

THE 15TH INTERNATIONAL CONFERENCE
ON

EARTH OBSERVATIONS AND SOCIETAL IMPACTS

ICEO&SI 2026

From Mountains to Oceans

Earth Observation for a Resilient Future

第十五屆地球觀測及社會衝擊國際研討會

 July 2–3, 2026

 Shangri-La Far Eastern Hotel
Tainan, Taiwan

Organized by



Taiwan Group on
Earth Observations



NCKU

National Cheng Kung
University

ABOUT CONFERENCE

The International Conference on Earth Observations and Societal Impacts (ICEO&SI) serves as a premier international platform for scientists, researchers, engineers, industry professionals, and students to exchange knowledge, foster collaborations, and explore innovative solutions to global challenges through Earth observation technologies.

Jointly organized by the Taiwan Group on Earth Observations (TGEO) and National Cheng Kung University (NCKU), ICEO&SI 2026 aims to advance interdisciplinary research and international cooperation in Earth observation and its applications to societal and environmental issues. The conference provides a unique opportunity for participants to present the latest scientific findings, discuss emerging technologies, and establish international networks with leading experts from academia, government agencies, and industry.

ICEO&SI covers a broad range of topics related to Earth observations and their societal impacts, including but not limited to natural hazards, climate change, water resources, weather and environmental monitoring, marine and coastal ecosystems, health, renewable energy, agriculture, biodiversity, geospatial technologies, and sustainable development. Special emphasis is placed on advancing Earth observation technologies and their applications in disaster risk reduction, environmental resilience, and societal well-being. Over the years, ICEO&SI has attracted more than 2300 participants from over 23 countries across five continents and facilitated the presentation of more than 1,300 papers, many of which have been published in prestigious international journals.

ICEO&SI 2026 warmly welcomes researchers and practitioners from around the world to join this exciting event in Tainan, Taiwan—a historic city with over 400 years of cultural heritage. Together, we will explore innovative ideas, strengthen international partnerships, and shape a more resilient and sustainable future through Earth observations.

WORKSHOP ORGANIZATION

THIS WORKSHOP IS JOINTLY ORGANIZED BY

Taiwan Group on Earth Observations (TGEO)

National Cheng Kung University (NCKU)

LOCAL ORGANIZERS:

Coastal Ocean Monitoring Center (COMC) in NCKU

Research Center for Water Science and Technology in NCKU

Department of Hydraulic and Ocean Engineering (DHOE) in NCKU

ICEO & SI 2026 CHAIRMAN

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Professor in the Department of Hydraulic and Ocean Engineering

& Director of Coastal Ocean Monitoring Center

National Cheng Kung University (NCKU)

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Prof. Yuei-An Liou

Chair Professor & Academician, National Central University (NCU)

Honorary President, Vietnamese Experts Association in Taiwan

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Workshop Executive Secretary

DR. YANG-MING FAN, Coastal Ocean Monitoring Center, NCKU

MRS. SUN-PEI YEH, TGEO Secretariat

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VENUE

Conference Rooms at Shangri-La Far Eastern Hotel, Tainan

Open Ceremony: 3rd floor

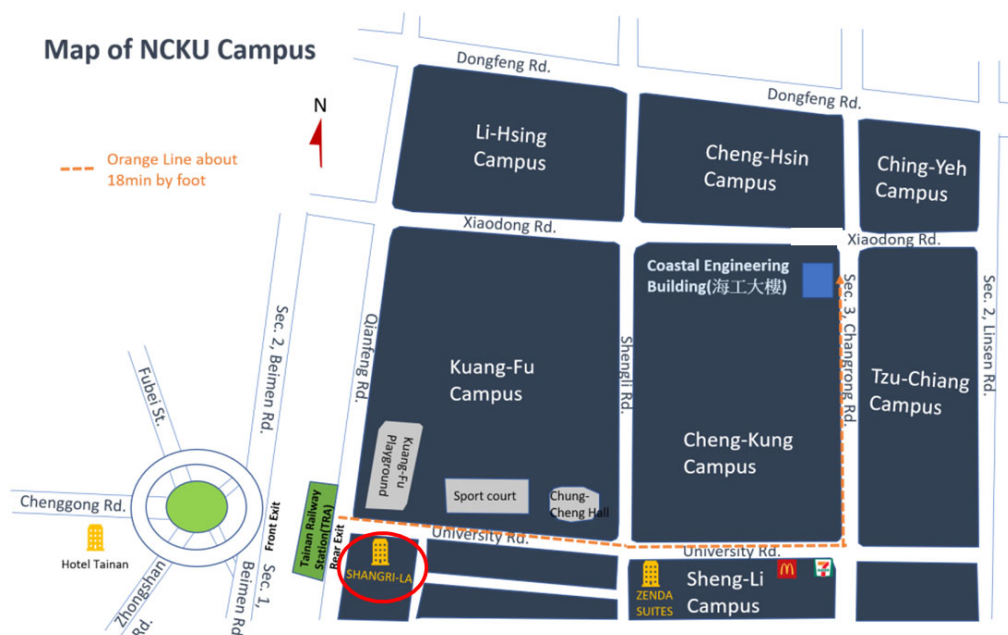
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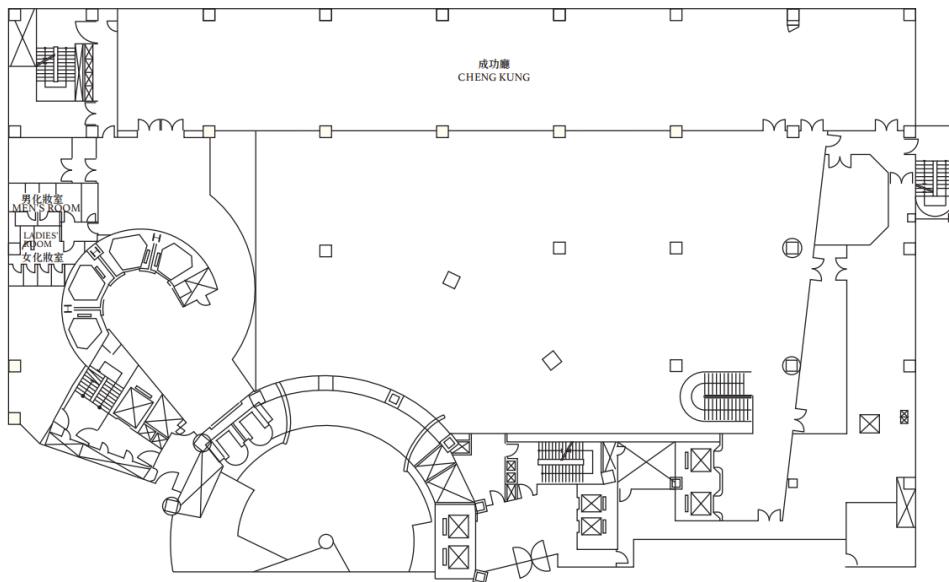


VENUE

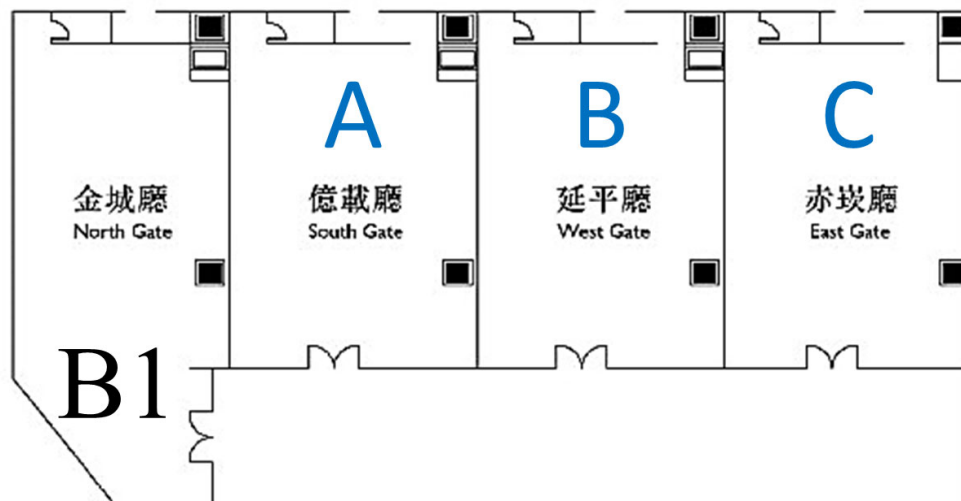
Conference Rooms at Shangri-La Far Eastern Hotel, Tainan

Open Ceremony: level 3

3樓
level 3



Session: level B1



INTERNET

The conference venue (Shangri-La Far Eastern Tainan) provides **complimentary Wi-Fi**.

