2023 World Water Challenge

Program Book

Ministry of Environment

KOREA WATER FORUM

KIWW2023

2023 World Water Challenge

DATE December 7th , 2023
VENUE #306A / Daegu, Rep. of Korea

Ministry of Environment

KOREA WATER FORUM

BACKGROUND

The World Water Challenge (WWCH) is an international contest for water solutions. It was created as a special program of the Science and Technology Process in the 7th World Water Forum to identify imminent water problems that the world is facing and to find feasible solutions based on the core value, “Implementation”.

Attracting great attention in the 1st edition in 2015 at the 7th World Water Forum, the program has become one of the symbolic platforms of implementation which has been followed up in the Korea International Water Week (KIWW) over the past 8 years, focusing on scientific and technological methods that have contributed to the world’s awareness on the importance of the roles of science and technology in solving water challenges.

This year, WWCH 2023 will also take place as one of the signature programs of KIWW 2023 in Daegu Metropolitan City, Republic of Korea. WWCH 2023 is dealing with 5 Main Topics to demonstrate a pathway to achieving the Sustainable Development Goals. And it is expected to serve its role as an important platform to share not only innovative scientific · technological methods but also policy towards solving the defined water problems around the world and to forge a broad network among the experts and stakeholders in water sector as well as the diverse pool of problem owners and solution providers.

OBJECTIVES

- To set the local and global water initiative and share the vision for implementing water solutions based on water partnership and cooperation
- To bridge between developed and developing countries throughout sharing of innovative technologies and well-developed policies
- To raise awareness on water by providing water education and training programs
- To develop and provide interface between water technologies and policies
- To follow up and develop the results of the 7th World Water Forum in Korea

OVERVIEW

- **Date &Time** December 7th, 2023
- **Venue** #306A, EXCO, Daegu, Rep. of Korea
- **Host/Organizer** Ministry of Environment, Rep. of Korea / Korea Water Forum

Session Schedule

TIME	CONTENTS
13:30-13:32 (02')	Opening
13:32-13:36 (04')	Opening Remarks
13:36-13:40 (04')	Welcoming Remarks
13:40-13:45 (05')	Introduction of the final round
Challenge 1: Energy-efficient (or Carbon-emission-reducing) Water Recycling and Reuse	
13:45-14:05 (20')	elerGreen Production and Waste Valorization from Water Pollutants using Renewable Electricity
14:05-14:25 (20')	Next-generation wastewater treatment process for carbon and energy neutralities
14:25-14:45 (20')	Recycling of wastewater to recover fresh water, reduce brine discharge and capture CO2
14:45-15:05 (20')	Coffee break
Challenge 2: Sustainable Water Resource Management	
15:05-15:25 (20')	Clean Water Village: Sustainable Water Resource Management Action from Catchment to Villagers
Challenge 3: Flood/Drought Risk Assessment and Management	
15:25-15:45 (20')	Climate resilient water management software powered by satellite imaging & AI
Challenge 4: Depletion and Pollution of Water Caused by Natural Disaster	
15:45-16:05 (20')	SWC
16:05-16:25 (20')	Coffee break
Challenge 5: Nature-based Solutions for Ecological Recovery and Resilient Water Cycle	
16:25-16:45 (20')	Nature based river rejuvenation: Mandakini River, India (part of Ganga basin)
16:45-17:05 (20')	Bamboo oasis
17:05-17:20 (15')	Presentation by The Grand Winner of WWCH 2022
17:20-17:25 (05')	Closing Remarks
17:25-17:30 (05')	Group Photo & Closing

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World Water Challenge 2023

Main Focus 1

Water and Wastewater Treatment

Challenge 1

Energy-efficient (or Carbon-emission-reducing) Water Recycling and Reuse

Solution 1

elerGreen Production and Waste Valorization from Water Pollutants using Renewable Electricity

- Hui Huang Hoe, elerGreen Industry Corporation

Solution 2

Next-generation wastewater treatment process for carbon and energy neutralities

- Rahul Gajanan Kadam, Chosun University

Solution 3

Recycling of wastewater to recover fresh water, reduce brine discharge and capture CO2

