

PAWEES 2026

ABSTRACT BOOK

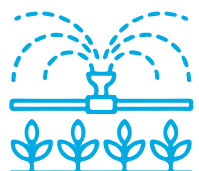
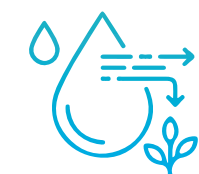
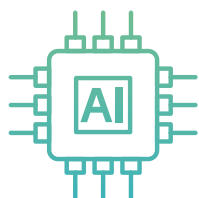
The 2026 Conference of
International Society of
Paddy and Water Environment
Engineering

Oct. 19^{MON} ~ 21^{WED}, 2026

Sejong Hotel, Chuncheon, Korea



AI-ENABLED CLIMATE-RESILIENT AGRICULTURAL WATER SYSTEMS TOWARD A CARBON-NEUTRAL FUTURE



International Society of Paddy and
Water Environment Engineering (PAWEES)



The Korean Society of
Agricultural Engineers (KSAE)



KANGWON NATIONAL
UNIVERSITY



Ministry of Agriculture,
Food and Rural Affairs



Korea Rural Community
Corporation



강원관광재단
Gangwon Tourism Organization



한국관광공사
KOREA TOURISM ORGANIZATION

PAWEES 2026

PROGRAM BOOK

01 CONFERENCE NAME

The 2026 Conference of International Society of
Paddy and Water Environment Engineering

02 DATE / VENUE

October 19~21, 2026 / Sejong Hotel, Chuncheon, Korea

03 ABOUT PAWEES

PAWEES is an academic conference for the purpose of exchange for the development of various engineering/science technologies, such as irrigation drainage, sustainable management of agricultural water resources, promotion of multi-functionality, regional development and planning, related to rice paddy farming and water environment in the Asian monsoon region. It was founded in 2003 by the Agricultural Engineering Societies of Korea, Japan, and Taiwan (KSAE, JSIDRE, TAES), and holds an international conference every year.

04 MAIN THEME & SUB-THEME 1-4

AI-Enabled Climate-Resilient Agricultural Water Systems toward a Carbon-Neutral Future

Theme 1 : Soil, Water, and Carbon for Agricultural Resilience

Theme 2 : AI, Digital Twins, and Smart Technologies for Agro-Water Systems

Theme 3 : Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

Theme 4 : Ecosystem Services, Policy, and Governance for Carbon-Neutral Water Futures

05 CONFERENCE ORGANIZATION

International Society of Paddy and
Water Environment Engineering (PAWEES)



The Korean Society of
Agricultural Engineers (KSAE)



Ministry of Agriculture,
Food and Rural Affairs



Korea Rural Community
Corporation



강원관광재단
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KOREA TOURISM ORGANIZATION

OPENING ADDRESS



Distinguished guests, esteemed colleagues, ladies and gentlemen, Good afternoon!

It is my great pleasure and honor, as President of the International Society of Paddy and Water Environment Engineering (PAWEES), to join you at the PAWEES 2026 International Conference in Chuncheon, Korea.

Today, global agriculture is facing growing challenges from climate change, water scarcity, and food security. The United Nations Sustainable Development Goals and recent international climate discussions, particularly COP28 and COP30, have emphasized the importance of climate-resilient agriculture, sustainable water management, and the transition toward carbon neutrality. The United Nations International Decade of Sciences for Sustainable Development (2024–2033) further

highlights the essential role of scientific innovation and international cooperation in addressing these interconnected challenges.

In this context, this year's conference theme, "AI-Enabled Climate-Resilient Agricultural Water Systems toward a Carbon-Neutral Future," reflects the evolving priorities of global agricultural and environmental research. Integrating artificial intelligence and advanced technologies with agricultural water management, carbon management, and ecosystem services opens new opportunities to strengthen climate resilience while supporting sustainable food production.

Since its establishment in 2003, PAWEES has served as an important international platform for advancing paddy and water environment engineering. Together with our member societies, academic institutions, and research partners, we have promoted scientific exchange and interdisciplinary collaboration across different agricultural regions. Our collective expertise and partnerships place PAWEES in a strong position to connect emerging scientific developments with practical solutions for agricultural and environmental sustainability.

Looking ahead, PAWEES will continue to strengthen international research networks, encourage knowledge exchange, and advance integrated approaches to agricultural water and environmental management. Through these efforts, we aspire to contribute to global climate action and sustainable agricultural development, while supporting the next generation of researchers and professionals in our field.

On behalf of PAWEES, I sincerely thank the Korean Society of Agricultural Engineers, Kangwon National University, the organizing committee, and all supporting organizations for their outstanding efforts in organizing this conference. I also thank our distinguished speakers and participants for their continued contributions to our scientific community.

I sincerely hope this conference will further strengthen connections among our members and international partners and inspire new directions for scientific cooperation and innovation.

It is my pleasure to declare the PAWEES 2026 International Conference officially open.

Thank you very much.

Dr. Yu-Pin Lin

President of PAWEES

WELCOME ADDRESS



Distinguished guests, colleagues, and friends.

I'm Jae-Yeon Jeong, President of Kangwon National University, and I would like to extend my heartfelt congratulations on the opening of the 「PAWEES 2026 International Conference」.

I would also like to express my sincere appreciation to President Sang-Min Kim of the Korean Society of Agricultural Engineers, to the PAWEES community and everyone who has worked to make this conference possible.

Additionally I would like to warmly welcome all the researchers and experts from Korea and around the world who have joined us today in Chuncheon, Republic of Korea.

As climate change intensifies, the conditions affecting agriculture and water resources are changing rapidly.

In response, the use of AI and digital technologies to respond proactively to climate change and manage water resources more efficiently and sustainably has become a key priority in agricultural water management and water-related environmental research.

In this regard, the theme of this year's conference, "AI-Enabled Climate-Resilient Agricultural Water Systems toward a Carbon-Neutral Future," is both timely and highly significant.

I hope this conference will serve as a meaningful platform for sharing research findings and experiences from around the world, connecting new technologies and ideas, and expanding international research collaboration.

Chuncheon, where we are gathered today, is a city blessed with abundant water resources, including Soyang River Dam, as well as a beautiful natural environment.

Alongside fruitful academic exchanges, I hope you will fully enjoy Chuncheon's beautiful water environment and the charm of autumn.

Once again, congratulations on the opening of the 「PAWEES 2026 International Conference」.

I sincerely hope that this conference will serve as a valuable opportunity for us to work together toward a more sustainable future for agriculture and the water environment.

Thank you.

Jae-Yeon Jeong

President of Kangwon National University

WELCOME ADDRESS



Ladies and gentlemen, esteemed colleagues, and distinguished guests,
Good afternoon!

It is my great honor and privilege to welcome you all to Korea for this year's International PAWEES Conference. As we gather to share knowledge, foster collaboration, and drive innovation, I am deeply delighted to stand before you today.

Over the past decades, PAWEES (International Society of Paddy and Water Environment Engineering) has served as an invaluable platform for exchanging cutting-edge science and engineering technologies related to paddy farming, agricultural water management, and rural environment preservation across the Asian monsoon region and beyond.

Today, our conference addresses a truly pivotal theme: “AI-Enabled Climate-Resilient Agricultural Water Systems toward a Carbon-Neutral Future.” As we face unprecedented climate volatility and ecological pressures, the intersection of artificial intelligence, climate resilience, and agricultural water management has never been more critical. By harnessing advanced technologies—such as deep learning, big data analytics, and smart infrastructure—we are called to pioneer innovative pathways that not only secure our agricultural water resources against climate extremes but also actively contribute to a sustainable, carbon-neutral future.

Through dynamic presentations, robust discussions, and cross-disciplinary networking, I am confident that we will generate groundbreaking insights and forge lasting partnerships to tackle these global challenges.

I would like to extend my heartfelt gratitude to all our participants, keynote speakers, organizing committee members, and sponsoring organizations whose dedication and hard work have made this event possible. Your contributions are vital in shaping the trajectory of agricultural engineering for years to come.

As you engage in our academic sessions, I also encourage you to take some time to experience the rich culture, warm hospitality, and scenic beauty of Korea.

May this conference be intellectually stimulating, professionally rewarding, and personally memorable. I officially declare the International PAWEES Conference open.

Thank you very much!

Sang Min Kim

President of the Korean Society of Agricultural Engineers (KSAE)

CONGRATULATORY ADDRESS



On behalf of the Japanese Society of Irrigation, Drainage and Rural Engineering (JSIDRE), I would like to offer my congratulations on the PAWEES International Conference 2026, to be held from October 19th to 21st, 2026, in Chuncheon, Korea. I hope that the conference will be a great success.

Furthermore, I would like to express my deep gratitude and respect to all of this year's awardees for their outstanding academic contributions and dedicated service to PAWEES. Please accept my warmest congratulations on your awards.

I would also like to express my sincere appreciation to the Korean Society of Agricultural Engineers (KSAE) and all those involved in organizing this conference.

The main theme, "AI-Enabled Climate-Resilient Agricultural Water Systems toward a Carbon-Neutral Future", is a most timely and relevant topic for discussing the sustainability of paddy farming, agricultural water use, and the water environment.

Particularly notable initiatives planned for this conference include the International Young Researchers Networking Session -designed for students and young professionals in agricultural engineering- and the Student Presentation Competition in the Technical Sessions.

I strongly believe that such initiatives targeting students, young researchers, and young engineers are vital for passing on the knowledge, the technology, and the research of paddy farming in the Asian monsoon region to the next generation.

Once again, I would like to express my gratitude to KSAE for organizing these visionary sessions. I hope that students, young researchers, and engineers will actively participate, deepen their knowledge and discussions, and engage in the future activities of PAWEES.

Specifically, I look forward to active submissions of research and technical papers from young researchers and engineers to our international journal, "Paddy and Water Environment," which is a major pillar of the Society's activities.

This journal has a history of over 20 years, and its position as an international journal has been established through the continuous efforts of its editorial board and members.

I believe our vision will be realized as the knowledge disseminated through this journal spreads globally, contributing to solutions for food security and related challenges through the advancements of paddy agriculture in various regions.

Moving forward, it is essential that we continue our global contributions by keeping these two core pillars hosting this international conference and publishing our international journal at the heart of our activities.

Finally, I hope that the outcomes of all sessions at the International Conference 2026 will contribute significantly to sustainable agricultural production, global food security, and environmental preservation.

Once again, I offer my heartfelt congratulations to everyone involved in the PAWEES International Conference 2026 in Chuncheon.

Dr. Masayuki Fujihara

President of the Japanese Society of Irrigation, Drainage and Rural Engineering
Professor, Kyoto University

CONGRATULATORY ADDRESS



Distinguished guests, fellow members of PAWEES, esteemed colleagues, ladies and gentlemen,

On behalf of the Taiwan Agricultural Engineers Society (TAES), I extend my warmest congratulations to the PAWEES 2026 International Conference and sincere appreciation to our Korean colleagues for hosting this important international gathering.

Taiwan's diverse topography and climatic conditions present unique challenges and opportunities for agricultural water management. With mountainous terrain, uneven seasonal rainfall, frequent extreme weather events, and diverse agricultural production systems, Taiwan has developed extensive research and practical experience in managing water resources under varying environmental conditions. These experiences offer valuable opportunities to explore approaches that may also apply to other agricultural regions facing similar challenges.

Building upon these experiences, Taiwan's agricultural engineering community has continued to advance research in smart irrigation, precision water management, climate risk assessment, and integrated agricultural water systems. By combining agricultural and environmental sciences with advances in digital technologies, we are exploring ways to improve water use efficiency, strengthen climate resilience, and support sustainable agricultural production. Research on low-carbon agricultural practices and ecosystem services also contributes to broader efforts toward agricultural sustainability.

As climate change puts increasing pressure on agricultural water resources worldwide, the diversity of environmental conditions and research experience among PAWEES member countries provides a strong foundation for international collaboration. We believe that sharing Taiwan's experiences, while learning from the different approaches developed by our international colleagues, can help identify more effective and adaptable strategies for addressing common water management challenges.

TAES greatly values its longstanding relationships with PAWEES and its member societies. We look forward to strengthening scientific exchanges, exploring opportunities for joint research, and working together to develop practical and scientifically informed solutions for agricultural water security and climate adaptation.

I sincerely appreciate the Korean Society of Agricultural Engineers, the organizing committee, and all supporting institutions for their dedication and efforts. I wish the PAWEES 2026 International Conference every success and look forward to continued friendship and collaboration among our international partners.

Thank you very much.

Dr. Yu-Pin Lin

Dean, College of Bioresources and Agriculture, National Taiwan University
Professor, Department of Bioenvironmental Systems Engineering, National Taiwan University

KEYNOTE SPEECH



Paddy Farming: Status and Future Directions

Ph.D. Jin-Yong Choi

Former President of KSAE, VPH of ICID

Paddy farming is one of the world's most important agricultural systems, providing staple food for billions of people while forming a distinctive agroecosystem through interactions among crops, soil, water, and the atmosphere. This presentation reviews the current status, emerging challenges, and future directions of global paddy farming from the perspective of paddy and water environment engineering.

Global harvested rice area increased from approximately 115 million ha in 1961 to 172 million ha in 2024, while paddy rice production increased from about 216 million to 820 million tonnes. During the same period, average yield rose from 1.87 to 4.76 t/ha, demonstrating the major contribution of technological and productivity improvements to global food security. Nevertheless, paddy farming faces increasing challenges from climate change, water scarcity, greenhouse gas emissions, changing consumption patterns, and aging agricultural populations.

Climate change is expected to increase production risks through changes in temperature, precipitation, drought, floods, and water availability. Meanwhile, flooded rice cultivation is an important source of methane emissions.

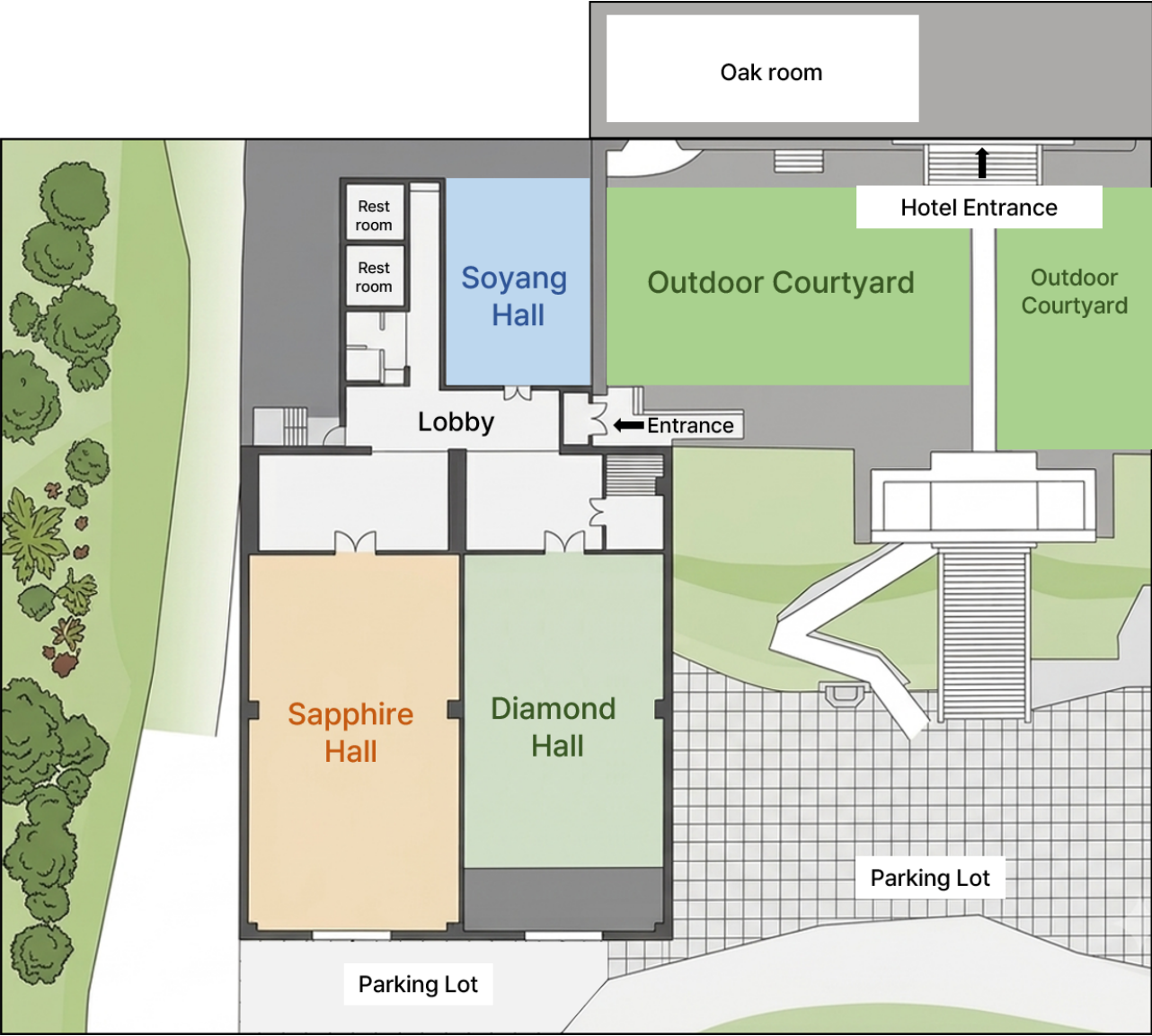
The importance of paddy farming, however, extends beyond rice production. Paddy landscapes provide multifunctional services including flood mitigation, water storage, groundwater recharge, water purification, biodiversity conservation, wetland functions, cultural heritage, and rural-community support. Africa also represents an increasingly important frontier, where rapidly growing rice demand, food-security concerns, import dependence, and irrigation potential create significant opportunities for sustainable rice development.

Future paddy farming should therefore evolve toward climate-resilient, low-carbon, multifunctional, and digitally managed systems, integrating advanced water management, methane mitigation, AI and digital technologies, ecosystem services, and expanded international cooperation.

PROGRAM AT A GLANCE

Oct. 19 (Mon.)					
Time	Diamond Hall (A)	Soyang Hall (B)	Oak Room (C)	Sapphire Hall (D)	Hallway (Poster)
17:00-20:00	VIP Welcome Dinner				
Oct. 20 (Tue.)					
Time	Diamond Hall (A)	Soyang Hall (B)	Oak Room (C)	Sapphire Hall (D)	Hallway (Poster)
08:30-09:00	Registration				
09:00-10:30	Student Presentation Competition 1 (SS1)				Poster Student Session (PS1, Taegon Kim)
	#1 SS1-A (Dong-Hyeon Kim, Hanseok Jeong)	#1 SS1-B (Hakkwan Kim, Shao-Yiu Hsu)	#2 SS1-C (Won-Ho Nam, Dongjun Lee)	#3 SS1-D (Soken Matsuda, Donghwan Kim)	
10:30-10:50	Coffee Break (Poster Viewing / Change)				
10:50-11:50	Student Presentation Competition 2 (SS2)				Poster Student Session (PS2, Taegon Kim)
	#1 SS2-A (Dong-Hyeon Kim, Shu-Yuan Pan)	#1 SS2-B (Li-Chi Chiang, Jung-Hun Song)	#2 SS2-C (Pu Reun Yoon, Feng-Hsun Chang)	#3 SS2-D (Donghwan Kim, Keigo Noda)	
11:50-13:00	Lunch		Lunch (Editorial Board Meeting)	Lunch	
13:00-14:00	Opening Ceremony & PAWEES Awards (Diamond Hall)				
14:00-14:40	Keynote Speech (Ph.D. Jin-Yong Choi) (Diamond Hall)				
14:40-15:00	Coffee Break (Poster Viewing / Change)				
15:00-16:30	Student Presentation Competition 3 (SS3)				Poster Student Session (PS3, Won-Ho Nam)
	#2 SS3-A (Seoro Lee, Cheng-Wei Yu)	#3 SS3-B (Dongjun Lee, John Paulo Sacdalan)	Executive Board Meeting	-	
16:30-16:50	Coffee Break				Coffee Break
16:50-18:00	Student Presentation Competition 4 (SS4)				Poster General Session (PG1, Won-Ho Nam)
	#1 SS4-A (Sanghyun Lee, Masaomi Kimura)	#4 SS4-B (Sang-Hyun Lee, Pu Reun Yoon)	-	-	
18:00-20:00	Dinner (Sapphire Hall)				
20:00-22:00	International Young Researchers Networking				
Oct. 21 (Wed.)					
Time	Diamond Hall (A)	Soyang Hall (B)	Oak Room (C)	Sapphire Hall (D)	Hallway (Poster)
09:00-11:00	General Oral Presentation Session (GS)				Poster General Session (PG2, Eunmi Hong)
	#1 GS-A (Fi-John Chang)	#1 GS-B (Taegon Kim)	#2 GS-C (Jin-Yong Choi)	#3 GS-D (Won-Ho Nam)	
11:00-12:00	Closing Ceremony & Awards (Diamond Hall)				
12:00-13:00	Lunch				
13:00-19:00	Technical Tour				

VENUE FLOOR PLAN



PAWEES 2026

INTERNATIONAL NETWORKING SESSION

International Young Researchers Networking Session

[About the Session] This networking event is designed for students and young professionals in agricultural engineering to foster international collaboration and professional networking. Join us for lively discussions and a friendly reception where you can connect with peers from around the world and building lasting international collaborations.

ELIGIBILITY Students and early-career professionals aged approximately 35 years or younger. The networking session will be held on October 20th with a welcome reception.

Networking Session

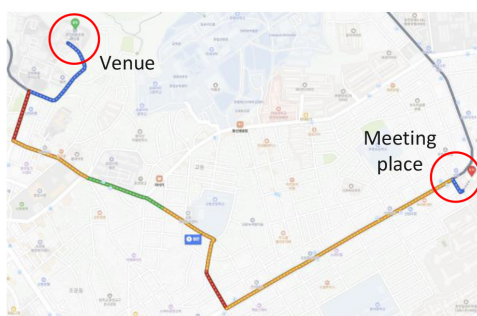
[October 20, 2026]

Welcome Reception and Networking with Young Researchers from Around the World.

TIME 8:00 – 10:00 PM (Following the Conference Dinner)

PLACE 가로솔길(Garosulgil), B1F, 316 Chuncheon-ro, Chuncheon-si, Gangwon-do

FEE KRW 20,000



- **Signature Menu**
- Fried Pork Ribs, Grilled Pork Back Ribs, Hanwoo Beef Tartare, Pork Belly with Tofu & Kimchi
- **Transportation**
- 10 mins by taxi from the venue (40 mins on foot)



How to register

FORM <https://forms.gle/fWsB1nfitPDxWiGL7>

DEADLINE **October 2, 2026**

CONTACT Min-Jin Kim [e-mail: minjin.kim@hknu.ac.kr]



Register Here

PAWEES 2026 TECHNICAL TOUR · CHUNCHEON

Technical Tour

Soyang River & Chuncheon Waterscapes

[About the Tour] A half-day technical visit to see agricultural water and water resources management in the field, from Soyang River Dam to the Udu warm-water pond.

DATE

Wed, Oct 21, 2026
13:30 – 18:40

MEETING POINT

Chuncheon Sejong Hotel
Board by 13:25

FEE

Free
Bus & tea provided

Tour Itinerary**[October 21, 2026]**

TIME	PROGRAM	DURATION
13:30	Depart from Chuncheon Sejong Hotel (boarding by 13:25)	—
14:00 – 15:00	Soyang River Dam · Observatory, Water Culture Center	approx. 60 min
15:20 – 16:20	Gamjabat Café (Potato Field Café) · Tea time & break	approx. 60 min
16:35 – 17:35	Udu Warm-Water Pond	approx. 60 min
17:45 – 18:25	Soyang River Skywalk	approx. 40 min
18:40	Return to hotel & end of tour	—



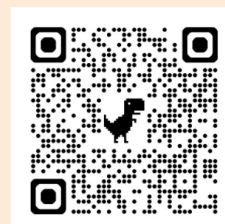
- All transfers by chartered bus (10–30 min between stops). Comfortable shoes recommended.
- Times are approximate and may change on the day.

How to register

FORM <https://forms.gle/A2YsCfMohUeHuAae8>

DEADLINE **[October 5, 2026]**

CONTACT Prof. Seoro Lee [e-mail: srlee@kangwon.ac.kr]
(General Inquiries) pawees2026@gmail.com



Register Here

PRESENTATION SCHEDULE

Student Presentation Competition 1 (SS1)

SS1-A | (#1) Soil, Water, and Carbon for Agricultural Resilience

Diamond Hall

Chair: Dong-Hyeon Kim (Jeonbuk National University), Hanseok Jeong (Seoul National University of Science and Technology)

SS1-A-1 09:00-09:15

Evaluating Carbon Dynamics and Flux Measurement Uncertainty in a Managed Perennial Agroecosystem

Yan-Ning Huang (National Taiwan University), Kuo-Wei Liao

SS1-A-2 09:15-09:30

Simulation of Fe^{2+} Dynamics under Different Infiltration Conditions in Paddy Soils

Mikito Oshima (The University of Shiga Prefecture), Soken Matsuda

SS1-A-3 09:30-09:45

Investigating the effects of artificial macropores on mass transport in saturated paddy soil for controlling spatial redox heterogeneity

Nagatsuki Tanaka (Okayama University), Yasushi Mori

SS1-A-4 09:45-10:00

The effects of water depth and disturbance on methane emissions from rice paddies

Yuma Yamanaka (Gifu University), Kengo Ito

SS1-A-5 10:00-10:15

Strategies of Greenhouse Gas Emission Mitigation in Paddy Through Water Management and Nitrification/Urease Inhibitors

Yu-Chi Cheng (National Taiwan University), Jilliane Clare Lu, Chuan-Fu Kao, Shan-Li Wang, Shu-Yuan Pan

SS1-A-6 10:15-10:30

Analyzing Multi-Pathway Methane Emission Mechanisms in Rice Paddies Using a Process-Based Model and High-Frequency Field Observations

Yi-Hui Lee (National Taiwan University), Shao-Yiu Hsu

SS1-B | (#1) Soil, Water, and Carbon for Agricultural Resilience

Soyang Hall

Chair : Hakkwan Kim (Seoul National University), Shao-Yiu Hsu (National Taiwan University)

SS1-B-1 09:00-09:15

Comparison of Alternative Objective Functions for Crop Yield Estimation under Rainfall Uncertainty

Yu-Syuan Cai (National Taiwan University), Gene Jiing-Yun You

SS1-B-2 09:15-09:30

Spatiotemporal Characteristics of Irrigation Water Balance and Climate–Reservoir Interactions in Korean Agricultural Reservoirs

Rahmon Abiodun Salau (Kyungpook National University), Kyung-Sook Choi

SS1-B-3 09:30-09:45

Understanding the Hydro-Climatic and Socio-Economic Drivers of Farmer Water Allocation for Enhancing Agricultural Resilience in the Subak System, Bali

Wily Goldramijaya (Tokyo University), Fumi Okura, Tasuku Kato

SS1-B-4 09:45-10:00

Automated and accurate detection of leak signals in pipelines by using pressure waves

Koichiro Takeuchi (Tokyo University), Yohei Asada, Yudai Fukushima, Atsushi Ishii

SS1-B-5 10:00-10:15

Functions of “Tamei” River Storage in Large Paddy Irrigation Scheme’s Project in Premodern Japan: The case study of Fukuoka’s LID

Russell Adonis Ekpelikpeze (University of Tsukuba), Atsushi Ishii

SS1-B-6 10:15-10:30

Factors governing groundwater pump operations in a village-community-level paddy irrigation district

Yuma Yagi (Kyoto University), Kimihito Nakamura, Takehide Hama

SS1-C | (#2) AI, Digital Twins, and Smart Technologies for Agro-Water Systems

Oak Room

Chair : Won-Ho Nam (Hankyong National University), Dongjun Lee (Kangwon National University)

SS1-C-1 09:00-09:15

Damage Assessment for In-Service Reinforced Concrete Headworks by AE Energy Analysis in Core Test

Yuika Ito (Niigata University), Hiromu Tanaka, Kazuma Shibano, Tetsuya Suzuki

SS1-C-2 09:15-09:30

Detection of Earthquake-Induced Damage in Road Bridge during Mj7.6 Noto Peninsula Earthquake by Anomaly Analysis with Optical Satellite Spectral Index[f1]

Kensho Nakagawa (Niigata University), Kazuma Shibano, Tetsuya Suzuki

SS1-C-3 09:30-09:45

Thermal Environment Simulation of Irrigation Dam Concrete using Physics-Guided Neural Network integrated with Three-Dimensional Shadow Analysis

Kazuma Shibano (Niigata University), Masaomi Kimura, Kentaro Ohno, Ninel Alver, Tetsuya Suzuki

SS1-C-4 09:45-10:00

Satellite-Based Assessment of Reservoir Storage and Irrigation Water Availability in North Korea

Si-Hoon Lee (Hankyong National University), Won-Ho Nam, Hee-Jin Lee, Hyeok-Jae Choi, Chan-Wook Kim

SS1-C-5 10:00-10:15

Bearing-Plate Extraction by UAV-LiDAR Point Clouds for Quantifying Plate-to-Ground Offset in Soil-Nailed Slopes

Hiromu Tanaka (Niigata University), Kazuma Shibano, Norihiro Otaka, Tetsuya Suzuki

SS1-C-6 10:15-10:30

Nondestructive Leakage Detection in Service Pipeline using Water Hammer Pressure with Different Transient Generation Conditions

Yuto Takahashi (Niigata University), Taiki Hagiwara, Tetsuya Suzuki

SS1-D | (#3) Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

Sapphire Hall

Chair : Soken Matsuda (The University of Shiga Prefecture), Donghwan Kim (Kangwon National University)**SS1-D-1 09:00-09:15**

Image-Based Classification and Mapping of Surface Cyanobacterial Blooms Using UAV Imagery
Siutiti Feao (Graduate School of Bioresource & Bioenvironmental Sciences), Akinori Ozaki, Masayoshi Harada,
 Toshinori Tabata

SS1-D-2 09:15-09:30

Climate-Induced Physicochemical Drivers of the Metalimnetic Oxygen Minimum in a Deep
 Monomictic Reservoir
Hojeong Yeom (Kangwon National University), Yoonhee Kim, Bomchul Kim, Eunmi Hong

SS1-D-3 09:30-09:45

Development of Technology for High-Resolution Land Surface Temperature and Paddy Area
 Estimation Using Satellite Image-Based Downscaling Techniques
Kiramat Hussain (Kangwon National University), Jeongho Han

SS1-D-4 09:45-10:00

Assessment of Suspended Sediment and Total Organic Carbon Simulation Performance
 Considering Spatial Distribution of Soil Organic Carbon in a SWAT-C Model
Seunghun Shin (Kangwon National University), Siwon Kim, Dongjun Lee, Kyoungjae Lim, Jonggun Kim

SS1-D-5 10:00-10:15

Evaluation of Nitrogen Removal Functions in Dry-Season Irrigated Paddy Fields in Vientiane, Laos
Koh Ochiai (The University of Tokyo), Keigo Noda, Masaomi Kimura, Yutaka Matsuno, Hiromasa Hamada,
 Somphasith Douangsavanh

SS1-D-6 10:15-10:30

An Integrated Geospatial Framework for Long-Term Spatio-Temporal Assessment of Hydrological
 Connectivity in the Bhoj Wetland-Catchment Using a Connectivity Index and Spatial Statistics
Manish Rawat (Indian Institute of Technology Roorkee), Ashish Pandey, Basant Yadav, Praveen Kumar Gupta

Student Presentation Competition 2 (SS2)

SS2-A | (#1) Soil, Water, and Carbon for Agricultural Resilience

Diamond Hall

Chair : Dong-Hyeon Kim (Jeonbuk National University), Shu-Yuan Pan (National Taiwan University)

SS2-A-1 10:50-11:05

An Additive-Based Agricultural Inundation Risk Assessment of Chungnam Province

Adisa Akinsoji (Kyungpook National University), Kyung Sook Choi

SS2-A-2 11:05-11:20

Flood Damage Assessment on Road Network and Agriculture in Agricultural Area: A Case Study of the Pursat River Basin, Cambodia

Panha Thouk (Tokyo University of Agriculture and Technology), Tasuku Kato, Davy Sao

SS2-A-3 11:20-11:35

Spatio-Temporal Variability and Regime Shifts of Extreme Precipitation in Tanzania: Implications for Climate Resilience and Water Resources

Salvatory Leonard Nasson (Kyungpook National University), Kyung Sook Choi

SS2-A-4 11:35-11:50

Development and Application of HAWQS for Spatial Assessment of Water Quality Loads in Small Agricultural Watersheds

Min-Jin Kim (Hankyong National University), Won-Ho Nam, Jaclyn Tech

SS2-B | (#1) Soil, Water, and Carbon for Agricultural Resilience

Soyang Hall

Chair : Li-Chi Chiang (National Taiwan University), Jung-Hun Song (Chungnam National University)**SS2-B-1 10:50-11:05**

Evaluation of a Lower-Boundary-Controlled Weighing Lysimeter for Measuring Evaporation under Shallow Groundwater Conditions

Fadhil Noor (Kagoshima University), Leon Nakayama, Ieyasu Tokumoto

SS2-B-2 11:05-11:20

Assessing Peatland Deformation under Agronomic Water Management and Extreme Droughts Using a Coupled Hydro-Eco-Mechanical Model

Cheng-Mao Hsu (National Taiwan University), Yi-Hsien Tu, Kuo-Wei Liao

SS2-B-3 11:20-11:35

Hydrologic and Crop Stress Responses to Field Slope in Korean Reclaimed Coastal Farmlands

Ye-Jun Lee (Hankyong National University), Won-Ho Nam, Jaehak Jeong

SS2-B-4 11:35-11:50

Development and Application of the SWAT+ PADDY Model for Paddy Field Hydrological Simulation in the Wu River Basin, Taiwan

Hsien-lun Liao (National Taiwan University), Li-Chi Chiang

SS2-C | (#2) AI, Digital Twins, and Smart Technologies for Agro-Water Systems

Oak Room

Chair : Pu Reun Yoon (Kongju National University), Feng-Hsun Chang (National Taiwan University)

SS2-C-1 10:50-11:05

Evaluation of Upstream Water-Level Monitoring for Early Gate Operation During Extreme Rainfall in a Main Irrigation Canal Using One-Dimensional Unsteady Flow Analysis

Kentaro Otsuka (Gifu University), So Imuta, Keigo Noda

SS2-C-2 11:05-11:20

Enhancing Agricultural Water Resilience through Integrated Hydraulic Modeling and Smart Water Management: A Case Study of the Guandu Plain, Taiwan

Ying-Jung Chen (National Taiwan University), Cheng-Mao Hsu, Kuo-Wei Liao, Sheng-Yi Chen, Jia-Haur Jeng

SS2-C-3 11:20-11:35

Interpreting Paddy Irrigation Demand under Alternative Water-Management Scenarios in the Wu River Basin Using SWAT+PADDY and Explainable Machine Learning

Chih-Mei Lu (National Taiwan University), Hsien-Lun Liao, Li-Chi Chiang

SS2-C-4 11:35-11:50

Plot-Scale Analysis of Climate Change Impacts on Crop Evapotranspiration and Irrigation Supply Scenarios Using SWMM in Upland Farmland, South Korea

Yongjin Park (Konkuk University), Yonggwon Lee, Jeehun Chung, Hyeonjin Lee, Seongjoon Kim

SS2-D | (#3) Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

Sapphire Hall

Chair : Donghwan Kim (Kangwon National University), Keigo Noda (The University of Tokyo)**SS2-D-1 10:50-11:05**

A coupled particle-based hydraulic and fish-behavior model for evaluating fish passage at drop structures

Atsushi Otsuka (Kyoto University), Tomoki Izumi, Masayuki Fujihara

SS2-D-2 11:05-11:20

Assessing the Influences of Climate Change and Non-Point Source Pollution on Long-Term Water-Quality Trends in Mountain Reservoir

Yu-Ning Chen (National Taiwan University), Chun-Hsiang Chiang, Cheng-Wei Yu, Yi-ting Chiu, Shu-Yuan Pan

SS2-D-3 11:20-11:35

Spatio-Temporal Assessment of Ecological Drought Vulnerability in the Nakdong River Basin Using the Environmental Ecological Flow Index

Kyudong Na (Kangwon National University), Eunmi Hong, Seongjoon Kim

SS2-D-4 11:35-11:50

A study on environmental ecological flow assessment using SWAT and boosting algorithms considering fish functional traits and watershed characteristics

Wonjun Jeon (Konkuk University), Yonggwon Lee, Yongwon Kim, Yongjin Park, Seongjoon Kim

Student Presentation Competition 3 (SS3)

SS3-A | (#2) AI, Digital Twins, and Smart Technologies for Agro-Water Systems

Diamond Hall

Chair : Seoro Lee (Kangwon National University), Cheng-Wei Yu (National Taiwan University)

SS3-A-1 15:00-15:15

Importance of peak wind gusts in PM₁₀ modeling: a hybrid AI-physics approach for Zhuoshui River aeolian dust stations

Adonis Gallentes (National Taiwan University), Yun-Kai Wah, Cheng-Wei Yu

SS3-A-2 15:15-15:30

Leaf Region Extraction for Individual Trees in Citrus Orchards Using a Deep Learning-Based UAV Image Processing Framework

Yenchun Chen (Kyoto University), Kimihito Nakamura, Takehide Hama

SS3-A-3 15:30-15:45

Hyperspectral diagnosis of soybean water stress with prompted SAM2 segmentation

Hyeokjin Lee (Seoul National University), Inhong Song

SS3-A-4 15:45-16:00

Water Stress Classification of Persimmon Leaves from RGB Images Using GoogLeNet

Naoki Onishi (Kindai University), Atsushi Okayama, Masaomi Kimura, Masahiro Tasumi, Rena Sanada, Yutaka Matsuno

SS3-A-5 16:00-16:15

Mamba-Based Classification of Summer and Winter Crops in South Korea Using Time-Series Sentinel-1 and Sentinel-2 Imagery

Seongju Jang (Seoul National University), Hyeokjin Lee, Inhong Song

SS3-A-6 16:15-16:30

Monitoring Agricultural Drought in South Korea Using MODIS-Derived Soil Moisture and Drought Indices: Spatiotemporal Analysis of Major Events (2022–2025)

Hyeonjin Lee (Konkuk University), Jeehun Chung, Yongwon Kim, Wonjun Jeon, Seongjoon Kim

SS3-B | (#3) Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

Soyang Hall

Chair : Dongjun Lee (Kangwon National University), John Paulo Sacdalan (Central Luzon State University)**SS3-B-1 15:00-15:15**

Rainfall-event responses in a headwater riparian zone: implications for water and ecosystem protection

Aaron Conte (Niigata University), Andrew Whitaker

SS3-B-2 15:15-15:30

Long-Term Research Trends in Agricultural Nonpoint Source Pollution and Implications for Best Management Practices in the Han River Basin

