Seventh International Seminar
on
"Irrigation in Local Adaptation and Resilience"

11 - 12 April 2017
Kathmandu, Nepal

KEYNOTE SPEECH AND ABSTRACT PAPERS

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Table of Contents

Farmer Managed Irrigation Systems (FMIS) Promotion Trust, Kathmandu, Nepal

Seventh International Seminar on

"Irrigation in Local Adaptation and Resilience"

The context, meaning and impact of adaptation and resilience of irrigation in the local situation have substantial sustainability dimension. It ultimately contributes in global improvement of climate change. The adaptation process and resilience, policy, institutions, technology and interaction with the environment and resources at the local level do affect livelihood of a larger number of agriculture based population. Urbanization, migration pattern, food-water security nexus and political agricultural economy as a whole have influence on irrigation adaptation and resilient response. Irrigation is found in all eco-geographic terrains where human civilization has flourished in general. Without irrigation, enrichment of civilization from agriculture is not possible. Without adaptation and resilience of the irrigation in the local context more so in the scenario of changing climate, a social and economic order cannot be thought of.

Objective of the Seminar:

The objectives of the seminar are to

a) provide a knowledge platform to learn, share and disseminate experience and information on local adaptation and resilience of the irrigation systems
b) understand the social, institutional, economic, financial and technical innovations in resiliently managed adaptation of the irrigation system
c) deliberate on the framework to assess the climate change impact for right innovative adaptation and a dynamic mix of organization and environmental resilience for the evolution of the irrigation system, and
d) make the policy makers, practitioners, researchers and observers of irrigation systems to be adequately informed about the process of adaptation and associated resilience of irrigation community and pursue and push for a learned framework that better serves farmers' irrigation interest and capacity enhancement in the changing climate context.

- **Contexts and Issues relevant to the Seminar:**

Farmers have been adapting, and building resilience to climate change impacts. Recent studies helped understand the climate change variability though a natural process and unavoidable phenomenon are found addressed by indigenous knowledge of the farmers in that area. The traditional and indigenous knowledge could be modified as per the need and help cope with the climatic extremes.

Many transitional countries are highly susceptible to climate change risks. Climate change is expected to intensify in these countries' already pronounced climate variability and frequency of climate extremes such as droughts and floods, steep terrain and heavy rainfall patterns. In extreme events, entire villages have been destroyed or washed away. Impact of these events are felt most at the local level.

Unlike organized FMIS, poor and marginalized people are especially vulnerable to climate variability and change. They generally are the least able to cope with disaster, live in the most at-risk areas and have limited information, knowledge and resources to help reduce their level of risk. The predicted impacts of climate change will intensify existing vulnerabilities, inequalities and exposure to hazards. In the agricultural sector, smallholder farmers if not organized well would face the greatest risk. They tend to own few livelihood assets such as land and livestock, receive a low income, and have a low level of education and limited access to community and government services. They are also likely to be dependent on rain-fed agriculture and occupy land that is prone to floods, drought and landslides. In agrarian societies, GHG emissions are primarily driven by the agricultural sector, which accounts for largest level GHG emissions. The climate-related events have put fragile agricultural ecosystems at risk. The impacts of climate change and related extreme events on agriculture often generate food insecurity, which primarily affects poor and marginalized people, including women and children. Ultimately this has repercussions on the nation's economic growth.

Though FMIS have developed mechanisms to cope with the environmental changes, it is crucial to understand and strengthen their overall institutional adaptive capacity and associated resilience. The identified four key components of adaptive capacity for farmer-managed irrigation systems are social capital, learning, governance, and asset base. Given the multiple drivers of change – especially climate variability, labor migration, and market penetration in rural areas – it is important to move beyond measurement of individual components of adaptive capacity. By measuring and addressing the inter-relations among multiple capacity dimensions and inherent opportunities offered by multiple water use system (MUS), refined understanding of adaptation and associated resilience permit the strengthening of farmer-managed irrigation systems in a range of contexts.

The proceedings of sixth international seminar on "small scale irrigation systems, challenges to sustainable livelihood" has noted good lessons from Nepal FMIS: "What is labeled non-conventional by technocrats and bureaucrats today is already widespread in Nepal, and with the impact of two key drivers, climate change and out-migration, will be part of the mainstream tomorrow." Findings from the field have also reported importance of appropriate irrigation design and infrastructures for adaptable irrigation operation. In the changing context, for example in the Ganges basin, solar power is considered the best suited to harness groundwater for irrigated agriculture. But in view of the global and national links of the changing climate, market, urbanization, labor and social mobility nexuses, gaps in institutions and governance across the adaptation issues and associated resilient responses, farmers' localized efforts at times are rendered unstable and inadequate.

The sub-thematic issues of the seminar may include:

a. National policy, institutions and intervention strategy on climate resilient local adaptation of irrigation

b. Design issues, technologies and quality features of irrigation infrastructures in improving local adaptability and resilience of irrigation

c. Irrigation governance, community and negotiation on water right and mechanisms of resource management and conflict resolution in the changing climate context

d. Financing and capability enhancement for local irrigation adaptation activities and associated resilient responses

e. Effects of urbanization, out-migration, labor and social mobility and local gender balance on irrigation adaptation and resilience

f. Information collection methodology and information sharing for improving adaptation resilience of irrigations.

Four types of paper presentation are expected:

- Keynote speeches
- Research Papers
- Invited Papers
- Individual Country Papers

Farmer Managed Irrigation Systems (FMIS) Promotion Trust, Nepal

Seven International Seminar
on
"Irrigation in Local Adaptation and Resilience"
11 - 12 April 2017

Program Schedule Details

Venue: Hotel Himalaya, Kupondole, Kathmandu, Nepal

Tuesday, April 11, 2017 (29 Chait 2073)		
I. Plenary- Initiation and Honor Ceremony: Skyline Hall		
Time	**Activity and Person/s**	
8.30-9.00 am	Participants' Registration	FMIST staff and FMIST Volunteers (Tea/Coffee)
	Chair Chief Guest Master of Ceremony	Mr. Naveen Mangal Joshi, Chairman, FMIS Promotion Trust Mr. Ramananda Prasad Yadav, Secretary,Ministry of Irrigation (MOI) Ms. Monica Maharjan
9.05	Welcome Speech and Introduction of the Seminar Theme	Mr. Sushil Subedee, Member-secretary, FMIS Promotion Trust
9.15	Book Launching *Medini-Kamala Award* presentation to better performing FMIS 1. Sringeghat Irrigation System, Kapilbastu, (Durga Sen) 2. Newarkulo, Pachathar (Mani K. Pradhan)	Mr. Ramananda Prasad Yadav, Secretary, MOI, Chief Guest and Mr. Lava Raj Bhattarai: Medini-Kamala Trustee
9.25	Announcement of FMIS Promotion Trust's Icons of Honor: 2017 Dr. Upendra Gautam Dr. Md. Abdul Ghani Introduction of Icons of Honor	Dr. Prachanda Pradhan
9.35	Presentation of Honor: *Dosallah Odhayera* (presenting shawl) Presenting Plaque Presenting Bouquet Dr. Upendra Gautam Reading out the Commendation Plaques Dr. Md. Abdul Ghani Reading out the Commendation Plaques	 Mr. Naveen Mangal Joshi Mr. Suman Sijapati Mr. Sushil Subedee Dr. Prachanda Pradhan
9.45	**Keynote Speech:** "For a Wealthy FMIS and AFMIS"	Dr. Upendra Gautam
10.00	**Keynote Speech:** "Irrigation Systems: Sustainability and Resilience in Climate Change Scenario"	Dr. Md. Abdul Ghani
10:15	Remarks by the Chief Guest	Mr. Ramananda Prasad Yadav, Secretary, MOI

10:20	Concluding of the opening session and Vote of Thanks	Mr. Naveen Mangal Joshi
10.25-11.15	**Group Photo and Tea at the Garden**	
Parallel Seminar Sessions		
Parallel Session-1: Skyline Hall		**Parallel Session-2: Rato Baithak Hall**
ICIMOD: Theme: Mapping Climate, Gender and Socio-ecological Challenges		**Theme: Climate Change and Irrigation Management**
Session Coordinator: Mr. Sushil Subedee		**Session Coordinator:** Mr. Suman Sijapati
Sub-session-1		**Sub-session-2**
Chairperson: Dr. Robert Yoder		**Chairperson:** Mr. Sharda Prasad Sharma
Reporter: Young Professional / Student		**Reporter:** Young Professional / Student
Time	**Activity and Person/s**	
11.15-11.45	"Mapping climate, gender and socio-ecological challenges Moderator: Dr. Anjal Prakash (*Detail session plan attached. Please see the last section of this program*)	"Impact of Climate Change on Small and Medium Irrigation Systems in Nepal" Paper presentation by Dr. Umesh Parajuli Floor Discussion
11.45-12.15		"Climatic Trends With Reference to Small Irrigation Management in Nepal" Paper presentation by Dr. Keshav Sharma Floor Discussion
12:15-12.45		"Water Measurement and Implications on Water Availability and Water Distribution and Impact of Climate Change on Irrigation Management: Examples of Sringeghat, Kapilbastu and Julfetar Irrigation Systems, Nawalparasi." Paper presentation by Mr. Rajendra Bir Joshi Floor Discussion
12.45-1.15		Perception on Climate Change and Reality in Small and Medium Irrigation Systems in Nepal" Paper presentation by Mr. Pravakar Pradhan Floor Discussion Concluding Remarks by Sub-Session Chairperson
1:15-2:15	**Lunch**	

<table>
<tr><th colspan="2">Sub-session-3</th><th colspan="2">Sub-session-4</th></tr>
<tr><td colspan="2">Theme: Farmers Perception of Farmers (CMIASP-AF)</td><td colspan="2">MUS: Challenges and Applications</td></tr>
<tr><td colspan="2">Chairperson: Mr. Noore Mohammad Khan, CMIASP-AF</td><td colspan="2">Chairperson: Som Nath Paudel</td></tr>
<tr><td colspan="2">Reporter : Young Professional /Student</td><td colspan="2">Reporter : Young Professional / Student</td></tr>
<tr><td>2:15-2.40</td><td>Newar Kulo, Panchthar
Presentation by
Mr. Mani Kumar Pradhan
WUA Chairman</td><td>2.15-2.45</td><td>"Upscaling MUSat Global Levels"

Paper Presentation by Dr. Barbara Von Koppen.

Floor Discussion</td></tr>
<tr><td>2.40 - 3.05</td><td>Sulitar IS, Chitwan

Presentation by
Mr. Bhoj Bahadur Rana Magar
WUA Chairman</td><td>2.45 -3.15</td><td>Economic Impact of the Multiple Use Water System Approach in Far West Nepal"

Paper Presentation by Dr. Corey O'hara, Dr. Luke Colavito, Dr. Madan Pariyar, Mr. Rabindra Karki

Floor Discussion</td></tr>
<tr><td>3.05 - 3.30</td><td>Atrauliputtar IS, Tanahu

Presentation by
Mr. Ramji Aryal
WUA Chairman</td><td>3.15 -3.45</td><td>"Multiple Perceptions on Multiple-use Water Systems (MUS). A Reflection on Potential and Constraints for Institutionalising MUS in Nepal"

Paper Presentation by Dr. Floriane Clement & Ms. Farah Ahmed

Floor Discussion</td></tr>
<tr><td>3.30 - 3.50</td><td>Hadiya Dama Paini, Jhapa

Presentation by;
Mr. Uday Narayan Dhungana
WUA Chairman</td><td rowspan="2">3.45-4.15</td><td rowspan="2">"Local Financing for Functionality Sustainability and Service Level Improvement – An Opportunity for MUS?"

Paper Presentation by Ms. Sanna-Leena Rautanen

Floor Discussion

Concluding Remarks by Sub-session Chairperson</td></tr>
<tr><td>3.50 - 4.15</td><td>Chakhola IS, Kavre

Presentation by
Mr. Gobinda Prasad Nepal
WUA Vice - Chairman

Floor Discussion

Concluding Remarks by Sub-Session Chairperson</td></tr>
<tr><td>4.15</td><td colspan="3">Tea at the Pre-function Area</td></tr>
</table>

Wednesday, April 12, 2017 (30 Chait 2073)		
Parallel Sessions		
Parallel Session-1: Climate Change and Methods of Adaptation and Approaches for Increasing Resilience		**Parallel Session-2, Water- Energy Benefit Sharing**
Skyline Hall		**Rato Baithak Hall**
Sub-session-5		**Sub-session-6**
Chairperson: Mr. Madhav Belbase, Joint Secretary, WECS.		**Chairperson:** Mr. Surya Nath Upadhaya, JVS
Reporter : Young Professional / Student		**Reporter:** Young Professional / Student
9.00-9:30	"Guidelines for Water Management of Highland Agriculture in Mae Sa Noi Village, Pongyang Sub-district, Maerim District, Chiang Mai Province " Paper presentation by Dr. Nathitakarn Pinthukas Floor Discussion	"Climate Resilience and Performance of Chapakot Irrigation System" Paper presentation by Dr. Khem Raj Sharma & Ms. Manju Adhikari Floor Discussion
9:30-10:00	"Water scantiness in Andhikhola River Basin: Farmers' Adaptation Strategies" Paper presentation by Ms. Shubhechchha Sharma Floor Discussion	"Integrating Irrigation Practices in Improved Water Mill Areas for Sustainable Livelihood" Paper presentation by. Mr. Mahendra Prasad Chudal Floor Discussion
10.00-10.30	"Integrating Resilience Concept in the Face of Changing Climate: Learning from Some NRM Projects in Nepal" Paper presentation by Dr. Ram Chandra Khanal Floor Discussion	"Solar Pumped Drip Irrigation." Paper Presentation by Dr. Robert Yoder Floor Discussion
10.30-11.00	"Barriers Affecting Human Living Under Consequence of Climate Change in Chiang Mai, Northern Thailand" Paper presentation by Juthathip Chalermphol, Nathitakarn Pinthukas, RujSirisunyaluck Floor Discussion Concluding Remarks by Sub-Session Chairperson	"Addressing Local Water Conflicts through Multiple Use Water Systems (MUS): A Learning from Calcnr Program at Dhikurpokhari, Kaski, Nepal " Paper presentation by Dr. Madan Pariyar, Mr. Vijaya Sthapitand Mr. Rakesh Kothari Floor Discussion Concluding Remarks by Sub-Session Chairperson
11.00-11.30	**Tea Break at the Pre-function Area**	
Sub-session – 7		**Sub-session – 8**
Past and Future of Irrigation Systems in the Context of Climate Change		**Theme: National Policy, Institution and Intervention Strategy**
Chairperson: Mr. Masoom Hamdard, Advisor, Ministry of Irrigation, Afghanisthan		**Chairperson:** Mr. Basu Dev Lohani, DDG, DOI
Reporter : Young Professional / Student		**Reporter :** Young Professional / Student
11.30-12.00	Multiple WaterUse Services: Economic Cost /	Water, Food Security and Asian Transition: A New

