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NEWS UPDATE

Minister visits to Proposed Headworksite of Sunkoshi Marin Diversion Multipurpose Project

Hon'ble Minister of Energy, Water Resources and Irrigation Barshaman Pun visited the proposed headwork site of Sunkoshi-Marin Diversion Multipurpose Project (SMDMP) on November 20th, 2018 . High level officials from Ministry and the department accompanied with the minister. Project Director of SMDMP, Mr Sushil Chandra Acharya has warmly welcomed the team at the site. Mr. Acharya explained the present status of the Project and briefly discussed for future plan. He also explained about the comparative advantages of various project options. Further, Mr. Acharya explained the plan for Marin river protection work. SMDMP is a project similar in nature to that of Bheri Babai Diversion Multipurpose Project (BBDMP) which is under construction in Western Nepal. It is presumed that the knowledge, skills and design of BBDMP can be replicated in the project. According to the Project Director, as compare to the cost of High Dam Projects (HDPs) the project of this nature can be constructed within limited budget and time with low social and environmental impacts and for the benefit of mankind.

It was informed that the Project Office will be established in Sindhuli at the premises of District Irrigation Division Office and procurement process for lands, consulting services, and other construction works will be initiated in the current fiscal year (FY 2075/76).

New Director General in the Department of Water Resources and Irrigation

Ms. Sarita Dawadi was appointed in the role of Director General in the Department of Irrigation and Water Resources on 26th December, 2018 (11 Poush, 2075). Ms. Dawadi is the first female director general in the department. She was working as a deputy director general before she appointed as director general of the department. A welcome program was organized in the department to welcome the newly appointed Director General. All high level officials from the department including the deputy director generals, project directors and section chiefs were attended the welcome function.

The newly appointed Director General, Ms. Dawadi expressed that with tremendous support from all staffs in the department, she can overcome all the problems and make successful completion of all projects within their targeted deadline. Prior to the welcome program, DG Ms. Dawadi was warmly received by the DDGs, senior officers and staffs of the WRID at premise of the Department. Editorial Board of Irrigation Newsletter expresses hearty congratulation to new

DG Ms. Dawadi and wishes her successful tenure in the department.

Further, Mr. Shishir Koirala, project Director of WRPPF was transferred to Multipurpose and Large Irrigation Projects Division of the department as a Deputy Director General. Mr. Maheshwar Nar Singh KC is appointed as Project Director of Irrigation and Water Resource Management Project (IWRMP) Further it was decided that the office of WRPPF now being directed under the project director of Sunkoshi Marin Diversion Multipurpose Project Mr Sushil Chandra Acharya.

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Editorial

World Water Day

Only a small portion of 2 to 3 % of total available water on earth surface and its beneath is suitable for consumption by all theliving creatures on the earth including plants and animals. So there is a situation of intense competition among the living creatures for available water resources for their life. The competition is getting intense day by day as the available scarce water resources is becoming more dearer for coming days to face. Recent studies in the developing world revealed that water resource in the areas where drainage densities are high has been reduced due to anthropogenic activities, whereas the draught areas has still the problem of severe shortage of fresh water to consume for settlements. Another research work's preliminary result shows that 35 per cent of the population of developing world lack of hygienic water for consumption and estimated that half of the population will not get access to hygienic and freshwater. Last year, a government study revealed that nearly half of India's population—some 600 million people—ekes by on scarce or polluted supplies of water. As many as 200,000 Indians die annually from the effects of water contamination. And it's been projected that more than 20 major cities—Delhi, Bangalore, and Hyderabad among them—will zero out their groundwater stores in less than two years (National Geographic, 2019 March).

The theme for World Water Day 2019 is 'Leaving no one behind,' which is the central promise of the 2030 Agenda for Sustainable Development: as sustainable development progresses, everyone must benefit. Today, billions of people are still living without safe water, which means 'safely managed drinking water service': water that is accessible on the premises, available when needed, and free from contamination. Their households, schools, workplaces, farms and factories struggling to survive and thrive. Marginalized groups – women, children, refugees, indigenous peoples, disabled people and many others – are often overlooked, and sometimes face discrimination, as they try to access and manage the safe water they need.

The human right to water entitles everyone, without discrimination, to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use; which includes water for drinking, personal sanitation, washing of clothes, food preparation, and personal and household hygiene. People are left behind without safe water for many different reasons. The following are some of the 'grounds for discrimination' that cause certain people to be particularly disadvantaged when it comes to accessing water: Sex and gender; Race, ethnicity, religion, birth, caste, language, and nationality; Disability, age and health status; Property, tenure, residence, economic and social status; Other factors, such as environmental degradation, climate change, population growth, conflict, forced displacement and migration flows can also disproportionately affect marginalized groups through impacts on water. To 'leave no one behind', we must focus our efforts towards including people who have been marginalized or ignored. Water services must meet the needs of marginalized groups and their voices must be heard in decision-making processes. Regulatory and legal frameworks must recognize the right to water for all people, and sufficient funding must be fairly and effectively targeted at those who need it most. So the main theme of World Water Day, 2019 is 'Water for all'. ●

9th Meeting of Koshi Gandak Joint Committee Organized

The ninth meeting of Nepal - India Joint Committee on Koshi and Gandak Projects (JCKGP) was held at hotel Himalaya of Kopundole, Lalitpur on November 28th and 29th, 2018. In the meeting, Mr. Saroj Pandit, the then Director General of the Department of Water Resources and Irrigation, led the Nepalese team and The Indian delegation was led by Mr. Tripurari Sharan, Additional Chief Secretary, Water Resources Department , Government of Bihar, India.

The team leader of Nepali Delegate Mr. Saroj Chandra Pandit welcomed the Indian delegation in Kathmandu and briefed about the mutual benefits of the Koshi and Gandak Projects. He also highlighted the cordial relationship between two friendly countries and expressed hope that it will further deepen in the days to come. He further stated that Koshi and Gandak Projects symbolize our common efforts to resolve common problems of flood and draught faced by the people of the both countries.

In the opening remarks, Mr. Tripurari Sharan, team leader of Indian side thanked the Nepali delegate for the warm reception and hospitality accorded to him and his team during their visit to Nepal. He mentioned that the Koshi and Gandak projects signify the close and excellent cooperation between India and Nepal. Many Issues pertaining to the projects have been resolved and the meeting would address all the remaining outstanding issues in the spirit of the Koshi and Gandak Agreements and for the

betterment of lives of the people of Nepal and India. During the opening remarks he also introduced the other members of the delegates.

During the meeting bilateral issues of agendas raised in the 8th meeting on inundation, damages due to submerged land and crops and its compensations were reviewed. Further, issues regarding the provision of agreements made during the treaty of Koshi and Gandak projects, operation and maintenance of the projects and timely operation of canal and proportion of irrigation water released during the canal operation were also duly discussed. Problems of timely repair and maintenance of liaison office blocks were also raised. Indian side agreed to resolve the issue within the 6 months in this regard. The two team also agreed to depute security personnel at the project sites and send the request to related wings for further earliest actions to resolve the issues. At the end of the meeting both team agreed upon to organize the next joint committee meeting in appropriate location and time in future to review the progress of decision made during the meeting and the leaders of both delegates signed on the minute of the joint committee meeting at the end.

In consequence, the 8th meeting of Joint Standing Technical Committee (JSTC) on ministerial level was held in New Delhi India during January 9th and 10th, 2019. The 8th JSTC meeting was attended by Nepali delegate led by the Joint Secretary of Ministry of Energy, Water Resources and Irrigation Mr. Sushil Chandra Tiwari. The Indian delegation was led by Chief of Ganga River Flood Control Committee Mr. Arun Kumar Sinha. Ms. Sarita Dawadi, the newly appointed Director General of the department also joined the meeting. During the meeting, the issues of Koshi and Gandak Projects were also reviewed and discussed.

