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NEWS UPDATE

8th ICID Asian Regional Conference successfully Organized in Kathmandu

The 8th Asian Regional Conference (ARC) was organized successfully under the banner of “Irrigation in Support of an Evergreen Revolution” at Hotel Yak and Yeti in Kathmandu during 2nd-4th, May, 2018. The conference was jointly



organized by Nepal National Committee of ICID (NENCID) and Department of Irrigation, Nepal and co-organized by USAID. The other partners, who joined hands in organizing the conference were Asian Development Bank, ICEWaRM, ICIMOD, IWMI, and the World Bank. More than 520, including approximately 100 international experts in the field of irrigation and water resources, participated the conference from more than 20 nations.

The conference was inaugurated by Rt. Hon'ble Bidya Devi Bhandari, President, Federal Democratic Republic of Nepal. In the presence of Hon'ble Barsha Man Pun, Minister, Energy, Water Resources and Irrigation. Opening remarks were delivered by the President and Vice President of ICID along with high level officials from the Government of Nepal.

Six key note speakers delivered their speech in the opening plenary session. The speakers include, Arnaud Cauchaus (Senior Water Resources Specialist, Asian Development Bank), Carol Jenkins (Head of SEED Office, USAID), Mr. Saroj Pandit, Director General, Department of Irrigation, Nepal), A. B. Pandya (General Secretary, ICID), and Ahmed Shawky (Senior

Water Resources Specialist, World Bank). The plenary session was moderated by Mr. Dipak Gyawali, the Chair of Technical Advisory Committee (TAC) of the 8th ARC. Release of Technical Report of ASRWG by President ICID and officials of ICID

The conference was held with five major themes:

- I. Enabling small holders' capacity to obviate farmers' distress;
- II. Coping with recurring droughts and floods in the context of climate change;
- III. Modernizing irrigation systems for better services;
- IV. Enabling Water Users Institutions (WUIs) for sustainability of irrigation systems; and
- V. Irrigation, ecosystem services, and aquatic biodiversity.

These themes had covered a wide range of disciplines including academicians, practitioners, policy makers and research scholars. One-hundred and five papers were presented in 15 technical sessions including the plenary symposiums

Prior to the main event, a young professional training program coordinated by Mr. Sanjeeb Baral, Project Director of WRPPF Project, was held on 1st May, 2018. 25 young professionals in the field of water resources from different countries participated in the training. Mr. Sanjay Sharma, Secretary of Ministry of Energy, Water Resources and Irrigation, Mr. Saroj Pandit (the DG of DoI), Mr. Madhav Belbase (Vice President of ICID and Joint Secretary of WECS), Mr. A B Pandya (Secretary General of ICID), Dr. Arnaud Cauchaus (Principle Water Resources Specialist in ADB), and Mr. Sanjeeb Baral provided encouraging remarks to the young professionals.

One and half day city tour was organized during the first and second

day of the conference. It was the complimentary program especially focused for spouse and companions of the participants. Two days' technical tour to the delegates was organized on 5th and 6th of May, 2018. It was an opportunity to understand the history of irrigation development in Nepal and also to visit popular and major tourist destination in Nepal. The participants visited one of the oldest irrigation system in Gundu located in Bhaktapur district. The conference was concluded successfully on 4th May 2018

65th Anniversary and Irrigation Day 2074 Celebrated

The 65th anniversary of Department of Irrigation (Irrigation Day, 2074) was celebrated on 7th April, 2018 with various activities. On the occasion of Irrigation day 2074, a special function was organized in the department. Honorable Minister Mr. Barshman Pun, from the seat of chief guest, in his inaugural speech, emphasized to promote employment generation in the country through irrigated agriculture.

