REPORT OF THE 23RD INTERNATIONAL CONGRESS ON IRRIGATION AND DRAINAGE

MODERNIZATION OF IRRIGATION AND DRAINAGE TOWARDS A NEW GREEN REVOLUTION

Mexico City, Mexico
8 - 14 October 2017

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INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE

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MXCID

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Report of the 23rd International Congress on Irrigation and Drainage

Mexico City, Mexico
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Modernization of Irrigation and Drainage Towards a New Green Revolution

ICID•CIID

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International Commission on Irrigation and Drainage (ICID), established in 1950 is the leading scientific, technical and not-for-profit international organization. ICID, through its network of professionals spread across more than a hundred countries, has facilitated sharing of experiences and transfer of water management technology for over half-a-century. ICID supports capacity development, stimulates research and innovation and strives to promote policies and programs to enhance sustainable development of irrigated agriculture through a comprehensive water management framework. The mission of ICID is to stimulate and promote the development and application of the arts, sciences and techniques of engineering, agriculture, economics, ecological and social sciences in managing water and land resources for irrigation, drainage, flood management, for achieving sustainable agriculture water management.

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EDITORIAL TEAM

Engr. Ashwin B. Pandya, Secretary General
Engr. Harish K. Varma, Executive Director
Dr. Sahdev Singh, Director Knowledge Management
Mr. Madhu Mohanan, Communication Officer

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Foreword

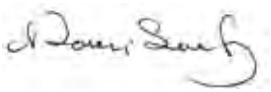
Climate change and unsustainable natural resource consumption are two of the biggest challenges that the humankind is facing at present. Population growth would be less of a concern, if the consumption patterns are aligned to the natural resources availability. For example, food production and the water availability are closely linked to the hydrologic cycle that is increasingly being influenced by a fast-changing climate. Extreme events such as floods and droughts are becoming common sights, raising the impact of the uncertainty associated with climatic processes. A significant part of the climate change phenomenon is also due to human activities, particularly the burning of fossil fuels, deforestation and environmental pollution to name a few. Therefore, Water-Food-Energy nexus requires a greater attention on the part of government policy makers, research and technology development agencies, financing institutions, field practitioners in various sectors of the economy, civil societies and the masses at large. Each stakeholder has to play a specific role in consultation with each other based on a common understanding of underlying physical, chemical and biological processes that transform the natural resources into products for human consumption.

"Efficiency" is emerging as the keyword across the width and the depth of development interventions in various parts of the world. The word has different meanings for different actors. A farmer is efficient if he/she uses less water to grow a certain quantity of food, but an environmentalist may a have a different opinion of this 'efficiency' when it comes to the groundwater recharge function of irrigation. These are contentious issues that can only be addressed through multi-disciplinary dialogue processes among the diverse stakeholders, and that is exactly what ICID Congresses facilitate. The ICID Congress in Mexico addressed subtle technical and practical aspects of agricultural water management (AWM) – including political prioritization for enabling policy development, use of new technology to improve the productivity of inputs and advocacy for sustainable consumption of precious natural resources such as freshwater. The presence of experts from diverse disciplines of sciences and engineering along with the participation of policy makers, NGOs and field professionals enriched the discussions that are captured in this Congress Report. The gathering also reflected the

emerging international partnerships for dealing with critical global issues of food and water security in many parts of the world with an eye on climate change impacts, particularly extreme events (flood and drought).

Advances in space technologies, water-saving irrigation equipment, and innovative cropping systems represent the brighter side of the big picture, however, much more needs to be done to harness these for sustainable development of our food production, processing and distribution value chains. Simultaneously a general consumer awareness should be created to promote virtues of efficient living and sustainable consumption.

As you are aware that the United Nations General Assembly has declared 2018 to 2028 as the "International Decade for Action – Water for Sustainable Development," so it would only be apt to urge all of us to join our global efforts to initiate committed actions at all levels using the best possible scientific knowledge of hydrologic processes with due consideration of social, gender and human equity in governance, development, management and operations. The expert recommendations on various aspects of AWM are highlighted in this Congress Report and we as ICID hope these will guide the way forward.



Dr. Saeed Nairizi
PRESIDENT

Preface

With the increasing threat of water scarcity and food insecurity, sustainable agricultural water management is the need of the hour. With this view in mind, the theme of the 23rd ICID Congress was chosen as 'Modernization of Irrigation and Drainage Towards a New Green Revolution.' To meet the growing food demand of ever-increasing population with the limited water resources available, there is an urgent requirement of a new green revolution which can ensure sustainable food production for the future generations without hampering the current resources, especially water. The discussion regarding the new green revolution demands newer technologies as well as management techniques where food production, energy and water resources are not viewed independently and rather considered as a nexus. Another important element in bringing about a revolution in agriculture is the knowledge of and access to these engineering and management techniques amongst the practitioners of specific social and economic backgrounds.

Background papers were prepared by experts from member and partner organizations to deliberate on the theme 'Modernization of Irrigation and Drainage Towards a New Green Revolution.' For a better understanding of the key elements required to bring a new green revolution, the 23rd ICID Congress was articulated in the form of two major questions. These questions were further sub-divided as follows:

Question 60: Water productivity: revisiting the concepts in the light of water, energy and food nexus

- Emerging issues and challenges of water saving, including impacts of transferring water out of agriculture
- Understanding water productivity, water and energy use efficiency and water footprint of crops
- Water security for growth and development

Question 61: State of knowledge of irrigation techniques and practicability within given socio-economic settings

- Adopting precision irrigation and improving surface irrigation to combat water scarcity
- Using ICT, remote sensing, control systems and modelling for improved performance of irrigation systems
- Adaptability and affordability of new technologies under different socio-economic scenarios

The 23rd ICID Congress, hosted by the Mexican National Committee of ICID (MXCID) and the CONAGUA, was organized in close cooperation with and in partnership with FAO, World Bank and many other International Partners during 08-14 October 2017 at Mexico City, Mexico. The Congress provided an opportunity to the policymakers, planners, farmers, youth and the industry to participate in the dialogue for the need of a new green revolution. Accordingly, the Congress included sessions on Questions 60 and 61 addressing the theme of the Congress, a Ministerial and Senior Officers' Roundtable discussion, Side Events including International Symposium, Seminar, Workshops, and International Exhibition.

Nearly 278 abstracts were submitted on various sub-themes. Further, 154 research articles and posters from more than 54 countries were received before the Congress. A total of 60 papers were presented and about 70 posters were displayed during the congress. These papers were presented during the 23rd ICID Congress in several parallel sessions and poster sessions, and the issues emerging from the sub-themes were discussed in the plenary sessions and presented in the Mexico Statement as the conclusions and recommendations of the 23rd ICID Congress. Participants were provided with a USB containing all the full-length papers including the Background Papers of the sub-themes. These papers can be accessed through ICID website.

Additionally, this post-congress report briefly summarizes the outcomes of the Symposium on 'Global review on institutional reform in irrigation sector for sustainable agricultural water management including WUAs, the International Seminar on 'Water use in food value chain: A challenge for a new Green revolution?,' the Workshop on 'Application of geo-synthetics to irrigation drainage and agriculture' and the Special Session on 'Technologies for Reuse of Wastewater in Agriculture and its Impact on Health and Environment.' The post-Congress report also contains excerpts of the discussion of the High-Level Advisory Group consisting of worldwide experts and senior level dignitaries from International Organizations and Governments.

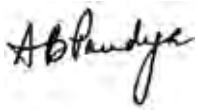
This post-congress proceedings of the 23rd ICID Congress include information on opening and closing ceremonies, outcomes of both the questions and sub-themes, outcomes of the roundtable meetings and side events; besides brief reports on exhibition and technical tours.

For the organization of a successful Congress, I would like to convey my special thanks to Mexican National Committee of ICID for the excellent logistics arrangements during the Congress. The sincerity and tenacity of MXCID, especially in the wake of the earthquake just prior to the Congress, is highly admirable. I extend my gratitude towards the contribution of colleagues from MXCID, IMTA

and CONAGUA for their commitment, successful coordination and organization of the 23rd ICID Congress during a national emergency.

I would like to especially acknowledge and appreciate the efforts of the technical experts who carefully examined the abstracts and papers. Their names are mentioned under Acknowledgements. Moreover, I would like to thank the rapporteurs of the two questions, Prof. AbdelhafidDebbarh (Morocco) and Dr. Ding Kunlun (China), for reviewing the papers and preparing General Reports on the two Congress Questions; and Dr. HafiedGany (Indonesia) and Dr. Olcay Unver (FAO) for chairing the Symposium and the seminar, respectively. I would also like to acknowledge Mr. MehrzadEhsani (Iran), VP Ian W. Makin (UK), PH Gao Zhanyi (China), Dr. Brian T. Wahlin (USA), Dr. KaluvaiYella Reddy (India), Mr. Franklin Dimick (USA) and other technical experts for chairing the sessions organized for the sub-themes.

My special appreciation is due to the ICID Central Office team consisting of Er. Harish Kumar Varma, Executive Director; Dr. Vijay K. Labhsetwar, Director; Dr. Sahdev Singh, Director; Mr. Madhu Mohanan, Communication Officer and the supporting staff for their contribution in bringing out this publication.



Ashwin B. Pandya
SECRETARY GENERAL

Acknowledgement

1. VP Prof. Abdelhafid Debbarh (Morocco)
2. VP Dr. Ding Kunlun (China)
3. Mr. Mehrzad Ehsani (Iran)
4. Dr. Raquel Salazar Moreno (Mexico)
5. VP Ian Makin (UK)
6. Dr. Mauricio Carrillo Garcia (Mexico)
7. VPH Dr. Gao Zhanyi (China)
8. Dr. Jesus Chavez Morales (Mexico)
9. Dr. Brian T. Wahlin (USA)
10. Dr. Heber Saucedo (Mexico)
11. Dr. Kaluvai Yella Reddy(India)
12. Dr. Victor Manuel Ruiz Carmona (Mexico)
13. VPH Dr. Franklin E. Dimick (USA)
14. Dr. Ignacio Sanchez Cohen (Mexico)
15. Dr. Vijay K. Labhsetwar (India)
16. Prof. Dr. Tsugihiro Watanabe (Japan)
17. Dr. Momir Vranes (Australia)
18. Dr. Daniele de Wrachien (Italy)
19. Dr. Nozar Ghahreman (Iran)
20. Dr. Clarke Ballard (Australia)
21. Dr. James E. Ayars (USA)
22. Dr. Takao Masumoto (Japan)
23. Dr. Waldo Ojeda (Mexico)
24. Dr. Maury Roos (USA)
25. Dr. Brent Paterson (Canada)
26. Dr. Sylvain-Roger-Perret (France)
27. Dr. Aynur Fayrap (Turkey)
28. Dr. Young D. Kim (Korea)
29. Dr. Man Singh, IARI (India)
30. Dr. Mohammad Javad Monem (Iran)

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6.	VP Ian Makin, IWMI	- Member
7.	Dr. Olcay Unver, FAO	- Member
8.	Mr. Steven Schonberger, The World Bank	- Member
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10.	Mr. Gustavo Hinojosa, Irrigation Districts Manager, Conagua (MXCID)	- Member
11.	Ms. Claudia Coria, International Affairs Manager, Conagua (MXCID)	- Member
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13.	Dr. Waldo Ojeda, Irrigation Engg. Sub-Coordinator, IMTA (MXCID)	- Member
14.	Ms. Patricia Herrera, International Affairs Specialist, IMTA (MXCID)	- Member
15.	Er. Avinash Chand Tyagi, Secretary General, ICID	-Member-Secretary

Abbreviations

AWM	Agriculture Water Management
CNCID	Chinese National Committee on Irrigation and Drainage
CONAGUA	Comisión Nacional del Agua, Mexico
EPDM	Ethylene Propylene Diene Monomer
ET	Evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
HDPE	High Density Polyethylene
HIS	Heritage Irrigation Structures
HLAG	High-Level Advisory Group
HLPW	High-Level Panel on Water
I&D	Irrigation and Drainage
ICID	International Commission on Irrigation and Drainage
ICT	Information and Communication Technology
IMT	Irrigation Management Transfer
IMTA	Instituto Mexicano de Technología del Agua
IWRM	Integrated Water Resources Management
KRC	Korean Rural Corporation
LDPE	Low Density Polyethylene
LLDPE	Linear Low-Density Polyethylene
MIS	Management Information System
MASSCOTE	Mapping System and Services for Canal Operation Techniques
MXCID	Mexican National Committee on Irrigation and Drainage
O&M	Operation and Maintenance
PIC	Proportional Integral Controller
PIDM	Participatory Irrigation and Drainage Management
PIM	Participatory Irrigation Management
PPP	Public-Private-Partnership
PVC	Poly-Vinyl Chloride
RWI	Reclaimed Water Irrigation
SDG	Sustainable Development Goals
UAV	Unarmed Aerial Vehicles
USDA, ARS	United States Department of Agriculture, Agricultural Research Service
WatSave	Water Saving
WEF	Water-Energy-Food
WG-IOA	Working Group on Institutional and Organizational Aspects
WUA	Water Users' Association


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y 68ª Reunión
Internacional
DE RIEGO Y DRENAJE
8 - 14 DE OCTUBRE, 2017
CIUDAD DE MÉXICO


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OPENING CEREMONY

23rd ICID Congress: Towards a New Green Revolution 2.0

The Hon. President Mexico H.E. Enrique Peña Nieto inaugurated the opening ceremony of the 23rd ICID Congress and 68th IEC Meeting on 9 October 2017 in the presence of Mayor of theMexico City H.E. Miguel ÁngelMancera Espinosa; Director General, CONAGUA, Mr. Roberto Ramirez de la Parra, Senior Director, World Bank, Mr. GuangZhe Chen; Deputy Director, Land and Water Division FAO, Dr. Olcay Unver; Special Adviser, Australia, Mr. Tony Slatyer; President ICID, Dr. Saeed Nairizi; and Secretary General ICID Er. Avinash C. Tyagi. The Hon. President also received the plaques and citation certificates for the two recognized Heritage Irrigation Structures (HIS) of Mexico from the ICID President in the presence of above dignitaries.