Seonah Lee (Kangwon National University), Eunmi Hong, Seyoon Jung

SS3-B-3 15:30-15:45

Evaluating Climate Change Impacts on BMP Reduction Efficiencies for Total Nitrogen Runoff Loads in Paddy Fields Using the APEX-Paddy Model

YongBin An (Kangwon National University), Eun-Mi Hong, Jin-Hyuk Ahn, Soon Kun Choi, So-Jin Yeob, Hyeongjin Bak

SS3-B-4 15:45-16:00

Microclimate Effects of Farmland and Ponds under Present Conditions and Land-Use Scenarios: An ENVI-met Simulation Study in Taoyuan, Taiwan

Nam Nguyen-Hoang (National Central University), Chen Pei-Yuan

SS3-B-5 16:00-16:15

Analysis of BMPs effects by major crop type in Korean upland fields using the APEX model

Jin-Hyuk Ahn (Kangwon National University), YongBin An, Se yoon Jung, So-Jin Yeob, Soon Kun Choi, Eunmi Hong

SS3-B-6 16:15-16:30

Integrating Root Reinforcement into Shallow Landslide Susceptibility Assessment for Nature-Based Management of High-Mountain Agricultural Slopes

Tzung-Tze Tsai (National Taiwan University), Yu-Chang Huang, Kuo-Wei Liao

Student Presentation Competition 4 (SS4)

SS4-A | (#1) Soil, Water, and Carbon for Agricultural Resilience

Diamond Hall

Chair : Sanghyun Lee (Jeonbuk National University), Masaomi Kimura (Kindai University)

SS4-A-1 16:50-17:05

Linking Multiscale Drought Indices to Observed Agricultural Drought Impacts through Lead-Lag Analysis

Jun-Yeong Seo (Hankyong National University), Won-Ho Nam, Young-Sik Mun, Min-Gi Jeon, Sang-Dan Kim

SS4-A-2 17:05-17:20

Characterizing the Life Cycle of Drought Clusters Using a Three-Dimensional Connected Component Approach in North Korea

Hyeon-Wook Shin (Hankyong National University), Won-Ho Nam, Young-Sik Mun

SS4-A-3 17:20-17:35

Linking Satellite-Derived Agricultural Drought to Paddy Rice Yield Loss across South Korea

Hyeok-Jae Choi (Hankyong National University), Won-Ho Nam, Hee-Jin Lee

SS4-A-4 17:35-17:50

Can Pareto-Optimal Ensemble Weighting Improve Compound Drought-Heatwave Projections? Evidence from NSGA-II

Qudus Adeyi (Kyungpook National University), Kyung Sook Choi

SS4-A-5 17:50-18:05

Cascading Drought Pathways and Adaptation Leverage Points in Agricultural Water Systems

Meng-Hui Lin (National Taiwan University), Ching-Pin Tung

SS4-B | (#4) Ecosystem Services, Policy, and Governance for Carbon-Neutral Water Futures

Soyang Hall

Chair : Sang-Hyun Lee (Chungbuk National University), Pu Reun Yoon (Kongju National University)

SS4-B-1 16:50-17:05

Monitoring Spatiotemporal Changes of Hilly Agricultural Landscape Using Remote Sensing-Based Ecological Index (RSEI) in Mihama Town, Japan

Most Mitu Akter (Mie University), Hidetsugu Morimoto

SS4-B-2 17:05-17:20

Evaluation of Dam Adaptability to Extreme Rainfall Events in Kyoto Prefecture under Climate Change

Hsiangling Chiang (Kyoto University), Masayuki Fujihara

General Oral Presentation Session (GS)

GS-A | (#1) Soil, Water, and Carbon for Agricultural Resilience

Diamond Hall

Chair : Fi-John Chang (National Taiwan University)

GS-A-1 09:00-09:15

ArcGIS-Based Identification of Rainwater Harvesting System Sites for Communal Irrigation for Rice Farmers in Tabuk City, Kalinga

John Paulo Sacdalan (Central Luzon State University), Jude Bagsao

GS-A-2 09:15-09:30

Comparison of Two Spatial Precipitation Datasets over Japan: CHIRPS and JMA Radar/Rain-gauge Analyzed Precipitation

Masahiro Tasumi (Kindai University), Masao Moriyama

GS-A-3 09:30-09:45

Agricultural Adaptation Practices Supporting Flood Resilience in Dhubri District, Assam, India

Marina Langhu (The University of Tokyo), Masashi Kiguchi, Taikan Oki, Haruhisa Asada

GS-A-4 09:45-10:00

Analysis of Water Control of Paddy Field Rill Irrigation and water efficient in Southern Taiwan

Hsieh Sheng-Hsien (Irrigation Agency, Ministry of Agriculture), Yeh Yi-Lung

GS-A-5 10:00-10:15

How Extreme Weather Altered Farmers' Irrigation Behavior: A Case Study of the 2023 Hot and Dry Summer in Niigata Prefecture, Japan

Asari Takada (National Agriculture and Food Research Organization), Takeo Yoshida, Kengo Shinohara, Hiroshi Nakagawa

GS-A-6 10:15-10:30

Assessment of Agricultural Drought Impacts on Pepper Using Soil Available Water Content and NDVI-Based Monitoring

Kwihoon Kim (Seoul National University), Seo Beomseok, Maga Kim, Jin-Yong Choi

GS-B | (#1) Soil, Water, and Carbon for Agricultural Resilience

Soyang Hall

Chair : Taegon Kim (Jeonbuk National University)

GS-B-1 09:00-09:15

Hydraulic Insights into the Design Philosophy of Historical Oblique Weirs through PIV-Based Analysis of Horizontal Turbulent Structures

Toshinori Tabata (Kyushu University), Masayoshi Harada, Akinori Ozaki, Takuya Kimoto

GS-B-2 09:15-09:30

Evaluation of hydrological responses to long-term land use changes using SWAT

Yongwon Kim (Konkuk University), Yonggwon Lee, Jeehun Chung, Yongjin Park, Seongjoon Kim

GS-B-3 09:30-09:45

Geopolymeric Flowable Fill for Backfilling

Quadri Babatunde (Kyungpook National University), Bright Bentum, Hong Ju Kim, Yong-Hoon Byun

GS-B-4 09:45-10:00

Electro-Assisted Recovery of Ionic Nutrients from Agricultural Waste Stream

Yu-I Lin (Feng Chia University), Hyunook Kim

GS-B-5 10:00-10:15

Field Monitoring Framework and Sediment Trapping Capacity in Traditional Taro Patches in Palau

Keigo Noda (The University of Tokyo), Masaomi Kimura, Wenpeng Xie, Elchung Hideyos, Felix Sengebau, Christopher Kitalong

GS-B-6 10:15-10:30

Pore-Scale Investigation of the Effects of Entrapped Bubbles on Dissolved Gas Transport: Implications for Greenhouse Gas Emissions from Paddy and Wetland Systems

Shao-Yiu Hsu (National Taiwan University), Yung-Wei Lee, Chia-Wen Tsao, Kai-Xiang Zhan, Qun-Zhan Huang

- GS-C-1 09:00-09:15**
A Geospatial–IoT Integrated Framework for Real-Time Precision and Sustainable Agricultural Management
Rahul Dev Garg (IIT Roorkee), Shubham Bhattacharjee
- GS-C-2 09:15-09:30**
Climate Attribution and Threshold Analysis of Reservoir Irrigation Water Demand Using Explainable AI Under Future Climate Change for Data-Scarce Region
Gezimu Gelu Otoro (Kyungpook National University), Kyung Sook Choi
- GS-C-3 09:30-09:45**
An AI-Driven Knowledge Retrieval and Decision Support Framework for Water Disaster Management Using Large Language Models and Advanced Retrieval-Augmented Generation
Po-Chuan Chi, Chu-Han Chen (ThinkTron Ltd.), Chia-Yueh Yang, Keng-Han Lin, Hau-Kai Peng
- GS-C-4 09:45-10:00**
Geospatial Modelling of Agricultural Inundation Under Climate Change in South Korea
Deepak Chaulagain (Kyungpook National University), Kyung Sook Choi
- GS-C-5 10:00-10:15**
Deformation Detection of Drainage Wells by the Backscattering Coefficient of SAR
Koki Ikeda (Niigata University), Kazuma Shibano, Kazunari Inaba, Tetsuya Suzuki
- GS-C-6 10:15-10:30**
Assessing Stream Drying in Ungauged Tributaries Using a Grid-Based Hydrological Model and Satellite Imagery
Yonggwon Lee (Konkuk University), Jeehun Chung, Yongwon Kim, Hyeonjin Lee, Seongjoon Kim
- GS-C-7 10:30-10:45**
Sentinel-1 SAR-Based Rice Yield Prediction Using Crop Growth and Agricultural Reservoir Dynamics in South Korea
Jeehun Chung (Konkuk University), Yonggwon Lee, Yongwon Kim, Wonjun Jeon, Seongjoon Kim
- GS-C-8 10:45-11:00**
AI Agent System for Agricultural Water Resources Management
Ming-Che Hu (National Taiwan University), Kai-Ming Tsang

GS-D | (#3) Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

Sapphire Hall

(#4) Ecosystem Services, Policy, and Governance for Carbon-Neutral Water Futures

Chair : Won-Ho Nam (Hankyong National University)

GS-D-1 09:00-09:15

An Integrated Vigor–Organization–Resilience and Ecosystem Service Valuation Framework for Wetland–Catchment Sustainability Assessment: A Case Study of Bhoj Wetland, India

Ashish Pandey (Indian Institute of Technology Roorkee), Manish Rawat, Basant Yadav, Praveen Kumar Gupta

GS-D-2 09:15-09:30

Detecting Changes in Seasonal Low-Flow Structure Using ELF Clustering: An Analysis of Long-Term Observed Streamflow Records in Japan

Takeo Yoshida (National Agriculture and Food Research Organization), Yuki Hoshino, Asari Takada, Seiya Aihara, Atsushi Maruyama, Shinji Fukuda

GS-D-3 09:30-09:45

Hydrodynamic Modeling of Salt Pan Restoration in Tainan Linking Tidal Dynamics, Sediment Supply, and Equilibrium Elevation with Vegetation Biomass

Chia-Chu Chu (National Taiwan University)

GS-D-4 09:45-10:00

Relationships between Insecticide Concentrations and Aquatic Insect Species Richness and Abundance in Subtropical Paddy Fields of the Yaeyama Islands, Japan

Keiko Shiromoto (University of the Ryukyus), Suguru Ohno, Tadashi Kajita

GS-D-5 10:00-10:15

From Coastal Time Series to Ocean Basin: Mechanistic Insights into Plankton Trophic Interactions and Biogeochemical Cycling

Feng-Hsun Chang (National Taiwan University), Cheng-Tai Wu, Wei-Ting Chen, Yen-Po Wang, Shih-Rong Su, Mao-Che Huang

Poster Student Session (PS)

PS1 | (#1) Soil, Water, and Carbon for Agricultural Resilience

Hallway

Chair : Taegon Kim (Jeonbuk National University)

- PS1-1** Evaporation from Soil Surface and Early Growth of Plants under Low/Microgravity Environment
Sota Sadazumi (Okayama University), Yasushi Mori
- PS1-2** Effects of Biochar Amendment on Leachate Salinity and Ion-Specific Solute Dynamics in Salt-Affected Paddy Soil Irrigated with Treated Municipal Effluent
Yu-Chen Wu (National Taiwan University), Li-Chi Chiang
- PS1-3** Assessment of Treated Wastewater Reuse for Sustainable Sorghum Irrigation in Kinmen, Taiwan
Ya-Ching Liang (National Taiwan University), Li-Chi Chiang, Ming-Zhen Zhu
- PS1-4** Applying Machine Learning to Digital Soil Mapping of Organic Carbon in the Zhoshui River Basin
Chenghsun Wu (National Taiwan University), Kuowei Liao
- PS1-5** Changes in Total Soil Water Potential across Bell Pepper Growth Stages in a Greenhouse on Coastal Reclaimed Land
Leon Nakayama (Saga University), Noor Fadhil, Ieyasu Tokumoto
- PS1-6** APEX-Based Simulation of Rice Growth and Yield Prediction under Weather and Agricultural Management Scenarios: A Preliminary Study for Future Agricultural Environmental Conservation Policy Evaluation
Maga Kim (Seoul National University), Jin-Yong Choi, Pu Reun Yoon
- PS1-7** Comparative Evaluation of Hourly Inflow to Agricultural Reservoirs Using Water-Level-Based Estimation Methods and Rainfall-Runoff Models
Seokhun Kang (Chungnam National University), Jung-Hun Song
- PS1-8** Assessment of the applicability of integrating satellite-based soil moisture and vegetation information with AquaCrop for agricultural water management
Arin Choi (Chungnam National University), Seokhun Kang, Jung-Hun Song
- PS1-9** Estimation of Wave Velocity in Steel Pipe–Mortar Piles Using Impact-Induced Reflected Waves
Masayoshi Yoshizawa (Tokyo University of Agriculture), Daisuke Shoda, Keisuke Inoue, Takeshi Kusumoto, Hiromu Okazawa
- PS1-10** Field evidence of soil-air confinement during infiltration under intense rainfall in Hawai'i
Qun-Zhan Huang (National Taiwan University), Yinphan Tsang, Yen-Wei Pan, Shao-Yiu Hsu
- PS1-11** Assessment of Future Soil Erosion Uncertainty Using CMIP6 Ensemble Models
Seoju Oh (Seoul National University), Sinae Kim, Seongjae Park, Moon-Seong Kang

- PS1-12** Effects of organic and conventional farming on methane-cycling microbial communities in Korean paddy soils
Se yoon Jung (Kangwon National University), Eunmi Hong, Hyuck Soo Kim, Woon-ki Moon
- PS1-13** Field Monitoring of Nitrous Oxide Emissions under Contrasting Crop and Fertilization Management
Seonah Lee (Kangwon National University), Kyudong Na, Seyoon Jung, Jin-Hyuk Ahn, YongBin An, HyuckSoo Kim, Eunmi Hong
- PS1-14** Integrated Assessment of Dam-Break Flooding, Sediment Deposition, and Agricultural Damage
Seongjae Park (Seoul National University), Jihye Kwak, Sinae Kim, Moon-Seong Kang

PS2 | (#2) AI, Digital Twins, and Smart Technologies for Agro-Water Systems

Hallway

Chair : Taegon Kim (Jeonbuk National University)

- PS2-1** AI-Based Surrogate Modeling for Hydrodynamic Simulation Using iRIC Data
Yishan Chang (National Cheng Kung University), Wenping Tsai
- PS2-2** Converting Geostationary Satellite Bands into Real-Time Fog Detection over Taiwan Using Gradient-Boosting Machine Learning
Cheng-Zhi Lei (National Cheng Kung University), Wen-Ping Tsai
- PS2-3** Applying deep learning technology to urban flood prediction
Chen-Yeh Shih (National Cheng Kung University), Wen-Ping Tsai
- PS2-4** Physics-informed remote sensing and deep learning for identifying hotspot of river dust emission in the Zhuoshui River, Taiwan
Yun Kai Wah (National Taiwan University), Adonis Taer Gallentes, Cheng-Wei Yu
- PS2-5** Effects of fertilization and air temperature during grain-filling on the appearance quality of rice
Sosuke Isoda (The University of Tokyo), Kazuhiro Nishida, Masahiro Nakanishi, Hironori Kitaaki, Shuichiro Yoshida
- PS2-6** Identification of Drought-Response Archetypes for Large Agricultural Reservoirs in South Korea
Jeong Lee (Jeonbuk National University), SangHyun Lee
- PS2-7** Evaluating the Performance of Missing Data Imputation Methods for Water-Level Data in Gap-Filling and Cluster Structure Preservation
Jeong Lee (Jeonbuk National University.), Sanghyun Lee
- PS2-8** AI-Assisted Landslide Identification from Multi-Source Remote Sensing Imagery for Post-Typhoon Watershed Conservation in Taiwan
YouDa Song (National Cheng Kung University), Chiehkai Yang, WenPing Tsai

- PS2-9** Deep Learning-Based Soil Moisture Classification Using RGB Images of Persimmon Leaves for Irrigation Decision Support
Atsushi Okayama (Kindai University), Naoki Onishi, Masaomi Kimura, Masahiro Tasumi, Rena Sanada, Yutaka Matsuno
- PS2-10** Leakage Detection in Model Pipeline using Water Hammer Simulation with Viscoelasticity and Structural Vibration
Kanae Suda (Niigata University), Yuto Takahashi, Taiki Hagiwara, Tetsuya Suzuki
- PS2-11** Preliminary Evaluation of Early Spider Mite Damage Monitoring in Edible Roses Using Low-Cost RGB Imaging and Color Indices
Rena Sanada (Kindai University), Honami Nakasuji, Atsushi Okayama, Masaomi Kimura, Yutaka Matsuno
- PS2-12** Network-Based Sensitivity Analysis of Optimized Irrigation Gate Operations
Ji-Hyeon Shin (Hankyong National University), Won-Ho Nam
- PS2-13** A Data-Driven Framework for Adaptive Reservoir Operation Using Machine Learning and System Dynamics
Mi-Hye Yang (Hankyong National University), Won-Ho Nam, Dong-Hyun Yoon
- PS2-14** Hydrological Modeling and Future Risk Assessment for Tea Plantations: A Case Study of Pinglin Tea Plantations
Hsin Chen (National Taiwan University), Shao-Yiu Hsu

PS3 | (#2) AI, Digital Twins, and Smart Technologies for Agro-Water Systems

Hallway

(#3) Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

(#4) Ecosystem Services, Policy, and Governance for Carbon-Neutral Water Futures

Chair : Won-Ho Nam (Hankyong National University)

- PS3-1** Detection of Spatially Persistent Rice Growth Variability Using Multi-Temporal UAV Vegetation Indices in an AWD Paddy Field
Kiseki Kurashina (Tokyo University of Agriculture), Tomoki Mizukoshi, Ke Zhang, Hiromu Okazawa
- PS3-2** Evaluation of the Effectiveness of a Solar-Powered, Low-Energy Drainage System
Dongseok Kim (Pusan National University), SangHun Lee, Jinhee Seo, Donghyeuk Gong, Hyenjung Chun, Man-Soo Choi, Jong-Soo Ryu, Jinki Park, Seolha Kim
- PS3-3** Performance Evaluation of an Automated Irrigation Scheduling System Based on Weather Data, Soil Water Content, and Evapotranspiration Estimates
Dongseok Kim (Pusan National University), Sanghun Lee, Jinhee Seo, Donghyeuk Gong, Hyenjung Chun, Man-Soo Choi, Jong-Soo Ryu
- PS3-4** Evaluation of Deteriorated Status in Service Steel Sheet Pile Canal by Integration of Point Cloud with Thermal Images
Keika Tagami (Niigata University), Kensho Nakagawa, Akio Ishigami, Norihiro Otaka, Yuji Fujimoto, Taiki Hagiwara, Yuto Takahashi, Tetsuya Suzuki

- PS3-5** Growth-stage-specific discrimination of waterlogging and drought stress in soybean using VNIR hyperspectral imagery and SPA-LDA
Shinhoo Yoon (Seoul National University), Inhong Song
- PS3-6** Seasonal habitat use of a domestic invasive bitterling fish: implications for efficient management in rural water systems
Kaito Moriuchi (Okayama University), Rintaro Taniguchi, Takanari Sumida, Koki Katsuhara, Kazuyoshi Nakata
- PS3-7** Burrow use by reproductive females of the invasive red swamp crayfish (*Procambarus clarkii*): implications for irrigation pond management
Junya Nakaichi (Okayama University), Kei Okuda, Koki Katsuhara, Kazuyoshi Nakata
- PS3-8** A SWAT–MODFLOW framework integrating bacterial infiltration and transport processes
Se yoon Jung (Kangwon National University), Eunmi Hong, Seonggyu Park
- PS3-9** Upstream migration behavior of freshwater shrimps in a V-shaped portable fishway: Implications for fishway design
Ryohei Nagao (Okayama University), Yuki Amano, Naoki Takahashi, Tatsuo Hamano, Koki Katsuhara, Kazuyoshi Nakata
- PS3-10** Assessing Parameter Sensitivity in the InVEST Annual Water Yield Model under Future Development and Climate Change Scenarios
Ze-Yu Chen (National Taiwan University), Cheng-Wei Yu
- PS3-11** Integration and Advancement of Climate Change Vulnerability Assessment for Agricultural Production Infrastructure Based on SSP Scenarios
Hayoung Kim (Chonnam National University), Soo-Jin Kim, Seung-Hwan Yoo, Seung-Jong Bae, Yeongcheol Kwak, Dalju Park, YunPyo Lee, MyungWon Lee

Poster General Session (PG)

PG1 | (#1) Soil, Water, and Carbon for Agricultural Resilience
 (#3) Water Quality, Aquatic Ecosystems, and Nature-Based Solutions

Hallway

Chair : Won-Ho Nam (Hankyong National University)

- PG1-1** Sulfur-induced thiol metabolism enhances arsenic uptake, oxidative stress tolerance, and mineral nutrient homeostasis in hydroponically grown rice seedlings
Ha-il Jung (Rural Development Administration), Chaw Su Lwin, Myung-Sook Kim, Eun-Jin Lee, Tae-Gu Lee
- PG1-2** Spatial Variability of Soil Physical Properties and Its Influence on Rice Growth and Grain Yield in Large-Scale Paddy Fields
Munehiro Ebato (National Agriculture and Food Research Organization), Shigeto Fujimura, Syuhei Yamamoto, Koutaro Saito
- PG1-3** Economic Analysis of Paddy Field Water Management with In-Field Ditches
Naoko Koshiyama (Civil Engineering Research Institute for Cold region), Takeshi Otsu
- PG1-4** Tracking the Seasonal Evolution and Migration of Drought Clusters for Agricultural Drought Monitoring in South Korea
Young-Sik Mun (Hankyong National University), Won-Ho Nam
- PG1-5** Assessment of Upland Drought Impacts and Si/Gun-Level Vulnerability Considering Crop and Soil Characteristics
Ra Na (Chonnam National University), Donghyuk Joo, Hayoung Kim, Seung-Hwan Yoo, Jung-Hun Ok, Hee-Rae Cho, Seung-Oh Hur, Sang-Hyun Lee
- PG1-6** Propagation of Rapid Onset Drought through Surface Water Systems and Vegetation in an Irrigated Rice Watershed
Hee-Jin Lee (Hankyong National University), Won-Ho Nam
- PG1-7** Episodic nitrogen leaching in sloping cropland under monsoon climate: re-evaluating the IPCC FracLEACH default
Jong-Mun Lee (National Institute of Agricultural Sciences), So-jin Yeob, Sang-Min Jun, Jinu Eo, Byungmo Lee, Yerin Yang, Buyeong Oh, Soon-Kun Choi
- PG1-8** A Web-Based Platform for Exploring Global Water Resource Data
Sangmin Jun (Rural Development Administration), Byungmo Lee, Soonkun Choi, Jaehak Jeong, Celray Chawanda
- PG1-9** Long-Term Hydrologic and Water Quality Responses to Crop Diversification in Paddy Rice Systems of the Saemangeum Reclaimed Watershed
Dong-Hyeon Kim (Jeonbuk National University), Younggu Her, Taeil Jang, Hakkwan Kim, Taegon Kim

- PG1-10** Four years of invasive red swamp crayfish (*Procambarus clarkii*) control promoted biodiversity recovery in an agricultural pond in Japan
Kazuyoshi Nakata (Okayama University), Yusuke Kuranishi, Sakura Anai, Tsuyoshi Nakanishi, Yuko Mori, Kunihiro Andachi, Nobuyuki Sasaki, Seong-Nam Ham
- PG1-11** Improving Agricultural Water Demand Estimation by Revising Unit Water Supply Based on Reservoir Operation Characteristics
Dong-Hyun Yoon (Hankyong National University), Won-Ho Nam
- PG1-12** Spatiotemporal Assessment of Agricultural Water Quality Using a National Agro-Environmental Monitoring Database
Donghyeon Kim (Jeonbuk National University), Liguang Cheng, Hyunsoo Park, Gisung Kim, Sungkwon Jeoun, Taeil Jang
- PG1-13** Monitoring and APEX-Paddy Modeling of Nitrogen Losses from Paddy Fields under Surface Application and Reduced-Rate Deep Placement
So-Jin Yeob (Rural Development Administration), Byeong-Mo Lee, Jinu Eo, Sang-Min Jun, Bu-Yeong Oh, Jong-Mun Lee, Yerin Yang
- PG1-14** Geo-Hydrological Characteristics of Traditional Taro Patches on Babeldaob Island, Palau
Masaomi Kimura (Kindai University), Elchung Hideyos, Reiji Mitamura, Keigo Noda, Wenpeng Xie, Atriyon Julzarika, Felix Sengebau, Christopher Kitalong
- PG1-15** Waterbird Compositions in Typical Coastal Wetlands and Agro-Fishery Production Patterns in Southwest coast of Taiwan
Meng-Chi Hung (Taiwan Biodiversity Research Institute)

PG2 | (#2) AI, Digital Twins, and Smart Technologies for Agro-Water Systems
 (#4) Ecosystem Services, Policy, and Governance for Carbon-Neutral Water Futures

Hallway

Chair : Eunmi Hong (Kangwon National University)

- PG2-1** Assessing and Forecasting Vegetation Dynamics in a Rapidly Urbanizing Gazipur District: A Remote Sensing Modeling Approach
N M Refat Nasher (Jagannath University)
- PG2-2** Field-Based Evaluation of the Environmental Effects of Paddy Water Management Using Observed Ponding Depth Data and DNDC Modeling
Pu Reun Yoon (Kongju National University), Jin-Yong Choi, Maga Kim
- PG2-3** Identification of Evaluation Factors for Assessing the Effects of Public Interest Direct Payment and Agri-environmental Conservation Policies
Yun-Gyeong Oh (Chonnam National University), Jeong-woo Son
- PG2-4** Development of a Geospatial Screening Method for Identifying Candidate Farmland Improvement Districts Using Open Farmland Parcel Polygon Data and Digital Elevation Models
Yasushi Noguchi (National Agriculture and Food Research Organization)

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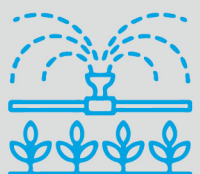
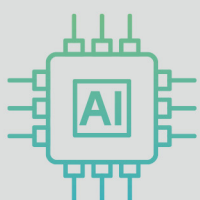
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ABSTRACT



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SS1-A-1

Evaluating Carbon Dynamics and Flux Measurement Uncertainty in a Managed Perennial Agroecosystem

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ABSTRACT

Managed perennial agroecosystems, such as tea plantations, experience frequent anthropogenic disturbances like pruning and harvesting, which complicates the accurate quantification of their field-level carbon dynamics. This study evaluated carbon exchange in a Taiwanese tea plantation from January through September 2026 by integrating branch- and soil-level chamber measurements. Branch photosynthesis and respiration were scaled to the plant level using allometric relationships, while static chamber data captured soil carbon dioxide fluxes. To rigorously account for the inherent variance in flux measurements and calculations, we implemented a Monte Carlo simulation framework—enforcing strict physical boundary conditions—to propagate measurement uncertainties into the preliminary Net Ecosystem Exchange (NEE) estimates. Our uncertainty-bounded results reveal pronounced temporal shifts in net ecosystem productivity.

Preliminary results show that following pruning, a reduced leaf area index and altered flux partitioning significantly weakened net carbon uptake. During subsequent canopy recovery, gross primary productivity rebounded, though this was partially offset by elevated leaf respiration during new flush growth in spring. Additionally, rising seasonal temperatures drove a marked increase in soil carbon dioxide efflux, further constraining the system's net carbon sequestration. These robust estimates demonstrate that carbon exchange in tea plantations is dynamically regulated by the interplay of management interventions, canopy phenology, and temperature-driven soil responses. The field observations also provide an empirical basis for future simulation of carbon dynamics using the Biome-BGC framework in managed perennial cropping systems.

Keywords: Tea plantations, Static chamber method, Net ecosystem exchange (NEE), Monte Carlo simulation, Carbon neutrality



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SS1-A-2

Simulation of Fe^{2+} Dynamics under Different Infiltration Conditions in Paddy Soils

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ABSTRACT

Methane emissions from paddy fields are affected by infiltration rate. However, the mechanisms linking infiltration, iron reduction, and methane production remain poorly understood. Because Fe reduction competes with methanogenesis for electron donors under anaerobic conditions, understanding Fe^{2+} dynamics is important for elucidating methane production mechanisms. This study used simulations to reproduce Fe^{2+} dynamics under different infiltration conditions and investigate processes controlling Fe^{2+} behavior in paddy soils.

Column experiments with rice cultivation were conducted under infiltration rates of 0, 15, and 30 mm/day. Methane emissions varied among treatments, showing differences among infiltration conditions. Two methane flux peaks were observed during cultivation and were associated with changes in Fe^{2+} concentrations. The first peak coincided with a shift in Fe^{2+} concentration from decreasing to increasing, whereas the second coincided with the plateau phase of Fe^{2+} concentration.

Fe^{2+} dynamics were simulated using HYDRUS-1D coupled with PHREEQC (HP1). Model parameters were calibrated with the 15 mm/day treatment and applied to the other treatments. The model reproduced Fe^{2+} dynamics in the deeper soil layer of the 30 mm/day treatment. In contrast, discrepancies between simulated and measured values were observed in the 0 mm/day treatment and in the shallow soil layer, suggesting influences of rice root activity and soil buffering processes not represented.

Simulations indicated that dissolved Fe^{2+} accounted for a small fraction of total Fe, while FeS and FeCO_3 precipitation and adsorption onto variable-charge reaction sites regulated dissolved Fe^{2+} concentrations. These results demonstrate the utility of HP1 for investigating Fe^{2+} dynamics and methane production mechanisms.

Keywords: Paddy field, Iron reduction, Infiltration, Reactive transport modeling



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SS1-A-3

Investigating the effects of artificial macropores on mass transport in saturated paddy soil for controlling spatial redox heterogeneity

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ABSTRACT

Many studies have reported the importance of soil redox heterogeneity and its impacts on biogeochemical processes in soils. Further investigations are increasingly encouraged, including the development of effective methods for measuring and predicting phenomena related to soil redox heterogeneity. However, the idea that soil heterogeneity may be not only observable but also controllable is still not widely recognized.

Here, we recently found that artificial macropores, which mimic natural soil macropores, affect the movement of water, solutes, and gases in saturated paddy soils, leading to the spatial redistribution of redox domains and methane transport pathways within the soil.

Our previous investigations originally aimed to reduce methane emissions from paddy soils by using artificial macropores as downward bypasses for oxidants. However, subsequent mesoscale column experiments demonstrated that artificial macropores may also serve as potential tools for soil-environment design. Specifically, artificial macropores functioned as advection-dominant domains, whereas the bulk soil, namely the domain outside the macropores, functioned as an advection-limited domain. Factors such as drainage intensity and the supply of oxidants may affect the development of mass transport in different ways. Therefore, understanding mass transport in saturated soils containing artificial macropores should be important for making soil redox heterogeneity controllable.

In this presentation, we will explain a newly proposed hypothesis based on the latest experiment and discuss additional data and a preliminary experiment designed to investigate the mechanisms of mass transport under drainage conditions with artificial macropores.

Keywords: artificial macropores, saturated paddy soils, soil redox heterogeneity, mass transport, drainage



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SS1-A-4

The effects of water depth and disturbance on methane emissions from rice paddies

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ABSTRACT

Methane, a greenhouse gas, is known to be produced by anaerobic methanogens in reduced paddy soil and released into the atmosphere. Consequently, extending the mid-season drainage period, thereby increasing soil oxygen supply and mitigating soil reductions is recommended. However, prolonged non-flooded periods in paddies can adversely affect aquatic organisms; thus, there is a need to develop methods that balance ecosystem conservation with methane mitigation. In lakes, which have reduced environments like those of paddy fields, studies have shown that the introduction of fish suppresses methane emissions through the activity of methanotrophic bacteria. Although the applicability of this approach to paddy fields was investigated, similar effects were not observed. This discrepancy is attributed to differences in the habitats of aerobic methanotrophic bacteria between lakes and paddies. In deep lakes, methanotrophs exist within the water column, making generated methane susceptible to oxidation as it rises through the water. In contrast, paddy fields are characterized by shallow water depths, which may limit the opportunity for methanotrophic bacteria to oxidize methane in the water column, potentially preventing sufficient methane oxidation before it is released from the soil into the atmosphere. Based on these findings, this study aimed to investigate methods for promoting efficient methane oxidation by increasing the opportunities for contact between methane and methanotrophic bacteria. The results showed a trend of reduced methane emissions with increased water depth; however, it remains unclear whether this reduction was driven by methanotrophic bacteria, necessitating further verification.

Keywords: greenhouse gases, methanotrophic bacteria, water depth, disturbance



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SS1-A-5

Strategies of Greenhouse Gas Emission Mitigation in Paddy Through Water Management and Nitrification/Urease Inhibitors

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ABSTRACT

Rice productivity is increasingly threatened by extreme climate events, while rice cultivation remains a major contributor to agricultural emissions of methane (CH₄) and nitrous oxide (N₂O), which are mainly associated with anaerobic conditions under traditional flooding irrigation and nitrogen fertilizer application. This study systematically summarizes GHG mitigation practices in paddy fields, focusing on water management and nitrification/urease inhibitor (NI/UI) application. Regarding the NI/UI application, analysis of covariance (ANCOVA) was adopted to control for potential confounding effects from differences in nitrogen application rate. The coefficient of inhibitor use was negative, suggesting a decreasing trend in N₂O emissions under NI/UI application. The estimated effect corresponded to an approximately 14.5% reduction; however, this effect was not statistically significant ($p=0.329$). These results suggest that the mitigation effect of NI/UI on N₂O emissions remains uncertain in the current dataset and may be influenced by other factors such as irrigation regime, soil conditions, and fertilizer type. After incorporating irrigation regimes into the linear model, the model became statistically significant ($p<0.05$). After controlling for fertilizer input and irrigation patterns, NI/UI application also exhibited a decreasing trend in N₂O emissions (19%); however, this effect remained statistically insignificant ($p=0.182$). In contrast, irrigation pattern had a significant effect on N₂O emissions ($p<0.05$), indicating that water management may be an important factor controlling N₂O emission variability. In conclusion, GHG emissions from rice paddies are jointly influenced by various farming practices; therefore, further sensitivity analysis is recommended to identify the dominant factors affecting GHG emissions and agricultural productivity.

Keywords: GHG mitigation, Water management, Nitrification/urease inhibitor, ANCOVA



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SS1-A-6

Analyzing Multi-Pathway Methane Emission Mechanisms in Rice Paddies Using a Process-Based Model and High-Frequency Field Observations

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ABSTRACT

This study analyzes measured methane (CH_4) emissions from rice paddies using a process-based model that integrates the major emission pathways: plant-mediated transport, ebullition, and diffusion. To evaluate the contribution of each pathway, we analyzed high-frequency (hourly) field observations collected over an entire rice-growing season, allowing us to dissect and quantify the relative contribution of each pathway to total methane transport. The process-based model was then validated against this comprehensive field dataset to assess its simulation accuracy and to identify the limits of its applicability under dynamic environmental drivers. The results show that the model only partially captures the temporal dynamics of CH_4 emissions, indicating that additional data are needed to improve its ability to represent the high variability of these emissions. Overall, this work aims to provide a quantitative assessment tool to support future climate-resilient agriculture and carbon-neutral management strategies.

Keywords: Growing season, Environmental drivers, Temporal dynamics



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SS1-B-1

Comparison of Alternative Objective Functions for Crop Yield Estimation under Rainfall Uncertainty

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ABSTRACT

Reliable crop yield estimation is fundamental to irrigation scheduling and water resources management, particularly under intensifying climatic variability and water scarcity. Crop yield integrates the effects of irrigation supply, rainfall uncertainty, crop physiological sensitivity, and stage-specific water stress. Because water deficits incurred at different phenological stages contribute unequally to overall yield reduction, the manner in which stage-wise yield responses are aggregated into a terminal yield metric exerts a decisive influence on the evaluation of alternative irrigation strategies.

This study formulates and compares three alternative objective functions for terminal yield estimation, grounded in the FAO-33 yield response framework. Stage-specific yields are first derived from relative evapotranspiration deficits at each growth stage and are subsequently aggregated into a final estimate through three distinct formulations: additive accumulation, multiplicative aggregation, and a conservative minimum-yield criterion. The additive formulation emphasizes cumulative production across stages; the multiplicative formulation captures the compounding effects of water stress and heightened sensitivity to severe deficits within any single stage; and the minimum-yield criterion embodies a risk-averse focus on the most limiting stage.

The framework is assessed within a stochastic irrigation setting that explicitly incorporates rainfall variability while preserving identical total water supply constraints. By holding the FAO-33 parameters constant, the analysis isolates the effect of aggregation logic on terminal yield outcomes. The results reveal substantial divergence in estimated final yield across the three formulations, even when stage-level responses are identical. These findings demonstrate that estimated crop yield is strongly conditioned by the choice of objective function, which should therefore be aligned with the specific priorities of irrigation management under uncertainty.

Keywords: deficit irrigation optimization, FAO-33 yield response, objective function formulation



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SS1-B-2

Spatiotemporal Characteristics of Irrigation Water Balance and Climate–Reservoir Interactions in Korean Agricultural Reservoirs

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ABSTRACT

Agricultural reservoirs are the primary source of irrigation water for paddy rice cultivation in South Korea, where reservoir operation is strongly influenced by seasonal irrigation demand and the East Asian summer monsoon. This study investigated the spatiotemporal dynamics of irrigation water balance in three representative agricultural reservoirs (Nohong, Pangog, and Soseong) located in Gyeongsangbuk-do, South Korea. Daily observations of reservoir storage, water level, rainfall, irrigation water requirement (IWR), canal water supply, and effective rainfall were analyzed at the dekadal, monthly, and annual timescales to evaluate interactions among climate variability, irrigation demand, and reservoir operation.

The results revealed a distinct seasonal irrigation cycle governed by rice phenology and monsoonal rainfall. Irrigation water requirement increased rapidly during the early growing season and reached its maximum during the vegetative growth stage, whereas effective rainfall substantially reduced irrigation demand following the onset of the Changma monsoon. Severe droughts during 2015–2016 and 2022 caused marked depletion of reservoir storage and increased reliance on managed reservoir releases, demonstrating the vulnerability of agricultural water supply to prolonged rainfall deficits prior to monsoonal recharge.

Correlation analysis showed that increasing air temperature increased irrigation water requirements and canal water supply, whereas rainfall reduced irrigation demand by increasing effective precipitation. Reservoir storage was influenced more strongly by irrigation withdrawals and antecedent storage conditions than by rainfall alone, highlighting the coupled interactions among climate variability, crop water demand, and reservoir operation. These findings provide a scientific basis for improving irrigation scheduling, adaptive reservoir operation, and climate-resilient agricultural water management in monsoon-dominated paddy irrigation systems.

Acknowledgements: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-202500562379).