	Benefit Analysis under Village Water Resources Management Project. Paper presentation by Mr. Pallab Raj Nepal and Sushil Subedi Floor Discussion	Perspective within the Face of Climate Change Paper Presentation by Dr. Puspa Khanal, FAO Regional Office Floor discussion
12.00-12.30	"Maktumba FMIS Resilience: The Last 25 years and the Next "We Never had It So Good, but Now Our Youth is Leaving" Paper presentation by Dr. Arend Van Riessen Floor Discussion	Use of Remote Sensing & Geospatial Technologies in Agriculture Paper Presentation by Mr. Asit Srivastava Floor Discussion
12.30-1.00	"Design Issues and Technologies of Hilly Irrigation Infrastructures in view of Climate Change: Case Study of Kalleritar Irrigation System" Paper presentation by Mr. Ashish Khanal Floor Discussion	"Impact of Earthquake on Water Resources in Selected Earthquake Hit Areas" Paper presentation by Mr. Som Nath Poudel and Ms. Anju Air, JVS Floor Discussion
1.00-1.30	"Addressing Climate Change Impacts on Farmers Managed Irrigation System Through Adaptation Measures" Paper presentation by Mr. Shree Bhagavan Thakur and Batu Krishna Uprety Floor Discussion Concluding Remarks by Sub-Session Chairperson	"People, Plan and Participative Municipal Planning of Natural Resources Management in Nepal: An Illusion" Paper presentation by Dr. Narendra Raj Paudel and Ms. Srijana Pahari Floor Discussion Concluding Remarks by Sub-Session Chairperson
1.30-2.30	**Lunch**	
Plenary Session:		
Theme: Meeting the Challenges of Climate Change: What Next?		
Chairperson: Dr. Keshav Prasad Sharma		
Coordinator/Rapporteur: Dr. Khem Raj Sharma, Program Director, NEC		
2:30-4:00	Panel: Panelist.1. Mr. Rajendra Adhikari, DG, DOI Panelist.2. Dr. Sugden Fraser, Head, IWMI-Nepal Panalist.3. Mr. Madhav Belbase, Joint Secretary, WECS Panelist.4. Dr. Ram Chandra Khanal, CDKN Panelist.5. Dr. Puspa Khanal, FAO, Regional Office. Panelist.6. Mr.Dipak Gyawali, Water Conservation Foundation. Floor Discussion Chairman's comment Vote of Thanks and Closing of the Seminar	
4:00	**Tea at the Pre-function Area**	

Program of 1st Session, Skyline Hall
Farmer Managed Irrigation Systems (FMIS) at the Crossroads
Mapping climate, gender and socio-ecological challenges
April 11, 2017

11:15 am to 1:15 pm, Hotel Himalaya, Kupondol, Kathmandu

Nepal is well known for its tradition of farmer managed irrigation systems (FMIS). In this system, farmers are collectively engaged in irrigated agricultural development as an enterprise. Numerous FMIS in Nepal ranging from high lands to mid hills and tarai region, provides irrigation services to about 70 percent of the country's total irrigated area of little over of 1.2 million ha. However, due to recent changes in the socio-ecological systems, FMIS has come under increased pressure. Some of the systems are defunct while others are facing problems in operation and maintenance. There is an increased groundwater usage in the command area in tarai region and farmers are experiencing reduced flow of water systems. Due to increased migration in hills and tarai, feminization of agricultural labour has been reported. Understanding the recent challenges, this session is organized to understand the climatic, gender and socio-ecological challenges faced by FMIS. The session will map the socio-economic, gendered, environmental, institutional and governance challenges faced by FMIS today.

Programme Schedule

Chair: Dr. Robert Yoder, Former Head of Country Program, IIMI-Nepal

Moderator: Dr. Anjal Prakash, ICIMOD, Kathmandu

11:15 – 11:20 – Opening remarks by Dr. Robert Yoder

11:20 – 11:30 – Masculinity in Irrigation: Imperatives for gender transformative decentralized water governance – Dr. Anjal Prakash, ICIMOD

11:30 – 11:45 – Achieving gender water equity in the face of changing climate context: Lessons from local water planning practices in Nepal - Pranita B Udas, ICIMOD

11: 45 – 12:00 - Gender and Water Governance:Women's Role In Irrigation Management and Development – Dr. Dilli R Prasai, Tribhuvan University, Biratnagar, Nepal

12:00 – 12:15 - Understanding the irrigation governance and mechanisms of water resource management for improved adaptive capacity - Krity Shrestha, Practical Action, Nepal

Panel Discussions: 12:15 – 1:15

Mapping Climate, Gender and Socio-ecological Challenges in FMIS

Moderator; Dr. Anjal Prakash, Programme Coordinator – HI-AWARE, ICIMOD, Nepal

Panelists:
Dr. Van Koppen, Principal Researcher – Poverty, Gender and Water, International Water Management Institute
Dr. Chanda G Goodrich, Senior Gender Specialist, ICIMOD, Nepal
Dr. Floriane Clement, Theme Leader, Gender and Poverty, International Water Management Institute, Nepal
Mr. Basudev Lohani, Deputy Director General, Department of Irrigation, Government of Nepal

FOR A WEALTHY FMIS AND AFMIS

UPENDRA GAUTAM[1]

In terms of managing and organizing the irrigation resources, FMIS in Nepal give us the best learning. Dr. Prachanda Pradhan, my university college teacher, the patron of FMIS promotion Trust, pioneered research work in this field. The Trust has recognized FMIS as a national heritage. They have been so because of their culture of social capital, autonomy, self-governance and their contribution to national food security. In particular, the conceptualization and formation of Trust in 1997-1998 at the CMS symbolized our professional as well as personal tribute to FMIS of Nepal.

In contemporary times, FMIS are also facing several challenges of Climate Change, outmigration and urbanization. We will not be doing justice to FMIS if we merely glorify them. They need concomitant supportive measures to develop their enough adaptive capability to handle these challenges. On the other hand, an AMIS lives in two cultures- a) the central political-bureaucratic and b) the local farming community. It is not self-managing and autonomous and depends elsewhere for important decisions. An AMIS is mostly perceived as less productive, taking issues with each other because of the two work cultures where stakeholders are put in a situation of getting spoiled.

Let us take the traditional discourse on so-called FMIS versus AMIS to another plane. Whether FMIS or AMIS, the ultimate person we need to benefit is the farmer in a way that he/she becomes increasingly capable and competitive in his or her times. But why a farmer in our scheme of things should generally be projected less capable and less competitive?

In mid 1990s, I had to organize and conduct a training program for senior engineers and social science staff in Water and Land Management Institute in Anand, Gujarat. I was required to use the outcome of the training in developing a farmer-friendly training course. Engineers and staff came all over from India. They were also taken to field visit of Mohini Cooperative in Valsad district of Kakrapar Irrigation scheme in Tapi river basin and had direct interaction with the farmers.

I did note that participant engineers coming from Bihar and UP refused to accept that they actually interacted with farmers. For them farmers could not be rich and articulate. They felt the interaction with farmers was stage managed and fake. They just could not recognize the fact that the farmers there were rich because they were collectively supplying sugarcane to the mills and they were also associated with the mills as shareholders. The wastages from the sugar mills which worked as good fertilizer were channeled to the agricultural farms had also established another mutually beneficial linkage between industry and agriculture.

We all are aware that farming community supports the national economy significantly and is important for the agri-economic diversity and local wellbeing. It critically contributes to the nation's food security. Society's law and order is much assured when agricultural activities in the farms intensify and proceed normally. Irrigation adds value to farmers' efforts in the field and supports the farming to be more productive. Yet irrigated agricultural activities are not perceived as enterprising. Is a farmer not an entrepreneur so he/she cannot be rich?

[1] Founding chair, Advisor FMIS Promotion Trust.

A typical individual farmer in our context is not rich. Yet at a field channel level, he or she has some land or some land operation right, possesses some water, has some labor at his/her disposal. He or she may also have some livestock. At the field channel level the existing water user association or farmer organization could be a catalyst in mobilizing and pooling individual farmer's resources under sound principle and mechanism of a cooperative enterprise. Farmer holds a direct and critical stake in the crop productivity and the price he or she fetches for his or her produce. His or her stake is much increased in the context of climate change and its impact on irrigated agricultural land, outmigration that brings labor crisis to agriculture and rapid pace of urbanization which so far has been viewed as an encroacher of farmer's land and anti-agriculture. We need to legalize a cooperative entrepreneurial set up in irrigated agriculture which a) is resilient in its responses to the local ecological and economic needs, b) enforces accountability transparently according to the recognized procedure, and c) is able to adjust and allocate cost and benefits after its every performance.

Now let us turn to Xinjiang region of China. It was middle of 2002. We were conducting interaction with the farmers in the Aksu prefecture in the Tarim river basin in preparation of forming WUA. This is the river that feeds surface irrigation schemes in the desert region. In 2001, China had officially become member of the World Trade Organization. This was big news in China as it was institutionally opening up and several matching reforms had to follow.

A farmer had a question for us: "Tell me as China has become a member of WTO, how we are going to make our product competitive?" I had never come across this type of question from a farmer before and that too from a farmer in Xinjiang. I tried to answer him as I had organizational tool of WUA with me, which, as I explained, would give a bottom-up scale and efficiency to the agricultural and irrigation performance.

I could see that it was not the asking farmer but an official listening to my response from the side line was visibly annoyed after hearing what I said. Later this official wanted to inform me that in the name of agricultural scale and efficiency now China could not go back to the commune model of agricultural organization. Clearly he was trying to be careful as any implications of commune would not have gone well with China's image of recent accession to WTO.

I explained to him that it was not Commune I was talking about. What I was talking about was distinctively different from a commune. Whereas a commune was imposed upon the farmers clearly with an ideological objective of control on farmer and production resources, a WUA/farmer organization was based on principles of i) delineated hydrologic boundary, ii) direct representation of the farmers, iii) empowerment of farming community, iv) self-governing interface with local government and related line agencies, and v) cost and benefit sharing. The WUA/farmer organization model could be reformed according to the business principles of a multi-function cooperative enterprise. As scale and efficiency matter, and indigenous innovations triggered by right institutional set up go a long way in harnessing farmers' capability and his or her product's competitiveness, commercialization of WUA/farmer organization offered a way out.

Innovation is going to be the element at the heart of capability and competitiveness building. In the context of climate change, a Chinese experience informs us a lot. What was done there sounds simple common sense: Seeds from the historically warm ecological region were used in cultivation in a region with increasing temperature. The local government and farmers' WUAs became the cooperative partners in this seed transfer and adaptation process. This experience showed that even in the context of climate change, strong and relevant local institutions become the effective vehicle for inter-regional transfer and use of seeds, the most important component for improved agricultural productivity. On top of this, this solution did not entail as much time and cost that breeding of new seed variety might have taken.

The Gujarat and Xinjiang cases have lessons for Nepal. An enterprising model of FMIS will take them beyond autonomy, and make them as capable and competitive enough as required. Such model will make AMIS on the one hand a dynamic partnership between public irrigation agency, the water and irrigation technology provider, and WUA, the water user, commercially viable. In this way an AMIS will effectively get transferred into an AFMIS ((agency-farmer managed irrigations system). In a specified timeframe, each AMIS will have a significant area under FMIS WUA that not only cherish autonomy within their jurisdiction but also increases effectiveness of shared cost and impact of improved benefits. This is a way we can jointly address the needs of both FMIS and AMIS utilizing their comparative advantage.

To take irrigated agriculture towards steady commercialization, some overdue policy actions are to be taken. In view of the huge investment made in public irrigation sector, donor and government recommendations so far have been centered on (i) expansion of irrigated area, (ii) irrigation management transfer and (iii) agriculture extension. During the life of the projects, all these measures contributed temporarily. In FMIS, formation of WUA was targeted more for meeting the financing covenant than graduating them to a higher wealth status.

A sustainable development approach asks for institutional solutions, whereby public irrigation systems are: first, localized to establish system's operational autonomy with ownership and governance; second, treated as a rich resource-base with water, land and labor; and third, recognized as multi-function cooperative enterprise of local stakeholders by law with authorities to enter into joint actions with relevant public and private organizations for promoting irrigation technology, commercialization and environmental quality of irrigated agriculture. For FMIS, above mentioned second and third institutional development solutions will be equally relevant.

While teaching history of ancient administrative thoughts to students of master's of public administration in Tribhuvan University, Confucius (551 BC – 479 BC) had always struck me by his prerequisites to run a government. The most important prerequisite identified was the people’s confidence in their rulers followed by sufficiency of food.

Kautilya (321 BC to 290 BC), the sage statesman of Magadh Desh, seems to have learned from Confucius (551 BC – 479 BC), when he said: "There is enemy equal to hunger. Poverty is death while living. There is nothing uneatable for a hungry one. The poor one is despised (hated) by his wife. Learning is wealth for the poor."