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Editorial

Department organization going under new setup

Department of Irrigation originated in the name of NaharBibhag in 2009 BS (1953 AD). The department was put under various ministries since then. In 1966 the department was accommodated under Ministry of Water and Electricity Power as Department of Drinking Water and Irrigation. In November of 1972 the department was named as Department of Irrigation and Meteorology under the ministry of Food, Agriculture and Irrigation. The department came under the Ministry of Water Resources during 1980s. In 1988 AD, the department is named as Department of Irrigation and continued under Ministry of Water Resources and organization extended with its district level offices in all 75 districts. It was in the year of 2001, the district level offices were re-organized in Division and Sub-Division offices. In 2008, Department of Irrigation was accommodated under newly organized Ministry of Irrigation. In 2015, existing setup has slightly been modified with increased number of divisions and subdivisions tallying to accommodate in each districts and irrigation Management and groundwater development divisions were added with its regional autonomous bodies in Bharatpur. Now with the promulgation of new constitution of Nepal 2072, Ministries has been merged and reduced in number. Department of Irrigation and Department of Water Induce Disaster Management under Ministry of Energy, Water Resources and Irrigation have been merged to form new department named Department of Water Resources and Irrigation from Fiscal year 2075-76.

The offices with higher command area coverage will continue its set up under the federal government. The Water Resources and Irrigation Department will be involved in development and management of irrigation infrastructures with irrigating capacity of more than 10,000 ha in Terai and 1,000 ha in Hill and mountain regions. With the new setup employees of the department will be reduced to the size of one third from its previous posts i.e. 1,833 in number altogether. With this change, the work efficiency is believed to be increased for the development and management activities of the department. ♦



Mr. Anup Kumar Upadhyay, Secretary of Ministry of Energy, Water Resources and Irrigation expected the enthusiastic development in irrigation sector in coming days to change the course to enhance improved irrigated agriculture as well as enhanced economic situation of the nation. On the occasion, Mr. Madhav Belbase, Joint Secretary of Water and Energy Commission Secretariat (WECS), Joint Secretary of Ministry of Energy, Water Resources and Irrigation Mr. Dandhwaj Basnet, Mr. Gajadhar Rohita Yadav, Chairman, Federation of Water Users' Associations in Nepal, Former DG of Dol and President of Society of Irrigation Engineers of Nepal (SIREN) Mr. Sharada Prasad Sharma, were also invited as special guests. The program was chaired by Mr. Saroj Pandit, Director General of the department. From the chair, DG Mr. Pandit, thanked the chief guest and honorable minister for his support to make the day very special. On the occasion, various best performing Water User Association (WUAs), offices among the irrigation division and sub division offices and ongoing projects during last fiscal year were also honored to the respective chairpersons, chiefs and project managers during the occasion. The honorable minister also distributed prizes and certificates to the winners of the various extra activities and games organized during the annual celebration. The life time achievement honor was given to former Director General and former Secretary, Mr. Bhuwanesh Kumar Pradhan, for his untiring contribution in water resources and irrigation sector. Similarly retired staffs of Dol from the date of current fiscal year were also honored in the occasion. A morning procession was also organized on the day. High ranking officials from the department including the director general participated the procession. The procession bearing placards with irrigation related slogans took course from Maitighar Mandala – Bagmati bridge – Kopundole – Harihar Bhawan– Pulchowk and ended at Dol premises. A blood donation program was also organized on the same occasion in which more than fifty Dol staffs participated.

Minister visited to various projects

Honourable Minister of Energy, Water Resources and Irrigation Mr. Barshaman Pun visited the project site of Bheri-Babai Diversion Multipurpose Project (BBDMP), a national pride project, from 4th to 6th June, 2018 (Jesth 21st to 23rd, 2075), accompanied by the secretary and other high level officials from the ministry and the department. Honorable Minister, Mr. Pun was welcomed to the Project site at Ramghat, Surkhet by the Project Director of BBDMP Mr Shiva Kumar Basnet. The project status was briefed by the Project Director to the honorable minister and other officials. Honorable minister observed the construction activities in BBDMP including tunneling work. The team also visited Rani Jamara Kulariya Irrigation Project, another national pride project, and Karnali River Management Project in Kailali and Bardiya district respectively.

