

Brief Report on

8th Asian Regional Conference

2-4 May, 2018, Kathmandu, Nepal



Prepared by

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1. Introduction

Nepal is one of the earliest members, joining International Commission on Irrigation and Drainage (ICID) in 1973 and is very active both nationally and internationally in the fields of irrigation and drainage. Nepal National Committee of ICID (NENCID) has been constituted under the chairmanship Director General, Department of Irrigation under the Ministry of Energy, Water Resources and Irrigation.

The 8th ARC was hosted by Nepal National Committee of ICID (NENCID) during May 2-4, 2018 in Kathmandu, Nepal. The theme of the conference was “*Irrigation in Support of an Evergreen Revolution*”. The conference focus was further sub-divided into following five sub-themes:

- I. ***Enabling small holders’ capacity to obviate farmers’ distress***: enhancing access to appropriate technology and non-conventional banking services; promoting asset management of small holders’; innovative and workable financing mechanisms; addressing to low productivity and market uncertainty; legal and institutional arrangements for collective farming of small holders’ organization; etc.
- II. ***Coping with recurring droughts and floods in the context of climate change***: characterizing climate variability/change and climatic extremes; climate change impacts on water availability and demand; issues/challenges of land and water management; developing resilience to climatic variability and extreme events; crop insurance; etc.
- III. ***Modernizing irrigation systems for better services***: multi-perspective evaluation of irrigation systems; approaches of irrigation system modernization for achieving Sustainable Development Goals (SDGs); innovation and technical advances for water energy-food security; system automation for efficient/effective management options; institutional reforms of large scale irrigation systems; cases of modernization as an intervention and lessons learnt; mainstreaming modernization process through various reforms; etc.
- IV. ***Enabling Water Users Institutions (WUIs) for sustainability of irrigation systems***: performance assessment, enterprising, and sustainability of WUIs; institutional and policy landscape of irrigation/drainage sectors; process and procedure of participatory irrigation development/operation/maintenance in various countries; role of irrigation/ farmers/water users’ organization in improved irrigation system performance; etc.
- V. ***Irrigation, ecosystem services, and aquatic biodiversity***: assessment of trade-offs between and optimization of consumptive uses of water and environmental flows; water-related natural infrastructure and ecosystem services in the water-energy-food nexus; impact of irrigation on water-related ecosystem services; contributions of traditional knowledge and citizen science to understanding and managing irrigation ecosystems; using information from valuation and other assessments in decision making for long-term ecological sustainability.

2. Program Summary

The 8th ARC was organized jointly by the Government of Nepal (Department of Irrigation & Department of Water Induced Disaster Management) and NENCID and Co-organized by USAID. The other partners (in alphabetical order) who joined hands in organizing the conference were ADB, ICEWaRM, ICIMOD, IWMI, and the World Bank. The conference was held during May 2-4, 2018 at Hotel Yak and Yeti in Kathmandu, Nepal. More than 520 participants, including approximately 100 international ones, participated the conference. The participants were from 22 countries in Asia and beyond. They cover a wide range of disciplines including academicians, practitioners, policy makers and research scholars. One-hundred and five (105) abstracts were accepted for the oral presentation in 15 technical sessions (TS) and/or plenary symposiums. A glance of the technical and other sessions in the conference program is provided in Table 1.

The number of TSs under the sub-themes 1-5 were, 2 (TS01 and TS03), 4 (TS04, TS06, TS08 and TS09), 5 (TS02; TS07; TS10; TS11; TS13), 3 (TS05; TS12; TS14), and 1 (TS15), respectively. Out of 105 abstracts, only 72 were scheduled to present in the TSs. Their distributions under the TSs 1-5 were 10, 19, 25, 13 and 5, respectively.

The conference provided a valuable networking opportunity and set the stage for further co-operation.





Table 1: Conference program at a glance

Time	Plenary/Parallel Sessions			
	Room			
	Regal1	Regal2	Dynasty	Crystal
Day 1: Wednesday, May 02, 2018				
07:00 - 11:00	Registration/Networking			
11:00 - 12:30	Inaugural Session			
12:30 - 13:30	Lunch/Networking			
13:30 - 15:00	Plenary – 1: Opening Session			
15:00 - 15:30	Coffee/Tea/Networking			
15:30 - 17:00	Plenary-2 Symposium: Modernization of Irrigation Systems [DoI/WB]	TS-01	TS-02	TS-03
17:00 - 17:15	Coffee/Tea/Networking			
17:15 - 18:15	Plenary-2 Symposium Contd...			
18:45 onwards	Welcome Reception (including Cultural Program) - Regal			
Day 2: Thursday, May 03, 2018				
08:00 - 09:00	Registration/ Tea/Coffee			
09:00 - 10:30	Plenary-3 Symposium: Irrigation, Ecosystem Services, and Aquatic Biodiversity [PANI]	Plenary-4 Symposium: Sustainable Irrigation [IWMI/ICIMOD]	TS-05	TS-06
10:30 - 11:00	Coffee/Tea/Networking			
11:00 - 12:30	Plenary-3 Symposium [Contd. ...]	Plenary-4 Symposium [Contd. ...]	TS-07	TS-08
12:30 - 13:30	Lunch/Networking			
13:30 - 15:00	Plenary-5 Symposium: Nexus Challenge to Irrigation institutions [FMIST]	Plenary-6 Symposium: Climate Change & Adaptation/Mitigation to Floods/Droughts [ICEWaRM]	TS-09	TS-10
15:00 - 15:30	Coffee/Tea/Networking			
15:30 - 17:00	Plenary-5 Symposium [Contd. ...]	Plenary-6 Symposium: [Contd...]	TS-11	TS-12
Day 3: Friday, May 04, 2018				
08:00 - 09:00	Registration/ Tea/Coffee			
09:00 - 10:30	TS-13	TS-14	TS-04	
10:30 - 11:00	Coffee/Tea/Networking			
11:00 - 12:30	TS-15	Plenary 7 – Inter-basin water transfer – Bheri Babai Diversion Project Experience Sharing		
12:30 - 13:30	Lunch/Networking			
13:30 - 15:00	Closing Session			
17:00 onwards	Farewell Dinner			

