

XVII World Water Congress

FINAL REPORT

DAEGU, REPUBLIC OF KOREA
29 NOVEMBER — 3 DECEMBER 2021

BY THE INTERNATIONAL WATER RESOURCES ASSOCIATION (IWRA)





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INTRODUCTION

Paving the way to Dakar 2022



The XVII World Water Congress was held in Daegu, Republic of Korea, for five consecutive days (29 November-3 December 2021). It was organised by the International Water Resources Association (IWRA) together with Daegu Metropolitan City, Korea Water Resources Corporation (K-Water), Korea Water Resources Association, and the support of the Ministry of Environment of Republic of Korea. The main theme was “*Foundations for Global Water Security and Resilience: Knowledge, Technology and Policy*”, with a focus on resilience and the need to find solutions to growing and changing challenges, in line with the 2030 Agenda, the 9th World Water Forum, and the 2023 UN Conference on Water.

The Congress called for an urgent need of dialogue and coordination across different disciplines and sectors to address complex water challenges. A post pandemic world recognizes water as a fundamental element of building resilience and long-term sustainable development. The importance of water for life and development must be reanalysed and its priority role must be understood in connection with sanitation, hygiene, and sustainable management of water resources and aquatic ecosystems.

With 1,094 total attendees (831 on-site and 263 virtual), IWRA and co-hosts welcomed participants from 26 countries to the sixteenth Congress, which also marked the 50th anniversary of IWRA's establishment (1971). Despite the restrictions still in place due to the COVID-19 pandemic, which had delayed the Congress by 18 months, the XVII World Water Congress included excellent high-level participation of multilateral organisations, including the World Water Council, the World Bank, UNESCO, OECD, IFAD, and FAO, as well as brought together water experts from over 30 universities who shared research findings, solutions, and proposals for leveraging water issues at global level.

IWRA was particularly pleased to welcome the participation of a ministerial delegation from Senegal in preparation of the 9th World Water Forum to be held in Dakar in March 2022. This included the Minister of Water and Sanitation of Senegal, Serigne Mbaye Thiam, and Abdoulaye Sene, Executive Secretary and Co-Chairman of the Preparatory Committee for the Organisation of the 9th World Water Forum to be held in Dakar in March 2022. The XVII World Water Congress was officially recognised as a milestone on the road to the 9th World Water Forum Dakar.

As mentioned by Mr. Sene in his keynote speech in the Opening Ceremony: “Takeaways of the Daegu Congress will be of big importance for our content in Dakar (...) We hope that the results coming from this Congress will really fit the next World Water Forum. Our Congress theme on water security is an important one, because we all know that water is essential, especially when we discuss fighting this pandemic and about enhancing the resilience of our societies and economies”.

THE XVII CONGRESS IN NUMBERS



100 HOURS OF CONTENT



60 SESSIONS

360 PRESENTERS



1,200 REGISTRANTS

1,094 PARTICIPANTS



26 COUNTRIES

6 HIGH-LEVEL PLENARIES



39 REGULAR SESSIONS

49 SPECIAL SESSIONS

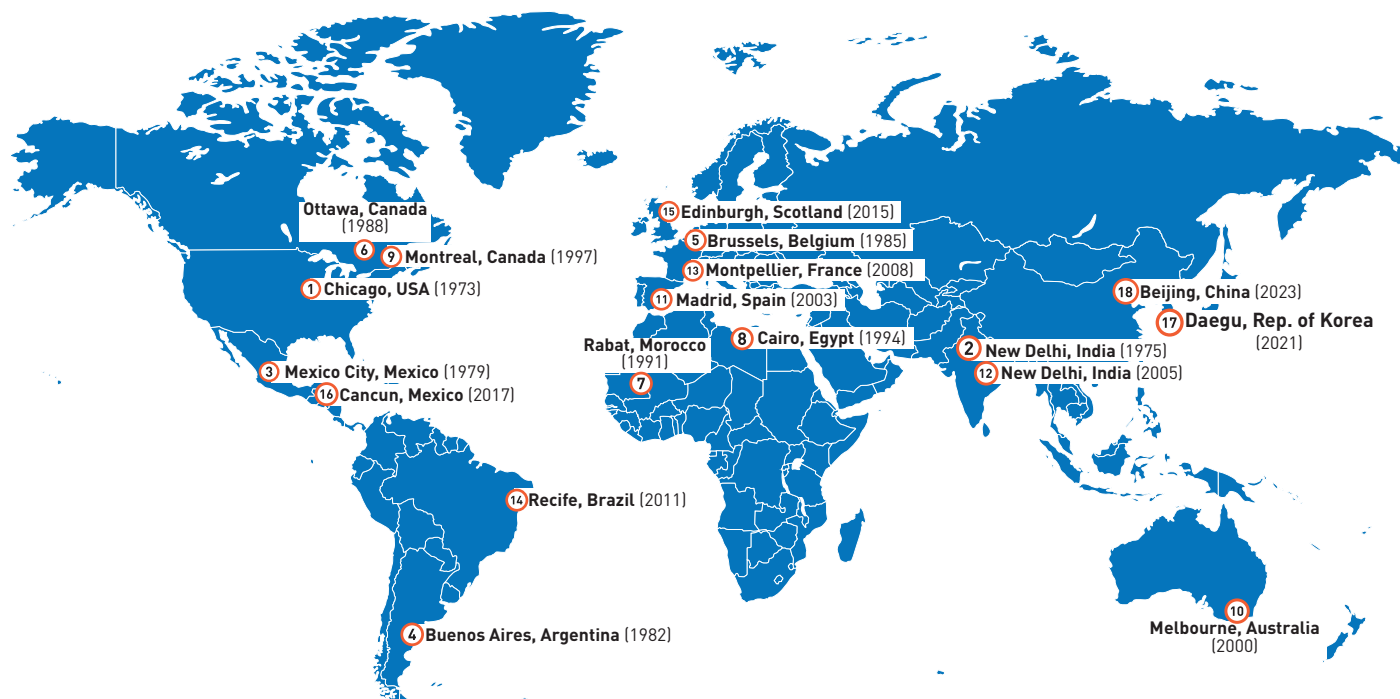
94 POSTERS



17 AWARDS



HISTORY OF THE IWRA WORLD WATER CONGRESS



Since 1973, IWRA has held a World Water Congress every few years in various locations around the world. The objective of the World Water Congress is to provide a meeting place to share experiences, promote discussion, and to present new knowledge, research results, and new developments in the field of water sciences around the world. For five decades, the World Water Congresses have been excellent events for the identification of global themes concerning the water agenda and for bringing together a large cross-section of stakeholders for the development and implementation of decisions in the field of water.

Daegu was the seventeenth edition of the IWRA World Water Congress, delayed by 18 months due to the COVID-19 pandemic. It was one of the first major international face-to-face water conferences to be held following this period of limited travel and gathering, and the delay meant that the Congress took place on the exact 50th anniversary of the foundation of the International Water Resources Association in 1971, in Wisconsin, USA.

HIGH-LEVEL SPEAKERS



Hong Jeong Kee, Vice Minister, Korean Ministry of the Environment

Kwon Young-jin, Mayor of Daegu, Daegu Metropolitan City

Serigne Mbaye Thiam, Ministry of Water and Sanitation – Senegal

H.E. Mr. TIAN Xuebin, Vice Minister, Chinese Ministry of Water Resources

Gilbert F. Hounbo, President, International Fund for Agriculture and Development (IFAD) and Chair of UN-Water

Virginijus Sinkevičius, European Commissioner for the Environment, Oceans and Fisheries

Armida Salsiah, Under-Secretary-General, United Nations / Executive Secretary, UN-ESCAP

Shin Bongwoo, Director, UNESCO i-WSSM

Deghyo Bae, President, Korean Water Resources Association

Jae Hyeon Park, President & CEO, K-water

Waqas Burney, Partner Manager, Google Search (APAC)

Pauline Mufeti, Head of Hydrological Services, Namibia

Jennifer Sara, Global Director, World Bank Group's Water Global Practice

Nara Lee, Assistant Representative, FAO Partnership and Liaison Office, Republic of Korea

Aziza Akhmouch, Head of the Cities, Urban Policies and Sustainable Development Division, Organisation for Economic Co-operation and Development (OECD)

Dominique Berod, Head, Earth System Monitoring Division, World Meteorological Organisation (WMO)

Lesha Witmer, Advocacy Leader, Women for Water Partnership

Anthony Slatyer, Water Policy Group Co-Founder, Australian Water Association (AWA), Alliance for Water Stewardship (AWS) & Australian Institute of Company Directors (AICD)

Yoonjin Kim, Planning Director, the Korea Water Forum

Sasha Koo-Oshima, Deputy Director of Land and Water Division, Food and Agriculture Organisation of the United Nations (FAO)

Loïc Fauchon, President, World Water Council (WWC)

Eric Tardieu, Director General, International Office of Water (IOWater)



"Water is above all, a political priority. Solutions are political and decisions are political. Responses and proposals should address the improvement of daily lives of people."

Loïc Fauchon, President, World Water Council



"A threat to water is a threat to economic progress and to peace and security."

Virginijus Sinkevičius, European Commissioner for the Environment, Oceans and Fisheries



"The challenge is to turn knowledge from one country to another into practice and implementation."

Jennifer Sara, Global Director World Bank Group's Water Global Practice



"The pandemic is teaching the humanity a lesson: we are all in the same storm but not on the same boat."

Gilbert F. Hounbo, President of the International Fund for Agricultural Development (IFAD), and Chair of UN-Water

OVERARCHING MESSAGES FROM THE XVII WORLD WATER CONGRESS

Water security is complex and interdependent of other systems, including health, ecosystems, energy, and agriculture, among others. Therefore, solutions to address them will not necessarily come from within the water sector itself. Our ability to rapidly respond to shocks including pandemics, climate change, or conflicts, will depend on how well we align policy and investment priorities to reflect the complexity and cross-sectoral nature of achieving resilient and sustainable water systems.

IWRA's XVII World Water Congress urged for investing in an enabling environment to improve the harmonization among and between cross disciplinary scientists, cross-sectoral stakeholders, and public policies.

The following were topics identified as being particularly critical for achieving global water security and resilience:

1. Disseminate nature-based solutions, together with the mainstreaming of public policies dedicated to water resources management and biodiversity preservation.
2. Reinforce IWRM and river basin approaches, with good and shared governance, including for transboundary resources, as confirmed and effective tools for peace and sustainable development.
3. Support solutions for productive and sustainable agriculture, respectful of soil health and its interdependence with water needs.
4. Improve coordination between scientists and educators to empower future generations with the right knowledge and tools.
5. Institutionalize the engagement of youth and early career professionals, through developing programs that reflect a long-term vision and commitment to including them as partners in the process.

WELCOME MESSAGES



Message from the President, IWRA

**Professor Gabriel Eckstein, President,
International Water Resources Association (IWRA) (2018-2021)**

Water governance matters. Collaborative and holistic thinking, policy, and management are essential to combatting climate change, especially in the complex area of water, which is often poorly understood by policymakers.

Events such as our World Water Congress encourage dialogue amongst stakeholders in the water sector. It is imperative that such dialogue relating to water and climate change are grounded on relevant and timely data and information, which should be shared broadly and used collaboratively.

Aged infrastructure and outdated technology hinder the flow of water data around the world. This compounds the challenge in knowing where to best invest public funds committed at COP26 to climate change mitigation and adaptation. This stunted flow of information means that not only constructive opportunities are missed, but it also creates the destructive potential for policy making, further hindering progress.

It is in these potential data vacuums that dialogue is most needed. In our increasingly technological age, there is a fashionable argument that face-to-face events as the World Water Congress can or should be conducted online. It is a valid argument, especially given the carbon and water footprints of such events. Yet, creativity and innovative thinking is often better served by face-to-face meetings, rather than through a screen.

Our Congress recently held in Daegu, Korea, came hot on the heels of the COP26 and brought together key stakeholders, including the Ministry of Environment of Korea, the European Commission, and a wide range of water resource practitioners from around world.

On the occasion of IWRA's XVII World Water Congress in Daegu, Korea, we were reminded once more that dialogue matters and relevant and needed partnerships result from these processes. If we don't advance under that assumption, then the most developed technology and tools will not solve the looming crisis that climate change presents. From IWRA, we will continue working tirelessly to advocate these principles and to convene stakeholders and partners from all corners of the world.

WELCOME MESSAGES



Message from the ISC Chair

Professor Gary Jones, Chair

International Scientific Committee, XVII World Water Congress

2021 has brought an unprecedented period of risk and disruption that has affected the entire world. The postponement of the World water Congress from year 2020 to year 2021, however, has provided an opportunity to update the congress thematic framework to include a new theme focused on the lessons learned from the COVID-19 pandemic. This theme explored how sustainable water management has been affected and what the global response has been.

The World Water Congress in Daegu is truly a global event. It has provided a vibrant meeting place for all of us in the international water community to reconnect and renew networks and collaborations. The Congress has also helped build a diverse, multidisciplinary, and multi-sectorial dialogue, enriched by cutting-edge research, new knowledge, and the opportunity for engagement in productive discussions.

The congress programme has not only focused on scientific, engineering, technical and policy aspects but it has also directly contributed to the international water and development agendas, particularly the implementation of the Sustainable Development Goals. High-level panels, distinguished invitees, and keynote speakers have helped bridge the Congress with other key global events, as a milestone, for instance, on the road to the 9th World Water Forum scheduled to take place in Dakar in 2021.

As Chair of the International Scientific Committee, I wish to thank everyone who has been involved in the organisation of IWRA's XVII World Water Congress in Daegu and I look forward to welcoming everyone to the XVIII IWRA World Water Congress in Beijing, in September 2023.

WELCOME MESSAGES



Message from Executive Director, IWRA

Mr. Callum Clench, Executive Director
International Water Resources Association

The XVII World Water Congress was the first IWRA Congress to be held in East Asia. Having the unique opportunity to convene in the Republic of Korea, hosted jointly by the Ministry of the Environment, K-water, Daegu Metropolitan City, and of course the Korea Water Resources Association, has further strengthened our on-going relationships and collaborations in this part of the world, as well as allowed us to develop new partnerships in the region. IWRA will be forever grateful to our co-hosts in Korea for putting on an incredible World Water Congress, despite the numerous and unprecedented difficulties caused by the COVID-19 pandemic.

We are also incredibly grateful to all the individuals who worked tirelessly and flexibly to ensure that this World Water Congress was a great success for all—those that could be there in person and those who attended online. This includes the International Scientific Committee Chair, Gary Jones and his committee, as well as the members of Congress Secretariate in Daegu and the IWRA Executive Office.

The theme of the Congress – Foundations for Global Water Security and Resilience: Knowledge, Technology, and Policy – represents the many challenges that have been exacerbated since the outbreak of the global pandemic. Guaranteeing water security is fundamental to any functioning nation. Today, however, simple preventative measures, like handwashing, have become truly complex. In a global context, where 30 percent of the world's population (2.3 billion people) do not have access to basic handwashing facilities, this has allowed infections to increase easily and rapidly. The World Water Congress has not come up with the answers for handling the global pandemic, but it did provide the setting for conversations that inform thinking on how we should manage the next pandemic.

Only through better collaboration, global knowledge exchanges, identification of innovative solutions, and joint commitments—aspects that were underlined at the XVII World Water Congress—will we be able to face what the future brings.

WELCOME MESSAGES



Message from the Minister of Environment

Jeoung Ae Han, Minister of Environment
Republic of Korea

It gave me a great honour that IWRA's XVII World Water Congress was held in the world's leading water industry city, Daegu, Republic of Korea, from 29 November to 3 December 2021.

Water is the essence of our life; it is vital not only for humans but also for nature.

Throughout history, water investments and management have been crucial contributions to the evolution of human civilization and life. Ensuring safe drinking water also has always been our basic human right.

Water security, accordingly, has been one of the defining challenges of our time. This challenging outlook on water security, with an increased severity in floods and droughts brought about by climate change, reflects an urgent need for better managing water risks.

The Korean government, as part of efforts for resolving those challenges, has driven and settled integrated water management by applying reasonable and balanced policy to ensure that no one is without access to safe drinking water.

Our policy for integrated water management reflects the vision for safe water supply as well as being an innovative water industry powerhouse. Technology advancement derived from the 4th industrial revolution has expanded the scope of water industry as well.

The Korean water industry has also widened its scope recently by encompassing smart water management and the water related energy sector. In recognition of significant development of water industry development, the Korean Ministry of Environment has supported the competent actors in public and private sector for their global expansion.

The XVII World Water Congress has provided a great place for sharing accumulated knowledge and experience, as well as introducing advanced technologies.

I truly hope the results of these discussions contribute to achieving the Sustainable Development Goals. I cordially express my appreciation for your support and participation at the XVII World Water Congress 2021 in Daegu.

WELCOME MESSAGES



Message from the Mayor of City Daegu

Young-Jin Kwon, Mayor of Daegu Metropolitan City

By successfully holding the 7th World Water Forum in 2015 and establishing the Korea Water Cluster (KWC), Daegu Metropolitan City has come to have a keen interest in the water industry as well as in global water issues. To further such interests, we annually host the Korea International Water Week (KIWW) and the World Water Cities Forum (WWCF). We have also been seeking to explore solutions to water-related issues facing mankind while forging a cooperative water network with various foreign cities.

Through such measures, we have been steadily making progress towards becoming the hub city for water that can represent the Republic of Korea by developing a global network into the World Water Partnership and capitalising on the Korea Water Cluster (KWC), which is the key infrastructure for the development of sustainable and innovative water technologies, as well as the Korean Institute for Water Technology Certification (KIWATEC).

In this regard, I believe that the World Water Congress has helped publicize the commitment of Daegu Metropolitan City to all these ongoing efforts and provide the necessary momentum to establish cooperative governance for addressing global water challenges in a concerted manner.

Since the successful hosting of the 7th World Water Forum in 2015, we have been reinforcing a global network by holding the World Water Cities Forum (WWCF), which is aimed at sharing water-related technologies and policies between cities from developing countries and those with advanced water industries. 2021 marked its 7th edition and provided participating cities with opportunities to gather collective wisdom, share best practices and offer feasible solutions to those cities with water problems on a hybrid platform. Under its theme of "Water Cities' Cooperation and Innovation," the WWCF strived to expand itself into a cooperative platform for addressing the water problems of cities worldwide by sharing the implementation status of solutions proposed at the forum as well as their tangible results.

The XVII World Water Congress was conducted on a hybrid platform where both on-line and face-to-face participants could mingle and interact together. This kind of hybrid event, which is becoming a new norm in the post-COVID era, is opening new opportunities for expanding our scope of global networking and cooperation. The XVII World Water Congress was no exception. Daegu Metropolitan City was pleased to provide optimal settings for all the participants so that they could make the most of the Congress. I hope everyone had a chance to enjoy the alluring beauty and charm of Daegu.

WELCOME MESSAGES



Message from the President & CEO, K-water

Jae Hyeon Park, President & CEO of K-water; President of the Asia Water Council (AWC)

I would like to express my gratitude for everyone's keen interest in IWRA's XVII World Water Congress, an international event that aimed to solve global water problems, hosted in Daegu, the water-centred city of the Republic of Korea.

In recent years, the importance of water security and resilience has been growing as the demand for water has dramatically increased. This has been due to complex issues, such as drought caused by global warming, population growth, economic development, and the urbanization of developing countries. A severe regional imbalance of water resources exists due to the disproportion between freshwater (accounts for only 0.7 percent of the Earth's water resources) and precipitation which is mostly concentrated in the areas where less than a third of the world's population lives.

The UN World Water Development Report-2014 predicted that 40 percent of the world's population will suffer from severe water shortages by 2025. This crisis is calling on us to take a more integrated view of dealing with water management and to promote international cooperation.

K-water, a co-host organisation of IWRA's XVII World Water Congress, is promoting joint research with the Asia Water Council (AWC) and the UNESCO International Centre for Water Security and Sustainable Management (i-WSSM) on international policies for securing water security and sustainable growth. K-water, as the chair of the AWC, Asia's largest water consultative body, has not only been leading the way in solving global water issues, but it has also been conducting several technology exchanges with foreign water organisations as well.

During IWRA's XVII World Water Congress, K-water shared the outcomes of our collaborative research, successful policies, technologies, and know-how accumulated over the past 50 years, and contributed to finding practical measures for both developing and underdeveloped countries. In addition, we took and developed the outcomes produced by IWRA's XVII World Water Congress to the 2nd Asia International Water Week which was held in Indonesia in October 2021. The goal was to contribute to securing global water security and sustainable growth beyond Asia.

Throughout this Congress, we brought together various ways of cooperation from water stakeholders around the world, to come up with more reasonable and balanced solutions to the water problems. Lastly, I sincerely appreciate all the hard work and devotion that was required for this meaningful event to be successful.

WELCOME MESSAGES



Message from the President, Korea Water Resources Association (KWRA)

Deghyo Bae, President of the KWRA; Professor of Civil and Environmental Engineering, Sejong University

On behalf of the Korea Water Resources Association (KWRA), it was my great pleasure to welcome all to IWRA's XVII World Water Congress, held in Daegu, Korea from November 29th to December 3rd, 2021.

The Congress was held with the central theme, “*Foundations for Global Water Security and Resilience: Knowledge, Technology and Policy*”. This theme highlighted the role of water in sustainable and resilient development. Essential for life and fundamental for social development, water is foundational to sustaining the world. Sustainable development requires not only resources, but also changes that must occur at various levels. These changes require resilience. The key to sustainable and resilient water management lies in innovative technologies as well as social changes implemented by water policies. Consequently, the solutions require contributions from different sectors and disciplines. In this regard, IWRA's XVII World Water Congress acted as a platform to share our visions, knowledge, and experiences across all aspects of sustainable water development and management.

Founded in 1967, KWRA has been promoting the scientific knowledge and leading the policymaking for water resources management in Korea. In doing so, close cooperation with international communities has always been one of the top priorities. KWRA, was very pleased to be able to work in collaboration with the International Water Resources Association, to make every effort for the successful delivery of the XVII World Water Congress.

We were pleased to see that the outcomes of the Congress were fruitful and provided an important step for creating innovative approaches towards sustainable water development and management. We also hope that participants in this Congress were able to enjoy Daegu and its vicinities, where the historic spirit of Korea lives on.

CONGRESS STEERING AND INTERNATIONAL SCIENTIFIC COMMITTEES



The content and thematic structure of the XVII World Water Congress were developed and overseen by a fantastic array of water professionals from around the world. Their dedication, time, effort, and inspiration were invaluable to the success of the World Water Congress.

International Scientific Committee (ISC)

Prof. Gary JONES, Chair, AUSTRALIA, Adjunct Professor with the University of Canberra, Institute of Applied Ecology; Chair of the International Scientific Committee

Prof. Dongil SEO, Deputy Chair/Bureau, KOREA, Professor, Dept. of Environmental Engineering, Chungnam National University

Prof. Henning BJORN LUND, Bureau, AUSTRALIA/DENMARK, Research Professor of Water Management and Policy; Chair of the IWRA Scientific, Technical & Publications Committee

Prof. Kun Yeun HAN, Bureau, KOREA, Professor of Kyungpook National University

Prof., Bureau, MEXICO, National Water Commission of Mexico (CONAGUA)

Dr. No Hyuk PARK, Bureau, KOREA, Chief Research Officer of K-water Research Institute

Mr. Eui-Rak HONG, Bureau, KOREA, Vice Mayor for Economic Affairs of Daegu Metropolitan City

Dr. Abou AMANI, Bureau, NIGER, Director of the Division of Water Resources, UNESCO IHP

Dr. Maria DONOSO, Member, PANAMA, Professor at Florida International University

Dr. Victor Hugo ALCOCER YAMANAKA, Member, MEXICO, Technical Deputy Director General

Dr. Lisa BEUTLER, Member, USA, Principal and Executive Facilitator at Stantec

Prof. Kwang-Ho CHOO, Member, KOREA, Professor in the Department of Environmental Engineering, KNU

Mr. Jean-François DONZIER, Member, FRANCE, General Secretary at International Network of Basin Organisations; Secretary General of Global Alliances for Water & Climate

Ms. Danielle GAILLARD-PICHER, Member, USA/France, Global Coordinator, Water and Climate Processes, Global Water Partnership

Prof. Jun-Haeng HEO, Member, Korea, Chair of the National Organising Committee; Professor of Civil and Environmental Engineering, Yonsei Univ.

Prof. Kazumasa ITO, Member, Japan, Head of Engineering, International Division, CTI; Engineering Visiting professor at Tokyo City University

Dr. Torkil JØNCH CLAUSEN, Member, Denmark, Chair of the Scientific Programme of the World Water Week in Stockholm; Governor of the World Water Council

Prof. DEGHYO BAE, Member, Korea, President of KWRA; Professor in the Department of Civil & Environmental Engineering, Sejong University

Prof. Kyung Soo JUN, Member, Korea, Dean of the Graduate School of Water Resources; Professor in the Department of Civil & Environmental Engineering, Sungkyunkwan University

Prof. Tae Yong JUNG, Member, Korea, Professor of Sustainable Development at Yonsei University Graduate School of International Studies (GSIS)

Prof. Jinyoung JUNG, Member, Korea, Associate Professor at Yeungnam University

Prof. Seong Joon KIM, Member, Korea, Director at Korean Society of Agricultural Engineers; Professor at Konkuk University

Dr. Karin KRCHNAK, Member, USA/Slovakia, Program Manager, 2030 Water Resources Group at World Bank Group

Prof. Soontak LEE, Member, Korea, Distinguished Professor of Hydrology and Water Resources Engineering; President of International Hydrologic Environmental Society

Prof. Yuanyuan LI, Member, China, Vice-President of the General Institute of Water Resources & Hydropower Planning & Design; IWRA Vice-President

Ms. Jae Lim LIM, Member, Korea, Head Researcher at K-water Water Resources Cooperation

Dr. Bindu LOHANI, Member, Nepal, Distinguished Fellow, Emerging Markets Forum; Head of Global Climate Change Practice at Centennial Group

Mr. Takashi FUKUWATARI, Member, Japan, Deputy Secretary General of Japan Water Forum

Dr. Somkiat PRAJUMWONG, Member, Thailand, Director-General of the National Water Resources Office

Dr. Götz REICHERT, Member, Germany, Head of the Department on Environment, Energy, Climate and Transport at the Center for European Policy

Ms. Adelina (Lennie) SANTOS-BORJA, Member, Philippines, Department Manager III - Resource Management and Development Department

Prof. Abdoulaye SENE, Member, Senegal, Co-Chair of the International Steering Committee of the 9th World Water Forum

Dr. Vladimir SMAKHTIN, Member, Russia/Canada, Director of the United Nations University Institute for Water Environment and Health (UNU-INWEH)

Dr. Cecilia TORTAJADA, Member, Mexico/Wales, University of Glasgow

Prof. Chieko UMETSU, Member, Japan, Professor at the Graduate School of Agriculture, Kyoto University

National Organising Committee (NOC)

The local co-hosts, and responsible for the high-level planning for the World Water Congress

Chair:

Jun-Haeng HEO, Chair of the National Organising Committee; Professor of Civil and Environmental Engineering, Yonsei Univ.

Bureau:

Sung Dae LEE, Director General of Innovative Growth Bureau, Daegu Metropolitan City

Yong-kwon SONG, Director of Water Industry and International Cooperation Division, Ministry of Environment

Jong-jin LEE, Vice President and Chief Global Officer (CGO), K-water

Members:

In Jong CHOI, President of Korean Water Cluster Conference

Zuwhan YUN, President of Korea Water Partnership
Il Pyo HONG, Research Fellow, Korea Institute of Civil Engineering and Building Technology
Ik Hun CHOI, Professor, Yonsei University
Jeong Soo LEE, Executive Director, Country Director of Korea Climate & Environment Network
Yoonjin KIM, Executive Director, Korea Water Forum
Ae Sook SUH, Managing Director of Korean Foundation for Quality
Won Sik SHIN, Professor of Department Environment Eng. Kyungpook National University
Kwang Ik SON, Professor, Dept. of Civil Eng. Yeungnam Univ.
Kwan Sue JUNG, Professor. Dept. of Civil Eng. Chungnam Univ.
Hung Soo KIM, Professor, Dept. of Civil Eng. Inha University.
Kyungtaek YUM, Professor, Sungkyunkwan University
Kyung Sook CHOI, Professor, Dept. of Agricultural Civil Engineering Kyungpook National University
Chang Hae LEE, Professor, Daejin University
Dongil SEO, Professor, Dept. of Environmental Engineering, Chungnam National University
Mi Young SONG, Doctor, Gyeonggi Research Institute

Local Organising Committee (LOC)

Responsible for the logistical coordination of the World Water Congress under the guidance of the NOC and in collaboration with the ISC and the IWRA Executive Office.

Chair:

Changsam JEONG, Induk University

Members:

Seungoh LEE, Hongik University

Chang Geun SONG, Incheon University

Younghun JUNG, Kyungpook National University

Taesam LEE, Gyeongsang National University

Hyun-Han KWON, Sejong University

Doosun KANG, Kyunghee University

Giha LEE, Kyungpook National University

Dongkyun KIM, Hongik University

Eun-Sung CHUNG, Seoul National University of Science and Technology

Yeonjoo KIM, Yonsei University

Tae-Woong KIM, Hanyang University

Yong-Won SEO, Yeungnam University

OFFICIAL SPONSORS



Korea Hydro & Nuclear Power Co., Ltd (KHNP) is the largest electric power company in Korea. We generate approximately 29.8% of the total electric power generated in Korea (Dec. 31, 2020/ The Monthly Report on Major Electric Power Statistics). Our mission and pride are represented by the motto, "We supply a stable power source not only to enrich the quality of life but also to provide a foundation for the growth of the national economy".



AXTER is a leading international manufacturer of top-quality waterproofing membranes including reinforced COLETANCHE bituminous geomembranes, widely used in mining and civil engineering applications around the world. **COLETANCHE** is used for dams, water ponds, canal lining, erosion protection, capping of contaminated land and to prevent water from intruding into rail track formations. COLETANCHE is a robust bituminous geomembrane that does not require a protective cover, such as soil or geotextile, and can stay exposed to UV. It is very tough and may be safely covered by large stones without being damaged. It has remarkable dimensional stability, is not affected by changes in temperature and is resistant to wrinkles formation. Its surface mass prevents wind uplift, and it can be sealed under water. Best of all, the number of welding joints is reduced, thanks to the 5.1-meter-wide rolls. COLETANCHE is the No.1 waterproofing solution for civil engineering and mining structures!



Since our foundation in 1973, **TAEYOUNG E&C** has experienced steady growth in all areas of the construction businesses, ranging from construction and civil engineering to plant construction and housing development. Especially, TAEYOUNG E&C boasts the first and most experienced contractor in waterworks and sewage construction in Korea. TAEYOUNG E&C seeks to become an industry leader that delivers outstanding future client value. By striking the right balance between growth and stability while also maintaining principles and integrity, we will strive to be the loved and trusted company our clients know us to be.



Incorporated in 1939, **DL E&C** is a parent company of DL Group, which consists of 13 affiliates. As a leader in the construction sectors in Korea, we provide a wide variety of products and services. Since its first overseas project in Vietnam in 1966, the construction division has successfully completed various construction, civil engineering, and plant projects in more than 40 countries worldwide. It has been recognized for its technical leadership and strong competitiveness in the global market.



Kumho E&C aspires to position itself as a leading company that considers meeting the needs of its customers as its top priority. Our company also intends to make itself a fun workplace where employees can enjoy their work so that they can develop their talents and maximize their capabilities. To that end, it makes efforts to nurture talent, facilitate creative ideation and voluntary participation, and uphold a culture that emphasizes effective communication and respects diversity. Kumho E&C is preparing for its next wave of high growth by focusing on promising areas, especially the water industry, nuclear power plants, and biogas facilities, based on its extensive business know-how and capabilities as well as cutting-edge technologies. We at Kumho E&C always stand firm with humble wisdom and unwavering courage in the face of obstacles and crises. Our most powerful strengths are our action-oriented imagination and spirit of challenge as well as passion to confidence. With this passion, Kumho E&C is committed to becoming a leading general contractor in both domestic and worldwide construction industries. We will do our utmost to meet your expectations.



Youngjin Construction Inc. was founded in 1973 as a civil and architecture company. We hold true to the values of the company and remain fully committed to expertise and customer service under the core vision of “happiness management”, “ethical management”, and “challenge management”. We know that our success in providing quality contracting services has always been dependent on the talent and genuine commitment of our employees. Youngjin Construction Inc. has always tried its best to maintain most of the skilful and experience people who are committed to our company and our clients. Over the decades, we have grown and succeeded in establishing ourselves as one of the most prominent construction firms in the Korean Construction Industry, performing Civil, Building, Landscape, Renewable Energy and Electrical works. We have expanded our company and extended our international construction market, with branch offices in Uganda and East Timor and two subsidiary companies in Poland and Vietnam. We believe that the attention to details established over the years in our construction market will help us to bring a greater level of service and expertise to the civil and building construction market. Our completed projects are always available on our website for review. We look forward to getting to know you and work with you.



Established in 1952, **Hanwha** provides new and distinguishing products and services in manufacturing, engineering, and construction, finance, and service and leisure fields with 56 domestic affiliates and other 249 global networks. Pioneering new business areas, Hanwha has been celebrating continued growth, and is taking up the challenges for better human life by gearing up with distinguished competitiveness in solar energy, defense, and petrochemical industries.



We have significantly contributed to upgrading the civil engineering and construction technology in Korea. **KOLON Global Corporation** has successfully completed major civil construction works such as highways, subways, bridges, industrial complexes, land development and SOC projects and has been recognized as a high-tech company. We have successfully constructed the 4.6 km long Jukryeong tunnel (the longest road tunnel in Korea), Misiryeong Tunnel, Incheon International Airport Highway, and Seoul Outer Ring Highway. In addition, we have top-notch technologies and methods, including TBM, NATM under-peening and TSP. On the other hand, KGC is engaged with wind power business in the field of renewable energy. We plan to expand the business to marine wind power generation based on projects like the Gyeongju wind power plant, Yangyang wind power plant, Taebak Gadeok Mountain wind power plant.



Established in 1947, **Hyundai E&C**, as a representative construction company, has driven the globalization of the Korean construction industry as a key player in the economic development of Korea. Hyundai E&C incorporates its profound expertise and experience from countless global projects with technology innovation to carry out civil engineering, architecture, housing, plant engineering, power plants, energy plants, and nuclear power plant projects for higher customer satisfaction. We will continue to lead the industry in providing customized solutions with creative and out-of-the-box thinking as we remain agile in the changing market environment. We will break away from the traditional construction-oriented business structure to offer total engineering solutions encompassing designing, engineering, and operations. By venturing into new markets overseas, and establishing an optimized management infrastructure, we will pursue the diversification of overseas projects and become a global EPCM company that leads the construction business worldwide.