Keywords: Agricultural reservoirs, Irrigation water balance, Reservoir operation, Paddy irrigation, Climate variability



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SS1-B-3

Understanding the Hydro-Climatic and Socio-Economic Drivers of Farmer Water Allocation for Enhancing Agricultural Resilience in the Subak System, Bali

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ABSTRACT

The Subak irrigation system in Bali, Indonesia, has sustained terraced-paddy cultivation for centuries through democratic, synchronized water sharing. However, intensifying climate variability and rapid socio-economic development increasingly threaten its sustainability. Achieving long-term agricultural resilience requires a deep understanding of the dynamic factors influencing how farmers allocate water. This study investigates the complex interplay of hydro-climatic and socio-economic drivers shaping farmers' decision-making within the Sungai River basin, Bali. Nine weirs are located in this river basin, diverting water from the river across 9 irrigation districts with 3,718 hectares of functional agricultural land, predominantly dedicated to double-crop paddy cultivation. We analyzed spatiotemporal water allocation patterns across 9 irrigation districts from 2017 to 2026 utilizing Sentinel-1 SAR time-series data paired with a random forest classification model. The drivers of these patterns were identified through interviews and field surveys, and the relations among these drivers were then quantified. Preliminary analysis indicates that, during the dry season, water allocation scheduling shifts are heavily influenced by hydro-climatic conditions associated with the El Niño-Southern Oscillation (ENSO). Furthermore, field surveys reveal that scheduling irregularities are also driven by interconnected socio-economic constraints. These include labor shortages, limited hand tractor access, delays in subsidized fertilizer distribution, market prices, and the traditional Balinese calendar. Crucially, the emergence of dual-income farming households acts as a key driver of irregular scheduling shifts, which creates vulnerable conditions that lead to the conversion of agricultural land to non-agricultural uses. As a future plan, these drivers will be utilized to model water allocation in Subak systems.

Keywords: Traditional irrigation management, Socio-hydrology, Irrigation scheduling



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SS1-B-4

Automated and accurate detection of leak signals in pipelines by using pressure waves

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ABSTRACT

Pipelines are widely used for water supply and sewerage systems, as well as industrial and agricultural water distribution systems. However, the number of leak accidents is increasing because of the aging of pipelines. When leaks worsen, they can cause land subsidence or inundation. The existing leak detection methods cannot always identify the location of leaks, and they are difficult to use for long-distance pipelines because repeated measurements are required. Therefore, an accurate and simple leak detection method is needed. Pressure-wave-based leak detection is an effective method that can be applied to long-distance pipelines. However, detecting leak signals from pressure transients contaminated by noise remains a major challenge. In this study, we developed a simple automated method for detecting reflective waves from leakage points as leak signals based on an adapted moving-average approach. This method can estimate leak locations and discharges from the occurrence time and magnitude of the detected leak signals, respectively. Validation experiments using a model pipeline demonstrated that the proposed method could extract the leak signals with high accuracy by removing noises caused by changes in pipeline structure, such as bends and variations in pipeline diameter, or by amplifying the difference between such noises and leak signals. Consequently, compared with the conventional method, the proposed method estimated leak locations with comparable accuracy and discharges with higher accuracy. The results also revealed that limiting the moving average window size is important for the simultaneous estimation of leak location and discharge based on the leak signal.

Keywords: Leak detection, Pipeline, Pressure waves, Direct transient analysis, Smoothing



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SS1-B-5

Functions of “Tamei” River Storage in Large Paddy Irrigation Scheme’s Project in Premodern Japan: The case study of Fukuoka’s LID

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ABSTRACT

Japan’s paddy irrigation systems have avoided drought-related damage and have sustained themselves since the Edo period. This reflects effective irrigation management by the government and water users. However, whether its successes are due to the natural abundance of water or to adequate water allocation remains a debate.

The objective is to clarify the functions of “Tamei,” a river storage infrastructure built during the Edo period for irrigation projects, within the policies that guide the establishment and management of irrigation schemes, which form the basis of the contemporary PIM system.

Focusing on the Fukuoka Land Improvement District (LID) in the Kokai River basin, the land preparation period was targeted because upstream paddy fields retained water, saturating the soil and preventing downstream drainage. The land preparation period was estimated using temperature constraints critical for rice cultivation and reconstructed pre-modern available water. The frequency with which Tamei River storage was necessary to complete land preparation on time was then evaluated.

Results indicate that Tamei storage was required during land preparation in 10/20 years (once every 2 years) and from transplanting through the maturation period in 7/20 years. These findings suggest that, since the Edo period, river storage has been built primarily to ensure timely land preparation, thereby reducing yield losses from temperature constraints, rather than merely meeting minimum water needs during intensive growing-season management. Thus, Tamei served as a strategy for agricultural stability, reflecting foresight in irrigation planning that aligns with modern PIM principles of equitable water distribution and risk management.

Keywords: Paddy field management, Premodern Japan, “Tamei” River Storage, Land preparation period



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SS1-B-6

Factors governing groundwater pump operations in a village-community-level paddy irrigation district

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ABSTRACT

In paddy fields, groundwater is often utilized as a supplementary water source when surface water supplied from water source facilities is insufficient. As climate change increases drought and high temperature frequencies, reliance on groundwater may rise. Therefore, establishing a water management system that aligns regional surface water supplies with groundwater preservation is crucial. This requires clarifying actual groundwater pumping operations at the village community level, constructing a groundwater use model, and identifying operational improvements to optimize regional water distribution. This study analyzed factors governing pump operation in a village-community-level irrigation district.

Daily pump operation records were analyzed during normal irrigation periods from 2022 to 2024 across a 37-ha service area using supplementary groundwater. Operating hours and intake volumes for three pumps (A–C) were examined in relation to surface water intake from the dam, meteorological conditions, and cropping stages.

Pump operation was influenced most strongly by cropping stages rather than supplied surface water or weather, with groundwater use increasing notably after mid-season drainage. Pump A continuously operated as the primary pump. Pump C was often operated concurrently when daily maximum temperatures exceeded 30 °C, particularly from early July onwards after mid-season drainage. Conversely, the operating timing and frequency of Pump B varied significantly by year without a consistent pattern. In conclusion, multi-pump systems in village-community-level irrigation districts assign primary or supplementary roles governed by basic operational rules—mainly differentiating pre- and post-mid-season drainage—with post-drainage management adapted to temperature. Further research should clarify manager decision-making rules across different irrigation districts.

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Keywords: groundwater use, paddy irrigation management, pump operation



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SS1-C-1

Damage Assessment for In-Service Reinforced Concrete Headworks by AE Energy Analysis in Core Test

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ABSTRACT

Non-destructive methods are important to maintain the structural integrity of agricultural concrete structures. Acoustic Emission (AE), which is one of the most effective non-destructive methods, enables evaluation of crack behavior in concrete cores. In this study, we focused on the relationship between AE energy release behavior and the internal structure of deteriorated concrete cores under compressive stress field. These cores were drilled from a reinforced concrete headworks structure. X-ray Computed Tomography (CT) was used to quantify the internal structure. Accumulated crack damage is quantitatively evaluated using inflection point information of cumulative AE energy curve, which is derived from AE double logistic analysis.

As a result, the testing cores were classified into two groups according to crack area ratio. Different AE energy release behaviors were detected depending on the maximum strain energy of cores with lower crack area ratio. High AE energy release occurred at an early stage in cores with higher maximum strain energy. The same behavior was observed during the middle to later stages in cores with lower maximum strain energy. In the low crack area ratio group, a significant positive correlation is confirmed in the right-bank pier cores between the crack area ratio and strain energy level at first inflection point of the cumulative AE energy curve ($R^2 = 0.691$, $p < 0.05$). No similar correlation is identified in the high crack area ratio group. The difference indicates that damage degree in cores is linked to AE energy release behavior.

Keywords: Concrete, Acoustic emission, X-ray computed tomography (CT), Strain energy, Double logistic analysis, Damage evaluation



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SS1-C-2

Detection of Earthquake-Induced Damage in Road Bridge during Mj7.6 Noto Peninsula Earthquake by Anomaly Analysis with Optical Satellite Spectral Index[f1]

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ABSTRACT

The Noto Peninsula earthquake (January 1, 2024) caused severe damage to agricultural infrastructure, including rural road, farm ponds, irrigation canals, irrigation dams, and pipelines. Rapid damage assessment is essential for recovery, however, immediate field surveys are often dangerous by road disruptions and secondary disaster risks. Satellite remote sensing has gained attention as an alternative approach. Most recent studies focus on building collapse or landslide detection using SAR or SAR–optical fusion approaches, and satellite-based damage detection for agricultural infrastructure still relies primarily on field surveys. This study proposes a method that requires no post-event training data and uses only optical satellite imagery to detect anomalies as soon as images become available. Anomalies of five spectral indices derived from optical satellite imagery are calculated, and the degree of abnormality is quantified using multivariate Mahalanobis distance. When applied to damaged sites in the Noto Peninsula, clear spectral anomalies were detected in damaged areas immediately after the earthquake. This method is directly applicable to agricultural infrastructure monitoring. Sediment burial and structural damage to water facilities affect surrounding vegetation and soil moisture, which appear as anomalies in spectral indices. Without training data and field surveys, the framework functions as an immediately deployable damage detection tool for road bridge after an earthquake. This study provides a practical foundation for automated damage detection of agricultural infrastructure through satellite remote sensing.

Keywords: Agricultural infrastructure, Satellite remote sensing, Spectral index anomaly, Mahalanobis distance, Earthquake damage detection, Optical satellite imagery



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SS1-C-3

Thermal Environment Simulation of Irrigation Dam Concrete using Physics-Guided Neural Network integrated with Three-Dimensional Shadow Analysis

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ABSTRACT

Non-destructive health monitoring of aging irrigation dams using passive infrared thermography (IRT) requires physically consistent thermal environment simulation. A technical issue lies in accurately quantifying solar radiation on dam surfaces, which is substantially affected by complex three-dimensional shadow patterns arising from surrounding topography and structures. Neglecting these shadow effects introduces systematic errors in heat balance calculations, resulting in physically inconsistent temperature predictions. This study presents a framework that integrates three-dimensional (3D) shadow modeling with a Physics-Guided Neural Network (PGNN) to construct a physically valid thermal environment model for an in-service hollow gravity concrete dam used for agricultural water management. Shadow simulation based on the Möller–Trumbore ray-triangle intersection algorithm enables geometrically consistent estimation of effective solar radiation at each surface point. The corrected radiation is incorporated into a heat balance model, substantially reducing physically implausible temperature discrepancies caused by unaccounted shadow transitions. A PGNN is subsequently trained with meteorological inputs, weighted through an attention mechanism to reflect the relative contribution of each variable, including air temperature, solar radiation, wind speed, and longwave radiation, while embedding heat balance equations as physical constraints to penalize thermodynamically inconsistent predictions. The PGNN achieves a mean absolute error (MAE) of 0.9°C, outperforming both conventional heat balance analysis (MAE = 2.5°C) and standard LSTM (MAE = 1.0°C). The attention mechanism reveals that solar radiation and air temperature are the dominant drivers of surface temperature variation, consistent with physical expectations and confirming the model's interpretability.

Keywords: concrete dam, thermal environment simulation, Physics-Guided Neural Network (PGNN), shadow modeling, infrared thermography, agricultural water infrastructure



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SS1-C-4

Satellite-Based Assessment of Reservoir Storage and Irrigation Water Availability in North Korea

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ABSTRACT

Agricultural reservoirs are the primary source of irrigation water in North Korea and play a critical role in sustaining agricultural production under increasing hydroclimatic variability. However, limited reservoir inventories, the lack of in situ observations, and restricted field access make it difficult to assess reservoir storage and irrigation water availability. This study presents a satellite-based framework for assessing reservoir storage and agricultural water availability using Sentinel-2 imagery and a Digital Elevation Model (DEM). Sentinel-2 Level-2A surface reflectance imagery was used to derive the Normalized Difference Water Index (NDWI) and delineate reservoir water boundaries over multiple observation periods. The extracted water extents were integrated with DEM-derived topographic information to estimate reservoir water levels and reconstruct quasi-bathymetric surfaces. Elevation–area–storage relationships were subsequently established to estimate temporal variations in reservoir storage and evaluate irrigation water availability. The proposed approach enables continuous monitoring of reservoir storage dynamics in regions where field observations are unavailable or difficult to obtain. By providing quantitative information on available irrigation water resources, it offers a practical tool for assessing water supply conditions in North Korea and other ungauged or inaccessible regions. The framework can support reservoir inventory development, agricultural water management, drought monitoring, and climate change adaptation by improving the understanding of reservoir storage dynamics and irrigation water availability.

Acknowledgements: This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, and Forestry (IPET) through Intelligent Agricultural Infra Management for Climate Change Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (RS-2025-02219764).

Keywords: North Korea, agricultural reservoirs, reservoir storage, irrigation water availability, Sentinel-2, digital elevation model (DEM)



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SS1-C-5

Bearing-Plate Extraction by UAV-LiDAR Point Clouds for Quantifying Plate-to-Ground Offset in Soil-Nailed Slopes

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ABSTRACT

In hilly and mountainous rural areas, farmland, farm roads, and irrigation facilities often adjoin natural slopes. Usually, slope stabilization works are installed to prevent failures. Among these works, the non-frame method reinforces a shallow unstable layer with soil nails. A discrete steel bearing plate is attached to each nail head, and the plates are connected by wire ropes. A protective cap covers the nut at each plate center. The cap projects from the slope by a specified distance. The design requires close contact between the plate and the ground. Erosion or ground deformation, however, may create a gap. Such a gap reduces the confining effect. The offset between the plate and the ground therefore indicates the remaining confinement.

This study proposes a workflow for quantifying this offset from UAV-LiDAR point clouds. Plate points and ground points are separated by an unsupervised Gaussian mixture model applied to color-derived features. Individual plates are isolated by connected-component clustering with a size filter based on the design dimensions. For each cluster, a plane is fitted to estimate the plate inclination. The point farthest from this plane along its normal is extracted as the cap apex, which defines the plate center. The ground surface beneath the plate is interpolated from surrounding ground points. The offset is then calculated along the same normal.

Among the color-derived features examined, the blue channel gives the best separation and is therefore adopted. Plates and ground are classified accurately. Each plate center is determined successfully.

Keywords: UAV-LiDAR, Gaussian mixture model, Point cloud classification, Bearing plate, Soil nailing



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SS1-C-6

Nondestructive Leakage Detection in Service Pipeline using Water Hammer Pressure with Different Transient Generation Conditions

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ABSTRACT

Leakage in service pipelines could not be easily detected because the pipelines are buried and extend over long distances. Transient test-based techniques (TTBTs) have been investigated as a pipeline leakage detection method. In these methods, transients are generated by changing flow conditions, such as valve closure. Leakage locations are estimated based on the reflection waves or the damping of water hammer pressure. In this study, water hammer pressure generated under several valve openings is investigated for leakage detection. Measurements were conducted on an in-service pipeline system. The pipeline system consists of ductile iron pipe and steel pipe with a total length of 18 km. Water hammer pressure was generated by closing a valve. Three valve openings of 1/2, 1 and 3 turns were examined. Leakage was simulated by opening a sludge discharge valve. Pressure gauges were used to measure the water hammer pressure. The measured water hammer pressure is analyzed in the time domain and the frequency domain. The amplitude spectrum is calculated by the fast Fourier transform (FFT). The magnitude of the water hammer pressure differs among the three valve openings. The damping of the water hammer pressure increases in the cases with leakage. Peaks of the amplitude spectrum are confirmed at the first, third and fifth harmonic components of the water hammer pressure. These peaks decrease in the cases with leakage. These results indicate that leakage in an in-service pipeline is detected from the damping and the amplitude spectrum of water hammer pressure.

Keywords: Transient, Pipeline leakage, Water hammer pressure



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SS1-D-1

Image-Based Classification and Mapping of Surface Cyanobacterial Blooms Using UAV Imagery

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ABSTRACT

Cyanobacterial blooms frequently occur in eutrophic agricultural reservoirs, adversely affecting irrigation systems and aquatic ecosystems. Surface bloom patches can rapidly redistribute in response to changing environmental conditions, yet these short-term spatial changes cannot be adequately captured by conventional point-based water quality monitoring. Consequently, the short-term spatiotemporal dynamics of surface blooms remain poorly understood. High-resolution UAV imagery combined with image analysis provides a promising approach for continuous monitoring of these rapid changes.

The objective of this study was to develop a UAV-based image analysis framework for high-resolution mapping of surface cyanobacterial bloom dynamics and evaluate its applicability for monitoring short-term bloom redistribution. The study was conducted in an agricultural reservoir on the Ito Campus of Kyushu University, Japan. UAV images, water quality measurements, and meteorological observations were collected on four days in October 2025. Representative image patches were visually classified into three bloom-density levels and used as training data. Color and texture features were extracted, and Principal Component Analysis(PCA) was applied for feature selection. Excess Green(ExG) and Entropy were identified as the most effective features, and a linear Support Vector Machine(SVM) was developed to classify bloom density across the water surface.

The proposed framework successfully generated high-resolution bloom-distribution maps and visualized rapid spatio-temporal variations in surface cyanobacterial blooms. The classified maps enabled quantitative comparison of bloom redistribution under contrasting meteorological conditions, demonstrating that image-based classification effectively captured short-term bloom dynamics. This approach provides a practical, non-contact monitoring technique for agricultural reservoirs and a useful basis for investigating bloom responses to environmental conditions.

Keywords: UAV imagery, Feature extraction, Machine learning, Spatial mapping, Agricultural water management



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SS1-D-2

Climate-Induced Physicochemical Drivers of the Metalimnetic Oxygen Minimum in a Deep Monomictic Reservoir

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ABSTRACT

Climate change is altering the thermal and biogeochemical dynamics of stratified reservoirs, complicating water quality management. This study assessed how meteorological variation and watershed environmental change affect the metalimnetic oxygen minimum (MOM) layer in Lake Soyang, a large stratified reservoir in South Korea. The CE-QUAL-W2 model, a laterally averaged two-dimensional hydrodynamic and water quality model, was constructed and verified against observations through a two-year simulation (2023-2024), showing high reproducibility for water level ($R^2 = 0.99$), water temperature ($R^2 = 0.97$), and dissolved oxygen ($R^2 = 0.65$). Multifaceted scenarios combining water temperature rise, wind speed variation, and fluctuation in inflow dissolved organic carbon (DOC) load were simulated to represent potential extreme conditions, and the contribution of each factor to the vertical dissolved oxygen structure was quantitatively analyzed. Results indicate that the MOM in Lake Soyang typically forms in mid-June and reaches maximum development between August and October at depths of 20-35 m. Rising water temperature and decreasing wind speed enhanced stratification stability by increasing the density difference with the hypolimnion and inhibiting physical mixing, whereas elevated inflow DOC load intensified biogeochemical oxygen consumption within the metalimnion. These findings indicate that future water quality management for Lake Soyang requires an integrated approach that couples dam operation strategies accounting for changes in physical stratification intensity with watershed measures that reduce DOC loading. The results are expected to support dam and watershed management reflecting the complex interactions between hydrodynamic and water quality factors under a changing climate.

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Keywords: CE-QUAL-W2, Climate change, Metalimnetic oxygen minimum (MOM), Metalimnion, Hypoxia



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SS1-D-3

Development of Technology for High-Resolution Land Surface Temperature and Paddy Area Estimation Using Satellite Image-Based Downscaling Techniques

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ABSTRACT

Land Surface Temperature (LST) is a critical parameter for monitoring agricultural landscapes, providing valuable insights into soil moisture conditions, crop health, and irrigation requirements. However, the 30 m spatial resolution of Landsat 8/9-derived LST is often insufficient to capture fine-scale thermal variability within heterogeneous agricultural fields. This study presents a multisource satellite-based framework for downscaling Landsat 8/9 LST from 30 m to 3 m by integrating spectral information from Landsat 8/9, PlanetScope, and Sentinel-2 imagery. Vegetation and surface-related spectral indices were employed as predictors to reconstruct fine-resolution LST patterns during the early growth stage of paddy fields. The downscaled 3 m LST successfully captured field-scale temperature variations that were not discernible in the original Landsat LST product, providing substantially improved spatial details across agricultural landscapes. The enhanced thermal information also improved the delineation of paddy field boundaries and enabled a more reliable assessment of temporal variations relevant to irrigation planning and agricultural resource management. Overall, the results demonstrate that integrating multisource satellite imagery with LST downscaling techniques can effectively improve the spatial representation of surface temperature, offering valuable support for precision agriculture, crop monitoring, and decision-making where fine-scale thermal observations are required.

Keywords: Land surface temperature, Spatial downscaling, Multi-source satellite imagery, Paddy area estimation



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SS1-D-4

Assessment of Suspended Sediment and Total Organic Carbon Simulation Performance Considering Spatial Distribution of Soil Organic Carbon in a SWAT-C Model

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ABSTRACT

Climate and land-use change increase the need to accurately capture interactions between water and material cycling within watersheds. Conventional SWAT/SWAT-C models, calibrated mainly at the outlet, often fail to represent spatial heterogeneity inside the watershed. Soil organic carbon (SOC), a key source of riverine total organic carbon (TOC), is especially sensitive to this limitation, as spatial errors in SOC directly raise uncertainty in simulated carbon dynamics. This study recalibrated three SWAT-C soil parameters (Sol_K, Sol_AWC, Sol_cbn) at the hydrologic response unit (HRU) scale using Sentinel-1-based soil moisture, Landsat-8-based land surface temperature (LST), and Random Forest (RF)-predicted SOC. The RF model used DEM, slope, land use, soil texture, LST, SAR backscatter, and NDVI as inputs, with SOC measured at 50 agricultural parcels near Jaun-ri, Hongcheon County, as the target variable. Sol_cbn was then re-estimated from the predicted SOC map to correct its spatial distribution. The revised model achieved higher accuracy in simulating streamflow and SS, particularly at medium and low magnitudes, than the conventional model. Under identical calibration, the spatial distribution of subwatershed-scale SS and TOC yields shifted, altering the identified priority-management areas. These results indicate that incorporating spatial variability in soil moisture, LST, and SOC improves in-watershed material-cycling and water-quality simulation accuracy, underscoring the value of spatially informed calibration for non-point-source management. Extending this remote-sensing approach, our group is also developing a Sentinel-2 composite index (LMDI) that combines organic-matter- and moisture-sensitive signals to detect liquid manure application on bare fields, targeting nutrient loading events conventional monitoring cannot capture.

Keywords: Remote sensing, Soil organic carbon (SOC), SWAT-C, Spatial calibration, Non-point source management



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SS1-D-5

Evaluation of Nitrogen Removal Functions in Dry-Season Irrigated Paddy Fields in Vientiane, Laos

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ABSTRACT

Rapid urbanisation in Southeast Asia is increasing nitrogen loading to aquatic systems, while wetland–paddy landscapes can provide important nutrient removal functions. In Vientiane, Laos, the Na Khay marsh functions as a natural treatment system where irrigated rice cultivation occurs during the dry season. However, the controlling processes of nitrogen removal and the role of irrigation management remain unclear. This study quantified monthly dissolved inorganic nitrogen (DIN), $\text{NH}_4\text{-N}$, and $\text{NO}_3\text{-N}$ balances across the paddy–wetland system over three dry seasons (2023–2026) using weekly water quality observations and discharge estimates based on stage–discharge rating curves. Sentinel-2 satellite imagery was used to derive monthly flooded paddy area and drainage dynamics through combined vegetation and water indices, and nitrogen dynamics were evaluated in relation to seasonal flooding patterns.

Across the three dry seasons, the system reduced DIN loads by an average of 167 Mg N per season (28% average removal efficiency). Ammonium was the dominant removed fraction (216 Mg N per season), whereas nitrate increased by 49 Mg N per season, indicating substantial internal nitrogen transformation. Seasonal removal efficiencies varied annually (35.2%, 34.0%, and 14.8%). Multiple regression analysis revealed that monthly DIN removal was positively associated with cumulative nitrogen loading ($p < 0.01$), but significantly reduced by the expansion of managed drainage area (coefficient = -251.2 , $p < 0.05$). These results suggest that intensive drainage operations can abruptly shift the system from an effective nutrient sink to a reduced-retention state, increasing downstream nitrogen export.

Keywords: Nitrogen removal, Paddy–wetland system, Irrigation management, Sentinel-2, Laos



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SS1-D-6

An Integrated Geospatial Framework for Long-Term Spatio-Temporal Assessment of Hydrological Connectivity in the Bhoj Wetland-Catchment Using a Connectivity Index and Spatial Statistics

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ABSTRACT

Hydrological connectivity regulates the movement of water, sediment, nutrients, and pollutants from surrounding catchments to wetlands, playing a key role in sustaining wetland ecosystem health and resilience. Despite its ecological importance, long-term spatio-temporal assessments of catchment–wetland hydrological connectivity remain limited, particularly in rapidly urbanizing landscapes. This study presents a geospatial framework for assessing hydrological connectivity in the Bhoj Wetland catchment, India, by integrating a dynamic Connectivity Index (IC) based on the Cavalli hydrological connectivity model with multi-temporal remote sensing, terrain analysis, and spatial statistical techniques. The analysis was conducted for ten hydrologically delineated sub-catchments over the period 1990–2023 under pre- and post-monsoon conditions using Landsat time-series imagery, DEM-derived topographic parameters, surface roughness, NDVI-based resistance, and flow-path analysis. Long-term connectivity dynamics were quantified using the Mann–Kendall test, Sen’s slope estimator, and linear regression, while spatial patterns were examined through Getis–Ord G_i^* hotspot analysis, Emerging Hot Spot Analysis (EHSA), and Local Indicators of Spatial Association (LISA) to identify connectivity trends, persistent hotspots, spatial clusters, and localized changes. The results revealed different connectivity trends across the catchment, with SC6, SC7, and SC10 consistently exhibiting high hydrological connectivity and low movement cost, whereas SC2, SC4, SC5, SC8, and SC9 were characterized by lower connectivity and higher transport resistance. Seasonal connectivity patterns remained largely stable between the pre- and post-monsoon periods, indicating persistent hydrological pathways across the catchment. LISA analysis further identified statistically significant High–High connectivity clusters around the wetland and major drainage corridors, while Low–Low clusters were primarily concentrated in the outer catchment. The integrated assessment delineated hydrological resilience, transition, stress, and degradation zones, providing a scientific basis for prioritizing conservation and restoration efforts at the sub-catchment scale. The novelty of this study lies in integrating long-term seasonal connectivity modeling with hotspot evolution and spatial autocorrelation analyses to establish a decision-support framework for sustainable wetland management. The proposed framework supports SDGs 6, 11, 13, and 15 by advancing integrated water resource management, sustainable urban planning, climate resilience, and freshwater ecosystem conservation.

Keywords: Hydrological connectivity, Connectivity index (IC), Geospatial analysis, Catchment–wetland interactions, Restoration prioritization



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SS2-A-1

An Additive-Based Agricultural Inundation Risk Assessment of Chungnam Province

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ABSTRACT

Agricultural inundation threatens food security across monsoon-dominated Asia, where mixed farming landscapes encompassing paddy and upland crops sustain disproportionate damage from extreme rainfall, yet spatially explicit indicator-based risk assessments tailored to agricultural systems remain scarce. This study operationalizes the Intergovernmental Panel on Climate Change (IPCC) risk framework, which conceptualizes risk as an additive composite of Hazard, Exposure, and Vulnerability, using Chungnam Province, South Korea, as a representative agricultural case. Indicators spanning all three dimensions are compiled: hazard indicators derived from digital elevation analysis and design-storm frequency modeling, encompassing topographic wetness index, slope, distance to stream channel, drainage density, and peak discharge; exposure indicators quantifying agricultural land distribution; and vulnerability indicators capturing farm-level socioeconomic susceptibility. All indicators are min-max normalized and weighted through a combined Principal Component Analysis (PCA) and Shannon Entropy (SE) method, harmonically averaged to resolve inter-indicator multicollinearity and information content, eliminating analyst subjectivity. Weighted scores are linearly aggregated and classified into five inundation risk levels by Jenks Natural Breaks optimization. Results reveal pronounced risk concentrations in low-gradient coastal agricultural plains and markedly reduced risk across upland areas. The additive formulation avoids zero-product suppression in multiplicative frameworks, providing a transferable, reproducible methodology for mapping agricultural inundation risk across monsoon-dominated mixed-farming regions.

Keywords: agricultural inundation, IPCC risk framework, mixed farming, PCA–Entropy weighting, additive composite, Jenks classification



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SS2-A-2

Flood Damage Assessment on Road Network and Agriculture in Agricultural Area: A Case Study of the Pursat River Basin, Cambodia

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ABSTRACT

As one of Southeast Asia's most disaster-prone nations, Cambodia faces significant challenges in sustainable water management. Pursat Province, located adjacent to Tonle Sap Lake, is particularly vulnerable to flooding driven by climate change, upstream runoff, and lake backwater. These recurring events devastate rural infrastructure and agriculture, incurring massive annual rehabilitation costs. This study investigates the impact of climate change on the hydrological regimes and flood extent of the 5,965 km² Pursat River Basin and to develop adaptation strategies. To forecast future impacts, a model-coupling approach was employed, integrating SWAT+ and HEC-RAS with Global Climate Models (GCMs) under the CMIP6 framework. The model demonstrated satisfactory performance during the calibration period (1995–2006), yielding an R² of 0.53, NSE of 0.53, and PBIAS of -1.21%; while validation result (2007–2015) were less robust, with an R² of 0.28, NSE of 0.25 and PBIAS of 0.5%. Interestingly, the streamflow results of monthly time series were improved and acceptable for calibration and validation with R² of 0.71 NSE of 0.71 and PBIAS of -5.19% and with R² of 0.52 NSE of 0.50 and PBIAS of -4.85%, respectively. For next plan, HEC-RAS will be simulated by employing the daily observed flow as the boundary condition. For future climate scenarios, the output of daily flow generated by SWAT+ will be used as the input for HEC-RAS again for flood extent; then, compare this result with the baseline of flood extent. Despite these statistical limitations, the findings will provide a scientific basis for developing adaptation strategies, flood protection, and resilient infrastructure.

Keywords: Flood, Road networks, Agriculture, SWAT+, HEC-RAS, Pursat River Basin, Cambodia



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SS2-A-3

Spatio-Temporal Variability and Regime Shifts of Extreme Precipitation in Tanzania: Implications for Climate Resilience and Water Resources

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ABSTRACT

Extreme precipitation in Tanzania has intensified over the past four decades, leading to substantial implications for flood risk and rain-fed agriculture. This study examines extreme precipitation variability, trends, and hydroclimatic regime shifts using 44 years (1981–2024) of daily CHIRPS v2 data. Twelve ETCCDI precipitation indices, the coefficient of variation (CV), and the precipitation concentration index (PCI) were assessed using an integrated framework that employed the Pettitt change-point test, Mann–Kendall trend test, and Sen’s slope estimator. Low rainfall variability (CV < 20%) was identified in approximately 80% of the country, whereas semi-arid regions showed irregular rainfall concentration (PCI > 15) and increased drought susceptibility. The Pettitt test revealed a significant regime shift between 2013 and 2015, with breakpoints in PRCPTOT (2014, $p = 0.018$) and SDII (2013, $p = 0.003$), indicating that rainfall intensity increased before rainfall frequency. Most precipitation indices, including PRCPTOT (94.26%), SDII (88.42%), RX5day (83.99%), and R10mm (81.5%), showed positive trends. In contrast, consecutive wet days (CWD) generally declined, reflecting shorter wet periods and reduced rainfall persistence. These results indicate that rainfall intensification in Tanzania is strongly associated with an abrupt transition after 2013, offering critical evidence to inform climate-resilient agriculture, flood management, and water resource planning.

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Keywords: Extreme precipitation, ETCCDI, CHIRPS, Mann-Kendall trend test, Regime shift, Spatio-temporal variability, Change-point year, Trends, Tanzania



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SS2-A-4

Development and Application of HAWQS for Spatial Assessment of Water Quality Loads in Small Agricultural Watersheds

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ABSTRACT

Climate change is increasing the frequency of extreme precipitation, intensifying nonpoint-source pollutant transport from agricultural lands and posing growing challenges to watershed water quality management. These impacts are particularly significant in small agricultural watersheds, where rapid hydrologic responses and heterogeneous landscape characteristics produce substantial spatial variability in runoff and nutrient export. To support efficient watershed-scale assessment, this study presents the development and application of the HydroAgro Water Quality System (HAWQS), a web-based modeling platform for hydrology and water quality analysis in South Korea. HAWQS is built on the SWAT+ (Soil and Water Assessment Tool Plus) model and provides an integrated environment for watershed delineation, simulation, and spatial analysis of water quality loads. The platform represents watershed heterogeneity using hydrologic response units (HRUs), enabling evaluation of runoff and nutrient loads by land use, soil, and slope. SSP scenarios from the IPCC Sixth Assessment Report were applied to small agricultural watersheds in South Korea to evaluate changes in hydrology and water quality. Area-normalized nutrient loads were compared among agricultural HRUs to identify spatial hotspots with high pollutant export potential under future climate conditions. The results demonstrate that HAWQS effectively captures spatial variability in water quality loads and supports identification of vulnerable agricultural areas. The platform can support climate-resilient watershed management and sustainable agricultural water quality planning in South Korea.

Acknowledgements: This research was supported by the Rural Development Administration (RDA) through Cooperative Research Program for Agriculture Science & Technology Development, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) [RS-2024-00396736].

Keywords: HAWQS, SWAT+, Spatial assessment, Nonpoint source pollution, Agricultural watersheds



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SS2-B-1

Evaluation of a Lower-Boundary-Controlled Weighing Lysimeter for Measuring Evaporation under Shallow Groundwater Conditions

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ABSTRACT

Field measurement of evaporation in agricultural soils is difficult under shallow groundwater conditions because atmospheric water loss, capillary supply, drainage, and soil-water storage changes can occur simultaneously. To address this limitation, we evaluated a lower-boundary-controlled weighing lysimeter (LBC-WL) developed for continuous monitoring of soil water dynamics and evaporation under field conditions. The LBC-WL controls the bottom pressure head by bidirectional water exchange between the lysimeter base and an external water tank, allowing evaporation, capillary supply, and downward percolation to be interpreted from the combined mass balance. TDR sensors installed inside and outside the lysimeter were used to examine whether the lysimeter reproduced the surrounding soil-water profile. Evaporation estimates were evaluated using independent gravimetric measurements from Wagner pots filled with the same field soil, and pump-operation records were used to identify possible errors caused by lower-boundary supply, drainage, and tubing storage. Preliminary field observations showed that the bottom pressure head in the lysimeter followed the external reference head during the selected low-rainfall period. Soil-water contents were not identical at all depths, but the vertical profile dynamics were hydraulically comparable. Daytime evaporation measured by the LBC-WL responded to solar radiation, and seasonal comparisons with Wagner pot measurements showed close agreement over a range of evaporative demand, including daily evaporation around 3.8 mm d⁻¹. These results indicate that the LBC-WL can provide a practical tool for evaluating evaporation under shallow groundwater conditions when pump-affected periods and soil-water differences between the lysimeter and reference pots are explicitly considered.

Keywords: Lysimeter, Evaporation



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SS2-B-2

Assessing Peatland Deformation under Agronomic Water Management and Extreme Droughts Using a Coupled Hydro-Eco-Mechanical Model

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ABSTRACT

Peatland subsidence poses severe threats to agricultural sustainability and soil conservation. This study uses a prominent cultivated basin as a case study, where sponge gourd is traditionally cultivated from March to October; winter fallow often leads to severe soil oxidation and structural deformation.

This study presents a four-stage framework integrating Regional Frequency Analysis based on L-moments (RFA-LM) with the MPeat model to evaluate peatland deformation under the combined impacts of extreme drought events and agronomic water management. First, historical meteorological data are analyzed using RFA-LM to establish baseline and extreme drought scenarios across various exceedance probabilities. Second, these RFA-derived climatic boundaries are coupled with field water-balance equations to define seasonal irrigation and drainage operational rules. The summer mode incorporates sponge gourd crop water requirements for planned irrigation alongside flood drainage routing. Conversely, the winter mode operates as an on-farm micro-detention reservoir, utilizing soil bund heights to extend water retention time. Third, the MPeat model simulates dynamic variations in water table depth, decomposition rates, and poroelastic skeletal displacement driven by these inflows.

Finally, scenario analyses investigate two core dimensions: (A) optimizing water retention strategies by evaluating the mitigation performance of various bund heights under different scenario-based drought return periods, simulating a continuous range of soil bund heights to identify the optimal height for minimizing land subsidence; and (B) quantifying how different drought exceedance probabilities impact internal water table drawdowns and subsequent subsidence mechanisms. Ultimately, this framework serves as a scientific tool for sustainable water-soil management in agricultural peatlands.

Keywords: Peatland subsidence, L-moment, Regional frequency analysis (RFA), Agronomic water management, On-farm micro-detention, MPeat model, Poroelasticity



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SS2-B-3

Hydrologic and Crop Stress Responses to Field Slope in Korean Reclaimed Coastal Farmlands

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ABSTRACT

Reclaimed coastal farmlands play an important role in expanding agricultural land and strengthening food production. However, their low-lying topography, poor drainage, and fine-textured soils restrict water movement within the soil profile, making them highly susceptible to surface runoff, waterlogging, and soil erosion during rainfall events. Although subsurface drainage systems have been widely adopted to alleviate these problems, their high installation costs and long construction periods often limit their economic feasibility. Adjusting field slope has emerged as a practical alternative for improving surface drainage. An appropriate slope can facilitate the removal of excess rainfall and irrigation water, thereby reducing waterlogging, whereas excessive slopes may increase runoff and soil erosion while decreasing soil moisture availability for crops. Consequently, sustainable management of reclaimed coastal farmlands requires site-specific evaluation of hydrologic processes and crop stress rather than the application of a uniform slope criterion. In this study, the Agricultural Policy/Environmental eXtender (APEX) model was applied to representative reclaimed coastal farmlands in Korea to simulate multiple field-slope scenarios and quantify their effects on hydrologic responses and crop water stress under contrasting site conditions. The simulations evaluated runoff generation, soil moisture dynamics, drainage, and crop stress across different slope configurations. The findings provide a scientific basis for developing site-specific field slope management strategies that improve drainage efficiency, reduce runoff and soil erosion, and sustain crop productivity in reclaimed coastal agricultural systems.

Acknowledgements: This work was carried out with the support of “Cooperative Research Program for Agriculture Science and Technology Development (Project No. RS-2023-00224283)” Rural Development Administration, Republic of Korea.

Keywords: Reclaimed coastal farmland, Field slope, Hydrologic response, Crop water stress, APEX



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SS2-B-4

Development and Application of the SWAT+ PADDY Model for Paddy Field Hydrological Simulation in the Wu River Basin, Taiwan

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ABSTRACT

Rice is a major food source for more than half of the global population and one of the largest agricultural water consumers. In Taiwan, rice cultivation involves complex irrigation and drainage operations, while conventional watershed models have limitations in representing field water-level control, irrigation sources, seepage, and drainage processes during different growth stages. SWAT+ is a reconstructed version of the SWAT model with enhanced capabilities for simulating human activities, including irrigation management and agricultural practices. This study selected the Wu River Basin in Taiwan as a representative case study and developed a SWAT+ model integrated with the SWAT+ PADDY module to simulate paddy hydrological processes and management practices.