- **Wi-Fi Network (SSID):** Shangri-La
- **Password:** None (No password required)

AGENDA

Time	July 2 (Thu)		
08:00-09:30	Registration		
09:30-10:00	Opening Ceremony		
10:00-10:30	Keynote Speech I Speaker: Prof. Sunil Kumar De Moderator: Prof. Yuei-An Liou Topic: A Study on Assessing Climate-Driven Glacial Lake Hazards in the Sikkim Himalaya, India		
10:30-10:50	Break		
10:50-11:20	Keynote Speech II Speaker: Prof. Weimin Huang Moderator: Prof. Hwa Chien Title: Ocean Remote Sensing Technologies: High Frequency, Marine and GNSS-Based Radar		
11:20-11:50	Keynote Speech III Speaker: Prof. Kaoru Ichikawa Moderator: Prof. Dong-Jiing Doong Title: Ferry-mounted GNSS to Monitor Wider Sea Surface Dynamic Height and Wave Field		
11:50-13:00	Lunch and TGE0 Annual meeting		
13:30-14:45	Session A1 Integrated Earth Observations for Drought, Heat, and Compound Climate Extremes (I)	Session B1 Observation, Investigation, and Numerical Modeling of the Formation and Evolution of the Mataian River Barrier Lake (I)	Session C1 Taiwan Polar Observation Research
14:45-15:30	Break / Poster Exhibition		
15:30-16:45	Session A2 Integrated Earth Observations for Drought, Heat, and Compound Climate Extremes (II)	Session B2 Observation, Investigation, and Numerical Modeling of the Formation and Evolution of the Mataian River Barrier Lake (II)	Session C2 Ocean Observation: Technologies, Methods, and Applications (I)
18:00	Banquet		

Time	July 3 (Fri)		
08:50-10:05	Session A3 Resilience Sustainability in the Digital Age: A Global Dialogue on Drought, Climate Extremes, and Earth Surface Dynamics (I)	Session B3 Radar Oceanography and Earth Observation of Coastal and Ocean Dynamics (I)	Session C3 Ocean Observation: Technologies, Methods, and Applications (II)
10:05-10:25	Break		
10:25-11:40	Session A4 Resilience Sustainability in the Digital Age: A Global Dialogue on Drought, Climate Extremes, and Earth Surface Dynamics (II)	Session B4 Radar Oceanography and Earth Observation of Coastal and Ocean Dynamics (II)	Session C4 GNSS Reflectometry and GNSS Interferometric Reflectometry for Earth Surface and Environmental Monitoring & Ocean Observation of the Earth Using Buoy Systems
11:40-12:00	Closing Ceremony		
12:00-18:00	Field Trip (International Guests or Invited only)		

KEYNOTE SPEAKERS

Keynote Speaker I : 10:00- 10:30 July 2 (Thu.)

Location: Cheng Kung Hall (3rd Floor)

PROF. SUNIL KUMAR DE

Department of Geography, North-Eastern Hill University, India

President, International Association of Geomorphologists (IAG)

Area of Interest:

Environmental Geomorphology;
Geomorphological Hazards specially Landslide,
Soil Erosion and Fluvial Hazards; River Health



Presentation topic:

A Study on Assessing Climate-Driven Glacial Lake Hazards in the Sikkim Himalaya, India

The Sikkim Himalaya has undergone significant glacial retreat due to the impacts of climate change, resulting in the rapid expansion of glacier-fed lakes. This growing trend raises concerns over the increased risk of glacial lake outbursts, which pose serious threats to downstream populations. This study focuses on the Chhombo Chhu watershed within the Tista basin, a region characterized by numerous large glacial lakes, situated between the Greater Himalayan Morphometric zone and the Tethyan Sedimentary Sequence. Through the analysis of medium- to high-resolution optical satellite imagery from 1975, 1989, 2000, 2010, and 2018, combined with extensive field surveys, the research documents a sharp increase in the number of glacial lakes, rising from 62 to 98. The total area of these lakes has expanded by $34.6 \pm 5.4\%$, growing from $8.5 \pm 0.2 \text{ km}^2$ in 1975 to $11.4 \pm 0.6 \text{ km}^2$ in 2018. Notably, the rate of expansion accelerated between 2010 and 2018, highlighting an intensification of landscape changes in recent years. A hazard assessment identified twenty-seven lakes in the watershed with varying degrees of outburst potential. The increasing trend in long-term annual temperatures ($0.283^\circ\text{C a}^{-1}$ from 1975 to 2013) closely correlates with both the retreat of glaciers ($-0.66 \pm 0.1\% \text{ a}^{-1}$) and the expansion of glacial lakes ($+0.80 \pm 0.1\% \text{ a}^{-1}$) from 1975 to 2018. These findings emphasize the significant role of climate change in reshaping glacial lake dynamics and the associated hazard risks in the Sikkim Himalaya.

Keynote Speaker II : 10:50- 11:20 July 2 (Thu.)

Location: Cheng Kung Hall (3rd Floor)

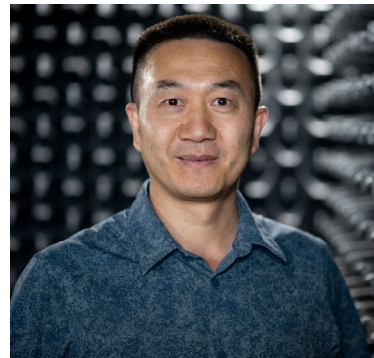
PROF. WEIMIN HUANG

**Department of Electrical and Computer
Engineering,**

**Memorial University of Newfoundland,
Canada**

Area of Interest:

High frequency (HF) radar remote sensing
ocean surface parameters (wave, wind, and current) and target, Sea surface
current and wave information and target detection & tracking by marine
navigation radar, Earth observation using Synthetic Aperture Radar (SAR),
Digital image processing and application



Presentation topic:

**Ocean Remote Sensing Technologies: High Frequency, Marine
and GNSS-Based Radar**

In this talk, the research on radar ocean remote sensing using high frequency (HF), X-band marine, and Global Navigation Satellite System Reflectometry (GNSS-R) radars will be introduced. First, the basic principles of HF radar and its applications in oceans current, wind and wave will be explained. Next, the technique of X-band marine will be illustrated along with its applications in sea surface current measurement, wave information extraction, and wind field mapping. Then, GNSS-R will be shown in terms of sea ice sensing, wave measurement, and wind speed sensing. Finally, some challenges and future directions about these three types of radar will be outlined.

Keynote Speaker III : 11:20- 11:50 July 2 (Thu.)

Location: Cheng Kung Hall (3rd Floor)

PROF. KAORU ICHIKAWA

**Research Institute for Applied Mechanics,
Kyushu University, Japan**

Area of Interest:

Satellite altimetry, Kuroshio Mesoscale Eddies,
HF radar, GNSS reflectometry



Presentation topic:

Ferry-mounted GNSS to monitor wider sea surface dynamic height and wave field

The Global Navigation Satellite System (GNSS) is possibly one of the most widespread remote sensing techniques. Currently, its receivers are integrated into various products, including automobiles, smartphones, smartwatches, and even pet tags. Ocean observations also greatly benefit from GNSS, as it can determine geolocation at any place and time, which is particularly crucial in the open ocean where no fixed landmarks are visible. Examples include the positions of observational casts, velocity measurements from surface drifter trajectories, and fish habitat tracking via biotags. Nevertheless, those geolocations generally refer only to horizontal positions, since accurate centimeter-level height measurement requires precise positioning techniques, such as real-time kinematic (RTK) and precise point positioning (PPP), using multi-frequency GNSS receivers. Moreover, extra height measurements between the antenna and the sea surface are necessary to convert the antenna height to the sea surface height (SSH).

Anchored surface GNSS buoys presume constant antenna heights above the sea surface, enabling variations in antenna height to be translated into heave motions induced by surface waves, tsunamis, and tides at specific sites. However, obtaining spatial distributions of the SSH demands the deployment of many buoys, which is practically unfeasible. Satellite altimeters have contributed to obtaining the SSH field and revealed active mesoscale eddies in open oceans and significant fluctuations of the Kuroshio current.

Furthermore, the recent introduction of the wide-swath SWOT altimeter has expanded the spatial resolution of the SSH maps. Yet, the temporal resolution of the SSH field is insufficient for fast-moving small-scale events, including coastal changes and the propagation of Kuroshio meanders. Because spatial expansion with reasonable temporal resolutions can be achieved by the use of repeated ferry cruises, ferry-mounted GNSS could be supplementary SSH observation methods together with satellite altimeters.

However, the ship's draft will vary due to payload and speed, so a constant antenna height with respect to the sea surface is no longer expected. By utilizing GNSS Reflectometry (GNSS-R) to determine the distance between the antenna and the sea surface, where GNSS signals are reflected toward the antenna with a longer travel path than the signals directly received by the antenna, the antenna's elevation above the sea surface can be determined, hence enabling the calculation of the SSH. Upon eliminating the geoid and tidal heights, the sea surface dynamic height (SSDH), whose gradient correlates with geostrophic velocity, can be derived along the ship tracks. The SSDH profiles along repeated ferry cruises across the Kuroshio are explained in this talk.

AGENDA DETAILS

Session A1: 13:30- 14:45 July 2 (Thu.) South Gate (A)

Topic: Integrated Earth Observations for Drought, Heat, and Compound Climate Extremes (I)

Chair: Cheng-Ling Kuo, Wen-Chin Hsu

13:30-13:45 John Francis L. Mansos, Yuei-An Liou

Enhanced Tropical Cyclone Track Forecasting Through Integration of Pangu-Weather and Forecast Correction

13:45-14:00 Tewabe Melkamu, Yuei-An Liou

Reconstructing Cloud-Induced Gaps in Landsat Land Surface Temperature Data for Urban Heat Mitigation in Taoyuan City

14:00-14:15 Yan Akhbar Pamungkas, Shou-Hao Chiang

Multiscale Hydroclimatic Drought Proxies and PSInSAR-Derived Land Subsidence over West Java Province, Indonesia

14:15-14:30 Xin-Ping Wu, Wen-Chin Hsu

Emotional Propagation on Social Media during Extreme Climate Events: A Weak Tie Network Analysis of the 2022 U.S. Drought

14:30-14:45 Chi-Wei Peng, Wen-Chin Hsu

Climate-Driven Power Risk in Taiwan's Semiconductor Industry: A Decision Support Framework Integrating Drought Indicators and Enterprise Vulnerability

Session B1: 13:30- 14:45 July 2 (Thu.) West Gate (B)

**Topic: Observation, Investigation, and Numerical Modeling of the
Formation and Evolution of the Mataian River Barrier Lake (I)**

Chair: Shien-Tsung Chen, Wen-Ping Tsai

13:30-13:50 Yu-En Yang, Shien-Tsung Chen

*Mataian Landslide-Dammed Lake Event in Taiwan: From Formation
and Failure to Watershed Resilience Governance*