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OPENING REMARKS

Dr. Saeed Nairizi
President
ICID

On behalf of the International Commission on Irrigation and Drainage, President ICID Dr. Saeed Nairizi welcomed the Honourable President Mexico, the Mayor of Mexico City, dignitaries of World Bank, FAO, Australia and other participants to the 23rd ICID Congress on Irrigation and Drainage. At the outset, President Dr.Nairizi conveyed his condolences to the families affected by the earthquake and appreciated the resilience of Mexico and its people who worked tirelessly and made swift recovery after the disaster struck the country. Focusing on the global issue of water scarcity, Dr. Nairizi described the implication of limited water availability and poorly managed practices around the world.

In line with the Sustainable Development Goals (SDGs) adopted by the UN, Dr. Nairizi introduced the ICID Vision 2030 which was launched during the 23rd ICID Congress aiming for a water secure world, free of poverty and hunger. He further added that the prerequisites required are an increase in crop production and water productivity for the vision to translate into reality. The water needs to be developed for irrigation and the groundwater exploitation needs to be sustainable. Hence, ICID is pursuing to achieve agriculture water management to balance the hydro-ecological and socio-economic dynamics in the most water-stressed regions of the world.

Dr. Nairizi suggested that the old traditional practices and concepts on irrigation development must be reviewed and investments should be made to increase the productivity of the irrigated lands to produce more food while safeguarding the environment. He concluded his remarks by emphasizing on the ICID Vision 2030 as an ambitious yet achievable goal with freshwater scarcity, environmental awareness, socio-economic leverage, political impediments as potential barriers which need to be dealt with very sensitively and strategically through smart agriculture water management. It is important that the framework for the second green revolution which aligns itself with the sustainable development principles is comprehensibly articulated to enable all the stakeholders to contribute towards the desired objectives with a synergistic collaboration.

WELCOME ADDRESS

Mr. Miguel Ángel Mancera Espinosa
Mayor of Mexico City

In his welcome address, the Mayor of the Mexico City, Mr. Miguel Ángel Mancera Espinosa greeted the Hon. President Mr. Enrique Pena Nieto and distinguished guests from other countries and United Nations. In the wake of earthquakes on 7 September and 19 September 2017, just weeks before the ICID Congress, Mr. Espinosa stressed on the need for a united front to deal with unannounced natural disasters. He credited the work of CONAGUA towards restoring the water services in the aftermath of the earthquake and in general, managing the water resources of Mexico sustainably. In this context, he appreciated the work of international organizations and the theme of the Congress which focuses on dealing with water scarcity and food insecurity and ways towards achieving the water and food sustainable future.

During his speech, Mr. Espinosa also recognized that resilience in the irrigation sector is paramount in order to respond to an emergency effectively. He added that Mexico has worked towards water management to deal with disasters such as floods, droughts and hurricanes. By encouraging private sector involvement, Mexico is building several large treatment facilities to recycle and reuse wastewater. Concluding his speech, he thanked the presence of all the international organizations and their contribution to Mexico in providing the support to carry out successful projects in several regions.

OPENING MESSAGE

Roberto Ramirez de la Parra
President of MXCID and
Director General, CONAGUA,
Mexico

In the opening ceremony of the 23rd ICID Congress, the President of Mexican National Committee on Irrigation and Drainage and Director-General of CONAGUA, Mexico, Mr. Roberto Ramirez de la Parra welcomed the participants, senior-level officials from governments and international organizations. He particularly appreciated the organization of a Congress on Irrigation and Drainage as it provides an opportunity to address the fundamental issues of water, food and environment.

In his speech, he addressed the growing issue of food insecurity in the face of climate change and rising population. Referring to water as 'blue gold,', Mr. Parra strongly recommended that the paradigm of cultivation must be changed and the agriculture sector needs to be empowered through a new green revolution in order to achieve higher water productivity to combat the double threat of water scarcity and food insecurity.

Providing an example of his home country, Mexico, Mr. Parra discussed on how Mexico is using its water efficiently through integrated water management. Globally, Mexico has achieved the seventh rank in terms of hydro-agricultural infrastructure. Mr. Parra credited this success to the efforts of the President and the mayor through appropriate interventions and collaboration of the administration with the water users. He then added, Mexico has achieved better planning and management in terms of optimum water and energy usage as well as the use of marginal water in agriculture to further contribute to efficient food production in the country.

He concluded his message by providing an excellent example of the efforts of consolidating a modern rural sector in Mexico which would further spread development across the country and ensure the human right to food.

KEYNOTE ADDRESS

Dr. Olcay Ünver
Deputy Director, Land & Water Division, Food and Agriculture Organization of the United Nations

Dr. Olcay Ünver, Deputy Director, Land and Water Division, Food and Agriculture Organization of the United Nations delivered the keynote speech on behalf of the Director-General of FAO. In his speech, Dr. Ünver stressed the importance of natural resources to cater to the demand of the global population for appropriate and nutritious food. To strive towards global development, sustainable management of the natural resources is of utmost significance, he said.

Dr. Ünver introduced the provision of adequate and nutritious food for all as one of the main contemporary challenges around the globe. The FAO's mandate emphasizes the premise that the natural resources, which are essential to provide food security and malnutrition, are managed sustainably and equitably. He further informed that according to FAO's projections, 60% more food needs to be made available to meet the global food demands by the year 2050 compared to the 2005-2007production figures. This increase in demand will have to be achieved against a challenging backgroundof increased competition for natural resources, especially water. He added that the impact of climate change,underinvestment in agriculture and unaddressed gaps in technology needs to be addressed urgently.

Food insecurity and malnutrition are increasing at an alarming rate across the globe. While food insecurity is more threatening in parts of Africa and Asia, the lesser highlightedissue, i.e. malnutrition, is plaguing most parts of the world. Hence, with the vision to end food insecurity and eradicate hunger and malnutrition, FAO has set strategic objectives which provide a holistic framework to achieve the goal of a food secure world, reduce poverty, to achieve inclusiveness in the agricultural and food systems and to increase environmental resilience.

During his speech, Dr. Ünver stressed on the importance of sustainable management of water and soil health, engagement of irrigation sector with other sectors to find synergies in water-food-energy and subsequently manage possible trade-offs to find sustainable solutions which fulfil the sustainable development goals (SDGs). With the vision of eradicating hunger and poverty, FAO is actively working in the irrigation and drainage sector and successfully collaborating with international organizationsto increase water productivity, generating wealth and contributing to overall economic development around the globe, especially in developing regions with water scarcity. In this context, Dr. Ünver highlighted the long partnership of FAO with ICID and the collaborative efforts of both the organizations in bringing forth water issues and presenting solutions to tackle them successfully.

KEYNOTE ADDRESS

Mr. Tony Slatyer
Special Adviser, Department of Foreign Affairs and Trade, Australia

Initiatives in the Irrigation Sector

In the opening ceremony, Mr. Tony Slatyer, Special Adviser to the Department of Foreign Affairs and Trade shared experiences on the initiatives in the irrigation sector and how important it is to help water users and governments to make better decisions in terms of water management. Mr. Slatyer assisted the Prime Minister of Australia, the Hon. Mr. Malcolm Turnbull in his role as a member of the High-Level Panel on Water (HLPW), the panel consisting of sitting Heads of State and Heads of Government. The panel members exercise their political leadership for achieving the ambitious global goal of ensuring the availability and sustainable management of safe water and sanitation for all the world's people by 2030 (SDG 6). The Action Plan of the HLPW addresses the issues according to the themes and not sectors. For irrigation sector, there are themes on infrastructure and investment, resilient economies and societies, water data, valuing water and water governance. During his speech, Mr. Slatyer provided an account of the initiatives by Australia which is leading two themes of direct relevance to the irrigation sector, namely, resilient economies and societies and water data themes.

Under the theme 'resilient economies and societies', the Panel has launched a series of practical projects on water use efficiency. In this context, Mr. Slatyer shared the work of Australia through developing of efficiency project to reduce the cost of water meteringaimed particularly at enabling cost-effective metering in poorer developing countries where high metering costs are a major constraint on their capacity to manage water use; and preparation of a handbook on experiences in Australia and some other countries in the modernisation of irrigation systems to assist the owners and manager of irrigation districts work through the many difficult issues involved in endeavouring to maintain or improve production while using less water.

Under the water data theme, also led by Australia, the Panel has proposed global adoption of a World Water Data Initiative. The aim of this is to assist water users and governments to make better decisions about water management. There will be guidance for governments trying to put in place sound institutional and legal frameworks for collecting, storing, using and disseminating water data. The cost and complexity of accessing and using data based on different standards and metrics will be reduced through efforts to align and harmonise these. Also, a technology challenge is underway

aimed at improving the capacity of the poorest farmers to access information about their water situation. This challenge is being funded by a new innovation funding mechanism called the Water Innovation Engine, launched at the Panel's most recent meeting in September 2017.

He acknowledged the role of the Panel co-chair Hon President of Mexico, Mr. Pena Nieto for hosting four major international water events in 2017. At the end of his speech, Mr. Slatyer requested all the participants to get behind SDG6 and contribute to it. He suggested that collaborative efforts of political leadership, industry, community and professional leadership are required to meet challenges in the water sector. He stressed that with proper water resources management, other fundamental global goals, such as SDG2 on ending hunger, can also be achieved.

KEYNOTE ADDRESS

Mr. Guangzhe Chen
Senior Director, Water Global Practice, World Bank

Building Irrigation Institutions for Water and Food Security

"The challenges of the past, as well as the emerging new challenges and opportunities require us to be more open-minded about the combination of approaches needed for effective governance of irrigation in support of agricultural production and overall water stewardship and sustainability."

Mr. Guangzhe Chen, Senior Director of Water Global Practice at the World Bank presented the work of the World Bank towards strengthening of irrigation institutions for water and food security for current and future generations. He emphasized that the biggest challenge facing the world is to grow more food using lesser water. In this pursuit, the World Bank is investing a total of US$ 6.2 Billion in 74 major irrigation projects in 25 countries globally [US$ 2.4 B in South Asia, US$1.6 B in Africa, US$1.1 B in South East Asia, US$0.7 B in Central Asia and Europe, US$0.3 B in Middle East and North Africa and US$0.3 B in Central and Latin America]. Mr. Chen highlighted the major upgrades incorporated by the World Bank to improve agriculture water management through interventions such as agricultural water stewardship, expanding the role of private sector in the agriculture water management and improving the role of irrigation institutions effectiveness. Mr. Chen shared the major challenges that the irrigation institutions face includes improvement of the project performance and proper fulfilment of the expanded responsibilities. The project performance is constrained due to several factors such as slow disbursements, extended implementation periods and unsatisfactory outcomes. The additional responsibilities of the project include the broader water resources management in terms of the quality and quantity of water and the increasing role of private sector in irrigation. He described irrigation institutions as mechanisms that are put in place to facilitate collective action and are defined primarily by their rules and incentives. The management structures can vary from empowered individuals to fully consensus approaches. For strengthening of institutions, various actions are involved such as defining the irrigation supply chain; identifying performance measures and benchmarking different institutional approaches.Mr. Chen underlined the key ideologies while considering irrigation institutions suggesting there is no "right approach" to irrigation management, the functioning of the irrigation institutions should be dynamic and robust, involving public, private and participatory approaches in the irrigation supply chain. He also added that trust between the stakeholders is often under-appreciated, however it is one of the key elements contributing to the institutional success.

KEYNOTE SPEECH

H.E. Enrique Peña Nieto
President of Mexico

The Honourable President of Mexico, Mr. Enrique Peña Nieto gave the keynote speech during the opening ceremony of the 23rd ICID Congress on Irrigation and Drainage in Mexico City on 9th October, 2017. The Hon. President graciously accepted the award from President Dr. Saeed Nairizi for the heritage irrigation structure of La Boquilla Dam and La Chinampa of Mexico and extended a warm welcome to the national and international delegates.

Mr. Nieto explained the water challenges faced by Mexico. He mentioned due to its unique geography and climatic diversity, Mexico is vulnerable to hurricanes, storms, floods as well asdry climate and droughts annually. He further added that Mexico is working consistently to increase the productivity of agricultural sector through modernization and maintaining old irrigation infrastructures at the same time. In this context, he appreciated ICID in recognizing the heritage irrigation structures to highlight sustainable development brought about by the traditional irrigation techniques.

To achieve sustainable water management, Mexico has adopted the rehabilitation and modernization of the irrigation districts as a key strategy and have rehabilitated nearly 800,000 ha of irrigation which has resulted in a saving of more than 3 million cubic meters of water annually, which is equivalent to the amount of water used by the Mexico Valley in two years. In another strategic move, Mexico is pushing for the treatment of wastewater to make intensive use of water in the agriculture sector without wasting it.

In his closing remarks, the Hon. President Mr. Nieto acknowledged and appreciated the work of state governments, central government, international organizations and the dedicated professionals in the water and agriculture sector who are striving to achieve a water and food secure world.

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Exhibition

A good number of exhibitors from Korea, Australia, Mexico, and international organizations actively participated in the exhibition to showcase their products, services and latest technologies. The exhibition also provided an excellent opportunity to catch up with existing clients and meet new one too.