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Loan Agreement between GoN and the World Bank for RJKIP second term

According to press release of Ministry of Finance (MoF) on 10th May, 2018, a loan agreement was signed between Ministry of Finance, GoN and the World Bank for the rehabilitation and modernization of Rani Jamara Kulariya Irrigation Project (RJKIP). The Agreement of Loan assistance was signed by Joint Secretary of MoF, Dr. Rajan Khanal on behalf of Government of Nepal and World Bank Country Director for Nepal, Mr. Quimao Feng, on behalf of the World Bank. According to the agreement, the loan amount of US\$ 66 million will be released and utilized for institutional strengthening of Water Users' Association of RJKIP and to make effort for increasing crop yield in the project area through intensive agriculture and irrigation program. On the signing ceremony, Dr. Khanal of MoF expressed special thanks



to the World Bank team for their continuous support to Nepal on its Socio-economic development. High level officials from the ministry of Energy, Water Resources and Irrigation and the Department of Irrigation were present in the signing ceremony.

TRAININGS/WORKSHOPS/SEMINARS

11th National Irrigation Seminar, 2075 organized

National Irrigation Seminar 2075 was successfully organized at Dhulikhel Lodge Resort, Kavre on 12 - 13th Jestha, 2075 (May 26-27th, 2018) under the banner of "Water Resources Development and Management in Federal Nepal: Challenges and Opportunities". Honorable Minister of Energy, Water Resources and Irrigation, Mr. Barshaman Pun inaugurated the seminar. On his inaugural speech, honorable minister Mr. Pun indicated that the country has now entered in administrative restructuring phase after the successful completion of elections in all levels. As the government has set a target for doubling the crop production in five years, irrigation sector now should focus on its effort to provide year round irrigation facilities in all agriculture land of the nation. He focused on improvement of irrigated agriculture to increase employment generation within the country and thereby reduce the trend of youth migration

abroad. He also emphasized spring irrigation in hills and mountain and groundwater in terai region to resume irrigation facilities at low cost. Special guest of the session and Secretary of Ministry of Energy, Water Resources and Irrigation, Mr. Sanjay Sharma, indicated the necessity to build sustainable mechanism for speedy development of irrigation sector. Mr. Gajadhar Yadav, President, National Federation of WUAs; Mr. Madhukar Rajbhandari, Director General, DWIDM, and Dr. Vishnu Prasad Pandey, Representative from IWMI, Nepal and other high level official from the Department of Irrigation were also attended the seminar. During the session, welcome speech was delivered by Deputy Director General Ms. Sarita Dawadi. Deputy Director General Mr. Bashu Dev Lohane expressed brief views on the design of seminar and selection of the papers being presented in the seminar.

Mr. Sanjeeb Baral, Project Director of Water Resources Project Preparatory Facilities (WRPPF), presented a special paper entitled "Conceptual Development of Multipurpose Projects in Nepal". At the end of inaugural session, the Director General, Mr. Saroj Pandit committed that the current encouraging performance of Irrigation Projects will continue in future as well and wished for the success of the seminar.

Four Technical Sessions with three paper in each, were designed with different sub themes. The first technical session entitled "Conceptual Development and Management of Inter-Basin Irrigation Infrastructures" was chaired by DDG Mr. Krishna Belbase. Mr. Mitra Baral, Project Director, Sunkoshi-Marin Diversion Multipurpose Project presented a paper entitled "Inter-basin Water Transfer Multipurpose Projects in Nepal". Mr. Rishiram Sharma Neupane, Senior Irrigation Management Specialist, presented his paper entitled "Learning from Irrigation Management Transfer Program in Kankai Irrigation System" followed by a paper by Mr. Prachand Pradhan on "Benefit Sharing between Hydropower and Irrigation in Nepal".

The second technical session was chaired by DDG Mr. Dan Ratna Shakya and was assisted by SDE Mahesh Yadav as rapporteur. The first paper of the session was presented by Mr. Raj Kumar GC entitled "The Role of Piped Water System for Production Uses in Mid-hills of Nepal". Mr. Ajay Adhikari of BBDMP presented a paper on "Groundwater Availability and Irrigation Potentiality in Rocky Aquifers of Nepal". The third paper was jointly presented by SDHGs Ms. Pramila Shrestha and Mr. Narayan Krishna Ganesh entitled "Groundwater Irrigation Potentiality in Hills of Nepal: A case study of Chyanglitar and Dhuwakot of Gorakha District".