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3. Proceedings of Plenary Sessions

Seven plenary sessions were convened during the three days. They are briefed hereunder;

3.1 *Plenary 1: Inaugural and opening session*



The conference was inaugurated by Rt. Hon'ble Bidya Devi Bhandari, President, Federal Democratic Republic of Nepal. Hon'ble Barsha Man Pun, Minister, Energy, Water Resources and Irrigation was also present in the inaugural session. Opening remarks were delivered by the President and Vice President of ICID, Joint secretary for Energy, Water Resources and Irrigation of Nepal and representative of Department of Irrigation, Government of Nepal.

The opening plenary was moderated by Dipak Gyawali, the Chair of Technical Advisory Committee (TAC) of the 8TH ARC. It was divided into two parts. In the first part, Mr. Gyawali provided context of the conference as well as technical highlights. Six high level speakers delivered keynote speeches in the session. The speakers include, Arnaud Cauchaus (Senior Water Resources Specialist, Asian Development Bank), Carol Jenkins (Head of SEED Office, USAID), Saroj Pandit (Director General, Department of Irrigation, Government of Nepal), A. B. Pandya (General Secretary, ICID), and Ahmed Shawky (Senior Water Resources Specialist, World Bank).

Mr. Gyawali discussed on cultural theory of social solidarities and their technological choices and highlighted importance of understanding key aspects of technological choices such as – What type of

technology is appropriate? To whom it is appropriate? What are the risks associated to the choices and who bears them? Mr. Cauchaous from discussed current global/regional mega challenges and shared how ADB is responding to address global/regional water challenges. Ms. Jenkins from USAID shared learning from recent field visit in Western Nepal and mentioned that irrigation or lack of water is the key constraint for agricultural productivity in Nepal. She also highlighted how USAID-funded projects such as KISAN, PAHAL, SABAL etc. are contributing to enhance access of water to farmers through various approaches including multiple use of water system (MUS). She then emphasized on the need for integrated watershed management approach, water use productivity/efficiency, and workable collaborative platform for all partners to provide better solution to the irrigation access. Mr. Pandit from DoI, Government of Nepal, provided an overview of irrigation development in Nepal and evolution of policies, institutions, and technological development. He also highlighted how development partners are continuously supporting in the irrigation development of Nepal. Mr. Pandya shared ICID vision 2030, which consists of six goals and corresponding action plans. Mr. Shawky from World Bank shared thoughts on the topic of “Water in Agriculture” with focus on water accounting, management efforts required for different levels of irrigation, and how vulnerable the agriculture is to climate change.



The second part of the opening session included release of the Technical Report of ASRWG-WT titled “Contribution of Agriculture Water to the Rural Development of Asia”. The ICID President and Vice-Presidents jointly released the report.

3.2 Plenary 2: Symposium on “Modernization of Irrigation Systems”

The Symposium on “Modernization of Irrigation Systems” was organized jointly by Department of Irrigation (DoI) and the World Bank. It was moderated/facilitated by Dr. Guna Nidhi Paudyal and Mr. Sanjeeb Baral. The three-hour session was addressed by three keynote speakers (Dr. Bart Schulz, Dr. Ian Makin, and Mr. Kyu Sung Choi). Five expert panelists (Mr. Arnaud Cauchaus, Mr Ahmad Shawky, Dr. Puspa Khanal, Dr. Purna Bahadur Chhetri, and Mr. Bakhodir Mirzaev) provided their views on the main theme of the symposium. During the keynote session, Mr. Choi, Chairperson of Korean Rural Community Corporation, shared the experiences in modernization of agriculture in Korea through Korean Rural Community Cooperation (KRC). The water shortage due to climate change and lack of manpower due to decreasing rural population was the key driver to move towards modernization of agriculture in Korea. As per Mr. Choi, key aspects of irrigation modernization in Korea are rehabilitation of irrigation facilities, ICT-based smart water management, flood control to cope with climate change, and integrated systems through river basin inter-link for complementary irrigation. Prof. Schultz provided an overview of irrigation and drainage facilities in three types of countries (i.e., high income, middle income, and low income) and emphasized that there are lots to be done in low-income countries as they have only 6% of irrigation and 1% of drainage facilities. The crux of his talk was that the increasing farm size and farm systems are required should we expect higher yield per hectare of land. Mr. Makin presented systematically the evolution of irrigation modernization process and highlighted that technical, managerial, and institutional elements are equally important and reforms of these elements in a balanced way are required to achieve irrigation modernization. He emphasized for realigning the yesterday’s system with the need of today and tomorrow.



During the panel discussion session, Dr. Puspa Khanal stressed on the need of focusing on dual objectives of land productivity and water productivity in irrigation modernization and then suggested to develop a comprehensive framework for that, build national capacities, and change in teaching approach in academic institutions as the way forward. Mr. Bakhodir Mirzaev discussed about

measurements, water accountability, and adequate capacity for sustainable modernization of irrigation systems. Dr. Purna Chhetri, on the other hand, emphasized on sustaining land use, strengthening Water User Association, crop system planning, and incentive to agricultural people as key elements for modernization. Dr. Ahmad Shawky from World Bank linked his discussion with modernization of Rani-Jamara-Kuleriya Irrigation System in Nepal and emphasized that the need of modernization is to retain people from migration to Arabian/Gulf countries. He then highlighted on positive incentives for increasing irrigation water use efficiency and also discussed various options on PPP model. Dr. Arnaud discussed characteristics of yesterday's irrigation system and mentioned that tomorrow's system should be different and be focused on market/commercial orientation, flexible, reliable, cheaper and efficient. He also stressed on the need of managerial, institutional, and technical aspects for modernization of irrigation systems. Eight persons actively participated in very interactive question and answers session.