The ultimate question is: Can we still afford to refuse learning and reform FMIS and AMIS for viable generation and fair distribution of wealth?

IRRIGATION SYSTEMS: SUSTAINABILITY AND RESILIENCE IN CLIMATE CHANGE SCENARIO[1]

MD. ABDUL GHANI[2]

ABSTRACT

Annual rainfall distribution patterns in countries like Bangladesh can not plan for year-round crop production without irrigation. Due to climate change, potential yield of most crops can not be achieved without irrigation. The country has irrigated area of 66% against its potential of 76%. About 78% of the irrigated area is using groundwater and the remaining 22% are covered with surface water. Major public irrigation systems are covering about 10% of total irrigation area. It has been observed that Bangladesh Water Development Board (BWDB) and Local Government Engineering Department (LGED) initiate organizing beneficiaries after completion of irrigation and flood control drainage and irrigation (FCDI) projects. This approach takes few more years in local adaptation of the projects to accrue benefits from the investments as well as contributes to lack of beneficiary participation in management, operation and maintenance (MOM) of irrigation and FCDI systems.

Irrigation systems developed in Bangladesh under public and private sectors are operating below 50% of efficiency levels. Management, operation and maintenance levels especially for the public irrigation systems are poor. About 78% of irrigated area is covered with groundwater based shallow and deep tubewells, which are under private or farmers management. Resilience of groundwater based irrigation systems are mostly related to annual recharge, which is satisfactory. However, resilience of public irrigation systems depends on annual o&m and availability of surface water status of both are below satisfactory level need improvement.

Surface water based low lift pump irrigation systems and larger public irrigations systems are planned to involve water users and ensure beneficiary participation, which has hardly happened. In most irrigation systems, water availability is problematic due to erratic availability of water in the rivers. However, water availability situation in the sub-continent can be resolved to meet dry season needs for irrigation and other purposes with effective cooperation among the nations.

Climate change will result to sea-level rise, increase in crop water requirement, increase in green house gas emission and increase salinity in coastal area. These in turn will make water environment more complex in Bangladesh and affect irrigation systems by making them more costly, unsustainable and problematic to resilience.

There are discussions and talks about participatory irrigation system or water management in Bangladesh since early 1970s. In real sense there have not been any significant improvements in water management and efficient use of water resources. It is believed that there have been changes of terminology but not much in utilization level of water resources and its management to date.

Key words: Climate, Irrigation, Management, Resilience, System, Sustainability, Water.

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[1] Keynote paper to be presented in the 7th International Seminar of Farmer Managed Irrigation Systems Promotion Trust on "Irrigations in Local Adaptation and Resilience" jointly organized with Department of Irrigation (DOI) and International Center for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal during April 11-12, 2017

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INTRODUCTION

Year-round water availability situation in most countries of the world demands creating irrigation facilities for increasing crop production. In most part of South-East Asia and especially in the sub-continent annual rainfall pattern is skewed and about 90% of the annual rainfall occurs in the rainy season or monsoon, which is during June to September. Onrush of river flows are also very high during these months and cause flooding in the countries of the region. Therefore, in most part of the sub-continent, flood control, drainage and irrigation (FCDI) is more important than irrigation or flood control alone for annual crop production and safe harvest. Global climate change has made water environment more complex by influencing on water availability and water use parameters. The changes are affecting water availability both in terms of quality and quantity for crop production and even human consumption. Therefore, water management has become more important and challenging to mitigate consequences of climate change, sustainability of irrigation and FCDI infrastructures and resilience of irrigation systems.

Government organizations cannot meet the challenges of operation and management (O&M) of irrigation (I), flood control and drainage (FCD) and FCDI projects without active participation of water users and water management organizations (WMOs). However, effective participation of WMOs can not be ensured unless project beneficiaries are convinced about importance of these projects in improving their livelihood. The WMOs may not like to contribute to O&M of irrigation and FCDI projects unless they are involved in management of the systems. In real sense, public-private, government-user and stakeholders participation in O&M of FCD and FCDI systems in most countries are either limited on writings or at very early stage of implementation. I understand this arrangement is at satisfactory level due to contribution of FMIS in Nepal but in Bangladesh it is limited in popular talks.

In this keynote paper, I will address importance of water and infrastructure management issues in FCDI projects with examples of Bangladesh and live it to distinguished participants of the seminar to compare with conditions they are encountering in respective home countries. Bangladesh deals with too much and too little water environment over the year. Excess water causes flooding every year between June to September, however, significant changes of the situation are observed in recent years. Extent of water availability status in Bangladesh may be felt from the following facts;

Bangladesh receives annually about 7.5 meters of water, 5.5 meters from surface flow and 2 meters from rainfall. About 90% of the huge water volume is available during June to September each year and remaining 10% is received during October to May. Therefore, water environment forces Bangladesh for irrigated agriculture supported by flood control measures and provision of drainage facilities. With water potential of the country, about 76% of the cultivable area can be irrigated of which about 66% are presently under irrigation. Due to fluctuation in availability and lack of control over surface water, about 78% of the irrigated area use groundwater.

Due to water shortage, crop production during October to May is not possible without irrigation. The National Water Policy acknowledges that surface water availability is unreliable and Bangladesh as the lower riparian has limited control over the rivers entering into its borders (Figure 1). Therefore, the country will have to depend mostly on groundwater for its agricultural production and household water supply. In most part of the country, whatever volume of water is withdrawn during dry season is almost fully recharged during the following wet season.

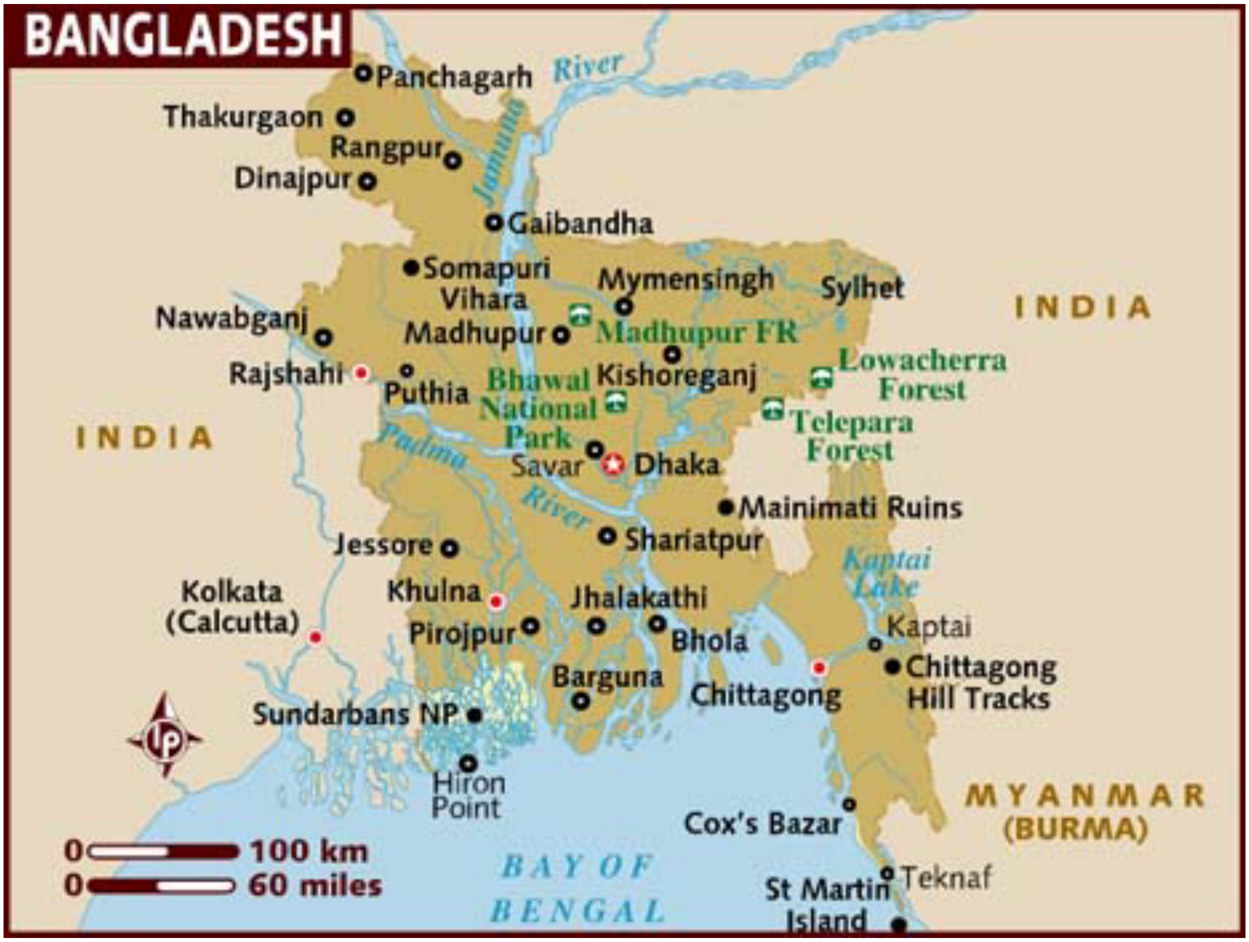

Figure 1: Bangladesh Map with Neighboring Countries, Bay of Bengal, Major Rivers and Forests.

The unfortunate scenario is that during dry season, (i) groundwater level goes down in many places beyond suction limit (>8m), (ii) arsenic contamination causes quality deterioration and crosses safe limit (>0.05 ppm), (iii) coastal salinity affects about 25% people of the country living in coastal areas, and (iv) surface water sources especially smaller rivers, and low lying areas become dry.

Bangladesh is facing adverse consequences of global climate change, which is further aggravating the above factors, though Bangladesh is a very insignificant contributor to the causes for global climate change. The probable impacts of climate change based on some common indicators are: (a) increased temperature, (b) increased evaporation, (c) lower dry season rainfall, (d) increased soil salinity, (e) higher monsoon rainfall, (f) increased intensity of storms including cyclones, and (g) increased sea level rise.

The country is irrigating about 5.5 million ha (Mha), that is 66% of its cultivable land against irrigation potential of 76% with ground and surface water irrigation systems, of which about 78% is irrigated with groundwater (MOA, 2015) (Table 1). Moreover, the country will have to provide adequate water for household uses during dry season mostly using groundwater. Arsenic contamination of groundwater, salinity increase in coastal water due to reduced river flow in dry season, emission of green house gases (GHG) from irrigated land have added new dimensions due to climate change. Emissions of GHG from agriculture is comparatively small but it directly releases into the atmosphere a significant amount of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and requires actions to minimize their affects.

Water conservation, especially in smaller rivers, canals, and low-lying areas (beels) can improve water availability in dry season and ensure water security for year-round use for agriculture, household and other purposes. It will also contribute to resilience of irrigation systems especially groundwater based systems through continued groundwater recharge. Therefore, conjunctive use of available water resources needs to be extended to face challenges of improved irrigation management and to mitigate challenges of climate change in Bangladesh.

Importance of water management in Bangladesh

Bangladesh is required to increase crop production per unit of land, unit of water and unit of time to feed increasing population and to match with very low land-population ratio. It is known that population density of the country is very high (1077/square kilometer) and cultivable land is decreasing annually by about one percent (1%) and population is increasing by 1.4%. The situation over the coming decades is illustrated in Table 2. To face the challenges of increasing food requirement, the country will have to produce about 35 million metric tons (MT) per year for consumption including seeds (about 10% of produce) and 2 MT to meet emergency, which is about 6.5 tons/ha. This is not possible without achieving potential yields of most crops under farmers' management with irrigation. Sustainable and economic return of crop production is not possible without improved water management of irrigation systems. We, irrigation professionals understand that cropping intensity of 250 to 300% (against present national average of 192%) and irrigation efficiency of about 70% will be required for years to come to support increasing population. Higher level of cropping intensity and irrigation efficiency will not be possible unless resilience of irrigation systems and continued quality improvement and management of land and water resources are ensured.

Annual crop production with irrigation

Bangladesh has created facilities for 5.5 Mha of irrigated and 5.89 Mha of flood control, drainage and irrigation (FCDI) area. Water potential permits irrigation development up to 6.55 Mha by 2025 and 7.45 Mha to the maximum (WARPO, 2000). Therefore, about 6 Mha may easily be planned for year-round crop production through effective use of FCDI facilities. About 10 tons/ha of grain can be harvested in the FCDI area per year adopting available technology. Therefore, the country can produce 60 million tons food grain (paddy + other grains + pulses) from the FCDI area, which may be about 45 million tons of net grain production (rice + other grains). This production target can be achieved adopting available research and management technology through integrated land and water management and adopting agricultural mechanization. Remaining about 2 million hectare even under traditional cultivation (which is not practical in the present context and improved cultivation may be practiced) will make the country surplus in food production. However, it will require coordinated efforts for improved water management, use of mechanical power in agriculture, post harvest technology, processing and improved storage for favourable returns to the farmers.

Rice and wheat are the major irrigated crops in Bangladesh. To most people in Bangladesh, irrigated crops mean irrigated rice. It makes sense as, rice covers about 77% of the total cropped area and it constitutes about 92% of total food grains. Furthermore, rice provides about 75% of the calorie and 55% of protein in the average daily diet of people of Bangladesh. To most Bangladeshis, ‘Rice is Life’ (Bhuiyan, 2004). Rice production needs adequate supply and management of water for optimum production. Therefore, increased production per unit of land and water is essential. For sustainable food and nutrition supply for the country, integrated land and water use and diversified agricultural production is essential.

WATER AVAILABILITY AND MANAGEMENT

It has been observed over several years that both tubewells using groundwater and large-scale canal irrigation systems in Bangladesh are operating at less than 50% of their efficiency level. All the systems, shallow and deep tubewells, low lift pumps and canal irrigations, irrigated about 5.5 million ha during 2014-15 irrigation season (Table 3). It can be observed from Table 3 that over the last 10 years, there was annual increase in irrigated area in nine out of ten years except only in 2005-06. It can be observed from Table 4 that in 2015, shallow tubewells were operated at about 42% of their rated capacity and irrigated about 2.08 ha against potential of 5 ha. Deep tubewells were operated at 66% of rated capacity and covered on an average 24.03 ha against potential capacity of 40 ha. Low lift pumps were operated at 24% of rated capacity and irrigated 6.62 ha against their potential area coverage of 28 ha.