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10th N.D. Gulhati Memorial Lecture of International Commissionon Irrigation and Drainage

Dr. Felipe Ignacio Arreguín Cortés

Reforms in the Administration of Irrigation Systems

N.D. Gulhati Lecture for the 23rd ICID Congress in Mexico was delivered by Dr. Felipe Ignacio Arreguín Cortés, Director General of the Mexican Institute of Water Technology (IMTA). Keeping in view the theme of the Congress and significance of irrigation institutions, Dr. Cortés presented the lecture on the 'Reforms in the Administration of Irrigation Systems' providing Mexican Experiences. During his lecture, Dr. Cortés provided a brief account of the process and impact of the transfer of the infrastructure, management and operation of Irrigation Districts in Mexico from the state to farmers.

With a land area of 1,964 km^2, Mexico borders with the United States in the north and Guatemala and Belize in the south; and to the east and the west, it borders the Atlantic Ocean and the Pacific Ocean, respectively. Due to its geographical location, Mexico is naturally exposed to a dry climate and recurrent droughtsand annual flooding due to tropical cycloneswhich affect the irrigation supply and makes the agricultural land more vulnerable. Out of 22 Mha of agricultural land, 15.5 Mha land corresponds to rainfed land and 6.5 Mha to irrigated land. In its strategic planning, a total of more than 10 Mha land is reserved which can be potentially expanded to provide food security. Mexico has 86 Irrigation Districts (IDs) and more than 40,000 Irrigation Units (IUs) distributed throughout its national territory. Almost 50% of the national agricultural production is harvested on irrigated land, producing 2.4 times more, per unit area, than in rainfed areas. With rapid urbanization concentrated in the northern and central part of the country with relatively limited water reserves, there is a lot of pressure on water resources and the agriculture production.

Regarding political organization in the watersector, Mexico has a set of institutions to carry out, in conjunction with users, the distribution and management of water, as well as the development, maintenance, and management of hydro-agricultural infrastructure. Water is considered a national asset and its use in the hydro-agriculture sector has the highest social priority.The Federal Government serves the national hydro-agricultural sector under the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food and the National Water Commission. Currently, Mexico ranks seventh in terms of availability of hydro-agricultural infrastructure at the global level.

During his lecture, Dr. Cortés provided an account of the present conditions and future projections of the hydro-agricultural sector in the country and further discussed the social background and the legal framework under which the transfer process has been planned and carried out. He also highlighted the participation of the users and the organizational framework adopted by them, which is enforced and consolidated, giving rise to a social organization. He also pointed out the linkages between different government agencies and user associations for the sustainable development of the hydro-agricultural sector, which has resulted in a series of programs aimed at the modernization and conservation of hydraulic infrastructure and to the efficient use and management of water at the on-farm level, all of this with the ultimate aim of increasing agricultural production per unit area and the volume of water used in this important sector.

In addition, a series of major challenges, problems, and opportunities that need to be addressed in Mexico were discussed to meet the current and growing food demand prevailing in the country. The main challenges for the irrigation sector in Mexico includeincreasing agricultural productivity in irrigated areas, opening of new irrigation zones in southern Mexico, sustainable optimization of water resources, greater technological transfer to the Mexican countryside, to promote governance to consolidate the functioning of institutions within the hydro-agricultural sector and adaption of the National Water Law and its bylaws. Government agencies are collaborating with research institutions and with users to promote the development, adaptation, transfer, and especially the appropriation of state-of-the-art technology for the benefit of the Mexican countryside.

The most prominent transformation and reform promoted in the hydro-agricultural sector in Mexico is the "transfer of irrigation districts to users" which transferred the administration and operation of the districts, except for supply sources and headworks, responsibility to the users. Further, in legal terms, several laws and regulations on national waters have been drafted and put into effect. For construction and modernisation in the irrigated agriculture, Federal government supports programs for hydro-agricultural infrastructure in 6.5 Mha of agricultural land. For the transfer of technology and skills to the Mexican countryside, a total area of 8.5 Mha is being provided with modern irrigation facilities to increase the agricultural production. Moreover, permanent training is being provided to the irrigation users.

The transfer of Irrigation Districts drives a series of processes that give rise to production improvement in Mexico. Under the responsibility of the National Water Commission, the water reforms are designed so that the water resources management in irrigation districts is achieved by transferring the hydraulic infrastructure and its integrated management to the users, including the responsibilities for the operation, maintenance, distribution, and delivery of water for irrigation. The State, through the National Water Commission, maintains the control and management of the headworks in the irrigation districts, i.e., of the supply sources such as dams and other bodies of water, as well as the series of wells making it possible to organize both small and large irrigation districts in the country.Depending on the availability of soil and water, the surface area for Irrigation Districts ranges from 10,000 hectares to 100,000 hectares. A famous example of the hydro-agricultural infrastructure which was constructed more than a hundred years ago, is the "La Boquilla" multipurpose dam which still generates electricity and caters the water needs of 75,200 ha of agricultural land.

In order to enhance the technical and administrative management of Irrigation Districts, the State, together with the users developed the "Master Plans for Irrigation Districts." These plans consider and prioritize the needs of economic investment, technical actions and policy aspects in each irrigation zone, based on a diagnosis that includes an analysis of the current situation and the pending problems, as well as a ranking of alternative solutions. The impact of investments and actions is

evaluated through a set of social, technical, and economic indicators within a framework of action aimed at the sustainability of Irrigation Districts. Through the Modernization and Rehabilitation Program for Irrigated Areas, the State shares 50% of the investments with the users to carry out the maintenance and rehabilitation works in canals, drains, and roads within the irrigation zones.

Hydro-agricultural infrastructure support programs include rehabilitation, modernization and adoption of newer technologies in the irrigation districts, provision of equipment for irrigation districts, efficient use of water and energy, reimbursement of payments for block water supply, modernization of gravity irrigation, recovery of saline soils with on-farm drainage, and training of users on management. The positive effects and impacts of these reforms are visible and quantified in a tangible way through the evidence associated with the construction of new dams to increase water availability for irrigation purposes; the construction and lining of canals to increase their conduction efficiency; the opening and piping of drains to drive surplus flow outside the irrigation areas, to lower elevated water levels, and to control salinity; the installation of wells and pumping plants to aid irrigation; and the transfer of irrigation technology itself, such as the Program for the Modernization of Gravity Irrigation from which 200,000 ha have benefitted.

Efforts are being made to reduce the overexploitation of aquifers and increase the overall efficiency with which irrigation water from surface sources is managed, distributed, and supplied, with the aim to increase its contribution to the overall quantum to not less than 50%. This is a complex problem, the solution of which requires both technical interventions and the correct and strict application of the National Water Law and its bylaws, as well as reconsidering electric energy subsidy programs for agricultural wells in overdrawn aquifers.

Mexico has a great water potential and availability of large arable areas. To exploit these assets in a sustainable manner, it is considered necessary to introduce systems to control application of excess water and in other suitable areas drill wells to harness groundwater for irrigation purposes., It will also be necessary to develop and design new irrigation infrastructure for diverting and using the water from the multiple and large rivers. In this context, Dr. Cortés stressed on the necessity of a robust legal framework on water and its impacts on the agricultural sector. He emphasized that in general users now have more entrepreneurial mindset and their priorities are focused on the search for financial and technical self-sufficiency; on increasing hydro-agricultural productivity; utilization, conservation, and extension of the useful life of the infrastructure under their control; and, of course, on the consolidation of organizations with a business approach that may guarantee the sustainability of the national agricultural sector. The legislature is also drafting the "General Water Law", which will regulate the actions of the three tiers of government (federal, state, and municipal), and will incorporate, among other aspects, the human right to water and food sustainability and security in the national hydro-agricultural sector with a priority to the social, technical, economic and environmental aspects.

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Modernization of Irrigation and Drainage towards a New Green Revolution

The 23rd International Congress on Irrigation and Drainage was held from 8-14 October 2017 in Mexico City, Mexico. The main theme of the Congress was "Modernizing Irrigation and Drainage for a new Green Revolution". An 'Abstract Volume' and a USB containing full papers and posters were published for the Congress and made available to the delegates. The general rapporteurs for the thematic questions of the Congress, Prof. Abdelhafid Debbarh (Morocco) for question 60 and Dr. Ding Kunlun (China) for question 61, presented the gistbased on 154 papers and posters submittedfrom more than 54 countries.

Question 60 – Water Productivity, Revisiting the concepts in light of water, energy and food nexus

General Reporter : Prof. Abdelhafid Debbarh (Morocco) - President Hon. Dr. Gao Zhanyi presented the report in the absence of Prof. Abdelhafid Debbarh

Question 60.1: Emerging issues and challenges of water saving, including impacts of transferring water out of agriculture

Chair : Mr. Mehrzad Ehsani (Iran); Vice-Chair: Dr. Raquel Salazar Moreno (Mexico)

Question 60.2: Understanding water productivity, water and energy use efficiency and water footprint of crops

Chair : VP Ian W Makin (UK); Vice-Chair: Dr. Mauricio Carrillo Garcia (Mexico)

Question 60.3: Water security for growth and development

Chair : PH Dr. Gao Zhanyi (China); Vice-Chair: Dr. Jesus Chavez Morales (Mexico)

The Question 60 focused on the "Water Productivity, Revisiting the concepts in light of water, energy and food (WEF) nexus". The Question 60 was further sub-divided into three sub-topics, i.e. emerging issues and challenges of water saving, Water-Energy and Food (WEF) Nexus and Water security for growth and development. A total of 86 papers from 27 countries were received for the Question 60. The sub-questions focused on three major areas, namely, 'Emerging issues and challenges of water saving, including impacts of transferring water out of agriculture', 'Understanding water productivity, water and energy use efficiency and water footprint of crops' and 'Water security for growth and development'. 31 papers from 16 countries were submitted for Q 60.1; 35 papers from 16 countries

for Q 60.2; and 26 papers from 12 countries were submitted for Q 60.3. As a whole, the excellent papers under Q60 addressed all the relevant issues and further raised several questions for research.

Question 60.1: Emerging issues and challenges of water saving, including impacts of transferring water out of agriculture

Irrigation and drainage management is considered at four levels, namely, field, farm, scheme and basin level. At each of these levels we must consider how to address management, technique, technology and policy in order to make water savings. The main issues of water saving in agriculture include limited freshwater, the imbalance between supply and demand, food security, conflicts for water access, competition for water, over-extraction of groundwater and other environmental issues.

Emerging issues and challenges of water saving have covered three aspects: (i) improvement of irrigation technology and techniques; (ii) Policy and legal approaches to save water; and (iii) managerial measures and approaches to water saving. Improvement of technology and irrigation techniques contribute effectively to reduce water losses, maximize water saving in agriculture by improving irrigation efficiency and water productivity while the policy and legal approaches related to water save and transfer out of agriculture and managerial approaches relates to exploring various avenues through which water can be saved such as recycling and reuse etc.

Technology Approaches

There are a number of technologies available for improving operation, better management and efficient use of irrigation water in fields and at farms levels. The main actions suggested are field water-saving irrigation technologies such as laser grading, integrated water and fertilizer management, sub-irrigation, drip and sprinkler irrigation systems, rainwater harvesting, automatic water monitoring technology, water recycling technology, volumetric measurement, evaporation reduction and finally increasing irrigation productivity.

Policy and legal approaches

A systematic approach to water saving in agricultural requires actions at all levels, from farms to irrigation schemes, and from local to national action and strategies. Reallocation of agricultural water share, modifying or changing crop patterns, water charging as the self-control policies, capacity development, appropriate national guidelines and regulations for water saving need to be developed and implemented.

Management Approaches

Irrigation management can be defined as a series of operations performed to uniformly provide crops with "sufficient amount" of water on a "specific schedule" and includes measures such as smart irrigation planning, volumetric water delivery, conjunctive use of surface and groundwater, controlled drainage. Using plastic covers to control evaporation from the soil surface (mulching), adopting alternate furrow irrigation technique, night irrigation, and continuous monitoring of water flow are among the measures taken to fulfil smart irrigation management goals.

There are many technologies that can be appliedtosave water, the cost of implementation can be a barrier for farmers due to the lack of subsidies.It is important to build a bridge between policymakers and farmers with 2-way information exchange.The Government not only has to design and implement basin plans for the water balance but also educate and provide training to the farmers.

In order to convince farmers to adopt the new technologies, research on behaviour economics is required.The management, technique, technology and policy should be considered at each level, field, farm, scheme and basin.

Question 60.2: Understanding , water and energy use efficiency and water footprint of crops

In order to feed the growing population agricultural production will need to keep pace and to be increased by 60% (and nearly 100% in developing countries) over the 2005-2007 base period. Another Green Revolution is called for with the optimal use of land and water resources; reducing the risks of climate variability and change by the provision of equitable and reliable irrigation services thereby enhancing agricultural productivity and preserving the ecosystem. There is an urgent need to modernize the irrigation systems for increasing irrigation efficiency and water productivity. The energy required for pressurized irrigation needs to be increased. The food production and supply chain consume about 30% of total global energy.

Water-Energy-Food Nexus (WEF) nexus, a central issue for agriculture and society, is an attempt to balance different uses of resources (energy, water, land, soil and socio-economic factors) to provide the optimum solution to the problem of rising food demand and limited availability of resources. Interactions between water, food and energy may result in synergies or trade-offs between different sectors or interest groups. The incentives for a nexus approach include "economic efficiency, resource efficiency and improved livelihood options" which require a consistent analysis and decision framework. The WEF approach offers a framework to increase coordination of policy and investment among agencies and ministries involved in resource utilization and management.