13:50-14:05 Ching-Yu Chao, Shien-Tsung Chen, Dong-Jiing Doong, Chia-Wei Hsu,
Po-Wei Huang, Yin-Tse Huang, Jiun-Huei Jang, Chen-Min Kuo,
Chia-Hsing Lee, Guan-Wei Lin, Yi-Chun Lin, Wei-Cheng Lo, Yih-Chin
Tai, Chin-Shiang Tsai, Wen-Ping Tsai, Chih-Ming Tseng, Jiun-Ling
Wang, Jian-Hong Wu, Tao-Chang Yang, Yu-En Yang, Pao-Shan Yu

*Integrated Framework for Landslide-Dam Breach Risk Management
and Watershed Resilience Governance in the Mataian River Basin*

14:05-14:20 Yen-Mo Wu, Jiun-Huei Jang

*Influence of Pre- and Post-Breach Topographic Changes on Flood
Inundation Scenarios in Mataian River*

14:20-14:35 Yin-Tse Huang, Po-Wei Huang, Chia-Hsin Lee, and Yi-Chen Tsai

*Analyzing the Microbiome diversity of the Hyperconcentrated flow
deposits of the Mataian incident*

Session C1: 13:30- 14:45 July 2 (Thu.) East Gate (C)

Topic: Taiwan Polar Observation Research

Chair: Wen-Ling Hong, Jack S. Giletycz

13:30-13:45 Hwa Chien, H.-M. Chang, A.-S. Wang, G.-M. Chiou, An Cheng

Pathway regimes and along-track SST persistence in the Fram Strait from a Taiwanese Clustered Drifter Program

13:45-14:00 Madeline Olivia, Hui-Ju Lee, Benny K.K. Chan, Hwa Chien, Slawomir Jack Giletycz, An-Yi Tsai, Ruei-Feng Shiu

Plastic debris reshapes the environmental partitioning of PFAS and organophosphate esters in a High-Arctic fjord

14:00-14:15 Jack S. Giletycz, Fang-Yu Tsai

Geological and UAV-Based Mapping of Newly Exposed Arctic Landscapes Following Glacier Retreat in Northern Kaffiøya, Western Svalbard

14:15-14:30 Ying-Chih Fang, Benjamin Rabe, Ivan Kuznetsov, Mario Hoppmann, Sandra Tippenhauer, Julia Regnery, Hailun He, Tao Li

Upper-ocean variability in the Amundsen Basin of the Arctic Ocean during early winter: insights from the MOSAiC expedition

Session A2: 15:30- 16:45 July 2 (Thu.) South Gate (A)

Topic: Integrated Earth Observations for Drought, Heat, and Compound Climate Extremes (II)

Chair: John Chien-Han Tseng, Yueh-Hsia Luo

15:30-15:45 Wei-Lun Hsu, Chia-Yu Chen, Yuei-An Liou, Yueh-Hsia Luo

Structural and Functional Remodeling of Vascular Endothelium under Acute and Intermittent Heatwaves

15:45-16:00 Zalfa Afifah Zahra, Kuan-Tsung Chang

Comparative study of machine learning models for district-level Urban Heat Island classification in Taiwan

16:00-16:15 John Chien-Han Tseng

Wave Propagation and Recurrent Circulation Patterns in the Atmosphere

16:15-16:30 Tri Anggun Lestari, Tang-Huang Lin

Landsat-Based Urban Heat Assessment in Medan and Batubara Using Land-Cover-Specific SUHI Baselines

16:30-16:45 Ulil Hidayat, Tang-Huang Lin

Satellite-Derived PM_{2.5} (SatPM25) over Indonesia: Validation, Seasonal Variability, and Spatiotemporal Distribution

Session B2: 15:30- 16:45 July 2 (Thu.) West Gate (B)

Topic: Observation, Investigation, and Numerical Modeling of the Formation and Evolution of the Mataian River Barrier Lake (II)

Chair: Yih-Chin Tai

15:30-15:45 Chin-Shiang Tsai, Pei-Jane Tsai, Jung-Sheng Chen, Jiun-Ling Wang

Integrating environmental, vector, and seroepidemiological surveillance into a post-disaster infectious disease early warning system: a three-year One Health framework for the Mataian landslide-dammed lake, Hualien, Taiwan

15:45-16:00 Yih-Chin Tai, Ting-Hao Liang, Pei-Yu Pan

A Solid-Fluid Coupled Approach for Modelling the Breach Evolution of Overtopping Dams

16:00-16:15 Guan-Wei Lin, Chih-Ming Tseng, Techeng Yi

Quantitative Analysis of Unstable Sediment Sources at the Mataian Landslide, Hualien, Taiwan

16:15-16:30 Jui-Hsien Huang, Cheng-Hsuan Wu, Ruo-Pin Li, Chin-Tung Cheng

Bridging GeoAI and AIoT for Enhanced Disaster Loss Reduction: Comparative Insights from Taipei and Hualien Emergency Operations Centers

16:30-16:45 Shih-Chao Wei, Guan-Wei He, Chen-Yu Chen, Kunche Chan, Chih-Yu Huang

Enhancing Debris Flow Monitoring through Scenario-Based Kinematic Routing: A Case Study at Yusui Stream

Session C2: 15:30- 16:45 July 2 (Thu.) East Gate (C)

Topic: Ocean Observation: Technologies, Methods, and Applications (I)

Chair: Chung-Ru Ho

15:30-15:45 Wen-Yao Chen, Po-Chun Hsu

Multi-Satellite Observations of the Influence of Island Wakes on the Island Mass Effect

15:45-16:00 Thi-Kieu Diem Nguyen, Po-Chun Hsu

Tracking Marine Heatwave Evolution during Tropical Cyclones through Satellite Observations

16:00-16:15 Faqih Musyaffa, Po-Chun Hsu

Multi-Satellite Assessment of Cumulative Thermal Stress Across Coral Habitats in the Waters Adjacent to Aceh

16:15-16:30 Thi Thuy Linh Nguyen, Po-Chun Hsu

Contrasting monsoon-driven chlorophyll-a and sea surface temperature variability in the Gulf of Tonkin and south-central Vietnam

16:30-16:45 Reza Fahlevi, Po-Chun Hsu

Satellite-Based Analysis of Island Mass Effect on Coral Thermal Stress Variability in the Natuna Reef System

Session A3: 08:50- 10:05 July 3 (Fri.) South Gate (A)

Topic: Resilience Sustainability in the Digital Age: A Global Dialogue on Drought, Climate Extremes, and Earth Surface Dynamics (I)

Chair: Takashi Oguchi

08:50-09:05 Takashi Oguchi, Yasutaka Nakata, Tomoki Hosokawa

Potential Effects of Droughts and Wildfires on Geomorphic Processes in Japanese Mountains

09:05-09:20 Kim Anh Nguyen, Yuei An Liou, Thi Kim Anh Ho

Understanding Green-Blue Space Inequalities in a Rapidly Urbanizing City: Evidence from Hanoi, Vietnam

09:20-09:35 Cheng-Ling Kuo, Wen-Qian Chang, Jann-Yenq Liu, Yuei-An Liou

Hyperspectral Imaging for 12U CubeSats via Attention-Based HSI-MSI Fusion: An EnMAP-Sentinel-2 Case Study

09:35-09:50 Truong-Vinh Le, Yuei-An Liou, John Francis L. Mansos

Assessing Typhoon Track Curvature in the Western North Pacific Using the Normalized Difference Sinuosity Index

09:50-10:05 Yuei-An Liou, Tewabe Melkamu, Kim-Anh Nguyen, Minh-Tin Thai, Truong-Vinh Le

Machine Learning-Based Scenario Simulations of Land Cover Change and Climate Warming for Policy-Relevant Urban Heat Mitigation

Session B3: 08:50- 10:05 July 3 (Fri.) West Gate (B)

Topic: Radar Oceanography and Earth Observation of Coastal and Ocean Dynamics (I)

Chair: Jian-Wu Lai

08:50-09:05 Yu-Hsuan Huang, Chia-Yan Cheng, Chung-Ru Ho, Jian-Wu Lai,
Yi-Chieh Lu

Cross-System Translation and QC of HF Radar Radial Velocity Data

09:05-09:20 Syuan-Ping Chen, Hsin Yu Yu, Li Ching Lin, Hao-Yuan Cheng,
Hwa Chien

Monitoring features of nearshore currents by X-band marine radars

09:20-09:35 Z.-H. You, C.-D. Lee, C.-T. Lin, H.-M. Chang, H. Chien, C.-Y. Lee,
and L.-H. Tsai

*Vessel Detection and Tracking Using the Spatial Beamforming of
Antenna-Arrayed HF Coastal Radar*

09:35-09:50 Li-Chung Wu, Jian-Wu Lai

*Microwave Radar for Ocean Observation in Taiwan: From Technology
Development to Practical Applications*

09:50-10:05 Shao-Hua Chen, Ying-Chih Fang

*Environmental and Instrumental Controls on HF Radar Surface
Current Observations in the Coastal Waters of Southern Taiwan*

Session C3: 08:50- 10:05 July 3 (Fri.) East Gate (C)

Topic: Ocean Observation: Technologies, Methods, and Applications (II)

Chair: Shi-Ming Chen

08:50-09:05 Shi-Ming Chen, Yih Yang, Chung-Ru Ho

Mooring-observed southward currents beneath the Kuroshio off eastern Taiwan

09:05-09:20 Hong-Thuong Ngo, Po-Chun Hsu

Spatiotemporal Characteristics of Marine Heatwave Conditions During Local and Migrating Typhoons in the South China Sea

09:20-09:35 Han-Yu He, Po-Chun Hsu

Impacts of the Arctic Oscillation on Marine Heatwaves and Sea Ice Thickness in the Barents–Nordic Seas