On the 2nd day, the third session was chaired by DDG Ms. Sarita Dawadi and the session was facilitated by SDE Suresh Kumar Sharma as rapporteur. The first paper on the session was jointly presented by SDE Mr. Tika Ram Baral, the Division Chief of Nepal Gandak Western Canal Management Division, Nawalparasi and Bhes Raj Thapa of IWMI entitled "Evaluation of water use pattern of conjunctive uses within command area of canal fed irrigation system: A case study of Nepal Gandak Western Canal". The second paper was presented by Apekshya Marasini on "Effect of Climate Change on Irrigation Water Demand: A case study of Chitawan District". The third paper was presented by Jit Narayan Kashichhwa entitled "Storm transportation method for probable maximum flood – a case study of Upper Seti Storage Hydroelectric Project". The last session was chaired by DDG Mr. Bashu Dev Lohane. Ms. Pramila Shrestha was rapporteur of the session. DDG Mr. Churna Bahadur Oli presented a paper



on "Issues and Challenges on Management of Inter-basin Water Transfer Project in Nepal: A case study of Bheri-Babai Diversion Multipurpose Project." The second paper was presented by Professor, Ashutosh Shukla of Nepal Engineering College, Kathamdu on "Prioritizing Demand Management vis-a-vis Supply Side Constraints in Irrigated Agriculture." The third paper was presented by SDE Mr. Mahesh Yadav on "Assessment of Agro-Climatic Potential of Okhaldhunga, Nepal."

Followed by the technical sessions, Plenary Session was organized on the topic "Water Resources Development and Management in Federal Nepal". The session was facilitated by the Director General of Department of Irrigation, Mr. Saroj Pandit and SDE Dr. Kishor Kumar Bhattarai as a Rapporteur. Dr. Sanjaya Sharma, Secretary, Ministry of Energy, Water Resources and Irrigation, Mr. Bhuwanesh Kumar Pradhan and Mr. Sheetal Babu Regmi, former Secretary, Ministry of Water Resources, Professor Dr. Khem Raj Sharma and Prof. Ashutosh Shukla participated in the session. The session was focused on sharing of resources and irrigation facilities among the federal, provincial and local government.

The closing session of the seminar was chaired by DG, Mr. Saroj Pandit. The special guests, guests and high level officials expressed their views on the seminar and thanked to the organizing committee.

Workshop on roles of the Department of Water Resources and Irrigation Organized

After promulgation of the Constitution of Nepal 2072, power and responsibility were divided into three tier governments. It is now a major challenge for the Department of Water Resources and Irrigation to reconsider the national policies of water resources and irrigation. A workshop was organized on 4th July, 2018 to briefly discuss the organization roles and responsibilities in the changing context of the country. The workshop was chaired by Director General of the department, Mr. Saroj Pandit. High level officials from the Ministry of Energy, Water Resources & Irrigation and water resources experts were invited in the workshop. Mr. Rajendra Bir Joshi, Senior Divisional Engineer, presented a paper entitled "Necessity of Revision and Updating



of Policy and Procedural documents of the Department." Mr. Ratneswor Lal Karna, a WR expert, presented a paper on "The Revision of Irrigation Policy". Water Resources, Experts Mr. Somnath Poudel and Mr. Sheetal Babu Regmi. Commented on the paper their common comment was the urgent need of an umbrella act and/or policy for entire water resources sectors. Mr. Regmi further pointed out the need of separate policy and the roles of difference sectors under one umbrella and should distinctly featured. Dr. Prachanda Pradhan, an irrigation expert emphasized on trade off policy between demand and supply to resolve conflicts among stakeholders. Mr. Bashu Dev Lohane, Deputy Director General, emphasized on PPP model in irrigation management attracting the private sector through shares of the property. Mr. Sanjeeb Baral, Project Director of WRPPF indicated the need of revision on sectoral priority of water resources and clear guidelines for conjunction use of water resources.

Further, Mr. Pradeep Kumar Manandhar, a WR experts, highlights the provision of proposed procedural guidelines of the Department of Water Resources and Irrigation. At the end of the workshop, the Director General of the department thanked to all the participants for their valuable suggestions regarding future policies of the water resources sector in the country.