The issues of water productivity, water and energy use efficiency and water footprint of crops have been discussed through three facets: (i) WEF nexus approach; (ii) water food print approach; and (iii) water use efficiency through water management. Even though WEF approach is being progressively adopted by a number of authors, its use is still limited; there is an urgent need for awareness and capacity development on this approach among all water actors. The Water Footprint methods seem to be efficient for better water management in irrigated areas. In this session, the discussion focused around the WEF nexus. A total of 32 papers were submitted/presented for the Question 60.2 out of which 10 papers focused on the WEF approach, 9 papers focused on the water footprint approach and 13 papers focused on the studies adopting sectoral water management approach.

During the discussion, it was recommended to require the use of consistent definitions of water productivity indicators, including units and boundaries of analysis.Development and dissemination of WEF approaches should be promoted. Food waste along the supply chain (field to fork) must be managed to reduce the loss of Food, Energy, and Water enabling more effective and efficient use of water, land, energy and human resources. Water footprint analysis is a useful tool to communicate and educate a broad range of stakeholders on these issues. Enabling active participating roles for farmers and society in research efforts will improve uptake of research results, in turn leading to better public policies to address WEF challenges.Emerging technologies offer new opportunities: Boosting the use of technological innovations such as precision agriculture, big data and internet of things for use on-farm and in the management of irrigation and water resource systems is recommended. This will help achieve sustainable increases in food production required to feed over 9 billion people by 2050.Knowledge and experiences of emerging precision agriculture and related precision water management technologies should be facilitatedand disseminated to a wider audience through publications, web content and other media.

Question 60.3: Water security for growth and development

To tackle water security issues, interdisciplinary approaches, including legislation development, innovation, adaptation of new technologies, socio-economic solutions (such as administration transfer) and research are necessary. The main problem affecting water security is water scarcity as well as climate variability creating different water distribution that causesfloods or aridity. The investigations were undertaken in the domain of social water security coupledwith those of similar studies dealing with integrated water management, irrigation water productivity and water saving. The question responses also examined the use of unconventional water resources for irrigation. It was brought out that the use should comply with sanitation regulations to avoid health risks for farmers and crop and soil contamination.

Water security for growth and development was discussed in two aspects: (i) environmental water security; and (ii) social water security. Other important issues regarding the water security for growth and development apart from environmental and social issuessuch aswater and sanitation aspects, water economy and water management aspects were discussed.

The discussion session further attracted questions from the audience on the success of Mexican Irrigation Management Transfer (IMT) and the benefits of the transfer were discussed in depth. It was pointed out that water security is a long-term issue, where problems may emerge after long periods of inadequate management. Also, in relation to cooperation in transboundary water sharing, the role of water security was discussed as a key priority.

Main features of measures leading to success were identified as sharing of responsibility, appreciation of internal problems of associations of beneficiaries and budget management.It was recommended that transfer of water from other regions and use of Non-Conventional Water Resources for Irrigation can solve part of the problems of water shortage.

Question 61 – State of knowledge of irrigation techniques and practicalities within given socio-economic settings

General Reporter : Dr. Ding Kunlun (China)

Question 61.1: Adopting precision irrigation and improving surface irrigation to combat water scarcity

Q 61.1: Dr. Brian T. Wahlin (USA), PE/Co-Chair: Dr. Heber Saucedo (MEXICO), Co-Chair
Question

Question 61.2: Using ICT, remote sensing, control systems and modelling for improved performance of irrigation systems

Q 61.2: Dr. Kaluvai Yella Reddy (India), PE/Co-Chair: Dr. Víctor Manuel Ruíz Carmona (MEXICO), Co-Chair

Question 61.3: Adaptability and affordability of new technologies under different socio-economic scenarios

Q 61.3: Mr. Franklin Dimick (USA), PE/Co-Chair: Dr. Ignacio Sánchez Cohen (MEXICO), Co-Chair

Q 60 addressed the current status of the irrigation techniques within specific socio-economic settings. New technologies and their applications can help in achieving the objectives of enhanced agricultural water use efficiency and productivity. In this context, surface irrigation and precision irrigation are the major areas where interventions are necessary. By addressing the "adaptability and affordability" of these newer technologies under different socio-economic scenarios, the real value addition can be ensured in practice.

A total of 62 papers from 24 countries were received for the Question 61 on the "state of knowledge of irrigation techniques and practicalities within a given socio-economic setting". Question 61 had three sub-questions namely 61.1, 61.2 and 61.3 and number of papers received for these sub-questions were 24, 22 and 16, respectively. The sub-questions focused on three major areas, namely, 'Adopting precision irrigation and improving surface irrigation to combat water scarcity', 'Using ICT, remote sensing, control systems and modelling for improved performance of irrigation systems' and 'Adaptability and affordability of new technologies under different socio-economic scenarios'. As a whole, the excellent papers in Q61 addressed all the relevant issues related to irrigated agriculture and some of the papers went even beyond.

Question 61.1: Adopting precision irrigation and improving surface irrigation to combat water scarcity

Water scarcity is a prevalent and critical issue in agriculture. It is important now, more than ever, for agriculture water users to conserve water. Two methods for combating water shortages in agricultureare precision irrigation and improving surface irrigation. However, there is no commonly accepted definition for precision irrigation. In general terms, it can be defined as collecting and using large amounts of data to precisely irrigate individual plants without spending water on non-essential applications. The technologies for precision irrigation include (1) equipment used to gather environmental, soils, or weather data and, (2) the equipment used to automatically control the irrigation system itself.

The Question 61.1 focused on combating water scarcity through adopting newer methodologies of precision irrigation and improving existing methodologies of surface irrigation. Research articlesaddressing the precision irrigation and innovative techniques to improve the surface irrigationwere received and presented for the Q 61.1 from countries such as Ukraine, China, Egypt, Taiwan, Indonesia, India, Mexico, USA, Thailand, Sri Lanka, South Africa, Uzbekistan, Iran, Argentina. The papers provided a nice balance of theoretical and field studies.

Adopting Precision Irrigation to Combat Water Scarcity

Precision irrigation should consider both accurate irrigation schedulingto define the amount of water needed by the crop and accurate application of the required water (e.g., with both efficient and uniform application). Thus "water demand" and "water application" are the two major study areas for "precision irrigation". And the papers presented covered some special aspects of these specific areas. Maintenance and water quality issues are very important for the long-term operation of any drip system.

Through a number of researches from all around the world, the papers presented and discussed under Q61.1 focused on answering issues related to precision irrigation. The papers presented during this session addressed water quality problems for using a drip irrigation system and wastewateruse for irrigation purpose. These papers discussed important issues like effects of irrigation water quality on soil quality, crop yield and quality, advantages and suitability of rain gun sprinkler irrigation system, amongst others. While other researches evaluated and presented specific aspects such as evaluation of water use efficiency and productivity by sprinkler and drip irrigation methods through field experiments, analysis of the meteorological parameters sensitivity in the FAO Penman-Monteith (P-M) model, and presented a simpler approach using FAO P-M equation with effective meteorological parameters. Other papers introduced the concept of multi-user shared central pivot irrigation equipment by small landholders, which is typically regarded only affordable to large-scale

farming and presented an evapotranspiration(ET)-based irrigation scheduling method to improve on-farm water-use efficiency, leading to an overall increase in water productivity by 34-50%.

Improving Surface Irrigation to Combat Water Scarcity

Surface irrigation is used primarily for water application on the field. It covers nearly 90% of the world total irrigated area; 86%, 92% and 43% in China, India and US respectively. Even though surface irrigation is extensively used around the world, it is believed to have low irrigation efficiencies. Although surface irrigation performance is low in many parts of the world, there is still a lot of potential for higher surface irrigation performance to rival the efficiency of pressurized systems. In most cases, the low efficiency of surface irrigation may be attributed to poor operating decisions. A good surface irrigation system requires simple operations that are less subject to irrigator errors. This also highlights the need for irrigator training for operating surface irrigation systems. Improved water management and control of flow can help modern surface irrigation systems and achieve their potential. Some of these interventions include use of farm reservoirs and farm wells to reduce the impact of poor water delivery service, improved land grading and land shaping for better surface irrigation systems, runoff recovery systems installations to reduce the runoff from the fields,closing of the furrows or downstream end of the borders to avoid mass losses in the irrigation systems in water scarce conditions and so forth.

Computer software packages can also be utilized to make recommendations to improve the performance of surface irrigation systems. Several software programs have been developed such as SIRMOD (Utah State University) and WinSRFR (USDA, ARS). These and other program provide additional tools that can be useful for improving surface irrigation performance.

Several papers in this session discussed progress in this area. Research from China presented a software package for design and management of basin, border, and furrow irrigation; and discussed technologies such as land levelling, computer simulation, and irrigation control aspects of surface irrigation. A few papers addressed topics related to rehabilitation and performance improvement of irrigation schemes, including MASSCOTE used for assessment of existing irrigation systems, rehabilitation and improvement of canal and field irrigation infrastructures, irrigation scheduling, surge irrigation, irrigation flow control, and optimization of the limited water resources. In addition, other papers also discussed alternative sources of water, including wastewater reuse.

Question 61.2: Using ICT, remote sensing, control systems and modelling for improved performance of irrigation systems

Smart Technologies for Improving Irrigation Performance

Smart technologies are nowadays spreading in all sectors of human activities.Remote sensing, modelling, sensors, remote control system, application of information and communication technologies (ICTs) are potential tools to improve the performance of irrigation system as used for precision irrigation and improving surface irrigation.Geospatial and drone technologies have been widely used for the management of soil, water and crop in irrigation systems, and to predict and mitigate the impacts of extreme weather conditions of droughts and floods. Question 61.2 focused on the sub-topics Remote Sensing, ICT, Control Systems and Knowledge Management and Mathematical Models on which the research papers were based and presented.

Remote Sensing

Research on using remote sensing as a powerful tool which can make use of satellite images for the management of irrigation areas, irrigation water availability, predicting corn crop growth stages, and drought monitoring and prevention was discussed. Additionally, research showed how some of the crop parameters such as crop Kc values and other parameters can also be obtained with the help of UAV (Unmanned Aerial Vehicles).

ICT, Remote Control and Knowledge Management

In this session, the importance of soft technologies such as ICT (Information and Communications Technology), remote control systems and knowledge management for modernizing irrigation was presented and discussed. Other researches deliberated on the use of methodologies such as the real-time control system for improving water and fertilizer use efficiency, ICT/remote control technology for water measurement and control of irrigation wells and canals, web-based MIS for irrigation management, and ICT use for improving irrigation system performance in West Africa.

Mathematical/computer modelling

Several papers presented in this session discussed the role of mathematical modelling in predicting the parameters required for improving the irrigation performance. Particularly, research indicating the use of modelling for improving water distribution in canal system, the use of a hydrodynamic model for improving performance of irrigation canals, a 3-D modelling used for groundwater management, the use of PIC (proportional integral controller) for canal control and the use of computer models for evaluating water uniformity of sprinkler irrigation were presented.

Question 61.3: Adaptability and affordability of new technologies under different socio-economic scenarios

Adaptability and Affordability of New Technologies

New technologies in irrigation are continually being developed, which must be brought into practice on the field on a large scale. Bringing a new technology into effect requires that it be adaptable, economically beneficial and acceptable to those who will use it. Keeping this in mind, the 'adaptability' and 'affordability'were the critical points addressed in this sub-question 61.3, for the use of any new technologies under various natural-social-economic conditions. As addressed by Q61.3, the "Adaptability and Affordability" of new irrigation technologies are the key secrets for their success in practice. Some of the key aspects addressed in the Q61.3 include water quality and wastewater reuse, modernization of irrigation systems, analytical tools, water management, dam safety, public policy, food security and improvements to irrigation schemes.

The papers mentioned that new technology is needed to maintain and improve irrigation systems and water use but that technology is only useful if it can be implemented by those who will use it and benefit by it. Technology must be implemented in a manner that does not overwhelm those who will use it. Otherwise, it will be abandoned.

A total of 17 papers were discussed on the adaptability and affordability of new technologies. Rehabilitation and modernization of irrigation schemes is still one important task and issues in many countries, as covered by the papers from Mexico, Pakistan, Indonesia, Philippines, China, Ukraine, Iran, Sir Lanka, India and Egypt, etc. indicating that the rehabilitation and modernization

of irrigation schemes will play an even more important role in food security for the countries with growing population and/or water shortage. For example, food production by irrigated land is: 45% world average, 75% in China, 90% in Pakistan and 40% in Mexico.

The introduction of new technology to farmers should take into account their needs, their expectations and their customs. It should bring benefit to the farmers (economic benefit brings conditions) and should be agreed upon by all users in the case of a collective system. The technology should beintroduced in a stepped manner, going from small economic contributions from farmers to covering most of the cost of it.The success of the adaptation to new technology depends on the training available for the farmers, the transfer of knowledge, and the assimilation and understanding of the benefits. Solution to an existing problem should be tailor-made and must take into account social, economic, cultural and technical aspects.More efforts should be diverted towards the adaptation of new technology in rain-fed agriculture, given that the area covered by it is larger than the area of irrigated land.The adaptation of new technologies may require an update of the existing legal framework.The use of several technologieshasproven to increase the resilience of the farmers.