The SWAT+ PADDY module enables representation of ponding depth, irrigation sources, and management events such as puddling and transplanting, providing a detailed description of rice growth-stage dynamics. Spatial and agricultural datasets, including digital elevation models, land use, soil properties, meteorological data, streamflow observations, and rice cultivation information, were collected for model development. In this study, a complete SWAT+ PADDY framework has been established as a foundation for calibration, validation, and paddy water balance analysis. Model performance were evaluated using R^2 , NSE, and PBIAS to assess the impacts of agricultural management practices and extreme hydrological conditions on paddy water balance, supporting smart irrigation and water resource management under climate change.

Keywords: SWAT+ PADDY, rice, smart irrigation, hydrological simulation, Wu River Basin



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SS2-C-1

Evaluation of Upstream Water-Level Monitoring for Early Gate Operation During Extreme Rainfall in a Main Irrigation Canal Using One-Dimensional Unsteady Flow Analysis

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ABSTRACT

Extreme rainfall events have increased the risk of overflow in irrigation canal systems, highlighting the need for early gate operation during flood events. This study applied a one-dimensional unsteady flow model to evaluate how gate operation timing influences overflow risk in a main irrigation canal. The analysis considered lateral inflow from a tributary, represented by the design discharge, causing a rapid water-level rise at the downstream end of the canal. Drainage operation was simulated by switching the downstream gate from overflow-weir to underflow operation. Gate operation was initiated when the water level at a designated monitoring point reached a predefined threshold. Simulations based on the current operational guideline, which uses the downstream end of the main canal as the monitoring point, indicated that gate operation was initiated too late to prevent overflow. Two alternative monitoring locations—the tributary inflow point and an upstream point on the tributary—provided lead times of approximately 10 and 20 minutes, respectively, enabling gate operation before overflow occurred. Furthermore, using the upstream tributary point as the operational trigger reduced the peak water level at the downstream end to nearly the same level as that achieved by switching the gate to underflow operation before the arrival of the design discharge. These findings demonstrate that strategically located water-level monitoring can provide valuable lead time for gate operation and improve flood management in irrigation canal systems during extreme rainfall events.

Keywords: agricultural water infrastructure, open canal flow



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SS2-C-2

Enhancing Agricultural Water Resilience through Integrated Hydraulic Modeling and Smart Water Management: A Case Study of the Guandu Plain, Taiwan

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ABSTRACT

Ensuring stable agricultural production under increasing climate variability and urban pressure has become a major challenge in peri-urban regions. This study proposes an integrated framework for optimizing water resource management in the Guandu Plain, an agricultural area in Taipei City. The region has long suffered from recurrent flooding during the wet season and water shortages during the dry season. Its water management system relies on several sluice gates and pumping stations, highlighting the need for a more adaptive and resilient operational strategy. We first conducted a comprehensive field survey, collected data from IoT sensors, and developed a hydraulic model of the Guandu Plain. By integrating data and model with the PySWMM package, which provides Python-based access to the SWMM model, we established a real-time simulation platform that improves both simulation efficiency and operational flexibility. The results show that flooding is strongly affected by tidal fluctuations, while also identifying areas with relatively high water stress. These findings demonstrate that real-time monitoring and prediction can support more effective water management and reduce both flood and drought risks. Overall, this study presents a smart water management framework that supports adaptive water resource operations, improves agricultural production stability, and provides a scalable approach for other complex agricultural water management systems.

Keywords: Smart water management, Agricultural resilience, IoT sensors, PySWMM, Real-time simulation



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SS2-C-3

Interpreting Paddy Irrigation Demand under Alternative Water-Management Scenarios in the Wu River Basin Using SWAT+PADDY and Explainable Machine Learning

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ABSTRACT

Efficient irrigation water allocation requires irrigation strategies that respond to hydroclimatic variability and local paddy-field conditions. This study develops an integrated framework combining SWAT+PADDY simulations with explainable machine learning to evaluate and interpret seasonal irrigation responses under alternative water-management scenarios. SWAT+PADDY was applied to the Wu River Basin in central Taiwan, with the analysis focusing on paddy hydrologic response units (HRUs) distributed across the mid- and downstream of the basin. Management scenarios were generated by varying the irrigation-trigger threshold, irrigation application depth, and drainage-related ponding threshold. Seasonal precipitation, potential evapotranspiration, maximum consecutive dry days, rice-growing season, and selected HRU characteristics were included to represent climatic, temporal, and spatial variability. Simulated seasonal irrigation application for each paddy HRU was used as the primary response variable. Percolation, soil-water status, ponding conditions, and water-stress indicators were retained as diagnostic variables to determine whether reductions in irrigation application reflected improved water management or inadequate water supply. Furthermore, Random Forest and XGBoost were trained as surrogate models to reproduce the irrigation responses generated by SWAT+PADDY. Model performance was evaluated using grouped cross-validation, while selected management-scenario combinations were withheld entirely from training and used for independent testing. SHapley Additive exPlanations (SHAP) were then applied to quantify the relative contributions of management and hydroclimatic factors, identify nonlinear response thresholds, and examine their interactions. The framework was used to identify management combinations that reduce seasonal irrigation application while maintaining acceptable paddy-field water and crop-stress conditions, and to determine whether the dominant controls differ between the first and second rice-growing seasons. This integrated modeling approach supports transparent screening of irrigation-management strategies and adaptive agricultural water allocation in paddy-growing regions.

Keywords: SWAT+PADDY, explainable machine learning, irrigation demand, water-management scenarios, Wu River Basin



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SS2-C-4

Plot-Scale Analysis of Climate Change Impacts on Crop Evapotranspiration and Irrigation Supply Scenarios Using SWMM in Upland Farmland, South Korea

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ABSTRACT

This study applied a SWMM-based water balance approach to a plot-scale upland farmland to assess how climate change may affect crop water demand and irrigation supply stability, using a testbed in Anseong, South Korea. Crop evapotranspiration for upland crops (soybean, hot pepper) was estimated via FAO Penman-Monteith with growth-stage crop coefficients, driven by both historical meteorological records and future climate change scenarios (SSP, Shared Socioeconomic Pathways), to project future crop water demand. SWMM applied LID (Low Impact Development) modules to represent upland infiltration and soil moisture dynamics within an integrated hydrologic network. Results were validated against about one year of testbed observations (AWS, irrigation, drainage, soil moisture, and groundwater level sensors). Using this validated model, surface water-only, groundwater-only, and hybrid irrigation scenarios were compared under both historical baseline (2010s) and future climate conditions (2080s) to predict future irrigation water supply requirements and evaluate supply stability. Results show that hybrid supply improves stability over single-source operation, and that under future climate scenarios, peak irrigation demand is projected to intensify and shift earlier in the growing season. This provides a foundation for climate-adaptive water management strategies in upland agricultural systems.

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Keywords: SWMM, Multi-purpose farmland, Climate change scenario, Surface-subsurface irrigation, Crop evapotranspiration



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SS2-D-1

A coupled particle-based hydraulic and fish-behavior model for evaluating fish passage at drop structures

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ABSTRACT

Drop structures are widely recognized as obstacles to fish migration. Where no fishway is provided, ayu (*Plecoglossus altivelis*) ascend these structures by leaping. A model reproducing fish migration around drop structures would be useful for designing structures that facilitate upstream passage. Coupled hydrodynamic and individual-based fish models have been applied to fishways but generally rely on grid-based computational fluid dynamics (CFD). Flow around drop structures involves large and rapidly varying free-surface deformations. Particle methods are more natural for representing such deformations, as they track the surface without a fixed grid. This study therefore develops a coupled hydrodynamic–fish behavior simulation model based on a particle method. A hydrodynamic model based on the incompressible moving particle semi-implicit (MPS) method was developed to simulate flow around drop structures. Boundary conditions were prescribed using the flow velocity and water depth measured at the crest of each cross-section. A fish behavior model incorporating rheotaxis, swimming, leaping, and fatigue was formulated and coupled with the hydrodynamic model so that each fish responds to the local flow. Using simplified bed geometry and provisional behavioral rules, the coupled model reproduced both successful and unsuccessful ascents, depending on the behavioral parameters. Future work will refine the boundary conditions and calibrate the behavioral parameters using field observations.

Keywords: MPS method, drop structure, ayu (*Plecoglossus altivelis*), coupled fish-flow model



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SS2-D-2

Assessing the Influences of Climate Change and Non-Point Source Pollution on Long-Term Water-Quality Trends in Mountain Reservoir

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ABSTRACT

Mountain reservoirs are more sensitive to climate change than lowland systems, yet long-term eutrophication trends in these reservoirs are difficult to interpret because nutrient concentration time series are simultaneously governed by pollutant loading and hydrological conditions. The Techi Reservoir, a mountain reservoir in Taiwan whose watershed ranges in elevation from 1,408 to 3,886 m, has recently faced intensifying rainfall, temperature changes driven by climate change, and expanding agricultural activity within the watershed. A slight rise in its Carlson Trophic State Index has been noted. This study analyzes water-quality records for the reservoir from 1993 to 2025, including total phosphorus, total nitrogen, dissolved oxygen, water temperature, and other important indicators, with four seasonal observations conducted each year. The Mann-Kendall test is first applied to characterize long-term water-quality trends and identify indicators showing statistically significant changes. Past extreme events, including intense rainfall and droughts, are also examined for their effects on reservoir water quality, together with changes in the extent of landslide-affected areas within the watershed. Beyond the influence of climate change, anthropogenic non-point source pollution forms a second focus of this study. Using Pearson's product-moment correlation, annual fertilizer application within the watershed is related to key water-quality indicators, such as total phosphorus and total nitrogen. Together, these analyses seek to disentangle the respective long-term contributions of natural forcing and human intervention to reservoir water quality, thereby informing eutrophication management and water-supply security for climate-sensitive mountain reservoirs.

Keywords: Subtropical reservoir, Eutrophication, Climate change, Mountain lake, Non-point source pollution



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SS2-D-3

Spatio-Temporal Assessment of Ecological Drought Vulnerability in the Nakdong River Basin Using the Environmental Ecological Flow Index

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ABSTRACT

Ecological drought occurs when river flow decreases below the level required to maintain aquatic ecosystem health, structure, and function. Unlike conventional drought assessments that mainly focus on precipitation or water resource deficits, ecological drought assessment should determine whether observed discharge satisfies environmental flow requirements for aquatic organisms. This study aims to assess the spatio-temporal characteristics of ecological drought vulnerability at 16 ecologically vulnerable aquatic ecosystem sites in the Nakdong River Basin. The study sites were classified into four regional groups: upper, middle, and lower Nakdong River regions, and the East Sea watershed region. Daily discharge and accumulated precipitation data from 2015 to 2024 were used for the analysis. Site-specific environmental flow requirements were estimated using PHABSIM based on habitat suitability indices for representative fish species. The Environmental Ecological Flow Index (EI) was calculated as the ratio of observed discharge to environmental flow, and ecological drought was defined as $EI < 1$. Run theory was applied to identify ecological drought events and quantify their duration and severity. The results are expected to identify vulnerable sites and periods where observed discharge frequently falls below environmental flow requirements. Regional comparison among the four groups can provide insight into spatial differences in ecological drought vulnerability. This study can provide baseline information for prioritizing vulnerable river reaches and supporting ecology-oriented flow management in the Nakdong River Basin.

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Keywords: Nakdong River Basin, Ecological drought, Environmental flow, Environmental Ecological Flow Index, PHABSIM



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SS2-D-4

A study on environmental ecological flow assessment using SWAT and boosting algorithms considering fish functional traits and watershed characteristics

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ABSTRACT

Ecological flow (E-flow) is essential for sustaining river ecosystems, but conventional habitat-based methods require extensive field surveys, limiting their applicability. This study proposes a watershed-scale E-flow estimation method integrating the SWAT (Soil and Water Assessment Tool), boosting algorithms, watershed characteristics, and fish functional traits. The model was developed using data from 38 unregulated river sites in South Korea obtained from the Water Resources Management Information System (WAMIS). SWAT simulated daily streamflow (2011–2020) to derive hydrological indices and watershed characteristics, while fish functional traits, which describe species' morphological, ecological, and behavioral characteristics, were incorporated to improve model performance and represent ecological requirements beyond physical watershed conditions. Among 136 candidate variables, 11 variables were selected using a two-stage feature selection approach. The mRMR method was first employed to retain variables with high explanatory power and low redundancy, followed by VIF analysis to remove highly correlated predictors ($VIF > 10$) and mitigate multicollinearity. Six ensemble machine learning models were evaluated using nested leave-one-out cross-validation, with Gradient Boosting achieving the best performance ($R^2 = 0.64$; $RMSE = 1.92 \text{ m}^3/\text{s}$). Bootstrap-based 90% prediction intervals achieved 86.8% coverage, although predictive uncertainty increased under high-flow conditions. SHAP (SHapley Additive exPlanations), response surface, and PDP-ICE (Partial Dependence Plot-Individual Conditional Expectation) analyses identified hydrologic soil group B, watershed area, mean streamflow, and total river length as the most influential predictors, accounting for approximately 60% of the model's explanatory power. Application to standard watersheds demonstrated the model's spatial applicability and its potential to extend E-flow estimation beyond conventional field survey-based approaches.

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Keywords: Ecological flow, SWAT, Machine learning, Fish functional traits, Watershed characteristics



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SS3-A-1

Importance of peak wind gusts in PM₁₀ modeling: a hybrid AI–physics approach for Zhuoshui River aeolian dust stations

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ABSTRACT

Riverbed aeolian dust events along Taiwan's Zhuoshui River threaten nearby agricultural communities and climate-resilient water management, yet operational PM₁₀ forecasts remain highly uncertain under changing hydrometeorological conditions. This study develops a station-scale hybrid AI–physics framework to evaluate the role of peak wind gusts in PM₁₀ prediction at two official monitoring sites (Yishian and Shiuguang Elementary Schools) located downwind of the lower river reach. We construct a physics-informed “source availability” index from river water levels and drying times, then compare two machine-learning models - Random Forest (RF) and a shallow multilayer perceptron neural network (MLPNN) - under different input configurations. Baseline models use only standard meteorological and hydrological variables; extended models add peak gust intensity and frequency. Model parameters controlling source availability are further calibrated with a global sampling/optimization routine (SPOTPY) to reflect environmental uncertainty in threshold selection. Using rolling timeseries cross-validation, we assessed deterministic performance and PM event detection skill. Preliminary results indicated that: (i) RF and MLPNN yielded comparable overall accuracy, (ii) including peak gust metrics produced better statistics for extreme PM detection at both stations. The proposed hybrid AI–physics approach provided a transparent, data-driven way to analyze how wind gusts, river conditions, and model choices influenced station-scale PM₁₀ forecasts.

Keywords: PM₁₀, aeolian dust, hybrid AI–physics modeling, peak wind gusts



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SS3-A-2

Leaf Region Extraction for Individual Trees in Citrus Orchards Using a Deep Learning-Based UAV Image Processing Framework

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ABSTRACT

Assessing treelevel leaf and soil water status is essential for implementing precision irrigation in citrus orchards. Leaf surface temperature can serve as an indicator of moisture conditions; however, accurately extracting leaf surface temperature from UAV imagery is challenging because orchard environments contain complex backgrounds such as soil, understory vegetation, and mulch sheets in addition to tree canopies. To address this issue, we developed a hybrid imageprocessing framework that extracts leaf regions within individual tree canopies from UAV RGB imagery and integrates them with thermal data to derive leaf surface temperatures for each tree.

First, a pretrained DeepForest model was used to detect individual tree canopies and generate rectangular bounding boxes. These bounding boxes were then provided as prompts to the Segment Anything Model (SAM) to produce detailed canopy masks. Subsequently, HSV (Hue–Saturation–Value) color filtering targeting yellow to yelloworange hue ranges was applied to remove background noise—including soil, branches, and mulch sheets—and isolate pure leaf pixels. Finally, the resulting leaf masks were overlaid onto georeferenced thermal images to convert digital pixel values into leaf surface temperatures.

Performance evaluations at flight altitudes from 10 to 120 m showed that the combination of DeepForest and SAM achieved optimal canopy detection at 40 m. HSV filtering effectively eliminated nonleaf regions, substantially improving leaf extraction accuracy. Overall, this deep learningbased hybrid framework enables highprecision extraction of leaf surface temperatures at the individualtree level and provides a robust foundation for treespecific waterstress assessment and future automated irrigation systems in citrus orchards.

Keywords: Deep learning, Unmanned aerial vehicle, Leaf temperature, Image segmentation



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SS3-A-3

Hyperspectral diagnosis of soybean water stress with prompted SAM2 segmentation

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ABSTRACT

Soybean (*Glycine max* L. Merr.) is susceptible to both waterlogging and drought at different reproductive stages, requiring non-destructive time-series diagnostics. Using VNIR hyperspectral images acquired in 2020, we segmented pot-level canopy pixels with a prompted SAM2 pipeline and derived five band-representative wavelengths via PCA. Four normalized difference indices (NDVI, GNDVI, NDRE, BNDVI) and four three-band mTCARI variants (R_Mid fixed at RE) were compared against the calendar-matched common control. Because Zone 1 (waterlogging) shared cameras between treatment and control while Zone 2 (drought) did not, Zone 1 was analyzed with paired t-tests and paired Hedges' g and Zone 2 with Welch's independent-samples t-tests and pooled-SD Hedges' g, with Holm-Bonferroni correction within each (zone × index) family. Under drought, three mTCARI variants (RE|R,NIR; G,NIR; B,NIR) yielded mean |Hedges' g| of 3.75–3.94, exceeding standard indices (1.52–2.31), and all four mTCARI variants together with NDVI, GNDVI and BNDVI showed Holm-significant treatment–control differences at R1, R3 and R5. Under waterlogging, mTCARI variants and NDIs performed similarly with mostly V5 significance. Because candidate-index multiplicity and PCA wavelength selection share the same data, external validation is required to confirm the diagnostic performance of mTCARI.

Keywords: soybean, waterlogging, drought, vegetation index, hyperspectral image, SAM2



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SS3-A-4

Water Stress Classification of Persimmon Leaves from RGB Images Using GoogLeNet

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ABSTRACT

Nara Prefecture is one of Japan's major persimmon-producing regions. However, irrigation management in persimmon cultivation often depends on growers' experience, creating a need for an objective and labor-saving irrigation decision method. Although soil moisture sensors are widely used for irrigation management, their high installation and maintenance costs limit their widespread adoption. Recent advances in deep learning have enabled image-based approaches that estimate crop water status from low-cost RGB images. In this study, we developed a water stress classification model for persimmon leaves using GoogLeNet and evaluated the effect of transfer learning.

RGB images of persimmon leaves and soil moisture data were collected from two orchards between 2022 and 2025. Soil moisture measurements were converted into pF values using a soil water retention curve, and leaf images were labeled into four soil moisture classes. Classification performance was compared between a pre-trained GoogLeNet model and a GoogLeNet model trained from scratch. To investigate the influence of training data size on transfer learning, 1,000, 2,000, and 3,000 training images per class were prepared for both models.

The pre-trained GoogLeNet achieved accuracies of approximately 65%, 68%, and 56% with 1,000, 2,000, and 3,000 images per class, respectively. In contrast, the model trained from scratch achieved approximately 61%, 69%, and 74%, respectively. These results suggest that transfer learning does not necessarily improve classification performance as the amount of training data increases. Future work will evaluate the model using images acquired under different cultivation environments and imaging conditions to improve its generalization performance.

Acknowledgements: This research received financial support from the Research on Creating SOPs for Smart Production Methods (Standard Operating Procedures for Introduction and Operation of Smart Agriculture Technologies) provided by the Project of the National Agriculture and Food Research Organization (NARO).

Keywords: Irrigation, Water stress, AI, Fruit trees, RGB image, Soil moisture



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SS3-A-5

Mamba-Based Classification of Summer and Winter Crops in South Korea Using Time-Series Sentinel-1 and Sentinel-2 Imagery

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ABSTRACT

Crop cultivation area and distribution data is crucial for agricultural water management and crop yield prediction. Remote sensing and deep learning have enabled accurate crop-type classification using satellite image time series. State space models such as Mamba have emerged as an alternative to transformer-based models owing to their computational efficiency in modeling long temporal sequences. The objective of this study is to classify summer and winter crops in South Korea using time-series Sentinel-1 and Sentinel-2 satellite imagery and a Mamba-based model. A Crop cultivation monitoring dataset was collected from four cities and counties in South Korea (Uiseong-gun, Yeongcheon-si, Naju-si, and Namhae-gun). The collected crop types were categorized into summer and winter crops based on crop cultivation schedules. Sentinel-1 and Sentinel-2 satellite images acquired during the cultivation period were used to construct the time-series datasets. Three classification models were trained using (1) Sentinel-1 imagery only, (2) Sentinel-2 imagery only, and (3) both Sentinel-1 and Sentinel-2 imagery. The performance of the three models was evaluated and compared using accuracy and mean intersection over union (mIoU). The results of this study are expected to contribute to agricultural water management, crop yield prediction, and agricultural supply management.

Keywords: Satellite image time series (SITS), Sentinel-1, Sentinel-2, Crop classification, Space state model, Mamba



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SS3-A-6

Monitoring Agricultural Drought in South Korea Using MODIS-Derived Soil Moisture and Drought Indices: Spatiotemporal Analysis of Major Events (2022–2025)

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ABSTRACT

This study presents a MODIS-driven framework for estimating daily soil moisture and monitoring agricultural drought across South Korea, with particular attention to the extended 2022–2023 dry spell in Jeollanam-do and the more localized 2025 event in Gangneung. Eight predictor variables were combined for the analysis: bias-corrected land surface temperature, NDVI, antecedent five-day rainfall, cumulative dry-day counts, soil texture fractions (sand, silt, clay), and terrain elevation. These inputs were paired with in-situ measurements collected from 76 RDA monitoring stations. To identify the most reliable estimation approach, six machine-learning algorithms—PLS, SVR, RFR, XGB, ANN, and TNR—were evaluated through repeated train-test partitioning alongside systematic hyperparameter tuning. Among these, XGBoost delivered the strongest results, both on average ($R^2 = 0.864$, $RMSE = 2.620$, $\rho = 0.929$) and under optimal conditions ($R^2 = 0.885$, $RMSE = 2.374$, $\rho = 0.941$). Based on this performance, XGBoost was adopted to produce daily soil moisture maps at 1 km resolution, which were subsequently converted into the Empirical Standardized Soil Moisture Index (ESSMI). Applying this framework revealed two distinct drought signatures: a chronic, sustained moisture shortfall in Jeollanam-do versus a fast-onset, fast-recovering pattern in Gangneung driven by short-term rainfall fluctuations. Together, these findings confirm that MODIS-based ESSMI can effectively differentiate between varying drought behaviors while enabling continuous spatial monitoring of agricultural drought conditions.

Acknowledgements: This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through Intelligent Agricultural Infra Management for Climate Change Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (RS-2025-02263147) and a grant (2022-MOIS63-001) of Cooperative Research Method and Safety Management Technology in National Disaster funded by Ministry of Interior and Safety (MOIS, Korea).

Keywords: MODIS, Soil moisture, Agricultural drought, Satellite, Empirical Standardized Soil Moisture Index (ESSMI)



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SS3-B-1

Rainfall-event responses in a headwater riparian zone: implications for water and ecosystem protection

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ABSTRACT

The conservation of riparian zones is widely recognized as a nature-based solution for the protection of aquatic environments. In headwater catchments, the water-regulating role of riparian zones is closely related to groundwater-surface water interaction along the hillslope-riparian-stream continuum. While this interaction is often controlled by the characteristics of local topography, projected scenarios of increasing climate variability suggest that extended dry periods may lead to a reduction of groundwater levels, affecting the capacity of riparian zones to regulate water and support aquatic ecosystems. Therefore, a better understanding of spatial and temporal controls on riparian hydrological function is essential for improving conservation and management strategies. As such, our objectives were to assess how rainfall events influence shallow riparian groundwater activation and stream temperature dynamics across seasons, and to examine how these responses may be conditioned by topographic controls. The study was conducted in a 30-ha forested headwater catchment located in Niigata prefecture, central Japan. Analyzed data included rainfall, stream and groundwater levels and water temperature at 10-minute intervals from June 2025 to May 2026, and topographic metrics calculated using a high-resolution DEM. Preliminary observations indicate that rainfall events produce seasonally contrasting stream and groundwater responses, with some events showing rapid thermal change and others showing delayed responses. The influence of local topography was also reflected in groundwater observations, as some wells showed intermittent water-level records, while others maintained continuous saturation throughout the monitoring period. Altogether, these results indicate how riparian hydrological function varies depending on season, antecedent moisture conditions and local topography.

Keywords: riparian zones, headwater catchments, groundwater-surface water interaction, rainfall-event response



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SS3-B-2

Long-Term Research Trends in Agricultural Nonpoint Source Pollution and Implications for Best Management Practices in the Han River Basin

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ABSTRACT

Agricultural nonpoint source pollution remains a major water quality management challenge in monsoon-dominated watersheds. However, few studies have examined the long-term connections among policy changes, research trends, and field-level management. This study analyzed the evolution of agricultural nonpoint source pollution research and future directions for best management practices (BMPs) in the Han River Basin, South Korea. We reviewed 70 reports from the Han River Basin Environmental Basic Survey (HanEBS) and 65 articles indexed in the Korea Citation Index (KCI) and compiled 89 BMP application cases. The literature was classified by period and research topic, while the BMP cases were grouped into five categories based on their primary mitigation mechanisms. Pollutant reduction efficiencies and the completeness of reported metadata were then evaluated. Research initially focused on monitoring and field surveys, subsequently shifted toward modeling and BMP evaluation, and more recently expanded to policy, climate change, and carbon-related topics. Mean pollutant reduction efficiencies were 82.7% for slope stabilization, 75.6% for agricultural practices, 67.4% for vegetative practices, 49.3% for sedimentation practices, and 43.3% for channel-based practices. However, only approximately 42% of the cases sufficiently reported key site metadata, limiting performance comparisons across conditions and broader application. These findings highlight the need to standardize BMP site and performance data and develop condition-specific watershed management frameworks integrating water quality, land management, and carbon dynamics.

Acknowledgements: This research was supported by the “Operation of Research Network and Establishment of the Master Plan for the Environmental Baseline Survey in the Han River Basin” (Project No.202600700001), funded by the Han River Basin Environmental Office, Ministry of Environment, Republic of Korea, and by the “Development of Adaptation Technologies and Vulnerability Assessment of Agricultural Runoff and Irrigation Water Quality under Changing Climate and Cropping Systems” (Project No. 00396736), funded by the National Institute of Agricultural Sciences, Rural Development Administration, Republic of Korea.

Keywords: Agricultural nonpoint source pollution, Best management practices, Han River Basin, Research trends, Pollutant reduction efficiency



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SS3-B-3

Evaluating Climate Change Impacts on BMP Reduction Efficiencies for Total Nitrogen Runoff Loads in Paddy Fields Using the APEX-Paddy Model

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ABSTRACT

Nutrient runoff from agricultural land is a major cause of water quality degradation and eutrophication. Nitrogen is highly soluble and can therefore be readily transported to receiving water bodies through runoff and drainage. Paddy fields account for approximately half of the agricultural land in Korea and undergo repeated ponding, irrigation, and drainage according to crop growth stages. These hydrological operations can result in concentrated nitrogen losses during rainfall events or managed drainage. Best management practices (BMPs), including drainage outlet management and improved fertilizer application, have therefore been implemented to reduce nitrogen losses from paddy fields. However, climate changes in rainfall amount and intensity may alter ponding conditions and runoff generation, thereby affecting the effectiveness of BMPs. This study evaluated changes in total nitrogen (T-N) runoff loads and the effectiveness of BMPs under future climate conditions using the APEX-Paddy model, which explicitly represents paddy hydrology and agricultural management operations. The model was configured using field-monitoring data collected from an experimental paddy field in Iksan, Republic of Korea, from May to September 2013 and was calibrated using observed monthly cumulative runoff and T-N runoff loads. The calibrated model was applied to BMP scenarios involving drainage outlet raising (DOR), fertilizer reduction (FR), slow-release fertilizer (SRF), and deep placement (DP). Shared Socioeconomic Pathway (SSP) climate change scenarios were subsequently incorporated into each BMP scenario to quantify future changes in T-N runoff loads and BMP effectiveness relative to conventional practices. This study provides a modeling framework for identifying BMPs that remain effective under changing climate conditions and supports the development of climate-resilient water and nutrient management strategies for paddy fields.

Acknowledgements: This study was conducted by National Academy of Agricultural Sciences under the project titled 'Development of impact, vulnerability assessment and adaptation technology for agricultural nutrient runoff, water quality under changes in climate and cropping system' (00396736) funded by the Rural Development Administration.

Keywords: APEX-Paddy model, Climate change, Paddy field, Nutrient runoff, Best management practices



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SS3-B-4

Microclimate Effects of Farmland and Ponds under Present Conditions and Land-Use Scenarios: An ENVI-met Simulation Study in Taoyuan, Taiwan

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ABSTRACT

Urbanization has rapidly transformed agricultural landscapes, while farmland and ponds play a vital role in regulating the local microclimate, particularly in regions experiencing increasing heat stress under global warming. In this study, the model of ENVI-met (a 3D microclimate model) was used to simulate the microclimate in the summer of a paddy field and pond in Taiwan under current conditions and other land-use scenarios (dry soil and concrete) to evaluate the microclimate change regarding key parameters such as air temperature at 2 m. The results showed that paddy field play a vital role in mitigating local heat through evapotranspiration and heat storage capacity. The comparison among these scenarios also illustrates that when the pond and rice paddy are replaced by dry soil/concrete/urban area, the average temperature could be increased by 2.3 - 2.6°C during the daytime. Even at noon, the temperature reaches a maximum exceeding 4°C in all scenarios. Moreover, from cooling range analysis, at 200 m downwind from the pond edge, the cooling intensity had decreased by approximately 73 - 94%; and on concrete surfaces, the cooling effect diminishes faster compared to dry soil. In addition, when the pond length was greater than about 200 m, there were no significant increases in the cooling benefits, indicating that the propagation of the cooling effect approached saturation. These findings contribute to the understanding of the role of rice paddies and ponds in regulating microclimate. Meaningful for sustainable land-use planning, where ponds and paddy fields serve as nature-based solutions.

Keywords: ENVI-met, Microclimate, Thermal comfort, Paddy fields and ponds, Nature-based solution



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SS3-B-5

Analysis of BMPs effects by major crop type in Korean upland fields using the APEX model

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ABSTRACT

Nutrient loss from agricultural land is a major nonpoint-source pollutant that degrades aquatic ecosystems. Reducing it through Best Management Practices (BMPs) is essential for sustainable agriculture. However, the reduction effects of BMPs can vary with cultivation methods and vegetation structures that differ by crop type. Although upland fields in Korea and other East Asian countries cultivate a wide variety of crop types, the effectiveness of BMPs has not been sufficiently evaluated by crop type. Accordingly, this study constructed and calibrated the APEX model for the major crop types grown in Korean upland fields, and evaluated both the nutrient loss characteristics of each crop type and the nutrient loss reduction effects of BMPs. The target crops were those with the largest cultivation area within each category of cereal crops, legumes, tuber crops, vegetables, and industrial crops. Input and calibration data for the crop-specific APEX models were collected from previous studies for corn (cereal crops), soybean (legumes), sweet potato (tuber crops), kimchi cabbage (vegetables), and perilla (industrial crops) fields. Although calibrated using only previously reported data, the models performed satisfactorily or better for both total nitrogen (TN) and total phosphorus (TP) across crop types. Using the calibrated models, TN and TP loss characteristics were analyzed by crop type, and BMP scenarios including filter strips, nutrient input reduction, and no-tillage were applied to evaluate reduction effects for each crop type. The results of this study are expected to serve as fundamental data for managing agricultural nonpoint-source pollution in Korea.

Acknowledgements: “Development of Adaptation Technologies and Vulnerability Assessment of Agricultural Runoff and Irrigation Water Quality under Changing Climate and Cropping Systems” (Project No. 00396736), funded by the National Institute of Agricultural Sciences, Rural Development Administration, Republic of Korea.

Keywords: APEX model, Best management practices, Crop type, Total nitrogen, Total phosphorus



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SS3-B-6

Integrating Root Reinforcement into Shallow Landslide Susceptibility Assessment for Nature-Based Management of High-Mountain Agricultural Slopes

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ABSTRACT

High-mountain agricultural slopes in Taiwan are frequently affected by shallow landslides due to steep terrain, intense rainfall, and land-use disturbance. Existing landslide susceptibility assessments generally represent vegetation conditions using land-use data or the Normalized Difference Vegetation Index (NDVI), but do not directly quantify the mechanical contribution of plant roots to slope stability. This study focuses on high-mountain agricultural slopes in Siji and Nanshan Villages, Datong Township, Yilan County, Taiwan, and develops a landslide susceptibility assessment framework integrating statistical analysis with physical mechanisms to support nature-based solutions for slope management.

The Frequency Ratio (FR) method is applied to integrate ten topographic, geological, hydrological, and land-use factors, calculate a shallow landslide susceptibility index, and produce classified susceptibility maps for identifying high-susceptibility areas. Field single-root pullout tests and root area ratio surveys are also conducted to estimate equivalent root cohesion and quantify the reinforcement effects of different vegetation types. These effects are subsequently incorporated into the original landslide susceptibility index to produce vegetation-adjusted susceptibility maps for slope-risk management.

The study will further include scenario simulations of vegetation management and slope conservation measures to quantify the effects of different vegetation configurations on slope stability. The expected outcomes will incorporate the mechanical contribution of vegetation into regional-scale landslide susceptibility assessment, strengthen the connection between modeling results and practical management actions, and provide decision support for agricultural management, slope conservation, and sustainable land use.

Keywords: Shallow landslide, Landslide susceptibility, Root reinforcement, Nature-based solutions, High-mountain agricultural slopes



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SS4-A-1

Linking Multiscale Drought Indices to Observed Agricultural Drought Impacts through Lead–Lag Analysis

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ABSTRACT

Agricultural drought impacts often emerge after meteorological drought signals, with response times varying by agricultural system and impact type. Quantifying these relationships is essential for improving impact-based drought monitoring and early warning. This study links multiscale drought indices to agricultural impacts through lead–lag analysis in three agricultural regions of South Korea (Seosan-si, Imsil-gun, and Goheung-gun). The Standardized Precipitation Index (SPI) was calculated at accumulation periods of 1, 2, 3, 6, 9, 12, 24, and 36 months and compared with six impact indicators: paddy and upland drought forecasting and warning, paddy drought-affected area, upland crop wilting area, agricultural water supply volume, and the Soil Water Deficit Index (SWDI). Correlation and lead–lag analyses within a ± 6 -month window identified the accumulation period and response time best explaining each indicator. The results revealed distinct system responses. Paddy-related impacts were more strongly associated with longer-term drought conditions, whereas upland crop and soil moisture indicators responded primarily to shorter accumulation periods. Meteorological drought signals generally preceded observed impacts, although the magnitude and timing of the lead varied by indicator and region. These findings demonstrate that drought timescale and temporal lag should be considered when linking meteorological drought indices to agricultural impacts. The framework supports impact-based drought monitoring, selection of appropriate indices and accumulation periods, and improved lead time for agricultural drought early warning.

Acknowledgements: This work was supported by Korea Environment Industry & Technology Institute (KEITI) through Climate Resilient R&D Project for Water-Related Disaster Management, funded by Korea Ministry of Climate, Energy and Environment (MCEE) (RS-2023-00230286).

Keywords: Agricultural drought, Multiscale drought indices, Observed drought impacts, Lead–lag analysis, Drought early warning



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SS4-A-2

Characterizing the Life Cycle of Drought Clusters Using a Three-Dimensional Connected Component Approach in North Korea

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ABSTRACT

Drought is a slowly evolving hazard that progresses through distinct stages, from emergence and expansion to peak intensity and termination. Understanding this life cycle is essential for improving drought monitoring, early warning, and risk management, particularly in data-scarce regions such as North Korea. This study characterizes the life cycle of drought clusters in North Korea using a Three-Dimensional Connected Component (3DCC) approach. Monthly precipitation from Climate Hazards Group InfraRed Precipitation with Station Data Version 3.0 (CHIRPS v3.0) and temperature from Climate Hazards Center InfraRed Temperature with Stations–ERA5 (CHIRTS-ERA5) were used to estimate climatic water balance and calculate the Standardized Precipitation Evapotranspiration Index (SPEI). Drought occurrence, spatial extent, duration, severity, and intensity were evaluated based on SPEI. The 3DCC algorithm was then applied to identify spatiotemporally connected drought clusters and reconstruct their life cycles by tracking initiation, development, expansion, peak, contraction, and termination. The framework reveals how individual drought events evolve in space and time under the combined effects of precipitation deficits and increased atmospheric evaporative demand, providing information beyond conventional grid-based assessments. By explicitly characterizing drought-cluster life cycles, this study offers new insights into drought dynamics and regional vulnerability in North Korea while providing a practical framework for spatiotemporal drought monitoring in data-limited regions.

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Keywords: Drought clusters, Drought life cycle, SPEI, Three-dimensional connected component (3DCC), Spatiotemporal analysis



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SS4-A-3

Linking Satellite-Derived Agricultural Drought to Paddy Rice Yield Loss across South Korea

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ABSTRACT

Agricultural drought can substantially affect crop production depending on drought intensity and persistence during the growing season. This study examined agricultural drought impacts on paddy rice production across South Korea by combining satellite-derived drought conditions with municipal rice yield records. MODIS evapotranspiration, potential evapotranspiration, and Normalized Difference Vegetation Index (NDVI) products were integrated to derive the Drought Severity Index (DSI) for Farm Map-based paddy areas within each municipality. Long-term conditions during 2001–2020 provided the reference for evaluating drought impacts during 2021–2023. Growing-season DSI observations from April to September were summarized according to drought intensity and persistence, allowing drought events to be grouped by severity–duration characteristics. Municipal rice yield records were converted into yield anomaly (YA) loss rates and compared across these drought groups. High-intensity mid-term drought showed the highest occurrence rate of YA loss cases (83.52%). Spatial comparisons further revealed regional differences in rice yield responses under comparable drought conditions. At the national scale, mean YA loss rate, the number of affected municipalities, and affected paddy area increased from 2021 to 2023. These results indicate that combining satellite-derived drought characteristics with crop yield information can support impact-oriented assessment of agricultural drought in paddy fields.