- Leo Hyoungkun Park, Capture6

Solution 1

elerGreen Production and Waste Valorization from Water Pollutants using Renewable Electricity

Hui Huang Hoe, elerGreen Industry Corporation

elerGreen addresses water pollution via elerGreen's novel reactor to turn waste pollutants from mining, chemical and manufacturing industries into valuable products by renewable electricity. Water pollution plagues North America and worldwide, when toxic effluents containing heavy metals and petrochemical wastes, are discharged into water and environment from mining and chemical industries. An example is Mount Polley Disaster in British Columbia, Canada with ongoing aftermath. Traditional thermochemical industry is more costly but less eco-friendly as we know, while the biochemical industry, is less reliable nor scalable due to various limitations of biochemical mechanisms. To address such issues, elerGreen invented unique electrochemical reactor of moving electrode against stationary blades to continuously harvest solid products. This facilitates pollutants conversion, including CO2, tailings and petrochemical wastes, into valuable metals, polymers and feedstocks, powered by renewable electricity. Interesting, this invention was conceived by a Eureka moment while jogging on a treadmill! For mining industry, toxic heavy metal ions in tailings are turned into solid metals with resaleable values while detoxifying the tailings. An example is pyrite (degrading land and water with acid mine drainage) conversion into metallic iron (saleable) and sulphuric acid/sulphate (feedstock). Other metals can be recovered similarly such as Zinc (Zn), Copper (Cu), and Gold (Au), winning PERUMIN Competition globally for meeting various UN Sustainable Development Goals (SDGs). For chemical industry, waste valorization includes converting toxic ethylene glycol in paint sludge and spent antifreeze, into harmless polyethylene glycol of various uses. Furthermore, the retrofitting features of elerGreen reactor and process allows existing facilities to utilized for low cost and quick implementation, in contrast to rebuilding new facilities. For manufacturing industry, elerGreen process allows compostable polymers to be produced at much lower costs and at industrial scale. An example is compostable polymer production, of polyglycolic acid for food packaging. This also prevents conventional, non-biodegradable plastics from polluting the land, water and ecosystem. Notably, elerGreen is a certified Made in Ontario company. elerGreen catalyses climate action for converting carbon dioxide or its derivatives into useful products, including carbon-neutral fuels as hydrogen and metals. It is also powered by renewable electricity, eliminating fossil fuel combustion besides being energy-efficient. Beyond technological innovations, elerGreen utilizes business model innovation, known as collaborative sales. It boosts cleantech viability while empowering community, by instalments, sharing subsidies, and joint-defence IP license spanning >111 countries for 94% of global market. Beyond cleantech mandate, elerGreen emphasizes giving back to the society. Notably, elerGreen coaches students in Venture for Canada (VFC) Intrapreneurship projects, to cradle future entrepreneurship endeavors for the youth. Such student-involved elerGreen projects are being upscaled with St. Lawrence College. The World Water Challenge for elerGreen would showcase Korea International Water Week's positive sustainable efforts on all community levels demonstrated above, and recently as Impactful Actions Awards in Young Leaders category.

Solution 2

Next-generation wastewater treatment process for carbon and energy neutralities

Rahul Gajanan Kadam, Chosun University

Activated sludge (AS) and its modified systems are still being applied for most parts of wastewater treatment processes worldwide. The AS-based process requires high energy consumption and biomass activity, which prevents an approach toward carbon and energy neutralities. This solution has three big approaches like below for making the wastewater treatment plant sustainable and carbon neutral.