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Additional Sessions

Additional special sessions were held during the 23rd ICID Congress. These events included an International Symposium organised by ICID with participation from 14 countries, an international seminar organized jointly by FAO and ICID, an international workshop given by International Geosynthetics Society (IGS) and a special session on the use of wastewater in agriculture (Mexico). The specific themes of each event are given as follows:

- International Symposium: Global Review of Institutional Reform in Irrigation Sector for Sustainable Agriculture Water Management, including Water Users' Associations (WUAs)
- International Seminar: Water use in food value chains: a challenge for a new green revolution?
- International Workshop: Application of Geosynthetics in Irrigation, Drainage and Agriculture
- Special Session: Technologies for Reuse of Wastewater in Agriculture and its Impact on Health and Environment

Symposium

Global Review of Institutional Reform in Irrigation Sector for Sustainable Agriculture Water Management, including Water Users' Associations (WUAs)

The ICID Working Group on Institutional and Organizational Aspects (WG-IOA) organized an international symposium with the theme Global Review of Institutional Reform in Irrigation Sector for Sustainable Agriculture Water Management, including water users' associations (WUA) during the 23rd ICID Congress in Mexico City. The symposium aimed to demonstrate the global perspective of the vast interdisciplinary area of institutional and organizational aspects of irrigation and drainage, and to deliberate on the issues related to institutional reforms needed for sustainable AWM. The symposium provided a platform to irrigation and drainage professionals and other stakeholders to share their knowledge and experience of sustainable agricultural water management (AWM) focusing on institutional and organizational reforms in the irrigation sector, participatory irrigation management (PIM), water users' associations (WUA) and other important issues. During the symposium, the legal framework and organizational structure including WUA for water supply services; participatory irrigation management and management transfer - approaches and condition for successful PIDM; and public-private-partnership (PPP) in irrigation and drainage operation and maintenance toward sustainable irrigated AWM were discussed.

For the symposium, 14 National Committees/Committee submitted their regional case studies from Australia, China, India, Indonesia, Iran, Japan, Malaysia, Mexico, Nepal, South Korea, Sudan, Chinese Taipei, Turkey, and Ukraine. The theme focused on the institutional reforms in irrigation sector for sustainable agricultural water management. Each of the papers highlighted the specific legal and institutional set-up, challenges and the status of participatory irrigation management in their countries and regions with diverse geography, climate, governance, socio-economic conditions, and level of development.

Agriculture is deemed the biggest freshwater consumer globally, i.e. nearly 70-80% of global supplies. With the growing demand for water from other sectors, the irrigation sector is facing severe competition for water which is expected to grow steadily in the coming years. The freshwater supplies are diminishing because of the high rate of population growth and climate change is one of the biggest challenges threatening the existing water and food security. Coupled with improper governance and management in several countries, the water availability problems are exacerbated further with more pronounced effects such as water scarcity, very low groundwater levels, and poor water quality.

Challenges such as lack of capacity/resources (technological, financial, human and institutional) of the WUAs, lower technological uptake, older infrastructure requiring rejuvenation, insufficient water information or accounting, lack of water pricing mechanism, unavailability of knowledge and skilled professionals in some countries, absence of private participation (PPP), difficulty in upscaling of the WUAs add to the crisis of sustainable water management in agriculture. In some countries, farmers receive fewer incentives from agriculture which is discouraging them from an active participation in the WUAs. Problem is further worsened by a lack of interest of youth population in agriculture and ageing of farmers. Upscaling of WUAs is another major issue faced by many countries. In some regions, the water footprint is much higher compared to the lower water supply due to physical scarcity or other issues.

To counter the challenges mentioned above, effective agriculture water management is the need of the hour. The success of irrigation sector largely depends on the legal and institutional framework of the country, which is unique for each country and affects the performance of WUAs to a large extent. Thus, for the smoother functioning of WUAs to manage water efficiently, apart from technical issues such as social, political, economic, environmental, and human aspects of water resources management need to be considered carefully.

To secure the functional sustainability of irrigation and drainage (I&D), development and maintenance of infrastructure must be carried out timely and effectively. It has been observed that institutional arrangements for I&D development and management vary across countries, especially regarding reforms related tothe organizational arrangement, approaches for successful participatory irrigation and drainage management (PIDM), working mechanism and involvement of the public-private-partnership (PPP), mechanisms of charging for I&D services as well as determination of the level of cost recovery, etc.

For better management at the field level, there is an urgent need for more involvement of the farmers in the decision-making in a systematic way for operation, management and maintenance of the irrigation schemes through the transfer of responsibilities.Irrigation Management transfer (IMT) is the transfer (full or partial) of authority for governance and responsibility for finances and management of irrigation systems from the government to the WUAs. IMT is achieved by involving farmers (water users) in different aspects of irrigation management such as planning, designing, construction and supervision, policy and decision making, operation and maintenance and evaluation of irrigation systems, or participatory irrigation management (PIM). The management transfer is well established in developed economies such as Australia, Japan, Malaysia, Mexico, Turkey, established and evolving in countries like China, India, Indonesia and Nepal, and at the emerging state in countries like Iran, Sudan and Ukraine. South Korea does not have PIM, the government agency Korea Rural Corporation is responsible for management at the field level.

Apart from food security, formation and functioning of WUAs, ageing I&D infrastructure and its operation and management (O&M) are the major institutional and PPP challenges for sustainable

AWM in the immediate future. The comparative evaluation analyses the issues related with institutional and organizational reforms with focus on the legal and organizational framework structure including Water Users' Association (WUA) for Water Supply Services; Participatory Irrigation Management (PIM) and Management Transfer; and Public–Private–Partnership (PPP) toward sustainable irrigation and drainage (I&D) and agricultural water management. For countries with smaller land areas but higher technology manufacturing, agriculture is now being viewed as technology-driven food factories of future whereas for countries with large land areas and significant base population, agriculture seems to dominate the development debate.

Conclusively, each of the countries and regions suggested recommendations and the way forward to strengthen the institutional capacity to enable sustainable water resources management in agriculture. The policy reform in the water sector in most of the developing economies is an evolving process. At the governance level, inclusive planning and equitable allocation are major considerations. While some countries have reported intentions for more specific investments in irrigation and drainage infrastructure, others have identified human capacity building at the water use level as a priority. Integrated water management plans from nation and province/state to local district/village levels is an emerging consensus in all reports. Institutional reforms in some countries are implemented as trial-runs or experiments, rather than long-term vision-based commitments. Inter-community, inter-sector, inter-state and even international cross-boundary water conflicts are rearing their heads, and therefore, international networks have much bigger challenges pertaining to agriculture water management. Collaborations, joint deliberations, human resource sharing, research cooperation, and capacity building are the main keywords that will guide the future path of sustainable development in an uncertain climate. Moving forward, most of the countries are planning to upscale the WUAs and support their functioning through better coordination and communication between the different stakeholders via participatory mechanisms. In certain regions with limited resources, market level intervention is recommended as a way forward for influencing farmer's crop choices.

Special Session

Irrigation techniques for reuse of wastewater in agriculture and its impact on health and environment

Session Chair: Dr. Jaime Collado (Mexico)
Rapporteurs : Ms. Sahar Norouzi (Iran) & Mr. Amali Abraham Amali (Nigeria)

To introduce the session, Dr. Waldo Ojeda Bustamante (Mexico)introduced the challenges related to the reuse of wastewater in irrigation emphasizing the Mexican experience. The discussion session concentrated on thelegal issues, the types of the crops to be irrigated,water quality (parameters and methods), the cost of treatment,soil and groundwater degradation and technological restrictions in the reuse of wastewater in irrigation. Audience attended the discussion and shared their ideas and experiences from their countries.

The session deliberated on issues concerning wastewater reuse in agriculture and the need for easier adaptability of wastewater by the end users. It also emphasised the importance of establishingthe guidelines for use and enforcing these guidelines so as not to compromise the food quality. In this context, bridging the gap between science and policy is also very important for implementation.

On the Mexican experience on the use of wastewater, there has been a considerable increase in yield and a decrease in the use of fertilizers. Low-cost equipment has been used to kill the microorganisms in wastewater. However, concerns were raised about sedimentation resulting from the use of wastewater in drip irrigation, and source of wastewater. Industrial wastewater has not yielded good results even after secondary treatments, especially for tubers and hence it is prohibited for use in tuber cultivation. A final guideline is yet to be established from the experimental results on wastewater reuse and the need to use more energy saving technologies already proven as effective in certain parts of Europe. Concerns on mixing wastewater with freshwater as well as degradation of water infrastructure from the use of wastewater were raised.

The session featured only one oral presentation on the effects of Reclaimed Water Irrigation (RWI) on crops and Environment by Wenyong Wu from China. Highlighting hisexperience from China, Dr. Wu mentioned the planned grain increase in China and its consequent impact on the freshwater demandby introducing Reclaimed Water Irrigation (RWI) as a key countermeasure to solve the problem of water shortage in China. He alsodiscussed the historical research and developmental stages of the use of RWI. Results from an experimental study area of South East Beijing consisting ofthe field experiments, monitoring stations and data analysis showed increased yield for fruiting, leafy and root vegetables with the content of heavy metals below standards. Although salt content increased yearly but was consequently leached outside the root zone with no significant difference for heavy metals. The infiltration increases from surface water to groundwater. Proper risk control measures involved in the planning, design and operation willresult in a high potential of wastewater reuse in China and consequently in other parts of the world.

It was stressed that the guidelines for RWI in China have not been enforced yet, despite its urgent need. The stringent guidelines by FAO for RWI were suggested. The key contribution to this strategy was the considerable reduction in the use of fertilizer in agriculture. Concerns were raised regarding the resultant food quality because of the virus and bacterial infections since the wastewater used is coming from a mixture of domestic and industrial sources. On the cost of wastewater on farmers considering the cost of treatment, it was impressive to know that the government of China was able to reduce issues of groundwater overexploitation by removing the cost of wastewater reuse in irrigation.

In order to encourage the use of wastewater by farmers, it was opined that it is important to take into consideration how the costs and benefits are shared for this technology. It was stressed that although technical solutions have already been established for use, however, there are huge gaps in policy and political implementation. For wider implementation, the unique country-specific policy and political issues need to be considered for this technology to be widely adopted.

To increase the export potential of agricultural products, the need to address gaps in the use of fertilizers for cultivation was raised. It was also emphasized that post-harvest handling of foods needs to be taken into consideration likewise.

Issues regarding the adaptability and acceptability of these technologies in certain countries were also raised despite proven results especially in the Middle East. There is an urgent need to build the public confidence in food safety from proper management and treatment of wastewater before its use. Hence the standards acceptable for wastewater reuse need to be enforced. The challenges of groundwater contamination by wastewater in Argentina were mentioned. Furthermore, the need for collaborations with the concerned stakeholders and the relevant institutions to establish guidelines for use of wastewater for irrigation were underlined.

The international seminar on 'Water use in food value chains: a challenge for a new green revolution?', organized jointly by FAO and ICID, was conducted by Dr. OlcayÜnver, Deputy Director, Land and Water Division, FAO. The seminar aimed to highlight the water use in food value chain, from production to consumption, and discuss relevant concepts and approaches to address the issue. The whole idea focused on starting a debate on the productive use of water throughout the process of food supply chain, from production to consumption; and the importance of water neutrality. Several examples were showcased to demonstrate it.

Food value chain is the biggest consumer of water; hence water plays a key role from production to consumption. Nearly 80% of the total water consumption in the food chain is utilized during

the production stage, and the remaining 20% during post-harvest supply chain. The consumption pattern for energy is opposite of the water consumption; nearly 80% is used in post-production activities compared to 20% at the production stage.

FAO estimated that one-third of all food produced globally is lost or wasted and with it all the water used to produce, process, store, and transport this food is also lost. At the same time, millions of people around the world do not have access to water and food. This is reflected in the sustainable development goals' targets, where the Target 6.4 deals with improving water-use efficiency and Target 12.3 deals withreducing food loss and wastage.

With globalization and changes in lifestyle, the diet patterns are changing, particularly in growing economies. Higher demand for meat, dairy products, and fizzy drinks, in the cultures, which in the past depended mostly on pulses, legumes, and vegetables for their calories intake means that more water is required. The challenge is to find ways for providing adequate and nutritious food to the world population and to ensure environmental sustainability and protection of water resources. This challenge translates into different, yet mutually supporting manner, three phases involved, i.e. production, value and supply chains, and consumption-end.From a perspective of water resources management, the production stage offers a number of options related to governance, management, technology and social and cultural norms and preferences which include more efficient and productive use of water, better irrigation system and on-farm management, appropriate technology, among others.

With this context, the seminar session conducted by FAO tried to address some of the important questions which still need to be addressed including the role of public-policy engagement in achieving water neutrality, the involvement of private sector, investments required to offset water footprint and best methods to assess water productivity and efficiency in food value chain.

The value and supply chains offer a different set of parameters, and associated opportunities, for water savings. Measuring water footprints can help understand the magnitude of water use in the food-value chain and water neutrality, a relatively recent concept to reduce and neutralize negative externalities of water use hence save water resources, can help improve the sustainability of water resources.There are two major elements of water neutrality: i) minimize water footprint by doing everything that is 'reasonably' possible; and ii) offset remaining water footprint through "reasonable" investment in projects that seek sustainability of water use and equitable use of water. Offsetting needs to be done in the same hydrological unit where water footprints are created and the investments should be proportional to the vulnerability of the water body or the region. The four dimensions of water for anthropogenic use highlighted were water availability, water stability, water quality and water access.

Irrigation and drainage played a crucial role in the Green Revolution that significantly boosted food production and contributed to reducing hunger and poverty. 20% of the world's arable land area provides more than 40% of the total agricultural output. Apart from food and water security, irrigation and drainage are key to providing livelihood to the rural population. While, small-scale irrigation in peri-urban areas and in drylands has lifted the poor from poverty over the years;large-scale irrigation and drainage systems have provided water for multiple needs of rural populations and therefore improved livelihoods of millions of people.

Despite its usefulness, the irrigation sector is facing several challenges hindering the green revolution such as environmental degradation, groundwater depletion, low water use efficiency, poor system performance, the financial burden on irrigation and drainage scheme management, competition for

water resources, water scarcity exacerbated by climate change amongst others. Many of the large-scale irrigation and drainage systems in the world are old and in dire need of improvements and modernization. Food insecurity, undernourishment and water scarcity are on a rise and pose as the biggest threat to the vulnerable population.

