of new schemes is likely to be slow while an approach to jointly address technical, institutional, socio-economic agricultural and environmental aspects of irrigation will have to be adopted by the stakeholders, especially the farmers and the agencies.

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Pond Irrigation: An Approach for Sustainable Livelihood in Dry Hill Areas

Er. Rakesh Regmi
Irrigation Coordinator, Cemeca HRA P. Ltd.
(rakeshregmi2@yahoo.com)
Er. Siddhi Nath Jha
Irrigation Coordinator, IDRS
(idrs@wlink.com.np)
Er. Bikesh Shrestha
Design Engineer, Cemeca HRA P. Ltd.
(bikesh1983@yahoo.com.ph)

Abstract

Nepal an agricultural based country needs irrigated water for overall development of total irrigable land. Some notable constraints for irrigation development are unavailability of sufficient fund, subsistence farming, and skewed land distributions with very small land holding patterns. In the process of addressing the issues and challenges of irrigation sector, Government of Nepal has brought out several plans, policies and strategies. However the results in irrigation are not encouraging. Most hill areas are faced with food deficit. The development of small-scale irrigation is likely to increase food grain production and provide opportunities to change traditional cropping patterns with diversified cropping pattern in potential areas. In connection with above, to use the small water sources such as spring and stream, which can not be used for surface irrigation due to lean flow during dry seasons, seems reasonable.

Helvetas-Nepal initiated in this light, Demand based Rural Infrastructure at Local Level (DRILL) (currently Local Infrastructure for Livelihood Improvement-LILI) in the year 2004 AD with a concept of Pond Irrigation to provide irrigation facilities to marginalized and disadvantaged group (DAG) in hill areas with participatory approach.

Pond Irrigation system follows the basic design concept of gravity flow water supply, but Ferro Cement Tank has been replaced by Silpauline Plastic Pond. Per ropani cost is NRs. 12,000.00 with command area having less than 25 hectares of land. From the experience, the contribution patterns are as follows: For project not less than 75% and for community participation not more than 25%.

Majority of poor and lower caste people own sloppy terraces for farming which are not irrigable by conventional surface irrigation methods. Also, the performance of large and medium sized agency managed irrigation system have come into sharp criticism due to the failure in achieving the anticipated agricultural production and accomplishing the needed operation and maintenance cost recovery. Hence, it would be proper to concentrate on cost effective, appropriate technology, local know-how impart, easy maintenance and optimum use of lean flow through pond irrigation, which will also act as tool for optimization of irrigation in hilly areas.

Key word: *hill irrigation, small-scale irrigation, pond irrigation, silpauline plastic pond, marginalized and disadvantaged group, Helvetas-Nepal.*

Introduction

Nepal is categorized as one of the poorest country in Asia with annual per capita income of US$ 190 as indicated in Human Index by UNDP. Data furnished by different institutions reveals that 39 percent of the total population is under poverty. In addition, over 90 percent of the poor reside in the rural area, which is characterized by socio economic disparity comprising of Dalit and Janjatis having low socio economic status across the country. Subsistence level of agriculture constitutes to be main occupation and source of livelihood for 80 percent of the total population.

Irrigation is the most vital input to increase agricultural productivity. Agriculture sector contributes to 38 percent of the total GDP. Estimates reveal that the total irrigation land consists of 1.77 million hectares out of which only 0.37 million hectares of land is available in the hilly areas. Out of 0.37 million hectares, only 66 thousand hectare land has access to assured irrigation facilities through out the year.

Most of the surface irrigation systems in Nepal are fed by medium or small rivers, with limited water resources available during the lean season which is insufficient for year round irrigation. Hence, development of year round irrigation through these systems is not possible unless maximum numbers of storage reservoirs are developed.

Over the years people's participation has been the key policy for development of irrigated agriculture. Irrigation policy has emphasized on people's participation from very beginning of planning, design of the infrastructure to even capital cost sharing mechanism for infrastructure development. However, past experiences suggest that people's participation in all infrastructures with capital cost sharing can not be taken as satisfactory. As poverty alleviation has remained one of the national goal of irrigation development, raising a part of capital cost from that community level that are already living below the poverty line are not socially justifiable.

Some notable constraints for irrigation development comprise of unavailability of sufficient fund, subsistence farming, and skewed land distributions with very small land holding patterns.

Helvetas-Nepal initiated in this light, Demand based Rural Infrastructure at Local Level (DRILL) in the year 2004 AD piloting in three districts of Mid Western region comprising of Surkhet, Dailekh and Doti. Pond Irrigation (non conventional irrigation system) was conceptualized for providing irrigation facilities for marginalized and disadvantaged group (DAG) in hill areas with participatory approach. LILI (Local Infrastructure for Livelihood Improvement) (formerly DRILL) programme was initiated with support from Helvetas for the development of hill irrigation system to increase agriculture productivity by providing irrigation facilities and reducing poverty at local level. LILI programme was implemented in mid and far western region of hill districts from two and half years pilot phase in July 2006 and started its First Phase from 1st August 2006. Currently, LILI is active in seven districts viz., Surkhet, Dailekh & Jajarkot in mid west; Doti & Achham in far west and Dolakha & Ramechhap in central region. CEMECA HRA and IDRS were assigned to providing consultancy services (survey, design, estimation and implementation) for LILI in active participation of the local service providers and users communities. Ten pond irrigation projects have been completed and about 24 are in pipeline. The district wise overview is presented in table 1.

Table 1 An overview of Pond Irrigation in Project Sites

S.N	Districts	Completed	In pipeline/under construction
1	Doti	6	7
2	Achham	-	2
3	Dailekh	1	5
4	Jajarkot		2
5	Surkhet	1	4
6	Dolakha	2	4
	Total	10	24

Necessity of Pond Irrigation for Hills

The level of irrigation services provided to the farmers to the date has not been very successful. Major irrigation systems developed so far is more dependable on seasonable variation of river discharge. The irrigation infrastructure facilities in most irrigation projects developed and supported by Department of Irrigation could not perform as per the expected targets. The efficiency and water delivering service and management of several existing irrigation systems are not in satisfactory level, and many irrigation systems are waiting further for effective government intervention. There might be several reasons behind these but some major cases are inefficiency in the identification, defective design of system, operation, management and repair and maintenance.

Irrigation is the greatest water use sector, where about 90% of the total water consumed is used in this sector. In spite of this, water availability for irrigation is not sufficient, especially in the winter and spring seasons. In the process of addressing the issues and challenges of irrigation sector, Government of Nepal has brought out several plans, policies and strategies. However, the results in irrigation are not encouraging. Most hill areas are faced with food deficit. The development of small-scale irrigation is likely to increase food grain production and provide opportunities to change traditional cropping patterns. In connection with the above, to use the small water sources such as spring and stream which can not be used for surface irrigation due to lean flow during dry seasons seems reasonable and appropriate. To use such water sources small intakes are constructed from where water is conveyed to the pond through pipe and fetch in to field when and where required.

Water scarcity foreseen particularly during the long dry season, is acute problem for the farmers. The problem is not one of the absolute shortages of water, but of the scattered distributions of the rainfall over the year. There are well known modern technologies for storage and lifting but these are costly and beyond reach for most of the rural households. Most needed are low cost, environmentally sound and locally sustainable options. The most obvious and already often used method is to store water in ponds. Ponds are in many aspects very suitable for storing water. They can build with locally available materials, environment friendly, technology with economically viable and overall efficiency is high as water losses through seepage and evaporation can be minimized by pond irrigation methods. By using pond, the water even of a small source can irrigate bigger areas when it is first collected and stored and then allocated at a time instead of continuously. Ponds can also be used for sometimes in fire hazardous in village and most often watering livestock, drinking, washing, bathing and fish farming. Sprinkler and trickle irrigations also can be used by using pond.

Merits of pond irrigation system

- The end use of pond water is located close to the command area, eliminating the need for complex and costly distribution systems.
- Pond water provides a water source when ground water is unacceptable or unavailable or it can augment limited ground water supply. Collected rainwater in the pond eliminates the needs for a water softener and the salts added during the softening process.
- Pond irrigation is appropriate for steep hill slope/terraced land/runoff.
- Pond irrigation reduces flow to storm water drains and also reduces non point source pollution.
- Pond irrigation helps in maintaining water demand during summer.

Demerits of pond irrigation system

- A considerable amount of fertile land occupied by pond.
- If not maintained properly chances of landslides are there.
- Loss of water due to evaporation is more than canal irrigation.
- It is used for very limited command area.