3.3 Plenary 3: Symposium on “Irrigation, Ecosystem Services and Aquatic Biodiversity”

This plenary was organized by USAID's PAANI project. The session was facilitated by Dr. Allen Turner and Ms. Nilu Basnyat from PAANI. The session consisted of one keynote speech from Prof. Jeff Opperman, four presentations from Dr. Ram Devi Tachamo Shah, Mr. Dibesh Karmacharya, Mr. Sanjeeb Baral, and Dr. Maheshwor Shrestha. The presentation was followed by panel discussion, in which five panellists (Prof. Jeff Opperman, Prof. Mark Weinhold, Prof. Ashutosh Shukla, Mr. Ashok Tharu, and Ms. Madhu Ghimire) shared their views. In his keynote, Prof. Opperman discussed on the power of rivers with the key message of the need to develop water infrastructure while maintaining healthy rivers. He highlighted several potential threats to ecosystems due to water infrastructure development and ways to move ahead with maintaining health rivers. The four presentations were focused on river health assessment, developing eDNA monitoring tool for analysing fish biodiversity, environmental flows (E-flows) assessment, and participatory river basin planning for water resources management.





The panel discussion was carried out in two rounds. In the first round, the panellists shared their views focusing on a key question “*What does a river scape and ecosystem approach to understanding and management mean?*” The panellists’ view ranges from the linkage between upper and lower riparian ecosystems, to integrated approach for water resources management, respecting and following socio-economic and cultural values, and regulatory measures for protection and conservation of biodiversity and ecosystem. The second round was focused on “*What have we learned and how can we put these lessons to good use in Nepal?*” The panellists responded that better information, their access, and flow within and outside the government system is lacking. In addition, there is a great opportunity for water infrastructure development in Nepal and political will is necessary for utilizing the resources in effective manner.

3.4 Plenary 4: Symposium on “Sustainable Irrigation”

The plenary was organized jointly by the International Water Management Institute (IWMI) and the International Center for Integrated Mountain Development (ICIMOD) and facilitated by Dr. Luna Bharati and Dr. Aditi Mukherjee of IWMI and ICIMOD respectively. The session covered topics on the emerging solutions in the arena of technological and institutional innovations and the various ways of managing future uncertainty and risks so that we move towards a more sustainable irrigation sector in the future. The first part of the session consisted of Five presentations by Dr. Santosh Nepal (ICIMOD), Dr. Alok Sikka, (IWMI), Dr. Xueliang Cai (UNESCO-IHE), Prof. Mathias Becker (Uni. Bonn) and Dr. Alan Nicol, (IWMI). The high level panel, which focused on technological and institutional innovations aimed at improving efficiency, equity and sustainability of irrigation systems in Asia, consisted of Hon. Karlene Mayward, Former Minister, Australia, Dr. David Molden, Director General, ICIMOD, Nepal, Dr. Vadim Sokolov, Head of the International Fund for Saving the Aral Sea (IFAS), Central Asia, Mr. Felix Reinders, President, International Commission on Irrigation and Drainage (ICID) and Mr. Ian Makin, Asia Director, IWMI. Dr. Santosh Nepal presented climate change scenarios and its implication on water resources and agriculture in Nepal. He emphasized future projection results with wetter and hotter future climate, decreasing glaciers, floods and extreme events, which would adversely affect irrigation systems and agriculture production in Nepal. In his presentation on managing climatic risks for sustainable irrigation, Dr. Alok Sikka presented various solutions to build climate resilience. The solutions included, optimizing reservoir operations, internalizing climate scenarios in the design of water infrastructures, water supply and demand management, risk transfer schemes such as insurance, modernizing irrigation, water and energy smart solutions including solar irrigation, capacity strengthening and regional cooperation. Dr. Xueliang Cai, mentioned that his studies with remote sensing tools show that small farmers are leading the bigger irrigation development and productivity gains in agriculture. Therefore, there is a need to further support new farmer lead initiatives. The presentation by Prof. Mathias Becker on the benefits and trade-offs on water-saving rice production stressed that water-saving production methods may entail production risks and possible trade-offs that have not been sufficiently considered when advocating these innovative cropping strategies. Finally, Dr. Alan Nicol, presented the social and institutional aspects of managing future risk and uncertainty. His presentation highlighted that although farmers see migration as a coping strategy against future risks, it is both a ‘safety valve’, and debt. trap. Dr. Nicol further emphasized the need to tackle future risks as part of a wider socio-economic development strategy. The high-level panel discussion on Technological and Institutional Innovations for Sustainable Irrigation emphasized that the context of irrigation is changing very fast due to rapid socio-economic changes and climate change. The panelists concluded that for irrigation to be sustainable, it has to cater to the changing context through appropriate policies, strategies and technologies. The discussion further stressed the need for farmers to be at the center stage of sustainable irrigation development.



3.5 Plenary 5: Symposium on “Nexus Challenges in Irrigation Institutions”

Irrigation is a combination of socio- technical and institutional aspects in order to be productive, hence, it operates within socio-ecological system consisting of hydrology, hydraulic, civil engineering, soil science, agronomy, institutions and human organizations and marketing. So, irrigation institutions have to break silo approach.

In this context, this plenary was organized by Farmer Managed Irrigation System Promotion Trust (FMIST) and facilitated by Dr. Prachanda Pradhan. It had a keynote session followed by panel discussion. During the key note session, Prof. Asit Biswas, Dr. Douglas Merrey, and Mr. Devesh Belbase shared their thoughts on nexus challenges in irrigation institutions.