Experiences indicate that over all irrigation efficiency levels of tubewells and canal irrigation systems can easily be increased to 75% and 70% respectively (it was proved it in Ganges - Kobadak and North Bangladesh Tubewell projects in 1980s). That means another 25% area can be brought under irrigation with increasing efficiency of the existing systems. Therefore, irrigated area of Bangladesh could be about 7 million ha with irrigation facilities operated during 2014-15. Thereby performance improvement of existing irrigation systems can be one of the ways of making the systems cost effective and sustainable.

Soil Moisture Management: Selected cereals, peas, pulses, oil seeds and vegetables can be grown with soil moisture management after harvesting Aman (Kharif – II) rice. Farmers used to practice it as irrigation was seldom provided to these crops. However, with improved price structure and demand, these crops are also irrigated for obtaining higher yield (research findings of NARS confirmed it). Experimental results show that significant quantity (70%) of water requirement for land preparation for rice cultivation can be saved by adopting dry land preparation with optimum soil moisture (closer to field capacity) and flooding rice plots before final pass for land preparation and transplant seedlings. This will save water for land preparation compared to traditional way.

FCDI Facilities: It has been highlighted that FCDI facilities are not performing efficiently. Impact analysis study in 10 FCDI sub-projects indicates that even underperforming projects contributed significantly in increased income, poverty reduction, and better production and living environment. During pre-project period, people of the study area were not able to have three meals daily, whereas after the project, people of the area take adequate food of better quality. Completed projects assisted in reducing poverty through irrigation development, protecting project area from flood and improving communication and contributing to economic development. It also assisted to achieve improved quality of life and life style, increased attendance to schools, increased attendance to health clinics and increased job opportunities (READ, 2008).

Change Water Use Pattern Especially for Rice Cultivation: In Bangladesh, irrigated agriculture means rice cultivation. Diversification of crops under irrigated conditions may make agriculture more profitable and may also reduce pressure on irrigation facilities. Wheat and other non-rice crops require much less irrigation water compared to rice irrigation and are becoming popular. But market variability of price for other crops still discourages cultivation of non-rice crops. Marketing system development for non-rice crops will require administrative supports from the government for facilitating market chain development for domestic and export markets. Irrigation management for rice cultivation should be revisited as alternate wetting and drying can save about 25% of irrigation requirement, which may bring about 25% additional areas under cultivation without significant yield reduction with same amount of water delivery against traditional irrigation (continuous standing water). This will make irrigation systems cost effective.

Conjunctive Use of Water: Bangladesh has 30 Agro-Ecological Regions (UNDP & FAO, 1988) of which 76% has adequate groundwater and 33% has adequate surface water for irrigation development. Therefore, irrigation or water resources development of the country should be different for different agro-ecological regions. The national development plan should be to maximize utilization of rain, surface and ground water through conjunctive use of these resources. Comprehensive studies should be undertaken at upazila level involving stakeholders, government and non-government organizations (NGOs) working in agriculture. Local level production plan for each upazila, considering information on land and water resources should be development and implemented. An exploratory survey revealed that there is wide variation in irrigated area coverage even within agro-ecological area. If appropriate professionals are provided opportunities, with stakeholder participation can narrow the gaps in irrigation achievement and make agriculture cost effective. It is assumed that this is similar to one of the priority issues considered by farmer managed irrigation systems (FMIS) approach in Nepal.

Surface Water Augmentation: Rain water and part of surface flow during later part of monsoon can be stored in low-lying area, canals and ponds for supplemental irrigation of rice crops. There are opportunities to use pond water for supplemental irrigation to stabilize yield of Aman crop and for dry season irrigation. Observations have also been made that with one ha of pond about 10 hectare lands can be brought under supplemental irrigation for rice. The same pond can also be used for irrigating about 10 hectare of dry season non-rice crops. Excavation of ponds and re-excavation of existing canals will increase storage capacity for subsequent use of water for irrigating the second crop. New ponds and re-excavated canals can also be used for fish cultivation (personal communication with fisheries experts). Fish cultivation alone in the ponds and re-excavated canals will be cost effective.

Bangladesh has river area of 12,790 square km of which about 1,890 square km (15%) have width between 25 to 100 meters. They can be converted to temporary water reservoirs during November to May with suitable water conservation structures for dry season irrigation. Water conservation in irrigation and drainage canals during the lean period will also provide opportunities for storing water over additional area of about 192,000 ha (Ghani, 2010).

Community based fisheries management system can be introduced in the seasonal water reservoirs following “Common Property Resource Management Procedure” of the country. Fisheries experts confirmed that these seasonal ponds could be brought under profitable fish cultivation program through stakeholder participation and on an average, 2.0 ton fish can be harvested per hectare of water body. Moreover, water stored in the dry season will be a continuous source for groundwater recharge, which subsequently can be used for irrigation using deep and shallow tubewells without severe lowering of groundwater table. Water conservation in rivers and canals will also contribute to afforestation program along the banks and irrigation development using low lift pumps for the lands adjacent to water bodies. This will also facilitate availability of drinking water and bathing place for cattle. Success of this approach in one river may be replicated in other area of the country, which will contribute to its overall development. This approach will also contribute to better natural and production environments.

Ganges Barrage: Government of Bangladesh has completed feasibility study and design of Ganges barrage project and intents to construct barrage as soon as possible. Completion of the barrage will benefit about 4.6 Mha, which is known as Ganges Dependent Area (GDA). Twenty six districts (partial or full) will be benefited from the barrage. The distribution network channels would carry fresh water from the Ganges to cater needs of: irrigation, pushback salinity front, internal navigation, open water fisheries and maintenance of ecological balance in the service area. GOB may advise agriculture extension service providers to plan development initiatives to achieve benefits from the costly investment. Experiences showed that BWDB and LGED engineers initiate organizing beneficiaries after completion of development projects, which takes few more years to accrue benefits from the investments. Agricultural engineers, if entrusted can play effective role in delivering potential benefits of the project from as soon as it starts providing irrigation water.

Trans-boundary Issues: It is an established fact that water availability situation in the sub-continent can be resolved to meet dry season needs for irrigation and other purposes with effective cooperation among the nations. Flood problem during wet season can also be minimized to great extent through water conservation especially in the Himalaya mountain area. This will also create ample opportunity for production of hydro-electricity. This is very important for Bangladesh as the country is the worst sufferer of existing unfavouravle water environment. Let us hope for better understanding among our political leaders for their contribution to best use of water resources of the region.

Climate change: Climate change may result to sea-level rise of 4.5 to 23 cm in 2025 and 6.5 to 44 cm by 2050 (Bangladesh Climate Change Strategy and Action Plan 2008). It may also influence to increase in crop water requirement by 25% by 2025. Rainfall in peak monsoon may be about 28.6% higher by 2050. This may increase flood problem and drainage requirements. Extent of drought will also be higher. These are water management related issues to be affected more by climate change. The community should be equipped to face all the adverse situations and save the nation through appropriate adaptation to the changes and mitigation of anticipated problems.

PROSPECTS AND PROBLEMS

Recently, much concern is being expressed about need for improving performance of irrigation systems and their sustainability. However, it is not new as irrigation systems are operated with low efficiency since beginning of irrigation in Bangladesh. Over the years, terminologies changed from Thana irrigation program (TIP) in early 1960s to water management during early 1970s, to on-farm water management (during late 1970s and 1980s), to improved water management (during early 1990s), to participatory water management (since late 1990s) and to the recent integrated water resources management (IWRM). In real sense there have not been any significant improvements in water management and efficient use of water resources. It is believed that there have been changes of terminology but not much in utilization level of water resources and its management since early sixties of last century to date.

Water Management: Irrigation system management and more specifically water management has different meanings to different people. Water is often considered to be free commodity; therefore, its management also varies. To me water management defined by Alvin Bishop is very relevant to our subject of discussion and he defined it as “Water management is a combination of science and art that requires application of knowledge of water, soil, climate, crops, and their interactions together with inputs and management for agricultural production”. Let us ask ourselves, can a single discipline oriented professional handle all the knowledge required for water management.

As professionals of this field let us ask ourselves, are we using our water resources and doing water management in our countries that meets the criteria set in the above definition? Probably not! We could achieve a lot through improved water management by achieving the development potentials. Some of the improvement potentials could be achieved without additional investment at least for infrastructure development.

Infrastructure Development: For protecting lives and properties of the people, FCDI facilities are essential. During infrastructure development for providing FCDI facilities, construction of embankments and irrigation and drainage canals are required. These infrastructures are mostly used for saving lives and properties and creating favorable environment for increasing agricultural production. Multiple uses of these facilities for afforestation and fish cultivation in addition to their primary uses will make irrigation systems more cost effective.

How the situation can be improved?

Irrigation personnel should be trained to use FCDI facilities and associated infrastructures for their best use with active participation of the stakeholders/beneficiaries. Participatory management and more specifically participatory water management in water sector projects are widely discussed now -a - days. Under present condition, government agencies are still the main player and beneficiaries are consulted for their opinion and expected assigned roles by the implementing agency or agencies. To be more specific, so far one of the agencies, which has been assigned responsibility of project implementation and operating funding arrangement for the development works become “captain” in the implementation team. Beneficiaries are expected to be good listeners and to follow directions of the captain. In real sense, beneficiaries should be the decision makers while agency personnel, researchers and NGOs engaged in development activities in the project area would work as advisors.

Other important deviation from common thinking is that, in most FCDI projects, activities related to management, operation and maintenance (MOM) of flood control, drainage and irrigation infrastructures although not addressed properly, get all the importance by the project management. Other components like, efficient use of water, crop production, fish, forest and livestock production are not getting due importance. Improvements of these aspects are left with the concerned line agencies and beneficiaries of the project area. However, multiple and integrated use of the FCDI projects and integrated water resources management (IWRM) should be the priority areas for water sector projects.

Few examples are cited in this respect to emphasize and elaborate difference of the concept from the existing operational procedures. Guidelines for Participatory Water Management (GPWM) in Bangladesh states that “Participation is an important voluntary process in which local stakeholders influence policy formulation, alternative plans/designs, investment choices and management decisions affecting their communities and establish the sense of ownership”. The GPWM indicate that “Give the local stakeholders a decisive voice at all stages of water management”. The co-management concept validated through a case study supports decision - making power than the decisive voice.

The GPWM also supports participation of local stakeholders to “prepare production plans on agriculture, fishery, forestry and livestock development and environmental management plan based on the feasibility study” by the implementing agencies. In real life, the implementing agencies, BWDB and LGED are not doing these as existing government mandates entitles Department of Agricultural Extension (DAE), Forest Department (FD), Department of Fisheries (DOF) and Livestock Department (LOD) to prepare their plan of action for the country including water sector project areas.

Co-management and participatory management support that mere participation in decision - making and consultation by agency personnel in water sector projects will not bring much benefit to the stakeholders. For increasing agricultural production, which is required for improved livelihood of stakeholders and for effective use of land and water resources in irrigation projects, stakeholders should have authority of decision – making for management of all infrastructures. Proposals agreed by the stakeholders should be implemented to achieve maximum benefit from the investment made in implementation of irrigation projects and in building infrastructures.

Improvement Potentials: The Ganges-Kobadak Irrigation Project (GKIP) is the oldest and largest irrigation project in Bangladesh. The project is highly criticized for low irrigation and water use efficiency, poor operation and management and cost recovery. Several rehabilitation programs have been undertaken with donor supports since its beginning of operation in 1962. Focus group discussions with project beneficiaries during 2015 revealed that management, operation and maintenance (MOM) of the system can be improved if the following actions are implemented through water management organizations (WMOs):

Sustainability of Water Management Organizations and Irrigation Project

The following activities and income generating approaches are suggested to make WMOs and O&M sustainable in GKIP. However, before handing over responsibilities to the WMOs for O&M of tertiary and secondary canals, the entire GKIP infrastructures should be rehabilitated (including replacement if required) by BWDB.

Water rate collection: A reasonable rate of water charge per crop season should be carefully reviewed and agreed with WMOs. Water rate collection may be handled on secondary canal basis and collection may be responsibility of water management association (WMA) for the secondary with support of water management groups (WMGs) formed at tertiary level. A fixed percentage of collection charge may be paid to the water management groups (WMGs) as incentive for water rate collection and submitting to BWDB or deposited in a bank account as agreed by BWDB and WMOs. There will be water management federation (WMF) for the entire project for sharing management responsibility with project management.

Crop production potential: Project area can easily be converted to triple crop area through year-round use of the irrigation facilities. Research data reveal that with annually two rice crops and a non-rice cultivation practices, production of at least 12 tons/ha of rice equivalent yield per year can be achieved adopting available technology. Therefore, about 11, 47392 tons (12 ton/ha x irrigated area of 95616) can be produced in the GKIP area against present annual production of 5, 92375 ton in 2013 (Agriculture Report). This will make the project economically viable (to be supported by benefit-cost analysis). Production of rice, wheat, maize, pulses, oilseeds, potato, winter vegetables and green manure crops will assist in increasing cropping intensity to about 300% and in soil health improvement. However, it will require comprehensive plan for integrated use of water and land resources.