09:35-09:50 Yun-An Yen, Po-Chun Hsu

Seasonal and Regional Variability of Ocean Warm Pools and Marine Heatwave Impacts

09:50-10:05 David Boyee Yang, Hsin-Pei Wang, Zhe-Wen Zheng, Chung-Ru Ho

Anomalous Nearshore Cooling in a Subtropical Bay: Cross-Shelf Intrusion of Kuroshio Subsurface Water Driven by Wind-Tidal Coupling during Tropical Cyclones

Session A4: 10:25- 11:40 July 3 (Fri.) South Gate (A)

Topic: Resilience Sustainability in the Digital Age: A Global Dialogue on Drought, Climate Extremes, and Earth Surface Dynamics (II)

Chair: Kim Anh Nguyen

10:25-10:40 Tsai-Fang Fan, Chia-Yi Liu, Chih-Chung Chung, Chun-Ping Chu

Assessing Drought and Extreme-Heat Risks under Climate Change for Resilient Adaptation: A Comparative Study of Taoyuan City and Hsinchu County, Northern Taiwan

10:40-10:55 Shih Ming Huang, Tsung-Yu Lee, Chuan-Yao Lin, Yi-Ying Lin, Huang-Hsiung Hsu, Fuh-Kwo Shiah

Impacts of Global Warming on Severe Drought in Northern Taiwan: A Future Projection Based on the Year 2021

10:55-11:10 Chia-Wei Hu, Lu-Chi Chen, Meng-Chen Tsai, Ke Yang Chang

Assemblage Structure of megafauna in the Waters of Offshore Wind Farm (OWF)

11:10-11:25 Oktif Rafiqka Fiddien, Kuan-Tsung Chang

Coastal Land Use Change and Ecosystem Degradation in Kaohsiung Taiwan (2000–2024): A Multi-Source Satellite Data and GIS-Based Analysis

11:25-11:40 Sandipan Mondal, Ming-An Lee

Neural Ocean's Future towards Diverging Trajectories? Nowcast–Forecast Responses of Taiwan's Coastal Seabream Fisheries to Climate Forcing

Session B4: 10:25- 11:40 July 3 (Fri.) West Gate (B)

Topic: Radar Oceanography and Earth Observation of Coastal and Ocean Dynamics (II)

Chair: Li-Chung Wu

10:25-10:40 An Cheng, Huan-Meng Chang, Hsin-Yu Yu, Hwa Chien

*Bistatic HF Radar for Coastal Surface Current Mapping:
Implementation and Validation of a Testbed in Taoyuan, Taiwan*

10:40-10:55 Kuan-Yung Chen, Hwa Chien, Li Ching Lin, Hao-Yuan Cheng,
Hsin-Yu Yu

*Ship Detection Performance Evaluation of HF Radar Based on
Ocean-Current Filtering*

10:55-11:10 Yakubos Samoria, Li-Ching Lin, Hao-Yuan Cheng, Hsin Yu Yu,
Hwa Chien

*Quality-Controlled Generation of Level-3 High-Frequency Radar
(HFR) Surface Current Fields in Northern Taiwan*

11:10-11:25 Yu-Chen Lee, Dong-Jiing Doong

*Possible Generation Mechanism of Large Rogue Waves Measured in
the Philippine Sea*

Session C4: 10:25- 11:40 July 3 (Fri.) East Gate (C)

Topic: GNSS Reflectometry and GNSS Interferometric Reflectometry for Earth Surface and Environmental Monitoring & Ocean Observation of the Earth Using Buoy Systems

Chair: Chung-Yen Kuo

10:25-10:40 Chi-Ming Lee, Chung-Yen Kuo, Jyh-Ching Juang

A CYGNSS DDM-Based Approach for Inland Water Level Monitoring over Large Lakes

10:40-10:55 Ming-Yi Chen, Yu-Fu Liou, Hwa Chien, Wen-Hao Yeh

Deep Learning-based Sea Surface Wind Speed Retrieval for the TRITON GNSS-R Mission

10:55-11:10 Hoa My Duong, Hwa Chien, Ming-Yi Chen, Li-Ching Lin, Wen-Hao Yeh

High-Resolution GNSS-R Observations of Arctic Sea Ice Using Taiwan's Triton Satellite

11:10-11:25 Wei-Cheng Chen, Dong-Jiing Doong

Marine AI and Earth Observation for Coastal Hazard Monitoring and Smart Ocean Safety

11:25-11:40 Kuan-Wen Liu, Chung-Hsiang Chang, Yen-Pin Lin, You-An Lin, Ching-Jer Huang, Chiung-Chu Huang

Preliminary Field Test Results of an Underwater Target Localization Buoy System

Poster: 14:45- 15:30 July 2 (Thu.)

1	Muhammad Khalif Arda	Argo-Based Evidence of Subsurface Atlantification near Svalbard
2	An-Shih Wang	Near-Surface Cooling in the East Greenland Current and Its Strait-Wide Expression: A Drifter-Based Assessment of Fram Strait Variability During 2016–2020
3	Chia-Hsuan Sung	Studies on the genetic diversity of Taiwanese hard clams (<i>Meretrix taiwanica</i>) in Taiwan
4	Chia-Wei Hu	An Integrated Approach for Identifying indicator Species in Coastal Trawl Ecosystems
5	Jin-Cheng Fu	Analyzing Vulnerability Gaps in Local Resiliency and Disaster Prevention Under Climate-Induced Extreme Hazards
6	Lu-Chi Chen	Species-specific responses of <i>Scomberomorus</i> catch rates to oceanographic variables: a GAM approach
7	Ya-Jiun Li	Analysis of Resilience Disaster Data Applications in Local Decision Support System
8	Yun-Hui Wu	Reproductive Biology of the Chinese Silver Pomfret (<i>Pampus chinensis</i>) off the Southwestern Water of Taiwan
9	Shih-Ming Huang	Seasonal Rainfall Variability in Reservoir Watersheds of Northern Taiwan
10	Zheng-Hao Yang	Optical Earth Observation for Rip Current Detection
11	Ruei-gu Chen	Interaction between the Kuroshio Current and China Coastal Current in Yilan Bay: Evidence of Water Mass Intrusion
12	Chia-Hsu Chih	Integrating Satellite Ocean Observation, DNA Barcoding, and Lagrangian Particle Tracking to Reveal the Spawning Grounds of Bullet Tuna (<i>Auxis rochei</i>) in Yilan Bay, Northeastern Taiwan
13	Hui-Ling Ko	DNA Barcoding Reveals Species Composition of Whitebait Fishery Catches from the Northern Coast of Taiwan
14	Yen-Wei Chang	Mesh Selectivity, Catch Composition, and Preliminary VIAME Image Annotation for Future

		Image Recognition of Single-Vessel Bottom Otter Trawls in Yilan Bay, Taiwan
15	Yueh-Feng Sung	Incorporating Satellite-based Oceanographic Data in Habitat Modeling for Economically Important Fish Species around Taiwan
16	Yun-Chen Chang	Trophic Dynamics of Bullet Tuna (<i>Auxis rochei rochei</i>) in the Penghu Waters Revealed by Stable Isotope Analysis
17	Chia-Ying Ho	Nearshore Flow Variability off Eastern Taiwan Driven by the Kuroshio and Tides
18	Hsin-Pei Wang	Using a Regional Ocean Model to Simulate Storm Surge Induced by Typhoon Haiyan (2013) and Assess the Impact of Track Variations
19	Yu-Wen Wang	The impact of oceanic changes during Typhoon Morakot (2009) on the abnormal rainfall in the mountainous areas of southern Taiwan
20	Kuo-Wei Yen	Ocean Heat Exposure and Coastal Food-System Resilience: Ichthyoplankton Assemblage Restructuring as an Early Warning Indicator in Southwestern Taiwan Waters
21	Miranda Anjelina Parhusip	Random Forest Approach for Subseasonal Rainfall Forecasting in the Riau Islands
22	I-Hui Chen	Applying LSTM and GAN to Risk Assessment of Monitoring Data in Large-scale Landslide Areas
23	Yu-Yun Hsu	Spatiotemporal Groundwater Level Imputation Using CWGAIN-GP
24	Yu-Chi Yen	Exploring the Limits of Redundancy in Water Resource Systems through Reservoir Capacity Expansion

Abstracts:

Oral Presentation

Enhanced Tropical Cyclone Track Forecasting Through Integration of Pangu-Weather and Forecast Correction

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ABSTRACT

Tropical cyclone (TC) track prediction remains a challenge to scientists and researchers. TCs significantly affect the Western North Pacific (WNP) region, so track forecasts are continually refined to provide accurate and effective disaster warnings, evacuations, and mitigation. Artificial Intelligence (AI)-based weather prediction models, such as Pangu-Weather, provide fast data-driven forecasts and simplify complex behaviors. This study aims to enhance TC track prediction by integrating forecast-correction and refinement techniques that are not implemented in Pangu-Weather.

A four-step process is conducted for this study. First, the input data are generated from ERA5 reanalysis data and converted to NumPy arrays. Next, a 6-hour, 7-day TC prediction is generated from Pangu-Weather. Then, the framework uses TempestExtremes (TE) to generate initial TC forecast positions, and post-processing is applied using techniques such as deep layer mean steering, mean sea level pressure (MSLP) recentering, thickness steering, and TE-anchored smoothing to adjust latitude and longitude values. Finally, a deterministic TC track forecast is produced. The enhanced forecast is verified using IBTrACS data and evaluated using metrics such as Direct Position Error (DPE), Root Mean Squared Error (RMSE), and Mean Absolute Error (MAE).