The video keynote speech by **Dr. Asit Biswas** emphasized that new approach is to be taken and go beyond the boundary of traditional approach in meeting the food requirement to the growing population. Example of India and China suggest that despite the limited land and water, food production can be increased by adopting new technology and approaches including expansion of connectivity by bringing food from surplus area. However, the presentation suggests to look for new institutional arrangements where **Dr. Douglas Merrey** presented his keynote speech by stating whether 21ST Century Water Users Associations will do better than in 20TH century. He emphasized that the new approach is needed to support farmer-led collective management of irrigation. Following these two keynote speeches, **Mr. Devesh Belbase** presented case study on Irrigation and Hydropower Trade-off which suggests that, due to fast growing water related infrastructures of irrigation and hydropower, there is now need of catchment management and basin planning for water allocation and management to strike a win-win situation between irrigation and hydropower.



A panel discussion followed the three presentations. Five learned panel members namely Dr. Hafied Gany (Indonesia), Mr. Susheel Acharya (Nepal), Dr. Masayoshi Satoh (Japan), Dr. Ding Kunlin (China) and Mr. A. B. Pandya, Secretary General of ICID (India) deliberated on the issues identified and provided insights from their vast experiences in the field of irrigation institutions. The panel discussion focused on following key issues;

- What policy instrument would help break the silo approach in irrigation institutions performance improvement?
- How should irrigation institutions be promoted with features of self-governing, self-regulating and self-supporting?
- How can irrigation and agriculture institutions work together to ensure food security?
- How can external and internal factors of irrigation institutions be integrated to meet the growing impact of climate change?

3.6 Plenary 6: Symposium on “Climate Change and Adaptation/Mitigation to Floods/Droughts”

This was the plenary organized by ICEWaRM and facilitated by Hon’ble Karlene Maywald. The session had a keynote from Dr. David Molden and 5 panelists (Dr. David Molden, Dr. Kaluvai Yella Reddy, Mr. Dipak Gyawali, Mr. Daniel Casement, and Dr. Luna Bharati). The key discussions of the session are summarized hereunder,

- Most glaciers are losing ice volume but in some regions like Karakoram region glacier thickening is observed. Irrigated agriculture in high altitude and communities depending on glacier/snow melt are hardest hit. To stop glacier melting, reduction of Green House Gas emission are needed. Activities like real-time monitoring of floods, identification of recharge area, irrigation water management, drainage area management and rainfall management are needed.
- Climate change impact depends not only in bio-physical activities but also socio-economical activities, so better analysis of climate change is needed. Data collection at the local level and decision making at the higher level can be done by utilizing the Citizen science for management at the local level which are more effective.

- Valuing of water and incentivising the water use efficiency for the benefit of farmers can be done. Water saving crop production techniques and micro-irrigation techniques can be adopted for ore production with less water. Training for the future and gender mainstreaming are necessary.
- Carbon footprint has practically doubled for no reason. Impacts of climate change can be completely out of expectation which may require critical decisions for water management. Murray Darling basin in Australia: off-farm engineering and on-farm engineering technologies adopted for mitigation of climate change impacts. Government – community-farmer partnership required for implementation of policy.



3.7 *Plenary 7: Inter-Basin Water Transfer in Bheri-Babai Irrigation Project – Experience Sharing*

This plenary was conducted by Bheri Babai Diversion Multipurpose Project (BBDMP) under the Department of Irrigation (DoI), the Government of Nepal. Considering the need for assured year-round irrigation, development of several Inter-Basin Water Transfer (IBWT) projects are identified by the government of Nepal with the aim of diverting water from "water surplus" rivers to "water deficit" rivers to supplement irrigation water requirement during deficit period. Among several IBWT projects in pipeline BBDMP is the first one undertaken for implementation. Considering its significance, the Government of Nepal has classified the project as "**Project of National Pride**" in July 2013 and has allocated assured funds from government's own exchequer.

Main objective of BBDMP is to provide round the year irrigation water to 51000 Ha cultivation land in Bardiya and Banke districts by augmenting 40 m³/s water in Babai river and secondary objective is to produce about 48 MW Hydroelectricity by utilizing the difference in elevation of 152 m between the donating Bheri river and receiving Babai. Total annual benefit is estimated to be about NRs 7.5 Billion (at 2017 price).



BBDMP comprises of three main components namely Diversion Headwork across Bheri river, Head Race Tunnel through the mountain between the two rivers and Powerhouse and accessories at Babai river. Because of the risks owing to the geology and also the topography of the alignment the head race tunnel is being implemented first in the first phase which will be followed by construction of Headwork and Powerhouse in the second phase.

Geologically, the tunnel alignment lies in the region occupied by rocks of the Siwalik group. Interbedded Mudstone, Sandstone and Conglomerate type of rocks with variable soil cover lies along the alignment which also intersects two local faults. For the given geology and topographical mountain situation of the tunnel alignment, mechanized tunnelling using Tunnel Boring Machine (TBM) and lined with precast concrete segments has been adopted to be the preferred method of tunnelling over the traditional Drill and Blast Method (DBM). It is for the first time that a tunnel is to be constructed in Nepal using TBM.

Highest overburden in the alignment is the Harre peak which is 820 m above the alignment and lowest is the overburden in valley formed by Toli khola which is about 220 m. Risks associated owing to highest overburden, the faults, especially the Bheri fault and water ingress along the alignment mixed with mudstone are the key factors in the design and selection of TBM. A hard rock double shield TBM with excavation diameter of 5.1 m manufactured by Robbins company has been adopted to construct the tunnel. The TBM has facility for installation of segments at the rear end of the shield. Also, facility for injection of pea gravel in the annular space and grouting, facility for advance probing and/or grouting of more than 30m are the key features of the TBM.