Fish cultivation: Opportunities for multiple uses of irrigation and drainage can be explored for additional income generating activities like fish cultivation in the secondary and main canals. Discussion with GKIP professionals, farmers and WMO personnel revealed that fish cultivation in the secondary and main canals is possible. The WMAs are ready to take responsibility of fish cultivation on profit sharing arrangement with GKIP management. Initial computation supports that 467 km secondary canals with average width of 10 meter and about of 2 meter water depth, water body suitable for fish cultivation will be about 147 ha. Personal communication with fishery experts confirmed that about 2 tons/ha fish can easily be produced in 6 to 9 months of irrigation season. Fish produced in the canal can be sold at the rate of Taka 150/kg at site. This will provide annual return worth Taka 44,100000 equivalent to US$572727 (considering 1US$ = 77 Taka) per year from the secondary canals. From 193 Km of main canal with average water width of 25 meter and depth of 3 meter, fish cultivable water body will be 482.5 ha. With similar assumed production and sales price, it will provide annual return worth Taka 144,750000 equivalent to US$1, 879870 (considering 1US$ = 77 Taka).

Therefore, total annual income from water bodies in secondary and main canals will be Taka 188,850000 equivalent to US$2, 452597. Cost of fish production per ha per year is about Taka 150000 (personal communication with fishery experts). Therefore, total cost of fish production for secondary and main canal area (949.5 ha) will be Taka 141825000 equivalent to US$ 1,841,883 taking similar Taka and US$ exchange rate. Therefore, net annual profit from fish cultivation will be worth Taka 97,025000 or US$ 610714. That means profit from water bodies will be Taka 198012 per secondary if the profit is divided among 49 WMAs, and with less than this amount WMAs can take care of annual O&M of all tertiary canals if they are given responsibility.

Plantation Program along Country Sides of Canal Banks: Secondary canals with average height of 1.5 meter and average side slope of 1:3 will have 420 ha land for 467 km of secondary canals. Main canals with average height of 3 meter and average country side slopes will have 347 ha of land area for 193 km of main canal. The total land area of 767 ha (420 + 347) can accommodate about 1,150500 trees along canal banks. This will also provide return worth Taka 23 billion equivalent to US$298 million after 20 years (taking wood value of Taka 20000 per tree after 20 years). That is on an average annual return form plantation will be Taka 1.15 billion equivalent to US$14.9 million.

The project management of similar projects in Bangladesh and elsewhere can have a look to take advantages of using infrastructures for fish cultivation and afforestation involving WMOs to make investments worthy and make FCDI projects self sustainable. Active participation of beneficiaries will ensure O&M of projects sustainable, cost effective and resilience which is one of the thrusts of this seminar. Plantation on embankment slopes and year-round crop production will also contribute to minimize affects of climate change assimilation of carbon dioxide gas.

SUMMARY AND CONCLUSION

In most irrigation and FCDI projects, management, operation and maintenance (MOM) are not addressed properly but it gets importance by the project management. Other components like, efficient use of water, crop production, fish, forest and livestock production are not getting due importance in the project area. Improvements of these aspects are left with the concerned line agencies and beneficiaries of the project area. Integrated use of FCDI infrastructures and integrated water resources management (IWRM) should be the priority areas for water sector projects to make them cost effective, sustainable, local adaptation and resilience.

The GPWM supports participation of local stakeholders to “prepare production plans on agriculture, fishery, forestry and livestock development and environmental management plan based on the feasibility study” by the implementing agencies. Co-management and participatory management suggest that mere participation in decision - making and consultation by agency personnel in water sector projects will not bring much benefit to the stakeholders. For increasing agricultural production, improved livelihood of stakeholders, effective use of land and water resources in irrigation projects, stakeholders should have authority of decision – making for management of all infrastructures.

The project management of similar projects in Bangladesh and else where can have a look to take advantages of using infrastructures for fish cultivation and plantation involving WMOs to make investments worthy and make FCDI projects self sustainable. Active participation of beneficiaries will ensure O&M of projects sustainable, cost effective and resilience which is one of the thrusts of this seminar.

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TABLES

Table 1: Projected Population and Availability of Net Cultivable Area (Million ha) for the Year 2000-2025.

Year	Population growth rate (%)	Population (Million)	Available net cultivable area	Per Capita cultivable area (ha)	No. of People per ha of net cultivated area
2000		127.22	8.42	0.066	15
2001	1.48	129.25	8.29	0.066	15
2005	1.33	136.57	8.19	0.065	16
2010	1.16	145.08	8.09	0.061	18
2015	1.07	153.22	7.99	0.056	19
2020	0.99	161.25	7.99	0.053	20
2025	0.90	168.96	7.89	0.047	22

Adopted from Bhuiyan, N. I. Keynote paper presented in National Seminar in connection with the observance of the International Year of Rice – 2004, held at BARC, Dhaka, Bangladesh, June 21, 2004. Population in 2001 is the actual population. Population growth rate is adjusted from estimated growth rate published by the World Bank.

Table 2: Present and Projected Regional Distribution of Net Cultivated Area (NCA) and Irrigated Area. In Million Hectares (Mha)

Region	Total Area (Mha)	1994 NCA (Mha)	2025 NCA (Mha)	Irrigated Area*					
				2000		2025		Maximum Dev.	
				Area (Mha)	%	Area	%	Area	%
NE	2.01	1.16	1.14	0.48	41	0.91	80	1.08	95
NC	1.60	1.06	0.99	0.55	52	0.89	90	0.98	99
NW	3.16	2.30	2.23	1.47	64	2.12	95	2.21	99
SW	2.43	1.28	1.24	0.59	46	0.99	80	1.19	96
SC	1.25	0.82	0.80	0.12	15	0.56	70	0.76	95
SE	1.01	0.68	0.65	0.32	48	0.58	90	0.62	96
RE	0.59	0.33	0.31	0.13	37	0.27	80	0.32	95
EH	1.93	0.34	0.33	0.11	33	0.23	75	0.29	95
TOTAL	13.98	7.97	7.69	3.77	47	6.55		7.45	

Note: Total irrigated area as of 2014-2015 is 5.3 million ha (MOA). NE=Northeast, NC=North Central, NW=Northwest, SW=Southwest, SC=South Central, SE=Southeast, RE=Rivers and Estuaries, EH=Eastern Hills. Source: Technical Paper No. 7(WARPO, June 2000).

Table 3: Trends in Irrigated Area in Bangladesh in Last Ten Years by Irrigation Technology in Thousand Hectares

Season	STW	DTW	LLP	Traditional	Major Canal	Total	% Increase over last year
2005-06	3121	701	803	28	107	4760	- 0.56
2006-07	3196	725	810	14	137	4882	2.56
2007-08	3197	786	904	24	138	5049	3.42
2008-09	3245	790	957	44	75	5127	1.54
2009-2010	3337	773	965	40	85	5200	1.42
2010-2011	3505	719	1010	04	19	5264	1.23
2011-2012	3418	759	1084	28	20	5322	1.10
2012–2013	3242	934	1036	28	98	5373	0.95
2013-14	3279	877	1083	28	101	5403	0.56
2014-15	3235	962	1107	20	96	5448	0.83

Source: Minor Irrigation Survey Report, Ministry of Agriculture (MOA), 2015.

Table 4: Status of Irrigation Coverage per unit of equipment during 1982 -03 to 2014-15

Average of Reporting Period	Area Irrigated in Terminal Year (000 ha)			Average Coverage per Equipment (ha) for Reporting Period		
	DTW	STW	LLP	DTW	STW	LLP
1982-03 to 1989-90	384	1037	484	16.98	3.99	9.50
1990-91 to 1991-2000	530	2123	582	18.42	3.58	9.40
2000-01 to 2008-09	790	3245	957	24.31	2.61	7.15
2008-2009	790	3245	957	24.56	2.36	6.52
2009-10	773	3337	964	23.5	2.34	6.42
2010-11	719	3505	1010	21.36	2.26	5.82
2011-12	759	3418	1084	22.23	2.28	6.12
2012-13	934	3242	1034	26.45	2.13	6.07
2013-14	877	3279	1084	24.33	2.10	6.33
2014-15	962	3235	1107	26.30	2.08	6.62
Expected	Coverage			40	5	28

Note: Number of STW, DTW and LLPs operated during 2014-15 were 1549711, 36566 and 167175 respectively (MOA 2014-15).

Farmer Managed Irrigation Systems (FMIS) at the Crossroads

Mapping climate, gender and socio-ecological challenges

Masculinity in Irrigation: Imperatives for Gender Transformation and Decentralized Water Governance

Abstract

Anjal Prakash , ICIMOD

ACHIEVING GENDER WATER EQUITY IN THE FACE OF CHANGING CLIMATE CONTEXT: LESSONS FROM LOCAL WATER PLANNING PRACTICES IN NEPAL

PRANITA B UDAS AND CHANDA G GURUNG[1]

The major challenge faced by farmers with increased temperature and erratic rainfall is variability in water availability at the source. Farmers are troubled with either too much or too little water. Drought and floods are the major problems farmers have faced. In the hills, the springs are drying off, while irrigation canals turn into drainage canal during rainy season. Local water planning is crucial in this context to minimize water conflict emerging from water competition for various uses, as well as to manage water induced disaster. Often water related decisions and control are in the hand of local elite as access to water also add to power base of individual and groups. Concerns for gender water equity and justice is often marginalized in this process. Gender sensitive and responsive water planning could avoid this marginalization to a large extent. This paper presents gender analysis of local water planning practices, popularly known as Water Use Master Plan (WUMP) of Village Development Committee, implemented in Nepal since late nineties. It highlights the lessons learnt from WUMP practices on achieving equity in water management planning and access. The WUMP practices have been recognized by water supply and local development sectors, whereas the recognition from irrigation sector is limited. The paper concludes that implementation of irrigation projects based on WUMP priority can be an effective modality for irrigation sector investment to achieve gender water equity in changing climatic and sociopolitical scenario.

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GENDER AND WATER GOVERNANCE: WOMEN'S ROLE IN IRRIGATION MANAGEMENT AND DEVELOPMENT

DILLI R. PRASAI[1]

"Gender" is defined as: "the social roles and relations between women and men. This includes the different responsibilities of women and men in a given culture or location. Unlike the sex of men or women, which is biologically determined, the gender roles of women and men are socially constructed and such roles can change over time and vary according to geographic location and social context" (UNEP 2016: 18).

Irrigation management is normally defined as "a process by which institutions or individuals set objectives for irrigation systems, establish appropriate conditions and identify, mobilize and use resources so as to attain these objectives while ensuring that all activities are performed without causing adverse effects". Irrigation management with a gender perspective starts by identifying the end-users, and by understanding their needs and interests. The basic premise here is that unless the actual users are willing and able to use the water delivered by the irrigation system efficiently and effectively, the objectives of the irrigation system will not be achieved. Hence, developing a gender perspective to irrigation management consists of answering the following questions:

1. What are the objectives of the irrigation system in relation to gender?
2. What are the needs of female and male water users in irrigation management?

Addressing gender issues in irrigation is essential in promoting and advancing the role and status of women, a concern that is increasingly acknowledged by the government. It's rectangular strategy for growth, employment, equity and efficiency, women as the backbone of the economy and society as well as in agriculture specially in the context of out-migration of male members. Rural people need to have equal rights and access to and control over those resources, as well as the opportunity to participate in public decision making including in irrigation water management. Although legal frameworks and mechanisms have been developed for gender equality and for empowering and inspiring women's commitment and participation, the capacities of women, social and cultural norms and internal rules and regulations in rural areas are still to be revisited.

Key words: Gender, decision-making, productive, irrigation-system, mechanisms

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UNDERSTANDING THE IRRIGATION GOVERNANCE AND MECHANISMS OF WATER RESOURCE MANAGEMENT FOR IMPROVED ADAPTIVE CAPACITY

KRITY SHRESTHA[1], BIMAL RAJ REGMI[2] AND ANJAL PRAKASH

There is limited understanding to date eliciting the issue of governance within Farmer managed Irrigation System (FMIS) and how this can be addressed in climate change adaptation with regards to capacity of institutions to deliver inclusive adaptation outcomes. The main purpose of this research is to understand the irrigation governance and mechanisms of water resource management in the changing climate context to increase the adaptive capacity of the FMIS.

The methodology for this study include the Institutional Analysis and Development (IAD) framework which was adjusted for adaptation governance analysis. The action situation include providers and beneficiaries of a collective adaptation good, whose interdependence is characterized by three sets of variables (biophysical conditions, community attributes and institutions). The study used household survey, key informant interviews and focus group discussion as key tools.

The FMIS is prone to climate change impacts such as variability in precipitation, rising temperature and increasing climate induced hazards. The farmers, dependent within the system, have reported loss of water discharge (about 50%) from the springs due to extreme variability in precipitation and increased temperature that can be attributed to climate change. The decreased access and availability of water has forced farmers to use ground water pumping as an alternative.

The extreme weather and climatic conditions have made the farming system more labour intensive and less productive. The evidences show that many farmers have shifted to other livelihood options other than agriculture. This has severely impacted the livelihood of the landless daily wage agricultural labourers as many of the labourers, especially women, have no other skills. In contrary, the institutional structure, currently in operation, is extremely weak in terms of mobilizing communities and poor in terms of providing equal access to all the farmers affiliated with the system. The institution is also unable to understand and strategize adaptive responses to deal with the growing impacts of climate change stresses.

The findings indicate that important factors shaping adaptive capacity of individuals, household and communities is their access to and control over water resources, access to water resource management knowledge and supporting networks and opportunities for enhancing capacity of institutions and individuals.

Key words: Climate Change, FMIS, Institution, Irrigation Governance, Adaptive capacity

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IMPACT OF CLIMATE CHANGE ON SMALL AND MEDIUM IRRIGATION SYSTEMS IN NEPAL

UMESH NTH PARAJULI[1]

There is a wide consensus that the climate change will have adverse impacts on Nepal's water resources and subsequently on irrigated agriculture. Being located in the region of the Hindu Kush-Himalayas, where the warming rate has been greater than the global average, threats to irrigated agriculture due to climate change further increases.

Most irrigation in Nepal is in small and medium run-of-the-river irrigation schemes developed by local community using indigenous knowledge and skills. They draw water from the second or third order tributary rivers where there is no storage possible and where there is already a shortage of water. Flows in these tributaries depend almost exclusively on monsoon rains. Infrastructure of these schemes is exposed to deterioration by even slight increases in river floods and landslides caused by climatic variability, mainly rainfall patterns. These systems are thus highly susceptible to climate change effects.