With water problems increasing globally, the demand for water in agriculture has increased substantially. Experts, during the discussion, suggested that irrigated agriculture must modernize itself; water must be used efficiently and productively throughout the production and supply chain. Without the right policies and strategies; improvements in governance and management of water resources throughout the food supply chain; and successful efforts to attain water neutrality, the new green revolution will be hard to achieve. Furthermore, water supports economic growth, and income generation, and thus economic access to food.

FAO suggested that improvements in water use efficiency can be improved at several stages of the supply chain in agriculture from the producer to the consumer end. At each stage, interventions are required such as:

- Production stage - Governance, management, technology, socio-cultural norms
- Value and supply chain - Water footprints measurement; water neutrality
- Consumers - Change in mindset, consciousness, support to right policies
- Stakeholders - Farmers, Private sector, Public-policy makers, Consumers

From a perspective of water resources management, the production stage offers a number of options related to governance, management, technology and social and cultural norms and preferences to implement moreefficient and productive use of water, better irrigation systems and on-farm management, use of appropriate technology, among others.Generally, food is produced by farmers but processed, packaged, distributed, marketed, and retailed by the private sector. Public-policy should guide and regulate and monitor their water footprints. A concerted effort of different stakeholders of food supply chain is needed to solve the complex issues that water sector faces today. The consumer-end involves two additional dimensions: (i) being better, conscious consumers who not only minimize waste (of food, water, energy) but prefer those products produced the same in mind, and (ii) being good stakeholders of the relevant frameworks supporting these policies, practices, and preferences.

Workshop

Application of Geosynthetics in Irrigation, Drainage and Agriculture

Herve Plusquellec

The workshop by the International Geosynthetics Society (IGS) focused on the utility of geo-synthetics in water containment and barrier, conveyance, reinforcement of soils, erosion control and testing of geo-synthetics.

Of the number of geo-synthetics available, Mr. Plusquellec introduced several of the prevalent ones such as geotextiles (1400 million m2/year), geogrid, geonets, geomembranes (300 million m2/year), geo-synthetics clay liner, geofoam (thermal isolation), geocells, geo-composite (geotextile bound to geomembrane). He indicated the dynamic nature of the geo-synthetic industry in providing a number of products and further talked about the utility in other sectors. Geosynthetics are polymeric products used to solve civil engineering problems with value in sectors such aspower, environment, transport through highways, railways, navigation, estuaries and so forth for activities such as sealing of hydraulic works: canals, reservoirs and large dams, waste containment, waterproofing, drainage, anti-contamination, strengthening of soils and erosion control.

Geomembranes have been used in hydraulic works for more than 50 years forlining of canals to control seepage losses and for repair of masonry and concrete dams and providing watertight facing on new RCC dams (up to 188 m) and impervious components on fill dams (up to 175 m) (over 265 dams in 2009).Geosynthetics can be used for the lining of canals and reservoirs by using a variety of geomembranes. Some of the examples of geomembranes include polyethylene: LDPE-HDPE-LLDPE, polyvinyl chloride (PVC), EPDM, butyl rubber, geosynthetic clay liner and bituminous geomembrane.

Geomembranes are today the dominant waterproofing materials in waste storage landfills and in mining applications. However, many irrigation canals are lined with concrete, even though concrete linings have drawbacks. Cast-in-situ concrete linings are not flexible and they tend to crack if they are not uniformly supported by the soil, because of differential settlement, localized soil subsidence, dissolution of gypsum in the soil, the collapse of loess-type soil, internal erosion and seepages from concrete-lined canals.

Providing the example of Nebraska, Mr. Plusquellec provided accounts of the seepage losses from recently concrete-lined canals are about 7-10 % of losses from unlined canals but could increase to about 50% or more after years of operation.Numerical models have demonstrated that canal lining with 0.1% crack area has a seepage rate of 70% of that for unlined conditions (depth to water table: 8m). Poor quality of construction and maintenance also causes ineffectiveness of rigid canal lining.

Mr. Plusquellec indicated the main reasons for slow adoption of modern innovative canal lining techniques as resistance to change by irrigation departments andrisk aversion and adherence to outdated designs. Other reasons such as lack of contractual motivation for consultants to introduce new technology and training at all levels from the university to the field, insufficient information about proven technologies and failures of pilot projects resulting in a long period before piloting new technologies also hamper adoption of innovative ways of lining techniques.

Some of the technical design issues include decision on design of canal lining: protected or exposed geomembrane; selection of the type and thickness of geomembranes; drag forces exerted by flowing water on geo-synthetics liners; uplift of geomembranes by dynamic pressure; bridging of cracks by geomembranes; actions of the winds; stability of the composite lining over side slopes amongst other technical specifications.

Mr. Plusquellec also pointed towards the debate between water resources and irrigation canal managers on several concerns such as the cost of pumping, deterioration of water quality, waterlogging and salinization of adjacent lands. Other arguments are often given such as water saving would become marginal with the use of geo-synthetics since seepage recharges the groundwater. Also, farmers use groundwater more efficiently. Several other deciding factors come into play such as the debate on the real losses because of lining, whether to line or not, the benefits from canal lining, estimates of seepage losses, where to line, the durability of lining, lining of existing canals under operations and so on.

Canal lining is a very expensive element in the canal construction and is often not given enough attention. Cost of lining typically represents as much as 70% of canal rehabilitation and could increase the cost of new construction multi-times. Concrete or geomembrane lining serves as the primary water barrier whereas the geotextiles drain and protect the geomembranes. For difficult soils such as loess and gypsiferous, the double lining may be recommended.

A thicker geomembrane provides longer durability and less civil works for preparation of the sub-gradegeomembrane and its protection. The geomembrane is the main item of the waterproofing works.Efficiency and durability depend on the properties and quality of the geomembrane. Selection cannot be based on one property. Even within the same type of geomembrane, different manufacturers produce a finished product with widely varying performance parameters.

Selection of appropriate geo-synthetics is paramount to its functioning in a given project. Any type of gain in a performance characteristic is often countered by a loss in another aspect. Balancing the puncture strength with a large number of lower quality field seams and difficulty of obtaining

intimate geomembrane/soil contact during installation. In some cases, the stronger option is not usually the better choice. PVC, LLDPE has higher resistance to puncturing under load than HDPE.

With an increase in crystallinity value, the flexibility, environmental stress crack resistance, ease of field installation and intimacy with supporting sub-grade decreases, whereas thermal expansion/ contraction increases with increasing temperatures cycles experienced in service conditions.The crystalline phase of a polymer is the portion of the molecular arrangement which is ordered in highly linear molecules through polymerisation of monomers; it defines the behaviour of the geomembrane.

While procuring the materials for canal lining with geomembranes, a particular chemical type of geomembrane is selected by the engineer during the bid specifications. Before signing the contracts, the technical specifications set out performance requirements which are the basis for acceptance tests.

Material cost is one of the least significant cost components of a geo-synthetics lining system. Proper selection of material and experienced installer is the major step to ensure a properly performing system.High-level expertise is needed during design and installation to assure the stability along soil-geo-synthetics and geomembrane/geotextile, stresses during installation and the thermal expansion of geomembrane provoking wrinkles and folds, differential settlements. Failure occurs in cases where proper attention is not given,such as failure of geomembrane lining of upstream facing of small earth damor uplift of geomembranes occurs by gas due to organic matter in the ground.

The presentation ended with remarks from Mr. Plusquellec on the lessons learnt from failures of canal linings: *"It is unwise to pay too much, but it is worse to pay too little. When you pay too much, you lose a little money, that is all. When you pay too little, you sometimes lose everything because the thing you bought is incapable to of doing the function it was bought to do".*

6

High-Level Advisory Group Meeting

Agriculture, being the largest consumer of freshwater with about 70% share globally, makes agricultural water management (AWM) the key to enhancing water security and achieving food security in a world confronted by limited natural resources. However, these ground level facts are not able to find sufficient attention in much of the deliberations under global sustainable development agenda. Two of the seventeen sustainable development goals (SDGs) exclusively focus on water and food, i.e., SDG 2 (food and nutrition) and SDG 6 (water and sanitation). However, the corresponding targets and consequently, the indicators do not provide the critical thrust for efficient use of agriculture water through efficient irrigation development and management, separating agriculture water use from others. Clubbing of AWM with other water-uses and sanitation makes it difficult to advocate for greater investments and capacity development in irrigation and drainage sector in national policy circles as well as to the political leadership. In most developing countries, generally irrigation and drainage are treated as sub-sets of agriculture with little involvement of other relevant ministries and policy development bodies. Climate issues which have a significant impact on AWM are often addressed from the perspective of the environment with little attention to an integrated approach. While we all recognize the urgent need for increased advocacy for political prioritization of irrigation and drainage, particularly to increase the resilience of farmers to vagaries of increasing climate variability, the way forward is still not very clearly articulated.

International Commission on Irrigation and Drainage (ICID) members strongly felt the urgency for effective advocacy for enhanced investment in the creation of new and maintenance of the existing irrigation and drainage infrastructure especially registering the message at the policy echelons. At the same time resources and means for sharing experiences, exchange of best practices, and transfer of technologies and capacity development, although recognized as the necessary components for better AWM, but do not materialize in practice. Keeping this in view and to bring focused attention on more effective and sustainable management of agriculture water by setting targets and monitoring mechanisms, ICID initiated steps to involve policy-making leadership and senior officials from its member states for focused discussions on key political priorities and actions in support of frameworks for sustainable agriculture water management in the fast-changing environment. UN Agenda 2030 alsorecommends "Partnership" as a means of implementing the agenda.

Accordingly, during the 2nd World Irrigation Forum at Chiang Mai, Thailand in November 2016, the Round Table meetings at Ministerial Level and at the level of Senior Officers were organized that

recommended the formation of a High-Level Advisory Group (HLAG) on "Partnerships for Agriculture Water Management". HLAG is envisaged as an action-oriented, multi-stakeholder partnership to facilitate effective policy making for food and water security at the national level. The ministerial declaration envisaged the specific mandate of HLAG as follows:

a) Facilitate improving agriculture water productivity, especially in irrigated areas where the competition for water is intensifying and/or water supplies are becoming less reliable;

b) Support member countries in achieving the SDG targets related to AWM by enabling existing partnerships as well as promoting new partnerships, where required;

c) Support the UN System efforts in monitoring the progress on related SDGs;

d) Strengthen the World Irrigation Forum, which provides opportunities for reviewing progress made by existing partnerships with inputs from regional and national partnership dialogues;

e) Advocate strong policy support for higher investments in AWM to ensure food and water security;

f) Review and provide policy recommendations at the regional level for consideration by relevant regional bodies; and

g) Use the partnership to share experiences on water-related SDG implementation.

First meeting of HLAG

Keeping in view the mandate of the HLAG and the fact that none of the existing partnerships focuses on issues related to AWM, the first meeting of HLAG was organized on 10th October 2017 during the 23rd ICID Congress at Mexico City to guide the process of developing the "Partnership on Agriculture Water Management" and to take the process further. The meeting was attended by the ministers and senior officials from nine (9) countries and two (2) international organisations as per details are given below.

Ministers/ Senator

1. **Iran** : Mr. Alimorad Akbari, Deputy Minister of Soil and Water, Ministry of Agriculture
2. **Sri Lanka** : Mr. W. W. GaminiZoysa, Minister of Irrigation and Water Resources Management
3. **Nepal** : Mr. Sanjay Gautam, Minister for Irrigation
4. **Nigeria** : Mr. Muhammad Ubali Shittu, Senator, Chairman, Senate Committee on Water Resources

Senior Officers

1. **Australia** : Mr. Tony Slatyer, Special Adviser on Water Department of Foreign Affairs and Trade
2. **Egypt** : Dr. Mohamed Wahba, Deputy Chairman, RegionalTraining Centrefor Water Resources and Irrigation, MWRI
3. **Italy** : Dr. Marco Arciery, Secretary General, ITALCID (on behalf of Ministry of Agriculture, Italy)

4. **Mexico** : Mr. Marco D Parra Cota, Deputy Director General for Hydro Agricultural Infrastructure, CONAGUA

5. **Ukraine** : Mr. MykhailoRomashchenko, Director, Institute of Water Problems and Land Reclamation

International Organisations

1. **FAO** : Dr Olcay Unver, Deputy Director of Land and Water Division

2. **World Bank** : Mr. Remi Trier, Senior Water Resources and Irrigation Specialist

At the outset, Mr. Parra Cota (Mexico) welcomed the participants to Mexico for this first meeting of the HLAG. Dr. SaedNairizi, President, ICID also welcomed the participants and provided a brief overview of the water resources management issues and need for dialogue at policy-making level to advocate focused attention towards agriculture water management to achieve water and food security.

Mr. Avinash C Tyagi, Secretary General, ICID provided a brief background, need for setting of HLAG, its mandate and broad structure to develop a partnership on agriculture water management. He highlighted that the following issues and key initiatives need to be considered while developing a process for partnership:

(i) Recognition of agriculture water management as a significant component of SDG 6 and 2, development of suitable advocacy practices and tools for its political prioritization, and allocating higher investments in AWM and irrigation and drainage,

(ii) Development of specific AWM indicators that can be incorporated in overall water policy development at regional, national and local levels for the sustainable development of agriculture water resources for food production under changing climate and increased pressure on the allocation of agriculture water, and

(iii) Knowledge integration through distributed yet virtually integrated hub at partnership level to develop national/local capacity through training and education, and sharing of best AWM practices, techniques, manuals, knowledge and practical know how.