Eighteenth INPIM Nepal Talk Program

Soon after the auspicious occasion of the 21st Anniversary of its establishment, INPIM Nepal organized the Eighteenth INPIM Nepal Talk Program on 14th May, 2018 in the Department. More than thirty participants participated the program. Mr. Suman Sijapati, President, INPIM Nepal welcomed all the participants and congratulated everyone for their active networking through



INPIM Nepal since last 21 years.

Mr. Sijapati also briefly presented the INPIM Nepal Activities and its current status. He, also briefly introduced Mr. Jeffrey C. David, President, SmartPhones4Water (S4W) who was key presenter in the program.

Mr. David presented on the topic "Why measurements matter: The role of participatory monitoring in participatory management." During presentation he highlighted the importance of measurements and explained how S4W Nepal has been utilizing citizen scientists for collecting water data in a participatory manner. He also cited the six types of data that they have been collecting in Kathmandu valley and explained how these data are being processed. He further explained how the system supports informed decision making in water and irrigation sector.

After the presentation, the floor was opened for question/ answers and discussion. The participants actively participated in this session. Several questions were raised on each of the

presentations and there was a good round of discussion and many participants expressed their views as to how such data can



be useful for researcher and irrigation managers.

FEATURE ARTICLES

Water-Food-Energy Nexus: A Holistic Approach of Sustainable Water Resource Management amidst Changing Climate

*✍ Udhav Raj Khadka, PhD**

Background

Earth is occupied with about 71% water. However, this vast amount of water is either not available or not suitable for living being. Out of the total amount, 97.5% of water is in the form of oceans or other salt-water and 2.5% is in freshwater form. Among the freshwater, 68.6% is locked in ice-caps and glaciers, 30.1% is groundwater, and 1.3% surface-water and other freshwater forms. Out of the surface-water and other freshwaters, 73.1% is ice and snow, 20.1% is lakes and rest (6.8%) are other freshwaters like soil-moisture, swamps and marshes, rivers, biological water, and atmospheric water (Shiklomanov, 1993). This suggests that the proportion of freshwater available and suitable for life is only about 0.01%. Therefore, the freshwater is precious as well as essential for human survival, existence and well being. However, in the present context of population growth, increased urbanization and economic development, the rare and precious freshwater sources are threatened by increased demand, overconsumption and increased discharge of wastewater polluting the remained water sources. Moreover, the present climate variability has further exacerbated the issues related to water.

The present population change is of great importance for earth's natural environment and resources. Global population has increased dramatically in the recent centuries. In the last 100 years, the world population has increased by three times, i.e. from 1.5 billion, in 1900 to 6.1 billion, in 2000 (Roser & Ortiz-Ospina, 2018). With the increase in population, rate of urbanization has also increased due to recent advancement of technologies and facilities in cities. Consequently, there has been growing demand for water, food and energy, as water and food are essential for human survival and existence, and energy is the key to human development. These resources (water, food and energy) are not only essential for human well-being, it is also essential for poverty reduction and sustainable development. Global projections indicate that demand for freshwater, food

and energy will increase significantly over the next decades under the pressure of population growth and mobility, economic development, international trade, urbanisation, diversifying diets, cultural and technological changes, and climate change (Hoff 2011).

With respect to water resource use sectors, agriculture is the largest user accounting 70% of the total global freshwater withdrawals. Water is used for agricultural production, forestry and fishery, along the entire agri-food supply chain, and is used to produce or transport energy in different forms (FAO, 2011a). At the same time, the food production and supply chain consumes about 30% the total energy consumed globally (FAO, 2011b). Energy is required to produce, transport and distribute food as well as to extract, pump, lift, collect, transport and treat water. Cities, industry and other users too, claim increasingly more water, energy and land resources, and at the same time, face problems of environmental degradation and in some cases resources scarcity (FAO, 2014). As water, food and energy are inextricably linked together, the problem already risen or likely to rise in future due to population growth, urbanization, economic development, international trade, etc. cannot be solved with the existing practice of sectoral approach, where water, food and energy development is considered separately and dealt by separate policy frame and institutional authority. In order to ensure sustained supply of water, food and energy, their development should be considered with 'Water-Food-Energy Nexus' approach- a holistic vision of sustainability that recognises and tries to strike balance between the different goals, interests and needs of people and the environment (FAO, 2014). The 'Water-Food-Energy Nexus' is framed within the broader debate on sustainable development and as part of FAO's vision of sustainable food and agriculture to achieve its mandate of eradicating hunger, reducing poverty, and sustainably managing and using natural resources and ecosystems (FAO, 2013).