This paper examines impact of climate change and local level adaptations in small and medium irrigation systems in Nepal. The paper is based on several case studies conducted during 2015 and 16 (Mott, 2016). The paper suggests that climate change does have influences on irrigation system and its management, but it is not the only agents for changes. There are other agents as well that bring changes on irrigation management.

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CLIMATIC TRENDS WITH REFERENCE TO SMALL IRRIGATION MANAGEMENT IN NEPAL

KESHAV P. SHARMA[1]

The study presents precipitation and temperature trends during the past forty years considering the cases of small irrigation systems located in south-east Nepal, central Nepal, south-central Nepal and western Nepal. Confirming the global pattern, all the cases indicated rising trends of temperature. Increase in annual average temperature were insignificant in the Terai belt of Nepal compared to mountainous areas with expected rise in maximum temperature as high as 0.6^{o}C per decade. Expected average annual warming rate in the project area was estimated at 0.2^{o}C/decade to 0.3^{o}C/decade. Based on the trend analyses, no significant long-term change in precipitation was anticipated; however, precipitation projections indicated 10% to 20% increase during summer monsoon but decrease by about 10% in the rest of a year. Assessment of the records showed slightly decreasing trends of precipitation in central and western Nepal. Observed decrease in precipitation is more pronounced in the last two decades. Irrigation systems need to consider the observed as well as projected delayed monsoon onset. Similarly, ENSO events needed to be monitored as weak monsoons are expected during strong ENSO. Similarly, the study indicated that twenty year floods were likely to become 15-year to 18-year flood. Increase in irrigation water demand is expected in both the scenarios of rise in temperature and reduction in precipitation. Since temperature rise as well as decrease in number of precipitation days have been found in all the case studies, irrigation facilities need to be enhanced.

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WATER MEASUREMENT AND IMPLICATIONS ON WATER AVAILABILITY AND WATER DISTRIBUTION AND IMPACT OF CLIMATE CHANGE ON IRRIGATION MANAGEMENT: EXAMPLES OF SRINGEGHAT, KAPILBASTU AND JULFETAR IRRIGATIONN SYSTEMS, NAWALPARASI

RAJENDRA BIR JOSHI[1]

Most of the irrigation systems in Nepal draw water from small and medium run-of-the river. Those river systems are neither gauged in terms of river flows nor in terms of precipitations. This paper is based on observations and measurement in two case studies (Juphe I.S. Nawalparasi and Sringeghat I. S. Kapilbastu).

Irrigation facilities need to be enhanced to increase water use efficiency, equitable water distribution, climate resilience and effective water management practice. Infrastructural development and improvement enhances reliability and efficiency of water delivery, which turn helps in building climate resilience irrigation systems.

The availability of water is not adequate to meet the irrigation need. The integration of small systems into a one system has a significant impact on irrigation management. Improvement of tube wells and land management helps enhancing system efficiency.

Increase in irrigation water demand is expected as a result of rise in temperature and changes in precipitation. The major impacts of climate change on irrigation management could be climatic variations on temperature and rainfall. The change on rainfall impacts – influencing the amount of water in river and water deficit which need to be made up by irrigation.

This paper examines the water availability in two irrigation systems as the rainfall and water at source. The paper suggests that climate change does have influences on irrigation management.

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PERCEPTION ON CLIMATE CHANGE AND REALITY IN SMALL AND MEDIUM IRRIGATION SYSTEMS IN NEPAL

PRAVAKAR PRADHAN[1]

This study analyzes the farmer's perception on climate change and its impacts on irrigation system and agriculture practices, by highlighting key climate variables in two different locations, namely, Singeghat Irrigation System (SIS) in Kapilvastu District and Julphe Irrigation System (JIS) in Nawalparasi District. The SIS and JIS watershed areas cover around 187 km^2 and 52 km^2 respectively.

The study was carried-out by using focus group discussion (FGD) methodology in order to capture the perceptions of the farmers on climate change aspects. Each FGD group consisted of 10-12 people inclusive of women representatives. The farmers were categorized into three groups. One group holding more than 3,386m^2 land[2] is categorized as rich. Another group holding less than 3,386m^2 land is grouped as not rich. Another group was Senior Citizens who have stayed more than 20 years in the command areas. The FGDs were conducted in the vicinity of three sections of these irrigation systems (i.e., head, middle and tail sections). The present study presents the findings of FGD on perceptions and experiences of the farmers on temperature, rainfall, agriculture practices, cropping pattern and the impact of climate change on crop choices and crop coverage.

Checklist was prepared to guide the FGD. Outcomes of the FGD have been converted into numerical values to identify the monthly/annually climate change scenario in the irrigation system compared to 10 years ago.

The FGD suggested that the temperature, in both summer and winter period, has been felt to be increasing compared to the previous years. The summers have become unbearably hot and in the winter, the numbers of cold days have decreased. The local recounted memories of fog in the morning only a few years back but now it is not felt. The farmers felt that the rainfall pattern has also changed, such as delayed monsoon and less rainfall in winter. They reported that the duration of heavy rainfall is short and the duration of dry spell is longer even during monsoon. During winter, the farmers have experienced either very less rainfall or no rainfall at all, which has significant impacts on winter crop production and productivity. These types of erratic rainfall patterns caused an adverse impact on the volume of water flow in the river as well as in the irrigation canals according to the farmers. Finally, the outcomes of the farmer perception on climate change in both irrigation systems were also compared with locally available scientific data (i.e. hydrological and meteorological) which are almost similar in nature.

Key words: Climate Change, Perception, Small and Medium Irrigation System, Agriculture, Farmer, Temperature, Rainfall, Water, Crops, Monsoon, Management

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2 It is equivalent to half a *Bigha* (10 *Katha* or 0.3386 hectare) of agriculture land (https://en.wikipedia.org/wiki/Bigha)

Farmer Perception (CMIASP-AF)

NewarKulo, Panchthar Presentation by - Mr. Mani Kumar Pradhan WUA Chairman
Sulitar IS, Chitwan resentation by - Mr. Bhoj Bahadur Rana Magar WUA Chairman
Atrauliputtar IS, Tanahu Presentation by - Mr. RamjiAryal WUA Chairman
Hadiya Dama Paini, Jhapa Presentation by; - Mr. Uday Narayan Dhungana WUA Chairman
Chakhola IS, Kavre Presentation by - Mr. Gobinda Prasad Nepal WUA Vice - Chairman

UPSCALING MUS AT GLOBAL LEVELS

BARBARA VAN KOPPEN [1]

This paper analyses recent trends in the uptake of Multiple-use water services (MUS) approaches by service providers and policy makers across the world, and especially in low- and middle-income countries. It seeks to unravel adopters' answers to the question: 'what is in it for me?'. For communities, the multiple uses of their multiple sources are a no-brainer. MUS adopters seek to respond to these practices envisaging several sets of general claimed or plausible benefits. However, 'what is in it for me' also differs because of the fragmented administrative structuring of public service provision. Four angles continue to shape global upscaling of MUS at different scales:

- From the domestic water supply angle ('domestic-plus');
- From the irrigation angle ('irrigation-plus');
- From a general 'water' angle, so without further specified funding earmarks (MUS by design funded by donors or otherwise); and last but not least:
- Implicit MUS approaches that emerge spontaneously wherever existing or newly introduced local planning processes are genuinely demand-driven according to communities' priorities.

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ECONOMIC IMPACT OF THE MULTIPLE USE WATER SYSTEM APPROACH IN FAR WEST NEPAL

COREY O'HARA, PHD [1]LUKE COLAVITO[2], MADAN PARIYAR[3], & RABINDRA KARKI[4]

Moving beyond conventional barriers between the domestic and productive sectors, community-based Multiple-Use Water Systems (MUS) provide sufficient water for domestic needs and productive use.[1] This study uses data from the USAID supported Market Access and Water Technologies for Women (MAWTW) project to determine the impact of MUS adoption on smallholder livelihoods, independent of other factors and interventions. Using propensity score matching in a quasi-experimental model with a controlled random sample of project households, we determine that all else equal, having access to water from a MUS contributed US$70 in average household income, which rose to US$190 for MUS farmers who used micro irrigation promoted by the project. In a subsequent study using follow-up data matched to baseline households, we employ a fixed effects model and control for project activities and socioeconomic conditions. We determine that households adopting a MUS earn approximately 51.7% greater income than equivalent households, holding all else equal. Our findings also indicate that MUS have measurable economic benefits beyond agriculture, which may be due to time savings, reduction in water-borne infection, and increased marketing power due to scale of production within a community. MUS also have additional benefits for health, nutrition, and women's empowerment.

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[1] Marieke Adank, Barbara van Koppen, and Stef Smits, on behalf of the MUS Group (Feb 2012). Guidelines for Planning and Providing Multiple-Use Water Services.

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MULTIPLE PERCEPTIONS ON MULTIPLE-USE WATER SYSTEMS (MUS).

A REFLECTION ON POTENTIAL AND CONSTRAINTS FOR INSTITUTIONALISING MUS IN NEPAL

FLORIANE CLEMENT[1] & FARAH AHMED[2]

Multiple-use water systems (MUS) are systems designed to address local people's multiple water needs through a participatory planning approach. Proponents of MUS argue that MUS are more cost-effective and sustainable than single-use systems. In the past, many farmers-managed irrigation systems (FMIS) were also 'MUS' and provided water for a wide variety of purposes, e.g. for livestock, washing clothes and even sometimes for drinking water. However, modern local water systems developed by the government and international funding agencies have been designed for single uses.

For the last decade, several hundreds of MUS that provide water to communities for irrigation, drinking water, micro-hydro, water mills etc., have been piloted and implemented but this implementation has been largely limited to donor-funded projects and there is still little buy-in for MUS from government agencies that are involved in local water resource planning and development.

This study explores the barriers and opportunities for a formal recognition and integration of MUS in water resource planning and development in Nepal. It starts with exploring the multiple perceptions on MUS of a wide range of stakeholders on what is MUS and how it could be upscaled. Our findings show how these perceptions are tied to different, and sometimes conflicting, visions and interests. We also examine different types of approaches to implement MUS, currently adopted by different international non-governmental organisations (INGOs) in Nepal. We recommend that MUS implementation follows a need-based approach and includes an analysis of social inequities in water access, needs of different individuals in the community and associated trade-offs, and strategies on how to address inequities and trade-offs.

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LOCAL FINANCING FOR FUNCTIONALITY, SUSTAINABILITY AND SERVICE LEVEL IMPROVEMENT – AN OPPORTUNITY FOR MUS?

SANNA-LEENA RAUTANEN[1]

This study focuses on community-managed rural water systems functionality and sustainability in Western Nepal. While Nepal exceeded its Millennium Development Goal target for water supply coverage, in 2010 it was reported that out of 37,931 gravity-fed rural water supply systems in Nepal, 12% needed major repair, 21% needed rehabilitation, and 9% reconstruction. This calls for serious attention into existing water supply schemes, while this is also an opportunity to bring in the multiple-use of water services (MUS) thinking, should the policy and financing mechanisms allow for cross-sectoral investment. This article first explores to what extent the water schemes studied in Western Nepal do feature MUS characteristics already now, whether or not they were originally designed for it, and then estimates what it would take to include MUS where there is a need to address functionality retrospectively. This study utilizes primary data from the Rural Water Supply and Sanitation Project in Western Nepal Phase II (2013-present) and from the Rural Water Supply and Sanitation Support Programme Phase III (1999-2005), both bi-lateral water supply and sanitation projects supported by the governments of Nepal and Finland, as well as from the Nawalparasi-Palpa WASH Project by WaterFinns that revisited the schemes supported by Finland 15-25 years ago. Appreciating the complexity and dynamic nature of the rural water sector, this study provides a number of recommendations applicable for those working with local governments and communities to integrate and scale up MUS while making the systems functional, sustainable, resilient and adaptive. This article concludes by describing how local funding for functionality, service level investments and MUS could be made available at the lowest tier of local governance. This study calls for close collaboration in between the stakeholders working with the farmer-managed irrigation and community-managed water supply systems, also at the policy level.

Theme: (d) Financing and capability enhancement for local irrigation adaptation activities and associated resilient responses

Key words: rural water, functionality, sustainability, financing, MUS, Nepal

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GUIDELINES FOR WATER MANAGEMENT OF HIGHLAND AGRICULTURE IN MAE SA NOI VILLAGE, PONGYANG SUB-DISTRICT, MAERIM DISTRICT, CHIANG MAI PROVINCE

NATHITAKARN PINTHUKAS[1]

The objectives of the study were to 1) study the participation of water management for agriculture, 2) analyze problems and obstacles of water management for agriculture, and 3) provide guidelines of water management for agriculture. 50 people were selected as the sample group. In this descriptive study and analysis received from the questionnaires and lecture summary from the interview, it was found that as follows: using water resources for the further agriculture relies on the ponds especially in the crisis and when inadequate natural resources and water supply. The problems usually found were from the physical biography of the area such as inadequate water for agriculture in the community. Catchment area was not enough for the usage. Farmers lack of knowledge and understanding about water maintenance. Farmers were not able to do their main occupation a whole year. Most of problems found were not serious but due to the physical biography of the area, there were other following problems. To solve these problems, there should be a meeting for water users to exchange idea in order to improve the water management within the group for the further effectiveness in term of the data, group meeting, and regulation within group, activities, the products and water supply.