Review meeting of Progresses of 3rd Quarter and Annual Period of Fiscal Year 2074/75 organized

Review meeting of progresses of 3rd quarter and annual period of the fiscal year 2074/75 was organized on August 23 th 2018 in the Ministry of Energy, Water Resources and Irrigation (MOEWRI). The meeting was chaired by honorable minister of Energy, Water Resources and Irrigation Mr. Barshaman Pun. these cretaries of Minsitry of Energy, Water Resources and Irrigation Mr. Anup Kumar Upadhyay (Energy sector) and Dr. Sanjay Sharma (Irrigation sector) incuding Other high level officials from the Ministry and the department also attended the meeting.

In the meeting, the progress made so far in the energy sector and irrigation sector were widely discussed. Mr. Dinesh Kumar Ghimire, Joint Secretary, (Energy) MoEWRI well described the present situation of the energy in the country and progress made during the fiscal year of 2074/75. Similarly, Mr. Sushil Chandra Tiwari, Joint Secretary, Water Resources & Irrigation MoEWRI presented the progress made in the irrigation and Disaster management related to Water Resources during the last fiscal year. It was highlighted that the overall physical progress of 60% were achieved out of the target in the fiscal year under discussion in the energy sector. The financial progress in the energy sector was 68%. On the other hand, the annual physical and financial progress achieved in the last fiscal year was 92.13 and 89.85 % respectively in the Irrigation Sector. A separate report as presented by the director general of the department of water resources and irrigation claimed that the

overall physical and financial progress of the department was 92% and 93% respectively for FY 2074/75.

At the end of review meeting, chairman of the meeting and honorable minister Barshaman Pun expressed his satisfaction with the progress made so far and also wished for further improvement in coming years.

Responsibility transfer in the Department of Water Resources and Irrigation

A few responsibilities were changed in the department during the period of this issues of newsletter. Mr. PradipThapa was transferred to the Water Induced Disaster Management Division of the department. Mr. Mohan Kumar Shakya, Mr. Prakash Chandra Pokhrel, Mr. Ramesh BanduAryal, Mr. SanjeebBaral, Mr. Shiva Kumar Basnet were transferred to Narayani River Management Project, Irrigation Rehabilitation Project (Kuwait Fund), Karnali River Management Project, Bheri-Babai Diversion Multi-Purpose Project, and Energy and Irrigation Development Program respectively as a Project Director of the respective Projects. Similarly, Mr. Krishna Nepal, Mr. Susheel Chandra Acharya and Mr. Hari Ram Shrestha were given the responsibility of Sikta Irrigation Project, Sun-Koshi Marin Diversion Multipurpose Project and Sunsari-Morang Irrigation Project as the Project Director.

TRAININGS/WORKSHOPS/SEMINARS

Nepal participated in the ICID International conference held in Canada

Nepal actively participated in the ICID International conference and 69th International Executive Council (IEC) Meeting of ICID which was held at Saskatoon in Canada during August 12th to 17th, 2018 with main theme "Innovation and Sustainable Agri-Water Management: Adapting to a Variable and Changing Climate". The President Honorary, Dr. Chandra A Madramootoo conducted the opening ceremony of the conference. On behalf of Government of Canada, Hon'ble Ralph Goodale, Minister of Public Safety and Emergence Preparedness Welcomed Participants of the Conference. During his speech, Mr. Goodale remarked that water is critical to agriculture in the Prairies and to realize that potential in the face of frequent floods and draughts caused by climate change and better water management is essential. As representative from Nepal, Member Secretary of Nepal National Committee of Irrigation and Drainage (NENCID) and DDG of WRID Mr. Bashu Dev Lohanee attended the conference and IEC meeting. The Conference focused on other three sub themes namely a) Competing Water Demand; b) Resilient Agriculture – Adapting Agriculture to Climate Change; and c) Irrigation and Drainage in Perspective.

During the conference, event of plenary session with two main concerns were highlighted. Firstly, the growing challenge of climate change leading to extreme floods and draughts situation and secondly the food security threat for growing population stemming from unsustainable global water use. Concurrent sessions of the conference focused on drainage and flood control strategies for resilient agriculture and irrigation infrastructure development with climate smart innovative technologies for enhancing water use efficiencies. During the sessions, exceptional irrigation examples of Saskatchewan were also discussed. Food and Agriculture Organization of United Nations (FAO) conducted sessions on' Hydro-economic modeling for transboundary river basin management –Toward more Integrated Approaches' and 'Data- driven Improvement of water use efficiency in Small-scale Irrigation.'

'Irrigation Production Forum' and 'Financing Irrigation Forum' were also organized during the conference. The forum focusing on the irrigation production highlighted the challenges encountered

due to evolving landscape and increasing global population needs and the opportunities arising with modernization and advancements in Science and Technology. Other parallel sessions included topics such as Irrigation and Water Resources Management in Transboundary Basins, Managing Competing Water Demands, Climate Change and its Impact of Agriculture, Irrigation and Drainage, Irrigation Water Footprint and Drainage and Flood Control Structures. As capacity Development, Training events for young professionals were also organized on classroom sessions on the development, regulation and maintenance of Canadian Irrigation Systems. The sessions further enhanced by technical field visit arranged for the young professionals focusing on soil sampling and modern techniques of irrigation scheduling and use of drone cameras to capture data through remote sensing. As a part of conference, several technical tours were organized for the participants. A pre-conference tour covered South Saskatchewan River Irrigation District(SSRID), which included visits to various crop fields, advanced tools and technologies and irrigation research. During the tour, participants got opportunities to visit SSRID focusing on the water conveyance infrastructures, other farm areas Saskatoon with varieties of crops and value-added products, where drip irrigation is majorly used.

FEATURE ARTICLES

Bagmati River Basin Improvement Project

Rajendra P. Adhikary*

Background:

Bagmati river basin as whole comprises of six river tributaries namely Bishnumati, Rudramati or Dhobikhola, Ichhumati or Tukucha, Manahara, Nakhu khola and Balkhu khola. From the origin at Shivapuri Baghdwar to Katuwal dhaha Chauvar, the Baghmati river is constantly fed by the tributaries and sub tributaries that drain the rain water of the Kathmandu valley

form the time of valley formation as a settlement area. There was a time in history of valley civilization when Bagmati river possessed adequate flow of water from the green mountain spring sources to sustain well balanced river ecosystems for the joyful livelihood of diverse aquatic creatures, flora and fauna along its serpentine path of movement. In the present context, the rapidly growing urbanization associated with unsystematically located infrastructures sprawling wide over the valley has converted the once pristine water flow of the Bagmati river into the drainage of dirty polluted swear delineating Bagmati river as a biological dead river - not useable for human beings and the aquatic lives. The Bagmati river basin despite being in pathetic condition, owns numerous temples and monuments on its bank built during the golden days of earlier civilization. Pashupati nath temple complex and Changunaryan are the two world heritage sites including many other historically significant complexes that reminds Kathmandu valley as an outcome of Bagmati river civilization.

Improving the water flow in the river within the WHO acceptable quality, regeneration of lost river echo system to establish suitable environment for aquatic lives and restoration of heritage at the bank of the river has been the long term objective of the Integrated Development of Bagmati Basin Civilization program in a project mode of execution. The various ongoing action plans associated with modern technologies that intervene in an integrated approach may bring back the Bagmati basin civilization in its earlier form with technologically modified shape.

The action plan is based on program of interventions in accordance to the categories of valley area Zoning. The outer periphery has been kept under the categories of natural conservation zone, rural zone and semi -urban zone respectively that comprises of 75% of land area in green hills and sloppy hill foots where the river water are less polluted than the highly populated Urban zone where the water quality of river is worst with mixing of domestic seaware.

Program components and the areas of focus:

Upstream catchment area:

This component of program focus on the conservation and management of upper slopes of Mahabharat hills around Kathmandu valley that primarily includes Shivapuri national park (SNP) and water catchment area of Bagmati river. The ongoing activities around national park are watershed improvement to regenerate spring water sources and the construction of rainwater harvesting 24 meter high Dhap dam. Spread in the area of 12.5 hector, the Dhap dam can store 8.5 lakhs cubic meter of rain water to release clean water flow to Bagmati river in Pashupati area ,thus improving the quality and quantity of Bagmati water up to the WHO bath able standard. Project Implementation Unit irrigation has been executing the project of dam construction under Design and Built approach along with the massive trees plantation work to comply the environmental need of watershed safeguard. In the course of two years time, reservoir on the hill top of dense forest Shivapuri area may not only be the natural hangout of the popular tourist destinations, but remains as a massive water body in the middle of the forest to improve microclimatic condition of the valley and its surroundings. Presently suffocating urban population of the valley may well get respite from the city cacophony within a short destination of 21 kilometer road uphill due North.