While sharing his views, Dr Olcay Unver, FAO emphasized that water scarcity, which is one of the leading challenges of the twenty-first century, can simply be the lack of water, i.e., physical scarcity. This may be caused either due to lack of adequate infrastructure, by a lack of access to water services, or by deteriorating water quality. Water scarcity is often due to the failure of institutions to ensure the reliable, secure, affordable and equitable supply of water to all users. The issue of water scarcity has the greatest relevance for the agriculture sector, which uses more than 70% of global freshwater withdrawals and for more than 90% of its consumptive use (from both surface and groundwater sources). It is also the sector with the largest scope and potential for adjustment in water consumption, but this will need to take place against a backdrop of increasing food demand. Realising the need to cope with water scarcity in agriculture, Food and Agriculture Organisation (FAO) launched a Global Framework for Action, named as WAter Scarcity in AGriculture (WASAG) to assist the governments, public agencies, private sector actors and other stakeholders in their efforts to cope with water scarcity in agriculture in a changing climate. Since no single stakeholder can solve the complex, multifaceted issues facing the agriculture sectors today, so new and innovative partnerships are needed to tackle the issues effectively by including governments,

civil society (including women and their representative organizations), the private sector, donors, academia, research institutions, non-governmental organizations and intergovernmental and multilateral organizations. Such partnerships will also support achieving and monitoring Sustainable Development Goal (SDG) targets related to water, i.e., SDGs 2, 6, 12, 13 and 15, especially SDG 6 on water and sanitation having six targets that are all relevant to water scarcity, with Target 6.4 (water use and scarcity) and Target 6.5 (integrated water resources management) directly related to water scarcity management for food security. More than 40 partners from 20 countries have come forward to implement the framework and many others have shown interest to join the partnership. Ownership of the WASAG programme will be by the partners, facilitated by FAO.

In order to provide the leadership required to champion a comprehensive, inclusive and collaborative way of developing and managing water resources and improving water and sanitation related services and realizing that achieving the Sustainable Development Goals (SDGs) will require governments, societies, and the private sector to change the way they use and manage water, the UN and the World Bank Group convened a High Level Panel on Water (HLPW), launched in April 2016, consisting of 11 sitting Heads of State and Government and one Special Adviser with a tenure of two years. Mr. Cázares Ahearne Sean Carlos (Mexico) informed that President of Mexico is a co-chair of the panel at present and further informed that panel is taking number of initiatives such as establishing thematic groups (WGs) such as water data, and water and peace to name a few to provide platform for experts from member countries to share experiences and best practices on issues related to water and provide their recommendations to HLPW on the related themes. Since water is being dealt in a number of UN organs, there is dialogue to fortify action on water and a new organization on water is likely to be established for focused action on issues related to water.

Mr. Tony Slatyer (Australia) highlighted that in a short tenure of two years HLPW has to exercise political leadership for achieving the substantial global goal of ensuring the availability and sustainable management of safe water and sanitation for all the world's people by 2030 (SDG 6). He further informed that Action Plan finalized by HLPW addresses the issues thematically and not sector-wise, and for the irrigation sector, there are themes on infrastructure and investment, on resilient economy and societies, on water data, valuing water and water governance. Two of the themes of direct relevance to the irrigation sector, resilient economies and societies and water data, are being led by the Australian Prime Minister. Under the theme 'resilient economies and societies,' a series of practical projects on water use efficiency such as preparation of a handbook of experiences in Australia and some other countries in the modernisation of irrigation systems and developing technology to reduce the cost of water metering have been launched. Under the water data theme, the Panel is proposing global adoption of a World Water Data Initiative with the aim to assist water users and governments to make better decisions about water management. There will be guidance for governments trying to put in place sound institutional and legal frameworks for collecting, storing, using and disseminating water data. In addition, a technology challenge is underway aimed at improving the capacity of the poorest farmers to access information about their water situation.

Dr. Mahamed Abd-El-MoneimWahba (Egypt), Vice President, ICID confirmed that water scarcity is a real and monumental challenge for most of the countries in arid regions, such as Egypt. In order to meet this challenge, he stressed the need for efficient water management, incorporating climate change into water sector management plans to ensure climate resilient developments, to take decisive action to adapt to and mitigate climate change impacts, to vigorously pursue recycling and reuse of water, to adopt participatory model for users' involvement and cooperation in the decision-making process, planning, and system operation and management. He suggested cooperation rather than competition, and collaboration rather than individual actions will pave the way towards effective water management for securing the right of each and every individual to attain a fair share

of water, food, and energy. In Egypt, a triple cycle of reuse (intensive water recycling in the form of reused treated wastewater, recycled mixed agricultural drainage water, and recycling of excess irrigation water recharging the Nile alluvium aquifer) to provide for about 30% of the demand is not uncommon. An overall national irrigation efficiency of more than 80% is achieved, which is among the highest in the world.

HE Minister Mr. Alimorad Akbari (Iran) said that water crisis is the third systematic risk confronting the world economy after climate change and weapons of mass destruction, and it needs to be dealt at the highest governance level. Iran, located in the arid and semi-arid region, is also facing severe water crisis in most of the areas across the country and has taken several steps and initiatives to increase water productivity and water use efficiency. Some of the actions taken in this direction include formation of integrated management coordination council with participation of all stakeholders both in government and private sectors, empowering farmers and stakeholders with collaborative management of water resources, updating national water document on recent water demand and climate conditions, adopting optimal national crop patterns as per ecological potential, developing new irrigation methods based on water accounting, migrating to less water-intensive crops, transferring high water consumption crops to greenhouses, using volumetric delivery method, shifting crop season of some of the crop for maximizing use of green water, using virtual water management (importing high water consumption product and exporting low water consumption products, and the recycling of water. Mr. Akbari supported developing of partnership with other countries and organisations and invited other member countries to join pilot projects proposed to be taken up to improve water productivity and share their experiences in such projects. Mr Akbari stressed on the need to promote environment-friendly traditional wisdom, integrate climate change in national development plans and reduce carbon and water footprint in agriculture for sustainable development and management of scarce water resources.

Mr. Arciery Marco (Italy) opined that the need for institutional reforms in irrigation and drainage sector as a very important and strategic issue in order to further advance progress in efficient water use enhancing agricultural productivity. Dr Marco conveyed the keen interest of Italian Government in fostering reforms besides the willingness to support further initiatives aimed at improving Agricultural Water Management and the development of capacity building initiatives in Italy and in nearby Countries, such as those bordering the Mediterranean area. The proposal to host the Regional Node of IRPID for the Mediterranean Area was emphasized as an example.

Mr. Rananand Prasad Yadav (Nepal) informed that Nepal, rich in water resources with about 225 BCM supply of which only 7% (15 BCM) in use, relies significantly on agriculture which contributes about 36% to the gross domestic product (GDP) and employs about 76% of the workforce. However, the agriculture sector is one of the most vulnerable sectors to the risks and impacts of global climate change, water shortages and natural disasters (landslides, floods, glacial lake outburst flood etc.), which are likely to increase as a result of impacts of climate change. Therefore, it is essential to take immediate measures to cope with climate change so that agricultural production from the limited cultivable area (only about 18% area of total) is maintained as well as improved to meet the future food demand of the growing population. Mr. Yadav highlighted continuous effort undertaken in his country to mitigate negative impact of climate change and the spatial and temporal variations of water availability for irrigation which include improvement of efficiency of the irrigation systems, enhance water use efficiency, use of groundwater for irrigation and also development of non-conventional irrigation systems, inter-basin water transfer and reservoir-based large irrigation systems. Also, the river training works and protection of the irrigation command areas are being implemented to manage the landslides and floods. He further advocated that in order to feed

growing population, investment in agriculture, irrigation infrastructure and rural development should be accorded the topmost priority by the Governments to boost food production and improve nutrition with focus on encouraging climate-smart farming techniques, protecting land from adverse effect of climate change and restoring degraded farmland, breeding more resilient and nutritious crops and improving storage and supply chains for reducing food losses. Mr. Yadav strongly supported partnership through HLAG with focus on meeting the targets set under SDGs and stressed on working together towards sustainable agriculture water management through inter-disciplinary approaches to economically viable, socially acceptable and environmentally sound irrigation, drainage and flood management.

Senator Shittu (Nigeria) said that job creation and livelihood opportunities are some of the most effective ways to address underlying grievances and perceptions of exclusion which in turn drive conflict and insecurity. Since the majority of the population in most of the countries including Nigeria relies directly or indirectly on agriculture for its livelihood, pushing an agenda of AWM through irrigation and drainage development to move from rain-fed agriculture to irrigated agriculture is of utmost importance to ensure food and national security. He stressed the need for advocacy at the highest level to bring AWM to the forefront and supported the idea of partnership development through HLAG initiative undertaken by ICID.

HE Minister Mr. Zoysa (Sri Lanka) informed that about 96% of water from the hydrological cycle is used for agriculture and food production contributes about 16% in the national economy. Keeping this in view, enhancing irrigated agriculture to be commercially viable and maximizing water use is recognized as critical for the development of Sri Lanka's agriculture sector in the National Policy. Although Sri Lanka is blessed with adequate freshwater resources, however potential impacts of climate change on rainfall regimes are already visible now and needs to undertake adaptation measures to cope with climate change through integrated water resources management (IWRM) in order to ensure food security, economic growth and productivity enhancement. He highlighted adverse agricultural practices associated with poor water management and overexploitation of groundwater, disposal of water and toxic chemicals into rivers and urban lowlands, leaching of residual fertilizers and agro-chemicals into groundwater and surface runoff, and prolific growth of aquatic weeds as some of the major challenges which need to be tackled to sustainably manage water resources of Sri Lanka.

Mr. Mykhailo Romashchenko (Ukraine) emphasized that strategic goal of the national water policy of Ukraine is achieving the reliable state of water security. He informed that Ukraine had adopted a strategy of irrigation and drainage rehabilitation and modernization for ensuring water and food security. The main aim of the strategy is to establish an effective and efficient irrigation and drainage sector that is managed with the participation of water users to ensure the sustainability of agriculture in the conditions of climate change. This will subsequently contribute to the strategic task of agricultural development of Ukraine in order to achieve the status of a commercially viable world leader in food production. He further informed that in order to fully implement the strategy the following issues need to be tackled on priority (i) Establishing of WUOs and the principles of their functioning, (ii) Transferring infrastructure facilities on the balance of the WUOs, (iii) Setting new tariffs for water services, (iv) Establishing principles for regional water management departments functioning, and (v) Developing principles of land consolidation. Mr. Romashchenko supported the need for partnership in AWM and reaffirmed support of Ukraine in the future activities of HLAG.

Way Forward

The discussion focused on guiding the process of developing the 'Partnership on Agriculture Water Management.' Apart from sharing successful experiences, the common opinion of the high-level experts and officials was the necessity to adopt sustainable practices for AWM in order to provide food and water security for current and future generations, especially in countries where agriculture plays a key role in driving the economy. There is an urgent need for dialogue at policy-making level to advocate focused attention towards AWM to achieve water and food security.

Since HLAG is envisaged as an action-oriented, multi-stakeholder partnership to facilitate food and water security, synergies with various partners such as FAO, World Bank on one hand and among member countries will have to be developed to raise level of water at international level, to achieve water and food security at national level and targets set under SDGs.

7

23rd ICID Congress Wrap-Up: Modernizing Irrigation and Drainage for a new Green Revolution

The 23rd International Congress on Irrigation and Drainage with the main theme "Modernizing Irrigation and Drainage for a New Green Revolution" was held during 8-14 October 2017 at World Trade Centre, Mexico City, Mexico, organized and hosted by Mexico National Committee of ICID (MXCID). The Congress was attended by more than 832 delegates from 35 countries.

During the Congress, questions regarding the water productivity and irrigation techniques were discussed at length. A total of 278 abstracts reviewed, 154 research articles and posters from more than 54 countries were received, about 60 papers presented and about 70 posters displayed. Based on the discussions of the participants, several recommendations emerged for the two questions discussed during the 23rd ICID Congress, Question 60 – 'Water productivity: revisiting the concepts in light of water, energy and food nexus' and Question 61 – 'State of knowledge of irrigation techniques and practicability within given socio-economic settings'. The recommendations for Q 60 and Q 61 are incorporated in the Mexico City Statement.

During the Congress, in addition to addressing these two questions, the following supporting events were also organised:

- Symposium on 'Global review on institutional reform in irrigation sector for sustainable agricultural water management including WUA',
- Special Session on 'Technologies for Reuse of Wastewater in Agriculture and its Impact on Health and Environment',
- International seminar on 'Water use in food value chain: A challenge for a new Green revolution?', and
- Workshop on 'Application of geo-synthetics to irrigation drainage and agriculture'.

Mexico City Statement - 2017

As a result of intense deliberations during above events, the following outcome in respect of Congress Questions 60 and Question 61, has been emerged.

Question 60: Water productivity: revisiting the concepts in light of water, energy and food nexus

1. To improve irrigation services through modernization, there is need to revisit water productivity by identifying challenges and opportunities. Various water saving measures should be passed through the water-energy-food prism for identifying challenges in associated domains and help find opportunities.

2. Investing in improving irrigation technologies and techniques help to save agricultural water and can improve equitability of distribution amongst the common stakeholders but the technology transfer is important through capacity building

3. Many techniques are available, especially the ICT based ones and also the measurement techniques for assessing the actual releases and regulating them. Water losses at the field level have been minimized using a suite of techniques.

4. Volumetric extraction systems for aquifers allow monitoring of allocated and recharge volumes from aquifers.

5. Water reuse/ recycle needs assessment of site-specific conditions in the contexts and should avoid stakeholder conflicts for water transfers and adoption of structural and operational reforms

6. Water, energy and food nexus has multi-dimensional features and is compounded by climate and social changes as has been revealed by studies in a number of countries across the globe.