Pond irrigation system is better than canal irrigation systems because

- Pond irrigation can be used for landscape irrigation
- Seepage loss is negligible in pond irrigation while these are high in canal irrigation.
- In pond irrigation, very small water sources can also be used
- Pond irrigation is cheaper than canal irrigation. Community can manage it easily.
- It can be used during lean flow also.
- Operation and maintenance cost of pond irrigation system is very low compared to canal irrigation system.
- Pond irrigation is more affordable to canal irrigation.
- Pond irrigation can be easily operated compared to canal irrigation.
- Sprinkler and trickle irrigation can be operated by pond but it can not be operated by canal irrigation.
- Pond irrigation system is environment friendly irrigation system but canal irrigation causes land slides.
- There is no contamination of water in the pond while in canal irrigation system there are a lot of chances of contamination of water.
- Pond irrigation is a time saving irrigation method compared to canal irrigation.
- Pond irrigation reduces hardship of works.
- Pond irrigation is suitable for hilly area.
- Pond irrigation system also works as a sedimentation tank.

Pond irrigation is the best irrigation practices in the water scarce area. The promotion and dissemination of this technology with community participation could play a substantive role in Nepal.

Design Aspect

Major Components

1. Intake Structure: Basically constructed to tap water from spring sources and small streams.
    a. Spring Intake: Contains small size, big size, attached with valve chamber and collection chamber containing valve chamber separately.
    b. Stream Intake: Contains small weir with minimum exposed cross-sections for minimum water flow resistance or temporary diversions.

2. Washout Chamber: Constructed at dip-points of pipe line alignment (valley in alignment) and as far as possible within 1000m from intake site. Incase of direct intake type (without collection chambers) this structure is mandatory except in the case of main line less than 500m.

3. Collection Chamber: Provided if more than one source is to be tapped.

4. Air Valve Chamber: Constructed in hill alignments to overcome blockage due to air pocket development.

5. Interruption Chamber: An automatic operating structure used to break the excess pressure in alignment. Constructed at the interval of 80-90m vertical elevation difference.

6. Valve Chamber: Usually constructed after pond to regulate water outflow.

7. Flow Regulating Chamber: Just like distribution chamber in other surface irrigation canals. It is used to proportionate water distribution to ponds. Usually of two types: 2 chambered and 3 chambered.

8. Silpauline Plastic Ponds: A simple earth excavated pond lined with 350 micron/120-gsm quality Silpauline plastic and fenced with either barbed wire or simple gabion mess. Side slope of pond as per the soil type of site. The depth of pond is recommended not more than 1.50m, while its free board should be 0.50m. Minimum of two numbers of HDPE pipes of not less than 60mm diameter should be provided as overflow.

Pond Capacity Design

The reservoir capacity of pond is based on four basic assumptions:

<u>Assumption 1:</u>
Average Demand of water in field is 800 liters per ropani per day (Water use in Drip irrigation is 150 liters, sprinkle irrigation uses 500 liters, bucket mug uses 250 liters and flooding irrigation requires 3 lps/ha. Here our adoption is based on average water use pattern, 800 l/Ropani/day).

Assumption 2:
Maximum base period of crops is 90 days i.e., ponds are designed for worst situation or to fulfill requirements of longest base period (except sugarcane). Here base period for cereal crops is 90 days and for vegetables it varies from 45 - 50 days, we adopt maximum to fulfill worse situation.

Assumption 3:
Average evaporation loss is 4mm/day (For hilly district winter evaporation is 1.5mm and maximum in summer is 7mm per day, mostly ponds are constructed in up hill and actual evaporation loss not exceeding 5mm per day).

Assumption 4:
Size of ponds can be selected based on two different source situations.

Situation A. Source discharge is less than daily average requirement: select pond size based on average water deficit for 90 days. Example: For average water deficit of 1000 liters, pond capacity will be 1000 x 90 = 90,000 liters.

Situation B. Source discharge is more than daily average requirement: select pond capacity of 5 times average discharge. Example: For 50 ropani land, pond capacity will be 50 x 800 x 5 litres = 200,000 litres

Standard Pond Sizes Adopted:

The standard pond sizes adopted have been presented in Table 2 below including the Silpauline plastic size.

Table 2 Standard Pond Size

Standard Pond (cum)		Bottom Size	Top Size	Silpauline Plastic Size
A	29	2m x 5.5m	4m x 7.5m	6.5 x 10m
B	60	5.5m x 5.5m	7.5m x 7.5m	10 x 10m
C	100	9.5m x 5.5m	11.5m x 7.5m	10 x 13.5m
D	160	15.5m x 5.5m	17.5m x 7.5m	10 x 20m

Outlet Pipe Design

Outlet pipe size is designed based on discharge of 2 liters per second per hectare.

Required Residual Head

Maximum	Optimum	Minimum
25 m	10 -15m	5m

Types of Pipe

A. High density polyethylene pipe: Pipe size above 20mm diameter to be used. For diameter above 32mm, pressure with 6kgf and above to be used.

B. Galvanized pipe: Used in rocky portion and exposed alignments.

Pipeline Design

Pipeline system for the pond irrigation is designed similarly as gravity flow water supply.

Financial Aspect

Cost of Major Components

The costs of major structures have been presented in Table 3.

Table 3 Approximate Cost of Major Components

S.N	Items	Cost in NRs. (Approx)
1.	Stream Intake	10,000.00-50,000.00
2.	Spring Intake	10,000.00
3.	Washout Chamber	10,000.00
4.	Collection Chamber	25,000.00
5.	Air Valve Chamber	8,000.00
6.	Interruption Chamber	20,000.00
7.	Valve Chamber	15,000.00
8.	Flow Regulating Chamber (2 Chambered)	7,000.00
9.	Flow Regulating Chamber (3 Chambered)	8,000.00
10.	Plastic Ponds 29 cum capacity	35,000.00
11.	Plastic Ponds 60 cum capacity	60,000.00
12.	Plastic Ponds 100 cum capacity	100,000.00
13.	Plastic Ponds 160 cum capacity	120,000.00

Note: The cost presented above does not include the costs of local materials.

Project Cost

LILI/Helvetas has set the maximum per ropani cost as NRs. 12,000.00 with command area limitation of 25 hectares, not exceeding 2.50 million rupees per project. However, as per our field experience it has not crossed even NRs. 8,000.00 per ropani.

Community Participation

LILI/Helvetas has followed the irrigation policy of the Department of Irrigation under Government of Nepal. However, there is no cash contribution from community side. Cash contribution is substituted by only kind contribution such as, collection and transportation of sand, stone and aggregate, portering of external materials from nearest road head to project site, unskilled manpower for pond excavation and distribution pipeline. Our experience revealed that less than 25% of the total project cost is being contributed by the community.

Conclusion and Recommendation

Realizing the pivotal role of irrigation in increasing agricultural productivity, Nepalese farmers have been traditionally investing in development and expansion of their irrigation systems. About half of the population of the community is living in hill and mountains. Majority of poor and lower caste people used sloppy terraces for farming, which are not irrigable by conventional surface irrigation methods. In addition to above, the performance of large and medium sized agency managed irrigation system have come into sharp criticism due to failure in achieving the anticipated agricultural production and accomplishing the needed operation and maintenance cost recovery. Hence, it would be proper to concentrate on cost effective, appropriate

technology, local know-how impart, easy maintenance and optimum use of lean flow through pond irrigation, which will also act as a tool for sustainable livelihood in hilly areas.

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TECHNICAL AUDITING FOR EFFICIENT AND SUSTAINED PERFORMANCE OF IRRIGATION PROJECTS

By:

Er. Prakash Paudel

(mailppaudel@yahoo.com)

Regional Director/WRID

Department of Irrigation, GON

Abstract:

The National Water Plan (2005) has fixed targets to expand and intensify irrigation facility in efficient and sustained condition. Despite sufficient institutional capacity of the Government of Nepal (GON) and established documented procedure, the coverage, intensity and efficiency of irrigation is below satisfying level. It is mainly due to lack of quality and adequacy of the system designed and constructed. The GON has introduced 'technical auditing' in all kinds of infrastructure projects. ISO defines (technical) audit as a systematic, independent and documented process for obtaining evidence and evaluating this objectively to determine the extent to which the expectations are fulfilled. The technical audit in irrigation projects has indicated the major nonconformance in ignorance of required documentation process, poor construction quality of the project and lack of funding arrangement for continuous service delivery. The audit process helps to rectify the defects and to improve project performance. The overall impact of technical auditing on irrigation projects is such that the project is established as an efficient and sustained system.