Improvement of Bagmati River Environment:

Improvement of river environment is focused in the downstream part of the river that includes the stretch of Bagmati river in Gokarna Uttergaya to Teku Dhovan. Numbers of additional waste water treatment plants are proposed to be constructed at the bank of the Bagamati river to purify the accumulated drainage water flowing through the main tributaries. In order to address holistic scenarios of Bagmati river and its surroundings, an strong implementing agency by the name of High powered committee for Integrated Development of Bagmati basin Civilization (HPCIDBC) with the financial and technical aid from Asian Development Bank has been actively engaged to execute the different components of program in the phase wise project modality. The inner sprit of the program interventions is to make urban people more close to the river environment in their daily lives, making communities more responsible in rejoicing the clean river water to carry out their daily religious and cultural rituals. Within the scope of current project, numbers of Ghat steps associated with the water drop structures are constructed in order to facilitate the easy access to the holy bathing population right in the river reach. The water drop structures besides forming the pool of water at the Ghat steps purify water by aeration phenomenon. The island and terraces located patch wise along the river are planned to make a green pastures with the aquatic plants surroundings which besides improving the river environment purifies the river water biologically extracting nutrients of the polluted water. Both sides of the river bank have got the green landscapes along with the paved foot path and the cycle track. Traditional and heritage work has been preserved by the use of flag stone pavement and natural hill stones cladding on the concrete made structures along the bank of the river. Several temples and monuments including mourning houses, inns and shelters built during the Lichhebis, Malla and Shah dynasties are planned to restore in its original architectural form. All theses heritage asset created in the project mode needs to be sustainably maintained in order to high light the cultural value of the Bagmati river basin civilization in the days of future generation. A basin level organization to be formed with HPCIDBC comprising of various stakeholders including the local, state and provincial government, will manage the entire asset developed in the basin-based on stakeholders participatory approaches by formulating Bagmati basin management acts and regulations.

Conclusion:

The day by day deteriorating environmental quality of Kathmandu valley - where the high political and administrative centre to run the country along with all the foreign diplomatic missions and the international organization like United nation

offices are set up- have been the prime concern to everyone. Kathmandu, besides being the knowledge and power centre for the all round development of the Nepalese people, makes a firsthand impression of the country when the visitor come here. A wider conscience based participatory initiation to be tied with the spirit of continuing Bagmati cleaning campaign and Bagmati River basin Improvement Project would ease the valley denizens to leave in clean and green valley in future not too far.

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Water pricing helps System Sustenance

✍ **Santosh Kokh-Shrestha***

Introduction

The collection of Irrigation Service Fee (ISF) started in Nepal after providing irrigation service in the systems operating under joint management of government and water users started collecting effectively in most of the systems under operation and maintenance (O&M).from last two decades. Till now, less than half of the systems regularly collect ISF. The practice has been initiated on voluntary basis with minimal water service charges in most of the irrigation systems. The collected service charges are considered to cover operation and maintenance cost of the systems to an extent. Most of the operation and maintenance cost are being covered by the government itself by annual budget in these systems. Against such practice, most of the farmer managed systems in Nepal have their own practices of raising the cost of operation and maintenance through their labour contributions and compulsory contribution of cash and kinds from each household of the beneficiaries, which makes it possible the system to sustain with almost local techniques from centuries back (Shrestha, 2017). As expressed National Water Plan, 2005 is it the target set to recover of O&M costs with collection of ISF share to 75 percent at the end of 2025 (WECS, 2005). Nowadays, however, recent trend shows that the total ISF collection amount to hardly 3.2 percent of average of total annual O&M budget allocation by Government in these systems.

Recently, some of jointly managed systems operating with surface sources have revised their irrigation service charges to moderately acceptable rate to cover the operation and maintenance cost. Others are raising their ISF charges on traditional rate and bases. Some other systems using lift and pumps have efficient mean to collect irrigation service fee (ISF) and have practices to raise the fee with the help of cost of consumed power to irrigate crops in the systems. So the farmers are being asked to pay higher irrigation service fees in these systems from the beginning.

Water productivity and water pricing

Productivity, in general, is a ratio referring to the unit of output per unit of input. Water productivity (WP), is a modern concept of measuring irrigation efficiency after Molden,et.al (1997, 1998, 1999, 2001), Perry,(2007, 2009, 2011), in broad term, which replaces classical concept of irrigation efficiency (Heydari,2014). Kanooni and Monem, 2014 and Baghei et al ,2013 indexed the method of calculating water productivity referring to relative yield to relative crop evapotranspiration as Doorenbos and Kassam function. WP interlinked with water pricing, considering water as economic good can broadly viewed for its numerous users and their rights over the limited resource (Hussain, 2004). In a study, as indicated by Baghei et al. ,2013 adopted after Molden et al 1998, Saktivadivel, 1999, as crop per drop (CPD) or apply irrigation water (AIW) as Kgm^{-3}. The performance indicator of irrigation practices adopted by Fraiture et.al., (1998) included gross production per unit command area; gross production per unit irrigated area; gross production per crop evapotranpiraton (ETo) in few irrigation systems under O&M. Units to measure the performance mentioned terms were $Rsha^{-3}$ and Rsm^{-3}.

Considering water as economic good (Helleger, 2006), this scarce resource with good price will have its optimized uses and saved water can be diverted and distributed to the other sector, where it can be further utilized. Such optimized practices are frequently prevailed with groundwater uses, where certain energy will be applied to bring up required amount of water to irrigate with minimized cost. Pay for water to utilize it optimally is for maximizing profit. Prompt pay for water will extend timely and quality service for maximizing benefit per unit input amount. The practice paying for water will also institutionally strengthen the organization, which is providing services and the trend will further be improved. Helleger with reference to Savenije, 2000 and Perry et al,2001 indicates treating water as economic good and is making about the right choice but not necessarily about setting the appropriate price as is often believed. Nor does it mean that water should be allocated by competitive market price. Furthermore, it is important to make distinct among price, cost and value of water. Pricing envisaged to the sustaining system for quality service and timely movement of requisite activities in ultimate evidences. Water pricing allotted to the sustaining systems used to achieve various objectives as cost recovery, optimizing water demand, improved allocation of water and much better productivity of water (Helleger, 2006). As Baghaei et al (2013) referring to Sarwar and Perry (2002) indicated low irrigation condition in wheat increased water productivity to 1.46 kgm^{-3}. Further, better water productivity would help to meet rising demand of food, to respond the pressure arising with water reallocation from agriculture to other remaining sectors, to reduce poverty and enhance food and nutrition security situation (Baghaei et al, 2013). As adopted from Hellegers, 2006, water pricing rate may get as low as its marginal value and such such conditions may prevelled due to government subsidies on

actual marginal value of the water. The marginal value of water ranges from Rs 5.8 ($ 0.01) to 16.6 ($0.15) m^{-3} depending upon the price of agriculture crops. With actual pricing of water in Bhairahawa Lumbini Groundwater Irrigation System (BLGWIS), the price of water nowadays farmers are paying or ready to pay is more or less same to above mentioned rate. Carruthers and Clark (1983) with various references concluded that irrigation charges levied in around 1974 varied from 10 to 15 per cent of gross outputs.