43 TCs were observed from 2023 to 2024 and showed a net-positive but non-uniform response to post-processing. The results showed that the mean RMSE decreased from 478.74 km to 469.64 km, and the mean MAE decreased from 387.09 km to 380.47 km. Of the 43 TCs, 21 improved in RMSE, 14 remained neutral, and 8 worsened. Stronger reductions in errors were observed in cases such as Ewiniar, Ampil, Bolaven, and Soulik, whereas other storms showed weaker improvements or slight degradation. These findings indicate that the proposed framework is best interpreted as a selective refinement layer that can improve many plausible AI-derived tracks, but not as a universal correction scheme.

Keywords: tropical cyclone, track forecasting, post-processing

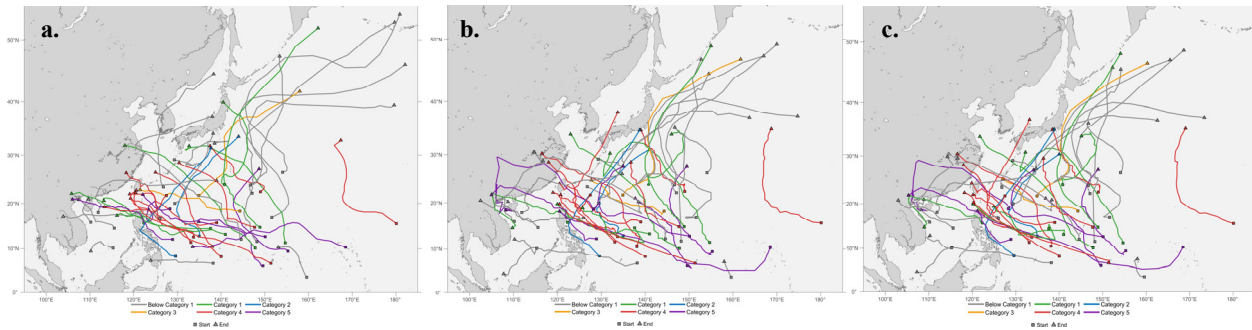


Figure 1. Tropical cyclone paths from 2023 to 2024 generated from (a) ground truth points in IBTrACS, (b) ERA5 reanalysis data via Pangu-Weather and TempestExtremes, and (c) overall forecast correction framework

Reconstructing Cloud-Induced Gaps in Landsat Land Surface Temperature Data for Urban Heat Mitigation in Taoyuan City

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ABSTRACT

Land surface temperature (LST) derived from Landsat Thermal Infrared (TIR) data is a critical variable for urban heat island (UHI) monitoring, urban climate resilience planning, environmental assessment, hydrology, and hazard detection. However, clouds are opaque to thermal infrared radiation, creating persistent spatial and temporal gaps in satellite-derived LST records that severely hinder the reliability of urban heat assessments. In Taoyuan City, analysis of Landsat 8 and 9 TIRS data over a 10-year period (2016–2025) revealed that only 47 out of 257 valid acquisitions had less than 5% cloud, while 105 scenes exhibited cloud cover exceeding 70%, underscoring the magnitude of data loss and its implications for continuous urban thermal monitoring.

To address this challenge, this study presents a gap-free LST reconstruction framework designed to support long-term urban heat monitoring and mitigation planning. The framework integrates the Annual Temperature Cycle (ATC) model with machine learning (ML) approaches, while preserving the spatial thermal dynamics. The ATC model was fitted to multi-year Landsat LST observations to capture the inherent seasonal thermal behavior of the land surfaces. To improve reconstruction accuracy, physically based auxiliary variables were incorporated, including SAR-derived surface soil moisture estimated from 10-year Sentinel-1 VV polarization, VV and VH backscatters, solar radiation factors, and terrain variables. By integrating these inputs within the combined ATC–ML framework, a spatially complete, gap-free LST dataset spanning the full 10-year study period was reconstructed.

Validation against clear-sky Landsat LST observations across the study period demonstrates that the reconstructed LST dataset successfully preserves both spatial thermal variability and local thermal heterogeneity without introducing significant systematic distortion. The resulting LST time series enables more reliable identification of persistent urban heat island hotspots and assessment of seasonal heat exposure patterns. The developed methodology is transferable and applicable to other cities and regions facing similar challenges.

Keywords: Land surface temperature; Cloud gap-filling; Annual Temperature Cycle; Machine learning; SAR soil moisture; Landsat; Taoyuan City

Multiscale Hydroclimatic Drought Proxies and PSInSAR-Derived Land Subsidence over West Java Province, Indonesia

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ABSTRACT

Land subsidence and drought-related hydroclimatic stress are major concerns in rapidly urbanizing regions, yet their relationship is difficult to evaluate because both processes vary spatially and temporally. Western Java, Indonesia, provides a suitable case study due to documented urban subsidence, complex terrain, and overlap between Sentinel-1 PSInSAR measurements and multi-source drought indicator. This study develops a multi-scale Hydroclimatic Drought Proxy Index (HDPI) to characterize drought conditions from fine-scale optical response and coarse-scale hydroclimatic forcing. Harmonized Landsat Sentinel (HLS) derived NDVI and NDMI represent vegetation and surface moisture, while CHIRPS precipitation and ERA5-Land root-zone soil moisture represent rainfall and soil-moisture deficits during 2015-2022. PSInSAR-derived vertical land subsidence was generated from 170 descending Sentinel-1 SLC pairs covering the same period. The HDPI temporal pattern was cross-checked against external hydroclimatic and statistical evidence, including ENSO, rain-gauge, paddy-production, and clean-water statistics, which supported the identified dry-wet anomaly periods. Subsidence hotspots were identified using DBSCAN clustering based on dense persistent-scatterer points and downward vertical velocity. The strongest hotspot showed median subsidence rates of 19-24 mm/year, confirming that deformation is spatially localized rather than regionally uniform. To evaluate drought-subsidence relationships, multiple HDPI components, PSInSAR response variables, and 0–12-month lag scenarios were screened using Spearman's rank correlation. Regional-scale correlation was weak; however, hotspot-specific lag analysis revealed clearer associations. Selected hotspots showed moderate lagged Spearman correlations of 0.49-0.59, with optimal lags of 8-11 months. These findings suggest that drought does not uniformly explain subsidence, but may locally modulate residual subsidence behavior. This study highlights the potential of integrating multi-scale drought proxies and PSInSAR observations to identify hydroclimatically sensitive subsidence hotspots.

Keywords: HDPI, PSInSAR, land subsidence, drought proxy, Sentinel-1, Western Java.

Emotional Propagation on Social Media during Extreme Climate Events: A Weak Tie Network Analysis of the 2022 U.S. Drought

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ABSTRACT

As climate extremes intensify, drought should not be understood only as a physical hazard, but also as a slowly accumulating social and emotional stressor. Unlike earthquakes, floods, or typhoons, drought does not produce a single dramatic moment of impact. Instead, its consequences gradually emerge through water shortages, agricultural losses, wildfire risks, supply-chain disruptions, food price concerns, and policy debates. As these pressures enter public discussion, social media becomes an important space where people interpret drought-related risks, express anxiety or frustration, assign responsibility, and share information. However, existing studies have often focused on whether public sentiment becomes more negative, while paying less attention to how drought-related emotion is diffused, amplified, or buffered through social media networks.

This study examines the 2022 U.S. drought, using October 25, 2022, when national drought coverage reached a major peak, as the focal event date. The purpose is to understand how drought-related stress is transformed into social media emotional responses. To explain this process, the study proposes a Trigger–Structure–Outcome framework. Drought events, news coverage, and policy discussions serve as triggers; weak ties, strong ties, central nodes, and pre-event information ties form the network structure; and negative emotion, emotional amplification, cross-community diffusion, and information buffering are examined as outcomes.

Methodologically, this study combines X historical posts, BERT-based sentiment analysis, event-window comparison, social network analysis, weak/strong tie classification, and drought severity data from NCEI and the U.S. Drought Monitor. Preliminary findings suggest that drought-related emotion is not simply proportional to drought severity. Instead, it is shaped by issue pathways, media narratives, and network interactions. In particular, users who had pre-event interactions with official, meteorological, media, or expert information sources showed a lower share of negative emotion after the event, suggesting that informational social capital may buffer emotional escalation during slow-onset climate disasters.

Keywords: weak tie theory, emotion propagation, social network analysis, extreme climate events, BERT, risk communication

Climate-Driven Power Risk in Taiwan's Semiconductor Industry: A Decision Support Framework Integrating Drought Indicators and Enterprise Vulnerability

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ABSTRACT

Taiwan's semiconductor manufacturing industry is a critical node in the global supply chain and among the most electricity-intensive sectors domestically. As climate change drives increasing frequency and intensity of extreme heat and drought events, the industry faces growing exposure to climate-driven power disruption risks. Yet existing research lacks complete causal chain modeling from climate signals to firm-level expected losses and offers few tools capturing firm-specific vulnerability differences. This study develops an end-to-end Decision Support System (DSS) integrating climate-driven power risk prediction and enterprise vulnerability assessment, targeting wafer fabrication and foundry firms across Taiwan's three major semiconductor science parks. The system's core is the Enterprise Power Vulnerability indicator (EPV), operationalized across three dimensions — supply-side risk, demand-side dependence, and buffer capacity — based on the IPCC vulnerability framework, with weights objectively determined through the entropy weight method. The DSS comprises three modules. M1 employs XGBoost to integrate satellite remote sensing, meteorological, and hydrological data to predict the trigger probability of power reserve margin falling below alert thresholds. M2 combines trigger probability, enterprise electricity load, Value of Lost Load (VoLL), and a firm-specific EPV coefficient to compute expected losses at the firm level. M3 integrates a large language model to translate quantitative outputs into structured natural language risk summaries, supporting managerial decision-making. This study is expected to advance climate risk and DSS literature by integrating earth observation, machine learning, and enterprise vulnerability quantification, providing semiconductor firms and policymakers with an actionable, firm-level climate energy risk governance framework.

Keywords: drought, satellite remote sensing, climate risk, decision support system, enterprise power vulnerability, XGBoost, semiconductor industry.