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Keywords: Agricultural drought, MODIS, Drought Severity Index (DSI), Paddy field, Rice yield loss



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SS4-A-4

Can Pareto-Optimal Ensemble Weighting Improve Compound Drought–Heatwave Projections? Evidence from NSGA-II

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ABSTRACT

Compound drought–heatwave (CDHW) events are governed by both the marginal behavior of drought and heat and their statistical dependence. However, CMIP6 multi-model ensembles (MMEs) are typically weighted solely by marginal performance, whereas more flexible weighting strategies may overfit the historical data used for calibration. We evaluate the Non-dominated Sorting Genetic Algorithm II (NSGA-II) as a Pareto-optimal ensemble-weighting framework for CDHW projection over South Korea using bias-corrected daily precipitation and maximum temperature from 24 CMIP6 GCMs and observations from 60 Korea Meteorological Administration (KMA-ASOS) stations during 1975–2014. Model performance is assessed across four compound-event dimensions: marginal fidelity, dependence structure (Kendall’s τ , tail dependence, and LMF), compound-event characteristics, and temporal behavior. NSGA-II optimizes a four-parameter linear weighting function against five simultaneous objectives (mixture CRPS, τ bias, LMF log-ratio, severity distance, and ensemble entropy) and selects the preferred solution from the Pareto front using TOPSIS. Performance is benchmarked against equal weighting, transparent MCDM (entropy/CRITIC–TOPSIS), Bayesian model averaging, and a multilayer perceptron (MLP)-based weighting model. NSGA-II achieved the largest improvement in calibration performance among the transparent methods, reducing compound loss from 3.700 for equal weighting to 2.615. A complementary perfect-model (leave-one-model-out) experiment show modest improvements in projected CDHW duration and joint 20-year return-level changes but no consistent improvement in event frequency. The results suggest that transparent, lower-dimensional weighting strategies provide more robust generalization, while multi-objective evolutionary optimization is better suited as a diagnostic benchmark than as a default framework for operational MME construction.

Acknowledgements: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government Ministry of Science and Information and Communication Technology (MSIT) (RS-2025-00562379).

Keywords: Compound heatwave-drought events, Multi-model ensemble, NSGA-II, CMIP6



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SS4-A-5

Cascading Drought Pathways and Adaptation Leverage Points in Agricultural Water Systems

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ABSTRACT

Drought impacts on agriculture are usually assessed through direct effects on water availability, irrigation, and crop production. However, agricultural water systems are embedded in coupled hydrological, infrastructural, ecological, and socioeconomic systems through which drought disturbances can propagate, interact, and compound. This study develops a pathway-oriented approach that translates systemic drought risk into adaptation priorities for agricultural water management. The analysis extracts hazard interactions and adaptation measures from the agricultural water components of Taiwan's local climate change adaptation implementation plans. The resulting network represents drought risk as recognized in adaptation planning, allowing structural influence and adaptation coverage to be compared within a common policy evidence base. Drought-centered pathways are reconstructed from this directed hazard interaction network and interpreted according to their functions in water supply, irrigation, crop production, infrastructure, and downstream socioeconomic systems. Transmission points are then ranked by their structural positions within cascading pathways rather than by hazard severity alone, identifying influential nodes and pathway segments as potential adaptation leverage points. Available adaptation measures are mapped onto these nodes and segments to assess where interventions could reduce, interrupt, or redirect risk propagation and where critical transmission points remain insufficiently addressed. By linking network structure with adaptation functions, the approach converts interconnected drought risks into an ordered set of intervention opportunities and provides a systematic basis for prioritizing measures capable of disrupting cascading impacts and strengthening agricultural water resilience.

Keywords: drought, systemic climate risk, cascading pathways, water management, climate adaptation, multi-hazard network analysis



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Monitoring Spatiotemporal Changes of Hilly Agricultural Landscape Using Remote Sensing-Based Ecological Index (RSEI) in Mihama Town, Japan

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ABSTRACT

Assessing the ecological environmental quality (EEQ) is crucial for protecting the environment. Rapid land use transformation driven by hilly development and agricultural intensification poses significant threats to eco-environmental quality in rural hilly areas. This study assessed the spatiotemporal dynamics of ecological quality in Mihama Town, Mie Prefecture, Japan, over 40 years (1985–2025) using the Remote Sensing-based Ecological Index (RSEI). Landsat time-series imagery 5 for 1985, 1995, and 2005 and Landsat 8 for 2015 and 2025 were employed to extract the Normalized Difference Vegetation Index (NDVI), Wetness (WET), Land Surface Temperature (LST), and the Normalized Difference Built-up and Soil Index (NDBSI) using Google Earth Engine (GEE), which were assessed through principal component analysis (PCA) to construct the composite RSEI in Python-3. The spatial autocorrelation was assessed by Global Moran's I and local Moran's I (LISA). The results revealed a declining trend in overall ecological quality, with RSEI values decreasing from 0.855 in 1985 to 0.818 in 2025. The area under very low ecological conditions expanded from 5.95 km² in 1985 to over 7.86 km² in 2025. Change-detection analysis showed environmental degradation in 29% of the area from 1985 to 2025, worsened primarily by rural land-use change. NDVI was the most influential positive factor, and Moran's I value (>0.90 , $p=0.001$) indicated strong spatial clustering of degradation around citrus farmland. These findings provide a remote sensing-based empirical foundation and offer valuable insights to help policymakers address environmental issues and improve future ecological management in hilly rural municipalities of Japan.

Keywords: RSEI, NDVI, NDBSI, LST, WET, Moran's I



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SS4-B-2

Evaluation of Dam Adaptability to Extreme Rainfall Events in Kyoto Prefecture under Climate Change

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ABSTRACT

Traditional hydrological frequency analysis assumes extreme rainfall series are independent and stationary. However, under global warming and given that atmospheric moisture-holding capacity increases at approximately 7%/°C following the Clausius–Clapeyron (CC) relationship, applying stationary models to estimate high-return-period design rainfall may systematically underestimate precipitation, affecting flood-control and reservoir designs still based on stationarity.

This study analyzes annual maximum daily rainfall (AMS) at 15 AMeDAS stations in Kyoto Prefecture over 42 to 67 years, and constructs both stationary and non-stationary models using temperature as a physically meaningful covariate. A daily-scale diagnostic at Kyoto station shows extreme wet-day precipitation increasing with concurrent daily temperature at approximately 7.6%/°C, consistent with CC theory and supporting this covariate choice.

Mann–Kendall trend analysis with Hamed–Rao correction for temperature shows that annual and summer mean temperatures rise significantly at all stations (0.3–0.5°C per decade), whereas AMS trends are generally non-significant, reflecting how high interannual variability masks long-term signals. Non-stationary GEV models were then restricted to the 8 stations with their own temperature observations, avoiding interpolation errors. Four models were compared using Akaike Information Criterion, likelihood ratio tests, and Probability Integral Transform-based Kolmogorov–Smirnov diagnostics.

The stationary model remains optimal for most stations, with only two stations showing non-stationary signals, while annual mean temperature outperforms summer temperature. Return-level estimates under warming scenarios indicate that some stations are sensitive to temperature increases. However, projections for $\Delta T \geq +2^\circ\text{C}$ extend beyond the observed covariate range and should therefore be interpreted only as sensitivity analyses rather than future predictions.

Keywords: Non-stationary GEV, Extreme rainfall frequency analysis, Design rainfall, Climate change adaptation, Kyoto Prefecture



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GS-A-1

ArcGIS-Based Identification of Rainwater Harvesting System Sites for Communal Irrigation for Rice Farmers in Tabuk City, Kalinga

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ABSTRACT

Fresh water from natural resources serves as a valuable source for irrigation, helping to meet the water demands of people. Given the region's diverse topography and rainfall patterns, it is considered necessary to develop a rainwater harvesting system. This research employs spatial modeling and multi-criteria analysis using the ArcGIS tool to evaluate various factors such as rainfall data, slope, stream order, drainage density, land uses/land cover, soil type, and distance to roads. The main goal of the research is to identify suitable sites for a rainwater harvesting system. The criteria were classified according to their suitability. The results show that 23.26% of the study area is classified as very high suitability, followed by 20.83%, 17.13%, 15.34%, and 14.38% as medium suitability, low suitability, high suitability, unsuitable, and others, respectively. The findings of the research can be a useful tool for concerned authorities and other agencies in identifying areas prone to flooding or erosion, guiding farmers to refrain cultivation in such vulnerable zones and implementing farm management strategies as well. Maps can highlight the soil properties, which farmers can use to identify crops best suited for specific fields. The rainfall condition of the study area can also be a basis for applying irrigation according to the water requirements of the crops to be planted, thereby preventing water waste and sedimentation.

Keywords: ArcGIS, Rainwater harvesting system, Spatial modeling, Suitability map



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GS-A-2

Comparison of Two Spatial Precipitation Datasets over Japan: CHIRPS and JMA Radar/Rain-gauge Analyzed Precipitation

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ABSTRACT

Precipitation data are essential for understanding hydrology and the water cycle, agricultural water resources and their management, and water-related disasters such as floods and droughts. Under changing climate conditions, the demand for precipitation information with detailed spatial distribution continues to grow. In this study, two spatial precipitation datasets are compared over Japan to investigate their characteristics and applicability: the Climate Hazards Center InfraRed Precipitation with Station data (CHIRPS), developed by the University of California, Santa Barbara (UCSB) and the U.S. Geological Survey (USGS), and the Radar/Rain-gauge Analyzed Precipitation produced by the Japan Meteorological Agency (JMA-R/A). Both datasets adopt a widely used approach that integrates remote sensing with ground-based rain-gauge observations. CHIRPS combines thermal infrared satellite observations with rain-gauge data and provides precipitation estimates at a spatial resolution of 0.05 degrees (approximately 5 km). JMA-R/A merges ground-based radar observations with rain-gauge measurements and provides precipitation at resolutions of 1 km or finer. Although both products aim to represent spatial precipitation accurately, their underlying sensors, calibration procedures, and target regions differ substantially, which may lead to differences in performance depending on the application. In this study, we evaluate the spatial coverage and relative agreement of the two datasets using fifteen years of monthly data from 2011 to 2025 over Japan. The results are expected to clarify the strengths and limitations of each dataset and to provide guidance for their use in hydrological, agricultural, and disaster-related applications.

Keywords: Precipitation datasets, CHIRPS, Radar/Rain-gauge Analyzed Precipitation, Japan



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GS-A-3

Agricultural Adaptation Practices Supporting Flood Resilience in Dhubri District, Assam, India

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ABSTRACT

Floodplain agriculture is often regarded as highly vulnerable to recurrent flooding, yet farming communities along the Brahmaputra River have sustained agricultural production despite frequent flood disturbances. Understanding how these agricultural systems persist is essential for developing sustainable adaptation strategies in flood-prone regions. Guided by a socio-hydrological perspective, this study investigates flood-adapted farming systems through household surveys conducted in three villages of Dhubri district, Assam, India. Information on cropping practices, livelihood dependence, flood experience and household adaptation measures was analyzed using composite indices of exposure, sensitivity, adaptive capacity and vulnerability. The results show that, despite high flood exposure, agricultural production is sustained through seasonal adjustment of cropping calendars, adoption of short-duration and flood-tolerant crop varieties, raised cultivation techniques and livelihood diversification. The widespread adoption of these practices among households with repeated flood experience indicates the development of practical knowledge and adaptive strategies for managing recurrent floods. These findings demonstrate that floodplain agriculture functions as an adaptive socio-agricultural system and provide field-based evidence to support agricultural adaptation strategies that build upon existing local knowledge in dynamic riverine environments.

Keywords: agricultural adaptation, flood resilience, socio-environmental, long-term learning, field-based evidence



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GS-A-4

Analysis of Water Control of Paddy Field Rill Irrigation and water efficient in Southern Taiwan

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ABSTRACT

In Taiwan, water conservation is aided by alternated wet and dry irrigation, with rill irrigation being another important water-saving method. This subject is to compare the rill and flooding rice field irrigation methods, conduct a model analysis for the two methods.

The site is located in Agriculture Irrigation Experiment Station of the Taiwan Chia-Nan Irrigation Association. The experiments carry out with different trials for five years from 2015 to 2019. The testing for this subject is divided into two separate lysimeter and field sites. The Rice cultivation on both sites adheres to the System of Rice Intensification (SRI), with seedlings planted at a 30 cm×30 cm density over three ditched and un-ditched experiments. On the field test site with clearly distinguished rill irrigation and flooding irrigation, on the other hand, traditional irrigation methods were used.

Based on the established rill irrigation model, the simulated water efficiency is 0.40 kg/m³, while the actual average water efficiency is 0.41 kg/m³. On the simulated flooding irrigation test site, water efficiency measures at 0.32 kg/m³, while the actual average water efficiency is 0.33 kg/m³. The findings illustrate that rill irrigation achieves higher water efficiency.

The sampling of the rill irrigation treatment at the lysimeter test site is divided into the spring rice crop and the summer rice crop. Compared with the higher water efficiency of 0.60 kg/m³ for the rill irrigation spring rice crop, the summer rice crop measures at a water efficiency of only 0.35 kg/m³, and the rill irrigation model is reliable.

Keywords: System of Rice Intensification (SRI), Rill irrigation



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GS-A-5

How Extreme Weather Altered Farmers' Irrigation Behavior: A Case Study of the 2023 Hot and Dry Summer in Niigata Prefecture, Japan

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ABSTRACT

During the summer of 2023, record-breaking heat and exceptionally low precipitation occurred in Niigata Prefecture, one of Japan's largest rice-producing regions. In response, managers of irrigation district reportedly implemented emergency measures, including temporary extensions of water-withdrawal periods and additional withdrawals. Estimating agricultural water demand under such extreme weather conditions is essential for sustainable rice production and water management in the context of climate change. This study investigated how the extreme weather increased irrigation withdrawals and explored the climatic factors that provoked the increase. To address this objective, we used daily irrigation withdrawal records and meteorological data from 2019–2023 in a 3,240-ha paddy irrigation district in Niigata Prefecture. Water demand was estimated from paddy water loss (evapotranspiration and percolation), puddling water requirements, and precipitation during irrigation demand periods derived from satellite imagery and a rice phenology model. The estimated demand was then aggregated to the district scale and compared with observed irrigation withdrawals. The observed withdrawals were calculated as the sum of daily withdrawals from the district's three major intake facilities. The comparison revealed that, in August 2023, the observed withdrawals exceeded the estimated demand on 23 days, far more often than during 2019–2022. Our analysis suggests that low summer precipitation and prolonged dry spells may be important climatic factors associated with excess irrigation withdrawals. Because irrigation withdrawals are determined by irrigation managers in response to farmers' requests, these findings imply that farmers increased their irrigation water use under extreme weather conditions.

Keywords: agricultural water demand, water shortage, climate change, rice phenology model, satellite imagery



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GS-A-6

Assessment of Agricultural Drought Impacts on Pepper Using Soil Available Water Content and NDVI-Based Monitoring

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ABSTRACT

Climate change has altered precipitation patterns, increasing the frequency and severity of agricultural droughts. Agricultural drought reduces soil moisture availability, limiting crop growth and causing yield losses. The objective of this study is to quantify the effects of drought severity based on soil water content (SWC) on pepper and sweet potato yields and to evaluate crop growth characteristics using the Normalized Difference Vegetation Index (NDVI) as an indicator of drought-induced yield reduction. The experiment was conducted in a rain-shelter greenhouse under controlled soil moisture conditions, where crops were subjected to different irrigation treatments representing various drought levels. Soil moisture and greenhouse environmental conditions were continuously monitored, and crop growth characteristics and multispectral images were collected throughout the growing season. The collected data are being used to evaluate the effects of different SWC conditions on crop growth responses and yield formation in pepper and sweet potato. Crop growth characteristics, biomass, and NDVI are continuously monitored throughout the growing season to investigate their relationships with soil moisture stress and to identify potential indicators for early assessment of drought impacts. It is expected that reduced SWC will negatively affect crop growth and yield formation, while changes in NDVI may provide additional information for detecting drought-induced crop stress during the growing season. The findings of this study are expected to contribute to the development of quantitative drought assessment approaches and support more efficient irrigation management strategies under changing climate conditions.

Keywords: Agricultural drought, NDVI, SWC, Pepper



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GS-B-1

Hydraulic Insights into the Design Philosophy of Historical Oblique Weirs through PIV-Based Analysis of Horizontal Turbulent Structures

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ABSTRACT

Oblique weirs were widely adopted in western Japan during the Edo period as traditional diversion structures because of their excellent water intake and flood conveyance functions. Their hydraulic advantages have long been recognized through empirical practice; however, the turbulent structures and scour mechanisms underlying their design philosophy remain insufficiently understood. This study aims to elucidate the hydraulic mechanisms underlying the empirical design philosophy of historical oblique weirs through a PIV-based analysis of horizontal turbulent flow structures downstream of the weir. Experiments were conducted under steady overflow conditions with weir angles of 45°, 60°, and 90°. The measured horizontal velocity fields were analyzed in terms of mean velocity, turbulence intensity, Reynolds stress, and vorticity. The results showed that the downstream flow consists of three characteristic components: the overflow current, the reflected current, and the compensation current. Their interactions generated distinct turbulent structures depending on the weir angle. Larger weir angles increased unit discharge and Reynolds stress near the riverbank, whereas smaller angles produced extensive recirculation and stagnation zones downstream of the weir. These findings demonstrate that the hydraulic impacts of oblique weirs on downstream riverbanks are strongly governed by angle-dependent turbulent structures and momentum transport. The present study provides a hydraulic basis for interpreting the empirical design philosophy of historical oblique weirs through analyses of turbulent structures and momentum transport.

Keywords: Oblique weir, Particle image velocimetry (PIV), Turbulent flow structure, Local scour, Hydraulic heritage



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GS-B-2

Evaluation of hydrological responses to long-term land use changes using SWAT

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ABSTRACT

This study aims to evaluate the hydrological responses to long-term land use (LU) changes from the 1970s to the 2010s in the upstream watershed of the Yeongsan River (714.8 km²), South Korea, using the Soil and Water Assessment Tool (SWAT). To accurately isolate the impact of LU change within a consistent spatial framework, a single overlaid land cover map was constructed by spatially intersecting the 1970s and 2010s land use datasets. A land use transition matrix was then applied to systematically quantify the spatial pathways and magnitudes of LU conversions such as the transformation of agricultural and forested lands into urban areas over the five-decade period. Based on this composite mapping approach, a One-At-a-Time (OAT) scenario was configured in which only LU conditions were substituted between the 1970s and 2010s, while all other environmental factors were held constant under fixed contemporary meteorological forcing (2011-2020), enabling attribution of hydrological changes to LU transitioned alone. Over the study period, urban and residential areas expanded approximately 8-fold, from 1.9% (13.5 km²) in the 1970s to 15.6% (111.7 km²) in the 2010s, primarily driven by the growth of Gwangju Metropolitan City, while agricultural area declined from 37.5% to 30.3%. The SWAT was calibrated at two streamflow monitoring stations within the basin, with R² ranging from 0.65 to 0.70 and NSE ranging from 0.63 to 0.65, confirming satisfactory model performance. The SWAT simulation revealed a consistent decrease in streamflow across all flow regimes under the 2010s LU scenario. The magnitude of flow reduction intensified progressively toward lower flow conditions, decreasing by 1.33% at Q95, 2.34% Q185, 3.36% at Q275, and reaching a maximum reduction of 4.23% at Q355 compared to the 1970s baseline.

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Keywords: Land use changes, SWAT, Overlaid land cover map, Transition matrix, Flow regime



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GS-B-3

Geopolymeric Flowable Fill for Backfilling

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ABSTRACT

Flowable fill has been widely used as a backfilling and bedding material around irrigation pipelines and underground utilities. This study investigates the efficacy of agricultural waste products, rice husk ash, on the flow, thermal, and strength characteristics of geopolymer-based flowable fill. Geopolymer cementation is governed by the reaction between alkaline solutions and aluminosilicate precursor. The alkaline solution is prepared with sodium silicate-hydroxide at 9:1, while the precursor is prepared with blended fly ash-slag at 3:7. The blended fly ash-slag is substituted with various contents of rice husk ash, 3 to 10%. The flowability and strength characteristics of the geopolymeric flowable fill are examined using the flow and unconfined compression tests. The thermal characteristics of the flowable fill are monitored using the rapid thermal conductivity tests. The results show that the flow value of the geopolymeric flowable fill decreases with increasing rice husk ash due to a higher specific surface area. The compressive strength of specimens increases with curing period and varies with rice husk ash content. The specimens show the optimum compressive strength when 3% rice husk ash is incorporated in the geopolymeric flowable fill. The thermal conductivity of the specimens significantly decreases with curing periods. Specimens prepared with rice husk ash exhibit lower thermal conductivity than unmodified fly ash-slag geopolymeric flowable fill. The findings from this study suggest that agricultural waste, such as rice husk ash, can be used to enhance the strength and thermal characteristics of geopolymeric flowable fill.

Keywords: backfilling, compressive strength, flowable fill, geopolymer, rice husk ash



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GS-B-4

Electro-Assisted Recovery of Ionic Nutrients from Agricultural Waste Stream

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ABSTRACT

Sustainable management of water and nutrients is critical for enhancing agricultural resilience and mitigating the environmental impacts associated with intensive food production. Agricultural wastewater, livestock-derived effluents, and anaerobic digestate often contain elevated concentrations of dissolved nutrients that may contribute to eutrophication, groundwater contamination, and soil nutrient imbalance when inadequately managed. Conversely, these streams represent valuable nutrient resources that could partially replace conventional fertilizers. This study investigated electrified ion exchange (EIX) as a continuous electro-assisted platform for separating, concentrating, and recovering ionic nutrients from waste-derived waters. EIX combines ion-exchange adsorption, electrically driven ion transport, and in situ electro-regeneration, reducing the need for chemical regenerants. Various ion-exchange resin wafers were synthesized and evaluated in a single-cell system under different electrical and hydraulic operating conditions. Based on these results, a continuous multistage configuration was developed to improve treatment capacity and recovery concentration. Ammonium was selected as a representative nutrient because it is both a fertilizer resource and a major pollutant in agricultural wastewater and digestate. During continuous treatment of digestate containing approximately 5 g-N/L, the system achieved 60–75% ammonium removal. The recovered solution was concentrated to approximately 15–20 g-N/L, with a current efficiency of ~70% and a specific energy consumption of <15 kWh/kg-N. These findings indicate that EIX has potential as a flexible technology for agricultural water treatment, nutrient recovery, and digestate valorization. The approach could contribute to circular soil–water–nutrient management by recovering useful ionic resources while reducing nutrient discharge to the environment.

Keywords: Ammonia, Electrodialysis, Liquid digestate, Ion exchange, Resin regeneration



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GS-B-5

Field Monitoring Framework and Sediment Trapping Capacity in Traditional Taro Patches in Palau

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ABSTRACT

Small island developing states, including the Republic of Palau, are highly vulnerable to climate change, extreme rainfall events, and land degradation. Traditional taro patches on the Babeldaub Island not only work for food production but also as Nature-based Solutions (NbS) for land-ocean environmental conservation. While we identified that taro patches rely on direct spring and surface water inputs from small hinterland catchments, the local sediment balance and the physical sediment trapping efficiency of these systems remain unquantified. This study evaluates the sediment balance and hydrological trapping mechanics of taro patches. Continuous monitoring of water inflow and suspended sediment concentration was conducted in a taro patch system. Furthermore, sedimentation in the drainage was directly measured to assess a sediment balance for the system. This paper introduces the design and practical considerations of the field monitoring framework tailored for the specific conditions of taro patches, in terms of topography, water management, and cultivation. Preliminary observations on flow behaviors and sediment trapped during initial rainfall events are presented, highlighting methodological insights for establishing a reliable, long-term sediment balance assessment in Pacific island environments.

Keywords: sediment balance, field monitoring, taro patch, Palau



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GS-B-6

Pore-Scale Investigation of the Effects of Entrapped Bubbles on Dissolved Gas Transport: Implications for Greenhouse Gas Emissions from Paddy and Wetland Systems

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ABSTRACT

Entrapped air bubbles are ubiquitous beneath paddy fields, wetlands, and aquifers, where they both retard dissolved-gas transport and supply the gas phase for episodic ebullition. Aquatic ecosystems account for an estimated 41–53% of global methane emissions, and groundwater discharge may deliver up to 70% of surface-water CH₄ flux, yet pore-scale coupling between dissolved transport and entrapped gas remains poorly resolved. Classical retardation models assume local equilibrium and fixed trapped-gas volume, neglecting interfacial mass-transfer resistance and bubble volume change. We used microfluidic visualization and a coupled two-phase transport model to resolve how dissolved CO₂ migrates through entrapped air. Three geometries were examined: a straight capillary tube, a pore doublet, and a complex pore network, with bromothymol blue imaging the dissolved CO₂ field directly. Simulated and observed bubble growth in the capillary tube agreed closely under constant-concentration and no-flux boundaries. In the pore doublet, trapped bubbles were remobilized by exsolution-driven expansion rather than viscous forcing. In the complex micromodel, trapped-gas expansion enhances the mobility of both gas and residual liquid, and bubble growth in turn reshapes dissolved-gas breakthrough, showing a two-way coupling that paddy and wetland carbon models should incorporate.

Keywords: entrapped air, dissolved CO₂ transport, pore-scale micromodel, gas exsolution, paddy field



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GS-C-1

A Geospatial–IoT Integrated Framework for Real-Time Precision and Sustainable Agricultural Management

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ABSTRACT

Increasing climate variability and growing pressure on water resources have intensified the need for intelligent and efficient agricultural management practices. This study proposes an integrated geospatial and Internet of Things (IoT)-based framework for real-time monitoring and decision support aimed at promoting sustainable precision agriculture. A ten-year archive (2015–2024) of Sentinel-2 imagery was utilized to derive key vegetation and moisture indicators, including the Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI), and Soil Adjusted Vegetation Index (SAVI), along with land surface temperature, slope, and elevation parameters to characterize moisture stress patterns across agricultural landscapes. Based on these spatial analyses, representative sites in Roorkee, India, were selected for the deployment of IoT-enabled soil moisture sensors integrated with microcontroller-based communication systems. Continuous in-situ measurements were acquired at different times of the day and translated into actionable irrigation categories to support timely water management decisions. The developed system demonstrated a real-time alert accuracy of 97.24%, highlighting the effectiveness of combining satellite-derived information with ground observations. Areas located farther from major water sources exhibited relatively higher moisture stress, emphasizing the importance of spatially targeted irrigation practices. The proposed framework offers a scalable and cost-effective approach for enhancing water-use efficiency, improving crop productivity, and strengthening climate-resilient agricultural systems. Its integration of geospatial technologies and IoT provides a practical pathway toward sustainable agricultural resource management and smart farming applications.

Keywords: Geospatial, IoT, Vegetation indicators, Moisture stress, Sustainable agricultural resource



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GS-C-2

Climate Attribution and Threshold Analysis of Reservoir Irrigation Water Demand Using Explainable AI Under Future Climate Change for Data-Scarce Region

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ABSTRACT

Agricultural reservoirs support food supply and livelihoods worldwide, but climate change and human activity are reducing their productivity, particularly where data is limited. Existing studies typically consider reservoir inflow or demand as a single aggregate figure, rarely isolating which climatic factors drive that demand or the thresholds at which they start to matter. Artificial Intelligence remains underused for filling the resulting data gaps in data scarce regions. This study builds an AI-based framework for reservoir management in data-scarce Conditions. Random Forest, Light GBM, and XGBoost models predict irrigation water release from inflow, storage, and climate variables, including threshold effects for each climatic factor. Missing climate and storage records are filled using interpolation, then SHAP values are used to break down what actually drives demand variability from historical data(1973-2024). Dependence plots pinpoint where the response to climate factors stops being linear. Future demand is projected using CMIP6 data under SSP245 and SSP585 from (2025-2100). The study also presents a Reservoir Climate Vulnerability Index, combining exposure, demand sensitivity, and storage-based adaptive capacity into one interpretable score. The target of this study is to close existing data gaps and pin down how much water demand will rise, why, and past what threshold, as climate conditions shift. Agricultural Reservoir managers and decision makers can use these findings to anticipate future scenarios and decide whether to expand storage or adjust seasonal allocations. The findings can be extending to other data-scarce contexts, including reservoir-level storage planning and farm-level irrigation regulation.

Acknowledgements: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government Ministry of Science and Information and Communication Technology (MSIT) (RS-2025-00562379).

Keywords: Explainable-AI, Threshold detection, Reservoir irrigation demand, Reservoir climate vulnerability index (RCVI)



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GS-C-3

An AI-Driven Knowledge Retrieval and Decision Support Framework for Water Disaster Management Using Large Language Models and Advanced Retrieval-Augmented Generation

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ABSTRACT

Extreme weather events, including typhoons and torrential rainfall, have significantly increased the complexity of water disaster management and decision-making. Although the Water Resources Agency has accumulated extensive disaster reports, operation manuals, and monitoring records, most of these resources remain in unstructured formats, making information retrieval time-consuming and limiting their effective utilization for emergency response. This study proposes an AI-driven Water Disaster Knowledge Retrieval and Decision Support Framework that integrates Large Language Models (LLMs), Dual-Module Document Parsing, Metadata-enhanced indexing, and an Advanced Retrieval-Augmented Generation (RAG) architecture to transform heterogeneous disaster documents into an intelligent and searchable knowledge base. The proposed framework employs layout-aware document parsing, optical character recognition (OCR), semantic chunking, hybrid retrieval, and metadata filtering to preserve document structure, improve retrieval accuracy, and reduce hallucinations in AI-generated responses. Beyond knowledge retrieval, the framework further supports decision-making by integrating a typhoon similarity analysis module and a mobile pumping machine deployment tracking module, enabling rapid comparison of historical disaster events and efficient assessment of emergency resource allocation. In addition, the framework is designed with standardized APIs and the Model Context Protocol (MCP) to facilitate future interoperability and system expansion. The proposed platform demonstrates the potential of generative AI to enhance disaster knowledge management, improve information retrieval efficiency, and provide reliable decision support for climate-resilient water resources management.

Keywords: Generative AI, Multi-agent system, Large language model, Retrieval-augmented generation, Water disaster management, Decision support



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GS-C-4

Geospatial Modelling of Agricultural Inundation Under Climate Change in South Korea

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ABSTRACT

Agricultural inundation is increasing under climate change, but its spatial extent cannot be explained by rainfall alone. This study quantifies how extreme precipitation, topography, land use, and drainage conditions interact to shape agricultural inundation across South Korea. A geospatial modelling framework integrated historical inundation records (2002–2024), extreme precipitation indices (1984–2024), topographic variables, agricultural land-use data, and drainage factors. GIS-based spatial and statistical analyses identified key controls and hotspots. Results show that inundation is concentrated in low-elevation (<100 m) and low-slope (0–5°) floodplains, particularly riverine and coastal agricultural zones with limited drainage. Mountainous regions showed lower inundation extent despite high rainfall intensity, indicating that steep terrain promotes rapid runoff and reduces water accumulation. Paddy fields were the most affected land-use type, with approximately 360 km² inundated during 2002–2024, followed by upland fields (160 km²), greenhouses (90 km²), and orchards (20 km²). The largest annual inundation occurred in 2012 (130 km²), followed by 2006 (88 km²), 2020 (75 km²), 2019 (66 km²), and 2023 (57 km²). Extreme precipitation indices, including R95pTOT, R99pTOT, RX1day, RX5day, and SDII, showed increasing trends. Analysis of 30,726 records revealed a weak relationship between inundation depth and area ($\rho = -0.07$, $p < 0.001$), confirming that inundation extent is governed by interacting climatic, terrain, land-use, and drainage factors. The study provides a transferable, data-driven framework for prioritizing drainage improvement, flood-risk reduction, and climate-resilient agricultural planning, supporting adaptation and integrated resource management.

Keywords: Climate change, Agriculture inundation, Drainage condition, Flood plain, Extreme precipitation, Terrain



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GS-C-5

Deformation Detection of Drainage Wells by the Backscattering Coefficient of SAR

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ABSTRACT

Drainage wells lower the groundwater level and stabilize slopes. Damage of drainage well causes the loss of their water collection and drainage function. Rapid diagnosis of the functional condition is required after an earthquake. On-site inspections are dangerous due to the risk of secondary disasters. This study focuses on a non-contact detection method for the post-earthquake functional condition of drainage wells using synthetic aperture radar (SAR). Nine drainage wells in landslide areas affected by the 2024 Noto Peninsula Earthquake, including one drainage well with shear damaged, are targeted. The SAR data are acquired by the C-band microwave satellite Sentinel-1. The lid of a drainage well acts as a scatterer for the incident microwaves and produces strong backscatter. Shear damage changes the position and inclination of the lid. This change reduces the backscatter intensity at the corresponding location. The proposed method, which analyzes time-series data of the VV-polarized backscattering coefficient, detects shear damage in drainage wells. The average difference in the backscattering coefficient before and after the earthquake is -0.02 dB for the non-damaged drainage wells. The backscattering coefficient of the shear-damaged drainage well decreases by 3.12 dB in January 2024 and remains low after the earthquake. The Crawford–Howell modified t-test and Grubbs' test both indicated a significant reduction in backscatter at the shear-damaged drainage well relative to the group of non-damaged drainage wells at the 5% significance level. A non-contact SAR-based detection method identifies shear-damaged drainage wells and prioritizes detailed field investigations.

Keywords: Landslide, Drainage well, SAR satellite, Contactless deformation detection, Backscattering coefficient



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GS-C-6

Assessing Stream Drying in Ungauged Tributaries Using a Grid-Based Hydrological Model and Satellite Imagery

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ABSTRACT

Small, ungauged tributaries are increasingly vulnerable to stream drying, yet conventional low-flow indices are poorly suited to detect it. The commonly used Q355 index requires a full year of data and relies on point-based gauge records, missing localized drying in unregulated tributaries beneath heavily managed mainstems. This study assesses stream drying across the Geum River basin, South Korea's third-largest basin (9,915.5 km²), where mainstream flow is sustained by two multipurpose dams and three multifunctional weirs while small and medium tributaries remain structurally exposed. We apply LEESMORM (Low-flow Estimation via grid-based Evapotranspiration and Soil Moisture Routing Model), a 1 km, 10-minute-resolution distributed hydrological model that explicitly simulates dam and weir operations at each grid cell, to reconstruct continuous streamflow across the basin from 2013 to 2025. Calibration at ten gauging stations, from dam outlets to small tributary sites, gives consistent performance (NSE 0.44–0.91) across the full regulation gradient. Using this simulation, we test 7-day and 30-day minimum flow (7dQmin, 30dQmin) as short-term surrogates for Q355. 7dQmin tracks Q355 closely outside the irrigation season, while 30dQmin deviates more under the region's variable precipitation regime. We validate model-derived drying zones against Sentinel-1/2 time series, deriving NDWI/MNDWI-based wetted-width metrics for continuous, multi-site, quantitative comparison with simulated low-flow indices. A naturalized-flow scenario, with irrigation and groundwater withdrawals removed, separates climate-driven from human-induced low-flow decline. Results show that over 80% of tributary stream cells experience persistent extreme low flow ($\leq 1 \text{ m}^3/\text{s}$), most severely during the 2017 spring drought in the Mihocheon, Bocheongcheon, and Chogang sub-watersheds.

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Keywords: Distributed hydrological model, Low-flow index, Ungauged tributary, Dam and weir regulation, Satellite remote sensing



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GS-C-7

Sentinel-1 SAR-Based Rice Yield Prediction Using Crop Growth and Agricultural Reservoir Dynamics in South Korea

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ABSTRACT

Timely rice yield forecasting is essential for production planning and agricultural water management. This study aims to develop a machine-learning-based approach that integrates crop-growth and reservoir hydrological indicators derived from Sentinel-1 C-band synthetic aperture radar (SAR) imagery for rice yield prediction in South Korea. Sentinel-1 imagery acquired from 2017 to 2025 will be processed using the Sentinel Application Platform to generate 10-m VV- and VH-polarized backscatter time series. SAR-derived crop-growth indicators will be extracted within paddy-field boundaries from the digital farm map, and phenological metrics, including stage-specific values, seasonal maxima, cumulative values, and rates of change, will be calculated. For agricultural reservoirs, multiple SAR-based surface-water extraction methods will be evaluated against optical water indices and land-cover data, and the best-performing method will be applied to generate surface-area time series. Reservoir storage will be estimated using reservoir-specific surface-area-storage relationships and linked to corresponding irrigation command areas as a proxy for water-supply conditions during the growing season. Crop-growth and reservoir variables will be integrated with regional rice yield statistics to construct a region-year dataset. Feature selection and automated machine learning will be applied for model screening and hyperparameter optimization. Performance will be evaluated using year-blocked cross-validation and phenology-based temporal cutoffs to assess temporal transferability and early-season forecasting. The contribution of reservoir information will be quantified by comparing the integrated model with a crop-growth-only baseline. This approach is expected to improve rice yield forecasting by jointly representing crop condition and reservoir storage dynamics, thereby supporting irrigation management and rice production planning.

Acknowledgements: This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through Intelligent Agricultural Infra Management for Climate Change Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (RS-2025-02263147). This research was supported by a grant (2022-MOIS63-001) of Cooperative Research Method and Safety Management Technology in National Disaster funded by Ministry of Interior and Safety (MOIS, Korea).

Keywords: Agricultural reservoir, Crop growth indicator, Machine learning, Rice yield prediction, Synthetic aperture radar



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GS-C-8

AI Agent System for Agricultural Water Resources Management

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ABSTRACT

Agricultural water resources are facing increasing pressure due to climate variability, rising food demand, and limited water availability. Efficient and adaptive management strategies are essential to maintain agricultural productivity while preserving environmental sustainability. This research introduces an AI agent system designed to support agricultural water resources management through the integration of hydrological data analysis, agricultural water demand simulation, water resources management, and policy evaluation. The system utilizes multiple specialized agents, each responsible for a specific task, and is coordinated by a Large Language Model (LLM) interface that interacts with users, interprets queries, and delegates actions to appropriate agents. This modular and intelligent system offers a powerful decision support tool for farmers, policymakers, and researchers aiming to achieve sustainable water use in agriculture.