Case of BLGWIS

The advantage of groundwater over the surface water resource is that farmer in group will neither have to wait longer nor they have to build irrigation schedule as usually have been developed in surface irrigation systems. The beneficiaries could abstract, whenever their crops needed water or when it would be convenient to apply the source and have more flexibility with cropping and irrigation facilities as a drought proofing method and stabilize year round crop yield (Bourfa and Kuper, and Madramootoo, 2012). Other advantages are, water accountability as with the account of pump operation, the amount of water withdrawn could be easily calculated and irrigation charge for payment would be accounted transparently. So groundwater based systems are economically and socially more efficient than the surface system (ibid). As referred by Bourfa and Kuper to Shah and Bhattacharya(1992), certain groups of farmers share the investment and running cost of deep tubewells and proved their viability without subsidy and government intervention in the evidence in Gujarat of India. Similarly, BLGWIS, being an Agency managed irrigation Systems with clusters of developed deep tubewells 169 in number provide year round irrigation facility with individual tubewells. BLGWIS system itself is not an ideal system, it has one third of tube wells become defunct due to various reasons. Most of defunct tube wells are from phase II of project (fig. 1). But remaining tube wells are operating with self sustaining system.

System is operated for more than three decades with water users' effort (the life exceeding Project normal period), through their institutionalized organization, strong bonding and timely operation of pumps and canal networks with the provision of resources collection and mobilization and indeed minimized evidences of conflict on water uses. Such institutions are called self sustained through participatory irrigation management activities (Budthapa, 2012). The system is with continued support from governmental agency with nominal allocation of operation and maintenance (O&M) budget. Fee due to irrigation service has timely been paid by its beneficiaries with its highest rate in Nepal i.e. Rs 220/per hour of pump operation exclusive of additional demand charge (which is reduced to half of its previous value after negotiation made between water users and Nepal Electricity Authority (NEA) in 2003 (BLGWIS, 2017).

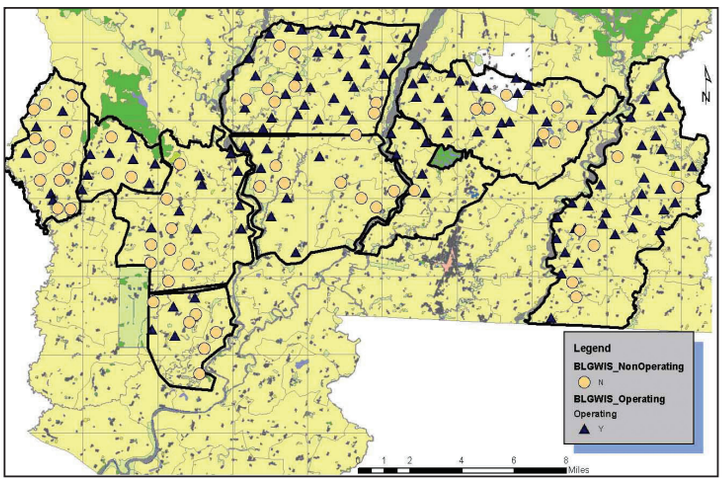

Fig1: BLGWIS tubewells status, (small circlet is for tube wells not operating small block trinaglet is for tube wells operating) by 2017

As indicated in the beginning of SA Report, the success of the project depends on water users' acceptance of the responsibility, for O & M of the irrigation and drainage networks served by each tubewell and reservoirs (in implementation phase reservoirs were not constructed so far), for repayment as developed structures would be handed over to the users. The Bhairahawa Lumbini Groundwater Project Office (BLGPO) would continue to be responsible for the O & M of tubewells, electrification networks and service roads. Further, at initial stage, the back bone of assured O&M budget provision by the government to sustain the system is reserved with store of necessary spare parts requisite for operational ease (IDA, 1984, 1990).

In the beginning, pumps of BLGWIS were operated on annual average of 980hrs causing operation cost Rs.8.6 million per pump per annum. The operation cost was burden upon the project itself. After turnover of pump operation responsibility to water users, the operation hours has been curtailed to annual average of 330 hours, which not only shift the burden of O&M cost from government, but also reduced the cost to one third of initial operation cost. The power also has significantly been saved. With this action it was expected that crop production and agricultural activities will be adversely affected, but after steady moment in starting period, the agricultural productivity has significantly increased in the following years (Gurung, 1997). This is the true evidence of water pricing, which also indicates the optimizing resource use. Recent record of pump operation shows that average annual pump operation does not exceed 150hrs for pumps and 200hrs for artisans. A way of raising economic efficiency of water use in irrigated agriculture is deficit irrigation, which will bring cost down below the level required for maximum yield; the cut in cost means that profits are higher enough. The economic targets mean to maximized financial profit per hectare with reduced costs maximize profit per m^3 of irrigating water (Wolff and Stein, 1998).

Expectation of Improvement

Recent reports (2015-17) of monitoring shows O&M expenses by irrigation offices considered in average 90 per cent of allocated budget and rehabilitation cost, development

of irrigation networks with repairs of regulators and gates in case of surface irrigation, replacement of old transformers, accessories of pumps in case of ground water irrigation through electricity and other spare parts for the last two years were also added to the cost. Monthly record of Pump and Artisan operation with their respective discharge capacity were used to calculate the water productivity (Rsm^{-3}) to all networks through respective pumps and artisans. With different rate of water charges graded with pumping capacity were utilized to calculate ISF target. Due to accountability of every records of water lift and its time charging is easy in Lift and Tube well irrigation systems. But due to many factors like actual amount of water in open channel, its conveyance losses during service delivery it is quite difficult to decide how much its service rendered to the farmers field at farm outlets of the systems. The amount of O&M expenses and collection of ISF for last ten years are shown in Table 1 below. With the raised amount in ISF, we can also see that rate of ISF collection against O&M expenses in declining trend. As compared to the share of ISF to O&M expenses ten years back the last years' ISF share is quite discouraging. Due to quite low rate of ISF, surface irrigation is cheap mean to apply its irrigation in crop cultivation, but construction of large massive infrastructure is not with the capacity of even wealthy farmers. Even government plans to construct such projects to an extent with the assistance of foreign countries and donor agencies, after completing feasibility studies and appraisals. And indeed, it takes time of a decade or a couple of so to complete. Farmer may prefer these large and medium sized irrigation projects, as these projects provide them irrigation water at low cost. Water from large scale projects is often highly subsidized if not entirely free. Further, farmers prefer larger systems instead of small, because they have to bear the burden of loan at larger share in case of small systems (Ostrom, 1992) and prevails risk of not operating on its full capacity.

The state of ISF collection from irrigation systems under O&M in Nepal is not encouraging. In some of large systems farmers have practice of ISF collection at Rs 60.0 (US$ <0.50) per annum and in few system only less than ten per cent of farmers are willing to pay regularly. So, in such situation, annual O&M cost of the system is almost sole burden to the government. Very few systems have their water users to pay their ISF at high rate (Rs. 190-220 per hour of pump operation in group of average 100 heads in BLGWIS, and Rs 750.0 per crop per annum in Marchawar Lift Irrigation System, MLIS). In contrast the return of crop cultivation per annum to farmers in these systems is quite higher as compared to the low rate ISF and low paying systems in average. Why this is happening is obvious i.e. timely maintenance and operation of canals in the system, which ultimately leads to system sustainability. Farmers are enjoying the three fold production rate nowadays as compared to earlier without project production in these systems, The rate of production is almost doubled to the rate indicated as after project in SAR of these projects (IDA, 1984, 1990 and BLGWIO, 2017).

Some systems recently revised the rate moderately and in the situation of sum amount of ISF has been slightly improved in a recent couple of years. Recently, a relatively small sized system in Gandak Pradesh, water users' general assembly recommended the annual rate of ISF as Rs.3,200/-per hectare per annum (Paudel, 2018). It is good indication that farmers are willing to pay for the rendered irrigation service to their farm and it is also expected that the amount collected through ISF will cover the O&M cost to a full extent. This incident may be a good example for the water users in other systems. Practice of pricing water itself in the long run is a welfare practice for farmers water users themselves in the long run. It will ultimately deduce good result economically and socially to optimal use of optimistically available scarce natural resources, there are indeed no other alternatives for this.

Willingness to pay the right proportion by water users is to be determined with the help of marginal value of their annual production to marginal cost they bear including irrigation as one component of cost to their farm production. Optimum willingness occurs where marginal value equalizes marginal cost. Actually, price of irrigation itself is farmers ready to pay against irrigation service rendered to increase their crop production by unit rate i.e. how much unit of production is increased with unit of timely applied increased unit of irrigation water. But in case of surface irrigation it is just impracticable to measure exactly such unit benefit against unit cost. So the term willingness to pay is appropriate for their average net incremental benefit with increased irrigation service. With various externalities including exceeding private use of the source may cause internalized externalities (Hellegers, 2006).