Mataian Landslide-Dammed Lake Event in Taiwan: From Formation and Failure to Watershed Resilience Governance

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ABSTRACT

The Mataian landslide-dammed lake event in eastern Taiwan was a cascading disaster triggered by a large-scale landslide, river blockage, rapid lake impoundment, and subsequent dam failure. On July 21, a magnitude 4.2 ground-motion signal was detected by a microtremor monitoring system, followed by the identification of a major landslide approximately 2,000 m wide and 2,700 m long, covering nearly 500 ha. The landslide formed a natural dam about 200 m high, 2,500 m long, and 600 m wide, with an estimated volume of 200 million m³ and a maximum impoundment capacity of 91 million m³. Subsequent rainfall events, including Typhoon Podul and Typhoon Ragasa, increased the likelihood of overflow and breach. On September 23, overflow occurred at approximately 12:00, followed by rapid erosion and dam-breach processes around 14:30. The release of water and sediment caused severe downstream impacts, including channel erosion, sediment deposition, levee damage, agricultural losses, infrastructure disruption, and casualties. This presentation summarizes the formation, monitoring, breach process, disaster impacts, and emergency response of the Mataian landslide-dammed lake event. It further highlights cascading hazards associated with unstable sediment sources, high-concentration sediment transport, and secondary dammed lakes. Based on the lessons learned, a watershed resilience governance framework is proposed, integrating sediment source assessment, satellite and ground-based monitoring, automated warning, numerical simulation, artificial intelligence, community preparedness, and cross-agency coordination to support long-term disaster risk reduction and adaptive watershed management in Taiwan.

Keywords: landslide dam; dam breach watershed resilience; risk governance; Mataian River

Integrated Framework for Landslide-Dam Breach Risk Management and Watershed Resilience Governance in the Mataian River Basin

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ABSTRACT

The breach of the Mataian River landslide dam created interconnected risks involving unstable sediment sources, sediment-laden floods, riverbed aggradation, inundation, transportation disruption, agricultural recovery, and public health. Although government agencies have initiated various post-disaster reconstruction measures, related data and implementation outcomes remain distributed across different administrative and technical sectors. An integrated framework is therefore needed to support watershed-scale assessment, interagency coordination, and engineering decision-making.

This study proposes a comprehensive framework for landslide-dam breach risk management and watershed resilience governance. The framework integrates five major components: watershed-wide risk assessment and decision support; hydrometeorological scenario analysis and unstable sediment-source quantification; sediment monitoring, transport modelling, and artificial intelligence-assisted rapid simulation; environmental health and agricultural land recovery; and transportation-network resilience and local collaborative governance. Data from field surveys, hydrological observations, remote sensing, sediment monitoring, numerical models, infrastructure systems, and environmental sampling are incorporated into a common decision-support platform.

The proposed framework connects monitoring, modelling, early warning, governance, and recovery through a continuous workflow. It enables the comparison of rainfall, sediment supply, dam-breach, riverbed-change, inundation, and engineering-intervention scenarios. The resulting risk maps and scenario analyses can support monitoring-site selection, sediment management, dredging strategies, flood-protection planning, evacuation planning, and post-disaster recovery prioritization. The framework is intended to consolidate cross-agency information into actionable engineering recommendations and to provide a transferable approach for managing future landslide-dam disasters in Taiwan.

Keywords: landslide dam; breach risk; sediment management; watershed resilience; decision support; Mataian River

Influence of Pre- and Post-Breach Topographic Changes on Flood Inundation Scenarios in Mataian River

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ABSTRACT

The increasing frequency and intensity of extreme rainfall events have raised the risk of landslides, debris blockage, and landslide dam formation in mountainous river basins. Once a landslide dam fails due to overtopping erosion or structural instability, a high peak discharge may be generated, resulting in a flood wave that propagates rapidly downstream and threatens settlements, agricultural lands, roads, and flood-control facilities. Therefore, numerical simulation plays a critical role in evaluating the inundation extent, maximum flood depth, and potential high-risk areas caused by landslide-dam breach floods.

This study applies the COS-FLOW two-dimensional flood model to simulate breach-induced inundation scenarios in Mataian River. A 5-m computational grid was used to preserve detailed topographic features such as river boundaries, levees, low-lying areas, and nearby settlements. A breach peak discharge of 9,000 m³/s, based on the reference value provided by the Forestry and Nature Conservation Agency, Ministry of Agriculture, was adopted as the upstream inflow condition. Pre-breach and post-breach topographic datasets were applied separately to compare maximum inundation depth and inundation extent under the same flow condition.

The results show that, under the pre-breach topography, floodwaters rapidly propagated downstream along the main channel of Mataian River and caused overtopping in the downstream reach. Significant inundation occurred in the southern low-lying areas, agricultural lands, and areas adjacent to Guangfu Township. In contrast, although the post-breach terrain reflects downstream riverbed aggradation caused by large sediment delivery from the upstream reach, inundation in Guangfu Township was substantially reduced after mitigation works, including approximately 22.71 million cubic meters of riverbed dredging and the repair of the southern Guangfu Levee. Only limited inundation depths not exceeding 0.3 m were observed in localized urban areas.

However, the improved flood defense capacity on the southern bank shifted the main overflow locations toward the northern side, resulting in new inundation in northern low-lying and agricultural areas. The post-breach topography also delayed the flood peak arrival time at Guangfu by approximately 10 to 20 minutes. These results indicate that topographic changes, sedimentation, and flood protection configurations significantly affect flood pathways, inundation depth, inundation extent, and flood propagation timing.

Keywords: COS-FLOW, landslide-dam breach, Mataian River, flood inundation simulation, flood risk assessment.

Analyzing the Microbiome diversity of the Hyperconcentrated flow deposits of the Mataian incident

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ABSTRACT

Hyperconcentrated flows resulting from catastrophic geomorphic events, such as dam-break incidents, fundamentally reshape downstream terrestrial ecosystems. The Mataian incident led to the rapid, massive deposition of dense mineral sediments across water fields, dry fields, and orchards, causing severe physical and chemical disturbances. Because rapid sediment accumulation severely restricts oxygen diffusion and creates deep anoxic microsites, public health concerns have emerged regarding the safety of the post-incident soil. Specifically, this study investigated whether the hyperconcentrated flow deposits became enriched with dangerous pathogenic anaerobic bacteria capable of causing human disease.

To evaluate this potential biological hazard, soil core samples were collected at the upstream of the Mataian River. DNA was extracted from the sediment soils to characterize microbial community composition, biomass, and diversity via Nanopore Metagenomics. Remarkably, metagenomic analyses revealed little to no detectable microbial DNA across all collected sediment samples. This scarcity of genetic material indicates a profound depletion of active microbial biomass within the hyperconcentrated flow deposits, signaling a near-total collapse of the soil ecosystem.

These findings suggest that the extreme physical compaction, rapid gas restriction, and acute organic carbon deficiency within the raw sediment matrix created an environment too hostile or oligotrophic to sustain an active microbiome, effectively suppressing both aerobic and anaerobic populations. Furthermore, the absence of detectable DNA refutes the hypothesis that these specific deposits serve as reservoirs for dangerous anaerobic pathogens. Instead, the primary ecological crisis of the post-incident Mataian soil is biological sterility. To restore soil health and ecological function, immediate remediation strategies, such as green manure rotation, are required to reintroduce organic carbon and kickstart microbial recolonization.

Keywords: Hyperconcentrated flow, Microbiome Diversity, Metagenomic sequencing

Pathway regimes and along-track SST persistence in the Fram Strait from a Taiwanese Clustered Drifter Program

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ABSTRACT

Recent discussion of the Atlantic Meridional Overturning Circulation (AMOC) has increasingly shifted from isolated deep-convection sites toward upstream transformation pathways in the Arctic–subarctic system. In this context, Fram Strait is not only a transport gateway between the Arctic Ocean and the Nordic Seas, but also a region where recirculation, marginal ice zone (MIZ) dynamics, and cross-gateway contrasts may modify signals before farther-downstream transformation. However, sustained surface Lagrangian observations in this gateway remain relatively limited.

Here we present a five-year clustered-drifter record from the Fram Strait MIZ collected between 2021 and 2025. The dataset consists of repeated annual deployments with near-real-time telemetry and includes trajectories together with sea-surface temperature (SST) and additional surface-state variables. Our objective is to examine whether this sustained drifter record can reveal pathway structure and signal evolution consistent with heterogeneous gateway behavior.

Initial analyses show three main results. First, clustered drifter trajectories reveal recurring pathway regimes, including northward transport, recirculation, and southward leakage. Second, along-track SST e-folding diagnostics indicate strong spatial contrasts in thermal persistence, suggesting that some pathway segments behave more like transport corridors while others behave more like transformation zones. Third, drifter-derived energy partition reveals cross-strait dynamical asymmetry, with a more mean-flow-dominated western side and more eddy-influenced autumn conditions near the MIZ.

Taken together, these results suggest that the Fram Strait gateway is dynamically and thermally heterogeneous, and that sustained clustered-drifter observations provide a useful observational basis for pathway-oriented gateway diagnostics. Rather than directly resolving overturning itself, this record helps constrain upstream preconditioning processes relevant to broader Arctic–subarctic transformation studies.