Hexagonal honeycomb type segment 0.3 m thick and 1.4 m long with design strength of 50 MPa is used for lining of the tunnel. Actual strength of the segments produced using state of the art segment production moulds is more than 60 MPa. Four number of segments are erected to form a ring with a finished diameter of 4.2 m (water flowing section).

Muck generated is transferred from the head to the train of muck carrying cart using conveyor belt and thereafter the muck cart discharges to the muck discharging platform which is then carried to various disposal sited using dump trucks.

All works associated with construction of the HRT including access road, TBM platform, TBM entry portal, site camp etc. has been grouped into one single contract at a contract value of NRs NRs10,569,832,141.52. Contractor is China Overseas Engineering Group Co Ltd. (COVEC), China. Start date is June 04, 2015 and completion date is April 2020.

TBM was designed at the Robbins office at Seattle, USA and manufactured at Shanghai China after which it was dismantled and transported using 56 containers to site via Kolkata to Rupaidiha. It took about 14 months for the entire operation including assembly at site which was concluded in October, 2017. Actual excavation and tunneling using TBM was started on November 06, 2017.

In the meantime, all peripheral works such as TBM Platform, TBM entry portal, employer's camp, contractor's camp etc has been completed. Likewise segment production plant is completed in all respect an about 80 segments are being produced each day.



As of April 25, 2018, 3.7 Km of the total 12 Km tunnel (31 %) has been successfully constructed including excavation, precast concrete segment lining and grouting of annular space (except for final grouting). Highest overburden at Harre peak which lies at 2.3 Km has been crossed smoothly. Average progress so far has been 22 m per day with a maximum of 52.8 m. Similarly, weekly maximum is 287 m with monthly maximum of 1001 m in April beating the Robbins TBM record of 879 m in India. Average monthly progress is of 660 m which is more than the estimated 400 to 500 m per month

Main geology encountered has been the alternate interbedded mudstone (sometime siltstone), sandstone (fine grained as well as coarse grained) and conglomerate (at few locations). Water ingress which seems to have been released from the water lying in the joints in sandstone is observed at various locations along the alignment, it is managed by allowing gravity flow in the channel provided in the bottom segment. In few cases, the discharge reduced after sometime whereas in others, continuous discharge is observed.

Thus, based on experience so far, it can be concluded that TBM can be successfully used to construct tunnel in the Siwalik geology to expedite the implementation of Inter Basin Water Transfer Projects where tunnel is in critical path of overall schedule. It makes the large projects techno economically viable providing the facilities to the users in relatively short period.

4. Proceedings of Technical Sessions

Fifteen (15) technical sessions under the five sub-themes of the conference were designed. The sub-theme wise description of the technical session proceedings is provided hereunder.

4.1 Technical sessions under sub-theme 1 “Enabling small holders’ capacity to obviate farmers’ stress”

There were two technical sessions (TS01, TS03) under the theme. Ten (10) presentations (Table 2) were scheduled under the two technical sessions, however, only seven presentations (not highlighted in Table 2) were actually made. The session also included 1 plenary symposium “Nexus challenge to irrigation institutions” with 3 presentations and 5 panelists.

Table 2: List of presentations scheduled under sub-theme 1

S.N	Paper ID	Title (Author)
1	TS01-1	Dealing with variations in access to water: An assessment of challenges and coping strategies in Far-western Nepal (<i>Ram Bastakoti, Emma Karki and Bhesh Raj Thapa</i>)
2	TS01-2	Paradigm shift in hill irrigation systems: A case study of Dolkha District (<i>Krishna Pd. Rijal</i>)
3	TS01-3	Building capacity of smallholder farmers for enhanced adoption of drip irrigation: Lessons from Karnataka, India (<i>Priyanie Amerasinghe, Alok Sikka</i>)
4	TS01-4	Impact assessment of water savings technologies in livelihood improvement of small and marginal farmers of India (<i>Neelam Patel, T.B.S. Rajput, J.P.S. Dabas, S.S. Parihar, Mairaz Hussain</i>)



S.N	Paper ID	Title (Author)
5	TS01-5	Strategic role of drip irrigation in efficient management of water resources and enhancing livelihoods: select case study –India (<i>Teki Surayya</i>)
6	TS03-1	Improving water use for dry season agriculture by marginal and tenant farmers in the Eastern Gangetic Plain (<i>Eric Schmidt, Ram C Bastakoti, Michael Scobie</i>)
7	TS03-2	Empowering small growers by gravity micro-irrigation technology (<i>Dilip Yewalekar, Manisha Kinge</i>)
8	TS03-3	Decentralized approach for waste water treatment and long term effect of treated and untreated waste water irrigation on crop and soil quality (<i>Sumit Pal, Neelam Patel, Anushree Malik, D.K. Singh</i>)
9	TS03-4	Rural water systems for smallholder farmers in the Hills of Nepal - An unrecognized irrigation service (<i>Raj Kumar G.C</i>)
10	TS03-5	Gender differences in water security and capabilities in Far-West Nepal (<i>Gitta Shrestha, Floriane Clement</i>)

The key message of this sub-theme is,

- Consolidating collective farming, not just physical, but in terms of their social capacity to demand services; and risk transfer approach (e.g., insurance mechanism) may help to obviate farmers' distress

4.2 Technical sessions under sub-theme 2 “Coping with recurring droughts and floods in the context of climate change”

Four technical sessions (TS04; TS06; TS08; TS09) were designed under this sub-theme and 19 presentations (Table 3) were scheduled. However, only 13 papers (not highlighted in Table 3) were actually presented. There was also one plenary symposium organized by ICEWaRM that was aligned with this sub-theme. The symposium had one keynote and 5 panelists.