Analytically, if all water users in every operating systems, ready to pay the amount of one fourth of the one which water users mentioned above ready to pay i.e. Rs. 3,200/- per ha per year,

Table 1: O&M Expenditure and ISF Collection

in Rs. '000

	FY065/66	FY066/67	FY067/68	FY068/69	FY069/70	FY070/71	FY071/72	FY072/73	FY073/74	FY074/75
O&M Budget	213393	350700	340465	457752	399230	398330	713966	1077524	1344884	1360094
O&M Expenses	172884	317112	320570	427566	379697	459537	663631	936799	1129116	1276628
ISF Collection	11962	13972	14692	15095	15991	14880	15444	16093	23739	21585
ISF % of O&M Exp	6.92	4.41	4.58	3.53	4.21	3.24	2.33	1.72	2.10	1.69

Source: Annexes 6 and 9 of Sinchai Barshik Pustika FY2069/70 -2074/75, WRID

the target of ISF in the running systems under O&M in Nepal against the poor situation of ISF collection against its full target which covers 2 per cent of its O&M expense is prevailing will cover almost one third of annual O&M budget of Irrigation Systems in Nepal. If the users are willing to pay the half of the above mentioned amount per annum, it will fulfill the target of collecting ISF which will cover almost half of the O&M budget. If all water users in every operating systems, ready to pay the amount Rs.3,200, it will fulfill the target of collecting ISF which will cover almost three fourth of the O&M budget that used to be allocated annually, in that condition it will fulfill the target of covering 75 per cent of O&M cost set by the end of 2027 by National Water Plan in 2005 (WECS,2005). Average annual income of Nepali people raised significantly to almost US$ 1,000.0 which is roughly equivalent to Rs. 1,13,000/- Say farmers' income in Nepal is slightly less than the average gross national income and annual payment for Irrigation service will be ~ 3 per cent of their annual income, while making the rate Rs100 per Kattha or Rs3,000 per ha per annum. Let the farmers first pay one fourth first i.e. Rs 750/- per ha per annum and do timely canal maintenance job for operation and see the result to be convinced.

Conclusion

Water pricing is the concept internationally discussed from a couple of decades back, but it is not in practice in Nepal in holistic form. With the experiences gained in various situations abroad, expected changes in income of water users may positively be changed with its other social benefit through optimal use and management of this scarcely available resource, for which concern of other sectors than agriculture is increasing day by day. Payment for the service rendered is a universal practice not only in case of using water. In democratic organizations like water users' associations, the institutions are raised to rule out the systems for sustainability with great effort of stakeholders. Low rate of payment than its actual price does not help individual to right use of available resources and to expect good service, ownership feeling to sustain the already developed infrastructures and system as a whole.

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Disaster Risk Management: Regulatory Framework in Nepal

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Introduction

Floods, landslides, droughts and other weather and climate-induced hazards are almost regular phenomena in Nepal. High socio-economic vulnerability of local communities; remote, rural, rugged and fragile geophysical environment mixing with unplanned settlement and population pressure, low social capacity to mitigate risk and prepare for difficulty create scenarios of high risk, inviting disaster. Those likely to suffer the most are the poor, marginalized and disadvantaged social groups, whose limited access to resources make them least able to adapt, prepare and cope to their uncertain environment. In order to address the root causes of vulnerability to natural disaster, Nepal is in the process of shifting its government policies towards proactive preparedness, mitigation and prevention.

A study carried out by UNDP/BCPR among 200 countries of the world, Nepal stands at 11th and 30th respectively with regard to relative vulnerability to earthquake and flood (UNDP, 2004). Because of these prevailing conditions World Bank (2005) has placed Nepal as one of the global hot-spots for natural disasters. Water induced disasters disrupt people's lives through displacements, destruction of livelihoods and property, deaths and injuries. Consequently they take back years of social and economic development of the country. This requires more vigorous attention and planning to mitigate the effects as they have impacted greatly on the country's fight against poverty and efforts to reduce the number of people living below the poverty line. The economic losses from the impact of floods, landslides and other natural disasters in the past have been estimated in billions of rupees. Reasons for the losses are attributed to insufficient public awareness, lack or inadequacy in preparedness, lack of early warning system, lack of coordination among inter-government agencies, inadequate financial resources, low quality of human resource in terms of skill in mitigation of natural disasters, and ineffective dissemination of knowledge and skills to the vulnerable population groups.

Data of flood and landslide shows that 3 percent of total annual budget and 4.70 percent of annual development expenditure is being lost every year by only these two types of water induced disasters. All the aspects for example institutional, organizational, structural, financial, and human must be functional for effective management of the disasters. This article tries to explain regulatory aspects of disaster management that the Nepal government promulgated. In the second part the article also displays the data series (from 1983 to 2018) on losses of human lives from various disasters.

1. The Constitution of Nepal, 2015

Nepal's current constitution mentions disaster risk management in the country for the first time and it has clearly assigned DRM as a concurrent responsibility of different tiers of governments, particularly the local governments. Article 51 stipulates the policies to be pursued by the state. The sub-article G that relates to "policies relating to protection, promotion and use of natural resources," mentions that the state shall formulate policies on development of sustainable and reliable irrigation by controlling water-induced disasters and expediting river management.

Article 273 of the Constitution gives the President several emergency powers. Article 273 (2) says, "if there arises a grave emergency in a State because of a natural calamity or epidemic, the concerned state government may request the Government of Nepal to declare a state of emergency in respect of the whole of the State or of any specified part thereof."

Table 1: Constitutional provision of assigning responsibility on matter of DRM

S.N.	Subject of schedule	Provision
1	Federal Powers/Jurisdiction	Land use policy, housing development policy, tourism policy, environment adaptation (#29)
2	Provincial Powers/Jurisdiction	--
3	Concurrent (federal and provincial)	Natural and man-made disaster preparedness,
	Powers/Jurisdiction	rescue, relief and rehabilitation (#17)
4	Powers/Jurisdiction for Local Level	Disaster management (#20)
5	Concurrent Powers/Jurisdiction for Federation, Province and Local Level	Disaster management (#9)

Constitution of Nepal has clearly stipulated that DRM is a shared responsibility of all levels of governments. While subjects on federal and provincial power are silent on DRM (with one provision of land use policy, housing development policy, tourism policy, and environment adaptation – remotely related to DRM assigned as federal power), the constitution clearly states that natural and man-made disaster preparedness, rescue, relief and rehabilitation responsibility falls under the concurrent power/jurisdiction of federal and provincial government. While twenty-two tasks are assigned to local level, disaster management is one of them (Schedule 8). In the list of concurrent powers of federal, provincial and local level, DRM is put as one of the subjects

(Schedule 9) – implying that DRM is a shared responsibility of every layer of governance system, but more so at downward level.

2. Disaster Risk Reduction and Management Act, 2017

On 24 September 2017, the legislative-parliament passed a new Disaster Risk Reduction and Management Act, 2017. The Act is considered far progressive than the hitherto existing Natural Calamity Relief Act, 1982 in many respects. First, its approach to disaster is much comprehensive and recognizes both risk reduction and management as integral part of the task. Second, instead of committee-based coordination mechanism, the Act has proposed a clear multi-tier institutional structure of disaster risk reduction and management (at the centre, the provinces, the districts and the local level). Third, there is also a clear provision of Disaster Management Fund at the federal, the provincial, the district and the local levels. Fourth, the law has given the security forces the responsibility of search and rescue under civilian command. Fifth, the Government of Nepal has the ultimate responsibility of declaring disaster emergency if circumstance emerges.