Keywords: Agricultural water resources management, AI agent, Decision support



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GS-D-1

An Integrated Vigor–Organization–Resilience and Ecosystem Service Valuation Framework for Wetland–Catchment Sustainability Assessment: A Case Study of Bhoj Wetland, India

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ABSTRACT

Wetlands are influenced by ecological and land-use changes in their surrounding catchments, particularly through runoff, sediment transport, nutrient loading, agricultural pressure, and urban expansion. This study presents an integrated geospatial Vigor–Organization–Resilience–Ecosystem Service Value (VOR–ESV) framework to evaluate the ecological condition and ecosystem service values of Bhoj Wetland and its surrounding catchment in central India. Multi-temporal satellite data, LULC maps, hydro-ecological indices, landscape metrics, literature-derived ecosystem service coefficients, and Consumer Price Index (CPI)-adjusted benefit transfer values were integrated to assess spatio-temporal changes from 2000 to 2022. For the wetland, Vigor was estimated using NDVI and MNDWI; Organization was derived from landscape metrics; Resilience was calculated using LULC-based resilience coefficients; and Ecosystem Service Value was estimated using wetland-specific benefit-transfer coefficients. For the surrounding catchment, annual mean NDVI was used to represent vigor; PCA-weighted landscape metrics were used for organization; LULC-based resilience coefficients were applied for resilience; and Indian wetland-catchment-based ESV coefficients were used for waterbodies, forest, agricultural land, barren land, and built-up area. The analysis revealed that wetland organization declined from 0.607 in 2000 to 0.450 in 2015, then partially recovered to 0.551 in 2020, while catchment organization decreased from 0.537 in 2000 to 0.491 in 2022, indicating increasing landscape fragmentation and declining structural stability within the catchment. Ecosystem service values (ESVs) were estimated using the Benefit Transfer Method and grouped into provisioning, regulating, supporting, and cultural services. Sensitivity analysis was performed by varying ESV coefficients by $\pm 10\%$, $\pm 20\%$, and $\pm 50\%$ to assess the reliability of transferred values. The novelty of this study lies in integrating ecosystem health assessment and ecosystem service valuation for both the wetland and its surrounding catchment within a single geospatial framework, enabling direct evaluation of how catchment landscape dynamics influence wetland ecological condition and ecosystem service delivery over time. The proposed approach supports science-based wetland and catchment management and contributes to SDG 6, SDG 11, SDG 13, and SDG 15 by promoting clean water, sustainable urban planning, climate resilience, and ecosystem conservation.

Keywords: Bhoj Wetland, Ecosystem service valuation, Benefit transfer method, Landscape metrics, Resilience assessment



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GS-D-2

Detecting Changes in Seasonal Low-Flow Structure Using ELF Clustering: An Analysis of Long-Term Observed Streamflow Records in Japan

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ABSTRACT

Detecting long-term changes in low-flow regimes is difficult because natural variability and human water management interact across multiple timescales. Conventional low-flow indices are generally based on single statistical values and may therefore overlook changes in seasonal structure, including those associated with water use, reservoir operation, and flow regulation. To characterize seasonal low-flow structure while reducing the influence of short-term rainfall variability, we constructed Expected Low Flow (ELF) series at 5-day intervals. We then applied two complementary clustering approaches: phase-splitting clustering to detect marked changes in seasonal structure, and phase-integrated clustering to identify gradual and cumulative shifts across the three historical periods described below.

The 70-year observation period was divided into three phases reflecting major stages of water development and management in Japan: Phase 1 (1951–1970), characterized by rapid multipurpose river development; Phase 2 (1971–2000), when water-resource systems expanded to meet growing domestic, industrial, and agricultural demands; and Phase 3 (2001–2020), when environmental flow and low-flow management became more prominent.

Analysis of observed streamflow records from 122 gauging stations detected cluster transitions at 42 stations. These transitions were concentrated in river basins where major water development, diversion, or flow-regulation projects had occurred. Phase-integrated clustering further revealed more gradual shifts that were not captured by discrete cluster transitions. The results demonstrate that ELF clustering can serve as a diagnostic framework for identifying where, when, and in which season low-flow regimes have changed, thereby supporting more detailed interpretation of human influences on river environments.

Keywords: expected low flow, river development, policy, hydrological drought



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GS-D-3

Hydrodynamic Modeling of Salt Pan Restoration in Tainan Linking Tidal Dynamics, Sediment Supply, and Equilibrium Elevation with Vegetation Biomass

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ABSTRACT

Salt pan restoration has emerged as an important nature-based solution for enhancing coastal resilience, biodiversity, and blue carbon potential in Taiwan. However, the long-term success of such restoration strongly depends on the re-establishment of suitable hydrodynamic conditions and platform elevations that support vegetation growth. This study proposes a numerical investigation of salt pan restoration in the Tainan coastal area, focusing on the interactions among tidal hydrodynamics, external sediment supply, and ecological response.

A process-based hydrodynamic model will be applied to simulate tidal inundation, water exchange, and salinity patterns under different restoration scenarios, including variations in dike openings and channel configurations. The simulated water levels and inundation regimes will be coupled with a simplified morphodynamic equilibrium framework that accounts for mineral sediment input from external sources. Building on the well-established parabolic relationship between marsh elevation and aboveground biomass (Morris et al.), the model will estimate the potential equilibrium elevation of the restored platform and the corresponding vegetation biomass.

The expected results will provide insights into how different hydrodynamic designs and sediment supply conditions influence the stability and ecological productivity of restored salt pans. This research aims to support the design of more effective nature-based restoration strategies in tidal environments and contribute to climate-resilient coastal management in southwestern Taiwan.

Keywords: Hydrodynamic modeling, Salt pan restoration, Vegetation biomass, Nature-based solution, Coastal management



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GS-D-4

Relationships between Insecticide Concentrations and Aquatic Insect Species Richness and Abundance in Subtropical Paddy Fields of the Yaeyama Islands, Japan

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ABSTRACT

Paddy fields serve as important aquatic habitats for a wide variety of aquatic insects. The subtropical Yaeyama Islands of southwestern Japan support exceptionally high biodiversity and include Iriomote Island, part of a UNESCO World Natural Heritage Site, where paddy fields are located close to forests, rivers, and mangrove ecosystems.

This study investigated the relationship between insecticide concentrations in paddy water and aquatic insect species richness and abundance on Ishigaki and Iriomote Islands. Field surveys were conducted at 21 paddy fields (11 on Ishigaki and 10 on Iriomote) from mid-May to early June 2025. Surface water samples were collected and analyzed for neonicotinoid, diamide, and other insecticides, while aquatic insects were sampled using standardized net sampling along paddy margins.

Neonicotinoids were detected at seven sites on Ishigaki and two on Iriomote, while diamide insecticides were detected at 10 and three sites, respectively. Some insecticides were also detected in fields with no reported insecticide application, suggesting possible off-site transport. Generalized linear mixed models showed significant negative relationships between total neonicotinoid concentrations and aquatic insect species richness ($\beta = -0.32$, $p < 0.001$) and abundance ($\beta = -0.67$, $p < 0.001$), with no significant differences between islands. No clear relationships were observed between diamide concentrations and either species richness or abundance.

These findings provide a basis for future studies on the ecological effects of insecticides in subtropical paddy ecosystems and may contribute to sustainable pesticide management and biodiversity conservation.

Keywords: neonicotinoids, aquatic insects, paddy fields, water quality, Yaeyama Islands



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GS-D-5

From Coastal Time Series to Ocean Basin: Mechanistic Insights into Plankton Trophic Interactions and Biogeochemical Cycling

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ABSTRACT

Energy flow and biogeochemical cycling in marine ecosystems are mediated by the growth and grazing mortality of planktonic organisms. To mechanistically understand how these trophic interactions shape ecosystem function, we have conducted dilution experiments biweekly at Chaojing Park, Keelung, Taiwan since October 2024, complemented by open-ocean sampling spanning the East China Sea, Taiwan Strait, South China Sea, and the northwestern Pacific as far south as Palau. Together, this time series and its broad spatial coverage allow us to resolve how environmental variability governs plankton trophic interactions. To determine how these interactions in turn feed back on energy flow and biogeochemical cycling, we couple the dilution approach with a suite of complementary techniques that expand our capacity to resolve the functional roles of plankton. Pairing dilution with high throughput sequencing lets us partition bulk community-level rates into taxon-specific growth and mortality, opening the door to testing central ecological theories such as niche theory and the Kill-the-Winner hypothesis. We further combine dilution experiments with dissolved organic carbon (DOC) measurements and stable isotope analysis, enabling us to quantify the impact of trophic interactions on both the quantity and lability of DOC and to constrain planktonic food web structure. By linking rate measurements to taxonomic identity, carbon quality, and food web architecture, this program provides an integrated view of how plankton trophic interactions translate into ecosystem-scale biogeochemical outcomes.

Keywords: Dilution experiment, High throughput sequencing, Dissolved organic carbon, Stable isotope, Marine foodweb



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PS1-1

Evaporation from Soil Surface and Early Growth of Plants under Low/Microgravity Environment

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ABSTRACT

Long-term space habitation will require sustainable food production systems. To support future space agriculture, it is important to understand how different gravitational conditions affect soil water behavior and plant growth. Therefore, this study investigated these processes under simulated microgravity using a 3D clinostat.

Soil water evaporation experiments were conducted under four gravity conditions (1G, 1/3G, 1/6G, and 0G) using Toyoura sand, clay soil, and Akadama soil. Evaporation was evaluated from mass loss over 48 hours.

For all soil types, evaporation decreased as gravity decreased. This trend is likely due to reduced buoyancy under microgravity, which suppresses vapor transport and maintains higher relative humidity near the soil surface. Numerical simulations using COMSOL Multiphysics under the same gravity conditions also showed higher relative humidity near the soil surface under 0G conditions, supporting the experimental results.

Planting experiments using cowpea seeds were conducted under the same four gravity conditions. Seeds were sown in capillary-saturated clay soil after 24 hours of gravitational drainage. Germination occurred earlier under 0G conditions, whereas no clear trend was observed among 1/6G, 1/3G, and 1G. Plant growth was greatest under 0G and decreased with increasing gravity. In addition, hypocotyl bending was observed under all clinostat conditions. These results indicate that reduced gravity affects not only soil water evaporation but also seed germination and early plant development.

Unlike drop tower and flight experiments, the 3D clinostat enables long-term experiments, and we plan to conduct further studies using this feature.

Keywords: micro-gravity, evaporation, water holding capacity, hydraulic conductivity, numerical simulation, plant germination



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PS1-2

Effects of Biochar Amendment on Leachate Salinity and Ion-Specific Solute Dynamics in Salt-Affected Paddy Soil Irrigated with Treated Municipal Effluent

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ABSTRACT

Soil salinization, freshwater scarcity, and nutrient losses challenge sustainable rice production and soil–water management. This study evaluated biochar effects on leachate salinity and solute dynamics in salt-affected paddy soil irrigated with treated municipal effluent. A two-factor pot experiment combined biochar rates of 0, 2.5, and 5% (w/w) with initial soil salinity levels of 2, 4, and 8 dS m⁻¹, yielding nine treatments with three replicates. Each pot contained 10 kg soil and received treated municipal effluent throughout the rice-growing period. Weekly leachate samples were analyzed for electrical conductivity (EC) and Ca, Mg, Na, K, and P concentrations. Across treatments, EC declined from 3.3–8.0 to 2.1–3.8 mS cm⁻¹, while Na decreased from 350–820 to 40–150 mg L⁻¹, consistent with progressive flushing of soluble salts. Fertilization produced distinct solute responses. After topdressing, P peaked at 4.7–7.4 mg L⁻¹ in unamended treatments versus 1.8–2.6 mg L⁻¹ with 5% biochar, although a delayed P increase occurred with 5% biochar at 8 dS m⁻¹. Eleven days after panicle fertilization, Ca and K reached 1,090–1,280 and 160–215 mg L⁻¹, respectively, in 5% biochar treatments, generally exceeding corresponding unamended treatments. These ion-specific responses suggest that biochar may alter solute mobility rather than uniformly reduce leachate concentrations. Overall, biochar showed potential to support salt management and agricultural water reuse. Further assessment of cumulative ion loads, soil exchangeable ions, and rice growth and yield is needed.

Keywords: Biochar, Treated municipal effluent, Soil salinity, Paddy soil, Solute dynamics, Agricultural water reuse



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PS1-3

Assessment of Treated Wastewater Reuse for Sustainable Sorghum Irrigation in Kinmen, Taiwan

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ABSTRACT

Kinmen, an offshore island of Taiwan, faces chronic water scarcity due to limited and unevenly distributed rainfall, prolonged dry seasons, and heavy reliance on groundwater for agricultural irrigation. Increasing climate variability has further intensified pressure on local water resources, highlighting the need for sustainable alternative water supplies. Treated wastewater has been recognized as a promising non-conventional water resource because of its stable availability and potential for circular water use. However, its agricultural application requires comprehensive evaluation to ensure that irrigation with treated wastewater does not adversely affect irrigation water quality, soil properties, or crop growth.

This study aims to evaluate the feasibility of treated wastewater reuse for sorghum irrigation under field conditions in Kinmen. A field-scale demonstration site was established near the Ronghu Water Resource Recovery Center using sorghum (*Sorghum bicolor* L. Moench cv. Taichung No. 5) as the test crop. The experimental field is irrigated using a treated wastewater-based irrigation system, in which treated wastewater is conveyed through an ecological storage pond before agricultural use, while a nearby field irrigated with conventional water from the Jinsha Drainage Canal serves as the control. During the 2026 growing season, irrigation water, soil, and crop samples are being systematically monitored to evaluate water quality, soil physicochemical properties, nutrient status, and crop growth performance. Baseline water quality monitoring conducted prior to the field experiment indicated that the treated wastewater irrigation system exhibited water quality comparable to the conventional irrigation source and showed no apparent increase in salinity or major ion concentrations.

The findings of this ongoing study are expected to provide scientific evidence for evaluating the feasibility of treated wastewater reuse in sorghum cultivation and to support sustainable irrigation management, agricultural water reuse, and circular water resource utilization in water-scarce island environments.

Keywords: treated wastewater irrigation, water reuse, sorghum, field demonstration, Kinmen



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PS1-4

Applying Machine Learning to Digital Soil Mapping of Organic Carbon in the Zhoshui River Basin

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ABSTRACT

Soil organic carbon (SOC) represents the largest organic carbon sink in terrestrial ecosystems, playing a vital role in the interactive carbon cycle, soil health, and climate change mitigation. Accurately estimating SOC distribution is increasingly critical for national decision-making. However, traditional soil mapping heavily relies on manual collection of point data, which often fails to capture the extreme spatial heterogeneity characteristic of highly dynamic landscapes and is labor-intensive. This limitation is particularly pronounced in Taiwan's Zhoshui River Basin, where extreme environmental gradients constantly redistribute carbon stocks between steep mountainous forests and lower alluvial plains, making point-based observations highly inadequate.

To overcome these predictive challenges, this study aims to develop an integrated framework by utilizing machine learning algorithms. The model incorporates environmental covariates—including topography, climate, vegetation indices, and land use—to map the continuous distribution of carbon sinks. To address the severe environmental noise caused by extreme topographic variations, this research employs a recursive zoned modeling approach. By utilizing elevation and slope as primary criteria, the basin is partitioned into distinct spatial zones. Specialized sub-models are then trained for each specific zone to mitigate the predictive interference between highly divergent lowland and high-mountain environments.

Keywords: Soil organic carbon, Machine learning, Zoned model, Zhoshui River Basin



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PS1-5

Changes in Total Soil Water Potential across Bell Pepper Growth Stages in a Greenhouse on Coastal Reclaimed Land

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ABSTRACT

In salt-affected greenhouse soils, a high-water content does not always mean that water is readily available to plants because dissolved salts can lower osmotic potential. We built a low-cost IoT monitoring system using M5Stamp Pico to examine both water and salinity conditions in the root zone. The logger recorded SDI-12 sensor data and sent the measurements to Google Sheets via Wi-Fi. TDR probes were installed at depths of 10, 20, and 40 cm in a bell pepper bed on coastal reclaimed land. Apparent dielectric permittivity and bulk electrical conductivity were measured from December 2024 to June 2025. We converted the measurements to volumetric water content and pore-water electrical conductivity with soil-specific equations. Matric and osmotic potentials were estimated at each depth. Data could be checked online during the field test. Water content near the surface responded to irrigation, whereas the value at 40 cm changed little and was affected by the shallow ground-water table. These observations suggest that water content and salinity should be evaluated together when root-zone conditions are examined. We are continuing the analysis of irrigation events, vertical gradients, and changes among crop growth stages to compare changes in matric potential, osmotic potential, and total soil water potential through the growing period.

Keywords: IoT monitoring, Matric potential, Osmotic potential



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PS1-6

APEX-Based Simulation of Rice Growth and Yield Prediction under Weather and Agricultural Management Scenarios: A Preliminary Study for Future Agricultural Environmental Conservation Policy Evaluation

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ABSTRACT

Intensive agricultural practices aimed at increasing food production have caused various environmental problems, including nutrient accumulation in soils, nutrient runoff, and water pollution. In response, the agricultural environmental conservation policy has emphasized not only the food production function of agriculture but also its public-interest and environmental conservation functions. In the Republic of Korea, policies such as the Public Interest Direct Payment System and the Agricultural Environmental Conservation Policy have been implemented to encourage farmers to adopt environmental conservation activities. Evaluating the effects of these policies requires continuous field-level monitoring of the application of agricultural environmental conservation activities and resulting environmental impacts, as well as an assessment of their effects on crop yield. However, field experiments and monitoring are time- and labor-intensive, and installing sensors and other monitoring equipment requires considerable costs. Therefore, when long-term field cultivation and observations are limited, model-based simulations provide a useful alternative for analyzing the effect of different agricultural environmental conservation activity scenarios.

This study conducted scenario-based simulations and predictions of rice crop production to establish a methodological foundation for evaluating future agricultural environmental conservation policy. The APEX (Agricultural Policy/Environmental eXtender) model, which allows the detailed specification of various agricultural management activities, was employed. Multiple weather scenarios were constructed using historical observation data, and agricultural management scenarios with varying sowing and transplanting dates were applied to simulate rice growth and yield.

Because rice has a relatively long growing period, crop yield is difficult to estimate accurately before harvest, and collecting sufficient yield data through field surveys is also labor-intensive. Accordingly, a yield prediction algorithm was developed by using simulated crop growth data and yield simulation results. The results showed that yield changes associated with different weather conditions and sowing and transplanting dates could be simulated. They also indicated the potential applicability of a yield prediction algorithm combining crop growth data from a specific growth stage with simulated yield. The findings are expected to provide a methodological basis for future evaluations of agricultural environmental conservation policies by extending the framework to a wider range of agricultural environmental conservation activity scenarios and deriving both environmental and productivity indicators from model simulation outputs.

Acknowledgements: This work was supported by the National Agricultural and Environmental Management Technology Development Program, Rural Development Administration, Republic of Korea (Project No. RS-2026-25505631).

Keywords: crop yield, crop model simulation, APEX model, Agricultural Environmental Conservation Policy



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PS1-7

Comparative Evaluation of Hourly Inflow to Agricultural Reservoirs Using Water-Level-Based Estimation Methods and Rainfall-Runoff Models

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ABSTRACT

Continuous measurements of inflow and outflow are often unavailable for small- and medium-sized agricultural reservoirs in South Korea, whereas water-level data are collected consistently. During periods without reservoir releases, inflow can be estimated from changes in reservoir storage derived from observed water levels. However, the direct application of an hourly water-balance method may amplify water-level measurement errors through temporal differencing, resulting in excessive fluctuations and negative values in the estimated inflow. This study compares water-level-based estimation methods and rainfall-runoff models for estimating hourly reservoir inflow during non-release periods. The water-level-based methods include the water-balance method, the Ensemble Kalman Filter (EnKF), and an Analytical Method (AM). The EnKF sequentially assimilates hourly water-level observations to update inflow and reservoir storage, whereas the AM simultaneously minimizes inflow variability and discrepancies between observed and estimated water levels. The rainfall-runoff models include the modele du Genie Rural a 4 parametres Horaire (GR4H), the Clark unit hydrograph method, and Cell2Flood. The estimated inflows are compared with observed inflows in terms of hydrograph accuracy, peak magnitude, peak timing, event runoff volume, temporal variability, and the occurrence of negative inflow values. Uncertainties associated with observational data, model parameters, and model structures are also analyzed, and parameter equifinality is investigated using multiple behavioral parameter sets. The results are expected to clarify the strengths, limitations, and applicability of each method and to provide practical guidance for selecting hourly inflow estimation techniques for data-scarce agricultural reservoirs.

Keywords: agricultural reservoir, hourly inflow, water level, EnKF, AM, rainfall-runoff model, uncertainty, equifinality



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PS1-8

Assessment of the applicability of integrating satellite-based soil moisture and vegetation information with AquaCrop for agricultural water management

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ABSTRACT

Climate change has intensified droughts and extreme rainfall, highlighting the need for precise water management considering soil moisture and crop growth. However, conventional water management relies on limited field observations and meteorological data, making it difficult to represent their temporal and spatial variability. AquaCrop is a crop water productivity model that simulates soil moisture, crop growth, and yield under climate, soil, crop, and management conditions for irrigation planning and water management. Its reliability depends on the availability and accuracy of input and field data, while point observations may not represent field-scale spatial heterogeneity. Satellite remote sensing enables periodic monitoring of soil moisture and vegetation over agricultural areas. Synthetic Aperture Radar (SAR) provides stable soil moisture information with limited effects from clouds and illumination, while the Normalized Difference Vegetation Index (NDVI) from optical imagery indicates crop growth and canopy development. This study integrates SAR-derived soil moisture and optical NDVI with AquaCrop to assess their applicability to agricultural water management. AquaCrop-simulated soil moisture and crop growth will be compared with satellite-observed temporal and spatial patterns to evaluate model reliability. The study will also assess whether this integration supports accurate irrigation timing and water requirements while complementing limited field observations. By establishing a data-driven agricultural water management framework reflecting field soil moisture and crop growth conditions, this approach is expected to improve water-use efficiency and strengthen responses to drought and crop water stress.

Keywords: Satellite imagery, Synthetic aperture radar, Soil moisture, Normalized Difference Vegetation Index, AquaCrop, Agricultural water management



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PS1-9

Estimation of Wave Velocity in Steel Pipe–Mortar Piles Using Impact-Induced Reflected Waves

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ABSTRACT

Steel pipe piles are widely used as stabilizing piles to prevent landslides and slope failures, often in combination with mortar. The velocity of impact-induced reflected waves is an important parameter for evaluating pile integrity and estimating damage locations. While representative wave velocities have been reported for concrete and steel pipe piles, studies on piles consisting of steel pipes and mortar remain limited. This study investigated the wave-velocity characteristics of steel pipe–mortar piles and examined the validity of an equivalent-medium model. Two model specimens with different mortar cross-sectional areas were fabricated, with one having twice the mortar area. Impact tests were conducted seven days after casting, and we measured reflected waves. Elastic waves were assumed to propagate as one-dimensional longitudinal waves, and each pile was modeled as an equivalent homogeneous medium. The equivalent Young's modulus and density were calculated as cross-sectional-area-weighted averages of material properties, and wave velocity was estimated accordingly. When the mortar cross-sectional area was doubled, the estimated wave velocity decreased from 4.04×10^3 m/s to 3.89×10^3 m/s, corresponding to 96.3% of the original value. Similarly, the measured wave velocity decreased from 3.93×10^3 m/s to 3.77×10^3 m/s, corresponding to 95.7% of the original value. Wave velocity decreased as the mortar cross-sectional area increased. The similar reductions in the measured and estimated wave velocities support the applicability of the equivalent-medium model. These findings suggest that wave velocity in steel pipe–mortar piles can be reasonably estimated using material properties and cross-sectional configuration.

Keywords: Steel pipe–mortar pile, Wave velocity, Impact-induced reflected wave, Equivalent-medium model



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PS1-10

Field evidence of soil-air confinement during infiltration under intense rainfall in Hawai'i

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ABSTRACT

Infiltration, the process of water entering soil from the soil surface, is an important process in hydrology and influences groundwater recharge, surface runoff, and solute transport. The process also impacts the water source contributing to an aquatic habitat. Though often neglected, air and water compete for flow pathways within the soil. Under high intensity rainfall, obstruction of the airescape path results in air pressure accumulation. This phenomenon is referred to as “air confinement.” The resulting buildup of air pressure suppresses water infiltration. One-dimensional theoretical analysis shows that when soil air escapes only through the ground surface, a critical rainfall intensity triggers air confinement. This threshold is lower than the saturated hydraulic conductivity. Moreover, to verify the existence of air confinement in the real world, we conducted 5-minute high-resolution monitoring of rainfall, soil water content, matric potential, and soil gas pressure at a residential hillside yard in Mānoa, O'ahu, Hawai'i. Observations show that water content at 100 cm depth is generally stable, with occasional saturation due to subsurface lateral flow. When intense rainfall coincided with lateral flow, a pronounced rise in soil gas pressure was recorded. This study provides field evidence of rainfall-induced air confinement and underscores the critical role of lower boundary conditions in governing infiltration dynamics.

Keywords: multiphase flow in porous media, soil air permeability, soil water permeability, soil water monitoring station



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PS1-11

Assessment of Future Soil Erosion Uncertainty Using CMIP6 Ensemble Models

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ABSTRACT

Changes in rainfall characteristics under climate change are a major driver of changes in soil erosion, and predicting future erosion requires accounting for the uncertainty inherent in climate projections. Because future climate cannot be represented by a single deterministic value, capturing this uncertainty requires a comprehensive approach based on multiple scenarios and models. Accordingly, this study used multiple SSP (Shared Socioeconomic Pathway) scenarios and CMIP6 (Coupled Model Intercomparison Project Phase 6) ensemble models to estimate the range of the rainfall erosivity factor (R factor) and assess the uncertainty of future soil erosion nationwide. First, the R factor was calculated from future rainfall data at 60 ASOS (Automated Synoptic Observing System) stations of the Korea Meteorological Administration. A 90% range (5th–95th percentiles) of R factor was derived from the spread across scenario–model combinations to quantify rainfall-based uncertainty. Station-based R factor values were spatially interpolated using kriging to construct a nationwide gridded R-factor map, which was combined with the soil erodibility (K factor), topographic (LS factor), cover-management (C factor), and support-practice (P factor) factors to estimate future soil erosion using RUSLE (Revised Universal Soil Loss Equation). Estimated soil erosion amounts across scenario–model combinations were used to characterize uncertainty. The results are expected to clarify the uncertainty in future soil erosion predictions and support soil conservation policy and climate adaptation strategies.

Acknowledgements: This work was supported by a Rural Development Administration (RDA) grant funded by the South Korean government, Ministry of Agriculture, Food, and Rural Affairs (MAFRA) (Grant No: RS-2024-00400192).

Keywords: Soil erosion, Rainfall erosivity factor (R factor), RUSLE, Climate change, Uncertainty



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PS1-12

Effects of organic and conventional farming on methane-cycling microbial communities in Korean paddy soils

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ABSTRACT

Methane (CH₄) emissions from paddy soils are an important contributor to climate change because microbial processes regulate both methane production and oxidation. This study investigated the effects of organic farming (OF) and conventional farming (CF) on methane-cycling microorganisms (MCM) in Korean paddy soils. Soil samples were collected from paddy fields in Gyeonggi and Chungcheong Provinces in 2022 and 2023. Microbial community composition was characterized by sequencing the V3–V4 region of the 16S rRNA gene to analyze methanogenic archaea (MA) and methane-oxidizing bacteria (MOB). The relative abundances of both MA and MOB were generally higher under CF than under OF. Farming practices significantly affected MA community composition, whereas MOB communities showed relatively limited differences between OF and CF. Co-occurrence network analysis also revealed distinct interaction patterns between the two farming systems. The OF network showed greater connectivity than the CF network, suggesting that methane production and oxidation under OF may occur through more complex and multistep microbial pathways than under CF. These contrasting responses further suggest that methane production may be more sensitive to farming practices than methane oxidation. These findings demonstrate that farming practices influence the abundance, community composition, and ecological interactions of MCM. Differences in organic matter inputs and resource management may stimulate or suppress specific microbial groups, thereby altering methane-cycling processes. This study provides foundational information on MCM in Korean paddy soils and is expected to contribute to the development of sustainable agricultural management strategies for mitigating CH₄ emissions.

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Keywords: Conventional farming, Organic farming, Methane, Methanogenic archaea, Methane-oxidizing bacteria, Paddy



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PS1-13

Field Monitoring of Nitrous Oxide Emissions under Contrasting Crop and Fertilization Management

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ABSTRACT

Well-drained agricultural soils are predominantly aerobic; however, rainfall following fertilization can rapidly alter soil moisture and mineral nitrogen availability, thereby stimulating nitrification and denitrification processes. Consequently, nitrous oxide (N₂O) emissions may increase sharply following fertilization and rainfall events. Emissions may also vary according to crop type, fertilization rate, and farming practices. These interactions highlight the need to evaluate greenhouse gas emissions under contrasting fertilization management conditions alongside their agronomic and water-quality implications. This study investigates N₂O emissions from experimental plots established in a gently sloping agricultural field. The plots include corn under conventional and Rural Development Administration (RDA)-recommended fertilization regimes and perilla under its standard fertilization regime. Gas samples are collected using static chambers following the USDA-ARS GRACEnet protocol, with regular monitoring supplemented by event-based sampling following major fertilization and rainfall events. Soil moisture, soil temperature, mineral nitrogen, meteorological conditions, and farming activities are concurrently monitored to characterize temporal emission patterns and examine potential environmental and management factors associated with their variation. The resulting dataset will provide baseline information on N₂O emission patterns under contrasting crop and fertilization management conditions and support subsequent process-based modeling of agricultural greenhouse gas emissions and the evaluation of alternative management scenarios.

Acknowledgements: This work was supported by the Rural Development Administration (RDA), Republic of Korea, through the project “Development of Integrated Management Technology for Nutrient Balance Impact Assessment at National and Regional Levels” (Project No. 25518288).

Keywords: Nitrous oxide, Agricultural soils, Static chamber, Fertilization management, Greenhouse gas emissions



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PS1-14

Integrated Assessment of Dam-Break Flooding, Sediment Deposition, and Agricultural Damage

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ABSTRACT

Extreme rainfall and the aging of agricultural reservoirs are increasing the risk of reservoir failure and downstream damage in rural areas of South Korea. Failure of an earth-fill agricultural reservoir can cause rapid flood propagation and the transport of embankment materials, resulting in farmland inundation, sediment burial, and damage to agricultural infrastructure. This study developed an integrated framework for assessing flooding, sediment deposition, and downstream damage following agricultural reservoir failure.

A breach outflow hydrograph was generated using the DAMBRK model. Flood propagation and sediment transport were simulated using HEC-RAS 2D. The simulated inundation extent, flood depth, and sediment deposition were integrated with spatial inventories of buildings, farmland, crops, agricultural facilities, and public infrastructure to assess the spatial distribution and magnitude of damage.

The model reasonably reproduced the observed inundation pattern and flood depths. Flooding affected a broad downstream agricultural area, whereas sediment deposition was concentrated near the breached embankment and along the downstream channel. These contrasting spatial patterns indicate that flooding and sediment deposition cause different types of damage and recovery needs. The damage assessment further showed that public infrastructure and farmland accounted for major portions of the total losses.

The proposed framework can support the identification of vulnerable agricultural areas, reservoir safety management, rapid damage assessment, and post-disaster recovery planning, thereby contributing to climate-resilient rural water management.

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Keywords: Agricultural reservoir, Dam-break flood, Sediment-laden flow, Agricultural damage



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PS2-1

AI-Based Surrogate Modeling for Hydrodynamic Simulation Using iRIC Data

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ABSTRACT

Hydrodynamic numerical models are essential tools for simulating flow processes and supporting water-related decision-making; however, their high computational demand often limits their applicability in real-time forecasting and large-scale scenario analysis. To overcome this limitation, this study develops an artificial intelligence-based surrogate modeling framework that enhances computational efficiency while preserving predictive performance. The model is trained using simulation outputs generated from the iRIC hydrodynamic platform. Input variables include spatial coordinates (X, Y), terrain elevation, temporal information, and discharge conditions, while water depth is defined as the prediction target. A multilayer perceptron (MLP) is adopted to model complex nonlinear relationships between variables. Data preprocessing procedures, including categorical encoding, normalization, and training-testing data splitting, are implemented to improve model stability and generalization. The results demonstrate that the proposed surrogate model achieves high accuracy and successfully captures the spatial distribution patterns of water depth. Compared with conventional numerical simulations, the approach significantly reduces computational time and enables rapid prediction. This study highlights the potential of integrating hydrodynamic modeling with machine learning techniques to support flood forecasting, water resources management, and disaster risk reduction.

Keywords: iRIC, surrogate model, multilayer perceptron, water depth prediction, machine learning, flood simulation



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PS2-2

Converting Geostationary Satellite Bands into Real-Time Fog Detection over Taiwan Using Gradient-Boosting Machine Learning

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ABSTRACT

Fog and low visibility are persistent hazards for road, marine, and aviation transport, yet operational monitoring in Taiwan still relies on a sparse network of ground visibility meters and manual interpretation that cannot resolve the spatial extent and evolution of fog in real time, frequently causing delayed warnings. Geostationary satellites offer wide-area, high-frequency coverage to fill this gap, but conventional satellite fog detection relies on fixed brightness-temperature-difference thresholds that must be retuned across seasons, terrain, and fog types and therefore generalize poorly. To address this, this study develops a data-driven fog-detection framework for Taiwan's Central Weather Administration that converts Himawari-8/9 AHI 16-band imagery (visible to thermal-infrared, full-disk every 10 minutes, ~2 km resolution) into present-visibility and fog (visibility below 1 km) products. A full-year 2023 dataset pairs satellite radiances with 78 automatic weather and freeway visibility stations, yielding about 2.55 million records with an extreme 0.63% fog rate (1:157 imbalance). Gradient-boosting models (LightGBM, with XGBoost and CatBoost compared) are trained separately for each physically distinct fog regime (orographic, radiation, and advection fog), using physically informed band-difference features, class-imbalance weighting, per-type decision-threshold optimization, and Leave-One-Month-Out cross-validation to test seasonal generalization. The tuned model attains an all-Taiwan AUC of about 0.93, and mountain (orographic) fog is operationally detectable with a probability of detection of about 0.65 and a critical success index of about 0.26, whereas thin lowland radiation fog remains the principal bottleneck. Per-type decision-threshold optimization roughly doubles the critical success index, demonstrating its importance for rare-event detection. SHAP-based interpretation confirms that the split-window brightness-temperature difference and water-vapor channels dominate the predictions, consistent with documented fog physics and indicating that the model captures genuine physical signals rather than statistical artifacts. Overall, the proposed framework provides an interpretable, modular tool for wide-area fog monitoring, supporting AI-assisted operational forecasting and laying the groundwork for future numerical-weather-prediction-based fog forecasting.

Keywords: Satellite fog detection, Himawari AHI, Gradient boosting, Ground visibility retrieval, Class imbalance, Brightness-temperature difference



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PS2-3

Applying deep learning technology to urban flood prediction

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ABSTRACT

Due to its location in the northwest Pacific typhoon belt, Taiwan is frequently threatened by typhoons and heavy rains during summer and autumn. In recent years, with the intensification of global climate change and the increasing frequency of extreme rainfall, combined with the rise in surface runoff caused by urban development, existing drainage systems have become unable to keep up. This has made urban flooding increasingly threatening people's lives and property, and flooding caused by heavy rain has become one of the major environmental risks. Currently, urban flood prediction technologies mainly rely on physical numerical models (such as HEC-RAS). These models are based on the conservation law of fluid mechanics and use hydrological and hydraulic parameters to analogize flooding boundaries that conform to physical laws. However, these models require a long time to compute and are difficult to meet real-time decision-making needs; To overcome the computational bottlenecks of traditional physical models mentioned above, this study aims to combine hydraulic engineering knowledge with deep learning techniques to conduct real-time forecasting research for future flood conditions. In flood prediction, this study uses the LSTM (Long Short-Term Memory) networks. LSTM has memory and forget mechanisms, effectively grasping the short- and long-term dependence between rainfall history and water level changes. It learns water level responses under different rainfall event conditions, making it suitable for handling urban flooding. The study also utilizes real-time sensor data, considering historical status and current input information, to predict future flood level changes.

Keywords: urban flood prediction, deep learning, long short-term memory networks



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PS2-4

Physics-informed remote sensing and deep learning for identifying hotspot of river dust emission in the Zhuoshui River, Taiwan

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ABSTRACT

Riverbed dust events are an emerging environmental concern in central Taiwan, especially during dry seasons (November-April) when exposed sediment surfaces may become potential dust sources and affect nearby agricultural and rural communities. The identification of potential dust-source hotspots is critical for climate-resilient river and agro-water environmental management. However, this objective is often impeded by the spatial limitations of PM_{10} observation data, which are typically confined to discrete monitoring stations rather than continuous pixel-level emission information. This study develops a supervised artificial neural network framework to map relative surface dust-source susceptibility in the downstream of Zhuoshui River using remote-sensing data from Sentinel-2 and two-station PM_{10} observations (Yishian and Shiuguang). Cloud-clear Sentinel-2 imageries were utilized to derive physically interpretable surface indicators, specifically NDMI-based dryness index and NDVI-based low-vegetation index. PM_{10} observations from monitoring stations were converted into pixel-specific labels using wind-alignment scores. For individual pixels, the station-to-pixel direction was evaluated against the prevailing wind direction during peak PM_{10} events, allowing station PM_{10} values to be fused based on directional credibility.

The fused PM_{10} values were subsequently transformed to reduce the influence of baseline PM_{10} concentration while preserving the intensity of high- PM_{10} events. The resulting model produced spatially explicit maps delineating relative surface dust-source susceptibility. Validation showed physically consistent feature responses, higher global-threshold hotspot ratios on event dates, and spatial agreement with Sentinel-2 RGB imagery and LULC information. The framework provides an AI-enabled remote sensing tool for supporting dust monitoring, hotspot prioritization, and climate-resilient river basin environmental management.

Keywords: PM_{10} , aeolian dust, hybrid AI-physics modeling, machine-learning



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PS2-5

Effects of fertilization and air temperature during grain-filling on the appearance quality of rice

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ABSTRACT

Objective : Rice grain quality in Japan has recently deteriorated because of high temperatures during the grain-filling period. This study aimed to quantitatively evaluate the effects of high temperatures during the grain-filling period and nitrogen fertilization on grain protein content and grain quality in the rice cultivars *Kinumusume* and *Hinohikari* using farm management records collected from commercial paddy fields in Okayama Prefecture.

Method : Daily farm management records collected from commercial paddy fields in Okayama Prefecture between 2021 and 2025 were combined with grain quality data obtained using a grain quality analyzer and a rice taste analyzer. Two multiple regression models were developed to evaluate the effects of nitrogen fertilization on grain protein content and the effects of the mean air temperature during the 20 days after heading (20DAH) and grain protein content on grain quality.

Result : The effects of nitrogen fertilization on grain protein content differed between the two cultivars. In *Hinohikari*, both basal and topdressing nitrogen significantly affected grain protein content, whereas no significant relationship was observed in *Kinumusume*. In both cultivars, 20DAH was positively associated with the percentage of immature grains. Grain protein content was negatively associated with the percentage of immature grains only in *Hinohikari*.

Conclusions : This study demonstrated that farm management records can be used to quantitatively evaluate the effects of high temperature and nitrogen fertilization on rice grain quality. The findings provide useful information for improving farm management practices according to cultivar and cultivation conditions.