- High energy consumption due to aeration necessity -> No aeration (Be-ANAMMOX)
- Wastewater is a good source of energy -> Recovery energy source (CEPT)
- Waste sludge has low biodegradability -> PS-based high-rate AD

The solution consists of an innovative strategy for transforming municipal wastewater treatment plants (MWWTPs) into environmentally sustainable and energy-efficient facilities, aligning with the principles of the "Green New Deal". Departing from conventional activated sludge systems, the strategy advocate for a revolutionary approach centered on optimizing resource recovery and minimizing energy consumption. Traditionally, MWWTPs have heavily relied on activated sludge-based processes, which fall short of meeting the demands of the Green New Deal. To tackle this challenge, a comprehensive solution encompassing multiple essential components has been put forth, working in synergy to elevate both performance and sustainability.

- Enhancing primary sludge recovery to maximize resource utilization.
- Bio-electrochemical anaerobic ammonium oxidation and efficient H2 recovery.
- Efficient high-rate anaerobic digestion of primary sludge.

Central to this new paradigm is the utilization of advanced primary treatment techniques. Primary sludge (PS) exhibits higher biodegradability compared to waste activated sludge (WAS) and contains valuable organic compounds that can serve as a viable energy source. Enhancing the separation efficiency of PS through advanced methodologies within MWWTPs emerges as a promising approach to decrease energy usage and augmented biogas generation in subsequent biological processes.

A groundbreaking feature of this approach involves bio-electrochemical anaerobic ammonium oxidation, a process that accomplishes ammonium oxidation to N2 while simultaneously converting it to H2 under anaerobic conditions. This dual mechanism significantly curtails energy requisites and waste sludge production, thereby addressing two prominent challenges in conventional activated sludge methods. Furthermore, the H2 gas generated through these processes serves a dual purpose by improving the quality of biomethane, as it acts to decrease carbon dioxide levels within the biogas.

Another cornerstone of this approach is high-rate methanation. This innovative step not only reduces the energy input required for aeration but also augments the production of methane-enriched biogas. The reclaimed H2 presents an opportunity to enhance biogas quality indirectly through biogas upgrading or by directly substituting process energy within the MWWTPs. Diverse anaerobic digestion methods can be employed to concurrently generate and enhance biogas, achieving shorter hydraulic retention times (HRT) in the process.
This holistic strategy possesses the potential to simplify and optimize MWWTPs by achieving elevated levels of both process efficiency and energy efficiency. Despite its promising attributes, the approach is not exempt from challenges and limitations, and they emphasize the necessity for ongoing research and development efforts to fully realize the potential of this innovative approach. In summation, the strategy articulates a novel pathway to revolutionize MWWTPs, steering them toward carbon neutrality and sustainable energy practices. By integrating advanced primary treatment techniques, bio-electrochemical anaerobic ammonium oxidation, and high-rate methanation, MWWTPs stand poised to emerge as models of both efficiency and eco-friendly infrastructure.

Soultion 3

Recycling of wastewater to recover fresh water, reduce brine discharge and capture CO2

Leo Hyoungkun Park, Capture6

As the climate crisis intensifies, water resources are becoming scarcer, leading many counties to add more desalination capacity to address water security. However, brine is an unavoidable product of seawater desalination and advanced wastewater treatment. Brine is commonly disposed of in oceans and seas, where it has negative effects on the surrounding marine environment and biodiversity due to the resultant increased salinity and temperature, as well as the presence of chemicals. At the same time, the UN Intergovernmental Panel on Climate Change (IPCC) confirmed in its April 2022 report on mitigating climate change that the deployment of carbon dioxide removals to counterbalance hard-to-abate residual emissions is unavoidable if carbon neutrality is to be achieved.

To address these water, climate and environmental problems in a holistic manner, Capture6 has developed a novel process that can capture carbon dioxide from the atmosphere by recycling brine from desalination and wastewater treatment facilities. Additionally, Capture6 can recover up to 70% fresh water from our brine water input for drinking and industrial purposes in the process of removing CO_2. This creates a meaningful synergy between carbon removal and water security. Furthermore, Capture6's process reduces brine discharge up to 65%. To conclude, Capture6 solution makes significant contributions to multiple Sustainable Development Goals (SDGs).