GS E&C has established its status as a top-ranking company domestically since its foundation in 1969 by achieving tremendous growth in the fields of architecture, civil engineering, housing, plant, environment, and power plant. Through continuous development of its human resources, acquisition of technologies, determined challenges and practices, GS E&C has set forth the steppingstones to leap as a Global Leading Company. As we continue to pursue global competency of our core business, GS E&C will continue its stable growth through systematic risk management and substantial management. GS E&C promises to devote ourselves to management with utmost priority in customer's value.



Since its establishment, **Ssangyong Engineering & Construction** has taken the initiative to create convenient and enriching homes for people. Based on the corporate philosophy, 'Quality Comes First', the company is committed to providing the maximum customer satisfaction. Ssangyong E&C has established its reputation as one of the top high-end construction companies in Korea by

building over 16,000 rooms in high-end luxurious hotels, including "Marina Bay Sands," known as the landmark of Singapore and 'the miracle of the 21st century.' It also built state-of-the-art hospitals with a total of 12,000 beds, along with other numerous luxury accommodations and intelligent buildings. As for advanced civil engineering projects, Ssangyong E&C is leading the way in the construction of roads, subways, bridges, and tunnels. For the construction of Singapore's Marina Coastal Expressway and Downtown Line (DTL), the company has recorded 10 million and 16.75 million accident-free man-hours, respectively.



Daewoo E&C has been a leader in the construction industry in South Korea since its founding in 1973, realising the best value for its customers through its dedication to change and its passion for innovation. Daewoo E&C is recognized as a world-renowned global construction company, and aims to be a Global Top 20 company by 2025. Our wide range of businesses

includes infrastructures, industrial facilities (including oil and gas plants), skyscrapers, and other buildings. We are also dedicated to leading the Fourth Industrial Revolution through the development of new and exciting technologies. We are committed to IT-based research and development, as well as an expansion into new business areas, creating the highest possible enterprise value and a better future for people everywhere.



Since its foundation in 1968, **SAMAN** is a No. 1 multidisciplinary engineering firm in Korea. Our excellence has been proven in many of the major domestic and international construction and development projects. SAMAN has led Korean construction engineering in the fields of Water Supply and Sewerage, Water Resources and Hydro Power, Railroad and Subway, Harbor and Coastal, Highway

and Airport, Urban Planning, Environment, and Transportation. SAMAN is also active in the planning, designing, and supervising of many infrastructure projects, and is funded by public and private agencies as well as by the Multilateral Development Bank (MDB).



Established in August 2017, **DAHIM E&C** has secured a continuous growth engine that leads the field of the structural framework based on our experiences and constant technological innovation. In addition, we have introduced Building Information Modelling (BIM), a new platform for the construction industry in the era of the 4th industrial revolution, and actively invested in the informatization of the construction. Through this, we have secured unique technology in the

field of structural framework. We are now reborn as a company most suitable for the information society. Going forward, DAHIM E&C will be committed to emerging as a professional company that leads the construction industry in the information society.



Established in 2002, **HASONG Construction Inc.** has been steadily growing in business areas such as civil engineering, architecture, and real estate development. HASONG Construction Inc. is creating new values and construction services based on the management ideology of “think ahead, bright future” and contributed to by the know-how accumulated in various business fields. HASONG Construction Inc. will try to lead a transparent construction culture through social responsibility management and a corporate culture faithful to the basics.



Lumirite Water Korea Co., Ltd. is preparing for a new leap forward with pure domestic technology and striving to develop more differentiated technology and talent for more creative management. We will develop into a company that contributes to environmental protections and preservation and enables the promotion of natural purification capabilities through the domestic distribution of technologies and materials

that is pursuing the ecological restoration and the improvement of the water quality of dams, lakes, and rivers. Our company promises to always do its best to become a leader in all areas of the environmental industry, including water environment improvement and aquatic ecological restoration projects.



Daechang Inc. was founded in 1995 as a Manufacturing of Pre-cast Concrete company. Daechang has successfully completed major Pre-cast Concrete works such as Water supply, Sewage, highways, subways, bridges, industrial complexes, land development and SOC projects. Our company is striving for research and development to focus on humans

and the environment and respond quickly to customer needs. We are doing our best today for the high added value of concrete products.



Founded in 1988, **Godeok Construction Co.** has grown rapidly to include electrical construction, firefighting system installation works, information and communications construction, housing construction, landscaping works, industrial and environmental equipment construction, and overseas construction business. Godeok Construction Co., Ltd. led Korea’s architectural

luxury for eco-friendly architecture, informatization architecture, and high-tech architecture and won the Minister of Public Safety and Security’s citation, the Fair-Trade Commission’s citation, and construction day Industrial Service Medal. All executives and employees are leading the future-oriented architectural culture of customer satisfaction based on the quality management system and are striving to secure transparency in management and expand social contribution activities through ethical management.



Established in 1991, **SOOSUNG** is a top-tier civil engineering consulting firm providing a full range of consultancy services in domestic as well as overseas countries. SOOSUNG is one of the most preferred firms by the Government Agencies and Project Developers for providing highly reliable and quality guaranteed services. We have completed over 4,000 projects, a record across the globe. SOOSUNG has achieved an immense track record in not only

providing engineering services but also managing civil works contracts under the FIDIC Conditions of Contract for projects funded by MDBs (ADB, WB, EBRD, AIIB, AfDB, CABEL). Through our outstanding technical competence, SOOSUNG has recently been listed as one of Top 225 International Design Firms of ENR in 2021.

DASAN CONSULTANTS

Dasan Consultants is a construction engineering company established in 1993.

It carries out planning, design, construction supervision & management, as well as safety diagnosis in the fields of transportation, water & environment, land development, and energy & plant. DASAN proves its technical competence

through its experiences more than 2,000 projects in 40 countries and has been successfully working with various clients and international financial institutions. Through continuous research and development of engineering technologies, DASAN was honoured with the "Civil Engineering Grand Prize" in 2011, 2016 and 2020, and it was awarded the "Presidential Award" for the excellent completion of the Cheonsa Bridge in 2020.



DOHWA Engineering Co., LTD. is South Korea's top-ranked multi-disciplinary engineering consulting firm. DOHWA Engineering Co., LTD., is the Number 1 ranking multi-disciplinary engineering consulting firm in South Korea that provides Planning, Feasibility Studies, Design, Analysis, Testing, Supervision, Commissioning, Evaluation/Assessment, and Consulting and Training Services

in all areas of Engineering such as the Water Supply and Wastewater Treatment, Water Resources Management, Urban Planning, Road Traffic, Structures, Harbor and Ports, Rail, Environmental Engineering, etc. DOHWA is also expanding its business to become the EPC services provider covering Design and Supervision as well as the Design of Constructions, Procurement and Supply of Materials, Construction Works, Commissioning, Permits, and Licenses, etc. DOHWA is a global engineering company that has been the first-of-its-kind in Korea and is exceeding expectations by providing the best engineering services to bring about a brighter future.



Core Institute of Hydrological Survey Making Safe, Clear and Nature-minded Water. As a public institute specialized in the hydrological survey, the Korea Institute of Hydrological Survey (KIHS) focuses on processing and analysing the national data on water resources like streamflow, sediment, evapotranspiration,

and soil moisture. Moreover, KIHS strives to develop water-related technologies. Through our tasks, we have improved public water welfare by mitigating the floods damage and stabilising supply of clear water.

EXHIBITOR LIST

Exhibitors

Axter Coletanche
 Yooil Engineering
 Jeong Woo Coupling Co. Ltd.
 ATT Co., Ltd.
 Coogy
 Daesan Co., Ltd.
 UNESCO i-WSSM
 IWRA
 Edison
 Daegu Metropolitan City -Dytec
 ESSA Co., Ltd.
 KED Co., Ltd.
 SC Solution Global Co., Ltd.
 Enertork Co., Ltd.
 KIWATEC
 Daegu Metropolitan City Government
 Ecoset
 Suntech Engineering Co., Ltd.
 Korea Water Cluster
 Water Lounge
 K-water
 Korea Fluid Technology Co. Ltd.
 Green Tech Co. Ltd.
 Midni Co., Ltd.
 SSENG Co., Ltd.
 Dong Hae Co., Ltd.
 JAINTECHNOLOGY
 Waterworks Headquarters Daegu Metropolitan City
 J. Tech Korea Co. Ltd.
 Kisan Machinery
 Daesung Tech
 Daegu Environmental Corporation
 Taeyoung Filtration System Co., Ltd.
 Youngwoo Science
 Judokorea Co., Ltd.
 Tap Water Public Relations Association
 Michigan Technology Co., Ltd.
 Iorex Co., Ltd.
 Taejung Industry Co., Ltd.
 Korea Green Resource
 SMFAB Co., Ltd.
 Excellent Products and Technologies in Water Industry

OPENING CEREMONY

DATE: 29 NOVEMBER 2021, 9:30-11:30

VENUE: 5F, AUDITORIUM, EXCO



Welcome Remarks

Gabriel Eckstein, President, International Water Resources Association

Deghyo Bae, President, Korean Water Resources Association

Hong Jeong Kee, Vice Minister, Korean Ministry of the Environment

Kwon Young-jin, Mayor of Daegu, Daegu Metropolitan City

Jae Hyeon Park, President & CEO, K-water

High Level Speakers

H.E Serigne Mbaye Thiam, Minister of Water and Sanitation, Republic of Senegal

Virginijus Sinkevičius, European Commissioner for the Environment, European Union (rec)

H.E. Mr. TIAN Xuebin, Vice Minister, Chinese Ministry of Water Resources (rec)

Gilbert F. Hougbo, Chair, UN-Water President, International Fund for Agriculture Development (rec)

Armida Salsiah, Under-Secretary-General, United Nations / Executive Secretary, UN-ESCAP (rec)

Loïc Fauchon, President, World Water Council

Aziza Akhmouch, Head of Cities, Urban Policies and Sustainable Development, OECD (rec)

Sasha Koo Oshima, Deputy Director, Land and Water Division, FAO (rec)

Jennifer Sara, Global Director, Water Global Practice, World Bank

Shin Bongwoo, Director, UNESCO i-WSSM

World Water Envoys

Georgina Mukwirimba (Zimbabwe) – Water Supply

Deepesh Jain (India) – Safety water and sanitation

Maria Almonte (Dominican Rep.) – Urban river management

Bayan Khalaf (Palestine) – Agrochemical pollution

Pallavi Pokharel (Nepal) – Groundwater pollution

Gary Jones, Chair, International Scientific Committee, XVII Congress

Session Summary

Under the theme, “*Foundations for Global Water Security and Resilience: Knowledge, Technology and Policy*”, and with a focus on resilience and the need to provide solutions to respond to raising challenges, the Opening Ceremony of the XVII World Water Congress of the International Water Resources Association (IWRA) counted with the presence of national authorities, experts from all continents and international organisations. These included the Ministry of Environment of Korea, as well as representatives from FAO, IFAD, the World Bank, OECD, UNESCO, ESCAP, the World Water Council, and the European Union, among others.

Introduced by IWRA President, **Mr. Gabriel Eckstein**, **Mr. Jeong Kee Hong**, Vice Minister of Environment of Korea, stressed the relevant momentum given by the recent COP26 and the upcoming 9th World Water Forum taking place in Dakar in March 2022. An aspect underlined by most invitees to the Opening was the level of expertise of the Congress. That was also emphasized by the President of K-Water, **Mr. Jaehyun Park**, who highlighted the uniqueness of the event in convening water experts from water, sanitation, hydrology, climate, and agriculture, among other disciplines.

Virginijus Sinkevičius, European Commissioner for the Environment, Oceans, and Fisheries participated in the Opening of the seventeenth edition of the IWRA World Water Congress, where he called to intensify efforts in building a bigger body of knowledge about water resilience. “*Biodiversity, food, energy, and climate - they all come back to water. To understand the interconnections, we need more research and innovation. They will help us to develop the tools and rules we need as well as the solutions we need to deliver lasting change,*” he stated.

The need to put technology and innovation at the core of water resources management was underlined by **Gilbert F. Hounbo**, President of the International Fund for Agricultural Development (IFAD) and Chair of UN-Water. As he mentioned, the pandemic is teaching humanity a lesson. Nature-based solutions and carbon reduction were identified as key paths for advancing towards the progress around SDG6. Reinforcing this approach, **Ms. Armida Salsiah Alisjahbana**, Under-Secretary-General of the United Nations and Executive Secretary of ESCAP, focused on building back better to address biological hazards.

HIGH-LEVEL PANELS

In addition to the Opening Ceremony, Closing Ceremony and Awards Ceremony, a total of three High-Level Panels and one special plenary session were held during the XVII World Water Congress. These plenary sessions were a chance to bring attendees together to listen and ask questions of invited high-level international expert panels on the following topics:

High-Level Panel 1: 50 Years of Water Resource Management–Past, Present, and Future

AUDITORIUM, 5F, EXCO

09:00-10:00, 30 NOVEMBER 2021



Summary

The first High-Level Panel included **Gabriel Eckstein**, IWRA President, **Lesha Witmer**, Advocacy Manager at the Women for Water Partnership, **Yoonjin Kim**, Planning Director at the Korea Water Forum, **Bassel Daher**, Assistant Research Scientist at the Texas A&M Energy Institute and Adjunct Assistant Professor at Texas A&M, and **Georgina Mukwirimba**, IWRA's World Water Envoy from Zimbabwe. The session's introduction was facilitated by **James Nickum**, Editor-in-Chief of IWRA and explored both the water challenges we will face in the coming 50 years and how IWRA hopes to address them.

Under that prism, the relevance of working in partnership was emphasized together with the contribution of IWRA in advancing issues such as water insecurity and in building relevant knowledge through research work and policy briefs as well as capacity building. For **Gabriel Eckstein**, IWRA President, *"the SDGs are surrounded by unpredictability; they are not milestones that can be achievable in a timeline manner, especially when we face new challenges such as water quality and availability."*

The need to open opportunities for vocational training on water-related topics was especially underlined by **Lesha Witmer**, from Women for Water Partnership, who stated that despite the advances around technology, there is still lack of qualified people to capitalize that: *"Qualified people are out there but they are not being hired. There is a huge lack of qualified people in the water sector,"* she said. The water and energy nexus was underlined by **Ms. Witmer** as one of the debates that needs to be addressed.

Following similar arguments, **Yoonjin Kim**, from the Korea Water Forum, mentioned the unique role of IWRA and how it differs from the rest of organisations dealing with water management. *“The interface between science technology and policy is the key function IWRA provides,”* he said. He mentioned the need to incorporate carbon neutrality at the core of water-related actions. **Bassel Daher**, from the Texas A&M Energy Institute, mentioned the raising challenges witnessed through the COVID-19 pandemic which obliges us to establish an interconnection between water, resilience, and other sectors. Due to this, *“there is not a single discipline or sector that can address these challenges alone; there is a need for heightened collaboration as well as for channelled investment to enable the development that cuts across these disciplines in order to allow a higher level of harmonization and coordinated planning,”* he explained.

The High-Level panel was closed by **Georgina Mukwirimba**, IWRA’s World Water Envoy from Zimbabwe, who said that *“Africa cannot afford to undergo a transformation that cities in Europe or Australia can afford to do. Under this assumption, population growth constitutes a big challenge. Solutions are outside of the water sector and outside of our reach; governments, the food sector, and other policy makers play a central role.”* As for the role that the youth can play, she mentioned that *“Youth should be involved in the planning stages and implementation around water.”*

High-Level Panel 2: Multi-Stakeholder Science and Policy Dialogue to Support Implementation of Sustainable Development Goals

AUDITORIUM, 5F, EXCO

09:00–10:00, 1 DECEMBER 2021



Summary

The second High-Level Panel was moderated by **Rabi Mohtar**, Chair of the Awards Committee at IWRA and Dean at the Faculty of Agricultural and Food Sciences in the American University of Beirut (FAFS-AUB) and TEES Research Professor at Texas A&M University who initiated the discussion around the role of science in supporting policy decisions in specific countries, like Senegal.

As underlined in the panel by **Abdoulaye Sene**, Executive Secretary and Co-Chairman of the Preparatory Committee for the Organisation of the 9th World Water Forum (Dakar, March 2022), Senegal is a pioneering country in Africa known for the management of transboundary rivers and water management due to the support of partners from the sanitation field and from the reforms aimed at attracting public private partnerships (PPPs). Under that approach, quality and access to water have been at the core of policy decisions. In 2020, access to drinking water was estimated to 96% compared to 82% in the past.

The difference is significantly higher in rural areas where this figure has reached 98% compared to 88% in the past. One of the key initiatives presented in the panel was the National Blue Fund, an example of multi-stakeholder partnership that has been based on the scientific vision. Another approach underlined was constituted by platforms of coordination that include the private sector, civil society entities and all ministries related to water. As for the future, capacity building and the establishment of a doctoral school on water and water quality at the University of Senegal were highlighted as mayor objectives.

Nara Lee, Partnership and Liaison Officer and Assistant FAO Representative in Korea, addressed the role that the SDGs are playing in decision making as well as in capacity building and technical expertise. About the contribution of FAO to SDG6, **Nara Lee** mentioned the provision of water data and information for better decision making, which is an important tool for supporting members in reducing water stress and increasing water efficiency. The relevance of innovation and more effective governance systems including innovative financing, access to quality water and sustainable management, and increased investment in water infrastructure were also underlined.

Jong-jin Lee, Vice-President and Chief Global Officer at K-water addressed the need to advance towards carbon neutrality. *"We would like to join the international trends on SDGs, as we decided to implement ESG elements in K-water work complying to international measures,"* he stated. Regarding innovative approaches, he mentioned the relevance of digital technology to establish smart water management tools in Korea as well as renewable energies. Partnerships were also mentioned as one of the needed approaches, and the example of the agreement with the Government of Pakistan was showcased.

Bassel Daher, Assistant Research Scientist from Texas A&M underlined the role of the SDGs as a roadmap for governments to achieve sustainable development and commented on specific experiences focusing on SDG6, SDG2, SDG 7. In particular, he presented the case study of Morocco, Lebanon, and US, highlighting the need to bring different stakeholders into the discussion.

Raya Stephan, IWRA Board Member and Deputy Editor-in-Chief at *Water International*. Commented that *"some countries have created mechanisms and committees on water, but they are not functioning."* Miscoordination, lack of financial mechanisms, and the inclusion of multiple stakeholders were mentioned as strategies for avoiding these situations. The way forward is to open opportunities to foster public-private partnerships, such as the role of UN Global Compact. Under that theme, the role of IWRA to facilitate partnerships between the private sector and academia was underlined by the panellists.

High-Level Panel 3: Water Related Data, Technology and Capacity Building for Developing Countries

AUDITORIUM, 5F, EXCO

09:00-10:00, 2 DECEMBER 2021

Summary

The acceleration of the information age and our capacity to harness data and technologies is impacting the way that humans can understand and implement solutions in water resources management. The current trends in data, artificial intelligence, connectivity, remote sensing, real-time access, and modelling give rise to opportunities for improving decision making. Opportunities to work at impactful scales with a widening variety of stakeholders and platforms, including innovations and entrepreneurship are augmenting our data and technological potential. Data harmonisation, inter-operability and our ability to interpret and utilise information in a concrete manner from national sources as well as the multitude of potentially useful other sources remains an important challenge. In addition, a key limitation in developing countries remains the continuing lack of basic water resources data.



Despite the steady and rapid rise of Information and Communications Technologies uptake on a global level, developing countries still lag far behind. The digital divide and appropriate data technologies remain an important problem that is further exacerbated by insufficiencies in capacity to collect, assess, use, and share the necessary data to enable improved outcomes for safe water supply, sanitation, and society's ability to sustainably harness water resources to drive socio-economic development. New opportunities are created through emerging technologies and a new, unified, data policy of the World Meteorological Organisation (to be approved by WMO Congress in October 2021), without forgetting the Water and Climate coalition in the framework of the SDG 6 accelerator.

Special Panel: Roles, Values, and Expectations in the Modern World

DATE: 2 DECEMBER 2021, 14:30-16:00

VENUE: 5F, AUDITORIUM, EXCO

Summary

Led by IWRA President, **Gabriel Eckstein**, this session brought together leaders from different international water organisations to discuss ways that they can work more closely together to increase their joint impact in improving the way water resources are managed around the world.

In recent years, membership associations, including those in the water space, have had to adjust their operations and activities in response to various factors, most notably the information age. In fact, the value of some associations has been called into question given that data and information is now so readily available via the Internet, and in-person conferences and discrete, hard-bound publications are being replaced by email exchanges, Skype calls, Zoom chats, open access publishing, online resource databases, and more. That said, what is the role and value of membership associations, specifically water-focused associations, in this new age? What value and benefits do these organisations offer their members, and how might they adapt to the new realities to ensure that they stay relevant? This session featured various leaders from some of the top water-focused membership associations globally. The discussion panel facilitated conversation between the panellists as well as with the audience.

THE DAEGU DECLARATION: A DECISIVE RESULT



The most evident representation of the generated commitment and the multi-stakeholder engagement at the IWRA World Water Congress was the [Daegu Declaration](#). The Declaration reflects the urgent need for dialogue and coordination across different disciplines and sectors to address complex water challenges, not only in connection with sanitation and hygiene but also with the sustainable management of water resources and aquatic ecosystems.

Five themes are addressed in the Declaration as critical for achieving global water security and resilience:

- 1) Disseminate Nature Based Solutions, together with the mainstreaming of public policies dedicated to water resources management and biodiversity preservation.
- 2) Reinforce IWRM and river basin approaches, with good and shared governance, including for transboundary resources, as effective tools for peace and sustainable development.
- 3) Support solutions for productive and sustainable agriculture, respectful of soil health and its interdependence with water needs.
- 4) Improve coordination between scientists and educators to empower future generations with the right knowledge and tools.
- 5) Institutionalize the engagement of youth and early career professionals, through developing programs that reflect a long-term vision and commitment to including them as partners in the process.

In addition to these five overarching themes, the Daegu Declaration proposes a call for action involving:

- Political leaders to leverage and to integrate water debates in the international policy agenda
- The scientific community to advance on the interlinkage between water security and ecological security so that Water should be jointly addressed at the same level of priority as biodiversity and climate change in the international and national levels.
- Youth that should take ownership of the intergenerational responsibility to tackle current challenges and to develop cooperation projects, cross-sectoral approaches, and to contribute beyond the conventional ways.
- The 9th World Water Forum in Dakar: to embrace the importance of systems thinking and breaking down disciplinary and institutional silos as it promotes future pathways and innovative responses that ensure the sustainability and resilience of the water sector.
- The UN 2023 Water Conference to accelerate the implementation of the SDGs around water security, something that requires strong cooperation between States, especially in the context of transboundary water management, through joint institutions and operational legal instruments.
- IWRA Board to reflect and to revise their vision and strategy to better support the momentum towards improved cooperation for coherent policies and strategies.

The Daegu Declaration was signed by **Prof. Gabriel Eckstein**, President, IWRA, **HaeYong Jeong**, Vice Mayor, Daegu Metropolitan City, and **Jun-Haeng Heo**, Chair of the National Organising Committee for the Congress (NOC).

[Read the full version of the Daegu Declaration and pledge your commitment.](#)

SELECTED HIGHLIGHTS FROM THE PROGRAMME

Collective action to achieve Water Security Peace and Development for the 9th World Water Forum



The session on “*Collective action to achieve Water Security Peace and Development for the 9th World Water Forum*” discussed the prospects of the 9th World Water Forum in Dakar, Senegal along with its key agendas and activities. The World Water Forum event is set to focus on inclusivity, stakeholder responsibility and interlinkage between the water, climate, and technology nexus. It was aimed to also include the key reflections from the World Water Congress 2021. The speakers and presenters highlighted the themes, logistics, deliverables, and working forces embodied under the theme of hydro-diplomacy and cooperation for regional integration.

The World Water Forum is a dynamic platform for the expression and exchange between local stakeholders and global stakeholders. The Forum plans on dividing into 92 sessions along with action groups that further work to implement the theme of water and sanitation in this week-long event. The main themes of the Forum, however, shall revolve around ecosystem protection and restoration, implementation of right to water security and sanitation, resilience building among the vulnerable population, and adaptation capacity in line with the climate change crisis.

One key aspect discussed in the Forum was the ‘promotion of cooperation’, which was in parallel to conflict prevention. The Forum aimed to contribute to the management of cross-boundary conflicts of river basins and build a cross-sectoral bridge between technology and governance. Finally, the forum planned to end by revising and refining the projects discussed in the sessions.

The 9th World Water Forum in Dakar, Senegal was prepared to host multi-national stakeholders and bring them together to solve the gravest issues of water security and conflict. The Forum was the largest of its kind with a strong focus on implementation and cooperation.

Speakers

H.E. Minister, Serigne Mbaye Thiam, Minister of Water Resources and Sanitation of Senegal

Mohamed Diatta, Executive Secretariat of the 9th Forum

Abdoulaye Sene, Co-chair of the International Steering Committee of the Forum

Ailoune Kane, University of Dakar, Senegal

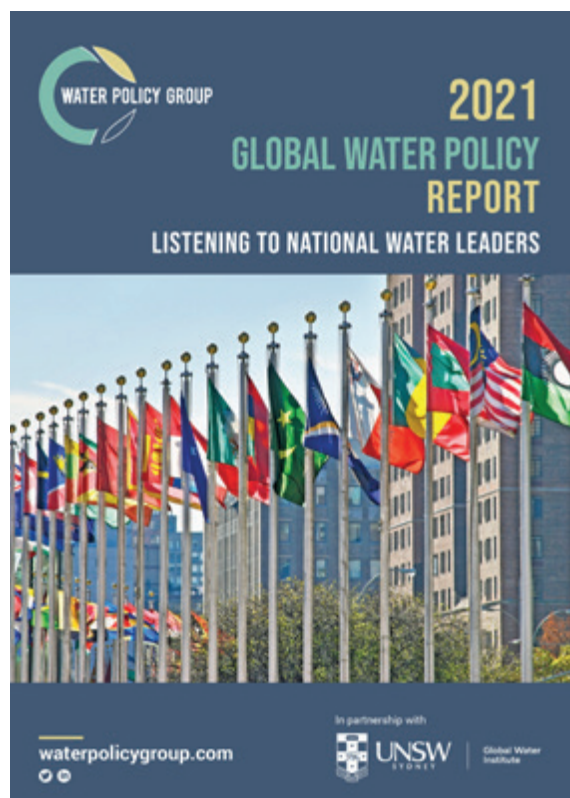
Rabi Mohtar, AUB, TAMU, USA

Yoojin Kim, Korea Water Forum

Aziza Akhmouch, OECD

Patrick Lavarde, Co-chair of the International Steering Committee of the Forum

Water Policy Report 2021 Launch



The session was the official launch of Global Water Policy Report published by the Water Policy Group in France. In partnership with the University of New South Wales's Global Water Institute, the 2021 Water Leaders Survey collected information on the key social, political, financial, and structural barriers inhibiting better progress on water—as identified by the officials and leaders charged with responsibility for water management. The outcome of this exercise is published in this final report.

Findings of the survey were introduced to session participants, which provided insight into :

- The greatest water risks and challenges faced by countries;
- The difficulties in achieving Sustainable Development Goal 6 on water and sanitation for all; and
- The pertinence of the Global Acceleration Framework.

The survey received input from 88 countries looking at the water security challenges during the COVID19 pandemic. Echoing the discussions at the UN Climate Change Conference in Glasgow / COP26, the financing of water management in low income or middle-income countries was identified as a key challenge.

Another area that surfaced in the research was about water governance. Transboundary groundwater is a major challenge

today because of the unusual abstraction of groundwater in arid and semi-arid regions. In Senegal, for example, water security, sanitation, and integrated water resources management is an important area of focus by Senegalese policy makers.

One of the main conclusions from the research is that the policymaker or the water manager should aim to take progressive decisions that minimize future impacts for low-income countries. It was noted that these are often the same countries where groundwater abstraction is a major issue and the authorities in those countries should put in place proper governance and regulatory policy frameworks.

Speakers

Tom Soo, Water Policy Group, France

Oyun Sanjaa, Director of External Affairs, Green Climate Fund

Mercedes Castro, CEO, Agualimpia, Peru

Design Naidoo, Climate Commissioner, South Africa, Former CEO, Water Research Commission

50th Anniversary of the International Water Resources Association (IWRA)



IWRA's XVII World Water Congress coincided with a landmark in the history of the Association: its 50th anniversary. A symbolic celebration was conducted during the first day of the Congress in which some of the IWRA Executive Board Members met around a birthday cake.

Together with the 50th Anniversary Reception celebrated at the World Water Congress, the IWRA 50th Anniversary Committee and the IWRA Awards Committee organised a series of interviews, included the theme under Water International, the official journal of IWRA, and the 50th Anniversary Awards.

The 50th anniversary served to remember the achievements, challenges, and efforts of the Association since its founding in 1971. Over the last 50 years, IWRA has built its expertise around a unique multidisciplinary forum for the water sector through publications, events, and projects.

By the time of the XVII World Water Congress, IWRA had increased its membership to more than 2 000 members from over 120 countries and has hosted partnerships of different nature. In that regard, specific mention was done to the Online Conference held in 2020 and 2021, respectively, with the support of UNESCO and FAO.

In the recent past, IWRA has also worked with the UNESCO, FAO, OECD, SIWI, the World Water Council, and K-Water, among others, as well as with a long list of reputable higher education institutions.

Capacity building activities have channelled the commitment of many water experts engaged in the work of IWRA. Of specific mention is the Master Class series on Water Diplomacy and Cooperation, a joint initiative launched in 2021 with the Universities Partnership for Water Cooperation and Diplomacy and the invaluable support of key institutions such as the IHE Delft Institute for Water Education, **Léna Salamé**, from the Geneva Water Hub, and **Aaron Wolf**, Professor of Geography at the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University (OSU).

The UNESCO-IWRA Partnership



Another milestone resulting from the World Water Congress in Korea has been the extension of the partnership undersigned between IWRA and the UNESCO International Centre for Water Security and Sustainable Management (i-WSSM)

IWRA President, **Gabriel Eckstein**, and **Bongwoo Shin**, Director at the UNESCO i-WSSM -International Centre for Water Security and Sustainable Management, reminded participants of the partnership between both institutions that commenced in 2018; they met in Daegu to formally extend the agreement until 2023.

The Global Water Security Issues (GWSI) is a collection of case studies published annually focusing on different aspects of Water Security. IWRA has been a leading partner with i-WSSM on this project since the start of the second edition, which focussed on “*Water Reuse within a Circular Economy Context*” and continued with the recently published third issue which focused on “*The role of sound groundwater resources management and governance to achieve water security*”. The Fourth issue on “*Water Security and Cities – Integrated Urban Water Management*” will be released in 2022.

The signing ceremony was followed by a session held with UNESCO i-WSSM to present some of the new case studies in this recently published third issue, including:

- Drivers for Collective Groundwater Management: The Case of Copiapó, Chile (**Elisa Blanco**, Pontificia Universidad Católica de Chile, Chile)
- Conservation, Protection, and Management of Urban Groundwater through City Master Plans: A Case of Indian Cities (**Lovlesh Sharma**, National Institute of Urban Affairs, India)
- Transboundary Groundwater, Peace, and Security: Opportunities and challenges in Central America (**Maureen Walschot**, Université Catholique de Louvain and the University of Haifa, Belgium)
- Groundwater Quality, Pollution Control, and Climate Change (**Malcolm J. Gander**, Department of Defence, United States).

In the spirit of the newly signed agreement, both organisations launched the call for abstracts for the fifth issue of GWSI, which will address “*Making Decisions for Climate Adaptation*”.

IWRA WORLD WATER ENVOYS



One of the most innovative components of the XVII World Water Congress was the introduction of the World Water Envoys. Youth have been traditionally identified not only as key drivers and contributors to address climate change and water security, but also as a highly vulnerable segment of our societies. IWRA and the congress co-hosts wanted to hear stories from representatives of the next generation and give them a chance to showcase the issues they face when it comes to Water Security during the XVII World Water Congress in Korea. The five selected representatives were called “World Water Envoys”.

The World Water Envoys were selected through a global competition, where applicants had to send a short video describing the water insecurity issue faced by their community and provide an “iconic” photo that portrays the issue. Following a selection process that included multiple interviews, five individuals were selected to come to Daegu and represent their communities.

XVII Congress IWRA World Water Envoys

Georgina Mukwirimba – Zimbabwe

Georgina focuses on the economics of water supply in cities in the context of Zimbabwe. She was doing an internship at UNESCO in Harare and was working on the “City Blueprint” programme.



Deepesh Jain – India

Deepesh focuses on the right to water and sanitation in slums in India. He has a Master's degree in Water Policy and Governance, worked with the Indian Sanitation Coalition, and worked on installing temporary toilets during giant pilgrim gatherings similar to Kumbh Mela.



Maria Almonte – Dominican Republic

Maria focuses on urban river management, specifically on the recent contamination of a river in Santo Domingo, leading to severe health problems in her neighbourhood, such as dengue fever. She sees education and awareness-raising around waste and water management as a key priority for her community. Maria finished her undergrad in civil engineering.



Bayan Khalaf – Palestine, West Bank

Bayan focuses on agrochemical pollution in Palestine, in rural areas, due to intensive uses of pesticides, which have had a big impact on people's health. Bayan was completing a PhD in Germany on the topic and is very passionate about the subject.



Pallavi Pokharel – Nepal

Pallavi focuses on groundwater pollution in the city of Kathmandu, Nepal, where 90% of people depend on groundwater that is contaminated with arsenic, chemicals, and viruses. Pallavi understands well the multifactorial complexity of the situation and is very eloquent. She finished her undergrad in environmental science.



Summary

During the opening ceremony of the Congress, the World Water Envoys had the opportunity to talk briefly about their water security challenge and its impacts on everyday life. They then discussed the issues in more detail with experts attending the Congress during a special session workshop. They presented the main things they learned from their interactions with water experts at the World Water Congress during the Closing Ceremony, highlighting the connections they made that might help their community to overcome its water security challenge.