1. Introduction:

1.1. Potential irrigation for agriculture: The planned Irrigation Projects are being completed and irrigated agriculture being increased since the very first national plan of Nepal. Nepal has 2.64 million hectares (ha) of cultivated land. Out of this about 1.76 million hectares (66%) is irrigable under surface irrigation and ground water irrigation system while some more are added with newly introduced micro irrigation technology.

1.2. Strategic Plan: The long term (25 years) purpose of Water Resource Strategy (2002) is, "benefits from water resources in Nepal are maximized in a sustained manner". The targeted output in Irrigation sector defined in the plan is, "appropriate and efficient irrigation is made available to support optimal and sustainable use of irrigable land".

1.3. Present Status and Targeted Irrigation for agriculture: The National Water Plan (2005) based on Water Resource Strategy (2002) is launched to receive following *targets* at the end of 2027 A.D.:

Table- 1: NWP Targets

Indicators	Present (2002)	Target (2027)
Irrigation Coverage of irrigable land	66%	97%
Year round irrigation of irrigable land	30%	67%
Irrigation Efficiency	30%	50%

1.4. Institutional attempts/achievement: The inputs for irrigation projects are clearly identified and to some extent established. The master plan for irrigation development and strategic plan for water resource development is prepared. National Water Plan is approved by the government. On the other hand, comprehensive manual for planning, design, implementation and monitoring of irrigation projects are already prepared by Department of Irrigation (DoI). Similarly there is not much shortage of qualified technical manpower and experts in DoI. Quite a lot has been done in improving the contract administration capacity. Recently the Government of Nepal (GON) has introduced effective legal mechanism to improve procurement system.

1.5. Irrigation System Performance: Despite the attempt made for developing a sound structural system as well as managerial capacity in irrigation projects, the questions of not fulfilling the requirements have been raised regarding *quality* of work, *adequacy* of the activities, *efficiency* of the components and *sustainability* of the system. Negligence in following the set *standards* and *guidelines* has caused the poor performance of irrigation projects. Lack of effective monitoring has hindered the improvement process of irrigation system performance.

1.6. Introduction of Technical Auditing: The technical audit is one of the strong tools of monitoring and evaluation, thus leading to improvement in future course of action. GON has introduced *technical auditing* in infrastructure projects of all types and sizes.

2. Fundamentals of Technical Auditing:

2.1. Definition of Technical Audit: Technical Audit is 'a systematic, independent and documented process for obtaining evidence and evaluating this objectively to determine the extent to which expectations are fulfilled'. *(Adapted from ISO)*

2.2. Definitions of other audit related terms: *Audit criteria* are the sets of standards meant for comparing *evidences* with the *expectations*. *Expectations are the* requirement as end results, expressed in various project related documents and mandatory legal documents (e.g. design manual, standard design and specifications; public work directives, public procurement act and regulations, Nepal standard; contract document, quality assurance plan; etc.). *Evidences* are the information or data or proof found or verified during audit. *Functionality* is the appropriateness to serve the purpose while *life cycle cost* is the total cost of the project during its full life cycle.

2.3. Types of audit: The audit is carried out by employing qualified (certified) auditor. The audit may be categorized as first, second or third party audit. The first party audit is conducted by the organization itself. The second party audit is carried out by the user or customer. The third party audit is carried out by an independent body. In Nepal third party audit is conducted by National Vigilance Centre (NVC) in infrastructure projects.

2.4. Conformance and Nonconformance: When the condition found (evidence) conforms fully to the condition expected (requirement), then it is called *Conformance;* when it does not conform fully, it is a case of *Nonconformance***.**

2.5. Audit Process and Audit Focus:

- **Audit process:** Audit criteria, checklist and questionnaire are prepared with the help of document reviewed and supplemented during audit itself. Audit is carried out by observations, interviews and verifications. The earned value of the project is assessed with the help of progress/expenditure data. The audit finding is also produced. The major nonconformance is presented separately in standard format signed by the auditor.
- **Audit focus:** The scope of work and focus of audit depends upon type of project and stage of its development. However general audit focus at various stages are as follows:

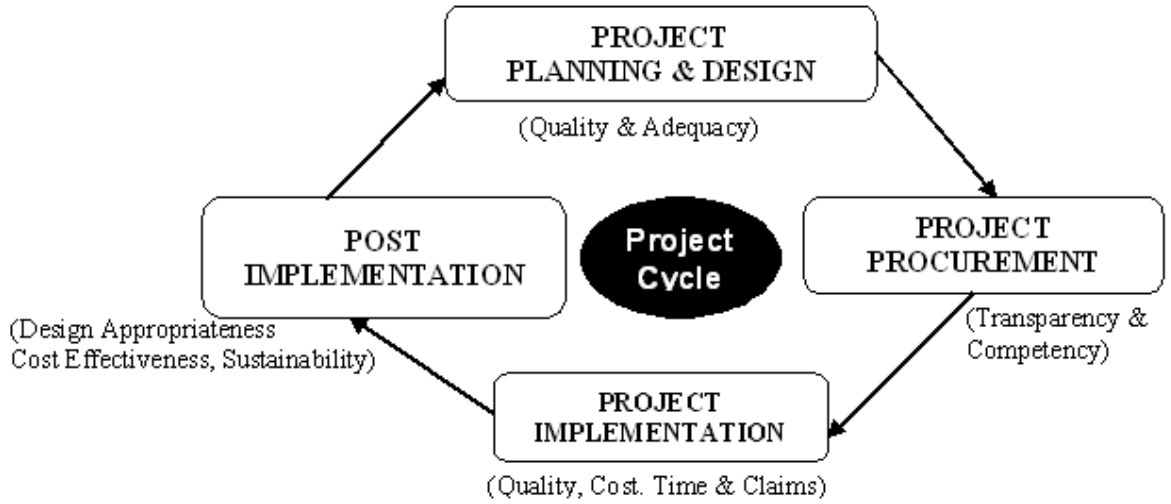


Figure 1: Project Cycle and Audit Focus

- **Planning/Design Stage:** Adequacy and quality of appraisal report, design and contract document (e.g. 'do they support the project objectives?')
- **Procurement Stage:** Transparency of the process, competency of the bidder and adequacy and quality of bidding documents and conformity with mandatory provisions (viz. act, regulations, donor's requirements etc.)
- **Implementation Stage:** Quality of work, schedule and budget/cost, time, price escalations, contractor's claims and litigations during construction period (major expenditure of the project flowed during this stage)
- **Post-Implementation Stage:** Design appropriateness (functional effectiveness), cost effectiveness, sustainability of the system and lesson learnt.

3. Audit Analysis

3.1. General: The aspects of audit analysis are discussed here with their basic theoretical approach and along with sample audit result of irrigation projects. Audit reports of twelve irrigation projects are selected to produce the general result here, while the examples of audit findings also include that from the pilot audit.

3.2. Earned Value (S-Curve) Analysis: Earn Value is the performance measurement of the progress/expenditure against the scheduled progress/budget. The cumulative progress

value till date is plotted against the time lapsed from beginning of project. Earned values of all (individual) activities are added to find out overall earned value or the *performance* of the entire Project.