7. Water footprint indicators seem to be useful in assessing water management in irrigated areas. Various water management techniques adopted, strongly influence the water footprints for specific crops at the field level.

8. Considerable advances are being made in the satellite image processing areas as well as simulation modelling, which need to be leveraged for better impact assessment of measures adopted or proposed for sectoral water management.

9. Water security has environmental and social aspects. While managing an extreme situation, both have to be considered in conjunction with each other. Analysis of water laws and legal frameworks to achieve sustainable water management leading to water security is necessary.

10. Challenges of water security emerging from international basins need be addressed through cooperation mechanisms based on principles of international water law.

11. User's role in water management is important at the basin level and need to be coordinated with better information dissemination.

12. To achieve water security through reuse/ recycle of water, policies have to take associated health issues into account.

Question 61: State of knowledge of irrigation techniques and practicalities within given socio economic settings

1. The definition of precision agriculture evokes different understanding amongst the community covering a wide range of options and technologies for application management at the field level and also the necessary decision support in a spatial and temporal manner for directing water in a required manner.

2. Advances in technologies like ICT and cloud-based computing models for real-time decision support coupled with the accurate determination of the status in the field using drones enable the application to large areas with multiple holdings as against large farms only in the past.

3. ET-based irrigation scheduling has the potential to improve on-farm efficiency.

4. The importance of organizing small farm holder community and ensuring institutional support is required for making the benefits of modernization reach them effectively.

5. Role of operating decisions play an important part in improving irrigation efficiencies and it is required that operations may be kept simple to avoid irrigator errors.

6. A number of software tools are available for simulating for irrigation system evaluation, design and operational analysis. Further progress in this area is required for using better infiltration models while maintaining computational speeds.

7. New technologies have to be adaptable in order to reap benefits after their implementation. Scaling up effects should be properly understood before large-scale implementation and adoption by the user communities.

8. Adaptability of the technologies should be seen in various contexts of climatic conditions, environmental and socio-economic conditions and then their validity should be determined.

9. Land tenure and size of landowners are important factors for adaptation of new irrigation technologies particularly in developing countries. However, new approaches like land pooling and cooperative farming can provide windows of opportunities to implement the techniques and thereby improve efficiencies.

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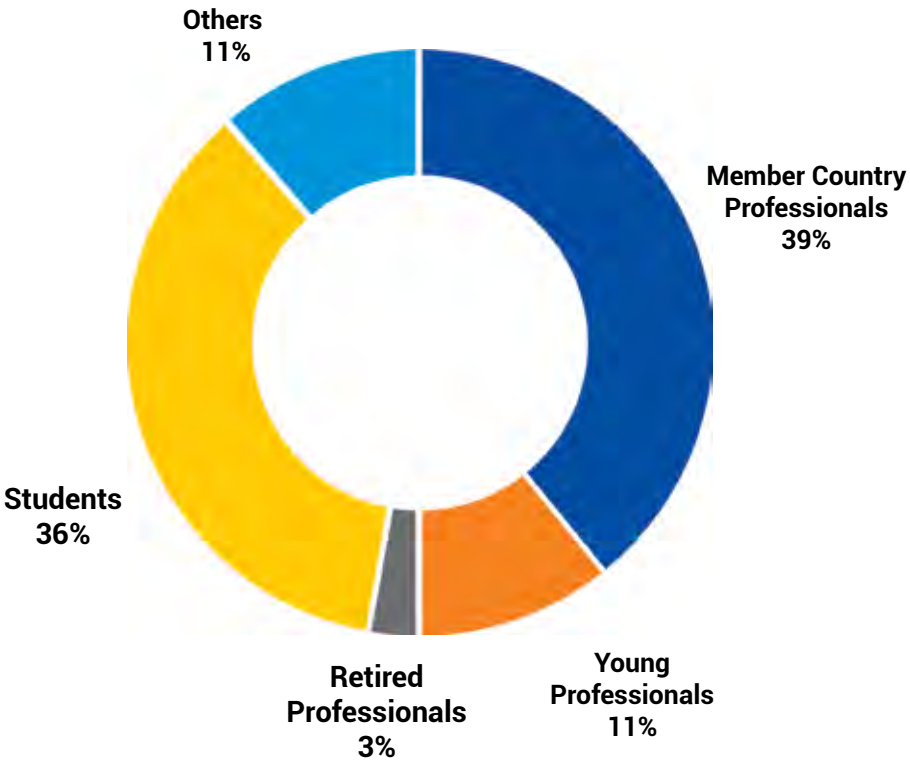
No. of Participants



Participants from various Countries

Country	No. of Participants	Country	No. of Participants
Afghanistan	3	Mali	0
Argentina	2	México	572
Australia	9	Morocco	2
Bangladesh	0	Nepal	7
Belgium	1	Netherlands	4
Bolivia	0	Pakistan	2
Brazil	0	Peru	0
Cameroon	0	Republic of Korea	35
Canada	4	Russian Federation	3
Chile	1	Saudi Arabia	0
China	34	South Africa	9
Chinese Taipei	27	Sri Lanka	4
Colombia	2	Sudan	0
Costa Rica	0	Tajikistan	0
Dominican Republic	1	Thailand	2
Egypt	3	Turkey	5
Estonia	1	Ukraine	5
Finland	4	United Kingdom	3
France	3	United States	15
Georgia	1	Uzbekistan	0
Germany	6	Vietnam	0
Ghana	0	Zambia	0
Hungary	0	**TOTAL**	**832**
India	15		
Indonesia	0		
Iraq	0		
Iran	17		
Italy	5		
Japan	20		
Malaysia	5		

Presentation of Awards, Plaques and Recognitions

Best Performing National Committee Award (BPNCA)

The Best Performing National Committee Award (BPNCA) based on the work undertaken during the last three years was given to Iranian National Committee on Irrigation and Drainage (IRNCID). A crystal trophy was presented to IRNCID.

Best Paper Award

The Best Paper Award for 2017 selected out of the papers published in the ICID Journal during the year 2016 was presented to Sabine J.Seidel, Stefan Werisch, KlemensBarfus, Michael Wagner, Niels Schütze and Hermann Laber from Germany for their paper titled "Field Evaluation of Irrigation Scheduling Strategies using a Mechanistic Crop Growth Model".

WatSave Awards

ICID presents every year the Annual WatSave Awards in recognition of the outstanding contribution to water conservation or water saving and thereby creating the culture of water savings for the benefit of all water-users. WatSave Awards are made in respect of actual realised savings and not for promising research results, plans and/ or good ideas/ intentions to save water. The WatSave Awards 2017 were given under 4 categories:

WatSaveTechnology Award

Mr. Chris Norman & Mr. Carl Walters (Australia)

The International Panel of Judges of WatSave Awards has adjudged Mr. Chris Norman & Mr. Carl Walters (Australia) for conferring the WatSave Technology Award 2017'.Mr. Chris Norman & Mr. Carl Walters (Australia) were selected for Technology Award for his work on "Developing 'Water Savings Calculator' for estimating water savings".

WatSaveInnovative Water Management Award

Prof. Wang Aiguo (China)

The International Panel of Judges of WatSave Awards hasadjudged Prof. Wang Aiguo (China) forconferring the WatSave Innovative Water ManagementAward 2017. Prof. Wang Aiguo (China) selected for Management Awardfor his work on "Promoting water saving interventions in large irrigation systems".

WatSaveFarmer Award

Dr. Sharad Deshmukh (India)

The International Panel of Judges of WatSave Awards hasadjudged Dr. Sharad Deshmukh (India)forconferring the WatSaveFarmersAward 2017. Dr. Sharad Deshmukh (India) selected for Farmers' Awardfor his work on "Effective Water Management through Farmer's Cooperative Interventions".

WatSaveYoung Professional Award

Mr. Mahdi Sarai Tabrizi (Iran)

The International Panel of Judges of WatSave Awards hasadjudged Mr. Mahdi Sarai Tabrizi (Iran) forconferring the WatSaveYoung ProfessionalsAward 2017. Mr. Mahdi Sarai Tabrizi (Iran) selected for Young Professionals' Awardfor his work on "Designing Micro-Lysimeter for accurate measurement of crop water requirements".

Heritage Irrigation Structures (HIS)

The 68thIEC meeting approved inclusion of 13 new heritage irrigation structures, which includes: Australia (2); China (3); Japan (4); Korea (2); and Mexico (2). President Dr. Nairizi presented the citation plaque of Mexican structures to Mexican President H.E. Enrique Peña Nieto during the opening ceremony of the 23rdICID Congress & 68thIEC Meeting held in Mexico City, October 2017.

1. **Australia – Goulburn Weir**
2. **Australia – Bleasdale Vineyards Flood Gate**
3. **China – Ancient Yellow River Irrigation System**
4. **China – Hanzhong Ancient Weir Irrigation System**
5. **China – Huang Ju Irrigation System**
6. **Japan – Doen Irrigation System**
7. **Japan – Nasu Irrigation System**
8. **Japan – Matsubara-Muro Irrigation System**
9. **Japan – Odai Irrigation Canal**
10. **Mexico – Chinampa (Prehispanicsubirrigated farm)**
11. **Mexico – La Boquilla Dam**
12. **Korea, Republic of – DangjinHapdeojke**
13. **Korea, Republic of – Manseokgeo Dam (IIwang Reservoir)**

Presentation of Plaques to retiring ICID Office Bearers

At concluding session, plaques were presented to the ICID Office Bearers who were to retire after the 23rd ICID Congress and 68th IEC in Mexico City, Mexico.

President — Dr. Saeed Nairezi (2014-2017)

Vice Presidents –

1. **Dr. Mohamed Abd-El-Moneim Wahba (2014-17)**
2. **Dr. Ding Kunlun (2014-17)**
3. **Mr. Bong Hoon Lee (2014-17)**

Secretary General — Engr. Avinash C. Tyagi (2012-2017)

President Dr. Saeed Nairizi Secretary General Avinsah C. Tyagi with President Elect Engr. Felix B. Reinders and Secretary General Designate Ashwin B. Pandya

Technical Tours

Chinampas in Xochimilco

This tour provided a visit to the famous ancient Aztec floating farms (chinampas) constructed by excavating lake sediments and creating a system of islets separated by channels. The chinampa has been a traditional land-use practice in the Valley of Mexico since Pre-Hispanic times and is considered a historical sustainable agricultural system based on the efficient use of farming technologies and resource management strategies for horticulture and floriculture production. The villages, that maintain chinampas as farming activity, are located in wetlands of Xochimilco and Tlahuac, counties located at south of Mexico City, featuring a small lake—reminiscent of the great Aztec-era lake system—where traditional trajineras (punt boats of sorts) cruise along scenic waterways surrounded by lush vegetation. For its historical and cultural value, it is declared as a UNESCO cultural heritage site and a RAMSAR site for conservation of wetlands.

Irrigation District 023 San Juan del Río, Queretaro

The tour provided a comprehensive understanding of the administration and operation of a typical Mexican irrigation district, including its hydraulic structures and farms. The Irrigation District 023 is located in the central part of the country, in the zone known as "El Bajio" of significant economic, cultural and agricultural importance. The Irrigation District 023 dominates an area of 11,835 hectares of which 9,373 are irrigable, distributed amongst 2,625 producers. The sources for irrigation are

dams with a total capacity surrounding 115 thousand m3, and 55 wells distributed in the irrigation zone. The irrigation district faces a high pressure for the water due to the growing demand for urban and industrial use. The technical tour exposed the problems of the region and how it is being solved through the exchange of water usesand its more efficient use through the technification of greenhouses. The visit also included Agropark is an agro industrial park with agreenhouse complex and Freixenet vineyard zone on 295 ha of land.

Accompanying Person's Tours

Polanco

A tour to the neighbourhood of Polanco with several art galleries, luxury-brand shops, avant-garde designers, five-star hotels and some of the city's best restaurants was provided to the accompanying persons.

Teotihuacan

A tour to the pre-Hispanic city of Teotihuacan, approximately 50 km northeast of Mexico City was provided. Famously known as "the place where the gods were created", Teotihuacan was built between 1stand 7th centuries and was one of the largest urban centres of the ancient world which at its peak of splendour came to have more than 100,000 inhabitants. It was the power centre of one of the most influential Mesoamerican societies in the political, economic, commercial, religious and cultural sectors.Its monuments are geometrically located, being the most relevant the Sun and the Moon Pyramids and the Quetzalcoatl Temple. Teotihuacan was declared a UNESCO World Heritage Site in 1987.

Historic Centre

Another tour to the UNESCO World Heritage Site, the Historic Centre, located at the heart of Mexico City was provided. Known for its beautiful Colonial-era buildings and monuments, the Zócalo, the main square of the city, is the political, economic, social and religious centre of the country. Here is the Templo Mayorw, the remains of the Aztec temples, and a statue of an eagle perched on a cactus, which the Aztecs interpreted as the chosen place to build their city: Tenochtitlan. The Palacio Nacional, which houses five murals by Diego Rivera, faces the square, as well as city hall and the Cathedral, the largest and oldest in Mexico.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24th International Congress on Irrigation and Drainage & 71st International Executive Council meeting

22-28 September 2020, Sydney, Australia. Website: https://www.icid2020.com.au/

Innovation and research in agricultural water management to achieve sustainable development goals

THANK YOU FOR YOUR PARTICIPATION IN THE 23RD INTERNATIONAL CONGRESS ON IRRIGATION AND DRAINAGE, MEXICO, 2017.

SEE YOU IN SYDNEY 2020!

Hosted by:

IRRIGATION AUSTRALIA

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