The Envoys programme is unique, as it gives an opportunity to young people that are not necessarily from the water world to become the ambassadors of their communities, to meet with international water experts, raise the profile of the water issues their communities face, and hopefully bring some concrete solution back to where they live. The Congress marked only the beginning of IWRA's relationship with the World Water Envoys, as they went on to attend the 9th World Water Forum and will continue to work with IWRA through Task Forces and with the next round of World Water Envoys as the programme will be repeated.

IWRA AWARDS



Since its creation, IWRA recognises the contributions made towards water management and the excellence of water researchers, professionals, and organisations. IWRA presents 5 main awards.

Crystal Drop Award

The Crystal Drop Award is provided to organisations or individuals in recognition of their laudable contributions to the improvement of the world's water situation. These contributions may be through path breaking research on water issues, practice in water management or governance, knowledge transfer or dissemination, and/or outstanding contributions. The Crystal Drop is awarded at each IWRA World Water Congress.

The 2020 recipient of the Crystal Drop Award was Prof. Doğan Altınbilek.

Prof. Doğan Altınbilek is an Emeritus Professor of Water Resources Engineering at Civil Engineering Department of Middle East Technical University, Ankara, Turkey. Prof. Doğan Altınbilek is an Honorary Member and the Past President (2013-2015) and Past Vice President (2007-2019) of the International Water Resources Association (IWRA). In addition, he served as a Governor (2006-2018) and Vice President (2012-2018) of World Water Council (WWC) where he continues to serve as an Honorary Governor.

Previous Recipients

2017: **Hilda Cecilia Tortajada Quiroz** and **Salman M. A. Salman**

2015: **Vijay P. Singh**

2011: **International Water Management Institute (IWMI)**

2008: **Mahmoud Abu-Zeid**

2005: **Malin Falkenmark**

2003: **Benedito Braga**

2000: **Yutaka Takahasi**

1997: **Rotary International**

1994: **Asit K. Biswas**

1991: **Yahia Abdel Mageed**

1988: **UNEP** and its Executive Director **Dr. Mostafa Kamal** (joint award)

1985: **UNICEF**

Ven Te Chow Memorial Award and Lecture

IWRA has established a Chow Memorial Lecture program to honour its first president as well as provide for an outstanding lecture to be delivered at its triennial World Water Congresses. IWRA has offered the Ven Te Chow Memorial Award and Lecture since 1988 in the name of the great hydrologist who was also the Association's founder and first president.

The award in 2020 went, fittingly, to **Prof. Dr. Soontak Lee**. He is presently a Distinguished Professor / Professor Emeritus of Hydrology and Water Resources Engineering of Yeungnam University, Korea. He is also an Honorary Governor of the World Water Council (WWC) and President of the International Hydrologic Environmental Society (IHES). Prof. Lee has been Co-Chair of the International Scientific Committee (ISC) of the 7th World Water Forum in Daegu-Gyeongbuk Korea since 2015, as well as a Chairperson and President of the UNESCO-IHP Intergovernmental Council from 2010 to 2012. He has obtained four Doctoral degrees, Ph.D., D.Sc., Hon. D. Eng. Sc. & Hon. Dr. Tech. Sc.

Previous Recipients

2017: **V. P. Singh**
 2015: **Rabi Mohtar**
 2011: **Peter H. Gleick**
 2008: **John Pigram**
 2005: **Benedito Braga**
 2003: **Asit K. Biswas**
 2000: **Janusz Kindler**
 1997: **Glenn E. Stout**
 1996: **Ben Chie Yen**
 1994: **Andras Szollosi-Nagy**
 1991: **Malin Falkenmark**
 1988: **Vujica M. Yevjevich**

Water Drop Award



Since 2020, the Water Drop Award recognises a student or early career professional, typically under the age of 35 who has made an innovative contribution to the water sector. These contributions may include but are not limited to ground-breaking recent research on water issues, entrepreneurship in the water sector, and raising the profile of younger people in the water sector.

In 2020, the first Water Drop Award was presented at the IWRA World Water Congress to **Dr. Laura Movilla Pateiro**. Dr. Pateiro is a lecturer in Public International Law at the University of Vigo, Spain. Her main field of research is international water law, with a focus on the law of transboundary aquifers.

New Honorary Members

Honorary Membership is the highest honour IWRA can bestow and is awarded to those who have made significant contributions to the field of water resources and/or attained acknowledged eminence in some field of water resources. IWRA Honorary Membership provides free membership for life to an individual. Up to two people can receive this award each year, and they are celebrated at the awards ceremony of each World Water Congress. In Daegu the winners announced from 2018 to 2021 were:

Alice Aureli, UNESCO's International Hydrological Programme & ISARM

Loïc Fauchon, World Water Council (WWC)

Patrick Lavarde, French Ministry of Environment

Claudia Ringler, CGIAR Research Program on Water, Land and Ecosystems

Claudia Sadoff, International Water Management Institute (IWMI)

Salman M.A. Salman, International Water Resources Association (IWRA)

Jennifer J. Sara, World Bank Group

V.P. Singh, Texas A&M University

New Fellow Members

IWRA Fellow Membership is granted to an existing IWRA member who has been with IWRA for at least ten years and has either made major contributions to the Association, has held a position of high responsibility, has attained a high level of academic qualification in the field of water resources management, or has made significant contributions through their work. IWRA Fellows are eligible for discounted membership for life. At each World Water Congress, we celebrate the people who have been awarded this membership since the previous World Water Congress. In Daegu the awardees were:

Emmanuel M. Akpabio, University of Uyo

Henning Bjornlund, University of South Australia

Carl Bruch, Environmental Law Institute

Michael Campana, Oregon State University

Zhao Hao, Ministry of Water Resources the People's Republic of China

Shaofeng Jia, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences

Yuanyuan Li, Ministry of Water Resources of the People's Republic of China

Jennifer McKay, University of South Australia-Justice and Society

James Nickum, Editor-in-Chief of IWRA's journal "Water International" and former IWRA Executive Board member

Christopher A. Scott, University of Arizona

Raya Marina Stephan, International Water Law Consultant

Poh-Ling Tan, Griffith University

Robert Varady, University of Arizona

Philippus (Flip) Wester, International Centre for Integrated Mountain Development (ICIMOD)

Water International Best Paper Award

The Best Paper Award and Honourable Mention Awards are awarded each year to authors based on the originality, innovation, technical quality, and contribution to water resources management of an article appearing in *Water International*.

BEST PAPER 2018 AWARDEE

"Water security and the pursuit of food, energy, and earth systems resilience". **Christopher A. Scott**, **Tamee R. Albrecht**, **Rafael De Grenade**, **Adriana Zuniga-Teran**, **Robert G. Varady**, and **Bhuvan Thapa**

HONOURABLE MENTION 2018 AWARDEE

"Poor water service quality in developed countries may have a greater impact on lower-income households". **Anna Robak** and **Henning Bjornlund**

BEST PAPER 2019 AWARDEE

"Hotel Middle East: Social shocks and adaptation in Jordan's domestic water sector". **Natasha Westheimer**, **Michael Gilmont** and **Troy Sternberg**

HONOURABLE MENTION 2019 AWARDEE

"Water markets as coupled infrastructure systems: comparing the development of water rights in Heihe, Shiyang, and Yellow Rivers". **Jesper Svensson**, **Dustin E. Garrick** and **Shaofeng Jia**

BEST PAPER 2020 AWARDEE

The devil's in the details: Data exchange in transboundary waters. **Patience Mukuyu, Jonathan Lautze, Alistair Rieu-Clarke, Davison Saruchera and Matthew McCartney**

HONOURABLE MENTION 2020 AWARDEE

"Irrigation management transfer in sub-Saharan Africa: An analysis of policy implementation across scales". **Cesario Cambaza, Jaime Hoogesteger and Gert Jan Veldwisch**

50th Anniversary Awardees

The XVII World Water Congress marked the exact 50th Anniversary of the foundation of the International Water Resources Association, when the founders of IWRA signed the articles of incorporation to establish the first organisation in the world dedicated to a global, interdisciplinary approach to water resources. The vision of the founders has proven over time to be the proper approach to water resource management because, although many water issues are local, there are similarities and synergies that transcend borders and subject-matter silos.

To honour the people who have served and supported the mission of IWRA over the past half-century, the 50th Anniversary Committee, chaired by our Treasurer **Renée Martin-Nagle**, established a special unique set of awards to mark this important milestone: the 50th Anniversary Awards were established in the following five categories:

- **Global Reach** to recognize those who helped IWRA achieve a global presence;
- **Foundation** to recognize key members of staff who volunteered their time;
- **Past** to recognize those who were most influential in IWRA's early years;
- **Present** to recognize those who have been most influential in recent years; and
- **Future** to recognize those who are expected to lead IWRA into the future.

The number and quality of nominees made the selection difficult, and the Awards Committee, consisting of **Rabi Mohtar, Christina Leb, Majduline El-Tahir and Renée Martin-Nagle**, selected awardees for each category. The winners are as follows:

GLOBAL REACH: James Nickum and Malin Falkenmark

FOUNDATION: Ben Dziegielewski

PAST: Cecilia Tortajada and Hiroshi Hori

PRESENT: Salman and Gary Jones

FUTURE: Bassel Daher

Thank you to the winners and to everyone who has allocated the time, energy, ideas, and financial support to IWRA over its long history. We are indebted to all of you. Together, we have built a solid foundation that will enable IWRA to celebrate another 50 years as we work toward our goal of collaborative, interdisciplinary, effective management of water resources.

SIDE EVENTS

World Water Cities Forum 2021

Since 2015, the World Water Cities Forum has been serving as an exclusive platform for city leaders and water experts to discuss water-related issues and solutions for each city and share best practices and policies related to water management. It is a forum for discussing how to utilize water management and the water technology/water industry development to create an attractive, liveable, resilient, and prosperous city. The 2021 WWCF was held under the theme of 'Water Cities Cooperation and Innovation'. The event featured presentations and discussions on water problems in Shaoxing, China, with Mikkeli in Finland.

World Water Cluster Leader's Forum

The World Water Cluster Leaders Forum is held regularly to promote technological exchanges and cooperation among water clusters in various countries around the world. It is a place to promote the successful operation of national water industry clusters by sharing the conditions, experiences, and successes of global water clusters. The 2nd World Water Cluster Leaders Forum discussed the cluster's digital transformation success strategy and the cluster's response plan to overcoming the climate crisis.

KIWATEC Water Industry Certification Seminar

This seminar was hosted by Daegu Metropolitan City and was organised by the Ministry of Environment and Korea Institute for the Water Technology Certification (KIWATEC). It was attended by more than 150 local government officials and water company certification system officials across the Republic of Korea.

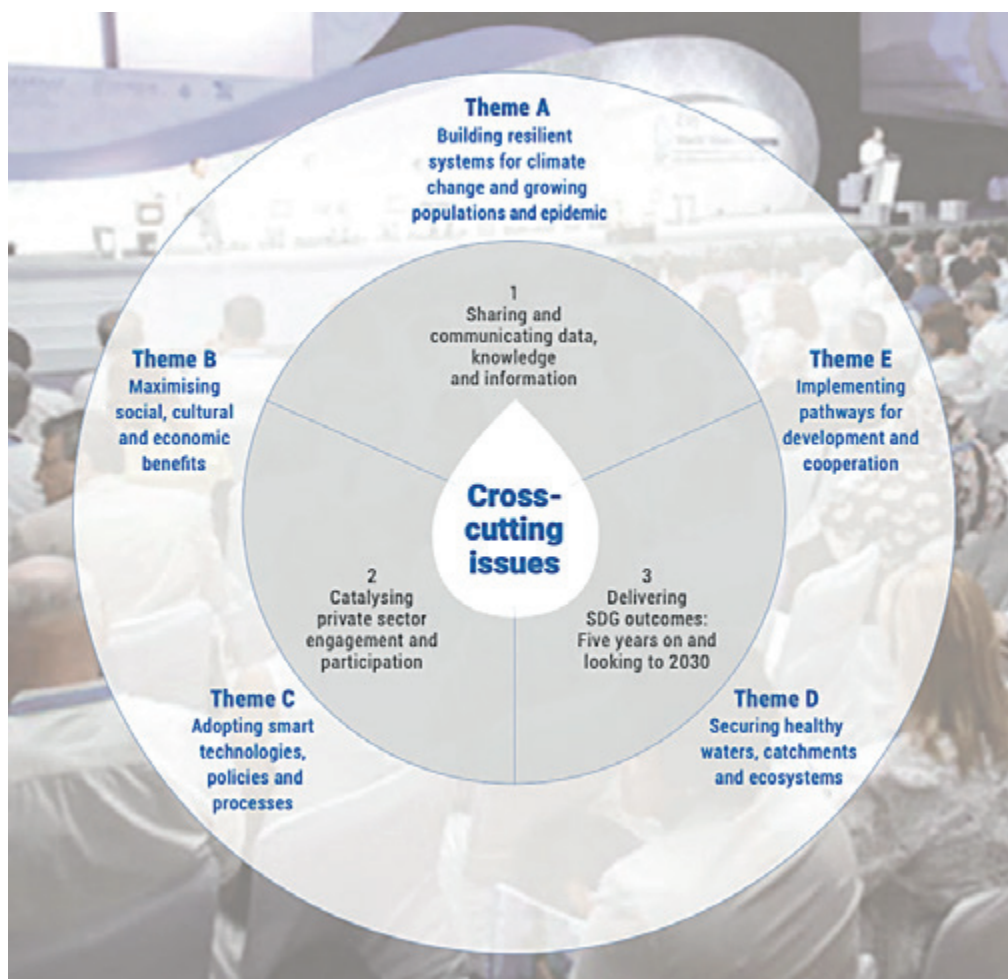
The Water Industry Certification and Verification System Operation Seminar held on November 30 introduced and promoted the certification system to inform the legal use of water products. The certification system was introduced on December 1st at the "Water Industry Quality Capability Reinforcement Seminar" and members discussed measures to secure water facility stability through quality management capability.

Youth Water Talk Concert

Youth "Water" Talk Concert is an event where the Youth from local communities can freely engage in discussions with water experts to enhance their understanding on such topics as the water industry and Daegu Metropolitan City's water industry policies, both of which might be too abstruse to be dealt with in our everyday life. This year, it was organized online during IWRA's XVII World Water Congress. With the participation of numerous water professionals, such as Professor Hun-kyun Bae from Keimyung University and Professor Kyu-tae Seo from Changwon University, as well as five hundred local students, the youth had a chance to engage with various activities, such as the water quiz and UCC video production, as well as learn about the importance of water in our daily lives while exploring answers to some of their own questions.

CONGRESS THEMATIC FRAMEWORK

The International Scientific Committee (ISC) for the XVII World Water Congress was responsible for the technical content of the Congress, including the development of its thematic framework, congress programme, the call for and selection of abstracts for presentation or posters, as well as proposals for special sessions and side-events. The thematic framework is set out below:



The Congress programme was organized across five key Themes, while each Theme consisted of relevant sub-themes:

A. Building resilient systems for climate change, growing populations, and epidemics

- A1. Balancing critical water needs: the people-food-energy-environment nexus
- A2. Managing water scarcity: supply-side and demand-side options
- A3. Reducing disaster risks: improving preparedness and resilience
- A4. Water sanitation and health: deepening inclusion, access, and service
- A5. Financing resilience: challenges, opportunities, and risks
- A6. Responding to a crisis: lessons learned from the COVID-19 pandemic

B. Maximising social, cultural, and economic benefits

- B1. Valuing water: perspectives from grassroots to governments
- B2. Water allocation and governance: balancing equity, legal, and economic needs
- B3. Access and authority: empowering youth women and other disadvantaged groups
- B4. Cultural water: traditional and indigenous values in water policy, planning, and law
- B5. Community participation: local programs improving water access and quality

C. Adopting smart technologies, policies, and processes

- C1. Water-smart cities: re-thinking the urban water cycle from site to basin scale
- C2. Smart water and ICT: applications for developing and developed countries
- C3. Water and food: improving efficiency, productivity, and nutritional outcomes
- C4. Appropriate technologies: low-cost innovations from concept to business plan
- C5. Smarter water: latest advances in education, research, and development

D. Securing healthy waters, catchments, and ecosystems

- D1. Basins and catchments: implementing IWRM from source to sea
- D2. Rivers and wetlands: ecological and engineering approaches to rehabilitation
- D3. Environmental water: innovations and outcomes in policy, law, and practice
- D4. Improving water quality: new economic, legal, regulatory, and technical approaches
- D5. Climate change and ecosystems: repairing impacts and preventing damage

E. Implementing pathways for development and cooperation

- E1. Managing trans-boundary waters: advances, regressions, and prospect
- E2. Water and migration: understanding and mitigating key drivers and risk
- E3. Water governance: reflections on progress in policy, law, and institutional reform
- E4. River basin organisations: case studies highlighting successes and challenges
- E5. Grass-roots action: collaboration in local government and civil society programs

The Congress Programme also included three cross-cutting themes:

1. Sharing and communicating data, knowledge, and information

- 1.1 Education and capacity-building: meeting the needs of developing countries
- 1.2. ICT platforms and apps: new initiatives and approaches to information sharing
- 1.3. Bridging science and policy: reflections on the Cancun Declaration from WWC XVI

2. Catalysing private sector engagement and participation

- 2.1. Water risks: improving water use and quality at sites and in supply chain
- 2.2. Financing needs: making the water sector more attractive for investors
- 2.3. Local participation: emerging roles and opportunities for small and large business

3. Delivering SDG outcomes: Five years on and looking to 2030

- 3.1. Progress on implementation: national, regional, and thematic perspectives
- 3.2. Predictions for 2030: best case, likely, and worst-case scenarios

SESSION SUMMARIES

On the occasion of the XVII World Water Congress in Daegu, Republic of Korea, Youth Ambassadors acted as rapporteurs for the participated in High-Level Panels, regular and special sessions, reporting on the content and topics of discussion during these sessions; developed these notes into short summaries. Whole reports were not produced for every single session. There were a total of 93 summaries from 3 plenary sessions, 39 regular sessions, and 49 special sessions, which are included in this section of the report.

Acronyms

HLP: HIGH LEVEL PANEL

RS: REGULAR SESSION

SS: SPECIAL SESSION

HIGH-LEVEL PANEL SUMMARIES

High-Level Panel 1

TITLE: 50 YEARS OF WATER RESOURCE MANAGEMENT – PAST, PRESENT, AND FUTURE

DATE: TUESDAY, 30 NOVEMBER 2021

Speakers

James Nickum, Editor-in-Chief, IWRA, Moderator

Gabriel Eckstein, President, IWRA, Panellist

Lesha Witmer, Advocacy, Women for Water Partnership, Panellist

Yoonjin Kim, Planning Director, Korea Water Forum, Panellist

Bassel Daher, Assistant Research Scientist, Texas A&M Energy Institute, Adjunct Assistant Professor, Texas A&M, Panellist

Georgina Mukwirimba, IWRA's World Water Envoys (Zimbabwe), Panellist

James Nickum, Editor-in-Chief, IWRA (Introduction)

- Focus on the future of IWRA
- Theme/role what are the future water challenges likely to come up in the next 50 years and how can IWRA position itself to meet those challenges?
- Special Issue for the 50th Anniversary – Most of it online
- The issues include interesting commentaries including one by Rabi Mohtar, Kevin Wheeler, etc.
- The issues have free access even for silver members and for non-IWRA for a set time period
- Quote from the past presidents Ven Te Chow (II World Water Congress, New Delhi): *"Members of IWRA are individual men and women involved in water resources and represent themselves only as individuals in the human society. Our association is neither concerned with nor involved in any matters of a political nature. IWRA serves the function of bridging organisations."*
- Special editions: focusing on specific issues in the water sector such as the one mentioned by the OECD (governance)
- Special issue edition on data
- Recent issue on state and water insecurity: Data focused. What can local communities do if the state does not reach them for one reason or another?
- Future: Policy briefs, webinars, etc.

Key Messages

Gabriel Eckstein

- SDGs are not milestones that can be achievable in a timeline manner. Much unpredictability.
- Consistent new challenges with water. Water quality, availability etc.

- New challenges – things we have not imagined yet.
- IWRA has people that are constantly adapting to the new situations and new reality. The ability to adapt and offer a platform for opportunity for adaptation to meet the challenges of the future.

Lesha Witmer

- Concerned about the lack of people with an education.
- Good sound vocational training with anything that related to water is needed.
- Technology exists. However, what we don't have are qualified people to apply the technology and use it.
- Qualified people are out there but are not being hired. There is a huge lack of qualified people in the water sector; how do we keep them?
- Another challenge will be the battle between energy and water. Many people in the water sector do not realize enough how much importance energy plays in water. Ideas on energy highly depend on water. There is not enough discussion or dialogue between these disciplines. IWRA should interest the people that might not be interested to be a member of IWRA only but also people that are interested in working with energy and water.
- We need to have open lines of communication to ensure viable solutions are identified and working in silos is avoided.
- If we are doing something in water, what happens in energy?
- The knowledge is out there but we are not talking to each other enough.

Yoonjin Kim

- IWRA is no longer providing the same function as other organisation. We need this distinctive feature we need to provide to the world.
- The interface between science technology and policy is the key function IWRA provides.
- The world is facing a global threat. The importance of carbon neutrality needs to be central to our work. Net Zero efforts have become more common among companies and governments and even among communities.
- In Korea, this is the top policy priority. Every sector is considering carbon neutrality from its angle.
- Companies, such as Facebook made pledges to carbon neutrality, including Ralph Lauren, etc.
- The energy sector needs to be integrated with policies as well as investment and financing. All this feeds into the carbon neutrality vision.
- Expertise from IWRA could be used for future IWRA priorities to inform policies more concretely.

Bassel Daher

- We saw a lot of complex challenges with the pandemic. These need to be looked at from a systems perspective. The interconnection between water, resilience, and other sectors.
- Solutions may not come from the water sector itself. But from other sectors as well.
- No one discipline or sector can address these challenges. There is a need for heightened collaboration.
- Investment in enabling environments that allow for the developments that cuts across these disciplines and allow a higher level of harmonization and coordinated planning.
- Right mechanisms that allow these spheres to converge as they move forward.
- IWRA is uniquely positioned by bringing together different disciplines and sectors in the same room. You don't see this in many professional organisations.
- IWRA can serve as a premiere platform within the scientific sphere but also to connect different spheres and heighten the dialogue between practitioners and science.

Georgina

- SDG 6: Clean Water and Sanitation focus is too much that wastewater treatment is forgotten. Wastewater treatment is key in water urban planning.
- Africa cannot afford to undergo a transformation that cities in Europe or Australia can afford to do. With population growth this is a big challenge.
- Solutions are outside of the water sector and outside of our reach.

- Governments, food sector, and other policy makers play a central role.
- Youth plays a key role as well. If we tap if their most vital potential, we can come up with solutions. They should be involved in the planning stages and implementation.

Gabriel

- How do people see water? We have a perception problem.
- We don't have a substitute for water. Two things we cannot do without: Air and Water
- We have not internalized this in such a way that when we talk about water challenges, we look at water waste project, as an SDG 6 challenge. But if we think about it, water is much more. It is critical for life. We need to be serious about it.
- We tell people in different parts of the world you need to take care of water. But at the same time, we have not realized how critical water is to everything we do. We have not internalized this into our decision making.

Lesha

- We have environmental impact assessments. Very little about water there.
- What if by agreement, we would do a due diligence on water impact for every single project/effort we made. This might create some of the awareness which is discussed here.
- World Water Development Report – Wonderful analysis around the value of water (social and cultural). The challenge is however that not many solutions were identified. The discussion is far from finished.
- SDG6.4 is wastewater: It is included there. Better treatment of water in general is emphasized here.
- Businesses that are trying to do things on carbon neutrality. Even Coca-Cola has reached 0 net emissions but what happens in the supply chains? Very tricky language.

Rabi Mohtar:

- Should IWRA in the future be the platform of the nexus of the water, food, climate, environment? Water is the catalyst. At the time of Ven Te Chow there was no awareness of the cross disciplinary. This is a valid question to be asked.
- Should we be the institution to embrace the nexus between the various sectors with water at the centre?

Bassel Daher:

- IWRA Task Forces: Different angles (Water Policy, Water Security, Water Climate, Young Professional Development)
- One of the common messages resonates with your comments and questions
- By having that nexus focus we will be positioned to be referenced for developing the kind of knowledge that we need to develop to be recognized in the space

High-Level Panel 2

TITLE: MULTI-STAKEHOLDER SCIENCE AND POLICY DIALOGUE TO SUPPORT IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOALS (SDGs) LED BY PROF. RABI MOHTAR

DATE: WEDNESDAY, 1 DECEMBER, 2021

Summary

On Wednesday, 1 December, 2021, a High-Level Panel session was held to discuss opportunities for addressing the interconnected resource challenges needed to achieve the SDGs. The focus will be to present the lessons learned for achieving the SDGs, which will be based on the experiences of the panellists.

Speakers

Rabi Mohtar, Professor, Texas A&M

Abdoulaye Sene, Co-chair of the International Steering Committee of the 9th World Water Forum, Panellist

Nara Lee, Assistant FAO Representative, FAO Partnerships and Liaison Office, Republic of Korea, Panellist

Jong-jin Lee, VP and Chief Global Officer, K-Water, Republic of Korea, Panellist

Bassel Daher, Assistant Research Scientist, Texas A&M Energy Institute, Adjunct Assistant Professor, Texas A&M, Panellist
Karishma Asoodani, Q&A Segment Moderator

Rabi question to Senegal: *What are the plans for SDGs in Senegal and how do you see the role of science supporting your plans moving forward?*

- Senegal is a pioneering country in Africa for management of transboundary rivers and water management. This has been made possible mainly with partners in the domain in sanitation. International community, SDGs 2030, Senegal launched major reforms which made the environment of the sector attractive to PPPs.
- This approach, considering quality and access to water, has made significant progress. Access to drinking water was estimated to be 96% in 2020 compared to 82% in the past.
- In rural areas, it was 98% compared to 88% in years before.
- Circular economic approach by diversifying its water resources and development of a sectoral approach.
- Key to success depend on innovative financing mechanism. To support the sector toward its autonomy in Senegal.
- National Blue Fund is being put into place combining different partners.
- The achievement could not have been made without the scientific vision. Future: capacity building, doctoral school on water and water quality at the University of Senegal.
- Ministry of Water and Sanitation is a big part of the SDGs. How is the coordination happening at the Ministerial level?
 - Several platforms of coordination. Inclusive of all partners, private sector, civil society, and all Ministers related to water.
 - Ministry of Water and Sanitation is in charge is working with all the other ministers.
- FAO is addressing more than agriculture, the one health concept, that supports a much broader umbrella. Can you tell us about SDG6?
- FAO is a custodian agency of SDGs, contributing to more specific SDGs and supports policy making and capacity building and technical expertise.
- New Strategy for more effective implementation of SDGs, for more resilient and better food systems.
- FAO places SDGs at the centre, FAO strives to fill the critical gaps.
- How FAO contributes to SDG6?
 - FAO provides water data and information for better decision making
 - Important tool to support members to reduce water stress and increase water efficiency
 - Accelerate important actions
 - Innovation and more effective governance systems
 - Innovative financing
 - Access to quality water and sustainable management and increased investment in water infrastructure
 - Services for water management
 - Saving water in irrigation makes more resource available
 - Capacity development tools to accelerate water resources
 - WASA water scarcity
 - Integrated approaches for SDGs Hand in Hand initiative
 - Water – food – energy nexus is key for FAO
 - Time to act in collaboration

K-Water

- Korea declared carbon neutrality. Korean policy works are also well reflected in K water works.
- We would like to join the international trends on SDGs. We decided to implement ESG elements in K Water work complying to international measures.
- Digital technology was adopted to establish smart water management tools in Korea
- Renewable energies will be developed further by 2030. Floating PV generation
- Carbon neutrality achievement is key
- Tap water production will be produced in a net zero manner
- Overseas projects: Pakistani Government collaboration
- Going forward, K Water will continue with projects in renewable energy development for carbon neutrality

- SDG6, 7, 13 (climate change) will be our priorities
- The role of Asia Water Council: Covers 27 countries and 140 different projects. At COP26 we presented water projects.
- We created a system so that member countries can embark on desired project. Carbon neutrality tax or border tax will be well informed so that the border countries can overcome their challenges.

Bassel Daher

- SDG is a great roadmap for national to achieve sustainable development
- Development might look very different from one country to another
- SDGs are wide in scope and relate to different stakeholders with different objectives and horizons
- Achieving SDGs is quite challenging because of this
- This is where the scientific community has a key role to play. Identifying trade-offs where different stakeholders have their roles to play. A platform for dialogue and policy making
- Science needs to create the right analytics for ensuring policies, technical solutions, and social and economic incentives. Also, to ensure that one SDG does not advance at the expense of another
- Texas A&M: Tools that focus on SDG6, SDG2, SDG 7
 - Case study on Morocco, Lebanon, and US. Identifying our thinking on what kind of analytics would bring different stakeholders in the discussion

Rabi: What are some examples of communications platforms for such efforts on the way forward? Space where disciplines can convene and address such subjects?

Bassel Daher

There is an opportunity for such wealth of knowledge platforms to draw from the expertise and have discussions across the sectors. To do so, there are some barriers we need to address. Regardless of how much institutions are aware of the need for the coordinated planning that needs to happen, some of the barriers are indeed at the institutional level and connected to institutional mechanisms and lack of resources for activities. We must have these in mind before we move to a platform for sharing knowledge. Tools and analytics could be catalysts toward this objective.

FAO: Resilient food systems in developing countries.

- Database and technology, academia, science are bringing more investment for water related and agriculture areas
- Private sector partnerships
- Capacity building (not only for farmers) but also for awareness raising for consumers as well. Consumers are leading the production of food and are a leading force in changes to achieve SDGs

K-Water

- Korea is still in the process of adopting many initiatives
- Corporate based regulations – we are trying to initiate
- ESG corporate mechanisms are the focus. SEA countries – K-Water gives support in the areas of water and energy
- Overseas projects which are valuable and what support is needed so that K-Water can intervene
- Cutting energy consumption as well. Creating Dams could cause social problems
- Floating pV or hydropower will be an example where we can transfer our technologies
- Urban areas and cities and smart cities which can use 4G or related powers for energy efficient cities

Raya

Some countries have created mechanisms and committees on water, but they are not functioning. How do you want to create a committee which coordinates effectively across the sector, not water only?

Bassel Daher

Danger of not coordinating planning at early stages. New knowledge needed for a systems approach and thinking. The urgency of coordination needs to be clearer, where each entity and sector has skin in the game, to catalyse concrete actions moving forward.

K-Water

National budgets, WB, and other finance sources for projects. We should focus on SDG focused projects. We should combine individual country efforts for step-by-step approach.

FAO

Achievement of better nutrition, environment, and life. More integrated approached. FAO would like to be a matchmaker. FAO is an expert in technology, technical expertise, and data to channel the investment in filling these gaps for the achievement of SDGs. One sector alone is not sufficient.

Senegal

How to put all stakeholders to work SDGs. Senegal Head of State Chairs the National Water Council (not operational). But also, a National Committee on Sustainable Development is indeed operational. This is one way a platform could integrate all collaborative action for better efficiency.

Rabi: Global Compact/Private Sector in mobilising resources in implementation of SDGs

- Bassel Daher: PPP allowed us to receive the COVID19 vaccine in good time
- Close coordination is key and a major role for the private sector to play in mobilising key solutions that need to be advanced
- Senegal: Head of State Summit with 4 international institutions. It could be useful to integrate private sector component. We will keep it open for this element.
- Private sector has the means and the experience for mobilising efforts and accelerating action (Rabi).
- IWRA can play a role in facilitating partnerships between the private sector and academia.

High-Level Panel 3

TITLE: WATER RELATED DATA, TECHNOLOGY, AND CAPACITY BUILDING FOR DEVELOPING COUNTRIES

DATE: THURSDAY, 2 DECEMBER, 2021

Speakers

Tom Soo, Executive Director, International Association for Hydro-Environment Engineering and Research (IAHR), Moderator

Eric Tardieu, Director General, International Office for Water, Panellist

Dominique Berod, Head, Earth Systems Monitoring Division, World Meteorological Organisation (WMO), Keynote

Waqas Burney, Partner Manager, Google Search (APAC), Panellist

Pauline Mufeti, Head of Hydrological Services, Namibia, Panellist

Key messages

- Overarching Message: Because water is the key to climate change management and mitigation, there needs to be a continuum from water data to information, to knowledge.
- Water data is vital to understanding and managing climate change.
- Data also helps build trust and bridges for interdisciplinary collaboration. We need a variety of data, but it's often unavailable, and 67% of national water monitoring networks are in decline.
- Data sharing is just as important as collecting data, though there's a disconnection between water demand and supply. What is available is difficult for some stakeholders to understand.
- Decentralized data systems can work just as well as centralized systems if they are interoperable for maximum work.

- Data challenges go beyond technical, such as conflicting agendas across agencies, low political will, and the inability to understand the data.
- We need to make sure the data is understandable and useful for users.
- Automated modelling data (such as flood modelling) needs to be supported by grounded observations and data.

Summary

The current trends in data, artificial intelligence, connectivity, remote sensing, real-time access, and modelling give rise to opportunities for improving decision making related to water resource management. Unfortunately, there remains a lack of water resources data. The purpose of the plenary will be to address the required paradigm change to tackle the continuing challenges and future opportunities of water related data, technology, and capacity for developing countries from different perspectives; the plenary shall also be invited to make reflections and recommendations on potential ways forward.

Dominique Berod's Keynote: We have heard the importance of water and water data, but we are far away from having the data processes we need to understand contexts at the different levels. Water monitoring is key for complex systems understanding and managing water to be part of an integrated system, incorporate any type of data source, and be part of a full value chain. Data also helps build trust and bridges for interdisciplinary collaboration. We need a variety of data, but it's often unavailable, and 67% of national water monitoring networks are in decline. Data sharing is just as important as collecting data, though there's a disconnection between water demand and supply and what is available is difficult for some stakeholders to understand. We need data for specific purposes, and we need to move towards a new paradigm to see hydrology as a component of the earth system. Lastly, there needs to be a continuum from data, to information, to knowledge.

"Climate challenges are water challenges. This isn't just about flooding and droughts."

Decentralized data systems can work just as well as centralized systems if it's interoperable for maximum work. Data challenges go beyond technical, such as conflicting agendas across agencies, low political will, and data illiteracy. Sometimes, though the data is available, the information given to stakeholders can be too late or too complicated to understand for laypeople. Some solutions to this include citizen science and community data ownership.