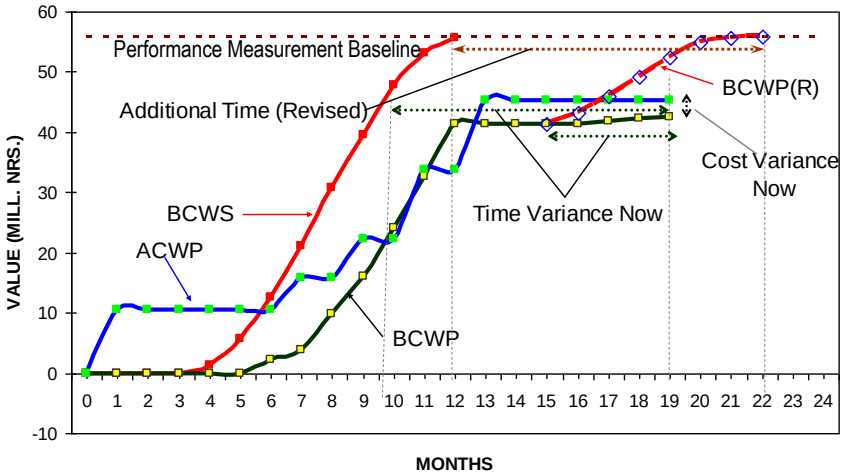
❖ **Important project management terms:**

- Budgeted cost of work scheduled (BCWS): Value of the *work planned*
- Budgeted cost of work performed (BCWP): *Work performed* (*Earned Value).*
- Actual cost of work performed (ACWP): *Payment* till date for the work
- Schedule Variance (SV) = Earned Value (BCWP) – Planned Budget (BCWS)
- Cost Variance (CV) = Earned Value (BCWP) – Actual Cost of Works (ACWP)
- Cost Variance at Completion (VAC) =

  Budgeted Cost at Completion (BAC) – Estimated Cost of Works at Completion (EAC)

❖ Following S-curve is reproduced from the audit report (2006) of an irrigation project. [Auditor: Er. D. K. Shreshtha; Courtesy: NVC]

Fig. 2: Earned Value Analysis of an Irrigation Project



ACWP =Actual Cost of Work performance;	BCWS(R) =Revised BCW Schedule;
BCWS =Budgeted Cost of Work Schedule;	BCWP =Budgeted Cost Work performed

Table- 2: Analysis of Earned Value Curve (End of 19th Month)

N.	Items	Unit	Normal	Revised
	1. Plan (Schedule)			
	1.1. Completion Time	Months	12.00	22.00
	1.2. Contract Amount	Million NRs	55.70	55.76
	2. Audit Evidence			
	2.1. Time Elapsed	Months	19.00	--- ---
	2.2. Progress (Earned Value)	Million NRs	42.43	--- ---
	2.3. Payment	Million NRs	45.19	--- ---
	2.4. Scheduled Progress	Million NRs	--- ---	52.51
	3. Analysis			
	3.1. Time Variance	Months	09.50	03.50
	3.2. Schedule Variance	Million NRs	--- ---	13.35
	3.3. Cost Variance	Million NRs	2.75	--- ---

3.3. Nonconformance Report (NCR): It is the formatted sheet issued by the auditor explaining details of nonconformance (NC) and proposed disposition to rectify the NC. The project or department has to confirm the action suggested by the auditor/NVC.

NCR contains six sections as per following table.

Table- 4: Nonconformance Format

Report Head: NCR No; Date; Project Name; Item of work; Locations etc.

1. **Details of Nonconformance**

   1.1. Condition Expected:

   1.2. Condition Found:

2. **Root Cause:** Why did this non-conformance occur? *(To be analyzed by the auditor)*
3. **Proposed Disposition:** Actions to rectify the NCR *(To be committed by the Project Manager)*
4. **Recurrence Prevention Measures:** NCR not to be repeated
5. **Confirmation of Disposition:** *(To be confirmed later by the Project)*
6. **Confirmation of Recurrence Measures:** *(To be reported to the NVC by Ministry or Department)*

3.4. Audit Finding: This is the comparison of audit evidence with requirements or criteria. Following are the general findings of irrigation projects audited.

Table- 3: Audit Findings

S.N.	Condition Expected	Condition Found
1	Flood Analysis is done with up date (2004) data	Hydrological data of 1964-75 only are taken

2	Contract document is duly completed and signed by agreeing parties	Contract data not filled-in properly; Signature of missing in bidding document
3	Detailed design/drawing are prepared and approved before awarding contract (or construction drawing prepared by the Contractor, if applicable)	Cost estimated on the basis of tentative design (feasibility?) and contract awarded; no drawing found approved; work carried out on the basis of hand sketch prepared by site engineer
4	Test result or certificate for material or work are attached with bill (IPC)	No test certificate of HDPE pipe, found; in-situ test not conducted as per Standard
5	Lined canal are built leakage-proof	Lined canal found leaking at various places
6	As-built drawings are prepared and maintained for O & M purpose	No as-built drawing are prepared and maintained by project.
7	Canal Operation Plan, Project Maintenance Plan and Institution Development Plan are prepared before transferring a AMIS to WUA	No such plans (COP,PMP,IDP) are prepared; in some cases, the work is not transferred as per agreement
8	Area irrigated during Rabi to be at least 50% of the total command area	Area irrigated during winter found only 35% of the command area (70% of target)
9	Field density test of compacted earth is to satisfy the standard specifications	Field density test of earth results show very poor performance (67% to 79%)
10	Construction joints are provided in PCC canal lining as approved by Engineer	# Construction joints provided randomly without Engineer's approval; # Canal lining found burst at places
11	All items of Works will have tech specifications and QAP	Some items found without having specifications or QAP
12	Work should meet the specifications	Works do not meet required specifications

3.5. Categorical Analysis of Audit Findings

Table- 5: Analysis of Nonconformance in irrigation projects (Total Projects Audited: 12)

Rank	Category	Project	NC	% NC
1	Quality Assurance/Certification/Control	6	11	37
2	Adequacy/ Quality of Document (including as built drawing, O & M plan etc)	7	7	23
3	Funding/WUA Contribution/Handover of the Project	3	5	17
4	Conformity with legal provision (Insurance etc.)	3	3	10
5	Conformity with Contract/Design Document & Drawing	3	3	10
6	Timely Completion of Works	1	1	03
7	Contractors Complaints/Litigations/Price Escalation	0	0	00
	Total		30	100

4. Effect and Impact of Technical Auditing on Irrigation Project Performance

4.1. Effect:

(a) Corrective/preventive action: As explained earlier the last two parts of NC-format are the follow-up actions taken by the organizations. The disposition to rectify the defects is taken by the project office. Similarly the preventive actions to eliminate the cause of defects are taken by the concerned Department/Ministry. Thus the recurrence of the defect and further potential damage are minimized in the project.

(b) Adequacy of documents and procedure: As the technical audit is introduced in every type/size of the projects, the project management will certainly be careful in preparing adequate document and follow defined procedure. This will lead to maintain the required quality and functionality of the work.

(c) Effective monitoring of the project progress: The physical progress, financial expenditure and their deviations from that planned are assessed from earned value analysis. This will help the builder as well as employer to take new course of action to meet the required progress and control the expenditure.

4.2. Impact:

(a) **Project Efficiency:** By technical auditing adequacy and quality of activities and components in any projects are checked and maintained to satisfy the requirements thus ensuring increased efficiency of the projects.

(b) **Project Sustainability:** Technical audit helps maintain the balance between functionality and life cycle cost of any project thus ensuring the sustainability of the project.

5. Conclusions and Recommendations:

5.1. Conclusions: By introducing technical auditing in any project,

- ❖ the effective monitoring, quality assurance and documented procedure are systematically established with improvement of quality and correction of defects
- ❖ adequacy and quality are maintained leading to increase in efficiency
- ❖ the life cycle cost of the project is balanced with functionality which ensures establishment of sustained system

5.2. Recommendations

- ➢ The basic training of technical auditing be provided to the engineers and other concerned officers of the department of Irrigation
- ➢ The first party auditing be introduced in the department of irrigation for establishment of effective monitoring system

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References:

1. Public Works Directives (Vol. IIA), 2002; Government of Nepal (GON)
2. ISO 9001:2000; ISO publications
3. Technical Audit Manual, 2005; National Vigilance Centre, GON
4. Technical Audit Reports (Irrigation Sector), 2005-2007; National Vigilance Centre
5. National Water Plan, 2005; Water and Energy Commission Secretariat, GON

Irrigation Newsletter, No.72 (Article 'Technical Auditing for improvement of performance of Irrigation Projects' by Mr. P. Paudel), Apr-May 2007, Dept. of Irrigation

1.1 Overview of Irrigation Development in Nepal

Lok Bahadur KC, Engineer, Water Induced Disaster Prevention division No 6, Banke
(kclokbahadur@yahoo.com)

Abstract

Nepalese agriculture remains to contribute significantly to the economic growth and the overall development of the country. Irrigation supplement to improve production seem to be an ancient culture and tradition of the people justified by the existence of more than 15000 farmers managed irrigation systems spread over the country. This paper attempts to outline and briefly compile what has been achieved so far and to outlay the threshold suggesting probable future course for reliable, sustainable, cost effective irrigation development activities envisioned by the Department.
The review reveals mismatching of targets and accomplishment in irrigation development. The annual irrigation expansion activities remain to be lower than 20,000 hectare spread over the entire ten five year plan periods. But, the department has excelled in development of design manuals, regulation, policies, guidelines, master plans and programs. Practical improvements, updating and revision seem necessary in application of these gadgets. The present milieu of irrigation development in Nepal with outlined constraints, uncertainties and potentials should assist future course of irrigation development planning.