The highly synthesized key message of this sub-theme is,

- Focus on multiple storage approaches, including artificial groundwater recharge, could be workable coping strategies/mechanism in semi-arid Asia

4.3 Technical sessions under sub-theme 3 “Modernizing irrigation systems for better services”

There were five technical sessions (TS02; TS07; TS10; TS11; TS13) with 25 presentations (Table 4) scheduled under this sub-theme. However, only 21 presentations (not highlighted in Table 4) were actually made. There was also one plenary symposium with 3 presentations and 5 panelists aligned with this sub-theme.

**Table 3:** List of presentations scheduled under sub-theme 2

S. N	Paper ID	Title (Author)
1	TS04-1	Digo Jal Bikas (<i>Luna Bharati , Vishnu Panday, Sanita Dhaubanjari, Diana Suhardiman, Ram Devi Tachamo Shah, Subodh Sharma, Nishadi Eriyagama, David Wiberg, Marc Jeuland, Emily Pakhtigian, Ram Bastakoti, Florian Clement, Emma Karki, Gitta Shrestha, Dipak Gyawali</i>)
2	TS04-2	Projected future climate for Western Nepal (<i>Sanita Dhaubanjari, Vishnu Prasad Pandey, Luna Bharati</i>)
3	TS04-3	Assessing spatio-temporal variation in water resources availability in Karnali-Mohana River Basin, Nepal (<i>Vishnu Prasad Pandey, Sanita Dhaubanjari, Luna Bharati</i>)
4	TS04-4	Spatio-temporal disintegration of different droughts in Nepal (<i>Manisha Maharjan, Anil Aryal, Rocky Talchabhadel, Bhesh Raj Thapa</i>)
5	TS04-5	A remote sensing and GIS approach to analyze agricultural drought trend, frequency and severity in Marathwada, Maharashtra, India (<i>Mohammadsanaulla K. Huddar, N.R. Patel, Abhishek Danodia, G. Paavan Kumar Reddy</i>)
6	TS06-1	Agro-Climatic atlas of Nepal: A tool for sharing climatic information for agricultural sector (<i>Rocky Talchabhadel, Ramchandra Karki, Mahesh Yadav, Manisha Maharjan, Anil Aryal</i>)
7	TS06-2	Climate change and water management impact on crop production in Bangladesh (<i>Md. Farid Hossain</i>)
8	TS06-3	Crop water status, severity of soil moisture stress and climatic variables on seed cotton yield in Semi-Arid region of India: A case study of Gujarat and Maharashtra (<i>R. B. Singandhupe, A. Manikandan</i>)
9	TS06-4	Optimal cropping pattern for sustainable agriculture under drought condition (<i>Jyoti Prakash Padhi, Bitanjaya Das, A. Sudarsan Rao</i>)
10	TS06-5	Assessment of meteorological drought using different approaches in the Karnali River Basin, Nepal (<i>Kabi Raj Khatiwada, Vishnu Prasad Pandey</i>)
11	TS08-1	Calibration of an annual crop Growth Model in order to simulate growth and water use efficiency (<i>Zeinab Mirzaie, Zuhair Hasnain</i>)
12	TS08-2	Issues and challenges in implementing rainfall harvesting systems in Malaysia (<i>Ngai Weng Chan, Mouleong Tan, Bakhtyar B, Aminuddin AB Ghani</i>)
13	TS08-3	The role of irrigation efficiency as a tool for mitigating the impacts of climate change (<i>Michael Davidson</i>)
14	TS08-4	Estimating paddy rice yield change considering climate change impact on cropping period (<i>Pu-Reun Yoon, Jin-Yong Choi</i>)
15	TS09-1	Management of water resources in Himalayan region for food security and rural development in context of climate change (<i>Abdul Latif Khan</i>)
16	TS09-2	A foresight for flood disaster management in Pakistan (<i>Qazi Tallat M. Siddiqui, Ahmed Kamal</i>)
17	TS09-3	Groundwater reservoir as a source of flood water storage - A case study from Punjab, Pakistan (<i>Ghulam Zakir Hassan, FaizRaza Hassan</i>)
18	TS09-4	Coping with recurring floods and droughts in the context of climate change in Sri Lanka (<i>T. Janaki Meegastenna, Badra Kamaladasa</i>)
19	TS09-5	Climate and aridity change (<i>Ootilija Miseckaite, Vesna Tunguz, Ivan Simunic, Palma Orlovic-Ieko</i>)