How do we understand what our data users need in terms of how it's presented and used? We must make the best of what is available. This means using technology to leverage the data as best as possible, creating very close research collaborations to address the different user requirements, and leveraging as much public data as possible to make life easier. Automated modelling data (such as flood modelling) needs to be supported by grounded observations and data. Data rights and ownerships are difficult issues to address sometimes, especially when sharing data, and this can make progress delayed and difficult to achieve.

CONGRESS REGULAR & SPECIAL SESSIONS' SUMMARIES BY THEME

A. Building resilient systems for climate change, growing populations, and epidemics

SPECIAL SESSIONS

WATER SECURITY: GROUNDWATER MANAGEMENT AND GOVERNANCE

HOST BY UNESCO I-WSSM

SESSION NUMBER: SS3-1

DATE/TIME: 30 NOVEMBER, 14:30-16:00

THEME: A2

Speakers

Seo Hyung Choi, UNESCO - iWSSM, Moderator

Dr. Eunheer Shin, UNESCO - iWSSM, Key-note Speaker

Mr. Lovelesh Sharma, National Institute of Urban Affairs, New Delhi, Oral presenter

Elisa Blanco, Researcher, Pontificia Universidad Catolica de Chile, Oral presenter

Maureen Walschot, PhD candidate, Université Catholique de Louvain, Oral presenter

Dr. Malcom Gander, Remedial Project Manager, Department of Defense, USA, Oral presenter

Callum Clench, IWRA Executive Director, Panel Discussion Moderator

Mary Trudeau, IWRA Project Officer, Panellist

Presentations

- Mr. Lovelesh Sharma, *Water Security: Ground Water Management and Governance, Conservation, Protection, and Management of Groundwater*
- Elisa Blanco, *Drivers of Collective Groundwater Management: The Case of Copiapo, Chile*
- Maureen Walschot, *Transboundary Groundwater, Peace, and Security: Opportunities and Challenges in the America*
- Dr. Malcom Gander, *Aquifer Restoration, Water Pollution, and Notes*

Key messages

- Ground water security needs to be developed through consensus-building by responsible stake holders using an integrated approach.
- City Master Plans can play an essential role in integrated and effective groundwater management.
- Municipalities have a set of tools at their disposal to mitigate impacts on groundwater from land development activities
- In Central America, the potential for conflict around transboundary aquifers can be assessed through a set of characteristics that predict transboundary groundwater security
- Although groundwater remediation does not guarantee drinkable water, there are options for bioremediation that reduce contaminants in aquifers to levels that are acceptable for industrial or other non-potable uses

Summary

There are many countries in the world which depend on ground water as their chief water source. Twenty-five percent of the people living in India depend on groundwater as their ultimate source of livelihood. India is on the verge of ground water insecurity if protection measures are not adopted. The solution to this insecurity, however, lies not only in understanding the baseline conditions but also with developing a robust city master plan which adopts water management measures. An important tool to reduce groundwater contamination is to place restrictions on the number of people per square meter of land surface.

In a case study of Copiapo's (Chile) groundwater, triggering factors such as dry weather condition, weather fluctuations, and conflicts are challenging management conditions. Finding a neutral space for necessary debates and/or discussions is important. Every governance action must be transparent and compatible with the local stakeholders. Different remediation methods for groundwater quality are available, including use of cooking oil and bacteria that can consume organic chemical pollution. Groundwater management and governance requires the intervention of multi-sectoral disciplines.

UNCERTAINTY OF WATER DEMAND AND SUPPLY IN A CHANGING ENVIRONMENT

HOST BY SEOUL NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

SESSION NUMBER: SS5- 1

DATE/TIME: 01 DECEMBER, 14:30-16:00

THEME: A-2

Speakers

Eun-Sung Chung, Moderator

Shamsuddin Shahid, Universiti Teknologi Malaysia, Malaysia, Key-note Speaker

Xiaojun Wang, Nanjing Hydraulic Research Institute, China, Oral presenter

Muhammad Shafqat Mehboob, Yonsei University, Republic of Korea, Oral presenter

Chang-Yu Hong, Pukyung National University, Republic of Korea, Oral presenter

Young Hoon Song, Seoul National University of Science and Technology, Republic of Korea, Oral presenter

Seung- Taek Chae, Seoul National University of Science and Technology, Republic of Korea, Oral presenter

Jin Hyuck Kim, Seoul National University of Science and Technology, Republic of Korea, Presenter

Presentations

- Shamsuddin Shahid, *Climate smart adaptation to groundwater-dependent irrigation system*
- Xiaojun Wang, *Water resources comprehensive utilization and management under changing environment.*
- Muhammad Shafqat Mehboob, *Projected socio-economic and climate change impacts on supply and demand in Upper Indus Basin, Pakistan*
- Chang-Yu Hong, *The Effects of urban flood risk on citizen perception*
- Young Hoon Song, *Uncertainties in evaporation projections associated with estimation methods and CM 16 GCMs for South Korea*
- Jin Hyuck Kim, *Future hydrological drought analysis considering agricultural water withdrawal under SSP scenarios.*

Key Messages

- Poverty stricken places should be given preference for future water policies.
- Water management can be controlled by socio-economic management. For example, introducing sectoral water consumption laws and introducing smart irrigation techniques, etc.
- The status of water scarcity and/or insecurity is expected to have an overarching effect in the demand and supply metrics of the water domain.
- The urban populations' response to the possible risks of urban floods should be used as an indicator to develop a preparedness map of hazardous events.

Summary

The ever-increasing contradictions between water supply and demand has severely impacted the population growth and socio-economic development sphere. This has further paved an unwanted path to a conflicted future which will result in climate change related disasters. The direct impacts of water insufficiency were reflected in this session with a highlight in economic and social disturbance. Since the risk of climate change due to water scarcity stems from interlinked sectors such as urbanization, poor governance, and lack of infrastructure, this symbolizes an exponential casualty to other topics as well.

The session had interventions from speakers focusing on comprehensive utilization of water resources and management as well as on the disparities between the global and the regional water scarcity situation that furthers scarcity issues. The scarcity of water is projected to get even more scarce in the future due to pollution, overutilization, and uncontrolled usage. An important factor would be irrigation which is heavily dependent on groundwater. Since irrigation systems solely rely on groundwater, it is important to acknowledge and address the adaptation measures needed to avoid climate change related risks due to irrigation. However, adaptation does not necessarily imply implementation of engineering-based solutions; adaptation should be studied with local populations in mind.

Chang-Yu Hong mentioned in his presentation that the disaster effects can have far reaching impacts in the perception of the local people. He gave an example of the effects of urban flooding in the perception of the local people about preparedness and planning in the face of an imminent flood hazard. This gives a general idea about the hazard management. **Professor Shamsuddin**, on talking about the irrigation, also mentioned the need of 'smart' methods to alleviate the problem of groundwater contamination. He suggested the utilization and storage of rainwater as a possible alternative to sustain in a large and efficient scale.

The session ended when **Young Hoon Song**, through his case study in South Korea, talked about rainwater not ignoring the evaporation projections in the region. Therefore, although climate change adaptation measures can help mitigate the scarcity of groundwater, factors such as rainfall, evaporation, water management, and socio-economic conditions are equally as important to consider for meeting the water demand in the future.

BLUE CITIES: ENHANCING WATER SECURITY AND BUILDING RESILIENT CITIES

SESSION NUMBER: SS6-2 SPECIAL

HOST BY OECD

DATE/TIME: 01 DECEMBER, 16.30 – 18.00

THEME: A6

Speakers

Eric Tardieu, General Secretary, International Network of Basin Organisations, Moderator

Oriana Romano, Head of Unit, Water Governance and Circular Economy, OECD, Panel

Gonzalo Delacámara, Head, Water Economics Department, Madrid Institute of Advanced Study, (IMDEA), Panel

Francois Brikke, Future Cities Team Leader, Mott MacDonald Indonesia, Panel

Martin Shouler, London Water Leader, Arup, Panel

Juliette Lassman, Policy Analyst, Water Governance and Circular Economy, OECD, Panel

Fang Za, Yangtze River Water Partnership, China, Panel

Krista Milne, Climate Change Director, City of Melbourne, Australia, Panel

Khin Ni Hi Thein, Initiator, Myanmar Water Think Tank, Panel

Key messages

- 19th-century institutions are dealing with 21st-century challenges. We need them to change and innovate themselves.
- Economic resilience and water resilience are interdependent on each other. One cannot be achieved without the other.
- The policy and Implementation framework needs to include both ecology and development.

Summary

The OECD forecasted in 2016 that the contribution of the ocean economy to global value is expected to reach USD 3 trillion by 2030. Coastal and maritime tourism and port activities alone should contribute to over a third of this amount. 570 low lying coastal cities face a sea-level rise of 0.5m by 2050, putting 800 million people at risk. Around 80% of marine pollution comes from land-based sources such as untreated sewage, including plastics. Blue cities are the ones that aim to combine economic growth, livelihood, innovation, and social wellbeing.

Panel Discussion 1

Extreme water events and land-based (originated) water pollution are putting economies at risk. By 2030, it is estimated that floods and other extreme events will increase by a factor of 4. By 2050, we will be 9 billion people and 75% of them will be in cities. Governments are planning to spend billions of dollars on green recovery measures. But still, a portion of water in the cumulative measures is only 21%. Cities have an important role to play, and they can be the centre of solutions, with having the capacity and space for activities. Cities should be resilient, inclusive, and circular, but it cannot happen without required water governance.

There is a need to focus on the link of economic resilience and water resilience. All levels of government can showcase how to implement proper water governance, stakeholder support, and monitoring. National, cities, civil societies and business leaders should be engaged with the need for 'time to act' and 'blue cities' mission.

It is important to focus on multi dimensionality of governance required. Innovation is required just not in technology but also in institutions. Climate change can see the same involvement in sectors like Information Technology, Health, and Finance. Water resilience must happen with climate resilience. They both cannot happen without each other. Food and energy security are required to have water security in the long term. Municipal wastewater systems also need to be resilient to floods as they can cause bigger damage to cities and themselves. We need to sustain economies to sustain urban systems and sustain urban systems to sustain economies. They are directly proportional to each other and are mutually dependent. A couple of years ago about 25% of Bangladesh was flooded.

There is a need to look at solutions holistically and in ways that include social resilience. The first ones affected by climate change are affected by the most adverse events. They need to become resilient before others. The culture of readiness-to-face shock has a relationship with resilience. Community pressure, community demand, and advice of the international community raises a challenge to every city. Every city is different, and its structural components may behave differently.

There are multiple stresses on the system. Rapid urbanization and an increase in flooding events are happening. We must build institutions and blue cities that can meet today's challenges and add extra capacity for future challenges. The power of collaboration, partnerships, and cooperation; the relationship between a city and its catchment; the power of sharing and communication; the importance of leadership and finance—these are all keys to achieving 'blue cities' and water resilience. Water is not alone; it is part of systems and subsystems. We must understand and take care of its connection with energy, agriculture, and ecology, etc.

Panel Discussion 2

An interview was done with 10 cities from different backgrounds, regions, and characteristics; from this, there were many insights. Some coastal cities are aware of the blue economy of cities. Some cities are adopting an approach to achieve economic prosperity by reducing pollution. In some cities, there is a focus on resilience to achieve economic growth. The lack of a systemic link between resilient cities and water resilience is there, and it needs to be addressed.

There is a need to find the right balance between ecological balance and development. The RCS (River Chief System) is an efficient system as it makes one person responsible for one river. But it has complications. At the basin level, there can be multiple chiefs. There is a need for 'one-river-one-policy'. We need an integrated environmental policy that includes both development and ecology.

When we have a culture, we follow it. The discontinuity of governments, changing of governments, and not being able to pick up on the governance models, leads to issues related to the cities. We must start from 'us' and 'we' to bring about change and to connect with people who think the same. The government reforms should have a top-to-bottom approach. The private sector must play a role in nation-building. Business-as-usual attitudes lead to damaging the

country. Long-term gains must be the focus, rather than short-term profit. Our civilization must shift to an eco-civilization.

By 2070, Melbourne is expected to have doubled the number of heat waves and to face a water shortfall by 2028. The people living in flood plains are being prepared for probable flooding which may happen as a result of climate change. There is a need to involve the community itself in the resilience process as they are the most important stakeholder of the process.

Q&A and Conclusion

A question was asked about the relationship between big cities and non-urban territories, and the hegemony of cities. Responses included having integrated systems between cities/towns and sharing resources and data. A city doesn't live in isolation, and it has effects on the whole catchment around it (catchment of water, food, people, etc.). The issue of leadership is talked about in multiple places, and it is crucial. Better leadership can bridge the gap between cities. Interconnection between all the values (leadership, governance, coherence, ecology, etc.) of development is the key to a blue economy and to blue cities.

REGULAR SESSIONS

SESSION NUMBER: GS1-1

DATE/TIME: 30 NOVEMBER, 10:30-11:45

THEME: A3

Speakers

Lesha Witmer, Women for water Partnership- steering committee member, Moderator

Min Ko Chul, ECOBRAIN co., Ltd, Key-note Speaker

Linh Nguyen, PhD student, Nagasaki University, Oral presenter

Jieun Kim, Hanyang University, Oral presenter

Jun Shik Hwang, Yeungnam University, Oral presenter

Stijn Reinhard, Wageningen Economic Research, Oral Presenter

Presentations

- Min Ko Chul, *A study on the correction of rainfall based on machine learning for hydrological application*
- Linh Nguyen, *The role of traditional ecological knowledge in the transformation towards adaptive governance: case study of the Vietnamese Mekong Delta*
- Jieun Kim, *Regional drought risk assessment using a gaussian mixture model*
- Jun Shik Hwang, *Implementation of drainage network layout as a flood mitigation measure: A case study in Seoul, South Korea*
- Stijn Reinhard, *Impacts of measures to stimulate farmers to adapt to freshwater scarcity: how to improve measurement of relevant indicators.*

Key Messages

- The flood vulnerability in urban areas can be reduced by introducing methods for urban catchments such as detention, retention ponds, pumping stations, levees, and drainage systems to mitigate flood impacts. A goal is to redesign the catchment network by changing its internal drainage network without disrupting the network for the entire catchment.
- The influence of agricultural factors has a higher impact than industrial or commercial factors in drought risk among vulnerable populations.
- The risk reduction measures must rely on vulnerability assessment.
- The concerned private and public stake holders must not look at the monetary value of each species; instead, they should focus on implementing policies to save the species that are affected by climate change and face grave danger.

Session Summary

The General session under the moderation of Lesha Witmer started with a focus on vulnerability management in urban areas and the mitigation measures to be implemented in managing the drainage networks for flood control in Seoul, South Korea. The comprehensive study was done in different catchments suggesting various counter measures for each. Some of the measures mentioned were detention, retention ponds, pumping stations, and drainage systems to mitigate these impacts. Witmer demonstrated different statistical analyses along with a general representation of the past and present trends of the topological characteristics to understand the catchment characteristics. The study concluded that the network configuration for the entire catchment remained the same; however, the internal network configuration kept changing.

The session continued with presentation on drought risk assessment with another case study in the context of South Korea. The presentation focused more on the comprehensive understanding of drought implications for regional and socio-economic conditions of the affected population. The evaluation of drought risk was done by using modelling, literature, and other secondary sources using the drought hazard index as the main indicator. The study concluded that the influence of agricultural factors has a higher impact than industrial or commercial factors in mapping the hazard of drought risk among the vulnerable population.

A different approach was taken to understand the stark difference between two species (rice shrimp and rice fish) to demonstrate the direct effect of unbalanced support from industries and government towards their availability, thereby directly depleting the population of the species. In the Mekong province of Vietnam, the rice shrimp was given more emphasis due to its higher demand, easier maintenance, and stakeholder support. However, protection of the rice fish, on the other hand, was not substantially backed by any governmental or industrial support.

The lack of knowledge among the indigenous community regarding the suitable environment and the nutrition requirements for the rice fish have now made the depletion of rice fish a major concern in the Mekong province. Therefore, although three different topics were discussed, it was evident that climate change vulnerability assessment is a major concern that needs to be addressed soon.

SESSION NUMBER: GS2-1

DATE/TIME: 30 NOVEMBER, 12:00-13:15

THEME: A2 & A4

Speakers

Karishma Asoodani, World Water Council, Moderator

Manikanta P R, Shiv Nadar University, Keynote Speaker

Pau Llinas, Axter Coletanche, Oral presenter

Aoife Quinlivan, University of Nottingham, Oral presenter

Yilin Zhuang, University of Florida, Oral presenter

Presentations

- Manikanta P R, *Managing water scarcity: Integration of supply-and-demand-side options in Kaveri River Basin*
- Pau Llinas, *Bituminous geomembrane: the blueprint to safe water resources*
- Aoife Quinlivan, *Preventing the rising tide of AMR: Utilising MOFs to remove antibiotics from wastewater*
- Yilin Zhuang, *Enhancing well water safety through university and health department partnership*

Session Summary

This paper is part of an ongoing research study regarding options in water management in the Kaveri basin in South India. Kaveri river is a conflict-ridden inter-state river that flows across three riparian states of South India, Karnataka, Kerala, and Tamil Nadu. Originating from the biodiversity hotspot, Western Ghats of Karnataka, the river

has a catchment area of 81155 Sq.km. The unequal and unscientific water sharing arrangements between the riparian states in the river basin has made Kaveri one of the most conflict-ridden and water-stressed basins in India.

The primary argument in this paper is that water management at a watershed/basin should focus on prioritising the use of locally available water resources. External water should be seen as a critical supplement to local water and not as its substitute. Our key research hypothesis is that we will be able to address water scarcity in the basin by a mix of supply- and demand-side solutions. For a detailed study, presenters have chosen the Mandya district, which falls under the Kaveri middle sub-basin. High variability in the monsoon and unequal water distribution has left the study area highly vulnerable to external shocks. From an agroecological framework, we identify several key levers that can move water use in the subbasin towards sustainable and workable solutions. This is the central task to be addressed.

The session argues that the adaptation and mitigation solutions to climate change should take the watershed or the river basin as the basic unit of analysis. The argument is based on the issues identified in the study area. Assured and centralized canal irrigation has drastically altered cropping patterns in the area, moving it away from Nutri-cereals and pulses to water-intensive crops, like rice and sugarcane. Poor irrigation management has led to salinity and soil degradation. Since irrigation from canals and groundwater systems accounts for over 78% of net irrigated area in the study area, demand management in agriculture is the kingpin of the strategy for addressing water problems. This paper shows how Climate Resilient Agriculture (CRA) practices provide a framework for addressing the challenges of scarcity manifested by both natural and social causes.

SESSION NUMBER: GS2-3

DATE/TIME: 30 NOVEMBER, 12:00-13:15

THEME: A3, D1, D2, E2

Speakers

Tom Soo, IWRA, Moderator

Burnice Karimi Ireri, Egerton University, Oral Presenter

Tae Sung Cheong, NDMI, Oral Presenter

Giang Nguyen, Kyungpook National University, Oral Presenter

Sofia E. Garrido Hoyos, Instituto Mexicano de Tecnología del Agua, Oral Presenter

Presentations

- Burnice Karimi Ireri, *Provisioning of water ecosystem services in Kapingazi catchment, Embu County, Kenya. Can prospects of willingness to pay improve water quality and quantity within the catchment?*
- Tae Sung Cheong, *Development of measured data based nomograph for flood warning system*
- Giang Nguyen, *Merging multiple satellite precipitation products in Korea by using random forest model*
- Sofia E. Garrido Hoyos, *Dispersion and transportation of pollutants in the low basin of the Yaqui river and the environmental impact on the marine organisms of the Lake Tobari (Gulf of California)*

Session Summary

Both region and frequency of localized extreme rainfall (hourly rainfall 100mm) are increasing as a result of climate change and geological effects. The river basins are the most vulnerable, experiencing 85% of flood disasters every year. Specially, more than 90% of river flood disasters occur in the small river basins because its restoration ratio is relatively lower than both 70% of the local and 98% of the national rivers. Restoration projects for unmanaged small rivers may be finished by 2079 if the budgets are kept to 2019 amounts, continuously.

In general, non-structural measures like a flood warning system can be used for adaptation options as structural measures like restoration projects may not be easy given economic and environmental issues. The study developed the Small Stream Flood Warning System (SSFWS) to support adequate responses to reduce flood damages in the unmanaged small rivers. Developed system estimates channel depths and discharges by using measured-based

nomographs and rainfall data forecasted by the McGill Algorithm for Rainfall nowcasting, using semi-Lagrangian Extrapolation (MAPLE).

The nomograph indicates the relationship between rainfall and discharges and depths, measuring data for from 2016 to 2017 in small rivers. In no proper rainfall case, only effective rainfall is considered to develop nomographs. This study also evaluated its estimating accuracy with discharges and depths data measured in the 2018 flood season. The evaluation results show that estimating flow discharges and depth well represent the measured data. It is expected then that measured data can be used for enhancing the SRFWS to estimate flow discharges and depths in the small streams.

SESSION NUMBER: GS3-1

DATE/TIME: 01 DECEMBER, 10:30-11:45

THEME: A2

Speakers

Bassel Daher, Texas A&M University, Moderator

Jeonghwan Kim, Inha University, Oral Presenter

Bashir Adelodun, Department of Agricultural Civil Engineering, Kyungpook National University, Oral Presenter

Chang-Yu Hong, Pukyong National University, Oral Presenter

Presentations

- Jeonghwan Kim, *Anaerobic membrane bioreactor for Wastewater Reuse and Energy Recovery: Development and Future Challenges*
- Bashir Adelodun, *Exploring water-saving potentials from food waste to managing water scarcity*
- Chang-Yu Hong, *The effects of urban flood risk and local river management policy: Comparative case study of citizen perception*

Session Summary

Conserving and maintaining clean streams in the urban environment is a main goal for restoration researchers, urban planners, and public staff around the globe. This researcher could observe many urban stream restoration efforts are designed to provide well-managed water to society and enhance ecological functions in these study sites. Universally, urban stream restoration is regarded as a process that provides multiple benefits and functions for human activities, including industrial, agricultural, aesthetic, wildlife, and community benefits. Among these functions, greening landscape infrastructure with riparian vegetation and increasing environmental parameters of the watershed have been commonly regarded as the primary goals and preferences in managing, restoring, and conserving urban stream systems. However, the reality of watershed and riverfront management can vary markedly from commonly estimated spatial landscaping revitalization and socio-cultural aspirations.

The findings of this session indicate that citizens' views and interests could be based on the inconvenience of daily life caused by recent flood events. The citizens who are living in the heavily urbanized downstream areas were more psychologically vulnerable to floods than those in the upper reaches of the watershed. The stakeholders of the populated metropolitan area had a relatively high awareness of their role in environmental restoration; thus, it was natural for them to place a high value on social restoration to mitigate flood risk. Urban environmental and hydro-spatial managers could use such information when restoring and designing waterfront spaces in terms of the water resources supply-demand concept.

SESSION NUMBER: GS4-1

DATE/TIME: 01 DECEMBER, 12:00-13:15

THEME: A3

Speakers

Christopher Scott, Pennsylvania University, Moderator

Muhammad Jehanzaib, Hanyang University, Oral Presenter

Byeong-Hee Kim, POSTECH, Oral Presenter

Linh Nguyen Van, Kyungpook National University, Oral Presenter

Jai Hong Lee, USDA-NIFA, SC State University, Colorado State University, Oral Presenter

Presentations

- Muhammad Jehanzaib, *Application of deep learning and soft computing methods for prediction of sediment load in reservoirs owing to climate change*
- Byeong-Hee Kim, *Role of runoff ratio in the sensitivity of streamflow*
- Linh Nguyen Van, *Application of remote sensing on spatial-temporal analysis of soil erosion due to land use and cover changes: A case study in Yongdam Basin, South Korea*
- Jai Hong Lee, *Climate teleconnection and predictability over midlatitude precipitation*

Session Summary

The objective of this session is to estimate the impact of LUCC on spatial-temporal distribution and to identify characteristics of soil erosion of the Yongdam basin from 2013 to 2021 under urbanization. Estimates are made using RS and GIS technologies with free available LANDSAT 8 data from United States Geological Survey (<https://earthexplorer.usgs.gov/>).

The study is intended to provide decision-makers and planners with the knowledge for taking priority steps for forest and soil protection. It is the second objective in this study. Implications of the project relevant to congress themes include the introduction of an effective approach for estimating soil loss annually and the understanding of land use and cover trends toward environmental problems. This will play an important role in soil conservation management and urban sustainability.

SESSION NUMBER: GS5-1

DATE/TIME: 2 DECEMBER, 10:30-11:45

THEME: A2

Speakers

Lesha Witmer, Women for Water Partnership - Steering Committee Member, Moderator

Joohyung Lee, Yonsei University, Key-note Speaker

Lea Dasallas, Chungnam National University, Oral presenter

Anqi Liu, Pohang University of Science and Technology, Oral presenter

Ryo Tsuchida, Kyoto University, Oral presenter

Sudharsan Malaiappan, International Water Management Institute, Oral presenter

Presentations

- Joohyung Lee, *Application of the artificial neural network to regional frequency analysis for estimating rainfall quantiles at ungauged sites*
- Lea Dasallas, *Developing an integrated urban inundation flood model for extreme rainfall events for Metro Manila, Philippines*
- Anqi Liu, *Trend and variability in groundwater level and quality over South Korea (2009-2020)*
- Ryo Tsuchida, *Can disaster adaptive strategy reduce disaster risks? Lessons learnt from flood-prone area as cases of 1913 and 2017 in Sri Lanka*
- Sudharsan Malaiappan, *Development and application of water security assessment framework*

Session Summary

Water security is based on the availability of acceptable quantity and quality of water supply and on acceptable level of water-related risks to people, environment, and economic sectors. It uses water scarcities (physical and economic) and quality and risks (using variability) to define and index (0-1) at different spatial level of catchments to river basins. Physical and economic scarcities are based on water footprints, water storage, and available water supply. The framework assesses water security at the industry premises or catchment. The industry catchment can be a watershed, a sub-basin or groundwater development block, depending on the source of water use for the industry. Interventions to increase water security depend on various dimensions (scarcities and risk) of the Water Security index.

The water security framework was applied to one industrial factory catchment in the Upper Bhavani Basin, India. Results show that water security risks vary at various geographical scales and requires different interventions. Capacity building and application of frameworks show that it is easy to use and is replicable across geographies. The framework can be used to periodically assess water security and monitor the impact of interventions once implemented.

SESSION NUMBER: GS5-3

DATE/TIME: 02 DECEMBER, 10:30-11:45

THEME: C5, A2, E2

Speakers

Tom Soo, IWRA, Moderator

Malcolm Gander, United States Department of Defense, Key-note Speaker

Bong-Joo Jang, KICT, Oral presenter

Tae Soo Eum, Department of Safety Engineering, Incheon National University, Oral presenter

Sabab Ali Shah, Hanyang University, Oral presenter

Mohammad Faiz Alam, ITC, Oral presenter

Presentations

- Malcolm Gander, *Groundwater pollution and aquifer restoration: Fundamentals and new technical developments in maintaining and MOFs improving water quality*
- Bong-Joo Jang, *WhiteBox: Easy and accurate personalized weather observation station*
- Tae Soo Eum, *Verification of flow analysis model for tracking sources of water chemical accidents*
- Sabab Ali Shah, *Estimating the impacts of climate change and human activity on streamflow variability in Han River basin, South Korea*
- Mohammad Faiz Alam, *Water balance-based tool for drought proofing agricultural watersheds*

Key Messages

- Pollution accidents in the water environment are increasing because of the leakage of harmful chemicals; as result, disaster prevention measures are required.
- Having accurate quantification of the effect of different factors like temperature on streamflow is necessary to understand the major driving factors involved in the variability of streamflow.
- Increased incidence of climate change induced water related risk of droughts is a threat to global agriculture.
- Water availability is considered the key limiting factor for crop growth.
- Water management interventions are central to drought proofing.

Session Summary

For the first presentation, "Verification of Flow Analysis Model for Tracking Sources of Water Chemical Accidents", the results show that the difference between simulation and measured results were insignificant; superiority of the

flow analysis model 'HDM-2D' was proven.

Results from the second presentation, "Estimating the impacts of climate change and human activity on streamflow variability in Han River basin, South Korea", appeared to show an increasing trend in both precipitation and streamflow. The change point is detected in 1997, and then human activities influence the variation of streamflow. Human activities are shown to be the main driving force, affecting streamflow with a contribution of 62.4% and climate change variability contribution of 37.6% in the human induced period.

Results from the last presentation, "Water balance-based tool for drought proofing agricultural watersheds" show that simulating interventions scenarios highlight the limitation of focusing on only structural supply or demand side interventions, which are not enough to drought-proof severe droughts.

SESSION NUMBER: GS6-1

DATE/TIME: 02 DECEMBER, 12:00-13:15

THEME: A3

Speakers

Raya Marina Stephan, IWRA, Moderator

Guy Tapie, PAVE/CED/Université de Bordeaux, Key-note Speaker

Amos Agossou, Kookmin University, Oral presenter

Ilpo Hong, KICT, Oral presenter

M. Rafiqul Islam, University of Verona, Oral presenter

Presentations

- Guy Tapie, *Drinking water: the emergence of a sustainable resource in the energy and climate transition of Bordeaux Metropole*
- Amos Agossou, *Technology development for optimal operation of groundwater using existing wells to cope with drought*
- Ilpo Hong, *Development of integrated index for flood resilience*
- M. Rafiqul Islam, *Rainwater harvesting as a resilient approach to mitigate water crisis problem*

Session Summary

The session for water management and distribution conducted under the moderation of Raya Marina Stephan included disparate themes that focused on water resource distribution. The session started with Guy Tapie who talked about the changes in the river basin distribution system of Bordeaux Metropole, France. The water, although well distributed in the city, did not include environmental factors that demand transition in the long run. Therefore, holistic planning is required to ensure an integrated water management system focusing more on sustainable use of the resource.

The presentation also iterated on the importance of imparting responsibility among citizens regarding the use of water resources. Among other drivers of changing water management dynamics, it was agreed that the provision of education is key to bridging the gap between construction and implementation of smart water utilization technologies. Information campaigns are thus deemed important for encouraging people to shift from passive consumerism to cautious and responsible one.

As the technologies and methods are advanced, there is also a question of cost addition to the services that are available. This can be managed if the local as well as national government subsidizes the cost in water resources to made it affordable to the public. Amos Agossou, another presenter, elaborated on the importance of civic responsibility in not only utilising the available water sustainably but also researching methods for preserving groundwater in its constant state in case of emergency conditions like drought. Another solution to water management could be rainwater harvesting which could help with not only preserving the water but also sustaining it in time of crisis.

The extension and diverse use of rainwater through rainwater harvesting is the major foundation for the resilient approach of water crisis mitigation.

Key messages

- A water development and management plan is essential for planning and creating a multi-level syndicate for the management and planning of the water resources.
- Planning policies need to include water distribution and management thereby enforcing reorganisation of resources in the city plan.
- Information campaigns are important for encouraging people to use water resources responsibly, thereby changing consumers from being passive consumers of a service to responsible citizens of the service.
- Some of the key motivations that can drive change to a city's inhabitants in terms of sustainable water use are making water a common good; securing the resources in long term; keeping prices affordable; giving preference to public-sector governance to improve the living conditions of the city's inhabitants etc.
- It is important to research how to keep groundwater constant to preserve necessary water for emergency and drought conditions.
- The extension and diversified use of rainwater through rainwater harvesting is the major foundation for a resilient approach to water crisis mitigation.

B. Maximising social, cultural, and economic benefits

SPECIAL SESSIONS

SUSTAINABLE MANAGEMENT OF WATER RESOURCES IN CHINA: INNOVATION AND APPLICATION

SESSION NUMBER: SS1-2

HOSTS BY GIWP, IWRA CHINA CHAPTER

DATE/TIME: 29 NOVEMBER 2021, 14.30-16.00

THEME: B2

Speakers

Yuanyuan Li, General Institute of Water Resources and Hydropower Planning and Design, Ministry of Water Resources, China, Presenter

Marcus Wishrat, Water Resources Specialist – China, World Bank, Presenter

Robert Speed, Specialist in Water Resources Management, Australia-China, Badu Advisory, Presenter

David Tickner, Chief Adviser, Freshwater, WWF-UK, Presenter

Yan Yang, Elected President, Chinese Chapter, IWRA, Presenter

Zhongjing Wang, Member, Chinese Academy of Science, Presenter

Jun Xia, Director, Research Institute of Water Security, Presenter

Presentations

- Jun Xia, *Water security issue and integrated river basin management of Yangtze River to the changing environment*
- Marcus Wishart, *A watershed moment? Innovation and application in managing the sustainable development of water resources in China*
- Yuanyuan Li, *Water security and management in China under changing environment*

Key messages

- China and rest of the world experience similar challenges: the challenge of implementation of policy and regulation frameworks.
- Flexibility, leadership, and collaboration are needed in the development of implementation frameworks.
- Innovation is the key to finding sustainable water resources in China and rest of the world.

Session Summary

The session, “Sustainable Development of Water Resources in China” focused on the components of innovation, improvement, supervision management of water resources, and ecological security. Achieving sustainable development is a big challenge in China and the world. According to the speakers, floods increased with climate change; urbanization and industrialisation is also continuously growing with agricultural development. The core of the philosophy of water security is to achieve water-human harmony. This means balancing both human needs and nature needs, balancing carrying capacity and risk mitigation capacity.

According to one speaker, China is transitioning toward more balanced and sustainable economic growth. He talked about the 13th Five Year Plan for ecological civilization. China has experienced an amazing development over the past 40 years. This development is most resonant with infrastructure. Flood control structures were a big part of it. However, development has also come at a cost in ecological sustainability, impacting economic productivity. There has been a transition from economic development to ecological and water management policies in the last few years. A smarter framework should include a range of values, adaptive policy interventions, and reforms, transitions to values-driven water management, and the establishment of monitoring and evaluation systems to determine the contribution of water.

The philosophy and management of water management is particularly fascinating in China. While it is challenging to implement these frameworks within a changing society, it is also important to have flexibility, collaboration, and leadership at a national and provincial level and to implement policy and governance frameworks. The idea of monitoring is a big challenge for water professionals everywhere.

Green development was also discussed where the process of developing a model for a river system in a manner that considers the environmental and ecology needs of the community are included in the process. Most of the speakers and presenters talked about results-based financing for ecological protection and restoration in the Yangtze River of China.