Keywords: Rice grain quality, Data-driven agriculture, KSAS



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PS2-6

Identification of Drought-Response Archetypes for Large Agricultural Reservoirs in South Korea

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ABSTRACT

Climate change is intensifying hydroclimatic variability and extreme drought, posing major challenges to agricultural water management. Agricultural reservoirs, however, respond differently to drought because of variations in climate, watershed and reservoir characteristics, and operational practices. These differences are rarely incorporated into conventional reservoir management. This study develops a national-scale framework for identifying drought-response archetypes among 66 large agricultural reservoirs in South Korea. Daily reservoir storage records for 2008–2025 were synchronized with 500-m gridded precipitation, temperature, and Penman–Monteith potential evapotranspiration data. Physical and topographic descriptors include the watershed-to-irrigated-area ratio, storage buffering capacity, watershed shape factor, and elevation. Hydroclimatic stress is characterized using the aridity index and irrigation-season precipitation deficit. Reservoir-response metrics represent rainless-period drawdown, irrigation-season storage reliability, annual minimum-storage vulnerability, and the mean annual duration below 50% storage. After screening highly correlated variables, alternative combinations of standardized indicators will be evaluated using unsupervised clustering to group reservoirs with similar drought-response behavior and timing. Each cluster will be interpreted as a representative archetype, and its dominant controls, sensitivity, vulnerability, and spatial distribution will be examined. The resulting archetype and vulnerability maps are expected to support targeted monitoring and provide a scientific basis for preliminary, archetype-specific drought-management strategies.

Acknowledgements: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2026-25472864).

Keywords: Agricultural reservoirs, Drought-response archetypes, Clustering, Reservoir vulnerability, Hydrometeorological indicators



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PS2-7

Evaluating the Performance of Missing Data Imputation Methods for Water-Level Data in Gap-Filling and Cluster Structure Preservation

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ABSTRACT

Reliable gap-filling of river water-level records is essential for hydrological analysis, water resources management, and data-driven modeling. However, missing data imputation methods have been only evaluated by numerical reconstruction accuracy, with less attention to whether they preserve the structure needed for subsequent signal-based analyses. This study evaluated the numerical performance and cluster-structure preservation of six imputation methods using daily water-level records from 25 gauging stations in the Saemangeum Watershed, South Korea, from 2020 to 2024. Artificial missing rates of 5%, 10%, 15%, and 20% were introduced, and missing values were reconstructed using simple linear regression (SLR), multiple linear regression (MLR), spline interpolation, k-nearest neighbors (K-NN), autoregressive integrated moving average (ARIMA), and inverse distance weighting (IDW). Numerical performance was assessed using the root mean square error, coefficient of determination, and Willmott's modified index of agreement (D_{mod}). Structural preservation was evaluated by applying the principal component analysis-based K-medoids clustering procedure to the original and each imputed dataset and comparing the resulting cluster assignments using the adjusted rand index (ARI). K-NN achieved the highest overall numerical performance, whereas MLR and SLR better preserved the original cluster structure. These results show that high reconstruction accuracy does not necessarily ensure preservation of the underlying time-series structure. Therefore, imputation methods should be selected based on the purpose of study, particularly for clustering and other signal-based hydrological analyses.

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Keywords: Daily water level, Time-series structure preservation, Principal component analysis, K-medoids clustering



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PS2-8

AI-Assisted Landslide Identification from Multi-Source Remote Sensing Imagery for Post-Typhoon Watershed Conservation in Taiwan

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ABSTRACT

Taiwan is frequently affected by typhoons and extreme rainfall, which trigger landslides in mountainous watersheds and increase downstream sediment-related risks. Rapid landslide mapping after major storm events is therefore essential for watershed conservation and disaster response, yet conventional landslide inventories still rely heavily on manual interpretation of satellite or aerial imagery, limiting the timeliness of large-area assessments.

This study develops an AI-assisted landslide identification framework that combines multi-source remote sensing imagery with Mask R-CNN instance segmentation, using Sentinel-2 as the initial satellite data source. A two-stage transfer learning strategy is adopted. The model is first domain-pretrained on the CAS Landslide Dataset to learn general landslide characteristics across sensors and resolutions, and is then fine-tuned with island-wide Sentinel-2 imagery of Taiwan and official landslide inventories provided by the Agency of Rural Development and Soil and Water Conservation. To reflect practical post-disaster applications, the framework emphasizes temporal generalization: the model is trained with pre-event imagery and existing landslide records, and evaluated on post-event imagery, focusing on newly developed landslides after Typhoon Gaemi in 2024. Preliminary experiments indicate that the fine-tuned model can effectively delineate large landslides at 10 m resolution.

The expected outputs include landslide masks and spatially explicit change information that support rapid screening of affected watersheds, prioritization of field verification, and post-disaster decision-making for watershed conservation in Taiwan.

Keywords: Landslide identification, Remote sensing imagery, Mask R-CNN, Transfer learning, Watershed conservation



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PS2-9

Deep Learning-Based Soil Moisture Classification Using RGB Images of Persimmon Leaves for Irrigation Decision Support

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ABSTRACT

Nara Prefecture is one of the major persimmon-producing regions in Japan, where appropriate irrigation management is essential for maintaining and improving fruit yield and quality. However, current irrigation practices often rely on growers' experience or soil moisture sensors, highlighting the need for a low-cost and practical irrigation decision support method. In this study, a deep learning model using RGB images of persimmon leaves was developed, and its classification performance was evaluated.

RGB images and soil moisture data were collected in an open-field persimmon orchard from June to September during 2022–2025. Soil moisture measurements were converted into pF values using a soil water retention curve and categorized into four soil moisture classes to label the leaf images. A convolutional neural network (CNN) model was developed, and its performance was evaluated in terms of the effect of training dataset size on classification accuracy, applicability to different years and orchards, and misclassification patterns.

The CNN model achieved a classification accuracy of approximately 70% with an F1-score of 0.7. Increasing the number of training images beyond 5,000 did not result in a substantial improvement in classification performance. Most misclassifications occurred between adjacent soil moisture classes. Furthermore, evaluation using data collected from different years and orchards revealed a decline in classification performance. Future work will investigate the effects of imaging conditions and orchard environments on classification performance and improve the model's generalization capability by incorporating more diverse orchard datasets.

Acknowledgements: This research received financial support from the Research on Creating SOPs for Smart Production Methods (Standard Operating Procedures for Introduction and Operation of Smart Agriculture Technologies) provided by the Project of the National Agriculture and Food Research Organization (NARO).

Keywords: Deep learning, CNN, Irrigation management, Fruit tree, Soil moisture



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PS2-10

Leakage Detection in Model Pipeline using Water Hammer Simulation with Viscoelasticity and Structural Vibration

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ABSTRACT

Water hammer pressure is widely used for pipeline leakage detection. This research aims to improve leakage detection by accurately simulating the transient pressure generated by water hammer in pipeline. A one-dimensional model of transient flow in viscoelastic pipelines is formulated from the continuity and momentum equations. The viscoelastic behavior of the pipe wall is described by the Kelvin–Voigt model, and the strain equation is derived. To validate the proposed model, experiments were conducted using a laboratory-scale pipeline. During the experiment, structural vibration of the pipeline is observed in addition to the pressure waves generated by downstream valve closure. Therefore, signal processing is performed on the measured data to isolate the structural vibration. The extracted component is combined with the transient pressure calculated by the method of characteristics to obtain the simulated response. The simulation is verified by comparing piezometric head data under non-leakage and experimental leakage conditions. In both cases, the calculated results were detected good agreement with the experimental measurements. These results demonstrate that the proposed simulation, combining the viscoelastic transient flow model with the structural vibration, is accurate and reliable. This study presents pipeline transient pressure simulation incorporating both viscoelastic water hammer analysis and experimentally observed structural vibration. The approach reproduces the measured responses under both non-leakage and leakage conditions and demonstrates its ability to capture responses that the conventional viscoelastic model alone cannot capture. Consequently, the proposed method is expected to contribute to the development of more accurate leakage detection techniques for pipeline systems.

Keywords: water hammer, pipeline leakage detection, viscoelastic pipeline



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PS2-11

Preliminary Evaluation of Early Spider Mite Damage Monitoring in Edible Roses Using Low-Cost RGB Imaging and Color Indices

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ABSTRACT

Spider mites are a major pest in edible rose production, yet early-stage damage is difficult to detect visually. Feeding scars, eggs, and frass typically become clearly visible only about three days after infestation, when control measures may already be delayed. Previous studies have shown that leaf hue is related to chlorophyll content and that RGB-derived color indices respond to changes in plant physiological status under stress, suggesting that such indices may enable earlier assessment of damage. This study examines whether quantitative color indices obtained from low-cost RGB imaging can detect spider mite damage earlier and more objectively than visual inspection. Rose leaves were photographed repeatedly after spider mite inoculation using a fixed imaging setup. Gray-card calibration was applied to reduce variability caused by illumination conditions. From the calibrated images, we calculated the Green-Red Vegetation Index (GRVI) and the CIELAB hue angle, both of which are associated with chlorophyll loss and leaf discoloration. To account for plant-to-plant variation, each plant's healthy condition was used as its own baseline, and subsequent changes were evaluated relative to a tolerance range derived from the healthy state rather than by applying a single threshold to all plants. Preliminary results showed that both GRVI and hue angles tend to decrease as damage progressed, indicating their potential as non-destructive indicators of early infestation. However, further validation with a larger number of plants is required, together with a quantitative comparison of detection timing with visual inspection. These findings provide a basis for the future development of a model for assessing spider mite damage severity in edible rose leaves.

Keywords: spider mite, GRVI, CIELAB



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PS2-12

Network-Based Sensitivity Analysis of Optimized Irrigation Gate Operations

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ABSTRACT

Multiobjective optimization can generate irrigation gate operation schedules that effectively balance irrigation water deficits and spatial water distribution. However, Pareto-optimal solutions often consist of numerous alternative gate combinations with similar performance, making it difficult to identify which gates consistently influence system performance and how irrigation network structure governs these responses. Existing studies have primarily focused on optimization and control performance, whereas the sensitivity of optimized gate operations and their structural dependence within irrigation networks remain poorly understood. This study proposes a network-based sensitivity analysis framework for optimized irrigation gate operations in the Geumseok irrigation district, South Korea. A reservoir–canal–paddy network was represented using EPA-SWMM, and weekly gate-opening ratios were optimized under drought, normal, and wet-year conditions using NSGA-III. Four objective functions were considered: irrigation deficit magnitude, deficit frequency, drainage distribution inequality, and supply–drainage imbalance. A representative Pareto-optimal solution was selected using TOPSIS, and its robustness was evaluated through knee-point comparison and weight perturbation analysis. Gate sensitivities were quantified by comparing Pareto-wide gate–objective relationships with one-at-a-time perturbations across multiple perturbation levels. Additional analyses of hydraulically connected gate pairs and near-optimal solutions under contrasting hydrologic conditions were performed to distinguish persistent sensitivities from scenario-dependent responses. Finally, the identified sensitivities were interpreted using irrigation network characteristics, including distance from the water source, irrigated area, branching position, elevation difference, and overlapping delivery pathways. The proposed framework identifies critical irrigation gates and explains their operational importance based on irrigation network structure, providing practical guidance for robust gate operation and irrigation water management under varying hydrologic conditions.

Acknowledgements: This work was supported by the Korea Environmental Industry & Technology Institute (KEITI) through Climate Resilient R&D Project for Water-Related Disaster Management, funded by the Korea Ministry of Climate, Energy and Environment (MCEE) (RS-2026-25501478).

Keywords: Multiobjective optimization, Pareto-optimal solution, Irrigation gate operation, Sensitivity analysis, Hydraulic network structure



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PS2-13

A Data-Driven Framework for Adaptive Reservoir Operation Using Machine Learning and System Dynamics

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ABSTRACT

Climate change has increased the frequency and severity of agricultural droughts, requiring adaptive reservoir operation to ensure reliable irrigation water supply. Although machine learning (ML) has improved reservoir storage prediction, translating predictive results into practical operational decisions remains challenging. This study proposes a data-driven framework that integrates ML-based reservoir storage prediction, feature importance analysis, historical reservoir behavior, and System Dynamics (SD) modeling to derive reservoir operation criteria for drought response. Historical hydrological, meteorological, and reservoir operation data were used to develop an ML model for forecasting reservoir storage. Feature importance analysis identified the key variables governing storage variation and supported establishing operation criteria. Historical drought events, rainfall patterns, and reservoir storage depletion characteristics were further analyzed to determine threshold conditions for implementing water-saving measures. The derived criteria were incorporated into an SD model to evaluate alternative reservoir operation strategies under different drought scenarios. The proposed framework enables reservoir operation criteria to be systematically derived from predictive information rather than expert judgment alone, while providing a decision-support tool for comparing alternative management strategies. By integrating prediction, data-driven rule derivation, and dynamic simulation within a unified framework, the proposed approach enhances adaptive reservoir operation and supports climate-resilient agricultural water management under increasing drought risk.

Acknowledgements: This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, and Forestry (IPET) through Intelligent Agricultural Infra Management for Climate Change Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (RS-2025-02219764).

Keywords: Agricultural reservoir, Machine learning, Reservoir storage prediction, System dynamics, Water-saving operation



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PS2-14

Hydrological Modeling and Future Risk Assessment for Tea Plantations: A Case Study of Pinglin Tea Plantations

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ABSTRACT

Tea plantations are perennial crop systems whose hydrological responses are influenced by rainfall, infiltration, slope drainage, soil water storage, and evapotranspiration. However, small-scale tea plantations often lack long-term and complete hydrological observations, resulting in uncertainty in model calibration, parameter identification, and future climate assessment. This study uses a sloping tea plantation in Pinglin, Taiwan, as a case study to develop a hydrological modeling and future soil water risk assessment framework.

Flux-tower observations, soil moisture observations, nearby long-term meteorological records, and statistically downscaled daily climate data are integrated to establish a daily hydrological analysis workflow. The climatic context of the flux-tower observation period is first examined, and a root-zone water balance model is then used to simulate soil water dynamics. Soil moisture observations are used as the primary calibration and validation target. Considering the possibility of multiple plausible parameter sets under limited observations, this study retains parameter sets that satisfy physical ranges and observational performance to represent model uncertainty.

Future climate data and management scenarios will be combined to assess soil water risks and potential adaptation directions for the Pinglin tea plantation under climate change. The expected outcome is a hydrological modeling workflow for this case study and a reference for future soil water risk assessment and agricultural water management planning at the study site.

Keywords: hydrological modeling, sloping tea plantation, flux tower, soil moisture, climate change



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PS3-1

Detection of Spatially Persistent Rice Growth Variability Using Multi-Temporal UAV Vegetation Indices in an AWD Paddy Field

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ABSTRACT

Alternate wetting and drying (AWD) irrigation can reduce methane emissions from paddy fields; however, spatially uneven soil drying may cause heterogeneous crop growth within a field. This study aimed to detect spatially persistent differences in rice growth using multi-temporal vegetation indices derived from UAV imagery in a sensor-based AWD paddy field. The study was conducted in a 20 m × 50 m paddy field in Japan during the 2025 rice-growing season. Multispectral UAV surveys were conducted at approximately weekly intervals. The normalized difference vegetation index, normalized difference red-edge index, green chlorophyll index, and red-edge chlorophyll index were calculated and aggregated within fixed spatial grids. For each observation date, the vegetation index values were standardized relative to their field-wide distributions to minimize the effects of temporal changes in crop development and observation conditions. The resulting temporal patterns were analyzed using unsupervised machine learning to identify areas that consistently deviated from the dominant growth pattern. Preliminary analysis of the vegetation index maps revealed spatially persistent differences in rice growth within the AWD field, with relatively low index values repeatedly observed in specific areas following the mid-season drainage period. The magnitude and spatial extent of these differences varied among vegetation indices and observation dates. Temporal changes in UAV-derived canopy height were also compared with the detected spatial patterns as supplementary evidence. These findings suggest that multi-temporal UAV-derived vegetation indices provide a practical approach for identifying persistent within-field growth variability under AWD irrigation without requiring dense networks of water level sensors.

Keywords: alternate wetting and drying, UAV remote sensing, vegetation index, unsupervised machine learning, spatial variability



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PS3-2

Evaluation of the Effectiveness of a Solar-Powered, Low-Energy Drainage System

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ABSTRACT

Paddy soils generally have lower permeability than upland soils and therefore remain waterlogged after rainfall. Because excess moisture adversely affects crop growth, effective drainage is essential when upland crops are cultivated in paddy fields. Open-ditch drainage reduces cultivable area and interferes with machinery operation, whereas subsurface drainage is more efficient but requires continuous external electricity to pump water from collection wells. This study developed a minimum-power-assisted passive drainage system that uses solar energy only for initial activation and then maintains continuous drainage without external power. Performance was evaluated through photovoltaic pump simulation and field-scale prototype testing. Three treatments were established in a field equipped with trenchless subsurface drainage: an undrained control, a collection well connected to the proposed system, and a collection well connected to a conventional electric pump. The prototype comprised a hydraulically designed discharge-induction unit, a photovoltaic power system, and a DC pump. When the water in the well exceeded a threshold, the pump transferred it to a small reservoir. Once the preset level was reached, a sensor activated the discharge-induction unit and initiated siphon flow, enabling gravity-driven drainage without further energy input. The effective pump energy supplied by the photovoltaic system differed from that of the conventional system by only 0.183 Wh day⁻¹, and the conversion efficiency reached 29.99%, closely matching the 30% design target. These results confirm the feasibility of solar-powered initial activation and demonstrate the potential of the proposed system as a self-sustaining, energy-efficient drainage technology for fields with limited access to external electricity.

Acknowledgements: This work was supported by the Rural Development Administration Research Program (PJ01783301), Republic of Korea

Keywords: Passive drainage systems, Solar-powered pumps, Subsurface drainage, Siphon effect, Agricultural drainage management



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PS3-3

Performance Evaluation of an Automated Irrigation Scheduling System Based on Weather Data, Soil Water Content, and Evapotranspiration Estimates

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ABSTRACT

Conventional soil moisture sensor-based irrigation systems often fail to reflect within-field variability and changing meteorological conditions, including rainfall, making uniform crop growth difficult to maintain. This study developed automated irrigation algorithms integrating crop growth stages, soil water content, and meteorological data, and evaluated the effects of evapotranspiration-based surface irrigation on soil moisture and crop growth.

A field experiment was conducted in 2025 in a sandy loam field at the Department of Upland Crop Sciences, National Institute of Crop Science. Five treatments were established: irrigation at 60%, 80%, 100%, and 120% of estimated crop evapotranspiration (ETc), and a rainfed control. Irrigation scheduling was automated using reference evapotranspiration (ETo), calculated from Korea Meteorological Administration data, and crop coefficients (Kc). Crop growth and soil water content were periodically measured and used to develop the irrigation algorithm.

During the 90 days after sowing, the 100% and 120% ETc treatments maintained higher soil water content and showed greater crop growth than the lower irrigation treatments and rainfed control. This trend continued until harvest, although branch and pod numbers did not differ significantly among irrigation treatments. These results indicate that plot-specific precision irrigation can effectively regulate soil moisture and promote early crop growth and development.

This study provides a basis for optimizing irrigation algorithms that account for within-field variability, thereby improving irrigation efficiency and crop productivity. The findings also provide essential data for establishing optimal irrigation standards.

Acknowledgements: This work was supported by the Rural Development Administration Research Program (Project No. RS-2025-RD023034), Republic of Korea.

Keywords: Evapotranspiration, Irrigation scheduling, Surface irrigation, Precision water management



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PS3-4

Evaluation of Deteriorated Status in Service Steel Sheet Pile Canal by Integration of Point Cloud with Thermal Images

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ABSTRACT

Severe corrosion of conventional and lightweight steel sheet piles used for drainage canals has become a major challenge for maintenance and management. Although non-destructive inspection techniques using Terrestrial Laser Scanning (TLS), infrared thermography and visible image have been investigated, quantitative evaluation by integrating geometric and thermal information remains limited.

In this study, point cloud data and thermal images were acquired from coated steel sheet pile in Hokkaido and Niigata, Japan, using a Focus S150 laser scanner made by FARO and an R550Pro infrared camera made by Avio. The point clouds of web elements are extracted by CloudCompare to define reference surfaces. Best-fit planes are generated to estimate the inclination of the steel sheet piles, and surface deviations are quantified by calculating the distances between the fitted planes and the measured point clouds. Thermal distributions obtained from infrared images were analyzed to detect coating delamination.

Thus, the proposed method estimated the inclination of steel sheet piles and quantitatively evaluated their surface geometry. Furthermore, integrating geometric information derived from TLS with thermal distributions enabled a more comprehensive evaluation of deterioration conditions. This study demonstrates the potential of non-contact inspection for detecting coating delamination and supporting objective condition evaluation and maintenance of steel sheet pile channels in agricultural drainage systems.

Keywords: Steel sheet pile channels, Infrared thermography, TLS, Non-destructive testing



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PS3-5

Growth-stage-specific discrimination of waterlogging and drought stress in soybean using VNIR hyperspectral imagery and SPA-LDA

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ABSTRACT

Soybean (*Glycine max* (L.) Merr.) is vulnerable to soil-moisture changes during the growing season, and its yield is strongly affected by two opposite water stresses, waterlogging and drought. Because they require contrasting management—drainage versus irrigation—distinguishing the type of stress early and non-destructively is essential for appropriate treatment. This study used visible and near-infrared (VNIR, 400–1000 nm, 224 bands) hyperspectral reflectance to classify control, waterlogging, and drought in soybean across five growth stages (V1, V5, R1, R3, R5) and to identify the spectral bands that distinguish the two stresses. To alleviate the strong multicollinearity among adjacent bands, the successive projections algorithm (SPA) selected few mutually low-correlated wavelengths, supplied to linear discriminant analysis (LDA); the number of wavelengths was set by nested cross-validation, and models were evaluated by leave-one-group-out cross-validation over four replicates. SPA selected mostly near-infrared wavelengths together with a short-wavelength visible band near 401 nm, and these few wavelengths matched or exceeded the full 224-band spectrum. In the LDA structure, near-infrared wavelengths around 940 nm mainly separated drought from the other treatments, whereas a red-edge wavelength near 710 nm governed the control–waterlogging boundary. Performance varied with growth stage and was highest at early pod filling (R3), with a macro F1-score of about 0.89. Interpreting few SPA-selected wavelengths through LDA can thus characterize the bands distinguishing waterlogging from drought, contributing to early, growth-stage-specific water-stress diagnosis.

Keywords: hyperspectral imaging, VNIR, soybean, waterlogging, drought, successive projections algorithm, linear discriminant analysis, growth stage



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PS3-6

Seasonal habitat use of a domestic invasive bitterling fish: implications for efficient management in rural water systems

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ABSTRACT

The establishment of invasive species has severely affected native organisms and ecological functions in rural water systems. Therefore, effective management of invasive species is essential for conserving biodiversity in rural water systems. Identifying seasonal habitat use is important for prioritizing control sites and improving eradication efficiency. The bitterling fish *Rhodeus atremius atremius* has become established as a domestic invasive species in multiple rural water systems in Japan, raising concerns about its ecological impacts on native bitterlings and rural biodiversity. This study aimed to clarify seasonal habitat preferences of this fish and provide information for its effective management in invaded rural water systems. Field surveys were conducted monthly from June 2023 to May 2024 at 19 sites in a river where the fish is established. Fish were collected using traps, and environmental variables including water temperature, velocity, depth, vegetation cover, above-water cover, substrate type, and revetment type were recorded. For the active season (April–October) and the overwintering season (November–March), generalized linear mixed models (GLMMs) were constructed using either presence/absence or number of individuals as the response variable. The analysis revealed that the fish preferred low water temperature, sandy substrates, and no above-water cover during the active season, whereas during the overwintering season it preferred habitats with above-water cover and formed overwintering aggregations. These findings suggest that the timing and locations of control efforts can be optimized by targeting overwintering aggregations. Concentrating management activities at overwintering sites may improve eradication efficiency while reducing management costs in rural water systems.

Keywords: rural ecosystem, invasive species, habitat preference, bitterling fish



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PS3-7

Burrow use by reproductive females of the invasive red swamp crayfish (*Procambarus clarkii*): implications for irrigation pond management

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ABSTRACT

The invasive red swamp crayfish (*Procambarus clarkii*) damages irrigation facilities through burrowing, causing water leakage from rice paddy levees and collapse of irrigation ponds in Japan. Consequently, effective management of *P. clarkii* is needed to reduce damage to agricultural infrastructure. A reproductive female of *P. clarkii* can produce approximately 700 eggs. Therefore, removing reproductive females is considered an effective management strategy. However, methods for selectively capturing them remain unclear. In this study, we aimed to identify conditions associated with capturing reproductive females of *P. clarkii* in irrigation ponds. Field surveys were conducted from May to December 2024 in an irrigation pond in Hiroshima, Japan. Crayfish were collected using baited cage traps or direct from burrows. For each individual, postorbital carapace length (POCL) and sex were recorded; for females, reproductive status (presence of eggs, hatchlings, or glair glands) was recorded. For individuals collected from burrows, the presence of a chimney (a chimney-shaped structure formed around the burrow entrance) was also recorded. Decision tree analysis was performed on all captured females using reproductive status as the response variable and capture method, sampling month, and chimney presence as explanatory variables. The analysis indicated that females collected directly from burrows with chimneys during August–October were most likely to be reproductive. In addition, females captured in traps had significantly smaller POCL than those collected from burrows (Dunn's test, $P < 0.05$). These findings suggest that targeting burrows with chimneys during August–October would enable the selective capture of large reproductive females of *P. clarkii*.

Keywords: burrow use, invasive species management, irrigation pond, red swamp crayfish, reproductive females



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PS3-8

A SWAT–MODFLOW framework integrating bacterial infiltration and transport processes

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ABSTRACT

Livestock manure applied to cropland and fecal deposition from grazing animals are important sources of *Escherichia coli* (*E. coli*). In many rural areas, drinking water is obtained from shallow wells beneath agricultural land. Contamination of shallow groundwater is difficult to detect, may persist after surface runoff ends, and can sustain in-stream bacterial concentrations through groundwater discharge. SWAT–MODFLOW links watershed hydrology with groundwater flow and represents pathways from precipitation and runoff to infiltration, groundwater movement, and stream return flow. However, existing SWAT–MODFLOW applications do not incorporate mechanisms for bacterial infiltration and transport. This study develops a SWAT–MODFLOW framework that integrates bacterial processes across the land surface, unsaturated zone, aquifer, and stream. In SWAT, livestock-derived *E. coli* loads undergo temperature-dependent die-off and rainfall-driven mobilization before being partitioned between runoff and infiltration. Infiltrated bacteria move through the unsaturated zone, where they undergo die-off and temporary soil retention and may be remobilized by subsequent rainfall. The bacterial mass reaching the water table is converted to a cell-specific recharge concentration using bacterial mass flux and groundwater recharge volume. Bacteria are then transported through the aquifer as reactive constituents subject to advection, dispersion, die-off, and attachment, and are returned to streams through groundwater discharge. The framework will be applied to an agricultural watershed to identify periods and locations of elevated contamination risk and evaluate livestock-manure management strategies.

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Keywords: Bacterial infiltration, *Escherichia coli*, Groundwater contamination, SWAT-MODFLOW



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PS3-9

Upstream migration behavior of freshwater shrimps in a V-shaped portable fishway: Implications for fishway design

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ABSTRACT

Among agricultural water facilities, intake weirs create vertical drops in rivers and channels, disrupting aquatic connectivity and restricting organism movement. Securing longitudinal connectivity is essential for maintaining populations of migratory aquatic organisms that move among the sea, rivers, channels, and rice paddies. In previous studies, we proposed a low-cost, portable fishway with a V-shaped cross section for agricultural structures. However, while knowledge regarding fish species has accumulated, information on fishway utilization by freshwater shrimps remains limited. This study aimed to clarify the upstream migration behavior of freshwater shrimps in a V-shaped portable fishway. Field experiments were conducted to analyze shrimp migration routes using video recordings, and laboratory experiments replicating field conditions were conducted to measure the hydraulic characteristics within the fishway. Upstream migration of three freshwater shrimp species was confirmed, and most individuals migrated within approximately 7 cm of the water's edge. In low-velocity sections, smaller individuals tended to migrate closer to the edge, a tendency particularly pronounced in juvenile individuals. Furthermore, even when discharge varied from 0.8 to 2.0 L/s, shallow water depth and low flow velocity were consistently maintained along the edge compared to the flow center, providing a favorable environment for shrimps. These findings indicate that, to improve the applicability of the fishway for freshwater shrimps, securing a 7 cm wide migration corridor along the sidewalls and providing a gradual transition zone from low- to high-velocity flow are crucial.

Keywords: aquatic connectivity, fishway design, freshwater shrimps, portable fishway, rural ecosystem, upstream migration behavior



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PS3-10

Assessing Parameter Sensitivity in the InVEST Annual Water Yield Model under Future Development and Climate Change Scenarios

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ABSTRACT

The concept of ecosystem services has received increasing attention in recent years, and various quantitative and monetary valuation models have been developed internationally for applications in urban planning and land-use change assessment. This study applies the Annual Water Yield Model in InVEST to evaluate changes in ecosystem services under future land development and climate change scenarios. By integrating IPCC AR6 climate change scenarios with land-use change data, this research assesses potential variations in annual water yield, utilizing the Taoyuan Aerotropolis, one of Taiwan's largest ongoing land development projects, as a case study. Given the high uncertainty associated with future land use and climate change, the Extended Fourier Amplitude Sensitivity Test (EFAST) is employed to analyze the sensitivity of model parameters. Historical river runoff data from the study area are used for model validation. Furthermore, to address inherent modeling uncertainties, a Markov Chain Monte Carlo (MCMC) algorithm is employed to determine plausible parameter bounds and optimal parameter configurations. By enhancing the predictive robustness and interpretability of water yield simulations, these findings provide a critical, evidence-based foundation for sustainable land-use planning and ecosystem service assessments under concurrent climatic and anthropogenic pressures.

Keywords: Ecosystem services, InVEST model, Land-use change, Climate change scenarios, Sensitivity analysis



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PS3-11

Integration and Advancement of Climate Change Vulnerability Assessment for Agricultural Production Infrastructure Based on SSP Scenarios

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ABSTRACT

The increasing frequency and intensity of extreme weather events driven by climate change, such as droughts and floods, pose serious threats to the stable supply of agricultural water and the safety of aging agricultural production infrastructure. This calls for an advanced vulnerability assessment framework based on the SSP scenarios of the IPCC Sixth Assessment Report (AR6). However, the previous assessment had limitations in the comprehensive interpretation of results across sectors and facilities and lacked quantitative validation procedures for indicators. This study aims to integrate and advance the previous vulnerability assessment framework and to establish strategies for applying the results across all fields of agricultural SOC (social overhead capital).

Redundant indicators were consolidated through correlation analysis, eight new indicators—four each for the water utilization and flood control sectors—were developed, and weights for climate exposure, sensitivity, and adaptive capacity were determined through AHP analysis. A vulnerability assessment was then conducted for 167 cities and counties and 511 rural agricultural water districts nationwide for 2031–2070, using 18 GCMs and a multi-model ensemble (MME) under the SSP2-4.5 and SSP5-8.5 scenarios. Sinan-gun and Muan-gun in Jeollanam-do were identified as highly vulnerable in the water utilization sector, and Suncheon-si, Haenam-gun, and Jangheung-gun in the flood control sector.

Furthermore, agricultural SOC was classified into five sectors, and a full life-cycle climate response framework—from design and construction to maintenance, diagnosis, and rehabilitation—was proposed with phased new research projects (RFPs). The findings are expected to serve as a scientific basis for climate crisis response policies in agriculture and rural areas.

Keywords: Climate change vulnerability assessment, Agricultural production infrastructure, SSP scenarios, Multi-model ensemble (MME), Agricultural SOC



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PG1-1

Sulfur-induced thiol metabolism enhances arsenic uptake, oxidative stress tolerance, and mineral nutrient homeostasis in hydroponically grown rice seedlings

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ABSTRACT

Sulfur (S) nutrition improves abiotic stress tolerance in rice, but its dual role in As accumulation in rice remains understudied. Therefore, this study elucidated the effects of different S regimes on As uptake, translocation, and plant growth in hydroponically cultivated rice seedlings. The seedlings were exposed to 15 μ M As under three S levels (0, 1, and 4 mM) for 15 days. Plant height, shoot and root dry weight, As content, oxidative stress markers, thiol metabolites, and nutrient profiles were evaluated. S supplementation alleviated As-induced growth inhibition in a dose-dependent manner and significantly increased As accumulation in roots and shoots. Elevated S supplementation reduced oxidative stress and lipid peroxidation and promoted thiol-based detoxification systems, particularly in roots. Additionally, S improved the uptake of major nutrients, such as nitrogen, phosphorus, and potassium, and selectively modulated micronutrient distributions under As stress. Correlation network analysis revealed that S supplementation coordinated biomass recovery, thiol-mediated As chelation, oxidative stress mitigation, and nutrient homeostasis. Overall, these findings suggest that targeted S fertilization plays a dual role in improving rice tolerance to As stress while enhancing As accumulation without compromising seedling growth.

Keywords: Arsenic, Rice, Sulfur, Detoxification, Thiol metabolism



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PG1-2

Spatial Variability of Soil Physical Properties and Its Influence on Rice Growth and Grain Yield in Large-Scale Paddy Fields

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ABSTRACT

In 2023, a field study was conducted in Minamisoma City, Fukushima Prefecture, Japan, to investigate the influence of spatial variability in soil physical properties on rice growth and grain yield in large-scale paddy fields. Four paddy fields, each approximately 1 ha in size, were surveyed.

Soil physical properties were characterized by measuring penetration resistance at 1-cm intervals to a depth of 60 cm and volumetric water content in the 1–10 cm soil layer at approximately 60 sampling locations per field. Rice growth was evaluated using unmanned aerial vehicle (UAV) imagery acquired in late July, from which the Green Normalized Difference Vegetation Index (GNDVI) was derived. Grain yield was measured in early September using a combine harvester equipped with a yield monitor, and yield data were recorded at a 5-m spatial resolution.

To integrate the datasets, each field was divided into 5-m hexagonal grids, and all measurements were assigned to the corresponding grids based on their geographic coordinates. Principal component analysis (PCA) followed by cluster analysis was then applied to the integrated geospatial dataset.

The first four principal components were interpreted as drainage conditions, crop growth, soil hardness, and grain yield, collectively explaining 73.5% of the total variance. Cluster analysis classified the study area into five groups characterized by distinct productivity patterns. These findings demonstrate that spatial variability in soil physical properties is closely associated with variations in rice productivity both within and among large-scale paddy fields.

Keywords: Spatial variability, Soil physical properties, Penetration resistance, GNDVI, Multivariate analysis



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PG1-3

Economic Analysis of Paddy Field Water Management with In-Field Ditches

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ABSTRACT

In Hokkaido, Japan, declining farmer numbers and expanding farm sizes have driven the need for water management and field design methods that minimize construction, maintenance, and management costs. We previously focused on ditches along the inside slopes of levees (hereinafter “in-field ditches”) as an irrigation method capable of reducing field-by-field water management labor and of minimizing terminal irrigation facilities. Field trials under this method were conducted in rice paddies using dry direct-seeding culture. While in-field ditches ensure uniform irrigation water distribution in the plot, they may also affect farm profitability by reducing the planted area. In this study, using field trial data—including on reductions in planted area, on labor hours, and on material costs—we estimated the labor requirements and farm profitability associated with installing and maintaining in-field ditches in hypothetical, huge rice paddy plots. It was found that, while economies of scale from larger field plots offset the increased costs of using in-field ditches, the financial impact of the reduction in planted area varies significantly depending on the ditch layout. To reduce water management labor while preserving the planted area, it is essential that economic viability be evaluated and that ditch layouts appropriate for the field scale be designed.

Keywords: Dry direct-seeding, Water management labor, Planted area



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PG1-4

Tracking the Seasonal Evolution and Migration of Drought Clusters for Agricultural Drought Monitoring in South Korea

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ABSTRACT

Agricultural drought evolves continuously in space and time, affecting crop production, irrigation demand, and water resource reliability. Conventional station- or grid-based assessments often fail to capture the persistence, expansion, and migration of drought-affected areas. This study tracks seasonal drought-cluster evolution across South Korea using high-resolution gridded climate data. Monthly precipitation from Climate Hazards Center InfraRed Precipitation with Station Data Version 3.0 (CHIRPS V3.0) and maximum and minimum temperature from Climate Hazards Center InfraRed Temperature with Stations-ERA5 (CHIRTS-ERA5) were compiled for 4,012 land grid cells from 1981 to 2024. Potential evapotranspiration was estimated using the Hargreaves method, and SPI-6 and SPEI-6 were calculated. Grid cells with index values ≤ -1.0 were grouped into spatiotemporally continuous clusters using ST-DBSCAN. Cluster evolution was evaluated by seasonal occurrence, spatial extent, duration, intensity, centroid displacement, stationarity, and migration direction. The framework characterizes how drought clusters persist, expand, merge, and migrate across regions, providing a practical basis for improved agricultural drought monitoring, early recognition of expanding drought conditions, and timely agricultural water management.

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Keywords: agricultural drought, drought clusters, drought migration, gridded climate data, spatiotemporal clustering



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PG1-5

Assessment of Upland Drought Impacts and Si/Gun-Level Vulnerability Considering Crop and Soil Characteristics

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ABSTRACT

Changes in precipitation patterns and the increasing frequency of climate-induced disasters threaten the stable supply of agricultural water resources. Although upland drought directly affects crop growth and productivity, systematic assessment and response strategies remain insufficient compared with those for paddy rice. This study proposes an assessment framework for upland drought impacts and vulnerability considering crop and soil characteristics, consisting of crop-specific impact assessment and Si/Gun-level vulnerability assessment. The impact assessment evaluates crop responses to soil water availability for Chinese cabbage, onion, sweet potato, and red pepper and develops a soil water balance model to simulate soil moisture dynamics. The model is then used to simulate crop growth and yield under different soil moisture conditions and to evaluate drought impacts under varying drought intensities and drought occurrence timings. For vulnerability assessment, the existing Upland Drought Vulnerability Index (UDVI) is extended to the Si/Gun administrative level. Using agricultural and water resource data at the Si/Gun level, the assessment framework is organized into three components—Exposure, Sensitivity, and Adaptive Capacity—to derive a regional vulnerability index. Furthermore, the impact and vulnerability assessment results are integrated with agricultural resource indicators, including crop yield, crop water requirement, and irrigation requirement, to establish a nexus-based assessment framework that considers the interactions among water, soil, and crop resources. The proposed framework is expected to support agricultural drought management and decision-making by improving methods for assessing upland drought impacts and vulnerability based on crop and soil characteristics and by incorporating an agricultural resource-based nexus approach.