**Table 4:** List of presentations scheduled under sub-theme 3

S.N	Paper ID	Title (Author)
1	TS02-1	Potential of using solar energy for irrigation in hilly region of Nepal (<i>Manoj Pantha</i>)
2	TS02-2	Application of the groundwater irrigation system using solar power generation as a Water-Energy-Food-Nexus model project (<i>Sungsoo Bang, Bongkyun Kim, Jeonyong Ryu</i>)
3	TS02-3	Opportunities and challenges faced by emerging renewable energy based lift-irrigation systems: A case study of hydro-powered irrigation pumps (<i>Pratap Thapa, Sujan Dulal</i>)
4	TS02-4	Solar powered irrigation pumps as a clean Energy solution for Nepal Terai (<i>Sugat Bajracharya, Devjit Roy Chowdhury, Vijay Khadgi, Nabina Lamichhane, Aditi Mukherji</i>)
5	TS02-5	Harnessing the hydropower boom: Enhancing water resources for farmer managed irrigation systems (<i>Rashmi Shrestha, Arica Crotofo</i>)
6	TS07-1	Irrigation development in Nepal: A comparative historical review and future orientation (<i>Bir Singh Dhimi, MadhavBelbase</i>)
7	TS07-2	Development of smart apps for data collection and decision support in India and Nepal (<i>Michael Scobie, Ralph Shippam, Erik Schmidt</i>)
8	TS07-3	Sprinkler irrigation management in loam soil (<i>Ootilija Miseckaitė, Viktor Lukashovich, Vladimir Zhaliakzo</i>)
9	TS07-4	Intermediate reservoir in irrigation laterals for improving irrigation system operation through making it efficient and women friendly (<i>Indra Lal Kalu</i>)
10	TS07-5	Development of reservoir operation model using reinforcement learning (<i>Maga Kim, Jin-Yong Choi</i>)
11	TS10-1	Irrigation modernization: Catching up with farmers' initiative - the case of Vietnam (<i>Xueliang Cai, Wim Bastiaanssen, Manh van Nguyen</i>)
12	TS10-2	Irrigation modernization by enhancing water productivity through water accounting (<i>Suman Sijapati, PuspaaR. Khanal, Jeffrey C. Davids</i>)
13	TS10-3	Irrigation Master Plan for Nepal through integrated river basin planning (<i>Trevor Beaumont, Beau Freeman</i>)
14	TS10-4	Efficient water management as a key for sustainable development: Context of national water policy in India (<i>K. Yella Reddy</i>)
15	TS10-5	Comparative assessment of various water application methods for dry season agriculture in the Eastern Gangetic Plain (<i>Bhesh Raj Thapa, Michael Scobie, Rabindra Karki, Manita Raut, Ram Chandra Bastakoti, Erik Schmidt</i>)
16	TS11-1	Development of a Decision Support System for scheduling irrigations and fertigations in drip irrigated crops (<i>T.B.S. Rajput, Neelam Patel</i>)
17	TS11-2	A review of agriculture water management technologies in a climate smart context (<i>Sugat Bajracharya, Devjit Roy Chowdhury, Vijay Khadgi, Nabina Lamichhane, Aditi Mukherji</i>)
18	TS11-3	Irrigation management under changing climatic scenario for evergreen revolution: Asian economic perspective (<i>A. K. Randev</i>)
19	TS11-4	Water Requirement of Different Horticultural Crops under Drip Irrigation System in Tamagarda - Erani Inter basin (<i>Amit Prasad, H.C. Sharma</i>)



S.N	Paper ID	Title (Author)
20	TS11-5	Scenario of Interbasin Water Transfer Projects in Nepal: A Case Study from Bheri Babai Diversion Multipurpose Project (<i>Ajaya Raj Adhikari, S.K. Basnet</i>)
21	TS13-1	Practices of irrigation and drainage management in terms of sustainability aspect: A case study of Chapagaun, Lalitpur, Nepal (<i>Suman Gyawali</i>)
22	TS13-2	Cultivable area recovered by using bamboo bandalling structures (<i>Md. Lutfor Rahman</i>)
23	TS13-3	Politics of 'clean green' technology of hydropower projects in Himalayas (<i>Shruti Jain</i>)
24	TS13-4	A study of quality control on time series of water level in agricultural reservoir (<i>Jaehong Bang, Jin-Yong Choi</i>)
25	TS13-5	Nepal - Challenges of sediment removal on Sunari Morang Irrigation project (<i>Brian Bromwich</i>)

The key message emerged from this sub-theme is,

- Solar pumping is a key emerging factor in modernization, but it can be both blessing and curse. Focus on multi-purpose projects (e.g. hydropower + irrigation + others) will be a key impetus to sustainable modernization.

4.4 Technical sessions under sub-theme 4 “Enabling Water Users Institutions (WUIs) for sustainability of irrigation systems”

Three technical sessions (TS05; TS12; TS14) with 13 presentations (Table 5) were scheduled under this sub-theme. However, only 12 papers (not highlighted in Table 5) were actually presented. One of the plenary symposium “Sustainable Irrigation” was also aligned with this sub-theme.

Table 5: List of presentations scheduled under sub-theme 4

S.N	Paper ID	Title (Author)
1	TS05-1	Japanese model of participatory irrigation management and Its implications (<i>Masayoshi Satoh</i>)
2	TS05-2	Participatory irrigation development and management procedures and empirical processes under the small land holding condition – With special seference to Indonesian condition (<i>A. Hafied A. Gany</i>)
3	TS05-3	Farmers Managed Irrigation Systems of Nepal: Assessment of the elements contributing to their sustainable operation and maintenance (<i>Deepak R. Pandey</i>)
4	TS05-4	Social complexity of participatory irrigation management (<i>Navin Kumar</i>)
5	TS05-5	Utilization of subsurface dams for agricultural water supply in S. Korea (<i>WooHoMyoung</i>)
6	TS12-1	Rejuvenating Water User Group: The Malaysia Granary Area context (<i>MukhlisZainolAbidin</i>)
7	TS12-2	Improved water management in Kankai Irrigation System, Nepal (<i>Birendra Kumar Yadav, Sanjeev Kumar Mishra</i>)



S.N	Paper ID	Title (Author)
8	TS12-3	Status and performance of irrigations projects: Case studies of selected projects in Nepal (K. R. Sharma, R. Dongol, N. P. Koju, A. Ghimire)
9	TS12-4	Operation performance of a modernised irrigation system: A case study of Sitagunj Irrigation System in Sunsari Morang Irrigation Project, Nepal (Sanjeev Kumar Mishra, Randhir Kumar Sah)
10	TS14-1	Reorganizing Water User Association from flood irrigation system to modernization of irrigation infrastructure: A case study of Rani, Jamara and Kulariya Irrigation System of Kailali district, Nepal (<i>Susheel Chandra Acharya, Prachanda Pradhan</i>)
11	TS14-2	Gendered need for irrigation development in changing climate context (<i>Pranita Bhushan Udas, Chanda G Goodrich, Santosh Nepal, Arther Lutz</i>)
12	TS14-3	A Success Story of Irrigation Management Transfer Program in Nepal: A Case Study of Kankai Water Users' Association, Kankai Irrigation System, Jhapa, Nepal. (<i>Chetman Budha, Prachanda Pradhan</i>)
13	TS14-4	Institutional preconditions for robustness and sustainability in Irrigation Management: Insights from Nepal and Thailand (<i>Ram Bastakoti</i>)

The key message emerged from this sub-theme is,

- Farmlands are not only the food producing units, but they also have multi-functional role, such as education, recreation, etc. Water use institutions will be better empowered when they are linked intrinsically with other important social functions of farms.