Keywords: Fram Strait, AMOC weakening, Drifter Cluster

Plastic debris reshapes the environmental partitioning of PFAS and organophosphate esters in a High-Arctic fjord

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ABSTRACT

Per- and polyfluoroalkyl substances (PFAS) and organophosphate esters (OPEs) are contaminants of emerging concern that are increasingly detected in Arctic environments. However, their distribution among natural and anthropogenic environmental compartments remains insufficiently characterized, limiting our understanding of their environmental fate. In this study, eight PFAS and nine OPEs were quantified in dissolved water, suspended particulate matter (SPM), sediments, and plastic debris collected from the Adventfjorden–Isfjorden system near Longyearbyen, Svalbard. The distribution of contaminants among these matrices was examined to evaluate partitioning patterns across environmental phases. Concentrations of both PFAS and OPEs varied substantially among matrices. Dissolved water generally exhibited the lowest concentrations, followed by sediments, whereas SPM and plastic debris showed comparatively higher contaminant levels. Plastic debris contained the highest concentrations of both contaminant classes across most samples. Principal component analysis revealed distinct contaminant assemblages among environmental matrices, suggesting differences in partitioning associated with compound characteristics such as chain length, functional groups, and hydrophobicity. Sediments were characterized by relatively high particle-associated fractions, while SPM exhibited intermediate characteristics consistent with exchange between dissolved and particulate phases. Plastic debris displayed contaminant compositions that differed from those observed in natural particles and showed elevated abundances of long-chain PFAS and hydrophobic OPE congeners. These results indicate that plastic debris represents a distinct environmental compartment for PFAS and OPE accumulation in Arctic coastal systems. Incorporating plastic debris into assessments of contaminant distribution may improve our understanding of the transport and environmental fate of emerging contaminants in polar regions.

Keywords: Per- and polyfluoroalkyl substances, Organophosphate esters, Plastic debris.

Geological and UAV-Based Mapping of Newly Exposed Arctic Landscapes Following Glacier Retreat in Northern Kaffiøyra, Western Svalbard

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ABSTRACT

Rapid glacier retreat across the Arctic is exposing previously inaccessible terrain, creating new opportunities to investigate geological structures, landscape evolution, and environmental responses to climate change. As part of Taiwan's growing contribution to polar research, field observations and UAV-based surveys were conducted in northern Kaffiøyra, western Svalbard, to document newly exposed geological formations and deformation structures revealed by ongoing deglaciation.

The study area is located south of Aavatsmark Glacier along the eastern boundary of the Hornsund Fault Complex, a major tectonic zone associated with the Eurekan Orogeny. Field campaigns carried out during the summers of 2022 and 2023 combined traditional geological mapping, structural measurements, and high-resolution Unmanned Aerial Vehicle (UAV) surveys. Orthomosaics and Digital Elevation Models (DEMs) generated from UAV imagery enabled detailed mapping of fault systems, lithological boundaries, and recently exposed bedrock surfaces.

Structural observations reveal the presence of both dextral and sinistral Riedel shear components, indicating a complex history of transpressional and transtensional deformation. The newly exposed outcrops provide valuable insights into the tectonic evolution of western Svalbard and improve our understanding of deformation processes associated with the Eurekan tectonic event. In addition, the study demonstrates how glacier retreat is rapidly increasing access to previously concealed geological records.

This research highlights the role of Taiwan's polar observation efforts in documenting environmental and geological changes occurring in the High Arctic. The integration of UAV remote sensing and field-based investigations provides an effective framework for monitoring emerging Arctic landscapes and establishing long-term observational datasets in regions undergoing rapid cryospheric change.

Keywords: Arctic observation, Svalbard, glacier retreat, UAV mapping, geological survey, Hornsund Fault Complex, Taiwan Polar Research

Upper-ocean variability in the Amundsen Basin of the Arctic Ocean during early winter: insights from the MOSAiC expedition

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ABSTRACT

Wintertime observations in the central Arctic Ocean are sparse. Here we present a unique early-winter data set of atmospheric, hydrographic, and ocean velocity observations from the first leg of the MOSAiC expedition, collected under nearly 100% sea ice concentration. This work examines the impact of a single storm on oceanic variability in the upper 200 m. Near-inertial internal waves (NIWs) were detected beneath the mixed layer base and were prevalent in the upper 100 m, with some showing downward energy propagation. The single storm potentially injected half the overall near-inertial energy into the mixed layer, underlining the importance of storm systems in the Arctic winter. Internal ice stress is found to dampen wind-to-ocean momentum transfer, leaving pre-existing stratification intact under full ice cover, while coherent sea ice motion emerges as the primary driver of upper ocean processes including NIWs. This work has been published in *Elementa: Science of the Anthropocene* and is available at <https://doi.org/10.1525/elementa.2023.00095>.

Structural and Functional Remodeling of Vascular Endothelium under Acute and Intermittent Heatwaves

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ABSTRACT

Under the escalating impact of climate change, extreme heatwaves have become a significant environmental risk factor for cardiovascular diseases. While clinical data correlate heatwaves with increased vascular events, the underlying biological mechanisms remain to be fully elucidated. This study aims to investigate how acute extreme heat and intermittent heat exposure drive the structural and functional remodeling of the vascular endothelium. Human microvascular endothelial cells (HMEC-1) were subjected to three experimental conditions to simulate diverse heat-stress scenarios, including acute continuous stress (41°C for 24 hours), intermittent stress (41°C for 4 hours daily over 5 consecutive days), and an immune–endothelial crosstalk model using an HMEC-1/THP-1 co-culture system exposed to 41°C for 24 hours. Cellular responses were characterized by morphological analysis and gene expression profiling. Under the acute and co-culture conditions, significant structural remodeling was observed, particularly in the co-culture group. This was characterized by marked cell elongation (increased aspect ratio) and directional spatial reorganization, as evidenced by a bimodal distribution in radar plot analysis. The qPCR results revealed a synergistic upregulation of pro-thrombotic markers, including vWF and PAI-1, alongside an increase in TGF- β , suggesting a compromised endothelial phenotype driven by immune-endothelial interactions. Under intermittent phase (5-day exposure), long-term intermittent stress shifted the focus toward adaptive impairment and chronic remodeling. Downregulation of TBK1 and BRCA2 suggested a weakened vascular barrier and compromised DNA repair capacity. The aberrant expression of HMMR and PKN2 highlighted persistent remodeling of the cytoskeleton and vasodilatory regulation under recurring heatwave patterns. Our findings demonstrate that heat stress induces both acute structural transformation and long-term functional gene remodeling in the vascular endothelium. The observed upregulation of pro-thrombotic gene markers and directional morphological shifts provide a mechanistic basis for the increased vascular risks associated with extreme climate events. These results suggest that public health strategies should prioritize the cumulative impact of recurring heatwaves on vascular integrity.

Keywords: Climate Change, Extreme Heat, Vascular Endothelium, Structural Remodeling, Gene Expression

Comparative study of machine learning models for district-level Urban Heat Island classification in Taiwan

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ABSTRACT

Urban Heat Island (UHI) is a major environmental consequence of urbanization that contributes to increased energy consumption, heat-related health risks, and environmental degradation. This study developed a district-level UHI classification framework for Taiwan by integrating Landsat 8/9-derived land surface temperature (LST) and daily in-situ meteorological observations from Taiwan Environmental Protection Administration (EPA) monitoring stations. A total of 1,949 matched observations collected between May 2025 and May 2026 were used to evaluate the performance of Random Forest (RF), Support Vector Machine (SVM), k-Nearest Neighbors (kNN), and Extreme Gradient Boosting (XGBoost) models for multiclass UHI classification. Predictor variables included Albedo, NDVI, EVI, SAVI, NDBI, NDWI, MNDWI, BSI, ambient temperature, relative humidity, and wind speed. UHI intensity was categorized into five classes using standard deviation-based thresholds, and model performance was assessed using five-fold cross-validation. The results showed that ensemble-based algorithms outperformed conventional classifiers, with XGBoost achieving the highest macro F1-score (0.9142), followed closely by Random Forest (0.9016). Feature importance analysis identified Albedo as the most influential predictor, followed by vegetation-related indices (EVI, SAVI, and NDVI) and the built-up indicator NDBI, highlighting the importance of surface reflectance, vegetation cover, and urban development in shaping thermal environments. Spatial prediction results further revealed a progressive expansion of UHI intensity across Taipei between 2020 and 2025, indicating increasing thermal stress associated with urban growth. The findings demonstrate that integrating satellite-derived environmental indicators with daily meteorological observations provides an effective framework for district-level UHI classification and offers valuable support for urban climate monitoring, heat-risk assessment, and sustainable urban planning in Taiwan.

Keywords: urban heat island, remote sensing, machine learning

Wave Propagation and Recurrent Circulation Patterns in the Atmosphere

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ABSTRACT

Large-scale recurrent circulation patterns and stationary wave propagation are closely associated with persistent extreme climate events. In this study, local wave activity (LWA), contour length of the 2-potential vorticity unit (PVU) isentropic potential vorticity (IPV), and principal component analysis (PCA) of IPV fields on the 340 K isentropic layer were used to investigate the persistence, propagation, and predictability of atmospheric circulation patterns.

The leading 20 principal components (PCs) derived from PCA of IPV anomalies were treated as a low-dimensional representation of large-scale circulation states. Evolution of circulation patterns was quantified using Euclidean distances between PCs at consecutive pentads. Persistent circulation regimes were characterized by smaller PC distances, elongated and meandering IPV contours, and enhanced local wave activity. Stronger LWA was associated with deceleration of zonal westerlies, increased waviness of the 2-PVU contour, and slower evolution of circulation states.

Results indicate that recurrent circulation patterns exhibit alternating periods of persistence and rapid propagation rather than continuous evolution. Persistent large-scale circulation regimes contributed to the background atmospheric conditions associated with the 2020 China flood and the 2022 China drought.

Based on these findings, a data-driven forecast framework was developed using PCs of IPV as predictors of circulation evolution. The results suggest that persistence-dominated circulation states are generally more predictable than rapidly propagating wave regimes, while wave propagation itself depends strongly on regional flow structures and background jet configurations. These findings imply that atmospheric predictability is flow-dependent and that propagation of Rossby wave packets cannot be represented solely as simple phase translation in low-dimensional PC space.

Keywords: isentropic potential vorticity (IPV), local wave activity (LWA), principal component analysis (PCA), and principal components (PCs).