Historical Account

Irrigation or irrigated agricultural practices have been adopted from ancient times. Egyptians were the first ones to incorporate irrigation in farming practices. According to N.D. Gulhati (1958), "Irrigation in many countries is an old art- as old as civilization – but for the whole world it is a modern science- the science of Survival". The areas generally associated with irrigation are those in which the annual precipitation is either insufficient in quantity or too strongly seasonal to sustain crop growth with out additional water.

In Nepal, as well, history of irrigation development remains to be an age-old art of living. Specific documentations of systems were not exactly known. However, *Rajkilo's* were constructed by the kings and rulers during those times. Katmandu valley was known to be the early settlement of Nepal where climate, fertile soil and water were abundantly available. Irrigated agriculture and trading flourished in the valley. Local farmers developed and managed traditional irrigation systems utilizing the locally available technology and resources. Government rarely assisted these systems. Accomplishment of history, Nepal has more than 15,000 and 1700 farmers managed indigenous irrigation systems covering around 70 % of irrigated land in the Hills and Terai respectively. The systems seem to be traditionally managed and operated from the non-formal self-propelling user communities headed by leading farmers. The basic characteristics of these systems noted were proportional water distribution, resource mobilization, addition of structures as per managerial requirement, adoption and acceptance of design to fail concept, wider flexibility, simple, low cost and temporary in nature, transparent and, autonomous having strong sense of community ownership. Likewise, government managed irrigation systems (GMIS) commonly cover large area mainly in Terai and Hills.

Chandra Shumsher Rana in1922 initiated the modern and scientific irrigation system "Chandra Canal" during their Autocratic Rule. This was the first documented agency managed irrigation project completed in 1928. It was built with assistance from the British engineers. The project commands 10000 ha of agricultural land of Saptari District. The clever Rana rulers in their last bid to stay in power for longer realized to win the favor of the people through development of infrastructure. After Chandra Canal, the irrigation sector step by step cautiously gathered momentum as Judha Canal 1943-1946 in Sarlahi, Jugdishhpur barrage 1939-1942 in Kapilbastu were developed.

History of Department of Irrigation

After the revitalized monarchial rule in Nepal in 1950, substantial irrigation activities were initiated. Indian engineers were involved in the development activities. In 1951 'Nahar Division' was established for development and management of irrigation sector. This Nahar Division was renamed as Irrigation and Water Supply Department in 1960 followed by Irrigation and Hydrology Department in 1972 prior to the present Department of Irrigation (DOI) under ministry of Water Resources in 1987. Then, the department established 75 district irrigation offices in 1988 to develop and to manage irrigation and river training activities in the districts.

After the installment of democratic rule in 1990, Nepal entered into the open market led, competitive and fast track development epoch. Soaring peoples desire, politicians' inexperienced ruling mechanism, slow, lengthy, adamant traditional bureaucratic procedures and congestion of priorities led to rise of conflicts, unbalanced growth and rampant corruption paving way to both revolutionary and reactionary forces. As a result the overall development activities were severely influenced and the irrigation sector also could not progress ahead as planned.

The government enacted Local Self Governance Act in 1998 and Local Self Governance Regulation 1999 to empower local bodies in governance. According to act the district level institutions working on small scale projects and programs needed to be under the umbrella of District Development Committee. This urged again for the restructuring of the departments' district based offices. Thus in 2002, the irrigation departments' district offices were abolished and division concept, as before in 1987 but with modification, was once again introduced.

Presently, the department has five regional directorates, 26 divisions, 20 sub divisions, 8 repair and maintenance divisions and 3 mechanical divisions with over 2000 working staff. For the development of ground water irrigation 8 field offices in Terai as established before continued to function under central level Groundwater Irrigation Development Project as per the development Board act 2013.

Once again the department seems to be at the threshold of restructuring its district based division offices on the basis of Integrated Water Resource Management concept and River Basin Approach. The most imminent transformation of the country into republican and federal states is bound to reorganize the department.

Agencies in Irrigation

First, Ministry of Water Resources, Ministry of Agriculture and cooperatives, Ministry of Local Development, and Agriculture Development Bank are involved in development of irrigation sector. Second, Private sector, I/NGO and civil societies are also involved in development, operation and management of small, micro, and non-conventional irrigation systems. Care Nepal, GTZ, Plan International, Helvetas, DFID, IDE, SAPPROS etc have been assisting small farmers' schemes. In particular, these sectors have substantial experience, expertise and knowledge in micro irrigation and non-conventional technologies using water harvesting, optimizing water resource application through drip and sprinkle irrigation techniques.

Third, the external donor agencies whose involvement, roles, and contributions guide the future of irrigated agriculture are World Bank, Asian Development Bank, EU, Saudi Fund, DANIDA, and some other bilateral and multilateral institutions. Finally, the stakeholders or the farmers or the users or the beneficiaries in the organized or traditional form of WUA directly involved in receiving, managing, developing the irrigation systems through the assistance from governmental and non-governmental agencies.

PERIODIC PLANS, PLANS AND PROGRAMS

The five-year periodic plans commenced from 1956 have provided ample importance to the irrigation sector. Periodic plans from first to the seventh stressed on the agency managed irrigation systems. During these period department constructed and managed small, medium and large irrigation systems. The concept of hand over projects to the farmers for operation, maintenance and management was rather overlooked. Widely known trickle down supply driven approach was prevalent. Both the government and the farmer largely ignored the post implementation phases of the systems.

After restoration of democracy in 1990, the country saw rapid development activities in all the sectors with no exception of irrigation, which principally remained on the priority list for poverty alleviation of the rural sector. The eighth, ninth and tenth periodic five year plan emphasized agriculture to be the major contributor to the national economic growth. For this, irrigated agricultural was the base of sustainable and broad economic growth. Decentralization, participation, social inclusion policies were adopted and presumed to significantly improve the awareness of the rural people. Similarly, the role of private sector and civil society boomed many fold over the years.

The Irrigation Master Plan 1990 was foremost and pragmatic milestone vision document of the irrigation department. It evidently attempted to outline challenges, potentials in the irrigation sector. It expressed concern over the dependency on construction alone excluding management and societal parts. The plan emphasized integrated development of land and water. The concept of land consolidation, land bank, integrated land use and harmonization with the forest were some of the development policy recommendations outlined by the document.

Then, Ministry of Agriculture introduced a twenty year "Agricultural Prospective Plan" (APP) in 1995 to bring green revolution and to make agriculture the engine of economic growth. The agricultural sector development with an annual target growth rate of 5 % was assumed to induce multiplier effects in agricultural and non-agricultural sectors. Extensive abstraction of groundwater for irrigation through development of shallow and deep tube wells for annual

covering of 24000 ha land in Terai was visualized by the plan. Similarly, surface water irrigation in the hills for cultivation of high value crops and fruits were proposed. However, present revelation is that the plan implementation could not meet the set target and review of the document seems inevitable.

Likewise, a 25-year "Water Resource Strategy Paper, WRSP" was finalized and introduced in 2002. The main objective of the paper was to improve the livelihood of the people through sustainable utilization, development, protection and management of abundantly available water resources of the country. The paper classified three water use categories namely security, use and mechanism with ten strategic water sector output development through short, mid and long term strategic planning. The strategy paper clustered disaster management and watershed management under security; water supply and sanitation, irrigation, hydropower and other economic activities under uses and legal framework, institutional mechanism, regional cooperation and water related information under the category mechanism.

To operate and implement WRSP "National Water Plan, NWP" was approved by the ministry of water resources in 2005. The NWP, with an aim to contribute in a balanced manner to the national goal of economic development, poverty reduction, food security, health, safety and improving the standards of living of the people, incorporates the principles of integration, coordination, decentralization, participation, good governance and equity. The main programs of irrigation sector outlined in NWP are integrated program for irrigated agriculture, improved management of existing irrigation schemes, improved planning and development of new irrigation projects, strengthening of capacity building of local institutions and national capacity building of local farmers.

The present programs of the department are expansion of irrigation facilities, rehabilitation, operation, maintenance and management of existing irrigation systems, institutional development and; study and research activities. These programs include sector programs; non-conventional irrigation projects; ground water irrigation activities; crop water management; irrigation management transfer; centrally and regionally managed large or medium irrigation schemes. The Public Works Directives PWD 2002 has included procedures and guidelines for planning, implementing and maintaining irrigation systems.