In recent period, water issue is becoming very critical day by day. The statements "the wars of the next century will be about water" given by the then World Bank Vice-president, Ismail Serageldin in the late 20th century (New York Times, 10 August, 1995), and "fierce competition for freshwater may well become a source of conflict and wars in the future" by the then UN General Secretary, Kofi Annan (March, 2001) in the early 21st century indicate the severity of global water crisis and related issues. The relevancy of the situation is further justified with the statement "too often, where we need water, we find guns instead" by the former UN General Secretary Ban Ki Moon, in 2008. Recognizing and realizing the issues of water, which is linked with the food and energy as well, in 2011, at the World Economic Forum in Davos, the water-food-energy-climate nexus was discussed for the first time (Reinhard et al., 2017). In November 2011, the German government held a global conference on the Water, Food and Energy Nexus which resulted in a growing recognition that a movement is needed away from a sector-by-sector approach to policy, science and practice, towards a more interlinked approach (Hoff, 2011; Dodds & Bartram, 2016). According to Asian Development Bank (2013), the global debate is not about water security or water scarcity in isolation; instead, it is about the water-food-energy nexus. It is the growing demand for food, with its high water requirement, superimposed on population growth, which crucially turns an abstract crisis into a critical and immediate one (Reinhard et al., 2017; Fig. 1).

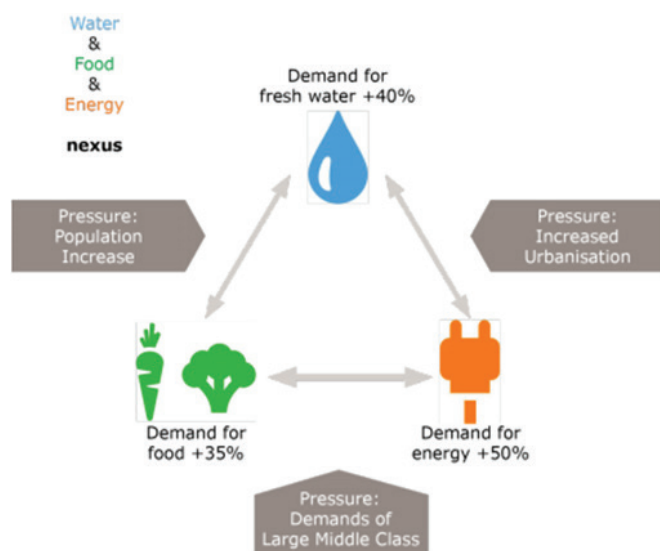


Figure 1 Relevance of water-food-energy nexus (Reinhard et al., 2017)

Securing reliable supply of water for key economic areas is critical in achieving economic growth. As water is vital to many other sectors like agriculture, food, hydropower, navigation, transportation and flood management, management of and investment in water resources often form the basis for broad regional and national development (Malik, 2008). Likewise, water management offers potential for food and energy security, and flood management in Nepalese and/or in regional context.

i. Water for food security

The Ganges River system, within which Nepal lies, is vitally important to food security; its flood plains that also includes Tarai region of Nepal, are considered to be the bread baskets of the region. Rice and wheat are the staple foods in the region. These two crops require huge amounts of water- about 1000 tonnes to produce one tonne of grain (Brown, 2009) and depend on irrigation in the dry season. Demand for food grains in the region is increasing owing to the growing population, increasing income, and a change in dietary preferences towards more consumption of meat (Rasul, 2012). Agricultural land is relatively scarce in the region. Per capita land availability ranges from 0.05 to 0.13 ha per person (Kumar et al., 2012) and has been declining sharply over the years owing to population pressure (Rasul, 2011).