Capture6's process is a proprietary, patent-pending liquid direct air capture (DAC) process designed for CO2 capture from the atmosphere and optional industrial point-source emissions. The process starts with waste brine from desalination and water recycling facilities. The brine is then processed using nanofiltration, ion exchange, reverse osmosis, and electrodialysis with bipolar membranes (EDBM). During EDBM, the brine passes through membranes under a direct current and is separated into NaOH and HCl. HCl can be utilized within the water treatment system, sold for other industrial uses or neutralized, and water. The NaOH solvent then reacts with atmospheric CO2 in an air contactor to form Na2CO3. If a source of calcium is available, then calcium carbonate can be produced, which can be used or stored permanently in sub-surface locations such as disused mines.

Our process differs from existing DAC and CCUS (Carbon Capture, Utilization and Storage) technologies by operating as a throughput process, rather than a regenerative process. This allows us to create significant value beyond traditional regenerative processes that yield pure CO2 for utilization or storage. Our process can create multiple forms of carbonates and other outputs (HCl, H2 gas, lithium extraction).

The entire process flow occurs at ambient temperatures and pressures without any need for thermal energy, so the process can run on 100% electricity, ideally from renewable energy. The unit processes and their energy consumption allow for electrical and load flexibility necessary for demand-side management. The mineralized carbonates are similar in physical properties and characteristics to rocks such as trona (sodium carbonate-bicarbonate), limestone (calcium carbonate), and magnesite (magnesium carbonate) that are geologically stable for thousands of years.

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Main Focus 2

Efficient Water Management

Challenge 2

Sustainable Water Resource Management

Solution 4

Clean Water Village: Sustainable Water Resource Management Action from Catchment to Villagers

-Ziyue Zeng, Changjiang River Scientific Research Institute

Solution 4

Clean Water Village: Sustainable Water Resource Management Action from Catchment to Villagers

Ziyue Zeng, Changjiang River Scientific Research Institute

The carrying capacity of water resources determines how far the economy and human society can evolve. Water resource protection and utilization also bear irreplaceable importance to promote the development of rural industries, improve rural residential environment, and bolster the sustainable development of farmers. At present, however, there is inadequate awareness of water resource protection among some river basins, regions, and villages across Lancang-Mekong countries, of which current practices in water resource protection and utilization fail to cater to urgent rural needs for qualified water resources, a healthy water ecosystem, a livable environment, and green development. Based on the experience of “river regulation to obtain clear water, water conservancy to benefit the people,” we have provided a set of solutions to water resource protection and green development for villages across the small river basins of Lancang-Mekong countries (one graphical picture seen in Fig 1.1 and can download separately). Through “clean water from source - clean water into each household - clean water for livelihoods,” we have fulfilled the objectives of “clean water village” including water security, economic development, a beautiful environment, and an income increase for villagers.

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Main Focus 3

Water and Natural Disasters

Challenge 3

Flood/Drought Risk Assessment and Management

Solution 5

Climate resilient water management software powered by satellite imaging & AI

- Nataliya Mykhaylova, WeavAir

Challenge 4

Depletion and Pollution of Water Caused by Natural Disaster

Solution 6

SWC

- YIN-CHI LIU, Ming Chi University of Technology

Solution 5

Climate resilient water management software powered by satellite imaging & AI

Nataliya Mykhaylova, WeavAir

The lack of accurate real-time insights on water body resilience and climate change sensitivity carry significant impacts, threatening agriculture, food security and infrastructure. While an increasing amount of satellite image data is available making use of a variety of imaging techniques and sensors, over 70% is not being used effectively because of challenges in tracking and extracting relevant information accurately and quickly. The conventional approaches still rely on the analysis of sensor data sequentially, processing image after image at fixed points, which leads to redundancy problems leading to increased data storage and long analysis times, preventing governments and society from being able to take action quickly, test and prioritize water management and climate interventions. We propose a new nature-inspired approach that increases the speed and accuracy of environmental anomaly data analysis, while reducing its costs. By combining satellite hyperspectral imagery and drone image data as well as machine learning models, the software supports real-time monitoring, reducing the cost and time required to make accurate decisions by at least 10-fold. The bio-inspired environmental prediction algorithm is used to detect anomalies like sudden or large changes in weather patterns and climate change predictors to identify and mitigate the risks like droughts and flooding. By building pre-trained algorithms for specific temporal and spatial patterns we are able to make the system robust at detecting pre-emptive signs and predictors of events like forest fires, flooding and diagnose exceedances in carbon emissions and sinks more accurately and quickly. These algorithms can be extracted and deployed in other solutions, improving the speed and accuracy of training on new datasets and creating new benefits for society. Our approach allows for analysis of the satellite image data pixels independently, increasing the speed of analysis by at least 50x, compared to conventional approaches of analyzing all the pixels sequentially.