Design Manuals, Acts, Regulations, Policies

In 1990 prior to the act, regulation and policy the department of irrigation had developed "Design Manuals for Irrigation Projects in Nepal" to be used by the technicians of the newly established 75 district irrigation offices. The manual included thirteen technical volumes encompassing general system planning, survey and mapping to tender document and construction; and operation, maintenance and management along with 8 other supporting manuals for the reliable system development and management. These voluminous documents are still in use but as elaborated above in the recent years numerous modifications in plan, design, implementation and management push them for instant updating, incorporating and revision.

The Water resource Act 1992 was enacted in 1992. The main objective of the Act were utilization, protection, management and development of water resource existing in the surface or ground or in any form and, to decide beneficial uses controlling any adverse environmental and likely consequences thereby maintaining pollution free sustainable water resources. The act outlines autonomous and prioritized uses of the resource base. Customarily, water resource

utilization for individual or group domestic water supply, water mills, boating, irrigation and activities alike need no prior approval and permission from the government. However, the act clearly prioritizes the water resource utilization in the following order for broader development feature as: i) water supply, ii) irrigation, iii) livestock, fisheries and agricultural related activities, iv) electricity generation, v) industrial use vi) water transport vii) recreational activities and viii) others.

The Water Resource Regulation 1993 has made a provision of District Water Resource Utilization Committee (DWRC) at the district level to issue permits for water resource use, investigation, protection and other water related beneficial activities. Along with this the regulation elaborates about conflict resolution, service fees, land acquisition and compensation and miscellaneous activities.

The Irrigation Regulation 1999 outlines formation and registration of inclusive Water Users Committees, River Training Committee, Collection of Irrigation Service Fee, Service utilization, Users Responsibilities etc. Farmers' participation and registration of WUA in the respective irrigation offices have been made mandatory. Depending upon the size, location and landholding farmers have to contribute ranging from 3 to 15 % in cash or kind as their contribution of the project cost.

In line with these, the "Irrigation Policy 2003" was promulgated in 2003, which outlines about Project Identification, Implementation; Resource Mobilization and Participation; Water Users Committee; Service Fee; Operation and Maintenance; System Management; Environmental Protection and Water Quality; Coordination, Monitoring and Evaluation; Accountability and Responsibility; Involvement of non governmental Organizations and Capacity Building activities.

Irrigation Development

In total, the agricultural land of the country as per DoI database is 2.640 million hectares: 1.359, 1.054 and 0.227 million hectare in Terai, Hills and Mountains respectively with an irrigable agricultural potential of 1.766 million hectares i.e. 1.356, 0.355 and 0.055 million hectares in Terai, Hills and Mountains respectively.

The irrigation facilities built by the end of tenth plan or 2007 are 67% or 11, 94,628 ha of total irrigable agricultural land behind 4% of National Water Plan target of 71%. It has been noticed that during the sixth, seventh and eighth periodic plans up to 76 % plan target was accomplished with an average irrigation development of 64700 ha per year. However, the entire plan period average irrigation development remains under 52 % of the annual target i.e. under 20,000 ha per year.

Employment generation and development of sustainable and reliable year round irrigation facilities to increase agricultural productivity are the main objectives of the interim plan. The plan 2008-2010 proposes to irrigate 95,900 ha of land of which 58,300 ha by surface and 37,600 ha by ground water. Expansion of irrigated area; reconstruction, operation and maintenance; institutional development and research and study are the programs outlined by the interim plan. The department implements medium, large, multipurpose, small modern surface and small ground water irrigation projects.

Environmental Protection Criteria

The concept of "environment is not a free good" has been more and more realized. Initial environmental examination (IEE) for new projects having command area 15-2000 ha in hill valleys, 10-200 ha in sloping hills and 25-2000 ha in Terai has been mandatory. Similarly, IEE is compulsory for rehabilitation and improvement of irrigation projects which have command area more than 500 ha in Terai, 200 ha in hill valley and 100 ha in sloping hills. In addition to this IEE is essential for relocation or resettlement of 25 to 100 people in the process of project execution.

Likewise, environmental impact assessment (EIA) has been compulsory for irrigation projects having command area larger then 500 ha for Hill Valley, 200 ha for sloping hills and 2000 ha for Terai. In addition to this EIA is essential for resettlement of more than 100 people in the process of project execution. Furthermore, EIA is a requisite for multipurpose reservoirs and inter basin water transfer project implementation.

Hydrology and Water Resource

Rainfall and runoff patterns show wide spatial and temporal variations and incessant localized downpour seem to be common over the. Approximately, 80% of the rainfall occurs during the monsoon i.e. Nepal faces problems of "too much water" and "too little water" causing land degradation. The western part of the country receives lower rainfall in monsoon and similarly the eastern part receives lower rainfall in winter. The rainfall ranges from 200 to 4000 mm with an annual average of 1530 mm. The climate ranges from sub-tropical in Terai to alpine in high Himalayas and the temperature varies from below zero in the north to above 45 ^{0}C in the south.

The rivers, streams and rivulets have surplus supplies during the monsoon from June to September. However; from November to May except for the systems harnessing water from the snow fed rivers the water flow from streams and rivulets is highly seasonal and limits irrigation to one cropping per year in many places. Due to extreme monsoon floods the systems seem to be recurrently damaged making annual repair and maintenance further difficult adding larger economic burden to the local farmers and subsequently to the government.

More than 6000 rivers, streams, rivulates across the country that flow from the north towards south to India provide ample possibilities for irrigation development. From all these rivers and streams, in total, a 225 BCM of water results as surface runoff of which Nepal has harnessed 15 BCM only so far. The groundwater resource is mainly confined in Terai. According to NWP, only 1.056 BCM that too 0.297 BCM for domestic and rest for agricultural use has been utilized. The maximum groundwater potential has been computed to be 12 BCM. Rivers feed large irrigation systems in the Terai, but older systems in hills.

Performance, Challenges and Prospectives

The overall performance of the department of irrigation remains lower than the target planned. Criticisms from the public sectors and users seem regular. Significantly noted reasons for poor performance were operational difficulties like no trained manpower for operating the systems, sophisticated management required for system operation, inadequate farmers' involvement, poor monitoring and evaluation in developing and maintaining the systems.

More reliable and low cost systems have already been developed. Left over and new systems seem to be increasingly expensive due to technical difficulties and social conflicts. Important potential challenges are natural setting of the country, operation and maintenance of existing irrigation systems, planning and implementation of large projects, internal or external resource mobilization, human resource development and the unpredictable political environment of the country.
In the recent years, to eliminate these constraints the department has introduced obligatory farmers' involvement in management, modernization or development of irrigation systems. Farmers associations are registered sign a memorandum of agreement with the office and commence the implementation of the project. Demand driven people centered approach; mandatory stakeholder inclusion and participation are adopted as the basis of project formulation, implementation and post implementation. The department of irrigation thus has initiated the process of equal responsibility sharing and subsequent empowerment of WUA in management of irrigation systems.

Still, about 570000 ha of potential irrigable land remain for entire infrastructure development and management. Most of the irrigation infrastructure developed so far by the government, farmers and other agencies remain to be rehabilitated or modernized or repaired and maintained to ensure sustainable and reliable year round irrigation facilities.

Assessment of Accomplishments

The importance of irrigation in Nepal has been widely recognized. Uncertainties, risks and difficulties for poor performances have been outlined. Availability of water, land, human resources, involved agencies, stakeholders and national requirements have been clearly defined. The department has excelled in development of design manuals, regulation, policies, guidelines, master plans and programs. Practical improvements, updating and revision seem necessary in application of these gadgets.

Government annual investment in irrigation appears stagnant or declining. The review reveals mismatching of targets and accomplishment in irrigation development. The annual irrigation expansion activities remain to be lower than 20,000 hectare well below the planned target spread over the entire ten five year plan periods. The existing central level planning remains extemporized to fix minimum annual targets to its field based offices. Annual irrigation development targets are computed from the periodic plan targets.

The existing trend of irrigation planning, management and development needs refurbishing. The NWP irrigation activities and the periodic plan activities should be reorganized into more quantitative and people centered societal basis. Decentralized, participatory and inclusive planning as preliminarily outlined in future suggestions could be a modality for irrigation development, modernization and management.

Reliability of available data remains dubious. Fundamental irrigation related data vary widely.