WORLD WATER ENVOYS WORKSHOP

SESSION NUMBER: SS2-5

HOSTS BY IWRA

DATE/TIME: 29 NOVEMBER, 16:30-18:00

THEME: B3

Speakers

Callum Clench, Executive Director, IWRA, Moderator

Gabriel Eckstein, President, IWRA, Opener

Maria Almonte, World Water Envoy, Dominican Republic, Oral Presenter

Bayan Khalaf, World Water Envoy, Palestine, Oral presenter

Georgina Mukwirimba, World Water Envoy, Zimbabwe, Oral presenter

Pallavi Pokharel, World Water Envoy, Nepal, Oral presenter

Deepesh Jain, World Water Envoy, India, Oral presenter

Presentations

- Maria Almonte, *Contamination in the Guajima Stream (Santo Domingo)*
- Bayan Khalaf, *Pesticides and water contamination in Palestine*
- Georgina Mukwirimba, *Economics of water supply in big cities, in the context of a failing economy in Chitungwiza (Zimbabwe)*
- Pallavi Pokharel, *Groundwater pollution in Kathmandu*
- Deepesh Jain, *The right to water and sanitation in Delhi slums (India)*

Key messages

- Main takeaway: water security is a challenge between water quality & water quantity. Inaction from local governments in addressing these issues have resulted in people losing trust in building a pathway for better water access, even though education could empower them to mobilize real change.
- The water resource community discusses river basins, but do not always bring up groundwater/aquifers that are finite. Groundwater is considered a free-for-all resource that is not managed well or regulated.
- Groundwater management is critical for the sake of giving people water security; yet, it goes beyond just water – we must also consider land management, sanitation, etc.
- Many people use groundwater for their daily needs, yet their sources are contaminated with pollutants and easily depleted.
- Often, insecurity is a matter of having too much water (aka flooding) and yet no water that is clean enough to drink.
- Education is the key to start mobilising change; that must happen within community groups to understand the challenges and possible solutions and empowering them to advocate to government officials for programs.
- If you want to be an advisor, be an advisor – if you want to be an advocate, be an advocate. Create dialogues with people to get to practical, clear action steps for solutions.
- Young people are the new voices we should listen to, so that we can ensure we keep ourselves looking to the future and make sure we don't get stuck in the academic technical conversations.

Session Summary

We know water security can be endangered in many ways: water scarcity, natural hazards, conflicts, contaminants... the challenges and priorities are multiple, complex, and diverse. That is why for this Congress, IWRA wanted to hear from around the world, voices representing the next generation to showcase issues faced when it comes to Water Security. Selected representatives are called “World Water Envoys” and they will share their perspectives during the next XVII World Water Congress.

A summary of separate presentations per country

ZIMBABWE: Chitungwiza is a high-density town relying on buying water from Harare, which has not been able to meet the demands of the suburb. The water supply infrastructure is very old, some are beyond repair, and water supply plants are not always operational. Raw water quality has declined because of increasing pollution from human activity (including sewage output into the waterways). Groundwater is the main supplement used, but the sources are not deep, are prone to contamination, and are easily depleted. Residents complain about the water quality even when the taps flow; normally they don't even drink it without boiling it, etc. Climate change has worsened the situation as well as exposed the weaknesses in the municipality. Households are unwilling to pay for improved services because their current services are too poor, which creates a perpetuating system of poor water services.

INDIA: Delhi's slums have many issues: their slum clusters are some of the largest in the world. However, they are not legally recognized by the government as owned by the inhabitants. They are considered illegal settlements, which means that they are not legally able to get services from providers. The slums are dependent on groundwater, through public borewells and the private vendors who treat the water. These households start flooding during rainy season – there's too much water around you, but none clean enough to drink. Poor solid waste management and sewage is polluting rainwater canals, and there's no affordable drinking water. We need proper finances to supply WASH to low-income areas, but we also need policies that give people in these areas the rights to access these services.

DOMINICAN REPUBLIC: The Guajima Stream in Santo Domingo (West) has been significantly contaminated, which is creating hazards for communities especially after rain events. This region used to be one of the most important sugar production areas. Since the 1960s, the stream's shore started urbanising. The stream's contamination is coming from the people's waste, businesses, raw sewage (due to non-existent sanitary systems), and growing urbanization. In the past 20 years, the stream has been completely encroached and polluted. Because of the pollution, the stream's poor health has increased diseases, landslides, floods, and poverty. The governments have big, sponsored projects, but little has been done (except for moving families from the streams and cleaning up the trash during election campaigns). People have lost faith in government projects because they have seen a lot of inaction.

PALESTINE: The country has been experiencing several water resources issues, and the water insecurities reflect the same as other MENA countries. Most people depend on groundwater. Groundwater is contaminated by agricultural inputs (e.g., pesticides, fertilizers), solid waste, sewage, and industrial residues (e.g., pharmaceuticals); different regions have different proximities to these pollutants. These contaminants introduce toxic heavy metals, bacteria, viruses, and other chemical pollutants. Pesticides cause human health issues, degrades the environment, and hurts wildlife. Pesticides are found virtually everywhere and in measurable concentrations. There are many technologies to purify pesticides out of water.

NEPAL: Kathmandu has 800 families living on the Manohara River, and they rely on groundwater. The alternatives exist when the groundwater is depleted, mostly by moving to another groundwater source. There is no water infrastructure and many polluted rivers. There is unplanned urbanization in the area, and the groundwater has been getting polluted for decades. The majority of water sources had high amounts of faecal, iron, and arsenic contamination, making it non-compliant with national drinking water quality standards. People are not using cleaning methods for the water they use, though some do filter it. Most people experience diarrhoea – 53% of the community – and most of the households have poor sanitation facilities.

IWRA INVESTING IN YOUNG WATER PROFESSIONALS – TOWARDS YOUTH EMPOWERMENT

SESSION NUMBER: SS4-2

HOST BY IWRA

DATE/TIME: 30 NOVEMBER, 16.30 – 18.00

THEME: B3

Speakers

Asma Bachikh, IWRA – Board Member, Morocco], Moderator

Callum Clench, Executive Director, IWRA, Key-note Speaker

Bayan Khalaf, IWRA World Water Envoy, Oral presenter

Deepesh Jain, Water Youth Network and World Water Envoy, IWRA, Oral presenter

Lesha Witmer, Women for Water Partnership (WfWP), Oral presenter

Bassel Daher, IWRA, Presenter

Miriam Hacker, Senior Research Implementer Lead, Water Center, Penn, Oral presenter

Key messages

- Social media is the new general tool for growth and networking among water professionals.
- Mentoring is an organic process. More is needed in the sector and people of all ages should have access to mentors.
- Young professionals can also support peer-to-peer learning.
- Organisations like IWRA has a role to play as home to young water professionals since it provides opportunities for interacting with people of similar backgrounds, thoughts, and disciplines.

Session Summary

Callum Clench started the session by talking about IWRA and its work with young professionals. He explained that IWRA recognizes the importance of inclusion and is constantly working on this direction. Over the past 50 years, IWRA has seen more diversity and wants to see more in the coming years. It was suggested that future professionals will be the ones who ultimately achieve water resilience for the global community.

Bassel Daher, Chair of the IWRA Early Career and Young Professionals taskforce, made a presentation on the taskforce's work and activities. He explained how the IWRA task force is engaging young members, facilitating opportunities for younger professionals, and giving them a stronger voice through onboarding efforts. The task forward is divided into four working groups: social media, webinars, outreach and partnerships, and the mentorship program. Daher also explained that they had run several online networking events, known as "Water Networking" cafes.

Panel speakers at the workshop included Bayan Khalaf, Deepesh Jain, Miriam Hacker, and Lesha Witmer. They talked about their perspectives on youth engagement and how IWRA (and organisations like IWRA) could and should support young professionals with different backgrounds. They talked about how knowledge is evolving and how young people have a capacity to learn new things. There was broad agreement that we should begin sensitising students at schools on the role and importance of water and sanitation. The participation of young women is particularly important in water, given that according to research, only 17% of paid jobs in the global water sector were done by women. This prompted a discussion about the challenges young women face in getting hired, such as the perception among employers that water and related disciplines like engineering and the sciences, are a “male thing”. Lesha mentioned how the Women for Water Partnership has been working on bridging the gap for training and mentoring women in the water sector. Miriam Hacker mentioned social media as a tool for facilitating professional growth among women in the sector.

In terms of dos and don'ts for young professionals, some concrete suggestions were made. It was mentioned that there shouldn't be an over reliance on networking and that we should place our confidence in the recruitment process, which is becoming more inclusive and sophisticated. Ultimately, the point was made that we must all figure out our own paths and not assume it is the responsibility of others.

In conclusion, IWRA has a role to play in brokering partnerships and building relationships between young people and enabling opportunities. IWRA is well placed to facilitate both the sensitive and, at times, difficult conversations between young people and industry players, something which is not currently happening.

REGULAR SESSIONS

SESSION NUMBER: GS1-4

DATE/TIME: 30 NOVEMBER 2021, 10:30 – 11:45

THEME: B2

Speakers

Rabi Mohtar, IWRA, Moderator

James Nickum, IWRA, Oral presenter

Elisa Blanco, Pontifica Universidad Catolica de Chile, Oral presenter

Normundari Erdene, TU Braunschweig, Oral presenter

Presentations

- James Nickum, *Democratic transition and the end of water pricing in Korean agriculture in comparative perspective*
- Normundari Erdene, *Water security index: An application to Ulaanbaatar, Mongolia*
- Elisa Blanco, *Drivers for collective groundwater management: The case of Copiapó, Chile*

Key messages

- It is important to understand the entire cycle of water pricing since it impacts food pricing as well as the livelihood of farmers.
- There are no easy options when it comes to water-pricing policies and mechanisms, which risks such complex matters to reductionist arguments.
- Technology has a complicated relationship with politics.

Session Summary

The session discussed the question of why there is a difference in pricing between Japan and Korea. In Korea, farmers' organisations have existed at the community level for farms with more than 50 hectares in area. In 1987, multiparty parliamentary democracy was introduced in South Korea. Farmers protested the policy of no-subsidy as well as an irrigation tax. Traditionally, water fees were collected in the form of grain and labour, like China.

It was explained by the presenter that in large systems, free water was considered a trade-off for requiring farmers to grow rice. The pricing of water has a major impact on the cost of food and therefore, the income of farmers. Globally, the income of farmers is low and any increase in pricing of irrigation water can reduce it further. Water-pricing is a very delicate societal and, ultimately, a political matter.

Korea has introduced ICT metering, but due to existing pricing structures, farmers don't have much incentive to save water. Situations like these can lead to challenges in stakeholder participation. The presenter concluded by observing that while technology presents many solutions, it maintains a complicated relationship with politics.

SESSION NUMBER: GS2-4

DATE/TIME: NOVEMBER 30, 2021

THEME: B2

Speakers

Asma Bachikh, IWRA, Moderator

Hyoyeon Choi, Researcher, K-water Institute, Oral presenter

Ian White, Emeritus Professor, Australian National University, Oral presenter

Presentations

- Hyoyeon Choi, *Assessing the ecological restoration value of brackish water zone in Republic of Korea*
- Ian White, *Lessons from water and sanitation policy and plan development in Pacific Island Countries*

Key messages

- Due to an economic boost in a short period (1965-90) in South Korea, the living standard increased which increased the water demand; more investment was made in sewage infrastructure; the government also invested in ecological restoration in many river streams of South Korea helped to maintain the aquatic biodiversity.
- K-Water conducted a survey regarding public opinion for ecological restoration projects, such as in the Nakdong river estuary. Public opinion was mixed on acceptance of the ecological restoration activities (e.g., due to dam operations that affect water availability).
- Policy development for water security was introduced at the local scale in the pacific island countries; stakeholders were engaged in order to set priorities; the region is more vulnerable to natural disasters (i.e., cyclones). Thus, the adaptive measures are required for the infrastructure development to withstand natural disasters.
- However, in some island countries, responsibility for policies on economic development, natural resources, and the environment is highly centralized without stakeholder engagement.
- The education of rainwater harvesting measures is given at the primary school levels; more involvement of women leaders for policy making can strengthen sanitation-related issues.
- A water security index is going to be set up at the city of Ulaanbaatar, Mongolia; the implementation of measures for city infrastructure development should be cost-effective; the city has continuous (24 hour) water supply, but it needs to be monitored properly for equitable distribution to the Ger and apartment areas.
- There is a huge difference in the Ger area, which has minimal water supply to the area, and the apartment area of the city, which has an abundant supply.
- There is a lack of acknowledgement by policy makers regarding human rights to water and sanitation for the Ger area residents; there is a lack of rigorous comprehensive assessment of urban water management.
- Ulaanbaatar needs to chart its own water management plans that are tailored to its own context and needs, inclusive of a participatory approach.

Session Summary

Protection of the world's freshwater resources present in the lakes and rivers requires diagnosing threats over a broad range of scales, from global to local. Most of the governing agencies focus on the ecological restoration aspects for the sustainable aquatic biodiversity. There are many ecological restoration projects done in the last two decades in South Korea; the main reason behind this is the sudden growth in the country's economy. The water demand and living standard of people also increased. The ecological restoration of the Nakdong basin estuary is one of the best examples to cite. The Nakdong estuary dam was started in 1983 and was operable by 1987. The supply area of the basin includes Busan, Ulsan, and the South Gyeongsan province of Korea. The residential capacity is about 310400 m³/day, which is very much required for the stakeholders of that region.

Massive investment in water technology can be managed by the rich nations to offset high stressor levels without remedying their underlying causes, whereas the less economically stable nations e.g., pacific island countries, remain vulnerable. Similarly, in the capital city of Ulanbatar, for the water security purpose, a lot of investment is required to maintain water supply services. The policies should be made in such way that the people living in the vulnerable areas can receive benefits.

There are different ways of building local strengths, such as well-developed local institutions, resilient social systems, sensitivity to environmental change, high degree of equity, etc.; these aspects should be a focus by the policy makers. The cumulative threat framework creates a tool for prioritising policy and management responses to this crisis and underscores the necessity of limiting threats at their source instead of through costly remediation of symptoms to assure global water security for both humans and freshwater biodiversity.

SESSION NUMBER: GS4-3

DATE/TIME: 01 DECEMBER, 12:00-13:15

THEME: B4, 3.1

Speakers

Asma Bachikh, IWRA, Moderator

Jinuk Kim, Konkuk University, Republic of Korea, Oral Presenter

Emmanuel M. Akpabio, University of Uyo, Nigeria, University of Dundee, UK, Oral Presenters

Presentations

- Jinuk Kim, *The damage cost estimation of agricultural drought using reservoir drought index*
- Emmanuel M. Akpabio, *Practical and institutional challenges to achieving improved WASH services for sub-Saharan Africa*

Key messages

- Sub-Saharan Africa not on track to meet SDG6 because of a lack of a nexus approach and poor governance for WASH-related efforts. Institutional coordination and conflict between different authorities makes progress difficult.
- How do neo-liberal policies of commercialization, individualization, deregulation, and commodification reconcile with the region's spiritual perceptions of water, religious water symbolism, water knowledge, and values of nature as a gift?
- Neoliberal politics impact the WASH sector because of disinvestments in WASH services and prioritising private sector practices.
- The socioeconomic drought index (SEDI) collects data through news data and has four categories where it measures damage costs: agricultural water deficit, water security, economic damage, and environmental and sanitation impact.

- There are few adaptation options considered for farmers in current water scarcity models other than to use less water. If other adaptations are not correctly included in water scarcity models, then food production will be underestimated.

Session Summary

Access to WASH services is an acute issue in sub-Saharan Africa with low performance compared to other regions of the world, making its performance on SDG6 low. Institutional coordination and the conflict/competition between different authorities makes progress difficult. For example, in Nigeria, different ministries feel like they have sufficient capacity to address WASH-related issues, but they do not have the budget or power to be successful or to coordinate efforts well. Additionally, sub-Saharan African countries also struggle with spatial, socio-cultural, and religious values that impact WASH behaviours and practices. Lastly, there are overbearing influences by external, neo-colonial actors and institutions that have resulted in practically no improvements. How do neo-liberal policies of commercialization, individualization, deregulation, and commodification reconcile with the region's spiritual perceptions of water, religious water symbolism, water knowledge, and values of nature as a gift? Neoliberal politics impact the WASH sector because of disinvestments in WASH services and the prioritising of private sector practices. This is exacerbated by climate change, which is damaging the available critical WASH infrastructures.

Another presentation discussed how drought is a costly and complex disaster. It reviews an agricultural drought assessment that accounts for socioeconomic factors that integrates data to understand the socioeconomic impacts of droughts. Previous studies have struggled to get the data and rely a lot on assumptions; this study used news data to create the socioeconomic drought index (SEDI). The SEDI has four categories: agricultural water deficit, water security, economic damage, and environmental and sanitation impact. The result of this initiative can support measuring the complete impacts of drought on a region as well as help to develop appropriate policies.

The last presentation discussed water scarcity and its impacts on small farmers. Water scarcity is likely to increase because of climate change, which impacts crop yields. There are few adaptation options considered for farmers in current water scarcity models, other than using less water. If other adaptations are not included in water scarcity models, then food production will be underestimated. Theories of change created by researchers aim to develop adaptation measurement outcomes to support more sustainable water planning and policy creation for irrigation purposes.

C. Adopting smart technologies, policies, and processes

SPECIAL SESSIONS

GROUNDWATER MANAGEMENT FOR LAND SUBSIDENCE IN AN URBAN CONTEXT

SESSION NUMBER: SS2-2

HOST BY UNESCO

DATE/TIME: 29 NOVEMBER, 16:30-18:00

THEME: C1

Speakers

Alexandros Makarigakis, Programme Specialist, UNESCO, Division of Water Sciences, France, Moderator

Heri Andreas, Geodesy Research Division Faculty of Earth Sciences and Technology Institute of Technology Bandung Indonesia, Indonesia, Oral presenter

Dora Carreon-Freyre, Centro de Geociencias, Universidad Nacional Autonoma de Mexico, Oral presenter

Shujun Ye, School of Earth Sciences and Engineering, Nanjing University, Nanjing, China, Oral presenter

Presentations

- Alexandros Makarigakis, *Groundwater management for land subsidence in an urban context*

- Dora Carreon-Freyre, *Land subsidence in inner cities: Mexico City case study*
- Shujun Ye, *Managing aquifers to reduce land subsidence: Shanghai case study*

Key messages

- There are four categories/examples of land subsidence - Deltaic areas (i.e., Mississippi); Coastal megacities (i.e., Jakarta, Bangkok, Venice); Arid regions (North China plains); and Seismogenic/faulted regions (i.e., Mexico City).
- Land subsidence, a silent process, can be reduced by appropriate management of the available (ground) water resources.
- Failure to manage groundwater sustainably puts massive benefits for human well-being at risk.
- UNESCO is providing scientific tools and assessment to improve management of Coastal aquifers and groundwater.
- Population growth is a significant driver of increasing water demand, both directly (using water) and indirectly (water-intensive good and service).

Session Summary

Land subsidence is a silent process and a global problem with different characteristics compared to other water-related disasters. The time frame for land subsidence is years, if not decades, and it can affect hundreds to thousands km² of area. Furthermore, it has a uniform spatial distribution with very low perception of its occurrence, and it is unrecoverable. It is important to manage this problem before it's too late.

Groundwater-related subsidence is the subsidence of land resulting from groundwater extraction. It is a growing problem in the developing world as cities increase in population and water use but lack adequate pumping regulation and enforcement.

Since two thirds of the population is living in coastal areas, it is particularly important to solve groundwater problems in coastal areas. Therefore, UNESCO is providing scientific tools and assessment for improving the management of coastal aquifers and groundwater.

For Mexico, most of the main cities are on the volcanic trans Mexican belt. Subsidence is mostly determined by faults in central Mexico. National Water Programs with public policies can improve water management and make a valuable contribution in combatting subsidence in Mexico.

In 2012, the Chinese government issued a 10-year program, known as the "National land subsidence prevention and control program" after learning that land subsidence will threaten 19% of the global population by 2040 – including communities in China. In Shanghai, the level of land dropped markedly from 1964 due to the excessive pumping of groundwater. However, after governments began to enact strong controls in the region, the level of land decrease has slowed to 4mm/year. There were also some mitigation measures put in place in Shanghai, including the reduction of groundwater pumping, artificial recharge, a monitoring network, and development of a policy and regulatory framework.

TRANSFORMING SMALLHOLDER IRRIGATION INTO PROFITABLE AND SELF-SUSTAINING SYSTEMS IN SOUTHERN AFRICA

SESSION NUMBER: SS3-4

HOST BY UNIVERSITY OF SOUTH AUSTRALIA

DATE/TIME: 30 NOVEMBER 30, 14:30-16:00

THEME: C3

Speakers

Henning Bjornlund, UniSA Business University of South Australia Chair Science, technology, and Publication Committee, IWRA, incoming vice president, IWRA, Moderator

Jamie Pittock, Australian National University, Key-note Speaker

Makarius Mdemu, Ardhi University, Oral presenter

Martin P, Mayo, International Crops Research Institute for the Semi-Arid Tropics, Oral presenter

Felicidade Jorge, Eduardo Mondlane University, Oral presenter

Karen Parry, PhD candidate University of South Australia, Oral presenter

Andre Van Roayen, International Crops Research institute for the Semi-Arid Tropics, Oral presenter

Presentations

- Henning Bjornlund, *An introduction to the 'Transforming irrigation in Southern Africa' project (TISA)*
- Makarius Mdemu, *The role of soil water monitoring tools and agricultural innovation platforms in improving food security and income of farmers in smallholder irrigation schemes in Tanzania*
- Martin P, Mayo, *The dynamics between irrigation frequency and soil nutrient management transitioning smallholder irrigation towards more profitable and sustainable system in Zimbabwe*
- Felicidade Jorge, *Do AIP and soil moisture and nutrient monitoring tools improve the production and livelihood of smallholder irrigators in Mozambique?*
- Karen Parry, *The importance of learning processes in transitioning small-scale irrigation schemes towards complex adaptive systems*
- Andre Van Roayen, *Identifying leverage points to transition dysfunctional irrigation schemes towards complex adaptive systems*

Key messages

- Small scale irrigation has significant potential for improving prosperity and food security in developing countries, but many systems are not working well (most of them are failed and performed poorly)
- Sustainable irrigation systems with increased profitability are desirable, so it is important to integrate technical and institutional mechanisms for investment in small-scale irrigation schemes
- Using available tools to assess soil conditions, farmers can gain production and socio-economic benefits, but they need government support for the tools and training
- Farmers benefit from system innovation, which also allows social learning, improving profitability

Session Summary

Two tools were provided to farmers to help them manage irrigation: the full stop wetting front detector (WFD) (extracting sample and see the soil profile) and Chameleon sensors (showing the state of the soil). There were two main interventions which were simple to use: soil monitoring tools and agricultural innovation platforms (AIPs).

After supporting the farmers, irrigation was reduced by half to two thirds, which led farmers to focus spending on other essentials such as education, households, and food. However, irrigation schemes are complex systems that require multiple institutional and infrastructural investments to be sustainable. Moreover, irrigation schemes cannot be maintained unless the farming system is profitable.

As soil water monitoring tools and agricultural innovation platforms were spread to farmers, they resulted in higher yield, income, and food security. Consequently, the two interventions improved smallholders' income and food security through increased yields, reduced resource use, and improved market access.

For Zimbabwe, improving the efficiency, sustainability, and productivity of irrigation was needed. However, market, production, and other barriers were the root cause of reduced productivity and profitability in existing and new smallholder irrigation schemes. Farmers knew that rainfall could be much better utilized with better information availability. Bringing irrigating stakeholders together and using the soils assessment tools has reduced the levels of water-related conflict.

Similarly, in Mozambique, soil moisture and nutrient monitoring tools have improved irrigation and agricultural production, with increased average yield and an increase in farmers' income, which placed farmers in a better position to pay for food, education, and health than before the project.

URBAN WATER CYCLE AND INTELLIGENT TECHNOLOGIES: DANISH EXPERIENCES

SESSION NUMBER: SS4-5

HOST BY INNOVATION CENTRE DENMARK

DATE/TIME: 30 NOVEMBER 30, 16:30-18:00

THEME: C1

Speaker

Michael Rasmussen, Innovation Centre Denmark, Presenter

Presentation

Michael Rasmussen, *Urban water cycle and intelligent technologies: Danish experiences*

Session Summary

The largest emerging challenges for water management are the aging water infrastructure, the growing population, and rising energy costs. In addition to these challenges, climate change has increased pressure on society and the ecosystem around the urban area. To overcome these challenges and support proactive decision making for urban water managers, the concept of Smart Water Management (SWM) could be applied.

SWM refers to water networks that allow for simultaneous real-time analysis and self-optimization. It allows water managers to collect, share, and analyse data to find leaks, predict failures, and optimize conditions more effectively. SWM also enables citizens to accurately know the status of the water systems and deploy resources intelligently and efficiently.

In Denmark, conventional methods for solving various water issues are shifting to data-driven and preventative maintenance. Several challenges in the water sector could be reduced through integration of water management and intelligent technologies in the entire water cycle.

Project 1. Distributed online monitoring of the urban water cycle enables cost-efficient distributed monitoring of the hydrological and hydraulic states of the urban water cycle and provides data and knowledge about system correlations (DONUT project, Aalborg University).

Project 2. Smart cities water solutions aim to develop software solutions for dynamic control of pumps and gates in sewer systems to minimize the risk of combined sewer overflows and flooding; this is done through storing and discharging excess water volumes in the least harmful manner possible (tbc, Water DTU, Technical University of Denmark)

Project 3. Flood risk management through an interactive map enables instant investigation of the risk factor and understanding of the effects of changing the terrain for urban planning, emergency management, climate adaptation, and watercourse.

The international consortium created during this special session provided the foundations for global water security and resilience by sharing knowledge and creating innovative ideas through discussion.

INNOVATIVE TECHNOLOGIES FOR ALTERNATIVE WATER RESOURCES

SESSION NUMBER: SS5-2

HOST BY KYUNGPOOK NATIONAL UNIVERSITY

DATE/TIME: 01 DECEMBER, 14:30-16:00

THEME: C5

Speakers

Vincenzo Naddeo, University of Salerno, Italy, Oral presenter

Irini Angelidaki, Technical University of Denmark, Denmark, Oral presenter

Damia Barcelo-Cullerès, Catalan Institute for Water Research, Spain, Oral presenter

Di Wu, Ghent University Global Campus, Belgium, Oral presenter

Kwang-Ho Choo, Kyungpook National University, Republic of Korea, Host

Presentations

- Di Wu, *Unlocking the potential of using saline water for cooling and flushing*
- Vincenzo Naddeo, *From wastewater treatment plant to “Green factory”: advanced technologies for the ecological transition*
- Damia Barcelo-Cullerès, *Assessing water treatment technologies for efficient removal of contaminants of emerging concern, ARG, microplastics, and SARS-COV-2 in urban wastewater and landfill leachates*
- Irini Angelidaki, *Biotechnology as a tool for capturing and recycling CO₂*
- Kwang-Ho Choo, *Quorum quenching membrane bioreactor technology for water reuse*

Key messages

- There are many new innovative water treatment technologies that exist to address modern issues – from high freshwater demand, greenhouse gas emissions, and new/tricky contaminants (e.g., microplastics and COVID-19).
- Direct utilization of seawater is a cheaper option for creating water to flush toilets and provide industrial cooling, compared to desalination, especially in coastal habitats.
- Wastewater and water-based industries rely on mechanisms that were created in colder European environments; these are causing trouble when applied in warmer, tropical areas. This requires new water innovations to ensure more sustainable water resource management in different environments.
- Membrane Bioreactor wastewater technology is fashion. Water and energy are engaged in cyclical interplay. To use energy, we need a large amount of water, and vice versa.

Session Summary

Water shortage and contamination require alternative water resources, for which innovative water technologies play a central role, particularly things like membrane technology and advanced oxidation. It was explained that the objectives of this special session were to present and share recent achievements on innovative water technologies for alternative water resources, especially as they relate to water reuse and desalination with international water professionals.

Climate change will increase the instances of environmental shocks, including water-related disasters. Direct utilization of seawater is a cheaper option for creating water to flush toilets and for industrial cooling, compared to desalination, especially in coastal habitats. Hong Kong uses seawater toilet flushing (since the 1970s), which saves up to 20% of total water demand and 52% of freshwater demand. Using seawater for flushing toilets means water innovation needs to happen, such as the SANI approach: sulphate reduction, autotrophic denitrification, nitrification, and integrated process. Future innovative water systems need to accommodate tropical environments and should integrate from water systems and sewage into potable water.

The number of large wastewater treatment plants are increasing significantly in the last 3 years. Bacteria “communicate” by quorum sensing, producing AHL, Pili, etc. Water and energy are engaged in cyclical interplay. One new idea is to combine algae with bacteria as a new membrane bioreactor that reduces greenhouse gas emissions from wastewater and treats complicated contaminants, such as microplastics, and viruses, like COVID-19.

INITIATIVE ON GLOBAL STANDARD FRAMEWORKS AND CERTIFICATION SCHEMES APPLICABLE TO SMART WATER CITIES

SESSION NUMBER: SS6-4

HOST BY IWRA/K-WATER AND ASIA WATER COUNCIL (AWC)

DATE/TIME: 01 DECEMBER, 16:30-18:00

THEME: C-1

Speakers

Monica Garcia Quesada, Project Officer, IWRA, Moderator

Gabriel Eckstein, IWRA President, Professor of Law, Texas A&M, Opening/Closing remarks

Callum Clench, Executive Director, IWRA Executive Office, Oral presenter

Oh, Chu Hyoung, Centre Director, K-Water, Oral presenter

Seok Kwan-Soo, Head Researcher, K-Water, Oral presenter

Neil Grigg, Colorado State University, Oral presenter

Oscar Ibañez, President of Water and Sanitation Board of the state of Chihuahua, Mexico, Oral presenter

Presentations

- Callum Clench, *Smart water city project*
- Oh Chu Hyoung, *Busan Eco Delta smart city*
- Seok Kwan-Soo, *UNESCO "Seal of excellence for urban water management"*
- Neil Grigg, *Smart city water management, a model framework*
- Oscar Ibañez, *Mexico Smart network for meter reading and pressure control management*
- Monica Garcia Quesada, *Initiative on global standard frameworks and certification schemes applicable to smart water cities*

Key messages

- Smart water cities are sustainable cities that consider the whole urban water cycle.
- Standard indicators could contribute to the implementation of smart cities in the future.
- Integration of ICT with good governance, research innovation, and stakeholder engagement are key to smart water cities.
- There is no one-size-fits-all; smart cities solutions need to be tailored to local communities.

Session Summary

The session, "Initiative on Global Standard Frameworks and Certification Schemes Applicable to Smart Water Cities", discussed various approaches for sustainable cities via the use of technology, environmentally sustainable infrastructures, economically feasible projects, and socially equitable plans, specifically in water quality, distribution, and management.

IWRA started the session by introducing the Smart Water Cities project it is undertaking with K-water and the Asia Water Council. Together, they aim to produce an international certification scheme for Smart Water Cities. The first report from this three-year project is about to be released. It examines 8 different existing standards used for measuring different aspects of sustainable cities. None, however, are well suited for measuring and comparing smart water cities. The report also included several case studies of smart water urban implementation around the world. Having a dedicated smart water cities certification scheme helps build capacity and provides exemplars for other cities to follow.

The session highlighted the need for moving beyond conventional water management and towards strengthening the management of urban water cycles. The smart water cities approach focuses beyond the conventional management of water services provision to include other areas, such as the restoration of urban water cycle, coexistence with nature, etc.

Two of the speakers discussed two different case studies - Busan Eco Delta City (Republic of Korea) and Ciudad Juarez (Mexico). The Busan Eco Delta City case study illustrated how ICT and advanced technologies are applied to new city development. The speaker focused on how the integration of ICT, technology, good governance, and innovative research helps to achieve the goals of sustainable cities. In the Ciudad Juarez case study, the speaker focused on how we can improve water efficiency and achieve sustainability in the existing water infrastructures using ICT applications, such as advanced metering.

The integration of ICT in water supply and distribution helps by enhancing operational efficiencies, detecting leaks, educating users, and informing behaviours. It provides other benefits which can be used to create tailored solutions based on the needs of the community and city. In the meantime, the panel clarified how smart cities are not only about having smart metering integrated in water supply distribution projects. They should also integrate good governance, research innovation, and stakeholder engagement as key elements.

REGULAR SESSIONS

SESSION NUMBER: GS1-2

DATE/TIME: 30 NOVEMBER, 10:30 -10:45

THEME C2, C3

Speakers

Dong il Seo, Professor, Chungnam National University, Moderator

Alejandra Escalante Paredes, National Water Commission, Mexico, Oral presenter

Manoj Potapohn, Chiang Mai University, Thailand, Oral presenter

Stijin Reinhard, Wageningen Economic Research, Netherlands Oral presenter

Presentations

- Alejandra Escalante Paredes, *Manifestation of energetic impact like a tool to optimize the water the water efficiency in the Cutzamala system, Mexico*
- Manoj Potapohn, *Control of water pollution: a solution for restoration of the Mae Kha Canal, City of Chiang Mai, Thailand*
- Stijin Reinhard, *Modelling choices and social interactions with a public good threshold: Investment decisions in a polder in Bangladesh*

Key messages

- Water pricing and scarcity are issues inter-related with energy costs and production.
- Farmers benefit from owning more efficient and advanced water pumping equipment, but their decisions to collaboratively purchase shared water pumps requires the support of institutions to assist in building cooperation for adoption of new technologies while also considering the influence of individual preferences and human interactions on farmers' decision making.
- Public understanding, control of pollution at its source, and joint actions are the keys to the successful restoration of the Mae Kha canal and for the transformation of it into an attraction for the city of Chiang Mai.

Alejandra Escalante Paredes

- The first presentation began by explaining that public thirst is public policy.
- Water deficit is based/affected by energy costs (manifestation of energetic impact).
- There was an introduction to a tool for quantifying electrical energy as an application methodology for a system of the treatment, conduction, and distribution of drinking water in Mexico. It could be used to optimize water efficiency and reduce the energy consumption of the water sector (thereby reducing the price of the water and resulting in economic savings of millions of dollars).
- The study included external economic variables and revealed that an increase in oil prices directly affects the price of water. An oil shock is, in effect, a water shock.

Manoj Potapohn

- It's time to draw attention to the Mae Kha canal in Thailand – that was the message of the second presenter who pointed out that its water quality suffers because it's considered a backyard, where anything is dumped.
- Urban development disconnects canals from the natural environment and natural systems.
- To restore the Mae Kha in terms of water quality/quantity, the flushing out and control at the source is essential.
- Stop gap measure & long-term solutions are required. The Governor and the Ministry of Environment need to be in a coordination role. Consensus building among local communities is also crucial.
- Public understanding and joint actions are the keys to the successful restoration of the Mae Kha canal and for the transformation of it into an attraction for the city of Chiang Mai
- Modelling is also an important investment for the restoration of the water quality that can be done, although its costly. This presents another challenge to consider in the future.