Key words: Guidelines, water management, highland agriculture

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WATER SCANTINESS IN ANDHIKHOLA RIVER BASIN: FARMERS' ADAPTATION STRATEGIES

SHUBHECHCHHA SHARM[1]

Climate Change impact entail farmers of three VDCs in Andhikhola River Basin to collaborate with no to less water, and requires farm modification. There are basically two potential modification strategies: extensive and intensive responses. Extensive responses includes purchasing of new farms, increasing the total irrigated areas, modifying crops and combinations, and embracing innovative arrangements. At the same time, intensive responses consist of selling of farms, and reducing areas under irrigation. We analyzed changes in farmers' planned versus actual strategies for five years in order to propose robust groundwork to strengthen future farm adaptation strategies. We found that knowledge of climate change and its impact influences farm adjustment strategies; farmers induced with climate change and erraticism were found to have adopted assorted intensive strategies. The liaison between climate change knowledge and embracing diverse farm adjustment strategies were internally originated, intensive strategies in particular. These results infer the need for farming policies focused on strengthening farmer's adaptability of water erraticism management and its association with future farm viability.

Key words: Erraticism, Collaboration, extensive responses, intensive strategies, climate change knowledge

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INTEGRATING RESILIENCE CONCEPT IN THE FACE OF CHANGING CLIMATE: LEARNING FROM SOME NRM PROJECTS IN NEPAL

RAM CHANDRA KHANAL[1]

Resilience has become one of the evolving discourses recently in development planning and management to respond to uncertainty and change. But, there exist inadequate understanding and institutional capacity among the stakeholders in Nepal to integrate this concept in regular development management and cultivate adaptive capacity to sustain development. Based on the author's involvement in natural management sectors i.e. agriculture, forestry and irrigation projects in last five years, the paper will examine how climate change and climate variability is affecting the resilience of socio-ecological systems and what parameters are important to improve resilience of this sector considering that resilience results from the combination of absorptive capacity leading to persistence, adaptive capacity, leading to incremental adjustments and adaptation, and transformative capacity leading to transformational responses in the face expected and surprising changes. In addition, the paper will also explore challenges and opportunities of integrating resilience in the NRM sector and outline major indicators that can be considered for assessing /evaluating resilience at operational level.

Key words: Resilience, socio-ecological systems, adaptive capacity, adaptation, and assessment.

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BARRIERS AFFECTING HUMAN LIVING UNDER CONSEQUENCE OF CLIMATE CHANGE IN CHIANG MAI, NORTHERN THAILAND

JUTHATHIP CHALERMPHOL, NATHITAKARN PINTHUKAS, RUJ SIRISUNYALUCK[1]

From actual perspective, small scale irrigation systems are of critical importance. The small farms provide the majority of country's agriculture products and a large proportion of these rely on irrigation system. Furthermore, agriculture is extremely exposed to climate change, as farming activities directly rely on climatic conditions.

This study focused on various aspects related to the impact of climate change to farmers of small scale irrigation systems in northern Thailand. We analyzed the barriers affecting human living under consequence of climate change in Chiang Mai, Northern Thailand, in term of risk on climate, government, input, prices, migration, irrigation and flood. The paper is based on the study of farmers in small scale irrigation systems in Chiang Mai covering two types of research site: adjoining district to the Chiang Mai city and high land area.

All head of 30 communities and small scale irrigation systems expressed that there have been many changes in water reliability during last 10 years. The water supply in the irrigation system is fluctuating in different seasons. There is not much difference in involvement of irrigation infrastructure maintained. The barriers affecting human living under consequence of climate change in Chiang Mai, Northern Thailand are risk of climate change and risk-uncertainty with yield price, the farmers concern about climate change could make it too hot to grow certain crops, and droughts caused by climate change could reduce the amount of water available for irrigation lead to crop production. Rising temperatures, changing precipitation patterns, and increasing droughts will affect the amount of water in rivers and streams, as well as the amount of water that leaks into the ground to replenish ground water. Communities might have to find new sources of water to support their needs. People might also have to adapt by using less water.

Key words: human living, climate change

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CLIMATE RESILIENCE AND PERFORMANCE OF CHAPAKOT IRRIGATION SYSTEM

KHEM RAJ SHARMA & MANJU ADHIKARI[1]

Chapakot Irrigation System is in Syangja District, Western Nepal. The system gets water from Jyagdi Khola through its main canal of over 25 km of which 14.5 km is the idle length. Also at the chainage of 6.06 Km there is a feeder canal from Bhumdi Khola and there are several control structures along the alignment. The system has a command area of around 885 ha and serves about 12,000 farmers living in 2,000 households. The system is managed jointly by Department of Irrigation and the local farmer community. For the study, monthly rainfall and temperature data at the DHM station in Syangja Bazar of the past 12 years were collected and analyzed. Farmers' perceptions about climate change over the years and the coping mechanism for increasing their resilience were assessed after field survey. The system performance with regard to irrigation water supply, cropping pattern and yields, system management activities was assessed through focus group discussion and field observation.

From the analysis it is observed that flow of water at the source during winter and spring seasons is drastically low as compared to the monsoon flow. Several spring water sources are drying up adding the drudgery of the local inhabitants especially women in fetching drinking water in the locality and prompting the farmers to avail support in constructing a lift water supply system from Chite khola. Pest and disease infestation as well as lack of markets have been a major problem in vegetable farming in recent years. Equitable water distribution between head and tail ends is a big challenge. Unreliable water supply and uncertain climatic pattern along with the labor shortage have resulted into reduced interest among the farmers in agriculture. Due to reduced water flow in the canal and migration of local youth for employment elsewhere, cropped area during dry seasons is considerably low as compared to the wet season. So far, the Water User Association has not introduced the provision of collecting irrigation service fee from the beneficiaries resulting into backlog of system maintenance. Farmers living in uphills have a tendency to settle into the downhills on the plain Chapakot tar thus gradually converting the agriculture areas into settlements. The landslide near the system headworks and along the canal aligment due to 2015 major earthquake and the floods affected the functional status of the system. Silt deposition in the canal intake has been a perennial problem. Farmers perceive that it is getting warmer in recent times, but whether it is climate change is not well perceived by the farmers. The cropping pattern is still traditional with rice – wheat/potato – maize/pulses domination in monsoon, winter and spring season respectively. With the construction of a gravel road from Galyang to Chapakot, things are changing lately. As a coping mechanism farmers are now apply high doses of pesticides, insecticides and fungicides, especially in vegetables. Use of chemical fertilizer is in the increasing trend for a better harvest. The system is currently under rehabilitation process with support from DOI through the Asian Development Bank funding.

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INTEGRATING IRRIGATION PRACTICES IN IMPROVED WATERMILL AREAS FOR SUSTAINABLE LIVELIHOOD

MAHENDRA PRASAD CHUDAL[1]

Watermill is an indigenous technology and being in operation since immemorial. Traditional watermills are directly connected to livelihood of rural communities through conversion of potential energy of water into mechanical energy and by providing agro-processing services. The improved watermill is an improvised version of traditional one in terms of increased efficiency of agro-processing services with replacement of traditional wooden runner kit by metallic ones. Besides the grain grinding services, the improved watermill is being capable to provide other services like paddy hauling, oil expelling, rice beating, saw milling and electricity generation etc. The improved watermill improves the standard of rural livelihood through providing energy services and generation of employment and income generation opportunities at local level. On the other hand the watermill is also directly connected with improvement of productivity of agricultural sector through irrigation. This is done in two ways i.e. sharing of watermill canals for irrigation purpose and improvement of existing irrigation canals for efficient utilization of water for multipurpose activities i.e. irrigation, agro-processing and electricity generation services.

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SOLAR PUMPED DRIP IRRIGATION

ROBERT YODER[1]

This paper describes recent work in developing and field-testing solar powered drip irrigation for smallholder farmers. Expanded gray market manufacturing in India in the 1990s with less ridged quality control resulted a product often referred to as low-cost drip. While attractive to smallholders low-cost drip promotion did not achieve the scale necessary to make access to replacement supplies sustainable. In recent years competition for the rapidly expanding commercial drip system market has both reduced its cost and it is making drip irrigation supplies availably in many countries.

Solar powered pumping has technically been available for many decades but only with the dramatic drop in the price of solar panel in the past six years has solar power become cost effective for operating water pumps. Since drip irrigation is more effective in placing water next to the plants than surface flooding, furrow or sprinkle application, it reduces the amount of water that needs to be pumped for a given area. By combining technologies of solar pumping with drip irrigation application it further reduces the cost of solar pumped irrigation. The paper concludes with discussion of field test results in India, Kenya and Nepal and observations and recommendations for moving these technologies into wider use around the world.

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ADDRESSING LOCAL WATER CONFLICTS THROUGH MULTIPLE USE WATER SYSTEMS (MUS): A LEARNING FROM CALCNR PROGRAM AT DHIKURPOKHARI, KASKI, NEPAL

MADAN PARIYAR[1], VIJAYA STHAPIT[2] AND RAKESH KOTHARI[3]

Community Based Adaptive Learning in Management of Conflicts and Natural Resources (CALCNR) is a four year program (2014- 2017) supported by the Netherlands Organization for Scientific Research (NWO). CALCNR is being implemented in Nepal and Bangladesh with the objective of generating evidence-based knowledge on the gaps between community management of natural resources, local adaptation innovations, and national policy debates over climate change and conflicts related to natural resource access. The CANCLR program conducted research on transforming intercommunity conflicts into cooperation over managing and distributing water through implementing the Multiple Use Water System (MUS) in Dhikurpokhari VDC in Kaski district.

MUS is an improved water resource management approach that uses technology appropriate for the needs of isolated and marginalized populations relying on subsistence farming. This system integrates socio-economic development of community members with the conservation and efficient use of water. Multiple Use Water Systems constructed in Dhikurpokhari, Kaski provide water to 68 households in *Dalit* community of Pariyar Tole. The main findings of the CALCNR research are: (a) water collected from the MUS for both domestic and agricultural needs, prevent conflicts between farmers, households and communities over water use, and (b) giving leadership and responsibility to community members through establishment of MUS User Groups to maintain the MUS is vital for long term sustainability of the system.

The MUS established in Dhikurpokhari VDC of Kaski district is found to be an effective approach for both reducing water scarcity and for resolving water-related conflicts in rural communities; and it greatly benefits communities to achieve climate resilience.

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MULTI USE WATER SERVICES: ECONOMIC COST-BENEFIT ANALYSIS UNDER RURAL VILLAGE WATER RESOURCES MANAGEMENT PROJECT (RVWRMP) SCHEMES IN FAR WEST NEPAL

PALLAB RAJ NEPAL,[1] SUSHILSUBEDI,[2]

Water provision for domestic and productive uses creates opportunities to address poverty and livelihoods of rural people. Proper management and utilization of available water resources is a concern of governments and development actors as a major component of sustainable development. Multiple Use Water Systems (MUS) have vital role to optimize the use of water resources for community benefits as disputes over uses of water sources and depletion/drying source yield are emerging challenge and call for more effective and efficient use of existing water sources in rural communities of Nepal. To achieve sustainable water resources management, there is a need for scientific analysis and integrated planning of available water resources according to social, environmental and technical viability. Water Use Master Plans (WUMPs) have proven an effective tool for scoping the MUS with brings up effective, equitable and efficient use of water, minimize water conflicts and build up ownership over water services at local level. Since, MUS is cost effective and covers broader area than the standalone system, it has been often the communities choice during WUMP preparation. This article presents economic cost-benefits analysis of four MUS schemes (WS+MIT*), out of 22 MUS schemes (WS + MIT) implemented by Rural Village Water Resources Management Project and will analyse based on changing cropping patterns, agricultural production, food security, new local employment opportunities and household incomes of smallholders after MUS services; and also competitive analysis of direct and indirect benefits of MUS and standalone water schemes (4 WS+ MIT Vs 4 standalone water supply schemes). Besides, this analysis also identifies future challenges to IWRM and the MUS implementation and recommends to analyse the opportunities of MUS while designing water schemes to maximise the water productivity and economic cost benefits.

Key words: Water Use Master Plan, Multi Use Water Services, IWRM, cost-benefits

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MAKTUMBA FMIS RESILIENCE: THE LAST 25 YEARS AND THE NEXT
"WE NEVER HAD IT SO GOOD, BUT NOW OUR YOUTH IS LEAVING"

AREND VAN RIESSEN[1]

The hills of eastern Nepal count thousands of mostly very small irrigation systems that are the basis for livelihoods and societies. They are now facing an existential threat, because of cropping system changes and youth leaving the villages. Revisiting 20 irrigation systems in 2010 and 2015, 25 years after they had been supported by Mechi Programme did not only teach us about resilience and adaptation in the past, but also about the future.

Twenty Schemes. In 1991 we as Mechi Programme staff predicted that only 55% of 20 supported irrigation systems would still be functional by 2000AD. When the schemes were finally revisited in 2010AD, it appeared that 75% were still functioning. Not as expected the lower altitude schemes, but the higher altitude schemes did best as they doubled command areas by converting to cash crops that need less water. Modern irrigation practices that were promoted 25 years ago through trainings, coaching and visits to FMIS in Sindhupalchowk and Palpa, were not always copied or continued but have been successfully adapted to make systems resilient.

Maktumba FMIS. In 2015, the small, very poor and isolated Maktumba FMIS (12hh, 16ha), was revisited to learn more about why in 2010 it was assessed to be non-functional, but it was found functioning again (at 65% capacity). The community and committee, assessed in 1991 as poor, illiterate, unaware and unconnected, had matured by steadily practicing and slowly adapting all the promoted O&M practices. Annual maintenance costs have been high, especially due to crab damage, but the increased wealth had made it all worthwhile.

The Next 25 years. Two major changes are happening now. First, many youth are leaving the village for studies, urban life and migratory labour, so that some households cannot contribute labour anymore, while O&M skills are being lost. Second, canals become less important as commercial farm products (rainfed broomgrass and goats in the case of Maktumba) are becoming more important than irrigated food crops. A small experiment in Maktumba in 2016 showed, communities are adapting by outsourcing canal maintenance and increased commercial agriculture, but to make the area interesting enough for youth to stay, much bigger efforts are needed in market system development, services and connectivity. And whether the irrigation systems will survive depends on the water needs of that commercial agriculture. We are not going to predict anything for the next 25 years, but assume that the community will probably surprise us again with new examples of resilience and adaptation.