In the Koshi River basin, a major tributary of Ganges, agricultural productivity and food security suffer from inadequate investment in irrigation and flood management. Rice yield in the Koshi basin in the state of Bihar, India, is about 1021 kg/ha, which is less than one-third of India's average rice yield (3358 kg/ha) and just one-fourth of the global average (4334 kg/ha). It suggests that the region is not able to harness the potential of the resources. It also implies in the Nepalese side Koshi basin as well.

ii. Water for energy security

The availability of energy, particularly electricity, is a necessary condition for industrialization, economic growth, and poverty alleviation. Except Bhutan, the Ganges region is one of the world's energy deficit areas with persistent shortages of energy in all of the countries of the region. The demand for energy will increase because of the rapid pace of industrialization and urbanization and the increased demand for food for ever growing populations. Energy is required not only to sustain the region's growth, but also to improve socio-economic conditions and human development.

At present, Nepal has installed capacity of only about 800 MW, while estimated electricity demand for 2015 was 1,721

MW that made country to face severe load-shedding (WECS, 2017). Furthermore, Nepal must depend heavily on imported petroleum products. In the Fiscal Year 2073/2074 (2015), the year of blockade in the Nepal-India boarder, the import of petroleum products was 1335000 kilo litre worth NRs 11.38 billion (USD 1.138 billion @ 1 USD = NRs 100) (NOC, 2017).

Water, Food and Energy in Nepalese Perspective

Nepalese livelihood is largely based on natural resources, thus natural resources are the main basis of development and prosperity in Nepal. Although, endowed with rich resource bases: forest, freshwater, agricultural land, suitable landscape for hydropower, mountains, suitable climate, etc., and despite significant recent socio-economic progress, the country remains one of the poorest in the world. Freshwater, once abundant, is under growing stress due to increased demand for competing uses. The climate change is further exacerbating the challenges by increasing the pressure on the basin's freshwater resources. Water availability and water security are becoming more uncertain through changes in temperature and precipitation, shifts in the timing and intensity of the monsoon, increased frequency of extreme events such as drought and floods, and accelerated melting of the Himalayan glaciers resulting in changes in short- and long-term runoff, snow cover, and melting patterns (Ericson et al., 2009; Shrestha & Aryal, 2011). These changes could have significant impact on water, food, and energy security (Webster et al., 2011). Due to lack of adequate technological invention and enhancement, the country has not been able to tap these resources, which are diminishing over the period of time without being used for nation development. For instance, Nepal is gifted with huge (225 BCM per annum) potential of water resources, however only very small fraction (15 BCM per annum) of the total water resources are being used. Agriculture sector uses largest (95.9%) proportion of used water in Nepal followed by domestic (3.5%) and industrial (0.3%) sectors (ADB/ICIMOD, 2006).

Nepal is predominantly an agrarian country wherein about 63% of the total population is engaged and it is the major (31%) contributor to the Gross Domestic Product (MoF, 2016). The country has a cultivated area of 2,642,000 ha (18% of its total land area), of which two-third (1,766,000 ha) is potentially irrigable. However, by 2016 the irrigated area has reached to 1433.357 ha accounting 54% of cultivated area under irrigation (DoI, 2017). Yet, proportion of year-round irrigated area is less (WECS, 2011). In Tarai, 82% of the total irrigated area (889,000 ha) is irrigated through surface irrigation and the remaining 18% through groundwater irrigation (WECS, 2011).

Despite the country is predominantly agrarian, the import of agricultural commodity seems steadily increasing in recent years due to insufficient internal production. It has been reported that Nepal imported agricultural produce worth NRs 40 billion in fiscal year 2016/2017 which was 39 million in the year 2015/2016. Among the imported agri-products, rice constitutes the major proportion. Besides, the import of maize, wheat, buck-wheat, barley, is also growing over the years. Nepal produces 10.5 million metric tons of raw food grains like rice, wheat, maize and buck wheat annually and after processing only 5.5 million metric tons of grains are left. However, the present population of Nepal requires 7.4 million metric tons food annually (New Business Age, 2017). In 2017, Nepal has imported cereals worth US\$ 409.82 million (<https://tradingeconomics.com/nepal/imports-by-category>; accessed 01 Sept., 2018). Nepal has experienced food insecurity, as it ranked 72nd in 2017 Global Hunger Index (GHI) value 22.0 (serious category) amongst the 119 countries (Von

Grebmer et al., 2017). Human Development Index of Nepal for 2016 was 0.558 ranking 144th position amongst the 188 countries (UNDP, 2016).