Stijin Reinhard

- The purpose of the paper was to model farmers' decision-making regarding the investment in a water pump, in a polder in Bangladesh.
- Farmers' income is significantly increased if a pump is present. Farmers typically collaborate in the investment, operation, and maintenance of a pump.
- In theoretical farmers' models, farmers decide to contribute or not when a threshold is reached (i.e., enough farmers are willing to contribute to the investment).
- A Consumat model, which defines cognitive behaviour rules under uncertainty, was followed and the interactions were visualized using an agent-based model.
- The main objective was to stimulate the decision-making process of buying a pump collectively by a group of farmers.
- The results highlighted the importance of institutions in building cooperation for the adoption of new technologies.

SESSION NUMBER: GS2-2

DATE/TIME: 30 NOVEMBER, 12:00-13:15

THEME: C1, C4

Speakers

Eric Tardieu, OIEAU, Moderator

Pedro Pignatelli, Director, Arch Pedro Pignatelli, Oral presenter

Gillian Clayton, Professor, University of the West of England, Oral presenter

Fabiana Piccoli, Cambridge University, Oral presenter

Presentations

- Pedro Pignatelli, *Seawater supply network in coastal cities*
- Gillian Clayton, *The control of pathogens in stored rainwater using direct electrochemical activation*
- Fabiana Piccoli, *The equitable and reasonable utilization of water in international law: sustainability as a necessary element for transboundary water management assessment?*

Key messages

- Cape town, one of the biggest cities in South Africa, faces a water crisis. Due to socio-economic growth, the gap between supply and demand is decreasing. The saline water in parallel to fresh water can be a smart approach to fulfilling water demands.
- It is becoming important to be sensible about our use of water in order to save for future generations. Rainstorm water that is full of bacterial colonies cannot be stored for long periods of time. Electrochemical Activity (ECA) is an approach that distils water and can be used in drought periods.
- Transboundary disputes between states are becoming more frequent. International water laws are important to update. Doing so would reduce the conflicts and save future generations from water law disputes.

Session Summary

The session covered broad issues relating to modern urban water supply schemes and the laws which must be implemented to ensure water quality and to safeguard the environment. The first presenter in the session talked briefly about the water crisis problems in one of the biggest cities of South Africa, Cape Town. In previous decades, there has been huge socio-economic development in the region, and more people have moved from village areas to urbanized areas.

Although coastal areas are enriched with sea water, it can't be used for domestic purposes. Therefore, it's time to think critically about how to fulfil the needs of the water sector. The author emphasizes that a mixture of fresh water and saline water can be used to fulfil the water demands in the region.

Gillian Clayton from the University of the West of England talked about a smart approach in which the stormwater can be stored for long periods without presenting a concern for bacterial growth. She explained that electrochemical activity (ECA) is effective against bacteria. Finally, the last presenter talked about transboundary water disputes and the need for updating laws and water governance structures between states.

SESSION NUMBER: GS3-2

DATE/TIME: 01 DECEMBER, 10:30-11:45

THEME: C5, D5

Speakers

Dong il Seo, Professor, Chungnam National University, Moderator

Kiyoung Seong, Gyeongsang National University, Oral presenter

Euntaek Shin, Department of Safety Engineering, Incheon National University, Oral presenter

Presentations

- Kiyoung Seong, *Climate change impact assessment for small basins with 10-min precipitation*
- Euntaek Shin, *Development of two-Dimensional River Flow Analysis Model Using Godunov's Scheme and TVD Limiter*

Key messages

- In terms of the existing analysis of river flow in the case of meandering rivers with severe curvature, the accuracy information obtained is poor. In these circumstances, a two-dimensional flow analysis is necessary.
- More analysis of rivers around the world needs to be done to ensure a more accurate understanding of global water security-related issues.
- To ensure global water security, it's necessary to have accurate data on future events, especially in vulnerable river areas.

Session Summary

The session began with the introduction by the moderator Professor Dong Il Seo. The first presenter began the presentation by providing explaining that "in 30 years, rainfall will increase by 50ml". This presents major challenges for communities in river basins and river ecosystems. Kiyoung Seong explained that sub-hourly data is necessary for preventing disasters in small river basins in vulnerable areas, which are particularly exposed to flooding. In addition, such generated data can provide more accurate information when designing the necessary hydraulic systems and infrastructure. In his study, he used the Population-NTD model procedure, where the model was enhanced to downscale daily precipitation data to P10M. As a result, an IDF curve can be simulated providing useful information for hydraulic constructions in small basins.

In the second presentation, presenter Euntaek Shin showed that in some cases, where the curvature of the river is very severe, a one-dimensional model is not enough to generate a good flow analysis. That's why the presenter's study aims to develop a two-dimensional flow analysis. During the session, he provided an overview of the shallow water

equation using an experimental channel example with experimental values. The presenter also explained that there were two methods used to demonstrate the model: the Godunov method and the TVD limiter. The presenter concluded that it was possible to analyse floods due to extreme rainfall and anticipate the diffusion of harmful chemicals through effective river flow analysis.

SESSION NUMBER: GS5-3

DATE/TIME: 02 DECEMBER, 10:30-11:45

THEME: C5, A2, E2

The water security framework was applied to one industrial factory catchment in the Upper framework to show that it is easy to use and is replicable across geographies. The framework can be used to periodically assess water security and monitor the impact of interventions once they are implemented.

Speakers

Tom Soo, IWRA, Moderator

Malcolm Gander, United States Department of Defense, Key-note Speaker

Bong-Joo Jang, KICT, Oral presenter

Tae Soo Eum, Department of Safety Engineering, Incheon National University, Oral presenter

Sabab Ali Shah, Hanyang University, Oral presenter

Mohammad Faiz Alam, ITC, Oral presenter

Presentations

- Malcolm Gander, *Groundwater pollution & aquifer restoration: Fundamentals and new technical developments in maintaining and improving water quality*
- Bong-Joo Jang, *WhiteBox: Easy and accurate personalized weather observation station*
- Tae Soo Eum, *Verification of flow analysis model for tracking sources of water chemical accidents*
- Sabab Ali Shah, *Estimating the impacts of climate change and human activity on streamflow variability in Han River basin, South Korea*
- Mohammad Faiz Alam, *Water balance-based tool for drought proofing agricultural watersheds*

Key Messages

- Pollution accidents in the water environment are increasing because of the leakage of harmful chemicals; disaster prevention measures are required accordingly.
- Having accurate quantification of the effect of different factors like temperature on streamflow is necessary to understand the major driving factors involved in the variability of streamflow.
- Increased incidence of climate change induced water related risks of droughts are a threat to global agriculture.
- Water availability is considered the key limiting factor for crop growth.
- Water management interventions are central to drought proofing.

Session Summary

For the first presentation, "Verification of Flow Analysis Model for Tracking Sources of Water Chemical Accidents", the results show that the difference between simulation and measured results were insignificant, such that, the superiority of the flow analysis model 'HDM-2D' was proven.

Regarding the second presentation, "Estimating the impacts of climate change and human activity on streamflow variability in Han River basin, South Korea", results appeared to show an increasing trend in both precipitation and streamflow. The change point is detected in 1997, and then human activities influence the variation of streamflow. Human activities are the main driving force impacting streamflow with a contribution of 62.4%. Climate change variability contributes to 37.6% in the human induced period.

For the last presentation, “Water balance-based tool for drought proofing agricultural watersheds”, the results show that simulating intervention scenarios highlight the limitation of focusing on only structural supplies or demand side interventions which are not enough to drought proof against severe droughts.

D. Securing healthy waters, catchments, and ecosystems

SPECIAL SESSIONS

THE ECONOMICS OF WATER QUALITY

SESSION NUMBER: SS1-1

HOST BY THE WORLD BANK GROUP

DATE/TIME: 29 NOVEMBER, 14:30-16:00

THEME: D4

Speakers

Jennifer Sara, The World Bank Group, Moderator

Esha Zaveri, The World Bank Group, Moderator

Jennifer Sara, The World Bank Group, Presenter

Esha Zaveri, The World Bank Group, Presenter

Hartwig Kremer, PhD Senior Program Officer, Head of the Global Environment Monitoring Unit, UNEP, Presenter

Hon. Serigne Mbaye Thiam, Minister of Water and Sanitation of Senegal, Panellist

Sungpyo Kim, Professor, Korea University, Seoul, Panellist

Jagdish Krishnaswamy, Senior Fellow, Suri Sehgal Centre for Biodiversity and Conservation, Panellist

Presentations

- Jennifer Sara, *The economics of water quality*
- Esha Zaveri, *Economics of water quality: Key findings*
- Hartwig Kremer, *Global environment monitoring of water quality*
- Jennifer Sara, *Global knowledge for water knowledge into implementation: World bank projects and water quality*

Session Summary

While there is broad agreement on the challenge that deteriorating water quality poses to society, the global impacts of water pollution remain poorly understood, and the solutions remain largely elusive. The objective of this session was to inform participants of the new insights into economic consequences related to poor water quality and the most appropriate policy solutions.

Deteriorating water quality has emerged as a threat to global health, sustainability, and development. While the global focus has largely been on water quantity given the intensifying levels of scarcity, the quality of water is just as important and poses a growing challenge as countries industrialize, urbanize, and populations grow. Although not fully quantified, the impact of poor water quality on human development and the environment is likely to be very large. Unsafe drinking water causes more deaths than all forms of violence and war combined, and it is responsible for a larger number of deaths of children and adults under the age of 24 than air pollution.

Moderated by World Bank’s Jennifer Sara, this session helped water sector specialists, academics, and policy makers to better understand the state of global water supplies, its causes, impacts, and most efficient policy solutions. The session was organized by the World Bank and included presentations and a panel discussion.

THE WORLD BIGGEST RIVER HEALTH INITIATIVE? INSIGHTS ON THE LARGE-SCALE ECOSYSTEM RESTORATION, WATER SECURITY AND RESILIENCE FROM THE YANGTZE RIVER, CHINA

SESSION NUMBER: SS2-1

HOST BY WWF, GIWP

DATE/TIME: NOVEMBER 29, 16:30-18:00

THEME: D1

Speakers

David Tickner, WWF, United Kingdom, Moderator

Christine Colvin, The River Trust, Panellist

LI Lifeng, FAO, Panellist

LI Yuanyuan, GIWP, Panellist

Thomas Panella, ADB, Panellist

Robert Speed, Badu Advisory, Panellist

David Tickner, WWF-UK, Panellist

ZHANG Yimo, WWF-China, Panellist

Presentations

- Robert Speed, *Strategic water management in China and beyond*
- Yuanyuan Li, *The yellow river water security and river health*
- Ying Qiu, *How does an NGO measure river health?*

Session Summary

For the healthy Yangtze Basin, a proper science-based, outcome-led strategy is necessary for green development and eco restorations, planning, drought risks management, and water resources infrastructure.

The speaker talked about the reduction in streamflow of yellow river. The reduction of 10% in total water discharge is noted. The speaker highlighted both causes and remedies.

The most fascinating part of the session was to develop the approach to measure the health of Yangtze River basin. Based on this new approach, that includes the hydrological index, aquatic biota index, and water quality index, the Yangtze River basin's health falls into B- category (66%). Laws, regulations, and policy implementations in the region should be forced. This report is the first to define the health of the Yangtze River basin as being in danger.

The session talked about the health of the Yangtze River basin and its restoration. Several factors, such as climate change along with socio-economic growth, would critically affect the water supply, consequently impacting the livelihood and agricultural practices of the inhabitants living within the region. Indices to assess river condition and management systems (laws, regulations, and policy) are needed for river health management.

LARGE-SCALE FLUVIAL HYDRAULICS EXPERIMENTS

SESSION NUMBER: SS4-1

HOST BY KOREA INSTITUTE OF CIVIL ENGINEERING AND BUILDING TECHNOLOGY

DATE/TIME: 30 NOVEMBER, 16:30 - 18:00

THEME: D2

Speakers

Chanjoo Lee, Korea Institute of Civil Engineering and Building Technology, Moderator

Chanjoo Lee, Korea Institute of Civil Engineering and Building Technology, Oral presenter

Gensheng Zhao, Nanjing Hydraulic Research Institute, China, Oral presenter

Dongwoo Ko, Kyungsoong University, Korea, Republic of, Oral presenter

Kawaike Kenji, Kyoto University, Japan, Oral presenter

Seojun Kim, Myongji University and HydroSEM, Korea, Republic of, Oral presenter

Kyungsu Lee, Korea Institute of Civil Engineering and Building Technology, Korea, Republic of, Oral presenter

Presentations

- Chanjoo Lee, *Introduction of KICT-REC and its recent experimental studies.*
- Dongwoo Ko, *A full-scale test on levee breach due to overtopping in REC*
- Kawaike Kenji, *Brief introduction of the Ujigawa Open laboratory, Kyoto University*
- Seojun Kim, *CCTV based automatic discharge measurement technology for the small streams*
- Kyungsu Lee, *A study on the spatial distribution of suspended sediment considering channel flow characteristics*
- Gensheng Zhao, *Hydrodynamic erosion in overtopping breach of cohesive embankments*

Key messages

- KICT-REC (River Experiment Centre) develops technologies for flood safety, river ecosystem enhancement, and hydrological measurements, based on experimental set-ups. They are looking forward to extending collaboration with research institutes around the globe.
- The equipped facilities like Ujigawa Open Laboratory in Kyoto University, Japan, have a heavy rainfall simulator, tsunami simulator, and flood inundation prototypes, etc., which can be used for academic research as well as for outreach activities, such as training citizens for public safety.
- The use of CCTV to for discharge measurement in small streams can be used for flood discharge estimation and for an early flood warning system.
- The levee breach delay effect of the levee, reinforced with biopolymer soil, is found to be approximately 7 and 2.7 times higher than those of sand and vegetation leaves, respectively.
- Surface erosion is the initial breach phase and it triggers the head-cut erosion, leading to the deepening the crest of river embankments.

Session Summary

The session, “Large fluvial Hydraulics experiments”, shared the experiment-based research achievements in the field of fluvial hydraulics. The emphasis was on flow-vegetation interactions, flow resistance, the use of the latest technology in hydraulic instrumentation, physical models, and real-scale experiments.

The session highlighted the KICT-REC work areas with a special focus on flood safety, river ecosystem enhancement, and hydrological measurements. This research facility in Japan is used for outreach activity to train the public and civil entities relating to firefighting, flooding, urban inundation, etc. Also, levee failure which has had a big impact on agriculture, ecosystems, and human settlements, was also discussed. The case was made that a biopolymer-reinforced levee is found to be superior to those constructed by sand and vegetation.

Likewise, the session highlighted the use of CCTV cameras for small stream discharge management and showed how it can be more cost effective and efficient in anticipating and monitoring flood discharges, providing an early warning system for flooding that is crucial. There was also a discussion on embankment breaching. The case was made for the use of 3D image scanners in certain time intervals which can provide effective approaches in anticipation of three types of erosion namely, surface erosion, head cut erosion and helicoidal erosion.

To conclude, the session discussed various hydraulic experiments in Korea, Japan, and China and recommended the use of high-tech hydraulic instrumentation along with real-scale experiments. As most of the world’s populations live on riverbanks, activities like flooding not only alter the landscape, but are also very serious. Therefore, study, research, investigations, and experiments into the hydraulic characteristics of these landscapes is crucial.

ECOSYSTEM-BASED ADAPTION IN THE BASINS OF LAKES, RIVERS, AND AQUIFERS: WHEN GREEN & GRAY MAKES... BLUE!

SESSION NUMBER: SS4-3

HOSTS BY GLOBAL ALLIANCES FOR WATER AND CLIMATE (GAFWAC), INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN), UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE (UNECE), MINISTRY OF ENVIRONMENT OF SOUTH KOREA

DATE/TIME: 30 NOVEMBER, 16:30 -18:00

THEME:CD5

Speakers

Eric Tardieu, Secretary, Global Alliances for Water and Climate (GAfWaC), France), Master of Ceremony

Emmanuelle Cohen-Shacham, Chair, Nature-based Solutions Thematic Group, Commission on Ecosystem Management, International Union for Conservation of Nature (IUCN), USA), Introductory Remarks

Sonja Koeppel, Environmental Officer, United Nations Economic Commission for Europe (UNECE), Switzerland, Moderator

Tracy Molefi, Member of the Okavango River Basin Water Commission (OKACOM) and National Coordinator for River Basin Organisations in Botswana, Botswana, Panellist

An Pich Hatda, Chief Executive Officer (CEO), Mekong River Commission (MRC), Lao PDR, Panellist

Carolina Wong-Landero, Sub Coordinator, Binational Commission of the Sixaola River Basin, Panama, Panellist

James Dalton, Water Policy and Governance Coordinator, International Union for Conservation of Nature (IUCN), Switzerland, Panellist

Serik Bekmaganbetov, International Fund for Saving the Aral Sea in the Republic of Kazakhstan, Kazakhstan, Panellist

Session Summary

Climate change's primary impact to water includes unpredictable rainfall patterns, aquatic ecosystem degradation, altered river flows, sea level rise-induced salinization of coastal groundwater, as well as more frequent and intense flooding and droughts. Water-related disasters represent about 90% of all natural disasters. Ecosystem-based Adaptation addresses this issue with Nature-based Solutions (NbS). It uses biodiversity and ecosystem services to adapt to the adverse effects of climate change.

This session argues that this approach should be implemented at the scale of lake, river, and aquifer basins, including those in transboundary settings. Through exposure to case studies from around the world, the audience was invited to question conventional climate change solutions and the associated risks of maladaptation, as well as to explore the range of "no-regret" Nature-based Solutions that Ecosystem-based Adaptation mobilizes. They were also tasked with considering the interest needed to carry out this approach across borders at the scale of lake, river, and aquifer basins.

The session will address ecosystem-based adaptation (EbA) in water resource management by sharing experiences from basins around the world. It will review ecosystem-based approaches and measures to adapt to climate change in basins, identify good practices and lessons learned, and formulate recommendations to scale-up actions. It aims to raise awareness, provide guidance, and catalyse action for ecosystem-based adaptation at the basin level.

Water-related ecosystems, such as wetlands, are severely impacted by climate change. Yet, healthy, and sustainable ecosystems increase our resilience to the adverse impacts of climate change because of the services they provide. Supporting ecosystems and adopting an approach of Ecosystem-based adaptation (EbA) is especially valuable at the level of the basins of lakes, rivers, and aquifers: it recognizes that water flows and does not stop at borders, and neither do ecosystems. The added value of applying EbA in basins is to avoid mal-adaptation and to enable the maintenance of ecosystem services within the basin.

This session also provided effective options for designing, financing, implementing, and maintaining EbA at the basin level. These include the dissemination of methodological guidelines from key institutions in the field of EbA at basin level (e.g. the Handbook for "management and restoration of aquatic ecosystems in river and lake basins" published by INBO in partnership with GWP and OIEau ; the publication of UNECE and UNISDR "Words into Action Guidelines Implementation Guide for Addressing Water-Related Disasters and Transboundary Cooperation" ; the handbook of the World Bank "Financing Climate Change Adaptation in Transboundary Basins: Preparing Bankable Projects"; IUCN's definition and standards for Nature Based Solutions).

FRESHWATER CYANOBACTERIA HARMFUL ALGAL BLOOMS: HUMAN DRIVERS AND CLIMATE CHANGE

SESSION NUMBER: SS5 - 3

HOST BY CHUNGNAM NATIONAL UNIVERSITY/UNESCO

DATE/TIME: 01 DECEMBER, 14:30-16:00

THEME: D5

Speakers

Dongil Seo (physical)

Sarantuyaa Zandaryaa (virtual), Chungnam National University; UNESCO, Co-moderators

Hans W. Paerl, Professor, University of North Carolina, Institute of Marine Sciences, USA, Oral presenter

Sandra M.F.O. Azeferedo, Professor, Federal University of Rio de Janeiro, Brazil, Oral presenter

Steven C. Chapra, Emeritus Professor, Tufts University, USA, Oral presenter

Dongil Seo, Professor, Chungnam National University, Oral presenter

Presentations

- Sarantuyaa Zandaryaa, *Introduction and setting the scene: Is climate change a threat to the quality of the world's water resources?*
- Hans W. Paerl, *The global proliferation of Cyanobacterial Harmful Algal blooms (cyanoHAB): human drivers and climate change impacts*
- Sandra M.F.O. Azeferedo, *Human health and ecological effects of cyanoHABs*
- Steven C. Chapra, *Detection, prediction, and modeling of cyanoHABs: The role of science in decision-making*
- Aoife Quinlivan, *Prevention, mitigation, and control of cyanoHABs*

Key messages

- Current and projected climate change will have adverse impacts on the quality of freshwater resources. This is an under-researched area.
- Higher water temperatures due to global warming, as well as nutrient releases, will promote the proliferation of algal blooms, some of which are highly toxic; algal blooms are predicted to increase exponentially by 2050.
- Possible solutions include temperature control, nutrient limitation, the encouragement of animal grazing and the provision of embayment for settling to remove nutrients.

Session Summary

The session addressed the worrisome proliferation of cyanobacteria in waterbodies and the drivers of climate change, including human health, detection, modelling, and prevention of the risks associated with cyanobacteria. The session concluded with potential recommendations and solutions for the devastating effects of algal blooms.

Cyanobacteria are a natural component of phytoplankton, which have a complex trophic cyanotoxin connection, thereby making the modelling process a herculean task. Findings from one of the case studies showed that Lake Taihu, which is the 3rd largest lake in China, recorded a historic increase in TN and TP loading while nutrient (N & P) in Taihu swung wildly, due to over-enrichment. This indicated a greater need for research to address the looming danger.

Cyanobacteria will continue to grow rapidly because of their high adaptation qualities, accelerated growth in conditions of higher temperature (which is currently being aided by global warming due to climate change), and a long history of evolution (because they have been in existence for billions of years). Possible solutions suggested during the talk were temperature control, nutrient limitation, grazing and settling/buoyancy.

Changes in the hydrological cycle such as precipitation seasonality and extreme events like droughts and floods will significantly reduce water quality. Simulation of cyanobacteria must focus more on the combined effect of Nitrogen and Phosphorus in water while nutrient management practices must aim to reduce both Nitrogen and Phosphorus inputs through imposition of nutrient restrictions. Cyanotoxins are highly potent toxins, which may be possibly carcinogenic,

not easily degradable and occur potentially in every aquatic ecosystem. Hurricanes and typhoons do not actually destroy algal blooms, but rather make them bigger. Cyanobacteria will increase exponentially by 2050 and beyond because of high temperatures brought about by climate change. Similarly, in earlier research by the speakers, growth rate of algae doubled for every 10° C increase.

Future research prospects must focus on physiological studies on alga affinity for high temperature; environmental conditions which stimulate these algae to multiply rapidly; and an understanding of whether cyanobacteria will keep growing without plateauing with increasing temperature.

As a concluding remark, UNESCO is focused on availing people with existing knowledge targeted at mitigating the effects of climate change to propagate policy frameworks that will lead to actions that will curb the proliferation of algal blooms.

REGULAR SESSIONS

SESSION NUMBER: GS1-3

DATE/TIME: 30 NOVEMBER, 10:30-11:45

THEME: D1

Speakers

Christopher Scott, University of Arizona - Udall Centre for Studies in Public Policy, Oral presenter

Kyungrock Paik, Korea University, Oral presenter

Yingshan Lau, National University of Singapore, Oral presenter

Roshni Jose, Abertay University, Oral presenter

Presentations

- Christopher Scott, *Anticipatory water security governance: Emerging challenges in Himalayan and Andean headwaters basins*
- Kyungrock Paik, *Toward a better estimation of catchment-wise evapotranspiration*
- Yingshan Lau, *Living in a watershed: the role of traditional and local practices*
- Roshni Jose, *Using a mixed method approach to determine the multiple benefits provided by sustainable Urban Drainage Systems*

Key messages

- Energy has climate and development challenges, as well as governance needs that makes it an “in transition resource”.
- Evaporation rates are predicted to increase due to climate change; however, data trends from several locations do not show an increasing trend even where air temperatures have increased. Research into several theories is underway to understand this discrepancy.
- Incorporating traditional knowledge and local knowledge in watershed management can empower the community and researchers while supporting collection of more accurate information based on community knowledge.
- Multiple benefits from sustainable urban drainage system techniques can be obtained if socio-economic factors are also included in the analysis, such as the enjoyment of green spaces by residents.

Session Summary

Himalayan communities in the Andes face energy and water challenges. One way to anticipate these challenges is to consider the use of hydropower.

Known equations to determine evaporation are estimates only as there is no precise data for evaporation. Satellite data from GRACE can support theoretical estimates. Expected evaporation increases have not yet been detected in the data, even with increasing air temperatures.

It is possible to obtain better results in research in watersheds when you have the participation of the community. Reasons for incorporating TK and LK increase the relevance for residents of research and enable adaptation activities within the watershed for development programs, and more. There is a moral obligation to treat watershed 'residents' with respect, and to integrate their TK / LK, which is integral to cultural identity and self-dignity.

The benefits of SuDs increase with the development of communication tools, which help residents understand the SuDS features and landscape architects, engineers, planners, and policymakers in decision making on SuDS.

SESSION NUMBER: GS2-3

DATE/TIME: 30 NOVEMBER, 12:00-13:15

THEME: D1, D2, A3, E2

Speakers

Tom Soo, IWRA, Moderator

Burnice Karimi Ireri, Egerton University, Kenya, Presenter

Tae Sung Cheong, NDMI, Republic of Korea, Presenter

Giang Ngugen, Kyungpook National University, Republic of Korea, Presenter

Sofia E. Garrido Hoyos, Instituto Mexicano de Tecnología del Agua, Mexico, Presenter

Presentations

- Burnice Karimi Ireri, Provisioning of water ecosystem services in Kapingazi catchment, Embu County, Kenya. Can prospects of willingness to pay improve water quality and quantity within the catchment
- Tae Sung Cheong, Development of measured data based nomograph for flood warning system
- Giang Ngugen, Merging multiple satellite precipitation products in Korea by using random forest model
- Sofia E. Garrido Hoyos, Dispersion and transportation of pollutants in the Low Basin of the Yaqui River and the environmental impact on the marine organisms of the Lake Tobarí (Gulf of California)

Key messages

- Ecosystems provide many beneficial systems for humankind, including water provision.
- When humans over exploit ecosystems, they affect ecosystem services intensively, endangering our own survival and development.
- 90% of river flood disasters occur in small river basins because its restoration ratio is relatively lower than local rivers (70%) and national rivers (98%).
- Measurement data can be used for enhancing the SRFWS to estimate flow discharges and depths in the small streams.
- Satellite-based precipitation products (SPPs) have been recognized as a reliable data source and can be used as valuable input for researchers in water resource management and hydrology.
- Extensive agricultural activity in the lower Yaqui river basin has led to the widespread use of pesticides and fertilizers that are transported through run-off water into the agricultural drainage system and thus, causing many adverse effects on the environment.

Session Summary

For the first presentation on the provision of water ecosystem services in Kapingazi catchment, Embu County, Kenya, survey results showed that 67% of respondents were willing to pay for improved water services in terms of water quality and water quantity within the catchment area. The respondents were willing to pay an average of USD 9.10 per annum in addition to the average water connection fee of USD 4.19 per month for improved water services in the

Kapingazi catchment. Logistic regression analysis revealed that age, education, and household size were factors influencing respondents' willingness to pay (WTP) for improved water service in the study area. Positive WTP for improved water service provision shows the need for improved water service provision in the Kapingazi catchment. The implications of the project suggest that decision makers should create an enabling policy for implementation of payment for ecosystem services (PES) to include improved water service provision while at the same time securing a healthy ecosystem in the Kapingazi catchment.

For the second presentation, "Development of Measured data Based Nomograph for Flood Warning System", researchers explained the development of the Small Stream Flood Warning System (SSFWS) and how it works to provide an adequate response to reducing flood damages in unmanaged small rivers. The system that was developed estimates channel depths and discharges by using measured-based nomographs and rainfall data forecasted by the McGill Algorithm for Rainfall. The nomograph reflects table-type relationships between rainfall, discharges, and depths, and is developed by measured data from 2016 to 2017 in small rivers. This study also evaluated its estimating accuracy with discharges and depths data measured in the 2018 flood season. The outcome suggested that measured data can be used for enhancing the SRFWS to estimate flow discharges and depths in the small streams.

In the third presentation, "Merging Multiple Satellite Precipitation Products in Korea by using Random Forest Model", speakers showed how the RF model performs when compared with observation data as well as with original satellite precipitation data. RF proves to be a robust method for rainfall, as estimated from multiple satellite products.

The last presentation, "Dispersion and Transportation of Pollutants in the Low Basin of the Yaqui River and the Environmental Impact on the Marine Organisms of the Lake Tobari (Gulf of California)" was a technical presentation based on agricultural discharges and the implications for water quality and wider ecosystem health.

SESSION NUMBER: GS3-3

DATE/TIME: 01 DECEMBER, 10:30-11:45

THEME: D1, D3

Speakers

Patrick Lavarde, IWRA, Moderator

Masaharu Motoshita, National Institute of Advanced Industrial Science and Technology, Japan, Presenter

Sang Yong Chung, Pukyong National University, Republic of Korea, Presenter

Alicia Correa, Justus Liebig University, Germany, Presenter

Presentations

- Masaharu Motoshita, *Sustainability of water consumption in global watersheds - current state and the effects of virtual water trade*
- Sang Yong Chung, *Enhancement of groundwater contamination-vulnerability assessment using DLNN method combined with optimized original DRASTIC methods*
- Alicia Correa, *The water-energy-food nexus (WEF) in Pacific-Andes-Amazon altitudinal transects towards Sustainable Development Goals*

Key Messages

- The use of sustainable water is considered a vital social issue and one of the Sustainable Development Goals (SDGs) by the United Nations.
- Ensuring a balance between pressure reduction on planetary boundaries and sustainability at the watershed level is a crucial issue for freshwater sustainability use.
- Enhancing the assessment of Groundwater contamination vulnerability using a Deep Learning Neural Networks (DNLL) is central.

- The reliable assessment of Groundwater contamination vulnerability (GCV) is very important for the effective management of Groundwater .
- Climate change has extremely adverse effects on water, energy, and food (WEF) security around the world, especially in vulnerable regions in the Global South.
- Assessment of Local Environmental and Socio-Economic conditions should be done more thoroughly to propose adaptation strategies for achieving multiple Sustainable Development Goals.

Session Summary

The first presentation, “Sustainability of Water Consumption in global watersheds - current state and the effects of virtual water trade”, reflected study results that show that 24% of total freshwater consumption exceeds the carrying capacities of watersheds. Freshwater demand for domestic and irrigation use accounts for 60% of the overconsumed part of the total freshwater consumption.

On average, there is a 60% gap in the water required for ecosystems in watersheds because of high freshwater demand. This has significant results on ecosystems. The demand for traded crops in the global supply chain indirectly contributes to freshwater over-consumption in watersheds, while around 5% of freshwater overconsumption is globally saved through virtual water trade. Freshwater overconsumption is imposed in some producing countries in addition to their national demand to satisfy the demands of leading global consumer countries.

The second presentation, “Enhancement of groundwater contamination-vulnerability assessment using DLNN method combined with optimized original DRASTIC methods’ compared Assessment capability of Optimized ODMs (ODM-PSO, ODM-DE) to that of supervised artificial intelligence DLNN using correlation coefficients with nitrate concentrations and VI maps. DLNN appeared to have a more accurate spatial distribution map, as well as higher coefficient of VI than the Optimized ODMs.

The last presentation, “The water-energy-food nexus (WEF) in Pacific-Andes-Amazon altitudinal transects towards Sustainable Development Goals” analysed current and future water resources and discussed a study of their interdependent hydro-energy and food sectors ranges from the water-towers of the Andean mountains to the Pacific Ocean and the Amazon floodplain. This research will help in ensuring the mobilization of resources for sustainable development, as well as the management of transboundary catchment and ecosystems.

SESSION NUMBER: GS3-4

DATE/TIME: DECEMBER 1, 10:30-11:45

THEME: D5

Speakers

Yeonjoo Kim, Yonsei University, Moderator

Wonjin Jang, Konkuk University, Oral presenter

Yongwon Kim, Konkuk University, Oral presenter

Soojeong Myeong, Korea Environmental Institute, Oral presenter

Presentations

- Wonjin Jang, *Assessment of future climate change impacts on ground water level using SWAT-MODFLOW in Geum River Basin of South Korea*
- Yongwon Kim, *Evaluation of streamflow and water quality impact of Yeongsan River basin by inter-Basin water transfer using SWAT*
- Soojeong Myeong, *Rice paddy ecosystem services for climate change using land use and climate change scenarios*

Key messages

- Groundwater contributes to 10% of total water demands in South Korea. The ground water level is projected to decrease 15 cm over the next ten years.
- Inter basin water transfer (IBWT) is one of the ways to fulfil the water demands; however, IBWT could change the water quality of the Yeongsan River basin in Korea.
- Nature provides its own natural eco system services and paddy rice fields provide soil carbon storage which improve the ecosystem. Due to climate change and urbanization, the annual carbon storage, along with the annual water yield, is decreasing in Korea.

Session Summary

This session talked about securing healthy waters, catchment, and ecosystems. River basins provide water for agricultural and domestic purposes. Groundwater fulfils 10% of the water needs in South Korea. The ground water level is changing, however, due to climate change and urbanization. Cities are now more developed and urbanized than before. Wonjin Jang, one of the speakers of the session, used a SWAT-MODFLOW model to project the changes in ground water level under climate change and land use scenarios. He projected a decrease of approximately 15 cm in ground water level along with total run-off in Geum river basin. Policy makers must consider this issue while making policies about water usage and should work to mitigate the abrupt decrease in ground water level.

Yongwon Kim from Konkuk University talked about how the water demands in a water scarce region can be fulfilled by inter basin water transfer (IBWT) techniques. By using the SWAT model, the speaker projected the water quality and water availability in Yeongsan River basin under 6 hypothetical scenarios. The IBWT approach can fulfil the water need, but it would also decrease the water quality and impact inter-basin water disputes between provinces. A representative from the Korea Environmental Institute shared research on how rice paddies can be used to boost ecosystem services. The land use has been continuously changing due to urbanization that decreased the paddy rice fields area. The paddy rice fields store the CO₂, but compared to the past 20 years, it has decreased, consequently impacting the ecosystem.

