

Towards a sustainable water future*

Water, being at the core of sustainable development, is strongly connected to all Sustainable Development Goals (SDGs). Meeting SDG6, viz. 'Ensure availability and sustainable management of water and sanitation for all', will help accelerate the implementation of the other goals on health, food security, poverty, climate action and economic growth. Drawing focus to this important goal, a recent conference brought together over 700 participants, including natural scientists, social scientists, technologists, civil society and policymakers in the SGD implementation process to develop knowledge-to-concrete actions and innovative solutions for a sustainable water future.

The opening plenary of the conference was on advanced water system assessments with an aim to address the water security challenges of the 21st century. This session was chaired by András Szöllösi-Nagy (Water Future). Charles Vörösmarty (Water Future) spoke about how the COMPASS initiative, a comprehensive assessment system for global water resources, can be used to monitor the progress of SDGs. His talk was also interspersed with policy implications, especially when such technologies enter the market. Alan Jenkins (Centre for Ecology and Hydrology, UK) addressed the newly emerging tools which could be used for tackling water-security problems. He observed that the global issues associated with reliable water availability might be engineering problems rather than a water-security issue. He also spoke about the HydroSOS initiative, which is used to monitor and predict freshwater hydrological conditions on a global scale. Stuart Bunn (Australian Rivers Institute, Australia) discussed his work on water resource planning at the Murray–Darling Basin in southeastern Australia. Veena Srinivasan (Ashoka Trust for Research in Ecology and the Environment (ATREE), Bengaluru)

shared her insights about the Cauvery basin. She also spoke about the reasons for groundwater scarcity and the biophysical processes which might be the hidden drivers. She also highlighted the science-policy gaps and the need for communication of scientific data. Praadeep Majumdar (Indian Institute of Science (IISc), Bengaluru), spoke about the increasing demands on water resources in India and how factors like climate change, population growth and urbanization will likely exacerbate the water-security problem.

The second plenary session on the challenges of water and climate change was moderated by Shailesh Nayak (National Institute of Advanced Studies, Bengaluru). Dietrich Borchardt (Water Future) discussed the challenges of extreme events of which extreme hydrological events, in particular, control water shortages compared to long-term aridity, and thus impact the ecosystem. He called for the development of next-generation of monitoring networks and assessments through technological innovation. John Pomeroy (Global Water Futures, Canada) discussed the challenges of water and climate change in the context of Canada, and how Modélisation Environnementale Communautaire (MEC)-Surface and Hydrology System (MESH) and Canadian hydrological models are helping with continental-scale hydrological modelling and water management. Karen G. Villholth (International Water Management Institute (IWMI), South Africa) mentioned that the impact of climate change on groundwater requires a historical understanding vis-à-vis recharge, quality, flow path, etc. She called for a need to update the global circulation models to take into account the groundwater processes to better understand the impacts on aquifers. She also called for better management of aquifer resources for improved resilience. Olcay Ünver (UN-Water, Italy) elaborated on the UN water policy brief on climate change and water which describes five actions: (1) act now; (2) consider water as part of the solution; (3) improve water management practices; (4) ensure transboundary co-operation in adaptation; and (5) rethink-

ing financing, for significant co-benefits for the climate and water. Sharad Jain (National Institute of Hydrology, Roorkee) described the challenges of water and climate change in the Indian context. He discussed the flood events that have occurred in India during 2000–2018, warming in the snow and glacier-covered regions impacting the northern Himalayan rivers and monsoon patterns in various parts of India. He called for a holistic approach for water management and decoupling of the use of resources with growth.

The third plenary session on the role of big data, Artificial Intelligence and blockchain technology in water diagnostics and governance was chaired by Amy Leurs (Future Earth). She shared her expertise regarding new-technologies in water supply and delivery. Nagaraja Rao Harshadeep (World Bank, USA) presented interesting use cases of disruptive technologies such as the spatial agent app developed by World Bank that offers access to interactive maps and charts of national and international datasets. Venki Ramachandran (Xylem, India) explained the basics of blockchain technology and how such a technology is used to trace the flow of water from the source to every point in the network. He also discussed how water meters, coupled with a crediting system, could be used to monitor existing consumption habits and incentivize consumers through differential pricing slabs. Katrina Donaghy (Civic Ledger, Australia) presented her work on using blockchain technology for publicly regulated water market places. She highlighted how technology could bring transparency and improve the interaction of people with the government. Yadati Narahari (IISc, Bengaluru) presented an approach using game theory and mechanism design integrated over a block chain platform to address the problem of water distribution. Balázs Fekete (CUNY, New York, USA) elaborated on employing advanced computer technologies like GIS and remote sensing for hydrological studies. He also highlighted how highly specialized GIS could be used to study gridded river networks and for complex modelling.