4.5 Technical sessions under sub-theme 5 “Irrigation, ecosystem services, and aquatic biodiversity”

There was only one technical session with five presentations scheduled under this sub-theme. However, only four papers (not highlighted in Table 6) were actually presented. One plenary symposium was also aligned with this sub-theme.

Table 6: List of presentations scheduled under sub-theme 5

S.N	Paper ID	Title (Author)
1	TS15-1	Sustaining spring sources through evidence based interventions to augment irrigation in Nepal middle hills (<i>Sanita Dhaubanjari, Karthikeyan Matheswaran, Vishnu P. Pandey, Ambika Khadka, Sudhir Kumar, Luna Bharati</i>)
2	TS15-2	Impacts of dairy farming systems on water quantity and quality in Brazil, Ethiopia, Nepal, New Zealand and USA (<i>Birendra KC, Ian McIndoe, Helen Rutter, Andrew Dark, Bart Schultz, Krishna Prasad, Suman Sijapati, Krishna Paudel</i>)
3	TS15-3	Pollution of groundwater due to extensive use of fertilizers (<i>H.C. Sharma</i>)



S.N	Paper ID	Title (Author)
4	TS15-4	Phosphorus concentrations in irrigation, flooding, and drainage water of paddy fields and their relationship (<i>Kwangsik Yoon, Dongho Choi</i>)
5	TS15-5	Prioritizing land and water interventions for climate smart villages (CSVs) (<i>Mohammad Faiz Alam, Alok Sikka</i>)

The key message emerged from this sub-theme is,

- Biodiversity conservation and irrigation have hitherto worked at cross-purposes creating sub-optimal conditions for both sectors. Two communities (irrigation & biodiversity conservation) should interact closely from the very conceptualization stage to assure healthy development both.

5. Additional Activities

The conference also had additional activities such as pre-conference young professional training program, cultural program, city tour and post-conference technical tour.

5.1 *Young professional training program*

The young professional training program coordinated by Mr. Sanjeeb Baral, Project Director of WRPPF Project, was held on 1st May, 2018 as a pre-conference event. The whole day program started with registration/networking and followed by opening session, and two training sessions. During the opening session, Mr. Sanjeeb Baral, Mr. Saroj Pandit (the Director General of Department of Irrigation), Mr. Madhav Belbase (Vice President of ICID and Joint Secretary of WECS), Mr. AB Pandya (Secretary General of ICID), Dr. Arnaud Cauchaus (Principle Water Resources Specialist in ADB), and Secretary of Ministry of Energy, Water Resources and Irrigation provided encouraging remarks to the young professionals.

During the 1st session, the training was provided by Dr. K. Yella Reddy and it was focused on water footprint and virtual water approach as a tool for improved water use efficiency. The second session of the training was three resource persons from CSIRO (Australia). They include, Mr. Andrew Johnson, Dr. Dave Penton, and Mr. Amit Parashar. The content was focused on basin planning, its implementation, and introduction on the basin planning tool “Basin Futures”.



5.2 Cultural program

A cultural program was also performed during welcome reception in the first day of the conference. It was aimed to provide a sense of cultural diversity in Nepal to all the conference delegates. The program included diversity of dances from mountains, hills and terai regions of Nepal.



5.3 City tour and technical tour

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 accompanies. Half day afternoon trip to Patan Darbar square and full day trip to Pasupatinath, Bouddhanath, and Kathmandu Durbar square, ending at Swyambhu Nath was the plan for city tour.

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 were taken to the oldest irrigation system in Gundu located in Bhaktapur district. They also visited Bhaktapur Durbar Square and stayed overnight at Nagarkot.



6. Conference Closing

The conference was concluded successfully on 4TH May 2018 with a closing remarks by the Minister for Energy, Water Resources and Irrigation, the Government of Nepal. the President and Vice-President of ICID, Joint Secretary of the Ministry for Energy, Water Resources and Irrigation, and Director General of the Department of Irrigation also shared positive remarks during the closing session. It was followed by certificate distribution to the participants of young professional training program and a farewell dinner to celebrate the success of the event. The event concluded with a very positive response from all the participants and stakeholders.

Following five key conclusions were presented by the Chair of the Technical Committee of the 8TH ARC as take home message of the conference,

- Consolidating collective farming, not just physical, but in terms of their social capacity to demand services; and risk transfer approach (e.g., insurance mechanism) may help to obviate farmers' distress
- Focus on multiple storage approaches, including artificial groundwater recharge, could be workable coping strategies/mechanism in semi-arid Asia



- Solar pumping is a key emerging factor in modernization, but it can be both blessing and curse. Focus on multi-purpose projects (e.g. hydropower + irrigation + others) will be a key impetus to sustainable modernization.
- Farmlands are not only the food producing units, but they also have multi-functional role, such as education, recreation, etc. Water use institutions will be better empowered when they are linked intrinsically with other important social functions of farms.
- Biodiversity conservation and irrigation have hitherto worked at cross-purposes creating sub-optimal conditions for both sectors. Two communities (irrigation & biodiversity conservation) should interact closely from the very conceptualization stage to assure healthy development both.