SESSION NUMBER: GS4-4

DATE/TIME: DECEMBER 1, 12:00-13:15

THEME: D2, D5

Speakers

Eric Tardieu, Secretary General, OIEAU, Moderator

Kola Yusuff Kareem, Ph.D. Scholar, ASTC, KNU, Oral presenter

Shiksha Bastola, Ph.D. Scholar, ASTC, KNU, Oral presenter

Moushumi Hazra, Research fellow, IIT Roorkee, Oral presenter

Soyoung Woo, Konkuk University, Oral presenter

Presentations

- Kola Yusuff Kareem, *Water level prediction using LSTM and GRU for data-scarce areas*
- Shiksha Bastola, *Climate change and its impacts on the ecosystem services*
- Moushumi Hazra, *Antibiotic resistant genes and integrons: A potential threat to the Ganga River ecosystem, India*
- Soyoung Woo, *Water quality and aquatic ecology simulation of Andong Lake in South Korea using SWAT-WET*

Key messages

- Many researchers are using deep learning technology in the field of water resources because big data analysis is more robust.
- The InVEST model, developed at Stanford University, focuses on changes in water yield, soil loss, carbon storage, and more.

- Carbon storage in some water basins is declining because of decreasing vegetation due to increases in built-up areas.
- Research indicates that water quality analysis of the largest river of India (the Ganges) is impacted by religious activities in the region, which increases the various infectious microbes such as E. Coli.

Session Summary

This session consisted of three presentations offering diverse application potentials in the fields of water resources and ecosystem services. References to a study using advanced technology (A.I.) and deep learning in the field of big-data analysis can help in predicting future climate change scenarios and can help policy makers in the field of water resources and in data scarce regions.

Researchers in this session also presented on various impacts to ecosystem services due to various anthropogenic interventions happening in developing nations. The research project going on at the IIT Roorkee to study water quality parameters of the Ganges River water show the presence of various microorganisms which can cause serious infectious diseases to people, depending on the river of that region.

Although there is a project led by the Indian government ('Namami Gange') to clean the Ganges water, there is hope that the study can locate important hotspot areas on spatial maps that will make city policy makers and municipality bodies more aware of purification and other measures for dealing with water pollution. They are taking water for domestic purposes. Public awareness is also required in this region regarding potential risk related to the human health that could break out because of the cultural and religious activities degrading the water quality of the river.

SESSION NUMBER: GS5-2

DATE/TIME: 02 DECEMBER, 10:30-11:45

THEME: D4

Speakers

Gary Jones, International Scientific Committee, IWRA, Moderator

Bethany Fox, University of the West of England, Bristol, United Kingdom, Oral presenter

Junho Lee, Yonsei University, Korea, Republic of, Oral presenter

Jaeyoung Kim, Chungman National University, Korea, Republic of, Oral presenter

Robert Michael DiFilippo, University of the Philippines, Philippines, Oral presenter

Presentations

- Dr. Bethany Fox, *Using a novel in situ fluorescence sensor to monitor biological contamination in the Hooghly River*
- Junho Lee, *Improvement deionization efficiency of CDI system using highly dispersible rGO based electrode*
- Jaeyoung Kim, *Dynamics of water quality and algal blooms in the regulated Geum River, Korea*
- Robert Michael DiFilippo, *Freshwater lens assessment protocol of Karst Island water resources: Towards an interdisciplinary approach*

Key messages

- Current water quality monitoring is insufficient. Ways for improving methods must be addressed.
- The electrical and surface properties of an electrode are important factors in determining ion removal efficiency.
- It has not been determined that Gate control of in-stream structures can improve water quality and algal blooms.
- Assessing root causes of saltwater intrusion is important; there is often inadequate resources available, contributing to saltwater intrusion in Karstic geographies.

Session Summary

In this session, there was a broad discussion about new methodologies for guaranteeing water safety. In the first presentation, Dr. Bethany Fox showed data on the current reality and the need to guarantee quality of the water in the Ganges River in India. She highlighted that this river provides crucial water resources. 3 billion litres of

urban wastewater enter the Ganges daily; yet, only 25% of the water is treated. To respond to these challenges, Dr. Fox discussed the VLux Sensor which can provide real-time fluorescence data, including information on turbidity and absorbance. Six samples were analysed. Two of the samples showed biological contamination that was later confirmed by laboratory analysis. It also showed a three-fold increase in Peak T. This was not reflected in the bacterial data but was seen in phosphorous concentration.

In his presentation, Junho Lee emphasized that urbanization and industrialization have negatively affected water in both quantity and quality. He discussed the use of CDI as a technology for water treatment that applies a weak current to electrodes in an aqueous solution to form an electrical double layer on the electrode surface. It adsorbs ionic substance by electrostatic force and detaches by applying an opposite current. For this study, rGO-H and rGO-D were used to measure the efficiency of salt removal, where the rGO-D significantly wetted the water more than the rGO-H, compared to the activated carbon electrode.

In his presentation, Jaeyoung Kim discussed that currently, Harmful Algal Blooms exist in regulated water bodies and are often found through hydraulic structures such as dams and weirs. The removal of such hydraulic structures can improve HABs. In addition, increased water velocity, such as gate opening can decrease algal blooms. Jaeyoung Kim said that the removal of such structures is beneficial. He noted it was very difficult to establish a large-scale water resource management plan based on this principle, because various factors such as socio-economic drivers limit options.

The last presentation, by Robert DiFilippo, discussed the problem of saline intrusion in karstic regions in the Philippines. This has not yet been resolved due to the lack of information and the poor resources available for investigating causes. Robert DiFilippo explained that he performed a 12-month examination of island geology, hydrochemistry, and key local and regional climate data through the development of a Freshwater Lens Assessment Protocol (FLAP) framework. This provided a first valuable step in understanding the problem and the challenge.

SESSION NUMBER: GS6-2

DATE/TIME: 2 DECEMBER, 12:00 -13:15

THEME: D3

Speakers

Laura Movilla Pateiro, University of Vigo, Moderator

Jagdish Krishnaswamy, Ashoka Trust for Research in Ecology and the Environment / Indian Institute for Human Settlements (IIHS), India, Key-note Speaker

Sung-Uk Choi, Prof, Yonsei University (Korea, Republic of), Oral presenter

Arnold Rafik, Pakmission Society, Pakistan, Oral presenter

Presentations

- Jagdish Krishnaswamy, *Barrage and dam operations, irrigation systems, and ecological flows in the Ganga and Indus basins, India: trade-offs and opportunities*
- Sung-Uk Choi, *Estimation of environmental flows from an ecological engineering perspective*
- Arnold Rafik, *Rainwater harvesting: A successor to human well-being*

Key messages

- There are no SDGs for freshwater ecosystems, so the life below water is not given much attention; yet dams, canals, and other works have significant impacts on aquatic ecosystems.
- Moderate reduction in agricultural water demands, combined with adaptive management of dam operations, can sustain the ecological needs of endangered species in rivers.
- Different methods of estimating environmental flows can underestimate actual flows, potentially endangering sensitive species during dry periods.

- Rainwater harvesting offers important opportunities for water availability, but they need to be supported by water management awareness, infrastructure for water storage at communal and household level, and water purification technologies (such as bio-sand filters).

Summary Sessions

Jagdish Krishnaswamy

- We don't have targets on life below water; there are no exclusive SDGs for freshwater ecosystems, so the life below water is not given much attention.
- Dams, barrages, and canals have major impacts on sediment flow downstream and upstream and this, in turn, affects endangered species such as dolphins, gharial etc.
- In this paper, the study area of interest was the Ghandak basin.
- The maintenance of dry season ecological for gharias in the Gandak river by:
 1. Obtaining data from long term data (2000-2018) on canal maintenance and river discharge in the Ghandak basin.
 2. Taking field measurements and statistical modelling of river hydrology in the dry season.
 3. Biodiversity surveys and interviews with local farmers and fishers (2014-2017)
 4. Obtaining knowledge from other change components: groundwater use
- Moderate reduction in agricultural water demand combined with adaptive management of barrage operations can sustain ecological needs of endangered species in the Gandak river.
- Limitations in existing surface-water irrigation systems lead to both trade-offs and opportunities in regulated riverscapes.
- For an increase of 1000ha in canal irrigated areas, a corresponding decrease of 4cumecs in river flow was estimated.
- Low to moderate reduction in water use in agriculture can make a big difference to river ecology.
- Barrage and dam operations need to be reconsidered for maintaining ecological flows in both wet (sediment release and flushing) and dry season (maintain ecological connectivity and avoid inundation of nests)
- Short term weather forecasts and monsoon forecasts can help with adaptive management of barrages and dams.

Sung-Uk Choi

- Environmental flow methods can be classified into four groups: hydrological method, hydraulic rating method, habitat simulation method, and the holistic method. Of these, the holistic method was not used.
- The objective of the study was to compare quantitatively the environmental flows from a habitat suitability perspective. A 20km long reach in the Naeseong-Cheon stream was selected as a study area.
- EF's change significantly depending upon the selection of the methodologies. This is because the principles by which EFs are estimated are different.
- The min flows by the hydrological methods were much smaller and the optimal flow by the hydraulic rating method was much larger.
- These two methods may result in inappropriate EFs for aquatic organisms in the river

Arnold Rafik

- Rainwater harvesting can improve human-wellbeing
- An average rainfall is 4inches in Sindh drought areas, hence 1inch= 25.4 mm can contribute to 4731.765 litres of water on a 2000sq.feet area.
- A person can get an average of 15litres a day from rainwater harvesting. Water stored in one monsoon season will be around 18 925 litres, which is enough for 180 days for households with an average of 7 members.
- Proposed solutions:
 1. Water management awareness
 2. Infrastructure for water storage at communal and household level.
 3. Provision of bio-sand filters for water purification.

E. Implementing pathways for development and cooperation

SPECIAL SESSIONS

AN INTEGRATED APPROACH TO THE GOVERNANCE OF SHARED WATERCOURSES IN AFRICA. SESSION 1: EAST AFRICA BASINS (NILE, OMO-TURKANA)

SESSION NUMBER: SS1-3

HOST BY UNIVERSITY OF STRATHCLYDE, UNIVERSITY OF ABERDEEN, INTERNATIONAL WATER MANAGEMENT INSTITUTE

DATE/TIME: 29 NOVEMBER, 14:30 -16:00

THEME: E3

Speakers

Paolo Burlando, ETH Zurich, Switzerland, Moderator

Z. Yihdego & J. Gibson, University of Aberdeen, United Kingdom, Key-note Speaker

Paolo Burlando, ETH Zurich, Switzerland, Oral Presenter

Eric Odada, University of Nairobi/ ACCESS, Kenya, Oral presenter

Kevin Wheeler, University of Oxford, Oral presenter

Fritz Kleinschroth, ETH Zurich, Switzerland, Oral presenter

Andrea Castelletti, Politecnico Milano, Italy, Oral presenter

Presentations

- Paolo Burlando, *A distributed approach to model the Water-Energy-Food -Environment Nexus: Conceptualization, application, and evidence in African basins*
- Z. Yihdego & J. Gibson, *Benefit-sharing and frameworks for cooperative transboundary governance in the Omo-Turkana*
- Eric Odada, *Assessment of vulnerability of water resources to environmental change in Africa: River basin approach*
- Kevin Wheeler, *Supporting transboundary planning through flexible modelling frameworks: multi-year drought management for the Nile River Basin*
- Fritz Kleinschroth, *Global narratives on African river basin management*
- Andrea Castelletti, *Exploring multisectoral synergies and trade-offs in dam filling in transboundary river basins: a case study in the Nile*

Key messages

- Africa has a high percentage of people that do not have sanitation systems nor clean water.
- Transnational law in transboundary settings could improve the decision-making on hydropower projects, providing an accurate understanding and analysis of a situation that can lead to more informed and better governance.
- The modelling approach of Water-Energy-Food -Environment uses the WEF Nexus evaluation model+ strategic optimization model (DAF), eco-system services descriptions, and more.
- Data exchange may potentially support cooperation, but it could be more effective for practical applications, such as flood control, drought forecasting. The lack of data exchange may limit practical usefulness of data.
- Despite important progress made in both projects, fundamental knowledge gaps remain in terms of aquifer dynamics.
- Existence of a strong RBO that gives focus to groundwater can be critical for elevating and sustaining cooperation on a particular aquifer.

Session Summary

This session reviewed the benefits of an integrated approach to governance of shared water courses in Africa. The session, "Integrated approach to the governance of shared water courses in Africa" was themed under the water-energy and food nexus with a focus on transboundary water resource management. The session started virtually with a presentation on the local demands of people for a transboundary approach to river basin management. The session

continued with a presentation aimed to serve as an exchange of knowledge among past projects and studies in the different river basins along with an acknowledgement to the space-time impact of the water-food and energy nexus.

The most captivating question put forth was “should we respond to local needs before applying a global perspective?”. The benefit of noticing and in fact solving local problems at the local level without any global intervention is that it allows them to understand and solve problems faster. It was also discussed that a global perspective does not necessarily mean that it is the key to solving problems. Therefore, to foster inclusivity and cooperation, discussion at the local level was deemed to be most important.

Another main conclusion was the knowledge gaps on the surface water and aquifer dynamics. The knowledge gaps in return demand a data management plan. Therefore, the transboundary water management does not only have a stakeholder approach but also touches the policy perspective, making it imperative to connect the bridge between governance and implementation.

AN INTEGRATED APPROACH TO THE GOVERNANCE OF SHARED WATERCOURSES IN AFRICA SESSION 1: EAST AFRICA BASINS (NILE, OMO-TURKANA)

SESSION NUMBER: SS2 - 3

HOST BY UNIVERSITY OF STRATHCLYDE, UNIVERSITY OF ABERDEEN, INTERNATIONAL WATER MANAGEMENT INSTITUTE

DATE/TIME: 29 NOVEMBER, 16:30-18:00

THEME: E3

Speakers

Julie Gibson/ Zeray Yihdego, University of Aberdeen, Moderator

Jonathan Lautze, International Water Management Institute, Oral presenter

Alistair Rieu-Clarke, Northumbria University, United Kingdom, Oral presenter

Fritz Kleinschroth, Ecosystem Management Group, ETH Zurich, Oral presenter

Salman Salman, Nile Research Consortium, Sudan, Oral presenter

Andrea Castelletti, Politecnico Milano, Italy, Oral presenter

Julie Gibson and Zeray Yihdego, University of Strathclyde and University of Aberdeen, Oral presenter

Paolo Burlando, ETH Zurich

Presentations

- Jonathan Lautze, *Conjunctive water cooperation in the SADC region: Emerging experiences*
- A. Rieu-Clarke, *The Convention on the protection and use of transboundary watercourses and international lakes (Water Convention) within an Africa context – lessons learned and future prospects*
- Fritz Kleinschroth, *Narratives underlying research in African river basin management: the case of Omo-Turkana Basin*
- Julie Gibson and Zeray Yihdego, *An integrated approach to water governance in the Zambezi: lessons and prospects*
- Salman Salman, *'The Nile River Basin and its Changing Legal Contours'*
- Andrea Castelletti, *Assessing present and future value of cooperation across sectors in the Zambezi River basin*
- Paolo Burlando, *A distributed approach to model the Water-Energy-Food-Environment Nexus development pathways and evaluate their impacts: Conceptualization, application, and evidence in African basins'*

Key messages

- The Omo-Turkana Basin is a cascading basin that is shared by Ethiopia and Kenya
- Sadly, there is no transboundary water agreement between both countries. This creates a need for proper water governance policies to curb the problems currently experienced in the basin.
- Active water infrastructural development has also contributed to the woes; therefore, a balanced water quality and quantity analysis is necessary.

- A comprehensive book addressing the constraints and solutions has been published and the chapters were presented briefly during the session.
- Labour-intensive agronomic practices characterized by hoe and local animal draught system affect crop production and livestock farming in the basin.

Session Summary

An integrated approach to water management, security and ecosystem services in the transboundary Omo-Turkana is urgently needed to address water security problems between the two countries (Ethiopia and Kenya). Construction of large dams has affected water levels in the basin while effects of climate change and lack of active transboundary body to govern trade between the two countries are apparently felt by the citizens and government. Soil mining tendencies, poor road access, poor animal husbandry system, natural disaster and insecurity have plagued the basin. This increases the need to implement effective policies on data management.

Potential solutions to the current menace are highlighted below:

- Soft law agreement
- Data collection and exchange
- Hard law treaty

In conclusion, to achieve the aim of the project, the two countries must work based on accurate science and mutual interest, not on perception and fear

ENSURING BENEFIT SHARING AND JOINT MANAGEMENT OF DAMS: THE ROLE OF INTERNATIONAL WATER LAW

SESSION NUMBER: SS6-3

HOST BY AIDA/GENEVA WATER HUB/UNIVERSITY OF GENEVA/IUCN

DATE/TIME: 01 DECEMBER, 14:30 – 18:00

THEME: E3

Speakers

Raya Stephan, Deputy Editor-in-Chief, Water International, Moderator

Ambassador, Guy Bonvin, Swiss Special Envoy for Water in Central Asia, Federal Department for Foreign Affairs, Key-note Speaker

Alejandro Iza, IUCN Germany, Oral presenter

Mara Tignino, Geneva Water Hub / University of Geneva, Oral presenter

Diego Jarra, IUCN Germany, Oral presenter

Christophe Brachet, Deputy General Manager, OIEau, Oral presenter

Maria Gwynn, Institute for Public International Law, University of Bonn, Oral presenter

M. Abdoulaye Sene, Executive Secretary and Co-Chair, Preparatory Committee for the IX World Water Forum, Presenter

Christian Brethaut, Scientific Director, Geneva Water Hub, Concluding Remarks

Key messages

- Political will and appetite for cooperation is more important than any other aspect of dam management or development.
- Existing frameworks, tools, and case studies in South America and Africa provide guidance to foster cooperation and better dam management.
- An IUCN dam management project has been initiated to provide principles and guidance that reflect more current values into dam development than were present when most existing dams were created decades ago. Moreover, climate change impacts were not known in previous decades and thus, needs to be included in dam management practices.

- Identification of ‘water windows’ is a technique successfully used in South America to have stakeholders identify their minimum needs under drought conditions so that enough water can be released from the dam to satisfy these needs through collaboration rather than conflict (e.g., for navigation, energy, water supply).
- Cooperation on transboundary water law is essential for peace and sustainability
- The “equitable and reasonable utilization” principle of international water law obliges that all states sharing a watercourse an equitable and reasonable use of the water resource. Equitable use must account for pollution and other conditions that impair use.
- The IUCN initiative is an open forum, and all are invited to participate in its further development

Session Summary

Ambassador Bonvin outlined an initiative for large dam management. Political will is essential for successful cooperation and dam management. International law needs to involve lawyers, ethical specialists, engineers, and others.

Large dams pose several planning, construction, operation, and decommissioning challenges. Technical, socio-economic, political, and environmental challenges characterize the challenge. Dams represent power—in terms of their size, location of importance, or what the dams represent, symbolically. Choices are required for all dams. There are several pre-requisites for dam construction. These include social and environmental risk assessments, transparency, key stakeholders’ involvement, etc. Also, there is status associated with owning institutions. IUCN joined forces with the Geneva Water Hub to build legal and institutional capacity for dam management. The World Bank’s World Commission on Dams was created and two resolutions on dam governance have since been adopted. Governments have supported continuous improvement for dam management. Also, the adoption of principles for dam management, including transparency, monitoring, and other elements have also been formulated. Both legal and planning tools have been developed under the joint initiative.

Six categories of tools have been identified for dam management, including the 1923 Geneva Convention, the UN Watercourses Convention (i.e., principles of international water law) and environmental law (sovereignty to exploit natural resources, duty not to cause harm, access to judicial and administrative remedies, the precautionary approach, duty to ensure prior notification, obligation to carry out environmental impact assessments, and others).

Seven multilateral environmental agreements are applicable to dams (Ramsar, World Heritage, Migratory Species, Law of the Sea, Biological diversity, Framework on Climate Change, Espoo Convention on Environmental Impact Assessment). A series of instruments in international human rights also pertain to dam management, dating from 1966 to 1998 (e.g., Aarhus Convention, and resolution to involve Indigenous Communities). Tools related to international standards are also relevant, e.g., OECD guidelines for private sector companies, among others.

The Senegal River Basin Organisation includes 4 countries. Nine countries are in the Niger River Basin (AGN). Institutional Conventions from the 1970s and 1982 are relevant for current management. The Niger Basin’s 1987 Convention sets out a series of objectives that have committees and initiatives in place to achieve these objectives.

In South America, there is a binational example for dam management: the Itaipu Dam, which is a hydroelectric dam on the Paraná River between Brazil and Paraguay. Generating 2.8 billion MWh, Itaipu is one of the largest energy producers in the world. The Parana River is shared by Brazil, Peru, and Paraguay. Climate change and activities in the upper basin are causing unprecedented low flow and water scarcity that endangers energy supply. Special operations, called water windows, is a system whereby stakeholders are identified to say how much water they require for energy, navigation, water supply, and the dam is then used to meet these needs. This dam is viewed as a successful example of cooperation. Itaipu is undertaking a very large reforestation initiative within its catchment area as part of an objective to restore ecological conditions.

No country in South America has ratified the UN Convention governing dam management. However, the principles of the convention are effectively implemented as part of the local governance of dams, including at Itaipu.

The Senegal River Organisation controls the river course, regulates rivers and energy grids, facilitates transport and navigation for industrial development, and organizes sharing property and benefits of dams. It was said at the end of the session that it was fitting that Senegal should be hosting the World Water Forum from 21-26 March 2022.

REGULAR SESSIONS

SESSION NUMBER: GS2-5

DATE/TIME: 30 NOVEMBER, 12:00–13:15

THEME: E1, E4

Speakers

Laura Movilla Pateiro, University of Vigo, Moderator

Michael Gilmont, University of Oxford, Presenter

Raya Marina Stephan, IWRA, Presenter

Emily Zmak, CDR Associates, Presenter

Kat Hartwig, Living Lakes Canada, Presenter

Presentations

- Michael Gilmont, *Regional pathways out of national water scarcity: a regional analysis of water resources of Israel, The Palestinian Authority and Jordan*
- Emily Zmak, *Linking community engagement to transboundary water management*
- Raya Marina Stephan, *Joint mechanism on a transboundary aquifer: a key for a successful cooperation*
- Kat Hartwig, *Collaboration to better address climate impacts on water in the Canadian Columbia River Basin*

Key messages

- Effective water governance starts with inclusive community engagement. If it's not inclusive from the outset, it risks jeopardising the overall objective.
- Transboundary water management is extraordinarily complex, compounded by unpredictable political pattern, migration movements and unexpected environmental hazards.
- Even the most sophisticated water governance arrangements have their problems.

Session Summary

The session began with a presentation on the approaches adopted by the state of Colorado towards stakeholder engagement. Emily Izmak explained that the model they used was founded on three principles: setting down clear parameters, understanding community interests and needs, and ensuring accessibility. It was explained that engagement efforts often fail when parameters are not defined. Once parameters are established, it is important to communicate what decisions can and cannot be shaped by community input thereby managing expectations. The presenter made the case that it was always important to fully explore and consider community interests. Finally, accessibility was key, the presenter explained, to get buy in, cautioning that those at the table are often paid to be there and that comes at the risk of missing key community interests. The presenter explained that gender and generational balance are often overlooked.

Using the case study of the Jordan River Basin, Michael Gilmont led a presentation on water scarcity challenges in the region. The Jordan Basin Region comprises three jurisdictions: Israel, Jordan, and Palestine. While all have made progress in increasing water security in recent decades, significant challenges still lay ahead.

The presenter explained that “water and environment insecurity are no longer national risks but regional threat multipliers”. The problems they pose are compounded by climate change and migration, most notably by the impact of a significant number of Syrian refugees into the region. He observed that regional cooperation was based not on a political wish to collaborate, but rather, by enlightened self-interest. He highlighted some of the difficult decisions that the region has had to face, collectively. For example, he explained that if Jordan were to cut water usage in agriculture by 25%, it would bridge the water scarcity gap. However, the political and economic ramifications of such a step would be significant. The presenter ended by highlighting that the use of treated wastewater presented one pathway which looked the most promising but would require a major investment.

Raya Marina Stephan presented on transboundary cooperation, explaining that it brought significant benefits to society, including economic growth, increased human well-being, enhanced environmental sustainability, and increased political stability. The presenter defined cooperation as including information sharing, coordination, collaboration, and other joint actions, observing that international water law has been created without being underpinned by institutions, creating or a robust governance framework.

The presenter cited three examples to highlight varying levels of coordinated activity between jurisdictions. The Geneva aquifer – shared by France and Switzerland – was presented as an example of full cooperation. She observed that even in this context, political and cultural differences presented some challenges. For example, France is a centralized state, while Switzerland is a highly devolved state, creating state-level asymmetry.

SESSION NUMBER: GS2-3

DATE/TIME: 30 NOVEMBER, 12:00-13:15

THEME: A3, D1, D2, E2

The Joint Authority for the Study and Development of the Nubian Sandstone Aquifer System was cited as an example of limited cooperation while the North-western Sahara Aquifer System was held up as an example of intermittent cooperation.

Speakers

Tom Soo, IWRA, Moderator

Burnice Karimi Ireri, Egerton University, Kenya, Oral Presenter

Tae Sung Cheong, NDMI, Republic of Korea, Oral presenter

Giang Ngugen, Kyungpook National University, Republic of Korea, Oral Presenter

Sofia E. Garrido Hoyos, Instituto Mexicano de Tecnología del Agua, Mexico), Oral Presenter

Presentations

- Burnice Karimi Ireri, *Provisioning of water ecosystem services in Kapingazi catchment, Embu County, Kenya: Can prospects of willingness to pay improve water quality and quantity within the catchment*
- Tae Sung Cheong, *Development of measured data based nomograph for flood warning system*
- Giang Ngugen, *Merging multiple satellite precipitation products in Korea by using random forest model*
- Sofia E. Garrido Hoyos, *Dispersion and transportation of pollutants in the Low Basin of the Yaqui River and the environmental impact on the Marine Organisms of the Lake Tobari (Gulf of California)*

Key messages

- Ecosystems provide many beneficial systems to humankind, including water provision.
- When humans over exploit ecosystems, however, they severely affect ecosystem services, endangering their own survival and development.
- 90% of river flood disasters occur in small river basins because its restoration ratio is relatively lower than both local rivers (70%) and national rivers (98%).

- Measurement data can be used for enhancing the SRFWS to estimate flow discharges and depths in the small streams.
- Satellite-based precipitation products (SPPs) have been recognized as a reliable data source and can be used as valuable input for researchers in water resource management and hydrology.
- Extensive agricultural activity in the lower Yaqui river basin has led to widespread use of pesticides and fertilizers that are transported through run-off water into the agricultural drainage system and, hence, causing many adverse effects on the environment.

Session Summary

For the first presentation: Provision of Water ecosystem services in Kapingazi catchment, Embu County, Kenya. The results of a survey show that 67% of the respondents were willing to pay for improved water services in terms of water quality and water quantity within the catchment area. The respondents were willing to pay an average of USD9.10 per annum in addition to the average water connection fee of USD4.19 per month for improved water services in Kapingazi catchment. Logistic regression analysis revealed that age, education and household size were factors influencing respondents' willingness to pay (WTP) for improved water service in the study area. Positive WTP for improved water service provision shows the need for improved water service provision in Kapingazi catchment. The implications of the project suggest that decision makers should create an enabling policy for implementation of payment for ecosystem services (PES) to include improved water service provision while at the same time securing a healthy ecosystem in the Kapingazi catchment.

For the second presentation entitled Development of Measured data Based Nomograph for Flood Warning System, it was explained researchers had developed the Small Stream Flood Warning System (SSFWS) to provide an adequate response to reduce flood damages in unmanaged small rivers. The system that was developed estimates channel depths and discharges by using measured-based nomographs and rainfall data forecasted by the McGill Algorithm for Rainfall. The nomograph is table-type relationships between rainfall and discharges and depths and is developed by measured data for two years from 2016 to 2017 in small rivers. This study also evaluated its estimating accuracy with discharges and depths data measured in the 2018 flood season. The outcome suggested that measured data can be used for enhancing the SRFWS to estimate flow discharges and depths in the small streams.

For the third presentation: Merging Multiple Satellite Precipitation Products in Korea by using Random Forest Model, it was shown that the RF model shows good performance when it is compared with observation data as well as with original satellite precipitation data, such that RF proves to be a robust method for rainfall estimated from multiple satellite products.

Regarding the last presentation, Dispersion and Transportation of Pollutants in the Low Basin of the Yaqui River and the Environmental Impact on the Marine Organisms of the Lake Tobari (Gulf of California) there was a technical presentation on agricultural discharges and the implications for water quality and wider ecosystem health.

SESSION NUMBER: GS4-2

DATE/TIME: 01 DECEMBER, 12:00-13:15

THEME: E1

Speakers

Raya Marina Stephan, IWRA, Moderator

Melissa McCracken, Oregon State University, Oral presenter

Laurie-Elise Mayard, Northumbria University, Oral presenter

Slavco Bogdanovic, EU-LINK Consultancy Agency Novi Sad, Oral presenter

Laura Rodriguez, Texas A&M University, Oral presenter

Presentations

- Melissa McCracken, *Defining Effective Transboundary Water Cooperation*
- Laurie-Elise Mayard, *Connecting the dots between law and transboundary water management*
- Slavco Bogdanovic, *The law applicable on harnessing hydropower of Western Balkans transboundary water*
- Laura Rodriguez, *A modelling perspective on the transboundary nature of the Allende-Piedras Negras Aquifer*

Key messages

- There are two key challenges to transboundary aquifer and surface water basin cooperative management: 1) a common definition of transboundary cooperation; and 2) a common definition of effectiveness of cooperation.
- Formal literature on cooperation tends to emphasize legal aspects whereas practitioners in the field emphasize relationships as the most important aspect of transboundary cooperation
- There are four frames for assessing cooperation: legal, institutional, relational, outcomes.
- There is no fixed definition of a transboundary aquifer. For instance, a transboundary aquifer can be defined as an aquifer where water flows across a boundary. Alternatively, water that does not flow but where the aquifer is shared by more than one country can also be considered transboundary.

Session Summary

There are 310 transboundary basins worldwide, so cooperation is vital for surface water management. There are just under 600 transboundary aquifers, covering about 20% of the earth's land surface. SDG-6 includes 6.5 for integrated water management including cooperation. There are inconsistent definitions of cooperation. Measuring 6.5.2 is an indicator of success. However, there are two challenges: there lacks a consistent definition of transboundary cooperation that is clear and that can be applied across watersheds; there is a desire to identify effective transboundary cooperation and measure it towards achieving goals. Literature in the field emphasizes legal aspects whereas practitioners emphasize relationships. For effectiveness, there must be equitability, relationships, and trust in the literature and practiced by practitioners. There needs to be a weighted model to assess 4 aspects of transboundary cooperation: legal (compliance), institutional (goal attainment), relational, outcomes (policies implemented, basin-wide goals achieved).

Hydropower in the lower Mekong River Basin is part of a very complex multi-country system of power generation. Transnational law is suitable for transboundary issues because it considers the diversity of actors, scales, and other aspects needed for transboundary water management.

There are many layers to law in the western Balkans, dating back to Russian influences. Many basins in the region do not have transboundary agreements in place. There are three binding conventions in place by the UNECE in addition to the UN Watercourses Convention. Small power plants create problems due to environmental impacts and the disruption of environmental assessments.

Transboundary aquifer flow direction can change with pumping, from nontrans boundary to transboundary. There are 36 transboundary aquifers along the US-Mexico border, only 11 of which are officially recognized. Modelling from 2000-2017 was undertaken because previous models only included the central part of the aquifer. The aquifer under study is partially under the Rio Grande, which runs through the centre of the aquifer region. Changes due to extensive pumping have been detected. Cessation of pumping resulted in some recovery of severe drawdown. 'Flow through' happens when the groundwater flows into the river, then later returns as groundwater to the aquifer. Water extracted exceeds the inflows. Mexico is pumping 95% of the volume removed, but the 5% pumped by Texas draws water towards the US because the wells are very close to the river. The hydrogeological conceptual model includes both Mexico and the U.S. An aquifer that is under both Texas and Mexico – Escondido River 1944 treaty and San Rodrigo River.

SESSION NUMBER: GS5-3

DATE/TIME: 02 DECEMBER, 10:30-11:45

THEME: C5, E

Speakers

Tom Soo, IWRA, Moderator

Malcolm Gander, United States Department of Defense, Key-note Speaker

Bong-Joo Jang, KICT, Oral presenter

Tae Soo Eum, Department of Safety Engineering, Incheon National University, Oral presenter

Sabab Ali Shah, Hanyang University, Oral presenter

Mohammad Faiz Alam, ITC, Oral presenter

Presentations

- Malcolm Gander, *Groundwater pollution & aquifer restoration: Fundamentals and new technical developments in maintaining and improving water quality*
- Bong-Joo Jang, *WhiteBox: Easy and accurate personalized weather observation station*
- Tae Soo Eum, *Verification of flow analysis model for tracking sources of water chemical accidents*
- Sabab Ali Shah, *Estimating the impacts of climate change and human activity on streamflow variability in Han River basin, South Korea*
- Mohammad Faiz Alam, *Water balance-based tool for drought proofing agricultural watersheds*

Key Messages

- Pollution accidents in the water environment are increasing because of the leakage of harmful chemicals; disaster prevention measures are required accordingly.
- Having accurate quantification of the effect of different factors like temperature on streamflow is necessary for understanding the major driving factors involved in the variability of streamflow.
- Increased incidence of climate change induced water related risk of droughts is a threat to global agriculture.
- Water availability is considered the key limiting factor for crop growth.
- Water management interventions are central to drought proofing.

Session Summary

Results from the first presentation, "Verification of Flow Analysis Model for Tracking Sources of Water Chemical Accidents", show that the difference between simulation and measured results was insignificant, such that, superiority of the flow analysis model 'HDM-2D' was proven.

Results from the second presentation, "Estimating the impacts of climate change and human activity on streamflow variability in Han River basin, South Korea", show an increasing trend in both precipitation and streamflow. The change point is detected in 1997, and then the variation of streamflow is influenced by human activities. Human activities are the main driving forces impacting streamflow, contributing to 62.4%; climate change variability contributes to 37.6% in the human induced period.