With respect to hydropower, the country has 83,000 MW theoretical potential with 45610 MW technically and 42133 MW economically feasible (Shrestha, 1966). The recent estimate at 40% dependable flows for the run-of-the-river (ROR) hydropower potential in Nepal stands at 53836 MW. However, at present, the country's installed hydropower capacity is only about 918.98 MW (NEA, 2017). Accordingly, the huge resource flowing untapped and is diminishing due to climate variability and uncertainty. Underutilization of hydroelectric potential is not only the wastage of an important national resource, it also limits capability in adapting climate change and meeting energy, food and water demand of the region (Rasul, 2015).

Policy Provisions and Institutional Arrangements in Nepal

There are several policies for water resource development and management in Nepal. Although, National Water Plan, 2005 seeks integrated and comprehensive management for developing and managing water resources and water services engaging all stakeholders, it does not well recognize the linkages between water, food and energy. Similarly, other water related policies seem to be based on sectoral approach. For instance, Nepal Environmental Policy and Action Plan, 1993 seems to be formulated basically for pollution control or regulation; Hydropower Development Policy, 2001 mainly considers hydropower development; Water Resource Strategy, 2002 expects to achieve short, medium and long term supply of and benefit from water resources; Rural Water Supply and Sanitation Strategy, 2004 seeks to address drinking water and sanitation related issues; Irrigation Policy, 2004 considers the development of irrigation facility using the existing water resources; National Wetland Policy, 2003 seeks sustainable utilization of wetlands.

Likewise, there are several implementation and operational level institutions established for the water resource development and management. However, almost all of them have their exclusive mandate to work for particular priority area. For instance, Department of Irrigation (DoI) work for infrastructure development for irrigation scheme and is least or not concerned of other water related schemes; Department of Electricity Development (DoED) is responsible for electricity development and disregards other water uses; Department of Water Induced Disaster Prevention (DWIDP) primarily focuses on disaster prevention and control; Department of Water Supply and Sanitation (DoWSS) works for city water supply and sanitation; Department of Agriculture (DoA) works for agriculture development and extension; Department of Hydrology and Meteorology (DHM) is meant for acquiring hydrological and meteorological data, and related works; Department of Local Infrastructure Development and Agricultural Road (DoLIDAR) assists local governments in civil engineering construction; and Department of Soil Conservation and Watershed Management (DSCWM) works for soil conservation and watershed management. All of these institutions, though work in water resource development and related areas, are working independently with a limited scope without recognizing the water-food-energy nexus, and synergy and trade-offs that arise from the management of these three resources.

Approach of Water Resource Development in Nepal

The policy provisions, and implementation and operational level institutional arrangement for water resource development and management in Nepal show that the country has adopted sectoral approach of water resource development and

management. As a result, it has lagged behind in harnessing its water potential in economic development and human wellbeing. The institutions constituted and policy formulated dealt with sectors or sub-sectors without due consideration of holistic approach of multi-sectoral use of water resources. The present climate change and variability has substantially increased water resource vulnerability with multi-facets impacts on agriculture, livelihood and economic development. Thus, in the present context, for ensuring sustainable water availability, food production and energy generation and better community and ecosystem resilience, the water resource management needs to be moved from sectoral to holistic water-food-energy nexus approach.

Conclusion

Freshwater is very precious, finite and vulnerable resources. The present trend of population growth, fast pace of urbanization, economic development have tremendously increased pressure on water resources. Furthermore, the present climate change and variation has exacerbated the water related problems. In context of Nepal, there are policies and institutions established for water resource development and management. However, till date, most of the policies and institutions work with a sectoral approach of water resource development without recognising the linkages of water, food and energy. As a result, the country seems lagged behind in terms proper utilization of its water resources with huge potential. There is need of recognising the linkages between water, food and energy and move from sectoral thinking to water-food-energy nexus approach that duly considers the interactions between these resources taking into account the synergies and trade-offs that arise from the management of these three resources. Thus, priority should be focused on creating enabling environment by having adequate umbrella legal provision and institutional arrangements to ensure sustained supply of water, food and energy for growing population in the present context of political and economic transformation amidst changing climate in Nepal.

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