Future Suggestions

Future irrigation development, modernization and management should be categorized as new irrigation expansion; rehabilitation; modernization; and annual repair and maintenance. The new irrigation development should result in expansion of irrigated area, increase in cropping intensity and increase in crop yield. Rehabilitation of schemes should result in increase of cropping

intensity, increase in crop yield and improved system functioning. Modernization of irrigation system should result in increased crop yield and improved crop water management activities. Lastly, the repair and maintenance of irrigation system takes into consideration of annual damages due to floods, landslides and similar natural calamities.

All irrigation offices or institutions i.e. regional directorates, divisions, sub-divisions, groundwater field offices should plan for minimum annual quantified hectare targets and central office should ensure unbiased allocation of resources in all categories. Central level and regional level projects should be planned and funded similarly. Data acquisition, updating and management should be strongly prioritized, emphasized and instigated.

Other activities like research and study, training, management etc should be quantified by the department. Programs, policies and project performances reviewing, monitoring and evaluation should be regular and result oriented. Finally, the overall quality assurance, further scopes, desires and self esteem of the institutions should be maintained.

The present milieu of irrigation development with above outlined constraints, uncertainties, potentials and development modalities will assist sustainable future course of irrigation management, modernization and development.

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Integrated Water Resource Management in Nepal; NewTools & Approaches

Er. Hari Bahadur Thapa
Program Associate, Group for Rural Infrastructure Development Nepal (GRID Nepal)
SAWA fellow, Masters' Degree in IWRM, Nepal Engineering College, nec
(haribahadurthapa@gmail.com, gridnepal@wiseuse.org.np)

Abstract

This paper is focused on the Integrated Water Resources Management of Nepal with river basin organization approach, to development of water resources and addressing the management and operational problems. The river basin organization structure is proposed as an autonomous body incorporating all the stakeholders related to water resources of Nepal, working in all level (user to national decision making level).

IWRM, shifting paradigm of water resource management, is comprehensive & integrated use of water resources by allocating water for the use by various sectors with proper management and efficient supply to manage the resources. It also important for increasing productivity, equitable distribution of resources for various users and conserving the resources for future use also.

Since 1950s, Government and non governmental organizations, professionals and communities are working in various sectors of water resources of Nepal, in organized manner. After political movement of 1990s, the activities in water resources among these stakeholders are rapidly increased. Till now we have no any significant governmental/non-governmental mechanism to co- ordinate the different sectors of water.

The main sprit of this approach is "All water resources of country is and for all the people of country," which will reduce the water resource conflicts.

Introduction

Before going to Integrating Water Resource Management (IWRM), any one concerned to water issues, should clear about Water Resource Management (WRM). People from different background seldom have the same idea about what water resource management implies to the people in arid water resource management means draught relief, irrigation, jobs, ground water & fresh water. To the people in wet areas water resources management means surface water, water works, and navigation, hydropower, and flood management. Obviously, for a water engineer, it is case of dam, reservoir, flood protection, river, training works, wet field development, treatment works etc. For an environmentalist, WRM is the subject of ecosystem loss, deforestation, land degradation, erosion, pollution, destruction of wetlands. Similarly, for a lawyer, WRM means the water ownership, water right conflicts, licenses, water law, regulation, international water law/issue, etc. simulate economic growth, employment generation, poverty alleviation, food security, cost recovery, economic analysis are the meanings of WRM for an economist.

In fact, WRM includes all the points of view. It is physical, economic, political, sociological, environmental and technical. The relative ease with which one of these aspects might be

quantifiable as compared to another, does not in any way reflect a correspondingly great importance, Hence WRM in its entire component is multidisciplinary.

Finally, WRM can be defined as the whole set up technical, institutional, managerial, legal and operational activities required to plan, develop, operate & manage water resource for sustainable use.

Integrated Water Resource Management (IWRM)

Integrated water resource management (IWRM) as shifting paradigm of water resource management has undoubtedly gained currency and prominence since the 1992 Dublin and Reo de Janeiro international conference (Box 1), which covered the issues of water, environment and development. The global water partnership (GWP) was established in 1996 and became the main social carrier of the nation. The GWP 'promotes IWRM by creating fora at global, regional and national levels, designed to support stakeholders in the practical implementation of IWRM'.

IWRM is comprehensive & integrated use of water resources by allocating water for the use by various sectors with paper management and efficient supply to manage the resources. It also important for in creasing productivity, equitable distribution of resources for various users and conserving the resources for future use also.

IWRM takes about of;

- A natural aspects of the water resources (Blue, green & yellow water)
- All sectorial interest and stakeholders.
- Spatial variation of resource and demands (national, international, regional, regional, District & local level)
- Relevant policy frame work (national objectives, constraints etc)
- All institutional levels (cross cutting policy, issue and objectives)

There are a number of issues & interest that cut across the decision process in IWRM. They are condition for sustainable development and desirable socio-economic development. Related to sustainability: The maintenance of water quality, financial sustainability, the existence of democratic control mechanism and institutional capacity. Related to public interest: equity, poverty alleviation, security, food security, health, environment, merit value.

Water and management in context of Nepal

Nepal is land linked (not land '**Locked**') country situated between two powerful countries India and china. The total population of Nepal is estimated about 27 Million and area of 147181 sq. km. 'Diversity' is the main characteristics of this country. Caste, religion, language, class, livelihood, ethnicity, profession, climate, geology, geography all are found in diverse pattern.

The geography of Nepal spread from Terai flat land in south to higher Himalayan ranges in north. Due to this variation in geography environmental and other climatic features are also found more different in different locations with shorter change of location. So, spatial and temporal variation in climatic parameters (rainfall, runoff, humidity, temperature etc.) play vital role, while go in water resource management term.

More than 6000 rivers are furnished Nepal as Kingdom of Beauty. The rivers are formed from mainly four geographical stages of country. The first type rivers originated from higher

Himalayan ranges, also from Tibetan land, second, third and fourth type of rivers are originated from Mahabharat range, Chure range and siwalik teari region, respectively. The main four river systems (Ganddaki/ Narayani, Mahakali, Koshi and Karnali) are originated from the higher Himalayan region and Babai, west Rapti, Bagmati, Kamala and Kankai are originated from Mahabharat range. These two types of river system play vital role in water resource quantity of country. Few of other river systems carrying comparatively lower discharge (Mansusmara, Bakaiya, Lothar, Ratu etc.) are originated from Chure, siwalik and terai region. Quantity of flow of river systems originated from Himalayan range are directly varies as per the variation of environmental temperature (snow melting rate) and the river flow oriented from Mahabharat, chure range are directly varies as per the rainfall occurred and recharge of its catchments. So, the rivers from various stages flow different hydrograph pattern. This is a good fact regarding to the annual quantity of river flow, where as the snow fed river contribute in dry season and the rainfall fed river contribute in wet season.

Table 1: Average Runoff in the Rivers of Nepal

S/ N	River	Drainage Area (km^2)		Population	Annual	Per capita	% of Total	
		Total	*within Nepal*	*in 2001* ('000)*	*Flow (m^3/s)*	*M^3*	*Flow*	*Popn.*
1	Mahakali **	15,260	5,410	454	698	24,519	9.8%	1.9%
2	Karnali	44,000	41,890	2,211	1,441	20,553	20.2%	9.4%
3	Narayani	34,960	28,090	4,426	1,753	12,491	24.6%	18.9%
4	Koshi	60,400	31,940	2,811	1,658	18,600	23.3%	12.0%
5	Babai	3,000	3,000	510	88	5,418	1.2%	2.2%
6	W. Rapti	3,380	3,380	1,020	100	3,100	1.4%	4.4%
7	Bagmati	2,700	2,700	2,167	139	2,015	1.9%	9.2%
8	Kamala	1,450	1,450	541	74	4,333	1.0%	2.3%
9	Kankai	1,148	1,148	280	615	6,798	0.8%	1.2%
10	Others	28,173	28,173	9,030	1,113	3,880	15.6%	38.5%
	Total	194,471	147,181	23,453	7,125	9,580	100%	100.0%
			Total in billion m^3		**225**			

* Estimate: WRSF Consortium (2000)

** Per capita availability for Mahakali calculated assuming Nepal's share to be 50%

Total annul Run off = 7125*60*60*24*365 = $225*10^9$ m^3 =25 Billion Cub Meter (BCM)

Ground water is other main source of water in Nepal. Terai & valleys are depending on ground water source. Surrounding hills/slope topography of valleys and upstream mountain & hills of Chure, Mahabharat ranges for Terai contributes for ground water recharge. So hills/ mountain, which seems barrier to hydrology but actually them contributing river basis by recharging ground water. Such type of topography separating river basins and act as barrier to monsoon from Bangal & Ganga for rainfall. So, these hills, mountains can be considered as beneficiaries,

while we execute & play with hydrology of Nepal. In other aspect, such topographical constraints creates uneven size of river basins also.