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DESIGN ISSUES AND TECHNOLOGIES OF HILLY IRRIGATION INFRASTRUCTURES IN VIEW OF CLIMATE CHANGE: CASE STUDY STUDY OF KALLERITAR IRRIGATION SYSTEM

ASHISH BHADRA KHANAL[1]

Nepal's climate is influenced by the Himalayan mountain range and the South Asian monsoon. The climate is characterized into four distinct seasons: pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and winter (December-February). Average annual rainfall is approximately 1530 mm. The highest rainfall occurs in the central and mid hill areas around Pokhara and northeast and east of Kathmandu valley. Temperature tends to increase from north to south and decrease with altitude. The winter season is coldest with the highest temperatures during the pre-monsoon period (NAPA 2010).

Analysis of recent observational data shows that the climate of Nepal is already changing. Temperature have increased strongly over recent decades, rising at much faster rate than the global average. There have also been changes in precipitation, including heavy rainfall extremes, though the trend is more complex and there are wide variations across the seasons and the regions in the country.

According to (NAPA), temperature rise in Nepal is in the trend of 0.04-0.06°C annually. Shrestha et al. (1999) reports a trend varying between 0.4 and 0.9 °C/decade in the mean annual maximum temperature across different ecological belts of Nepal, with the high Trans-Himalayan region showing the highest and the Terai (lowland region) showing the lowest. While for the same regions for winter season, they reported a trend varying between no trend in Terai to 1.2 °C/decade in the Trans-Himalaya.

With regard to precipitation, NAPA states that there is a general decline in pre-monsoon precipitation in far- and mid-western Nepal, with a few pockets of declining rainfall in the western, central and eastern regions. In contrast there is a general trend of increasing pre-monsoon precipitation in the rest of the country.

Nepal currently suffers high economic costs due to current climate variability and extreme events. The annual direct costs of current climate variability in Nepal, on average, are estimated to be equivalent to 1.5% to 2% of 2013 GDP. In extreme flood years they can be much higher rising to 5% or more (Technical Report, 2014).

The agriculture sectors accounts for approximately three quarters of employment and one-third of GDP in Nepal. Irrigation is prime input for the growth of agricultural sectors and Government of Nepal has invested huge amount in irrigation infrastructures. Because of climate change and soaring temperature, the crop water requirement is increasing every year in each irrigation system consequently demanding more discharge from the irrigation canal. When crop water demand is higher, more discharge needs to be diverted to the canal, however if the canal section was not considered for climate change accommodation during design, the irrigation scheduling would be affected. Hence, this paper has made an attempt to find out the impact of climate change in hilly irrigation system of mid Nepal viz. Kalleritar Irrigation System by observing the design canal discharge and discharge needed at present and future.

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ADDRESSING CLIMATE CHANGE IMPACTS ON FARMERS MANAGED IRRIGATION SYSTEM THROUGH ADAPTATION MEASURES

SHREE BHAGAVAN THAKUR[1] and BATU KRISHNA UPRETY[2]

Agriculture accounts for nearly one□thirds of the gross domestic product and two-thirds of labor employment of Nepal. Irrigation is important to increase agriculture production and productivity and sustain country's economy. Preliminary studies and climate variability confirm 'too much water' (increased flood) and 'too little water' (drought) resulting to severe water scarcity and this is aggravated due to climate change impacts. Glacial and snow melt is an important source of the lean flows of snow-fed rivers but model-based predictions indicate possible decline in river and stream flows in future. The inevitable impacts of climate change would be much more pronounced. In Nepal, Farmer Managed Irrigation Systems (FMISs) is deeply rooted in irrigating large agriculture land. Irrigation had a positive impact on crop diversification and commercialization. Smallholder farmers are disproportionately vulnerable to the impacts of climate change which is adversely impacting agricultural sectors and food security. This paper approaches to enhance understanding on the impacts of climate change on irrigation system in order to inform farmers and stakeholders for addressing these impacts through climate change adaptation planning to build adaptive capacity and promote resilient design of FMIS in Nepal.

Key words: Adaptation, agriculture, irrigation, climate change, farmers, and resilient.

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WATER, FOOD SECURITY AND ASIAN TRANSITION: A NEW PERSPECTIVE WITHIN THE FACE OF CLIMATE CHANGE

PUSPA RAJ KHANAL[1]

Asia has made impressive economic growth and rapid rural transformation in the past decades. Millions of rural mass has come out of poverty and starvation through opportunities offered by new economic environment. Water has played a central role in this transformation supporting agricultural change and economic growth while also providing foundation for rural livelihood. While water is still at the centreof food security and rural transformation in Asia, the issues are much more complex than before as the rural livelihoods continue to transform under the combined effect of population growth, rapid rural to urban migration, and profound structural transformation of national economies. Climate change will further compound the existing water management challenges changing the patterns of demand and supply of water for agriculture.

This paper first analyzes the challenges facing water and food security within the context of ongoing Asian transition. It argues that food security is still a rural agenda, and future water and food security largely hinges on the prosperity of these rural population. Water management that facilitates these transitions and promote inclusive, equitable and greener growth will be a key to future water and food security agenda.

It then looks at the broad and more specific impacts of climate change in major food production systems in Asia. It explores how the extent and productivity of both rainfed and irrigated agriculture are expected to change in major Asian production system, and its implication to the rural poor who are likely to be disproportionally affected. It finally suggests various water management response options that could help address the impact of climate change in these production systems and help Asian continent successfully manage its ongoing transitions.

Key words: water, food security, Asian transition, climate change

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USE OF REMOTE SENSING & GEOSPATIAL TECHNOLOGIES IN AGRICULTURE

ASIT SRIVASTAVA

Primarily Nepal being an agriculture dependent economy base as well as major part of its population deriving sustenance out of agriculture and the fact is that weather determines it productivity and which in turn impacts the economy. Cropping system in Nepal is quite varied and even within a single cropping season, the sowing dates vary to the tune of a month. At times double sowing of short duration varieties or re-sowing in failed crop areas is quite common.

Satellite images, remote sensing and geospatial technologies play a major role in agriculture identifying the different crop patterns in any particular area. Using the remote sensing technique one can estimate the yield of crop, crop damages, its presence or absence or land use change. Administrators could use information derived from satellite/UAV images to study the health of different crops and total area grown to estimate the productivity (acreage estimation).

Early warning systems for disease infestation like the locust, drought, and floods can also be provided to farmers in a timely manner to take precautionary measures. Crop insurance companies could use satellite/UAV images to study the different crop patterns, presence or absence of crop on the ground, to identify crop damage areas, reason for crop damage, to estimate the yield.

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IMPACT OF EARTHQUAKE ON WATER RESOURCES IN SELECTED EARTHQUAKE HIT AREAS

SOMNATH POUDEL[1] & ANJU AIR[2]

Earthquake has been notoriously damaging Nepal since time immemorial. Among the several impacts of earthquake, the impacts on physical, social and economic sectors are more documented. While, the impacts on environmental sectors, for example, ecosystem, species and genetic level has been less documented. This study encompasses the visible impacts of earthquake on water resources of selected earthquake hit districts by Gorkha earthquake of 7.8 M on Richter scale. The main objectives of the study were i) to assess the status of water resources (water quantity and quality) ii) to explore the associated impacts due to loss of water resources and iii) to assess available protective measures/disaster preparedness with regard to water resources. Dapcha-Kashikhanda Municipality (Ward No.14) was studied in Kavre-palanchowk district and Dakshinkali, Chandragiri, Kirtipur Municipalities & Bagmati river have been studied in Kathmandu district.

The quality and quantity (status) of water resources were identified through visual observations, associated impacts and available protective measures were identified through Key Informants Interview (KII) and Focus Group Discussion (FGD). The study revealed that most of the ponds, stone spouts and springs in the areas were substantially affected. Ponds have been adversely affected by the earthquake in Dapcha-Kashikhanda Municipality. The study showed that almost 36% of the ponds and 14% of stone spouts have been completely dried out of 35 studied water resources in Dapcha-Kashikhanda Municipality. Similarly, almost 14% springs got increased water flow in the area. Unlike to Dapcha-Kashikhanda Municipality, most of the stone spouts have dried in the Chandragiri Municipality, Dakshinkali Municipality and Kirtipur Municipality in Kathmandu District. Besides the earthquake, there lies other factors responsible for drying up of water resources. The flow of water was either increased, decreased or static. There have been also reported pseudo-changes in the quantity and quality of water in all study sites. Locals have to face adverse impacts due to the scarcity of water such as loss on agricultural production by direct impact on Farmer Managed Irrigation System (FMIS), problems in animal husbandry, hurdles in daily activities, perturbation of social harmony and impact on aquatic ecosystem etc. Unfortunately, locals lack any plans to enhance water security except in Dapcha-Kashikhanda Municipality and Bagmati River Basin (BRB). The efforts of locals in conservation of Daraune-Pokhari Pond (Dapcha-Kashikhanda Municipality) as recharge pond is praiseworthy. Likewise, BRB is being managed by High Powered Committee for the Integrated Development of the Bagmati Civilization (HPCIDBC) to ensure water security in Kathmandu valley.

The study recommends that the water security in the areas can be achieved through rain water harvesting, restoration of traditional spouts, identification and conservation of recharge ponds. Likewise, improvement of water supply services are important to meet the water demands. It is mostly said that there is no problem of water availability in Nepal, the existing problems are due to the socio-economic water scarcity. Socio-economic water scarcity is caused in absence of infrastructures, coordination and implementation problems among institutions.

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PEOPLE, PLAN AND PARTICIPATIVE MUNICIPAL PLANNING OF NATURAL RESOURCES MANAGEMENT IN NEPAL: AN ILLUSION

NARENDRA RAJ PAUDEL[1] SRIJANA PAHARI[2]

People's participation means an association of people in the process of plan preparation, plan implementation and benefit reaping by beneficiary citizens. Thus, it is said that people show interests, take initiatives, press demands and shoulder responsibilities in order to making effective planning process. Government of Nepal adopted policy to mobilize people in planning process in general and particularly at the local level. For example, Local Self-Governance Act 1999 mentions planning process as a mandatory provision to follow while preparing planning at Municipality.

In this context, the paper attempts to look into the question of natural resource management like water, air and pollution at the municipal level. The municipality has an administrative unit called Environment Department which is suppose to look into the management of these resources.

The question arises to what extent the participative municipal planning process is adopted and subsequently implemented the same plans. Sub-questions of this paper are: Does municipality forward guideline to each of its ward office in time? Does ward office inform Citizen properly for planning process? Is there enough people's participation to set plan which reflects need and aspiration of common Citizens? Are these plans decided by Council of Municipality and followed by implementation of these plans? To explore the answer of these questions, twelve municipalities were chosen purposively. The secondary data were retrieved from minutes of Ward offices of municipality, budget book of respective municipalities and documents of related to plan completion. This was followed by interview with executive officers and employee of respective municipality on the issues of the plan formulation and implementation. The study revealed that all municipality forwarded guidelines which were not clearly spell out about the way of operations. Citizens were not informed through proper channel about planning meeting. The plans were decided partially by Council of municipality. Therefore, the study concludes that the planning process at municipality of Nepal is illusion which does not reflect the real need and aspiration due to lack of human resource and proper homework. As the result, natural resource management does not get required attention.

Key words: Participation, planning, plan, people, Municipality, Ward office, Government of Nepal etc.

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REHABILITATION OF EARTHQUAKE AFFECTED IRRIGATION SYSTEMS AT DHAP VILLAGE, SINDHUPALCHOWK AND KALLERITAR IRRIGATION SYSTEM IN DHADING DISTRICT

PRACHANDA PRADHAN

Big earthquake visited Nepal on 25 April 2015. This brought tremendous damages in the houses of the people rendering them homeless. Communities and villages were destroyed by earthquake. It brought not only physical damages but also social and psychological uncertainty among the earthquake affected people.

As a temporary measure, tents, clothes and food were distributed by government, NGOs and foreign countries International non-governmental organization. However, these efforts of short term support was appreciable but these activities made the community dependent on others in the long term. The important question here is: How can they have long term food security? How can they have rebuilding of village and community? Rebuilding of the community confidence was a big challenge. April is the time that farmers need to get prepared for monsoon paddy cultivation. Unfortunately, many irrigation systems got damaged by earthquake. Then, the question is: How can the community be revitalized? Let us analyze the community capacity based on 5 capitals for sustainable livelihood approach.

This presentation aims to take the cases of Dhap village of Sindhupalchowk and Kalleritar village in Dhading district. In both cases (Dhap and Kalleritar) due to damage of physical capital, even the natural resource like water supply got disturbed in the farm lands of the villages. Both physical and natural capitals of these villages got damaged. This situation rendered villagers to be uncertain for long term food security. Due to physical and natural capitals, financial capitals got disturbed for any further activities in the village. However, two resources like that of human (death from earthquake destroyed infrastructures) and social capitals did not get directly destroyed. This paper aims to look at the role of the human capital and social capital to bring back the jovial village and confidence among the villagers.

In order to rebuild confidence of the villagers, support for long term food security is considered important. This is the time for preparation for paddy cultivation which gives them long term food security by cultivating paddy. The important input for timely paddy cultivation is the village irrigation systems in both villages. Discussed with the villagers, how can they rebuild the village irrigation systems (FMIS)? Can they do it by themselves? In both villages, farmers expressed that they can do by themselves provided some external financial resources are made available to them. They have been managing these systems by themselves for long period of time. On the basis of the discussion, FMIST made funds available to the farmers WUA for rehabilitation. They took responsibility for rehabilitation.

While doing this exercise, local leadership, local technology local materials, local skill were used. In short period of time, they made temporary rehabilitation and brought irrigation water to the farmers field. Once they made the water flow in the canal, other problem was the paddy seed. Whatever they were saving from last year got buried in the destroyed house debris. Paddy seeds were made available to them. Finally, they could cultivate the paddy field and harvested paddy which provided food security and confidence among the villagers. By making use of existing social capital of the villagers and human capital could bring the functioning irrigation system back.