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The speakers in the fourth plenary session discussed the challenges in global water governance. The chair, Ravi Narayanan (Asia Pacific Water Forum, India) set the context by highlighting that harmony amongst governance, science and technology, and capacity will drive change. Anthony Slatyer (Water Policy Group, Australia) emphasized that immediate and quick action needs to be taken by governments in terms of prioritization, policies and decision-making for effective management of water. Claudia Pahl-Wostl (University of Osnabrück, Germany) spoke about the need for development of a conceptual–methodological research–approach framework for transforming a multilevel challenge like water governance, role of climate change as an agent in bringing about a transformative change, changing roles of first nations, and nexus approach towards integrated governance. Håkan Tropp (OECD Water Governance Programme, Sweden), introduced the OECD principles of water governance that guide in determining what works at different scales (country/city) in terms of implementation and best fit. He urged for better understanding of the multilayer of solutions nexus to come up with lasting solutions for the future. Robert G. Varady (University of Arizona, USA) discussed the exigencies of transboundary water-security and the key role played by community resilience in transboundary water-security issues. Sharachandra Lele (ATREE, Bengaluru) highlighted the lack of emphasis on biophysical and social justice in SGD6, which focuses more only on the quality, availability and sustainability aspects. Indicating a democratic deficit in the water sector due to the lack of decentralization in the system, he recommended an analysis of how water is being governed across institutional layers. William Young (World Bank, USA) emphasized that rather than focusing on the processes, there is a need

to focus on the outcomes when we are dealing with water – outcomes that we get from water now and outcomes that we could get in the future when different interventions are made in infrastructure and governance.

The final plenary session on key issues regarding water security in India was moderated by Anik Bhandari (Future Earth). M. S. Mohan Kumar (IISc, Bengaluru) gave a summary of the surface-level water availability in India and the water-scarcity threat associated with overexploitation of surface water. Aditi Mukherjee (International Water Management Institute (IWMI), New Delhi) spoke about the role of groundwater in the context of water–energy–food nexus. She talked about the link between water and food security, and highlighted some key issues related to depletion and scarcity of groundwater. Shaminder Puri (Water Future) addressed groundwater as a hidden treasure. He explained the process of aquifer recharge using a lucid bank account analogy and outlined some critical steps to ensure water security. These include efficiently managing aquifer recharge, converging science with socio-economic and cultural conditions, and employing a new underlying philosophy of low water use. Anil Kulkarni (IISc, Bengaluru), spoke about the state of the Himalayan cryosphere and how it is changing. He gave a primer on the major glaciers in the Himalaya, including the Karakoram range and how climate change can influence these cryospheres and their melt-off rates. H. Paramesh, (IISc, Bengaluru) spoke at length about the connection between water and health. He also highlighted the role of medical professionals in environmental issues. Muthukumara Mani (World Bank South Asia region) spoke about climate change and its effects on communities around the world. He explained how rapid urbanization might lead to water scarcity and conflicts, and the economic impact of

such events. He listed a mix of solutions that need to be employed on our way forward, which included: (i) increased agricultural productivity using drip irrigation and climate-smart agriculture techniques; (ii) applying new machine learning and blockchain technologies for efficient allocation and distribution of water, and (iii) stringent water quality management.

The conference concluded by highlighting the contexts, problems, solutions and action plans in its recommendation report, which was channelled into the Third Budapest Water Summit of October 2019. The objective of this summit was to raise the profile and visibility of water on the political agenda, since water is going to be one of the important issues of the 21st century. The outcome of a conference titled ‘Bengaluru–Budapest Science Action Plan’ was included in the proceedings of the Budapest Water Summit. This Science Action Plan calls for the development of an evidence-informed and value-based digital operating framework for water across scales. This framework will integrate effects of hydrological, biogeochemical, ecological, human health, cultural, social-economic behaviour, institutions and understand feedbacks at different scales in near real-time for all stakeholders. This will help identify, predict and adjust responsible production and consumption behaviours under varying risk conditions based on evidence-based science. The recommendations included in the Science Action Plan emphasized that this digital framework is essential for society to understand the potential tipping points of the water crisis in order to mitigate its impact.

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