Results in the last presentation, "Water balance-based tool for drought proofing agricultural watersheds" show that simulating intervention scenarios highlights the limitation of focusing on only structural supply or on the demand side interventions which are not enough to drought proof severe droughts.

SESSION NUMBER: GS6-3

DATE/TIME: 02 DECEMBER, 12:00-13:15

THEME: E2

Speakers

Karishma Asoodani, World Water Council, Moderator

Jiyoung Yoo, Hanyang university (ERICA), Oral presenter

Muhammad Jehanzaib, Department of Civil & Environmental Engineering, Hanyang university, Oral presenter

Xuan Hien Le, Disaster Prevention Emergency Management Institute, Kyungpook National University, Oral presenter

Presentations

- Jiyoung Yoo, *Three-dimensional perspective analysis of spatio-temporal drought characteristics for developing a drought risk map*
- Muhammad Jehanzaib, *Developing a non-stationary drought index using a generalized additive model for drought risk assessment*
- Xuan Hien Le, *Bias correction of daily satellite-based precipitation data using the convolutional neural network model*

Key messages

- 3.5% of the total world population has migrated. The major reason is related to water problems; thus, better water management strategies for addressing water scarcity is necessary.
- Droughts are a complicated, yet natural phenomenon that develops slowly. These days, global warming is contributing to the drought process both directly and indirectly.
- Two drought types, Hydrological and metrological, are separate types but interrelated, since more than 50% of hydrological droughts are affected by metrological droughts.
- Bias-corrected rainfall products provide a higher data quality than the satellite-based products.

Session Summary

The development of drought is a complicated process. One study compares the two drought types—metrological and hydrological—and found that there were 37 hydrological drought and 32 metrological drought cases in Korea.

The results suggested that duration of droughts is longer in hydrological droughts than metrological ones. More severe droughts were found in the north region of Korea; metrological droughts were more severe than hydrological droughts.

Droughts can be categorized into four types: metrological, agricultural, hydrological, and social-economic. The effects of droughts have on the population can vary. In Korea, 60% of rain comes during summer, so other seasons are vulnerable to potential drought.

Conducting a studying using CNN (convolutional neural network) and CAE (convolutional autoencoder), researchers found that bias-corrected rainfall products provide a higher data quality than the satellite-based products. Also, despite using different data sources, the bias-adjusted precipitation products still exhibit competitively excellent performance. This shows that the CAE model appears to be particularly effective.

1. Sharing and communicating data, knowledge, and information

SPECIAL SESSIONS

TRAIN, RETRAIN, RETAIN: BUILDING CAPACITIES OF PROFESSIONALS TO IMPROVE WATER MANAGEMENT

SESSION NUMBER: SS3-3

HOST BY INTERNATIONAL NETWORK OF WATER TRAINING CENTRES (INWTC), KOREA WATER FORUM (KWF), QUÉBEC'EAU WATER TRAINING CENTRE, CANADA

DATE/TIME: 30 NOVEMBER, 14:30-16:00

THEME: 1-1

Speakers

Joseph Pronost, Director of French National Water Training Center, France, Host

Yoonkin Jim, Planning Director, Korea Water forum, Republic of Korea, Moderator

Wayida Mahomed, Group Human Resources Executive, Rand Water Academy, South Africa, Panellist

Newton Lima Azevedo, Director General, Hydrus National Water Training Center, Brazil, Panellist

Ikram Abdeljelil, Coordinator Quebec'Eau, Water Training Center, Canada, Panellist

Mady Koanda, Director General, International Institute for Water and Environmental Engineering (2iE), Burkina Faso, Panellist

Lee Hak-Soo, CEO, K-water, Republic of Korea, Panellist

Stephanie Laronde, Secretariat, International Network of Water Training Centers, France, Lead

Key messages

- Capacity building must be a tailored and embedded long-term system that integrates across the entire sector, touching all levels, skills, and local contexts. Creating different, dynamic training must accommodate all human resource needs for water management.
- Capacity building includes human resources development, institutional development, and the creation of an enabling environment. It is also about including all stakeholders and integrating water resource management (WRM) within its elements (including water & sanitation, food, energy, etc.).
- The water management sector's capacity-building still faces challenges with data and knowledge gaps, lack of human resources, gender inequality, and a lack of institutional and technical capacities.
- Many countries lack the development and ability to integrate capacity building needed to make sure that professionals have the skills necessary for addressing challenges in their work and making progress in water resources management.
- Water sector capacity building must be tailor-made, long term, and must focus on improving the quality of decision making, planning, and implementation.
- Siloed approaches limit collaboration for WASH stakeholders with different sectors.
- Capacity development must address four key pillars: delivering tailored training that is innovative and inclusive, managing knowledge, strengthening partnerships, and monitoring, evaluating, and learning.
- Capacity building must (1) identify problems to determine how to establish appropriate programs; (2) train trainers to create a multiplying effect on sharing information; (3) facilitate utility-to-utility partnerships; and (4) build a hub and spoke strategy.

Session Summary

Despite the progress made (thanks to the successive international agendas for development), the statistics on global access to water and sanitation nonetheless remain grim. It is vital to address the increasing demand for skilled staff so as to optimize the investments made in both the big and small water cycles. Training staff and administrations in charge of water resources management and of municipal water and sanitation utilities delivers multiple benefits, including improving services and increasing the lifecycle of infrastructure. The objective of this session is to demonstrate how training centres may be created for water professionals as a solution for bridging the gap of existing and required

capacities of water professionals. The session looks at capacity building work happening with the Kenyan Water Institute, Beijing Water Works Group, Cap-Net, UNSECO I-WSSM, and a case study in Senegal.

Strengthening institutions at all levels is important for ensuring sustainable water resources development. It can include a favourable policy environment, better planning, implementation, and evaluation. Capacity building is about including all stakeholders and integrating WRM within its elements (including water & sanitation, food, energy, etc.). Capacity building includes human resources development, institutional development, and creating an enabling environment (through policy and regulatory frameworks).

Many national and local institutions working in water management do not work effectively or efficiently. This can be because of a mismatch of policies, unclear definitions, inadequate resources, capacity gaps (e.g., data, technology, and skills), or as a result of insufficient education and training. The water management sector's capacity building still faces challenges with data and knowledge gaps, lack of human resources, gender inequality, and a lack of institutional and technical capacities. To improve the quality of decision making, and improve planning and implementation, water sector capacity building must be tailor-made and long term. This is the only way that water professionals can build skills sustainably over time and improve their work.

The Kenyan Water Institute is developing practical diploma and certificate courses for water specialists to take; it also offers tailor-made short-term training courses on high-level and practical/mechanical topics such as leak detection, plumbing, and drilling operations. The Beijing Water Works Group tied its capacity development program to the work they have in operating the utility daily and how it relates to working with customers. Cap-Net shared important points on siloed approaches that limit collaboration for WASH stakeholders within different sectors; they noted a lack of common mechanism for tracking capacity development.

Capacity development must address 4 key pillars: delivering tailored training that is innovative and inclusive, managing knowledge, strengthening partnerships, and monitoring, evaluating, and learning. UNESCO I-WSSM indicated that capacity building must (1) identify problems to determine how to establish appropriate programs; (2) train trainers to create a multiplying effect on sharing information; (3) facilitate utility-to-utility partnerships; and (4) build a hub and spoke strategy.

REGULAR SESSIONS

SESSION NUMBER: GS1-5

DATE/TIME: 30 NOVEMBER, 10:30-11:45

THEME: 1-2, 1-3

Speakers

Guy Fradin, Director, IWRA, Moderator

Jonghun Kam, POSTECH, Republic of Korea, Oral presenter

Vivian Vargas-Franco, Universidad Nacional de Colombia, Colombia, Oral presenter

Seok Gwansoo, K-water, Republic of Korea, Oral presenter

Bassel Daher, Texas A&M University, USA, Oral presenter

Presentations

- Jonghun Kam, *What is the role of big data in water-related disaster mitigation?*
- Vivian Vargas-Franco, *Towards and index with artificial intelligence to evaluate vulnerability to climate change in micro-watersheds in Colombia*
- Seok Gwansoo, *Initiative development of "UNESCO certification on tap water management"*
- Bassel Daher, *Toward Understanding the Convergence of Researcher and Stakeholder Perspectives related to Water-Energy-Food (WEF) Challenges: The Case of San Antonio, Texas*

Key messages

- Data helps improve water management across different levels—from citizen and social response to climate change events, to professionals planning for improve water management systems, to rebuilding trust between citizens and water utilities.
- Using artificial intelligence methodologies that look at environmental degradation from its pressures, current state, and response helps to evaluate climate change vulnerability for micro-watersheds. These indicators can then be extended to apply to macro-watersheds.
- Big data, including Google and social media, provides valuable information about water-related disasters and social/human responses. The water sector needs educated specialists who understand how to mine data from these sources to inform communities about responses to water-related disasters.
- Different professional and research communities do not communicate enough across different sectoral networks (e.g., energy, food, water, cross-cutting); the impact of this are silos that increase water resilience risks. This can be improved with cross-sector planning that creates legal and procedural mechanisms, financing, consistent vocabulary, and unified values systems and goals.
- A seal of excellence certification for urban water management authorities can help improve their tap water quality and rebuild citizens' trust in tap water.

Session Summary

This session explored the use of data for managing water and its challenges, including disaster mitigation, climate change, and the water-energy-food nexus. The session discussed using artificial intelligence in Colombian micro-watersheds to help communities understand their climate vulnerability. The results have shown the micro-watershed has suffered major environmental damage because of land-use changes, population growth, wastewater discharge, poor solid waste management, acid discharges, water and soil conflicts, institutional problems, and low local participations. Artificial intelligence methodologies that look at environmental degradation from its pressures, current state, and responses can help evaluate climate change vulnerability for micro-watersheds.

Another presentation reviewed social media responses by analysing online “big” data during the California drought (2011-2017). Big data can help foster an understanding of natural trends and help in changing behaviours based on mitigation needs. By using artificial intelligence, data can be used to understand how people will respond to future water-related disasters.

Different professional and research communities do not have any level of communication across different sectoral networks in San Antonio, Texas (e.g., energy, food, water, cross-cutting). The only groups that communicate across networks are government agencies. This can be improved through stakeholder cooperative planning efforts at the local level, though many lack both the mechanisms to communicate as well as the capacity to manage these kinds of conversations. Some barriers to communication include legal and procedural barriers, financing, inconsistent vocabulary, different planning horizons, different values systems and goals, competition, and prioritising self-interest over collective goals.

The UNESCO Seal of Excellence Initiative helped create an evaluation criterion for certification that can improve tap water management at K-water and rebuild its citizens' trust.

2. Delivering SDG Outcomes: 5 years on and looking to 2030

SPECIAL SESSIONS

COLLECTIVE ACTION TO ACHIEVE WATER SECURITY FOR PEACE AND DEVELOPMENT FOR THE 9TH WORLD WATER FORUM

SESSION NUMBER: SS1-4

HOST BY WORLD WATER COUNCIL

DATE/TIME, 29 NOVEMBER, 14:30-16:00

THEME: 3-1

Speakers

Patrick Lavarde, 9th Forum Co-Chair - WWC, France, Presenter

Abdoulaye Sene, 9th Forum Co-Chair- Executive Secretariat, Senegal, Presenter

Session Summary

The 9th World Water Forum will follow a different path from previous editions. Its framework has been developed around four "Priorities": Water Security, Rural Development, Cooperation, Means and Tools, and it will strive to move directly towards actionable "outcomes." This will allow the creation of a series of activities aimed at achieving concrete change collectively, in line with Agenda 2030.

The special session discussed the progress of the activities of each Priority. Participants were given the opportunity to share knowledge gained from the XVII World Water Congress week and to contribute to the preparation of the 9th World Water Forum. The meeting convened representatives leading each of the four Forum Priorities with other interested stakeholders through roundtables discussions. The goal was to discuss the status of the activities and the Framework, and to identify the steps needed to achieve final outcomes.

The session Informed participants about the 9th World Water Forum preparation and how they can participate, while providing a platform for all stakeholders to engage, exchange, learn together, and catalyse concrete ideas for the development of the Forum's Priorities. In addition, the session was an occasion for Forum's actors to discuss and to receive constructive suggestions and move their work forward. During the session, synergies with the 2030 Development Agenda and other global processes were identified, particularly in terms of the Sustainable Development Goals.

As the World Water Congress took place few months before the Forum, the special session aimed to share the progress of the Preparation Process and to offer the opportunity to all interested stakeholders to contribute to the Forum's further development, to the ordinary sessions planning. The session was coordinated in line with the essential objectives of the World Water Congress and address most off the issues of the main themes. In particular, the session's structure and content facilitated a debate and provided an interface between stakeholders from different horizons to enable the catalyst of technical and policy related collective action, to achieve concrete outcomes for water security, and to improve the management and development of water resources.

LISTENING TO NATIONAL WATER LEADERS: LAUNCH OF THE FIRST GLOBAL WATER POLICY REPORT

SESSION NUMBER: SS2-4

HOST BY WATER POLICY GROUP

DATE/TIME: NOVEMBER 29, 2021

THEME: 3-1

Speakers

Tom Soo, Water Policy Group, France, Moderator

Oyun Sanjaa, Director of External Affairs, Green Climate Fund, Oral presenter

Mercedes Castro, CEO, Aqualimpia, Peru, Oral presenter

Desigen Naidoo, Climate Commissioner, South Africa, Former CEO of the Water Research Commission, Oral presenter

Presentations

- Oyun Sanjaa, *General Presentation of Water Policy Report 2021*
- Mercedes Castro, *General Presentation of Water Policy Report 2021*
- Desigen Naidoo, *General Presentation of Water Policy Report 2021*

Key messages

- The Water Policy Group published its first Global Water Policy Report at the World Water Congress.
- The report was based on the 2021 Water Leaders Survey published by University of New South Wales's Global Water Institute. It drew on contributions from 88 countries looking at water security challenges during the COVID19 pandemic.
- Respondents said the highest water-related risks their countries face are from climate change and associated pressures on water supplies and worsening floods and droughts.
- The greatest challenges faced are with the integration and prioritization of water issues within governments. Administrative problems of fragmented water institutions are of as much, if not greater, concern than factors such as public resistance to reforms.
- COVID-19 has not affected the priority of water and sanitation services.
- For most, the Sustainable Development Goal 6 targets are 'challenging' or 'impossible', considering governance problems and lack of financing.

Session Summary

The session was the official launch of Global Water Policy Report published by the Water Policy Group, based in France.

In partnership with the University of New South Wales's Global Water Institute, the 2021 Water Leaders Survey collected information on the key social, political, financial, and structural barriers inhibiting better progress on water—as identified by the officials and leaders charged with responsibility for water management. The outcome of this exercise is published in this final report.

Session participants were introduced to the findings of the survey which provided insight into the perspectives on:

- The greatest water risks and challenges faced by countries; and
- The difficulties in achieving Sustainable Development Goal 6 on water and sanitation for all and the pertinence of the Global Acceleration Framework.

The survey received input from 88 countries looking at the water security challenges during the COVID19 pandemic. Echoing the discussions at the UN Climate Change Conference in Glasgow / COP26, the financing of water management in low-income or middle-income countries was identified as a key challenge.

Another area surfaced in the research was that about water governance. Transboundary groundwater is a major challenge presently because of the unusual abstraction of groundwater in arid and semi-arid regions. The example of Senegal was provided. Water security, sanitation, and integrated water resources management is an important area of focus by Senegalese policy makers.

One of the main conclusions from the research is that the policymaker or the water manager should aim to make progressive decisions that minimize future impacts for low-income countries. It was noted that these are often the same countries where groundwater abstraction is a major issue. The authorities in those countries should put in place proper governance and regulatory policy frameworks.

REGULAR SESSIONS

SESSION NUMBER: GS4-3

DATE/TIME: 01 DECEMBER, 12:00-13:15

THEME: B4, 3.1

Speakers

Asma Bachikh, IWRA, Moderator

Jinuk Kim, Konkuk University, Republic of Korea, Oral Presenter

Emmanuel M. Akpabio, University of Uyo, Nigeria, University of Dundee, UK, Oral Presenters

Stijn Reinhard, Wageningen University, The Netherlands, Oral presenters

Presentations

- Jinuk Kim, *The damage cost estimation of agricultural drought using reservoir drought index*
- Emmanuel M. Akpabio, *Practical and institutional challenges to achieving improved WASH services for sub-Saharan Africa*
- Stijn Reinhard, *Impacts of measures to stimulate farmers to adapt to freshwater scarcity*

Key messages

- Sub-Saharan Africa is not on track to meet SDG6 because of a lack of nexus approach and poor governance for WASH-related efforts. Institutional coordination and conflict between different authorities make progress difficult.
- How do neo-liberal policies of commercialization, individualization, deregulation, and commodification reconcile with the region's spiritual perceptions of water, religious water symbolism, water knowledge, and values of nature as a free gift?
- Neoliberal politics impact the WASH sector because of disinvestments in WASH services and prioritising private sector practices.
- The socioeconomic drought index (SEDI) collects data through news data and has four categories where it measures damage costs: agricultural water deficit, water security, economic damage, and environmental and sanitation impact.
- There are few adaptation options considered for farmers in current water scarcity models, other than to use less water. If other farmer adaptations are not correctly included in water scarcity models, then food production will be underestimated.

Session Summary

Access to WASH services is an acute issue in sub-Saharan Africa with low performance compared to other regions of the world, making its performance on SDG6 low. Institutional coordination as well as conflict/competition between different authorities makes progress difficult. For example, in Nigeria, different ministries feel like they have sufficient capacity to address WASH-related issues, but do not have the budget or power to be successful nor to coordinate efforts well. Additionally, sub-Saharan African countries also struggle with spatial, socio-cultural, and religious values that impact WASH behaviours and practices.

Lastly, there are overbearing influences by external, neo-colonial actors and institutions that have resulted in practically no improvements. How do neo-liberal policies of commercialization, individualization, deregulation, and commodification reconcile with the region's spiritual perceptions of water, religious water symbolism, water knowledge, and values of nature as a free gift? Neoliberal politics impacts the WASH sector because of disinvestments in WASH services and prioritising private sector practices. This is exacerbated by climate change, which is damaging critical WASH infrastructures that are available.

Another presentation discussed how drought is a costly and complex disaster. It reviews an agricultural drought assessment that accounts for socioeconomic factors and integrates data to help understand the socioeconomic impacts of droughts. Previous studies have struggled to get the data and have relied a lot on assumptions; this study used news data to create the socioeconomic drought index (SEDI). The SEDI has four categories: agricultural water deficit, water security, economic damage, and environmental and sanitation impact. The result of this initiative can support measuring the complete impacts of drought on a region and help to develop appropriate policies.

The last presentation discussed water scarcity and its impacts on small farmers. Water scarcity is likely to increase because of climate change, which impacts crop yields. There are few adaptation options considered for farmers in current water scarcity models, other than to use less water. If other farmer adaptations are not correctly included in water scarcity models, then food production will be underestimated. The researchers created a theory of change to help develop adaptation outcomes for measurement to support more sustainable water planning and policy creation for irrigation purposes.

POSTERS

- B-5 - [From community to community: Collective participation in improving water quality in Jaqueira/PE, Brazil](#). Alba Lemos, National Health Foundation, Brazil
- 3-3 - [Qualitative risk assessment in the use of water stored in cisterns by rural communities in the Brazilian semiarid region](#). Alba Lemos, National Health Foundation, Brazil
- E-4 - [Estimation of inundation risk index for providing flood risk information](#). Narae Kang, Korea Institute of Civil Engineering and Building Technology, Korea, Republic of
- E-2 - [Comparison of accuracy of areal rainfall between rain gauge and radar](#). Seokhwan Hwang, Korea Institute of Civil Engineering and Building Technology, Korea, Republic of
- E-2 - [Numerical analysis of behaviour of alternate bars in the channel with oblique wier](#). Gijung Kim, Korea National University of Transportation, Korea, Republic of
- 1-2 - [Development of a user-friendly web application for providing stochastically simulated rainfall time series](#). Dongkyun Kim, Hongik University, Korea, Republic of
- B-2 - [Efficient water allocation plan of domestic and industrial water in the Han River basin](#). Dongjin Lee, K-water, Korea, Republic of
- 1-2 - [GRID based rainfall-runoff model on flexible cloud platforms](#). Young-Jin Won, HermeSys, Korea, Republic of
- A-2 - [Water balance change of the Han River Basin by climate change](#). Yongchan Kim, Hongik University, Korea, Republic of
- A-2 - [Development of waterbody extraction algorithm for river surface based on sentinel-1](#). Soohyun Kim, Hongik University, Korea, Republic of
- A-1 - [Changes in the winter-spring centre timing over four major river basins in Pakistan](#). Shahid Ali, Pohang University of Science and Technology, Korea, Republic of
- A-2 - [Trend and probable change point in the hydrologic regime of Seomjin River, South Korea \(1997-2020\)](#). Yeonjin Son, Division of Environmental Science and Engineering, POSTECH, Korea, Republic of
- A-1 - [Development of continuous low concentration hypochlorous acid generator customized to green biotechnology industry](#). Jiyeon kim, Yonsei University, Korea, Republic of
- A-1 - [Comparison of quantile mapping, random forest and deep learning for bias correction of GCMs](#). Song Young Hoon, Seoul National University of Science and Technology, Korea, Republic of
- A-2 - [Estimation of agricultural water use using logistic regression: A case study of South Korea](#). Moonhyung Park, KICT, Korea, Republic of
- A-1 - [Spatial prioritization of permeable pavement considering multiple general circulation models: Mokgamcheon Watershed](#). Mohammed Sanusi Shiru, UTM, Nigeria
- A-2 - [Hydrologic design for sand dam construction at the small valley in upstream area](#). Il-Moon Chung, Korea Institute of Civil Engineering and Building Technology, Korea, Republic of
- A-2 - [Application of hydro-economic optimal water allocation model: Case study on Namhan River Basin in South Korea](#). Gimoon Jeong, Kyung Hee University, Korea, Republic of
- A-5 - [Development of framework for resilience to seasonal operation in hydro-power dams](#). Dong Hyun Kim, Hongik University, Korea, Republic of
- A-4 - [Emphasizing gender equality and social inclusion approaches in sanitation interventions to increase community resilience in disaster affected areas](#). Jatmoko Jatmoko, Yayasan Plan International Indonesia, Indonesia
- A-3 - [Simulation study of proper sample size for bivariate frequency analysis of extreme rainfall event](#). Kyungwon Joo, Yonsei University, Korea, Republic of
- A-3 - [Development of Flood Damage and Losses Assessment Model in Korea](#). Gilho Kim, Korea Institute of Civil Engineering and Building Technology, Korea, Republic of
- A-3 - [Analysis of urban drainage network characteristics based on Gibbs' model](#). Kyungjae Kim, Yeungnam University, Korea, Republic of
- A-3 - [Conditional gap-filling of in-situ soil moisture for continuous water monitoring](#). Minha Choi, Sungkyunkwan University, Korea, Republic of

- A-3 - [Effect of spatial heterogeneity of rainfall on areal reduction factors.](#) Dongkyun Kim, Hongik University, Korea, Republic of
- A-3 - [Assessment of GLUE likelihood indices and trend of parameter samples in IPSO-GLUE for TOPMODEL.](#) Jeongha Park, Hongik University, Korea, Republic of
- A-3 - [Combination of stochastic rainfall models to reproduce rainfall variances at the time scale of one hour to one year.](#) Jeongha Park, Hongik University, Korea, Republic of
- A-3 - [Identification of homogeneous regions for rainfall regional frequency analysis considering typhoon events in South Korea.](#) Hyunjun Ahn, Yonsei University, Korea, Republic of
- A-3 - [Evaluation of different erosion models for debris flow modelling.](#) Lee Seungjun, Chungnam National University, Korea, Republic of
- A-3 - [Contaminant entry point identification in water distribution network using travel path balancing method.](#) Malvin Samuel Marlim, Kyung Hee University, Korea, Republic of
- A-3 - [Investigation of drought-flood abrupt alternation in the Yangtze River Basin, China.](#) Ho Jun Son, Hanyang University, Korea, Republic of
- A-3 - [The inference of directly connected impervious areas to direct runoff hydrographs in urban catchments.](#) Jun Shik Hwang, Yeungnam University, Korea, Republic of
- A-3 - [Flood risk management and climate change adaptation in South Korea.](#) Sunghun Kim, Yonsei University, Korea, Republic of
- A-3 - [Estimation of future water deficit under changing climate based on joint drought management index.](#) JI SOO YU, Presidential Water Commission Support Department (Deliberation Support Team), Korea, Republic of
- A-3 - [Dealing with observed zero data in hydrologic frequency analysis of snow depths.](#) Dongwook Kim, R&D Centre, Burin Co., Ltd., Korea, Republic of
- A-3 - [Assessment of hydrological drought severity using hidden Markov Bayesian classifier.](#) Muhammad Nouman Sattar, Hanyang University (ERICA), Korea, Republic of
- A-3 - [Mapping 4-R's of resilience and 6 components of regional drought planning in South Korea.](#) Dong-Hyeok Park, RAON TNC Inc. (R&D Centre), Korea, Republic of
- A-3 - [Experimental and numerical investigations of characteristics of water surface at a crossing connected non-orthogonally with four channels.](#) Woo Chang Jeong, Kyungnam University, Korea, Republic of
- A-3 - [Forecasting urban groundwater level decline risk related to the construction activities near the groundwater level monitoring point of Seoul metropolitan city using statistical and deep learning methods.](#) Gyobeom Kim, Yonsei University; Korea Environment Institute, Korea, Republic of
- A-3 - [Derivation of IDF curves for future periods using RCP4.5 and RCP8.5 scenarios.](#) Heechul Kim, Yonsei University, Korea, Republic of
- A-3 - [Estimation of the frequency factors for probable maximum precipitation \(PMP\) in South Korea.](#) Miru Seo, Yonsei University, Korea, Republic of
- A-3 - [Early warning system development in mountainous area.](#) Yujin Ahn, Gyengsang National University, Korea, Republic of
- A-3 - [An analysis of flood vulnerability by administrative region through big data analysis.](#) Yeong Uk Yu, Kyungpook National University, Korea, Republic of
- A-3 - [Optimization of water disaster reduction technology in Korea's coastal mountainous areas considering surface-ground water interaction.](#) Jae Beom Lee, Kookmin University, Korea, Republic of
- A-3 - [Utility of deep learning model for hydrologic forecasting over dam-affected river basin.](#) Eunmi Lee, POSTECH, Korea, Republic of
- A-3 - [Evaluation of APEX model parameter uncertainty for runoff.](#) In Kyo Choo, Kyungpook National University, Korea, Republic of
- A-3 - [Simulation of synthetic snow depth time-series using stochastic weather generator.](#) Jeongha Park, Hongik University, Korea, Republic of
- A-3 - [Development of heavy rain damage triggering criteria based on machine learning.](#) Jongsung Kim, Inha univ., Korea, Republic of

- A-3 - [A multiscale precipitation forecasting framework to seasonal and daily extreme rainfall prediction.](#) Yong-Tak Kim, Sejong University, Korea, Republic of
- A-3 - [Seasonal groundwater quality change with intensive pumping in an agricultural area, Korea.](#) Kyoochul Ha, Korea Institute of Geoscience and Mineral Resources, Korea, Republic of
- A-3 - [Development and application of the evaluation method for ecohydrological cycle soundness in Korean watersheds.](#) Jae Beom Lee, Kookmin University, Korea, Republic of
- A-3 - [Development of a highway climate change prediction tool according to RCP scenarios.](#) Lee Jugoang, Korea Expressway Corporation, Korea, Republic of
- A-3 - [A study on snow removal resources distribution method suitable for regional characteristics of Korea.](#) Chan-Young Lee, Korea Expressway Corporation Research Institute, Korea, Republic of
- A-3 - [A study on snow removal guidelines suitable for regional weather patterns of Korea.](#) Chan-Young Lee, Korea Expressway Corporation Research Institute, Korea, Republic of
- A-3 - [Simulations of pollutant storage effects in emergent vegetated region.](#) Inhwan Park, Seoul National University of Science and Technology, Korea, Republic of
- A-3 - [Flood forecasting using coupled long short-term memory \(LSTM\) and generative adversarial networks \(GAN\) with hybrid activation function – A Case Study for Hangang River, South Korea.](#) Hyung Ju Yoo, Hongik University, Korea, Republic of
- C-2 - [Use of big data analytics in machine learning to improve management of water distribution system with smart water grid in Korea.](#) Kang Min Koo, Graduate School of Water Resources, Sungkyunkwan University, Korea, Republic of
- C-2 - [Drone-based parameter estimation process for flow measurement.](#) TaeGyu Ha, Gyeongsang National University, Korea, Republic of
- C-4 - [Use of moringa oleifera lam. seed and zeolite filter in the treatment of textile effluent from dye shops and laundries.](#) Alba Lemos, National Health Foundation, Brazil
- C-4 - [Development of multiple-leakage detection approach for water distribution networks.](#) Jeongwook Choi, Department of Civil Engineering, Kyung Hee University, Korea, Republic of
- C-4 - [Development of activity diagram for flooding during construction of utility tunnels.](#) Eun Taek Shin, Department of Safety Engineering, Incheon National University, Korea, Republic of
- C-4 - [A study on evaluation of streamflow station considering the importance of station and field conditions.](#) Eunjeung Shim, Korea Institute of Hydrological Survey, Korea, Republic of
- C-4 - [A study on the development of flow measurement method using drones.](#) Tae Hee Lee, Korea Institute of Hydrological Survey, Korea, Republic of
- C-2 - [Demand based optimal selection of multi-water resources in economical and sustainable way: A case Study of Yeongjong Island, Rep. of Korea.](#) Kapil Gnawali, Sungkyunkwan University, Korea, Republic of
- C-2 - [Optimization of water distribution network by using genetic algorithm.](#) Uchit Sangroula, Sungkyunkwan University, Korea, Republic of
- C-2 - [Performance comparison of outlier detection methods in smart water grid: A case study of YeongJong Island, Korea.](#) Kang Min Koo, Sungkyunkwan University, Korea, Republic of
- C-4 - [Estimation of the streamflow during dry season using artificial neural network.](#) Sungho Jung, Kyungpook National University, Korea, Republic of
- C-4 - [Water network partitioning for smart water management.](#) Khoa Xuan Bui, Kyung Hee University, Korea, Republic of
- C-2 - [Introduction of smart urban flood forecasting technology based on X-band small radar network.](#) Wansik Yu, K-water Research Institute, Korea, Republic of
- C-4 - [Recurrent neural network for rainfall analysis and prediction.](#) Changhyun Jun, Chung-Ang University, Korea, Republic of
- C-5 - [Analysis of groundwater withdrawal impact on groundwater level variations using long short-term memory network.](#) Mun-Ju Shin, Jeju Province Development Corporation, Korea, Republic of
- C-5 - [A study on the recharge characteristics of groundwater in the Jeju Samdasoo watershed using stable water isotope data.](#) Hoyoon Ryu, Jeju Special Self-Governing Province Development Co., Korea, Republic of

- C-5 - [Bias correction of rainfall ensemble data using qm technique.](#) SangHyup Lee, Kyungpook National University, Korea, Republic of
- C-5 - [A study on the calculation factors for mean velocity of surface velocity using acoustic doppler current profile \(ADCP\).](#) Lee Jae il, Korea Institute of Hydrological Survey, Korea, Republic of
- C-5 - [The estimation of cold wave risk index for flow measurement.](#) Ki Sung Lee, Korea Institute of Hydrological Survey, Korea, Republic of
- C-5 - [Uncertainty analysis of quantitative rainfall estimation based on hydrological and meteorological radar.](#) Jae-Kyoung Lee, Daejin University, Korea, Republic of
- D-2 - [Application of physics-based erosion model for agricultural lands.](#) Minho Yeon, Kyungpook National University, Korea, Republic of
- D-1 - [Suggestion of a rating curve considering hydrologic factors in tidal river.](#) Myungjin Lee, Inha University, Korea, Republic of
- D-2 - [Estimating Nonpoint Source Pollution Removal Effect of Road Sweeping by SWMM.](#) Heeman kang, Korea Expressway Corporation, Korea, Republic of
- D-2 - [Estimating of non-point pollution load reduction on highway by road sweeping.](#) Heeman kang, Korea Expressway Corporation, Korea, Republic of
- D-2 - [Field survey on the maintenance of nonpoint pollution treatment facilities.](#) Heeman kang, Korea Expressway Corporation, Korea, Republic of
- D-2 - [Numerical investigation of turbulent flow in a hydraulic jump at \$Fr = 7.5\$.](#) Byungjoo Kim, Gangneung-Wonju National University, Korea, Republic of
- D-4 - [Water quality changes in the Mid-Nakdong River due to weir constructions.](#) Natnael Shiferaw, Chungnam National University, Korea, Republic of
- D-4 - [Controlling organic matters in tap water.](#) Suhan Kim, Pukyong National University, Korea, Republic of
- D-5 - [Climate change adaptation in water resource management: variability of hydro-climate variable, rainfall to soil moisture, and Its projection over South Korea.](#) Sumiya Uranchimeg, Sejong University, Korea, Republic of
- D-4 - [Water quality prediction using climate information within a hierarchical Bayesian framework.](#) Minkyu Jung, Sejong University, Korea, Republic of
- D-5 - [Estimation of flooded area based on satellite imagery and terrain data.](#) Dongkyun Kim, Hongik University, Korea, Republic of
- D-5 - [Performance of a rain barrel sharing network under the rcp scenarios.](#) YOUJEONG KWON, Yeungnam University, Korea, Republic of
- D-5 - [Study on the satellite-based spatial evapotranspiration evaluation using eddy covariance data.](#) Yeongil Lee, Korea Institute of Hydrological Survey, Korea, Republic of
- D-4 - [River water quality grading and water pollution assessment based on statistical techniques.](#) Kang Young Jung, National Institute of Environmental Research Yeongsan River Environment Research Centre, Korea, Republic of
- D-4 - [Solar-driven electrochemical advanced oxidation process for wastewater treatment.](#) Hyoungil kim, Yonsei University, Korea, Republic of
- D-4 - [The effect of an instream structure on harmful algal blooms in the Geum River, Korea.](#) Jaeyoung Kim, Chungnam National University, Korea, Republic of
- D-4 - [Effect of food waste addition to municipal wastewater treatment facility on the effluent quality.](#) Sang-Hyoun Kim, Yonsei University, Korea, Republic of

SPECIAL THANKS TO

The Korean Ministry of Environment

Daegu Metropolitan City

Korea Water Resources Corporation (K-water)

Korea Water Resources Association

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