The most important of all, in terms of institutional structure, there will be a new National Disaster Risk Reduction and Management Centre (NDRRM Centre) at the Ministry of Home Affairs as the implementing arm of the government. The NDRRM Centre will be headed by a Secretary as the Chief Executive. The NDRRM Centre will work under direct supervision of the Executive Committee headed by Minister for Home Affairs. The Executive Committee, in turn, will make sure that the decisions and policy directives of the National Disaster Risk Reduction Council (NDRRM Council), the apex body headed by the Prime Minister, are implemented.

3. Other DRM Regulatory Frameworks

The Natural Calamities (Relief) Act was enacted in 1982. Although by its name it emphasizes the post disaster related activities, however, emphasis was also given to pre-disaster related activities such as preparation and mitigation measures besides relief and rescue operations. After the declaration of the International Decade for Natural Disaster Reduction (1990-1999) by UN, both the government and non-government agencies started to emphasize activities in areas related to preparedness against and mitigation of disasters in Nepal. The Act (1982) also made provision of Natural Disaster Relief Committees at central, regional, district and local levels and also two sub committees at central level.

Several efforts such as the National Action Plan on Disaster Management in Nepal (1996) were made to address different challenges posed by disasters in Nepal. The National Planning Commission developed Tenth Five Year Plan (2002 - 2007), and the Interim Three Year Development Plans (2007-2010 and 2011-2013) are the other important policies towards disaster risk management. The Guidelines implemented for distribution of relief materials to disaster affected people is another policy measure in that direction. Sector level policies on agriculture, water resources, health, housing building, mines and geology, etc. have also been playing major roles in managing disaster risks in Nepal.

Existing legal framework comprises the following:

3.1 Local Self Governance Act, 1999

The Local Self Governance Act, 1999 has promoted the concept of local-self governance within the decentralization framework for managing the environment-friendly development. The Act has given due emphasis to interrelationship between development process, environment, and disaster. The Act encourages local entities, i.e., District Development Committees (DDCs), Municipalities, and Village Development Committees (VDCs) for finding suitable solutions to local problems and challenges by themselves. In the absence of necessary rules, regulations, frameworks and predictable amount of budget, the Act was not effectively implemented by local bodies despite the responsibility given to them.

3.2 National Strategy on Disaster Risk Management (2009)

The National Strategy for Disaster Risk Management (NSDRM) (2009) was developed and enacted by government of Nepal in line with the Hyogo Framework for Action (HFA) (2005-2015). NSDRM is the result of the necessity felt for a concrete, meaningful and integrated document based on (HFA) reflecting the global common concept, which the United Nations declared in 2005 in participation of 168 nations including Nepal. NSDRM is a national framework on disaster risk management with commitment of the government to protect its citizen, properties, physical and cultural assets. NSDRM was developed and endorsed by government almost after five years of the HFA.

NSDRM (2009) tired to translate all five priority areas of HFA (2005-2015) into action. Therefore, based on the situation (policy, institutional mechanism, national capacity and financial resources), it emphasized the importance of mainstreaming disaster risk reduction to development at all levels. The NSDRM (2009) was useful to continue the advocacy on importance of mainstreaming DRR into development, capacity building, bringing private sector in DRR and post disaster related activities, and to some extent urban disaster risk reduction initiative in Nepal.

3.3 National Disaster Response Framework (2013)

The Government of Nepal endorsed the National Disaster Response Framework (NDRF) in 2013 with a view "to guide

more effective and coordinated national response in case of a large scale disaster" and its scope was : a) limited to the response preparedness and emergency response at national, regional, district and local levels, and b) it consisted of actions taken immediately before, during and after the disaster directly to save lives and property, maintain law and order, take care of sick, injured and vulnerable people, and to provide essential services and to protect public property.

3.4 National Adaptation Programme of Action (NAPA)

NAPA is a strategic tool to assess climatic vulnerability, and systematically respond to climate change adaptation issues by developing appropriate adaptation measures. The document contains a discussion of the national setting, the Nepal adaptation program framework, NAPA preparation processes and the methods and criteria used in prioritizing the proposed interventions, identification of key adaptation needs, lists of priority adaptation actions, and finally conclusions. Out of about 250 adaptation options proposed by the Thematic Working Groups (TWG), nine integrated projects have been identified as the urgent and immediate national adaptation priority. They are:

1. Promoting Community-based Adaptation through Integrated Management of Agriculture, Water, Forest and Biodiversity Sector
2. Building and Enhancing Adaptive Capacity of Vulnerable Communities Through Improved System and Access to Services Related to Agriculture Development
3. Community-Based Disaster Management for Facilitating Climate Adaptation
4. GLOF Monitoring and Disaster Risk Reduction
5. Forest and Ecosystem Management for Supporting Climate-Led Adaptation Innovations
6. Adapting to Climate Challenges in Public Health
7. Ecosystem Management for Climate Adaptation
8. Empowering Vulnerable Communities through Sustainable Management of Water Resource and Clean Energy SupplyPromoting Climate Smart Urban Settlement

3.5 Local Adaptation Plan of Action (LAPA)

Apart from the National Adaptation Program of Action (NAPA) the government has also prepared Local Adaptation Plan for Action (LAPA). LAPA provides guidelines for the disbursement of at least 80 per cent of adaptation funds on the implementation at the local level. To support implementation, the Government of Nepal has developed a national framework for LAPA , which aims to make adaptation planning a bottom-up, inclusive responsive and flexible processes that will identify the most climate vulnerable people and allow them to make informed decisions on priority adaptation actions. It provides an opportunity for undertaking developmental activities that are climate resilient with strong co-benefits for poverty reduction. The integration of local level Climate and Energy Plans with the LAPA could facilitate some triple-wins and produce low carbon climate resilient development (LCCRD). However, the biggest challenge to achieving these aims will be the quality of governance at all stages.

3.6 Local Disaster Risk Management Planning (LDRMP) Guideline, 2011

Keeping in view the need to develop disaster risk management from the central to local level and mainstream it with development plan, policy and programmes at all levels, and also in order to ensure the notion of sustainable development, the "Local Disaster Risk Management Planning Guideline, 2068" has been approved and put into effect. This was also done bearing in mind the main spirit and thrust of the National Strategy for DisasterRisk Management (NSDRM), 2009 and to make disaster management participatory, transparent, accountable, inclusive and responsible by optimally mobilizing local resources and capabilities, and by ascertaining the access and ownership of all affected communities and people.

3.7 Disaster Preparedness and Response Plan (DPRP)

Nepal is highly prone to natural hazards such as floods, landslides, fires, extreme weather events and earthquakes. Disaster preparedness activities are important as a precursor for a more effective humanitarian response and for reducing humanitarian caseloads during disasters. Experience confirms that an effective humanitarian response at the onset of a crisis is heavily influenced by the level of preparedness planning of responding agencies, as well as the capacities and resources available at all levels.

Nepal should therefore be prepared in case of emergencies and disasters due to natural hazards as mentioned above or man-made causes to protect it's people from personal injury and loss of lives and protect property from damage. Emergency and Disaster Preparedness is one important component of Disaster Risk Reduction. It consists of actions intended to increase the coping capacity of districts and make them more resilient to disasters.

The national workshop on DRR in 2010 recommended 21 points which was approved by the Central Natural Disaster Relief Committee (CNDRC) for an effective disaster preparedness initiative at district, regional and national levels. One of the recommendations was to create District Lead Support Agencies (DLSA) in 75 districts among the national and international agencies to support DDRC for preparing District Disaster Preparedness and Response Plan. It resulted into very positive feedbacks from all the DRR actors. As a result, so far, almost all districts have the DPRP. However, the implementation of the DPRP has many limitations. Particular problems are dearth of resources.