Keywords: Upland drought, Impact assessment, Vulnerability assessment, Agricultural resources, Nexus



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PG1-6

Propagation of Rapid Onset Drought through Surface Water Systems and Vegetation in an Irrigated Rice Watershed

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ABSTRACT

Rapid onset droughts can develop quickly and affect agricultural water availability before conventional drought signals become fully established. In irrigated rice watersheds, reservoirs, river networks, and managed water supply systems may moderate the effects of rapid soil moisture depletion. This study evaluates how rapid onset drought propagates through surface water systems and influences vegetation conditions in the Anseongcheon mid-watershed, South Korea, from 2017 to 2024. Rapid onset drought intensity is represented by the Flash Drought Intensity Index (FDII), derived from changes in soil moisture percentiles. Surface water conditions are assessed using WSA_spread, a river network indicator based on satellite observations of reservoir water surface area. Vegetation response is evaluated using Normalized Difference Vegetation Index anomalies as indicators of vegetation condition and potential crop stress. Weekly FDII, monthly WSA_spread, and NDVI observations at 16 day intervals are harmonized to monthly time steps. Time series comparison, correlation analysis, lag correlation analysis, event centered composite analysis, and compound stress classification are used to examine temporal linkages among drought intensity, surface water deficit, and vegetation response. The analysis is expected to clarify how rapid soil moisture depletion affects surface water availability and vegetation condition, while identifying periods of simultaneous stress. The framework can support drought monitoring, agricultural water management, and climate resilient rice production.

Acknowledgements: This work was supported by the Korea Environmental Industry & Technology Institute (KEITI) through Climate Resilient R&D Project for Water-Related Disaster Management, funded by the Korea Ministry of Climate, Energy and Environment (MCEE) (RS-2026-25501478).

Keywords: Flash drought, Drought propagation, Reservoir water surface area, Vegetation stress, Agricultural water management



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PG1-7

Episodic nitrogen leaching in sloping cropland under monsoon climate: re-evaluating the IPCC FracLEACH default

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ABSTRACT

Indirect nitrous oxide (N₂O) emission inventories rely on the IPCC default fraction of nitrogen lost via leaching and runoff (FracLEACH: 0.30 in 2006, revised to 0.24 in 2019), yet its applicability to monsoon climates and sloping croplands remains uncertain. This study quantified interannual variability in FracLEACH using the process-based APEX model, calibrated and validated against five years (2021–2025) of field observations from a sloping lysimeter cropland (13% slope) in South Korea. Model performance was satisfactory, with Nash–Sutcliffe efficiency (NSE) values of 0.83–0.89 for runoff and 0.52–0.57 for total nitrogen load. Estimated FracLEACH ranged from 0.12 to 0.69, with a five-year mean of 0.26 falling between the two IPCC default values. However, most years fell below both defaults, while one year showed a markedly elevated value driven by episodic leaching, in which nitrate accumulated during an extended dry period was rapidly mobilized by consecutive rainfall events. Nitrogen loss was dominated by deep percolation rather than surface or lateral flow, indicating an infiltration-driven hydrological response. These results show that FracLEACH in monsoon systems is governed by the temporal coupling between nitrogen availability and hydrological events rather than by annual rainfall or nitrogen input alone, so a single default value cannot adequately capture its variability. Region-specific, multi-year, observation-based approaches are needed for emission factor estimation, and the findings provide field-scale evidence to reduce uncertainty in indirect N₂O emission estimates under changing monsoon conditions.

Keywords: APEX model, interannual variability, indirect N₂O emissions, nitrogen transport, emission factor uncertainty, episodic leaching



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PG1-8

A Web-Based Platform for Exploring Global Water Resource Data

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ABSTRACT

Access to global-scale water resource information remains a challenge for many researchers, policymakers, and practitioners, especially where high-resolution model outputs are difficult to obtain or interpret without specialized tools. This study presents an open-source web platform designed to make such information easy to explore. Built on the CoSWAT (Community SWAT+) framework, a globally applied hydrological model, the platform provides interactive maps, time series charts, and area-based statistics for over 42 water-related variables, including precipitation, evapotranspiration, runoff, snowmelt, and soil moisture, covering 197 countries at high spatial resolution. Users can browse different regions and time periods, compare variables or locations side by side, and extract data for specific points or areas without needing specialized software. The underlying global model was evaluated against real-world river flow and evapotranspiration observations. Results showed that the model captures general spatial and seasonal patterns well, though additional calibration is needed to improve accuracy at individual river basins. The platform was developed collaboratively by the Rural Development Administration of Korea and Texas A&M AgriLife Research. It is freely available under an open license, supporting research, education, and water-related policy decisions worldwide.

Keywords: SWAT+, CoSWAT, web-based GIS platform, water resources visualization



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PG1-9

Long-Term Hydrologic and Water Quality Responses to Crop Diversification in Paddy Rice Systems of the Saemangeum Reclaimed Watershed

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ABSTRACT

Crop diversification in rice-dominated regions is accelerating, but there is still limited evidence on how rotating rice with upland crops changes key water-related ecosystem services, especially groundwater recharge, while also affecting productivity and nutrient outcomes. This study examined the long-term hydrologic and water-quality implications of transitioning from continuous irrigated rice to rotation systems in a watershed of the Saemangeum reclamation area, South Korea, where management is expected to shift soil water balance and percolation pathways, such as less standing-water irrigation, different rooting and evapotranspiration patterns, and altered seasonal recharge. Using a coupled watershed-groundwater analysis (SWAT with MODFLOW), we evaluate four representative cropping systems, including irrigated rice, rice-wheat, corn-wheat, and soybean-wheat, and evaluated streamflow, groundwater heads, groundwater recharge (as a provisioning service), total nitrogen loads, and yield-based metrics including water productivity and water-use efficiency. The modeling reproduced observed hydrologic behavior and crop yields at acceptable levels. Results indicate that rice-wheat rotation increased groundwater recharge and improved water productivity and water-use efficiency relative to continuous rice monoculture, suggesting that diversification can enhance both agronomic performance and groundwater-related services in paddy-dominated landscapes. Rotations that fully transition to upland crops (corn-wheat and soybean-wheat) produced smaller watershed-scale changes in streamflow, but showed potential for modest long-term reductions in total nitrogen loads while maintaining or slightly improving recharge. Overall, the findings highlight rotation, particularly rice-wheat, as a practical pathway for rice-dominated reclaimed watersheds to improve groundwater sustainability and nutrient management, while also addressing a key knowledge gap on the groundwater consequences of diversification with upland crops.

Acknowledgements: This study was carried out with the support of “Cooperative Research Program for Agricultural Science & Technology Development (Project No.RS-2026-25517429)”, Rural Development Administration, Republic of Korea.

Keywords: Rice paddy, Crop rotation, Nitrogen, Groundwater, Water productivity



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PG1-10

Four years of invasive red swamp crayfish (*Procambarus clarkii*) control promoted biodiversity recovery in an agricultural pond in Japan

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ABSTRACT

Agricultural ponds provide irrigation water storage and important habitats for aquatic organisms. In Japan, the invasive red swamp crayfish (*Procambarus clarkii*) was designated as a Conditional Invasive Alien Species in 2023 because of its adverse impacts on biodiversity. In March 2026, the Ministry of Agriculture, Forestry and Fisheries published a manual for red swamp crayfish management in rural areas, highlighting the need for effective control measures in agricultural ponds. This study evaluated the effectiveness of four years of crayfish control and its ecological effects in a small agricultural pond in Yamaguchi Prefecture, Japan. Crayfish were continuously removed using hand nets, cage traps, continuous-capture traps, artificial vegetation traps, and artificial burrows. Aquatic organisms were simultaneously monitored to assess ecological responses to crayfish suppression. A total of 7,858 crayfish were removed during the study period. Catch per unit effort (CPUE) in continuous-capture traps decreased from 51.8 individuals trap⁻¹ at the beginning of the control effort to generally less than 10 individuals trap⁻¹ after two years, indicating a substantial reduction in crayfish abundance, particularly of large individuals. Reduced crayfish density led to a stepwise recovery of aquatic biodiversity. Amphibians re-established breeding populations, dragonfly larvae, particularly benthic species, increased markedly, and juveniles of the endangered Japanese medaka (*Oryzias latipes*) appeared in the fourth year, indicating improved habitat quality. These findings demonstrate that sustained invasive species management can promote ecosystem restoration and can be integrated into sustainable agricultural water management to enhance the multifunctional value of agricultural ponds.

Keywords: agricultural pond, biodiversity recovery, ecosystem restoration, invasive species management, red swamp crayfish



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PG1-11

Improving Agricultural Water Demand Estimation by Revising Unit Water Supply Based on Reservoir Operation Characteristics

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ABSTRACT

Agricultural water demand in South Korea has traditionally been estimated using a requirement-based approach centered on evapotranspiration and percolation. To better reflect actual irrigation practices, recent national policies have shifted toward estimating demand using unit water supply derived from observed water deliveries. However, the current unit water supply is estimated using a nationally averaged correction factor derived from limited gauged-reservoir data, without accounting for differences in reservoir operation characteristics or spatial variability. In addition, inconsistencies in irrigation area datasets reduce the reliability of facility-level water demand estimation. This study proposes an improved framework for agricultural water demand estimation by revising unit water supply based on reservoir operation characteristics. Reservoirs were classified according to operational and spatial characteristics, and operation-specific correction factors were developed to estimate water supply from ungauged reservoirs. Field-survey-based irrigation area data were incorporated to improve the spatial consistency between water supply facilities and irrigated areas, and revised unit water supply values were estimated for both reservoirs and pumping stations. The updated unit water supply values were aggregated at the watershed scale and incorporated into an agricultural water balance model to evaluate their effects on watershed-scale water balance and agricultural water demand estimation. The proposed framework reduces uncertainties associated with uniform correction factors and inconsistent spatial data, providing a more reliable basis for agricultural water demand estimation and supporting water allocation and irrigation planning under changing climatic and operational conditions.

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Keywords: Agricultural water demand, Unit water supply, Reservoir operation characteristics, Water balance, Irrigation water management



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PG1-12

Spatiotemporal Assessment of Agricultural Water Quality Using a National Agro-Environmental Monitoring Database

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ABSTRACT

Climate change and rapid changes in agricultural environments have increased uncertainty in agricultural water quality, creating an urgent need for improved monitoring and assessment systems. While South Korea operates a national water quality monitoring network, current observations are primarily focused on major rivers, resulting in limited information for rural streams and small agricultural watersheds. This study aims to enhance the utilization of the Agro-Environmental Monitoring Database maintained by the National Institute of Agricultural Sciences (NIAS), Rural Development Administration, by developing a standardized framework for evaluating agricultural water quality across small watersheds. Water quality records collected from more than 300 agricultural stream monitoring sites throughout South Korea between 2015 and 2024 were analyzed. Measurements obtained three times annually (April, July, and October) were used to investigate long-term spatiotemporal trends using the Mann-Kendall (MK) and Regional Kendall (RK) tests. To provide an integrated assessment of water quality conditions, standardized evaluation methods, including the Nemerow Pollution Index (NPI) and Water Quality Index (WQI), were applied to classify and compare water quality across agricultural watersheds. The proposed framework integrates long-term statistical trend analysis, standardized water quality evaluation, and artificial intelligence to improve the reliability of agricultural water quality assessments. The results are expected to provide a scientific foundation for watershed-scale agricultural water quality management and support the development of environmentally sustainable agricultural policies under changing climate conditions.

Acknowledgements: This study was carried out with the support of “Cooperative Research Program for Agricultural Science & Technology Development (Project No.RS-2026-25517429)”, Rural Development Administration, Republic of Korea

Keywords: Agricultural water quality, Spatiotemporal analysis, Agro-environmental monitoring, Small agricultural watershed



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PG1-13

Monitoring and APEX-Paddy Modeling of Nitrogen Losses from Paddy Fields under Surface Application and Reduced-Rate Deep Placement

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ABSTRACT

Climate change is altering rainfall patterns and increasing the frequency and intensity of extreme rainfall events, thereby increasing the variability of nutrient losses from paddy fields. These changes highlight the need for fertilization practices that reduce nutrient losses while maintaining crop productivity.

Deep-placement fertilization places fertilizer at a soil depth of 25–30 cm and is intended to improve fertilizer use efficiency and reduce nutrient losses. Over two years (2024–2025), total nitrogen (T-N) loads were monitored for individual rainfall–runoff and managed-drainage events in two adjacent paddy plots: a surface-fertilized plot and a deep-placement plot receiving 70% of the standard fertilizer rate. The APEX-Paddy model was calibrated and validated using event-based rainfall–runoff observations.

Across all monitored events, the reduced-rate deep-placement treatment decreased cumulative T-N export by approximately 72% in 2024 and 20% in 2025 compared with surface fertilization. The reduction was most pronounced during managed-drainage events. For rainfall–runoff events excluding managed drainage, the deep-placement treatment also reduced T-N loads by approximately 12% on average over the two years. This pattern is consistent with the expected mechanism of deep placement, in which fertilizer is positioned below the ponded-water layer, resulting in lower nitrogen concentrations in drainage water shortly after fertilization than those associated with surface application. The greater reduction observed in 2024 was partly attributable to the higher initial nitrogen application rate in the soil-test-based surface treatment that year.

APEX-Paddy reproduced event-based surface runoff reasonably well, with R^2 values ranging from 0.77 to 0.88. The model also captured T-N loads during rainfall–runoff events excluding managed drainage. For the surface-fertilized plot, the T-N R^2 values were 0.83 for calibration and 0.70 for validation. For the deep-placement plot, the corresponding R^2 values were 0.55 and 0.58, respectively, with a validation NSE of approximately 0.59. Agreement between observations and simulations was closest in 2025, when the standard fertilizer rate was applied to the surface-fertilized plot. However, further refinement is required to adequately represent the reduction in nitrogen losses from the deep-placement treatment during managed-drainage events.

These results demonstrate that reduced-rate deep-placement fertilization can substantially decrease nitrogen losses from paddy fields, with much of the reduction occurring during managed drainage. Improving the representation of nitrogen dynamics during managed-drainage events would enhance the ability of APEX-Paddy to evaluate deep-placement fertilization under changing rainfall conditions.

Keywords: paddy field, deep-placement fertilization, total nitrogen, managed drainage, non-point source pollution, APEX-Paddy



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PG1-14

Geo-Hydrological Characteristics of Traditional Taro Patches on Babeldaob Island, Palau

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ABSTRACT

Traditional taro patches (*mesei*) are a wetland farming system in Palau that supports food production under coastal conditions. Their locations may reflect accumulated local knowledge of freshwater availability, drainage, and salinity risk, suggesting relevance to climate adaptation. This study identifies the geo-hydrological characteristics associated with taro patches on Babeldaob Island using two spatial datasets: taro patches mapped in a 2006 land-cover dataset and those extracted from the 2015 agricultural census covering all farms on the island.

For each taro patch, elevation, slope, and distance from the coastline were calculated using GIS. The Strahler order of streams intersecting each taro patch was used as an indicator of hydrological connectivity and upstream contributing extent. Surface salinity, estimated from the red-to-green band ratio of high-resolution satellite imagery and calibrated against field measurements, was incorporated to characterize potential salinity exposure.

Preliminary analysis indicates that the two datasets exhibit consistent distributions of elevation, slope, and coastal distance and correspond broadly to the two geo-hydrological groups previously identified for Palauan taro patches. Most taro patches are located in low-lying, gently sloping terrain near the coast. Ongoing analysis examines how stream order and surface salinity further distinguish freshwater supply, drainage conditions, and coastal exposure among taro patches. The consistency across the datasets suggests that traditional taro cultivation has developed within recurrent geo-hydrological niches balancing freshwater access, drainage, and salinity risk. These findings provide a spatial basis for evaluating the climate adaptation potential of traditional wetland agriculture and identifying taro patches vulnerable to future hydrological and coastal changes.

Keywords: Taro patch, Geo-hydrological characteristics, Climate adaptation, Surface salinity, Hydrological connectivity, Palau



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PG1-15

Waterbird Compositions in Typical Coastal Wetlands and Agro-Fishery Production Patterns in Southwest coast of Taiwan

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ABSTRACT

The southwest coast of Taiwan is located at the midway of the East Asian-Australasian Flyway, widely distributed with sandbars, salt pans, fishponds, and farmlands, serving as an important wintering ground and stopover site. While natural sandbars are constantly disappearing, salt pans, fishponds, and dry farmlands not only meet human production needs but also provide critical ecosystem services. In recent years, to mitigate global warming and adapt to climate change, solar photovoltaic energy has become an important carbon-neutral option to achieve the 2050 net-zero emissions policy. Not only does solar energy rely on the dual elements of land and sunlight, but the entire agricultural production and environmental ecology also depend on these two factors. Salt pans, fishponds, and farmlands are typical human-made wetlands along the southwest coast of Taiwan, and their flooded patterns are closely linked to seasons, crops, and aquaculture practices. Human disturbance here is more severe than in natural wetlands, and the factors influencing bird utilization are also more complex than those in natural wetlands.

The pond-drying (sun-drying) process is a critical period for wintering birds to forage in fishponds. Some non-drying fishponds can serve as habitats for specific functional groups of birds due to factors such as bund vegetation or proximity to neighboring natural wetlands. Around October each year, after the wet season ends, farmers begin draining shallot fields to plant upland crops. The flooded period prior to planting serves as a foraging habitat that provides stopover energy replenishment for autumn-migrating waterbirds. Abandoned salt pans are also widely utilized by wintering waterbirds. However, because of their large area and long-term lack of maintenance of their water channels since stopping salt production, there is high uncertainty regarding habitat availability. This study focuses on typical artificial wetlands such as salt pans, fishponds, and dry farmlands along the southwestern coast, establishing monitoring programs in several selected sample areas to accumulate observational data.

Acknowledgements: The author thanks the funding awarded by the Ministry of Agriculture, Taiwan.

Keywords: abandoned-salt-pans, fish-farms, shallot-fields



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PG2-1

Assessing and Forecasting Vegetation Dynamics in a Rapidly Urbanizing Gazipur District: A Remote Sensing Modeling Approach

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ABSTRACT

Dhaka Division has experienced substantial land-use transformation over the past two decades, driven by industrial expansion, urban sprawl, and the decline of forest and agricultural land. The study used six cloud-free Landsat images from 2000, 2005, 2010, 2015, 2020, and 2025 to analyze vegetation dynamics using NDVI differencing and a combinatorial matrix approach, integrated with spatial regression modeling. To move beyond simple change detection, Global Moran's I testing on model residuals and the class-transition matrix, complemented by spatial regression analysis, the non-parametric Mann-Kendall test, and the Theil-Sen slope estimator, were used to identify statistically significant greening and browning trends across the landscape. The ANN-CA model was applied to forecast vegetation transitions through 2030. The findings point to a marked expansion of dense vegetated land, rising from roughly 22% of the district in 2000 to about 57% by 2025, while sparse vegetated land fell from approximately 71% to 41% over the same interval. The transition matrix showed that the primary pathway of change was the conversion of sparse vegetation into dense vegetation and, to a lesser extent, built-up surfaces. Projections for 2030 suggest this trajectory will persist, with non-vegetated land covering roughly of the district's area. Moran's I results were the strongest among vegetation loss. Collectively, these results point to an intensifying pattern of vegetation degradation in Gazipur District and underscore the importance of spatially targeted land-use policy to safeguard remaining green space and support long- term environmental resilience.

Keywords: Land-use, Vegetation, Resilience, Conversion



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PG2-2

Field-Based Evaluation of the Environmental Effects of Paddy Water Management Using Observed Ponding Depth Data and DNDC Modeling

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ABSTRACT

Sustainable paddy water management is an important component of agricultural environmental conservation practices because it influences both water use and greenhouse gas emissions. Reliable evaluation of these environmental effects requires consideration of actual field conditions rather than only prescribed water management schedules. This study evaluated the environmental effects of paddy water management using observed ponding depth data and process-based modeling to support evidence-based assessment of agricultural environmental conservation practices. Water-level sensors were installed in 19 paddy fields in Paju, South Korea, and ponding depth was monitored throughout the cultivation period. The processed observations were incorporated into the DNDC model to simulate greenhouse gas emissions under actual field conditions, which were then compared with emissions under representative water management scenarios. The results showed substantial variability in methane emissions among fields depending on their water management patterns. Fields with limited drying periods exhibited emissions comparable to continuous flooding, whereas fields with more frequent or prolonged drying periods generally showed lower methane emissions. Overall, observed farmer water management practices resulted in lower methane emissions than continuous flooding but higher emissions than idealized intermittent irrigation. These findings demonstrate that integrating field observations with process-based modeling provides a practical approach for evaluating the environmental effects of paddy water management under realistic farming conditions. The proposed approach can support evidence-based assessment of agricultural environmental conservation practices and contribute to the evaluation of the environmental effectiveness of paddy water management.

Acknowledgements: This work was supported by the National Agricultural and Environmental Management Technology Development Program, Rural Development Administration, Republic of Korea (Project No. RS-2026-25505631).

Keywords: Paddy water management, Agricultural environmental conservation, Ponding depth, DNDC model, Methane emissions



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PG2-3

Identification of Evaluation Factors for Assessing the Effects of Public Interest Direct Payment and Agri-environmental Conservation Policies

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ABSTRACT

Recent public interest direct payment and agri-environmental conservation policies have promoted various activities related to rural landscapes, including the sustainable management of farmland, cultivation of landscape crops, environmentally friendly farming, and conservation of agricultural ecosystems. However, there has been limited research on evaluation factors and analytical methods for spatially and quantitatively assessing the effects of these policy activities on rural landscapes. Therefore, this study reviews relevant previous studies and policy and institutional documents, reclassifies the detailed activities of the Public Interest Direct Payment System and agri-environmental conservation policies that are closely associated with spatial and ecological changes in rural landscapes, and structures the relationships among policy types, detailed activities, landscape impacts, evaluation factors, and spatial scales. This study is significant in that it systematically identifies landscape effectiveness evaluation factors by linking specific agricultural and environmental policy activities with the spatial and ecological characteristics of rural landscapes and proposes spatial analysis methods for evaluating their effects. The findings are expected to provide a basis for developing a rural landscape effectiveness assessment framework by integrating parcel-level policy participation data with spatial information on cultivated crops, land use, and ecological and environmental characteristics.

Acknowledgements: This work was supported by the National Agricultural and Environmental Management Technology Development Program, Rural Development Administration, Republic of Korea (Project No. RS-2026-25505631).

Keywords: Rural landscape, Landscape assessment, Agri-environmental conservation policies, Public Interest Direct Payment, Evaluation factors



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PG2-4

Development of a Geospatial Screening Method for Identifying Candidate Farmland Improvement Districts Using Open Farmland Parcel Polygon Data and Digital Elevation Models

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ABSTRACT

Farmland consolidation and field reorganization are important for improving agricultural productivity, smart farming, and food security. However, preliminary selection of candidate areas for land improvement projects often relies on field surveys and expert experience, making it difficult to compare regions objectively and explain prioritization. This study develops a geospatial screening method for extracting candidate farmland improvement districts by integrating open farmland parcel polygon data with digital elevation model (DEM) information. The method was applied to Ibaraki Prefecture, Japan, using about one million farmland parcels and 5 m elevation data. First, parcels below 0.3 ha were identified as indicators of fragmented field conditions. Parcel geometry was evaluated using indices including area, perimeter, rectangularity, convex hull filling ratio, aspect ratio, concavity, and angular irregularity. Priority seed parcels were selected based on these indicators, and neighboring parcels were aggregated using distance-based rules to form districts with a target scale of approximately 30 ha. For each district, minimum and maximum elevations were extracted from the DEM, and elevation differences were calculated to evaluate terrain flatness and feasibility for field reorganization. Districts with an elevation difference of 5 m or less were retained and summarized by total area, number of parcels, compactness, geometric continuity, and elevation conditions. The case study demonstrated that the proposed method can identify spatial concentrations of small, irregular parcels in relatively flat terrain. The approach enables rapid, reproducible, and explainable prefecture-wide screening using open geospatial data and provides a decision-support tool for farmland improvement planning and smart agriculture infrastructure development.

Keywords: farmland improvement, farmland parcel polygon, digital elevation model, geospatial screening, field consolidation, smart agriculture, open geospatial data



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PG2-5

Toward Precision Monitoring of Invasive Plants in Paddy Field Environments Using Drones: A Foundational Study of *Alternanthera philoxeroides*

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ABSTRACT

Alternanthera philoxeroides (alligator weed) is an invasive species that spreads rapidly through vegetative fragments and poses threats to agricultural water management systems. Early detection is essential for effective control; however, conventional field surveys are labor-intensive because infestations are often scattered across extensive agricultural water environments and frequently occur in locations that are difficult to access safely. Drone-based monitoring offers a promising alternative, but practical survey conditions that balance detection performance and operational efficiency remain insufficiently understood.

This study evaluated the relationships among flight altitude, spatial resolution, survey coverage, and species detectability using drone imagery acquired over alligator weed habitats in Chiba Prefecture, Japan. Images were collected at multiple flight altitudes ranging from 5 m to 42 m above ground level, corresponding to different ground sampling distances (GSDs). Detectability was assessed by visually examining the ability to distinguish alligator weed from surrounding vegetation.

The results revealed clear trade-offs between image detail and survey efficiency. At a GSD of approximately 1 cm, differences in texture between alligator weed and surrounding vegetation could be recognized, although leaf shape was difficult to distinguish. At a GSD of approximately 0.3 cm, leaves and flowers became identifiable, while a GSD of approximately 0.1 cm enabled detailed recognition of morphological characteristics. These findings provide practical guidance for designing drone-based survey strategies that balance monitoring accuracy, survey efficiency, and safety for invasive plant management in rural environments.

Keywords: invasive plant species, drone monitoring



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PG2-6

Development and Evaluation of a Flood Water Level Prediction Algorithm for Ungauged Reservoirs Using High-Resolution Hydrological Information

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ABSTRACT

Climate change-driven extreme rainfall has intensified flood risk at agricultural reservoirs, yet reliable water level prediction remains difficult because inflow data are rarely measured. This study developed and evaluated an AI-based algorithm that predicts flood-season water level fluctuations in ungauged reservoirs by learning directly from 10-minute high-resolution water level, rainfall, and meteorological data, thereby bypassing inflow estimation models. Yedang Reservoir (basin area 37,360 ha, total storage 47.39 million m³) in Korea was selected for its short time of concentration and documented flood evacuation history. A hybrid mapping approach combining 5-km short-term forecast grids with 1-km radar rainfall preserved spatial rainfall heterogeneity within the watershed. A stepwise quality control procedure comprising time normalization, missing-value imputation, Hampel filtering, and an inter-percentile range fence was applied to 296,640 time steps to secure data reliability. An integrated dataset combined 13 grid rainfall series, observed and forecast meteorology, gate release, and derived cumulative and rate-of-change features. Optuna-optimized machine learning models and a GRU-TCN hybrid deep learning model were trained, and performance was evaluated separately for the total, constant, and rising periods, with rising-period accuracy as the key criterion since it governs early warning and pre-release decisions. XGBoost (window = 12) achieved the highest rising-period accuracy (NSE 0.9949, RMSE 0.0459 m), while GRU-TCN reached a rising-period NSE of 0.9839. An input window of approximately two hours was most effective for reproducing the initial inflow response to heavy rainfall. This rising-period-centric framework provides quantified criteria for real-time flood forecasting and warning in ungauged reservoirs.

Acknowledgements: This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through the Intelligent Agricultural Infrastructure Management Technology Development Program for Climate Change Response, funded by the Ministry of Agriculture, Food and Rural Affairs (MAFRA), Republic of Korea (RS-2025-02215604).

Keywords: Ungauged reservoir, Flood water level prediction, High-resolution hydrological data, Data quality control, Machine learning



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PG2-7

Advanced Reservoir Storage Rate Prediction Using Rating Curve Calibration and M5-SGB Algorithm: A Case Study of Baekrok Reservoir

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ABSTRACT

Increasing climate variability underscores the vital importance of efficient water resource management and prompt disaster response in agricultural reservoirs. Although a preliminary reservoir storage rate prediction model was developed in 2024 by the Rural Research Institute of the Korea Rural Community Corporation using disaster prevention monitoring data and Meteorological Administration forecasts, it exhibited significant time lag issues. These limitations stemmed from an absolute shortage of training data due to monitoring equipment being installed only in late 2023, as well as accuracy limitations in ultra-short-term precipitation forecasts. To overcome these constraints, this study proposes an enhanced framework to optimize reservoir storage rate prediction models.

Site-specific stage-discharge rating curves were developed for two main inflow streams entering the Baekrok Reservoir, utilizing 1-hour average water level data converted from 10-minute interval RAWRIS measurements. Comparative analysis revealed that default discharge data provided by RAWRIS calculated via automated meters and Manning's equation were significantly overestimated; thus, calibrated discharge values derived from field-based rating curves were employed as primary model inputs. To complement this, ultra-short-term forecast accuracy was refined, and predicted upstream streamflows were added to current storage volumes to calculate future storage rates. As a prediction algorithm, the M5 Model Tree with Stochastic Gradient Boosting (M5-SGB) algorithm, which is excellent for learning complex non-linear patterns, was applied. Four distinct prediction models were established for lead times of 1, 2, 3, and 6 hours, utilizing 40, 43, 46, and 55 input variables, respectively. The proposed integration of calibrated inflow estimation and M5-SGB modeling effectively eliminates data distortion and reduces predictive lag, providing a robust tool for real-time agricultural water management and flood risk monitoring.

Acknowledgements: This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through Toward an Integrated Modular Disaster Monitoring Sensors and a Disaster Management Platform Based on Digital Twin Technology for Agricultural Dam Program (or Project), funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (RS-2025-02263904).

Keywords: Reservoir storage rate prediction, Research background, Stage-discharge rating curve, M5-SGB, Baekrok Reservoir, RAWRIS, Reservoir water resource management



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PG2-8

Point Cloud-Based Infrastructure Monitoring for Sustainable Paddy Agriculture: A Deep Learning Approach for Damage Detection

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ABSTRACT

Agricultural infrastructure monitoring is critical for sustainable paddy farming systems that support global food security. This study develops an automated crack detection system for concrete structures using 3D point cloud data and deep learning techniques to enhance the reliability of water management facilities. PointNet architecture is employed for binary crack classification using point clouds acquired by Terrestrial Laser Scanner (TLS) on a reinforced concrete headworks structure. To optimize detection performance, four distinct input feature combinations are systematically evaluated: XYZ coordinates only as a baseline, XYZ enhanced with intensity values, XYZ combined with RGB color information, and XYZ integrated with local geometric features derived from eigenvalue decomposition. The local geometric features are calculated through covariance tensor analysis and third eigenvalue extraction, providing spatial context not captured by coordinate data alone. Experimental results demonstrate that the best crack detection performance is achieved using XYZ coordinates combined with local geometric features, yielding an F1 score of 0.667, with precision of 0.591 and recall of 0.765. This configuration represents substantial improvement over coordinate-only input, which achieves an F1 score of 0.639, and significantly outperforms both intensity-enhanced input (F1 score: 0.612) and RGB-enhanced inputs (F1 score: 0.636). The findings confirm that feature extraction and selection are crucial components in deep learning applications for point cloud analysis. Specifically, the results demonstrate that strategically adding local geometric features which are not included in the standard PointNet architecture proves highly effective for improving detection accuracy. This enhancement enables the model to better capture local surface variations indicative of structural damage. This automated monitoring approach enables early detection and proactive maintenance of water management infrastructure, thereby contributing significantly to sustainable agricultural systems by ensuring reliable irrigation and drainage facilities essential for paddy farming operations. The technology offers potential for widespread application in maintaining critical agricultural infrastructure.

Keywords: Point cloud, Deep learning, Damage detection, Reinforced concrete headworks



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PG2-9

An On-Premise Multi-Agent LLM System Integrating Weather and Soil Data for Climate-Resilient Paddy Farming Decisions

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ABSTRACT

Increasing climate variability is disrupting established cropping calendars in paddy rice systems, requiring farmers to make time-critical decisions on transplanting, fertilization, and water management with limited advisory support. Public agricultural information services in Korea provide weather, soil, and cultivation data, but these resources remain fragmented across separate portals, and general-purpose large language models (LLMs) are not suitable for site-specific agronomic advice because of hallucination and the absence of authoritative domain knowledge. This study developed a generative AI-based farming decision support system that couples an on-premise LLM with retrieval-augmented generation (RAG) and a multi-agent architecture built on the Model Context Protocol (MCP). The system comprises four functional modules: cropping calendar management, soil chemical property interpretation, soil characteristic grading, and an organic farming advisory chatbot. Domain documents were chunked, embedded, and indexed in a vector database, and retrieval combined dense and lexical search with a reranking step. MCP servers exposed external resources, including national weather forecasts, soil environment databases, and cultivation schedule services, as standardized tools, allowing the agent to select and invoke them dynamically rather than following pre-scripted workflows. Paddy rice was included as a primary target crop, with cultivation logic differentiated by early-, mid-, and mid-late-maturing varieties so that recommendations respond to seasonal weather deviations. An automated RAG evaluation protocol based on Ragas was established to assess faithfulness and answer relevancy prior to field deployment. The principal contribution is the use of MCP-based tool orchestration to connect a domain-specific LLM with live public agricultural data sources, an approach not yet reported for paddy farming advisory systems in Korea. Operating the system on institutional infrastructure keeps farm and soil data within the organization, addressing data governance requirements for public agricultural services. Ongoing work integrates the four modules into a single interface and advances to field demonstration with farmers, with planned extension to irrigation scheduling and paddy water management.

Acknowledgements: This study was carried out with the support of the Research Program for Agricultural Science and Technology Development (Project No. PJ01768901), National Institute of Agricultural Sciences, Rural Development Administration, Republic of Korea.

Keywords: Agricultural decision support, Large language model, Multi-agent system, Retrieval-augmented generation, Paddy rice, Climate adaptation



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PG2-10

Improvement of Non-destructive Leakage Detection Quality for In-service Pipeline using Piecewise Uniform Transient Damping Method

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ABSTRACT

Pipeline leakage detection is difficult due to buried structural characteristics. Transient Test-Based Techniques (TTBTs) have been investigated as pipeline leakage detection method. These techniques utilize water hammer pressure waves generated by valve closure or pump stoppage, and leakage locations are estimated based on reflected waves or transient damping caused by leakage. Among these approaches, few studies have applied transient damping-based methods to in-service pipeline facilities. In addition, previous studies using model pipelines assumed a uniform spatial eigenfunction. This assumption may reduce the accuracy of leakage localization in in-service pipeline systems composed of multiple pipe materials and diameters. Therefore, this study aimed to improve the accuracy of leakage localization using a damping-based method with spatial eigenfunctions. The target pipeline was an in-service pipeline with a total length of approximately 5.5 km and consisted of multiple pipe materials. Water hammer pressure was generated by stopping pump operation, and leakage was reproduced by opening a sludge discharge valve. Leakage locations were estimated using the damping characteristics of the generated pressure waves. As a result, the damping-based method with spatial eigenfunctions improved the localization accuracy in five of the six test cases. In addition, leakage locations were estimated with errors of less than 10% in five cases. These results indicate that considering spatial eigenfunctions can improve the accuracy of leakage localization in in-service pipeline systems with nonuniform structural properties. The proposed method may provide a more accurate approach for leakage localization in in-service pipeline systems using transient damping.

Keywords: Water hammer pressure, Pump operation, Transient damping-based method, In-service pipeline



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PG2-11

Evaluating the Potential of Cyclic Irrigation for Inland Flood Mitigation Using SWAT+: A Case Study of the Lake Inbanuma Basin

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ABSTRACT

Increasing inland flooding caused by extreme rainfall has become a major challenge in Japan, highlighting the need for basin-scale flood management strategies. The Lake Inbanuma basin, located in Chiba Prefecture, is a low-lying reclaimed agricultural area where flood risk is amplified by limited drainage capacity and narrow operational water-level margins. At the same time, cyclic irrigation is widely practiced in the basin, allowing agricultural drainage water to be reused and reducing dependence on direct water intake from the lake. This operation has the potential to increase available flood storage during normal periods while maintaining irrigation functions.

This study investigates the feasibility of incorporating cyclic irrigation into basin-scale flood management through hydrological modeling. A SWAT+ model was developed for the Lake Inbanuma basin using a 10-m digital elevation model, land-use data, FAO soil data, and meteorological observations for 2016–2024. Simulated streamflow was compared with discharge observations collected using Acoustic Doppler Current Profiler (ADCP) measurements at the Hatori station on the Kashima River. The model is currently being refined by incorporating local irrigation schedules, mid-season drainage practices, pump operation, and canal management to improve its representation of agricultural water use.

Future analyses will quantify the effects of cyclic irrigation on lake water levels, flood storage capacity, pumping costs, and potential reductions in flood damage under alternative management scenarios. The proposed framework aims to provide scientific evidence for integrating agricultural water management into basin-scale flood mitigation and to support adaptive water-level operation in lowland agricultural watersheds under increasing climate extremes.

Keywords: Basin-wide flood management, Irrigation water management



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PG2-12

Detection of Pre-Leakage Sign in In-Service FRPM Pipelines using Nighttime Outflow Data

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ABSTRACT

Water leakage accidents in in-service FRPM pipelines have increased in recent years. Detection of pre-leakage sign is important for preventing serious accidents. This study focuses on detecting pre-leakage signs from irrigation water management data of an in-service agricultural pipeline. A leakage accident occurred at 3:03 on September 19, 2025, 1,610.9 m downstream from the discharge tank, where the water head difference is 47.1 m. Water level and inflow at the discharge tank in the upstream section were measured at 3-minute intervals from April 2021 to December 2025. Outflow for the irrigation season from April to October was calculated, and the dataset contains 19,436 points. Nighttime outflow data from 21:00 to 3:00, during which water use is assumed to be low, are used for the analysis. Monthly percentiles (10th, 25th, and 50th) are obtained as time-series. Change-points are detected by the Pettitt test in June 2023 for the 10th percentile and in May 2023 for the 25th and 50th percentiles at a significance level of 5%. An increasing trend over this period is confirmed by the Mann-Kendall test. The values are all 0.000 m³/h before the change-point, increasing to an average of 4.125 m³/h after it for the 10th percentile. This increasing trend is confirmed across all percentiles. In contrast, no change-points are detected over the same period in two farm ponds supplying a section without leakage. The percentile analysis of nighttime outflow and change-point detection can statistically detect pre-leakage signs.

Keywords: Pipeline, Leakage detection, Pre-leakage sign, Change-point detection, Prevention



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Low-cost vision-based system for sensing pipe deformation under hydraulic transients

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ABSTRACT

Pressurized pipelines are widely used for transporting water over long distances. They are vulnerable to water leakage caused by pipe material deterioration and earthquake loading. To overcome this challenge, the authors have developed pipeline monitoring methods using pressure wave propagation induced by valve closure or pump shutdown and image-based strain measurement, i.e., digital image correlation (DIC), to characterize pipe surface deformation. This method detects artificial leaks over distances of several kilometers, using pressure waves that carry leak information. In this study, a low-cost DIC system for pipeline monitoring under hydraulic transients is developed for on-site investigation. The proposed device features a multi-camera system controlled by Raspberry Pi. To demonstrate its performance, a laboratory experiment was conducted using a 65-meter-long PVC pipeline. Pressure waves were generated by valve closure at the downstream end, and the images of pipe deformation induced by the pressure waves were acquired using the proposed device. As a result, pipe strain on the surface of the model pipeline is detected by the image-based method. In addition, damping of the pipe strain over time due to energy loss is observed under artificial leak conditions. Future work will focus on integrating image data from multiple measurement points to achieve precise pipeline monitoring.

Keywords: pipeline, water hammer, digital image correlation, strain measurement

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