Solution 6

SWC

YIN-CHI LIU, Ming Chi University of Technology

Due to serious desertification, people's livelihoods have been affected, about 10 to 20 percent of the dry land has been degraded, affecting a total of about 1,200 square kilometers of land and 100 million people. Shelterbelts are planted to prevent the spread of desertification, but they are easily infected by livestock or pests, making trees difficult to grow and requiring human care. At present, Africa is carrying out the Great Green Wall plan, which brings together more than 20 countries in the Sahel and Sahara region to cooperate with the African Union to plant shelterbelts to prevent the spread of desertification, but the completion rate is only 20%.

SWC is a water collector that protects the growth of shelterbelts, mainly Senegalese catechu in the Sahara Desert of Africa. It prevents the wind from blowing down the immature tree trunk, and collects a small amount of dew and rain below. When soil doesn't have enough water, it diffuses the water inside to help trees grow. When the trunk is strong, the product breaks down back into the soil. The product is made of natural materials and can be used for 1~2 years. The product is coated with local oil to reduce access to pests and diseases, and the high walls of the product protect young trees from livestock.

At the early stage, several trees are planted in the Nursery pot. After 3 months, the trees with a height of about 15 cm can be transplanted. Three parts are placed in sequence into a hole 30 cubic cm deep, and each plant is at least 4m apart. After 1 year, the tree is about 50 cm tall and the tree diameter is about 3 cm, SWC can protect it for at least one year, and at this time the tree has been rooted, the height of the product is about 5 cm higher than the tree at this time, when about 3 years, the diameter of the product can no longer load the tree, and collapse, return to the soil to provide nutrients.

The whole product is 75 cm High, 55 cm above the soil, 20 cm below the Nursery pot planting area, and the opening is 8cm, and the water storage area is 12 cm. After transplantation, the High wall opening diameter is 30cm, which reduces the gnawing by livestock, but keeps the trees growing.

The main material is tree branches and gum, which are crushed into pulp and made into pulp. After filling the mold, the appearance is coated with real estate hard training oil, and then the gum is added through different proportions to make the paper hydrophilic, which will produce better diffusion rate and supply the trees as water transfer. Through the tree's own branches and gum production, reduce the purchase burden of local residents, and allow local sustainable production and manufacturing, so that local people can protect their own land.

SWC helps local users better plant shelterbelts to stop the spread of desertification, improve the growth rate of trees in shelterbelts, protect young trees and reduce the possibility of death. More trees can reduce sand and dust, increase soil fertility and planting area, and reduce the need for watering and labor loss.

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Main Focus 4

Ecosystem and Water

Challenge 5

Nature-based Solutions for Ecological Recovery and Resilient Water Cycle

Solution 7

Nature based river rejuvenation: Mandakini River, India (part of Ganga basin)

- Meesha Tandon, Sustainability and Adaptation Planning Foundation

Solution 8

Bamboo oasis

- Zhen-Yan Zeng, Ming Chi University of Technology

Solution 7

Nature based river rejuvenation: Mandakini River, India (part of Ganga basin)