According to a study (Mr. Hari Man Shrestha for his Ph.D. Thesis) regarding to rivers (water resource) of Nepal, 83000 MW hydroelectricity can be produced with in geography of Nepal. Among which 43,000 MW is found economically & 25000 MW found techno economically fesible. But truth is that till now not more than 615 MW hydro electricity is installed. This figure shows two facts;

→ How much water resource potential we have?
→ How we lag in use/manage of avail water resource?

In the context of Nepal, water resource consumption pattern is not so far differing from global use pattern. Water supply, irrigation, hydropower, mechanical (Industrial) sectors in main priority. Conventional use of water resource is main in rural areas. Only finger countable water resource projects are launched in Nepal, with engineering aspects, such as Koshi, Mahakali, Marsyangdi, Kaligandaki 'A' etc. Most of them are depends on foreign aid. Big and ambitious projects and regarding to water resource in Nepal are associated with interest of foreign countries and almost all water related cases are associated with down stream 'Big Brother' country India. This is geological, hydrological, economical, cultural & political constraint of Nepal.

So till now, water resource of Nepal only be the cause of disaster (flood, land slide, inundation etc). Most of the rural people consider river as disaster producer and development barrier. Beside of this fact, many small & medium scale water resource programs are running in local levels from 'Rana' Regime, in the sector of water supply, hydropower & irrigation and other many organizations lead & managed by water professionals, local people, development planner, economists & government organs are in also function since the political movement of 1990, but till now most of such organizations, their priority sectors, planning & functions are not influenced by multi disciplinary approach. Even no co- ordination is found among the sectorial workers of water resources working in same territory & resource. Due to this season, large human/ non human resource & time could not give expected result. So, with a structural well managed & professional team could able to give more output with in short period of time in the sector of water resources, consuming limited resource/ economy, if multidisciplinary / integrated approach is applied.

Now in world, water issues would bound to be single most significant component in the struggle to sustain the global ecosystem, which if not managed, would breed struggles among the countries and may eventually lead to potential 'water war'. Nepal would not separate from this case, if we do not go to proper manage of water resource; even we have in favorable position of fresh water. Till now we have no any significant governmental/non-governmental mechanism to co- ordinate the different section of water resource (irrigation, hydropower, water supply, sewerage, etc.). In coming days integrated Water Resource Management (IWRM), can be apply as tool of water resource management of Nepal in river basin approach.

River Basin Management (RBM)

The Dublin conference 1992 set the stage for the application of this concept followed by earth summit on environment and development in 1992. The integrated development of 'River Basin' has become important in the institutional set up in required to address the challenges brought by this competition. A river basin is one of the most clearly defined territorial units of hydrology

and ecosystem. It has functional linkage with the socio- economic, political, and natural environment of the basin. Therefore institutional development in a river basin depends on the type of management needed in that particular basin is affected by the stages of basin development, which is measure by water availability, current use, pattern & development of new water use activities and the level of water scarcity. So the function of institution may be differ in different river basin.

Mostert (1998) defined river basin management as context of all activities aimed at better functioning of the river basin; including the water system and land in as far as it affects or is affected by the water system. This definition implies that in most cases land and water resources are managed conjunctively in river basins. Mostert distinguishes six properties of river basin management. They are natural science engineering, social optimization, law, decision, making & ethics.

Box 1: The Dublin- Rio Principle

- *Fresh water is finite and vulnerable resource, essential to sustain life, development and the environment.*
- *Water Development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.*
- *Women play a central part in the provision, management and safe-guarding of water.*
- *Water has an economic value and should be recognized as an economic good.*

River basin management (RBM) in Nepal:

In the context of Nepal, there are four prime river systems drain from north to south, originated from Himalayan range and cut the mountain ranges to from deep river, ultimately falls in Gangas. Saptakoshi, Narayani (Gandaki), Karnali & Mahakali are four prime river system. The other five main river systems, originating from Mahabharat chure range. Kankai, Kamala, Bagmati, West Rapti & Babai are falls in this category. The southern river rising from the Siwalik range have little water in dry season but they cause clash foods during monsoon and carries water induced disasters(flood, inundation, landside etc)the total annul run off of these rivers systems are estimated about 225 billion cubic meter (BCM), under data of certain stations up to 1995. So, while taking about hydrology of Nepal, main nine river systems can be taken as major basins. Among these basins there are numbers of sub basins (catchments) in all river basins.

It is world wide truth that, there is neither possible nor necessary to match the political & hydrological boundary, nationally & internationally. In other words. It is almost all impossible to cover a river catchments basin with in a single political boundary and vice- versa, in case of Nepal, rivers are taken as political boundary, due to so, too, a river basin falls under two or more political divisions. Due to such constraints, real management of water resource regarding to lawful distribution is a difficult task. As per formal commitment of main political parties of Nepal and present scenario of Nepal, country is going to in federal system. But no clarification is declared fill now what will be the parameter(s) of formation of Federal system. It is true that distribution and ownership of natural resources among the federal stake will be a genuine issue. So if hydrological boundary is taken as the boundary of federal state, natural resource (especially water resource) related conflicts will be certainly lowered.

Water resource stakeholder and water professionals should clarify the situation and reality regarding to water resource to political leaders, planners, policymakers, while they restructuring state and going to federal system due to while conflicts issues can be forecast, analyze, and resolve in federal system. During the restructuring of state, if natural/ water resource ownership/ distribution issue is keep in lower profile, than unequal distribution/ ownership will make few states more powerful and rest states become more weak. Ultimately, which led to country in inter state conflict/war.

To minimize this/ such types of conflict, between states (whether country really go or not in federal system), the water resource management mechanism of whole country should make isolated and autonomous body (table 1) of national government formulating river basin structure. The proposed body is only the legislative structure. It is responsible for planning and formulating the policies it self, so to implement the program current executive mechanism (beurocracy) of government should be reformed as IWRM approach in RBO approach. So current formation of government body will be spilt and merged as per new arrangement.

All the current government bodies regarding to sectorial water resources should be filled in this new River basin organization structure. This autonomous body will be responsible for whole integrated water resource management (IWRM) of country. The main sprit of this mechanism will be “All water resource of country is and for all the people go country,” which will reduce the water resource use.

Table2: Frame work of RBO for IWRM

Bottom up approach of proposed National Water Resource autonomous body structure

In above structure, many representatives of all level organization may be same or repeated on two or more political boundaries, which will be main key for conflict resolution, benefit sharing and mutual understanding among states. All the body is autonomous itself started from national level to grass root level users of water resource in each and every discipline. Political and of other interfere should be discouraged as for as possible.

Limitations for River Basin Approach

- IWRM may not be as universally supported as is sometimes claimed in the global water debate.
- The political and hydrological boundaries do not concide each other, political and power sharing conflicts may create.
- This approach covers only the surface water; it does not cover the case of ground water, because the boundaries of surface water and ground water formations (aquifers) need not to relate each other.
- Physical boundary problems also occur where water supply networks or artificial waterways, such as canals, cross form one river basin to another, e.g., Melamchi water supply project for Kathmandu valley drops the water from Koshi basin to Bagmati basin.
- Existing political and administrative units may be affected.

Conclusions:

'Coming war for water' this is common slogan of development workers, planners and leaders. This warning alerts us that we are near the water related war. 'WAR' it self danger, unwanted and intentional man made disaster, so if we want to push it space, we should properly manage the water related issues with in time. Until this moment, we are doing, thinking separately and spatially, so if no sustainable development planners, leaders & water professionals do not think, understand and execute about integrated, water resource management, sustainable water resource development is stars of sky.

Water resource of Nepal, is not only interest of, Nepal, even we do not want, associated with interest of down stream 'Big brother' India. So the water resource management & development is the issue of international interest also. In the context of Nepal, many hydropower projects doing by multinational companies. Many water treaties between Nepal and India are in functioned and Nepal it self go on world trade organization, WTO.

Many of conflicts & civilization constraints are associate with water directly- indirectly. So the water resource management just a topic of debate for professional, issue for leaders for election, it is challenge to government, water professionals and au human & living beings. So, in the context of Nepal, integrated water resource management (IWRM), in river basin organization approach is more suitable, possible & required for sustainable strategy for water resource develop, which will assist in raising the livelihood of people and growing economy of country.

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