Loss of Lives by Different Disasters in Nepal (1983 - 2018)

Type of Disasters	1983-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Flood &Landslide	5829	196	441	232	131	141	114	216	134	135	240	252	120	219	242	134	247	238	36	9267
Earthquake	726	1	0	0	0	0	0	0	0	0	0	6	1	0	0	8891	-	0	0	9630
Windstorm, Hailstorm &Thunderbolt	491	38	6	62	10	18	15	40	16	7	70	105	149	149	102	109	108	79	14	1590
Avalanche	98	0	0	0	0	21		6	0	2		0	11	8	13	1	-	0	0	160
Fire	1116	26	11	16	10	28	3	9	11	35	69	46	64	59	67	89	41	56	87	1843
Epidemic	10721	154	0	0	41	34	0	3	10	462	36	9	33	4	12	3	19	14	5	11560
Stampede	71	0	0	0	0	0	0	0	0	0		0			0	0	-	NA		71
Rainfall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11	11	5	6	0	9	13		55
Boat Capsize	NA	0	NA	NA	NA	NA	0	NA	NA	NA	NA	6	7	7	9	0	7	1		37
Bridge Collapse	NA	NA	NA	0	NA	NA	0	NA	NA	NA	NA	2	0		0	0	-	0	15	17
Cold Wave	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	72	1	2	0	0	-	48		123
Air Crash	NA	NA	NA	0	NA	NA	0	NA	NA	NA	NA	NA	34	1	18	0		NA	47	100
Snow Storm	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	2	-	0		39
Others	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	7	14	23	58	67		171
Total	19052	415	458	310	192	242	132	274	171	641	415	509	433	461	518	9252	489	516	39	34663

Source: Ministry of Home Affair, SinghDurbar, Kathmandu, 2018

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GIS Based Planning and Design of Lift Irrigation Schemes in Hilly Terrains

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1. Background

Nepal's economy is driven by agriculture and it provides employment to more than 60 percent of the population. The sector not only contributes 32 percent to the national Gross Domestic Product (GDP) but also accounts for 50 percent of the national exports. Although, total agricultural land in the country is about 2.6 million hectares, only 1.43 million ha has basic irrigation facilities mostly with conventional methods. Of the entire cultivated land, 76 percent lies in Terai plains and 21 percent lies in the hills in form of river valleys and upland terraces.

The Government of Nepal (GoN) and Department of Water Resources and Irrigation (DWRI) have largely focused on development of irrigation schemes in the terai region of the country where the terrain and other feasibility factors favor greatly. Owing to the unfavorable terrain and inconvenience in data collection planning and development of irrigation schemes in mid-hills has been stagnant. This unavailability of proper irrigation provision has lead farmers from these regions to migrate which have resulted in overcrowding of Terai. Furthermore, labor productivity in agriculture is about one fourth of the productivity in rest of the economy as a result it has driven people away for better employment.

Nevertheless, agriculture sector possess potential to improve the country's agriculture productivity and food security. In other words, it is essential to transform agriculture and irrigation through non-conventional approaches and mechanization in order to meet the nation's growing need of food. Moreover, development of digital technology like GIS, which has the ability to combine spatial and non-spatial information and produce the desired results, provides enormous support to tackle water management problems in areas with difficult terrain and limited accessibility.

2. Objective and Scope

The overall objective is to identify suitable location and develop a feasible system based on technical and financial grounds for pumping of water from nearby streams in hilly areas with sizeable irrigation coverage in order to provide year round irrigation.

In order to achieve these objectives, the study will focus on GIS based data retrieval and assessment for delineation of the command area. In addition, the use of the retrieved data for planning and modeling of a feasible lift and distribution pipeline to meet the irrigation water requirement will be explored.

3. Methodology

The planning of a lift irrigation scheme should be done to effectively accomplish two main tasks, i.e. extraction from the source and then delivery to the field. Firstly, to lift the required water from the water source at a lower level to the main delivery chamber at higher level needs external energy supplied by pumps. Secondly, to equitably distribute this water to the field of the beneficiary farmers demands a suitable and proper distribution system. To achieve these tasks following steps are to be carried out.

- Selection of Potential Command Area
- Preparation of Thematic Maps
- Selection of Location and Design for Reservoir and Intake
- Layout and Design of Rising Main and Distribution Pipes

3.1 Selection of Potential Scheme Area

The identification of potential lift irrigation schemes are governed by various physical, social and economic indicators. The major factor which should be taken into account are availability of sizable irrigable land, possibility of pumping lift, proven deficiency of water faced by the farmers, limiting opportunity of crop diversification and productivity enhancement, potential of improvement in cropping system and practices and gains in the productivity and income with the development of the scheme. Also, the existing or future possibilities of marketing input and output to support the commercialization should be given due importance. Most of the above criteria can be evaluated through visual interpretation of the available satellite images and other reliable databases. However, a field survey is instrumental for accumulating data on socio-economic conditions of the farming community.

3.2 Preparation of Thematic Maps

First step towards the preparation of conceptual plan for an irrigation project is mapping of spatial data. The base map of the selected scheme is created and subsequently topographic maps and relevant satellite images are collected. The base features from available topo-maps are digitized and converted to thematic layers using ArcGIS Software which includes major roads, forests, settlements, rivers, streams, contours, agricultural land and administrative boundaries. Digital elevation model (DEM) can now be generated through contour interpolation. The output of the contour interpolation is a raster map, using linear interpolation which makes use of first order polynomial equation. To determine the water requirement for irrigation it is also necessary to analyze the cropping pattern of the region. The information on the crops can be extracted from the GIS environment or through visual interpretation of Google Earth images of various acquisition dates. Furthermore, data of soil texture and water retention capacity from field tests can be geo-referenced and organized through GIS-tools to produce a thematic layer.

Recently, drone technologies are also being used for the surveying and mapping. The design and study of the project areas can be done using drones, drone imagery and photogrammetry techniques that help the designers and mappers to design the project efficiently and effectively. Detailed digital surface models help to plan irrigation structures in fields to minimize soil erosion, while aerial imagery from drones can be of multipurpose including the crop monitoring.

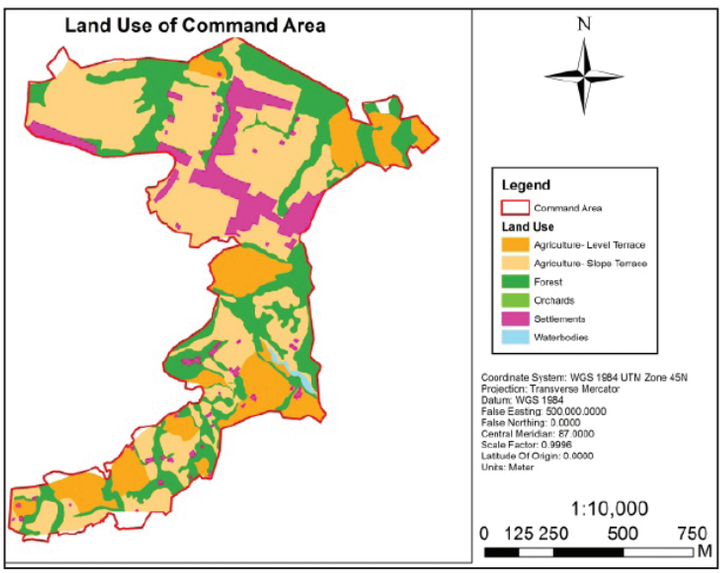

Fig: Land Use Map of command area.

3.3 Selection of Location and Design for Reservoir and Intake

The reservoir or tank is built as collection chamber to not only create head for gravity driven distribution system but also to balance the volume of water being pumped from the intake and the amount being supplied. As a result, it should be located at the highest point in the command area. In case of hilly regions, a special consideration to the stability of proposed location is crucial. Thus in these cases it might be necessary to do a slope stability analysis of the selected site based on the DEM generated for the command area. The design capacity of the reservoir is decided based on the demand and supply for irrigation in 24 hours during the peak demand condition.

The intakes of lift irrigation schemes are located on the flood plains of the river which consist of the sump well with collector pipes under the river bed. The location of the intake is selected so that the length of the rising main is the lowest possible and subsequently friction loss is minimal. The design of sump well assumes to tap the water below the minimum water level of the stream. The depth of the well should be such that at least 0.5m water head is always available above the top of outlet pipe from the well. Diameter of the well is governed by the number, diameters and spacing between the collector pipes. Also, the collector pipes shall be surrounded by adequate gravel packing in order to prevent the entry of silt laden water.