Meesha Tandon, Sustainability and Adaptation Planning Foundation

Rivers across Asia are under extreme stress due to population growth, urbanization and climate change. It is estimated that melting glaciers, hotter summers, severe or extreme weather conditions are likely to increase with climate change. Ganga, one of the largest rivers in the world, is under threat from anthropogenic pressures like encroachment, excessive groundwater withdrawal, sand mining, retreating glaciers, glacial overland flow, formation of glacial lakes, water pollution, reducing biodiversity, declining water regime, flooding and drought in the same basin and many more and these changes are likely to increase with climate change. India faces damages of more than $150 billion as a result of heat waves alone in 2021 and is amongst the top 10 countries vulnerable to impacts of climate change. Nearly 2/3 of Indian population depends on Ganga, directly or indirectly, thereby, prioritizing the need to sustain the river. Climate change is manifesting itself in the form of floods, droughts and glacial melt in the Ganga basin. Several measures are being taken to rejuvenate the river, however, most of these measures are centered around construction of wastewater treatment plants and development of grey infrastructure which can even have adverse impacts on the river ecosystems. Most examples of river restoration in India point towards concretization of the river floodplain, lack a basin and community level approach for water body restoration, underestimate the need for lateral and horizontal connectivity of river with its floodplains; and ecosystem restoration of the river as a whole is underestimated. Measures towards damming and desilting of rivers are prominently adopted and the adverse environmental and ecosystem impacts of these are not understood properly.

We propose a nature-based approach for revival of Mandakini River, a tributary of Ganga, which can act as a model for ecosystems-based approach of river restoration. Nature based measures for river restoration can lead to increased capacity of the river ecosystem to sustain floods and increased capacity of the river to recharge the water table, thereby addressing issues of water security, droughts and climate change.

To explain this, the case example of Mandakini River restoration proposal (prepared and submitted to government officials as part of city development plan for Chitrakoot city) has been discussed here. The river restoration or rejuvenation process focuses more on restoring the ecosystem and environmental degradation of the river while ensuring lateral and horizontal connectivity of the river. It is proposed that a comprehensive ecologically sensitive river rejuvenation plan for Mandakini be developed by a panel of experts including environmentalists, ecologists, environmental planners and other subject matter experts. Since most part of the catchment area is located in another state, it is crucial that a holistic trans boundary effort be taken up to revive Mandakini by reviving the catchment as well as the streams. This rejuvenation plan focuses on community engagement for holistic revival of the river.

Solution 8

Bamboo oasis

Zhen-Yan Zeng, Ming Chi University of Technology

Climate change in recent years has led to frequent high temperatures and increased likelihood of droughts. In Africa and other arid regions, severe water shortages caused by droughts have forced people to travel longer distances and spend more time fetching water. Water sources may also be contaminated, leading to health problems. Additionally, children are often tasked with fetching water and may miss out on education, while mothers spend a significant amount of time on water-fetching tasks, making it difficult to contribute to their families' economic well-being.
We found several problem points.

1.Long distance
Water extraction over long distances affects women and children. If women help to fetch water, it will lead to a decrease in household income. If children help to fetch water, it will affect the school attendance rate of children.

2.Clean water
The lack of clean drinking water caused many diseases. If you want to get clean drinking water, sometimes it is necessary to travel long distances.

3.Health
Nearly 1 million people die each year from water sanitation-related diseases. On average, a child dies every two minutes.

Then, we designed Bamboo oasis. It is a bamboo structure that provides clean water to residents directly at home. Inspired by African thatched hut architecture, the design incorporates a water collection feature into the building structure. The collection system made of bamboo weaving, utilizes small mesh holes to collect dew. The lift roof can be opened and closed, prevents rainwater from entering the interior when closed, but can capture dew when opened. The bamboo bucket structure inside the Bamboo Oasis serves as both a water channel and support structure for the roof, integrating functionality with architectural design.
Through Bamboo Oasis, the capability to collect dew is harnessed, providing villages with a clean water source. This helps prevent health hazards caused by water pollution, ensuring residents have access to a safe and affordable drinking water supply. The initiative addresses water scarcity issues exacerbated by climate change and tackles local water resource hygiene concerns

MEMO

MEMO

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