3.4 Layout and Design of Rising Main and Distribution Pipes

The layout of rising mains and distribution pipes can be drafted on GIS environment through the overlay of thematic layers including cultivable land, forests, settlements, other permanent structures and contours. The longitudinal profiles for each section can be extracted from DEM to further refine the drafted layout. Moreover, GIS mapping of all points for elevation right from lifting station to distribution outlet is very crucial for designing the whole system. After the length of each section pipes from layout and elevation of points along it are available the next step is to determine the size of pipes based on supply for the period of highest water requirement. As the diameter of pipes to be provided is dependent on the allowable friction losses it can be calculated from either Darcy-Weisbach or William Hazen Formulae.

Rising mains constitutes one of the important items of lift irrigation scheme which delivers the water pumped from intake to the reservoir. As far as possible the rising main should be straight and avoid large undulation like gullies. The selection of size and type of pipe is affected not only by technical aspects but overall economics. In case smaller than required diameter pipe is selected, the friction loss would be higher and thus the total pumping head would increase. This increases HP of the pumping units and results in its higher initial cost as well as greater running charges. On the other hand for larger than required diameter, the friction losses and the total head are low. This reduces HP of the pumping units and results in lower cost of power consumption, but the initial cost of investment increases. Therefore, the size of the pipe should be selected such that the unit head loss of the system does not exceed 1% or 10m head loss per Kilometer length of pipe.

The water distribution pipelines are designed based on the available pressure and demand for irrigation. The whole command area to be irrigated shall be divided into blocks covering 2-3 Ha of area and each block houses one outlet. The distribution pipes are laid up to the outlets and from there farmers can use field channels or hose pipes to irrigate their fields. The design and sizing of each conduit can be done through formulated spreadsheets with pipe flow equations as mentioned earlier or using hydraulic modeling tools. EPANET is one of the most commonly used applications worldwide to model a pressurized pipe network. It provides an interface to visualize and edit the network which consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. The software allows the designer to track the hydraulic properties of flow in each pipe and pressure at each node throughout the period of simulation. Also, extended simulation provides more realistic analysis of the system with varying demand over a certain time period.

4. Discussion

The posed problem of food security and land and water development for sustainable future requires being resolved with a holistic approach. Advancements in GIS and RS technologies have opened a new door for designers to provide economic

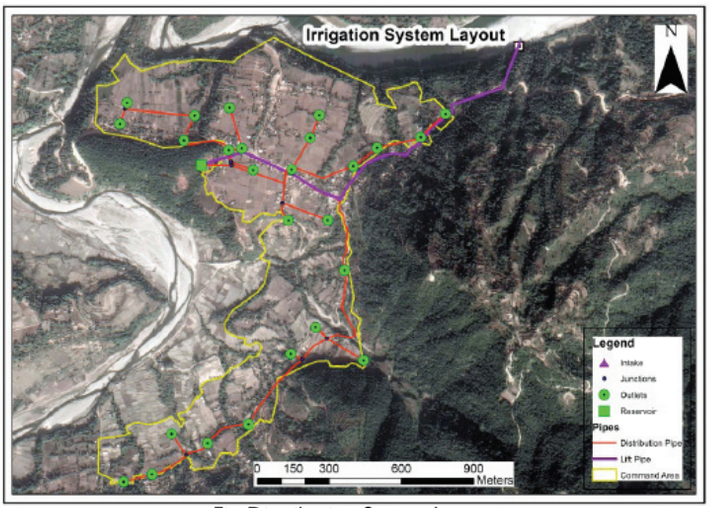

Fig: Distribution System Layout

solution to water resources issues in areas with very limited accessibility. One evident benefit of lift irrigation scheme in hilly region to deliver water is that farmers will be enabled to practice sophisticated and innovative methods of irrigation in river terraces to not only boost production but also increase effectiveness of fertilizers. Secondly, the possibility for employment of sprinkler and drip methods will promote uniform cropping pattern and increased cultivation of cash crops and vegetables. Thirdly, the dependency of people in Mid-Hill on Terai region in terms of agriculture and job opportunities would significantly reduce as such projects is successfully implemented. Finally, transfer of surplus water to meet domestic water requirement would allow people to have uninterrupted drinking water supply close to their dwellings thus elevating the living standard in the region.

5. Conclusion

- Geographical Information System (GIS) can play a substantial role in planning and design of Irrigation schemes in hilly areas with unfavorable terrain.
- The data incorporated in the thematic maps are instrumental for analyzing various aspects of the system.
- GIS-environment provides convenience to organize and visualizes different datasets to make a well informed decision for site specific conditions.
- Drones are very useful emerging technology in the field of agriculture and irrigation, which is used for the mapping, precision farming, crop monitoring.
- The possibility to integrate GIS with hydraulic modeling tools like EPANET caters to immense benefit of more realistic analysis over varying demand and supply conditions.
- Development of potential lift Irrigation schemes using such advance tools is crucial for meeting nations growing need of food and trade balance.

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Forthcoming Events

Water for Food, Global Conference 2019, 29-30 April 2019, Nebraska Innovation Campus Conference Center, University of Nebraska, Lincoln, Nebraska, USA , organized by: Daugherty Water for Food Global Institute,Nebraska Innovation Campus, 2021, Transformation Drive, Suite 3220, P.O. Box 886203, Lincoln, NE 68588-6203, Contact: Molly Nance, (+1)402 472 5512, mnance@nebraska.edu Theme: Water for a Hungry World: Innovation in Water and Food Security,Website: https://waterforfood.nebraska.edu/explore-our-conferences,

International Symposium on Energy, Water and Environment (SEWE 2019) 25th to 26th May 2019 Regina, Canada Website: http://isewe.org/ Contact person: Ms. Jewel Hou Organized by: University of Regina Deadline for abstracts/proposals: 30th March 2019

4th International Conference on Renewable Energy and Conservation (ICREC 2019),8th to 10th June 2019,Hiroshima, Japan,Website: http://www.icrec.org/,Contact person: Ms. Rachel Cao,Organized by: ICREC Deadline for abstracts/proposals: 15th April 2019

2019 10th International Conference on Enviromental Engineering and Applications (ICEEA 2019) ,26th to 28th June 2019,Prague, Czech Republic,Website: http://www.iceea.org/,Contact person: Ms. Dana Huang, Organized by: ICEEA, Deadline for abstracts/proposals: 15th April 2019

5th International Congress on Water, Waste and Energy Management, WWEM-19,22nd to 24th July 2019, Paris, France, Website: https://waterwaste-19.com/,Contact person: Javier Ladera, Organized by: Sciknowledge European Conferences, Deadline for abstracts/proposals: 1st April 2019

International Conference on Water Conservation & Environmental Management (WC2EM), 26th to 28th July 2019 Ho Chi Minh, Vietnam, Website: https://inwascon.org.my/wc2em/, Contact person: Alhakim ,Organized by: INWASCON, Deadline for abstracts/proposals: 31st May 2019

3rd World Irrigation Forum (WIF3) and 70th International Executive Council Meeting, 1-7 September 2019, Bali, Indonesia,Theme: Development for water, food and nutrition security in a competitive environment , Organized by Indonesian National Committee of ICID (INACID) and Ministry of Public Works and Housing, Directorate General of Water Resources, SDA Buiding, 8th Floor,Jalan Pattimura no. 20,Kebayoran Baru, Jakarta Selatan 12110, Indonesia,Website: https://icid2019.com/

17th Milan International Conference on "Agricultural, Biological and Environmental Sciences" (MABES-19 5th to 7th August 2019, Milan, Italy, Website: http://www.iicbe.org/2019/08/07/108, Contact person: Conference Secretary: MABES-19 Organized by: International Institute of Chemical, Biological & Environmental Engineering (IICBE).

22nd International Water Technology Conference 12th to 13th September 2019, Ismailia, Egypt, Website: http://iwtc2019.website2.me, Contact person:Walaa Tarek, Organized by: IWTA, Deadline for abstracts/proposals: 1st April 2019

2019 The 10th International Conference on Construction and Project Management (ICCPM 2019) 27th to 29th September, 2019 Hong Kong Website: http://www.iccpm.org/ Contact person: Ms. Anna Wu,Organized by: ICCPM, Deadline for abstracts/proposals: 30th May 2019

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