Landsat-Based Urban Heat Assessment in Medan and Batubara Using Land-Cover-Specific SUHI Baselines

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ABSTRACT

Urban heat is an increasing climate risk in rapidly developing tropical cities, but its intensity depends strongly on how surrounding non-urban areas are defined. The Surface Urban Heat Island (SUHI) effect is commonly quantified by comparing urban land surface temperature (LST) with a generalized rural baseline. However, this approach assumes that rural areas are thermally homogeneous, which can distort SUHI interpretation. This study integrates Landsat-8/9 thermal observations, ESRI 10 m Annual Land Cover data, MODIS water vapor, and ground-based air temperature measurements to assess daytime urban heat patterns in Medan and Batubara, North Sumatra. Landsat Bands 4 and 5 were used to derive NDVI-based emissivity, while Band 10 was converted to brightness temperature and corrected using MODIS water vapor. Non-urban land cover was separated into forest and agricultural baselines to compare generalized rural SUHI, forest-referenced SUHI, and agriculture-referenced SUHI. The retrieved LST showed reasonable agreement with station observations, with correlations of 0.8780 in Belawan, 0.7238 in Deli Serdang, and 0.7293 in Batubara. Results show that agricultural land was 3 to 4°C warmer than forest in both study areas. In Medan, the generalized SUHI was 7.96°C, while forest-referenced SUHI reached 10.58 °C and agriculture-referenced SUHI decreased to 7.33°C. In Batubara, the corresponding values were 4.28 °C, 6.37 °C, and 2.44°C. These findings show that rural baseline selection strongly affects urban heat assessment. Separating forest and agricultural baselines provide a necessary correction for more accurate heat-risk mapping and urban climate mitigation planning.

Keywords: Urban Heat Assessment, Surface Urban Heat Island, Land Surface Temperature, Landsat-8/9, Land Cover, Rural Baseline.

Satellite-Derived PM_{2.5} (SatPM25) over Indonesia: Validation, Seasonal Variability, and Spatiotemporal Distribution

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ABSTRACT

Ground-based PM_{2.5} observations are increasingly available in Indonesia, but their spatial density remains limited relative to the country's large archipelagic domain. Many monitoring records are also relatively recent, limiting their use for assessing long-term PM_{2.5} variability and climatological patterns. This study uses the global satellite-derived PM_{2.5} product, SatPM25, developed by the Atmospheric Composition Analysis Group at Washington University in St. Louis, to investigate PM_{2.5} spatiotemporal variability over Indonesia from 2004 to 2023. The reliability of SatPM25 was assessed for 2022–2023 using monthly PM_{2.5} estimates derived from AQICN AQI records at 16 BMKG air quality monitoring stations. AQI values were converted into PM_{2.5} mass concentrations using the standard AQI breakpoint approach. The validation shows that SatPM25 generally captures monthly PM_{2.5} variability at the regional scale. The mean time series of 16 stations shows moderate agreement with AQI-derived PM_{2.5}, with $R = 0.70$, $RMSE = 4.45 \mu\text{g m}^{-3}$, and a small bias of $-0.41 \mu\text{g m}^{-3}$. In contrast, the station-month comparison shows weaker agreement, indicating larger local-scale discrepancies. Therefore, SatPM25 is more suitable for analyzing regional and seasonal PM_{2.5} variability than for direct station-level interpretation. To represent Indonesia's spatial heterogeneity, the analysis was further conducted at national and island-region scales. Seasonal patterns indicate higher PM_{2.5} over Sumatra and Kalimantan during SON, likely associated with late dry-season biomass burning, while Java shows relatively stable PM_{2.5} levels throughout the year. In other island regions, PM_{2.5} unexpectedly peaks during DJF, followed by SON, possibly due to actual seasonal conditions, clear-sky sampling bias, and sea-salt-related retrieval uncertainty. Jakarta and Palangka Raya were also examined as contrasting examples of urban-dominated and biomass-burning-influenced regimes. Overall, SatPM25 is useful for regional and long-term PM_{2.5} assessment over Indonesia, although local station-scale interpretation requires caution.

Keywords: PM_{2.5}, satellite-derived PM_{2.5}, Indonesia, AQI conversion, seasonal variability, air quality

Integrating environmental, vector, and seroepidemiological surveillance into a post-disaster infectious disease early warning system: a three-year One Health framework for the Mataian landslide-dammed lake, Hualien, Taiwan

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ABSTRACT

Background and Rationale

The 2025 large-scale upstream landslide and repeated dam-break cycles along Mataian River (Guangfu Township, Hualien) created sustained hydrological disturbance across a downstream corridor encompassing densely populated and agricultural zones. Post-flood conditions, including stagnant water accumulation, soil mobilization, and disrupted sanitation, substantially amplify the concurrent transmission risk of soil-associated bacteria (*Burkholderia pseudomallei*, *Leptospira* spp.), enteric pathogens, and mosquito-borne diseases. Eastern Taiwan already sustains endemic populations of *Anopheles minimus* (a competent malaria vector) and *Aedes albopictus* (dengue/chikungunya vector); post-flood landscape changes are expected to further expand vector breeding habitats. Despite these converging threats, no integrated post-disaster infectious disease surveillance platform currently exists for eastern Taiwan.

Study Design

This medical sub-project, nested within a larger interdisciplinary disaster recovery initiative funded by the Ministry of Public Construction and the NCKU Higher Education Sprout Project, establishes a three-year One Health surveillance platform covering three complementary domains: environmental pathogen monitoring, mosquito vector surveillance, and community seroprevalence assessment.

Methods

Environmental surveillance

Fifteen fixed monitoring stations spanning upstream landslide zones, mid-stream transitional reaches, agricultural irrigation networks, and downstream residential areas undergo routine monthly sampling supplemented by event-driven sampling at post-flood Days 3 and 7 (triggered when projected 48-hour cumulative rainfall exceeds 400 mm). Water and soil specimens are analyzed by dual-track detection, selective culture and TaqMan qPCR, targeting *B. pseudomallei* (TTS1/BPSS1187), *Leptospira* spp. (lipL32), and enteric pathogens via multiplex PCR panels (including *Clostridioides difficile* tcdA/tcdB/cdtA). Year 2 expands to *Rickettsia* spp. and environmental fungi, with representative isolate whole-genome sequencing.

Vector surveillance

Concurrent mosquito monitoring will document the spatial distribution and seasonal abundance of *Anopheles minimus* and *Aedes albopictus* across the affected watershed. Surveillance findings will be correlated with post-flood landscape changes and meteorological parameters to model vector habitat expansion risk.

Community seroprevalence

A cross-sectional serological survey is proposed among residents of Guangfu and Wanrong Townships to establish baseline and post-flood seroprevalence of anti-*Leptospira* (MAT) and anti-*B. pseudomallei* (IHA/IgG ELISA) antibodies, pending ethical approval. This component aims to estimate subclinical infection burden and identify high-risk occupational or residential subgroups.

Risk modeling and clinical translation

Quantitative qPCR outputs are integrated with real-time meteorological and hydrological data (QPE/QPF, bridge water-level sensors, micro-seismometers) from the Forestry and Nature Conservation Agency to construct a lag-effect predictive risk model. Color-coded alerts (yellow/red) interface directly with local health bureaus and emergency departments, enabling proactive differential diagnosis of melioidosis and leptospirosis during acute febrile presentations following flood events. Year 3 will deploy environmental decontamination interventions at identified hotspots and establish point-of-care diagnostic (POCT) protocols and prevention SOPs, including post-exposure doxycycline prophylaxis, tetanus booster algorithms, and vector control guidance, for disaster responders.

Expected outcomes

Over three years, the platform will yield: a longitudinal environmental pathogen and vector database (>2,000 environmental specimens); a proposed seroprevalence component targeting two neglected tropical pathogens (*Leptospira* spp. and *B. pseudomallei*); a spatially stratified risk map; at least three SCI/SCIE publications; and a deployable disaster infectious disease response SOP — establishing the first integrated One Health post-disaster surveillance and early warning model for eastern Taiwan.

Keywords: melioidosis; leptospirosis; environmental surveillance; *Anopheles minimus*; *Aedes albopictus*; disaster medicine; One Health; early warning system; eastern Taiwan

Quantitative Analysis of Unstable Sediment Sources at the Mataian Landslide, Hualien, Taiwan

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ABSTRACT

The Mataian landslide, triggered by the July 2025 rainstorm, represents a large-scale mass movement with persistent sediment supply risks to the downstream Mataian River. This study presents a multi-sensor remote sensing framework to quantify the activity and volume of unstable sediment sources in the landslide area, with the primary objective of delivering actionable spatial datasets prior to the 2026 flood season.

The analytical workflow integrates three complementary displacement detection techniques: SAR offset tracking and SBAS-InSAR using Sentinel-1 ascending and descending orbit imagery, optical image change detection, and Digital Image Correlation (DIC) applied to 3-meter-resolution satellite imagery. Three-dimensional surface displacement fields derived from multi-orbit SAR data were subsequently used to invert landslide body thickness based on a mass conservation approach.

Results from the analysis period February–May 2026 reveal that the most active zones are concentrated in the lower slope below the original failure headscarp and in the dam body remnant area, with estimated active mass thicknesses reaching approximately 200 m and 185 m, respectively. Optical change detection further documents progressive debris redistribution: imagery from October 2025 to February 2026 shows expansion of the debris accumulation zone down the valley, development of braided flow channels, and emergence of depositional lobes, indicating ongoing sediment transport toward the main channel. The integrated approach provides spatially continuous estimates of high-activity sediment volumes, offering a basis for downstream hazard assessment and the prioritization of monitoring and engineering countermeasures.

Bridging GeoAI and AIoT for Enhanced Disaster Loss Reduction: Comparative Insights from Taipei and Hualien Emergency Operations Centers

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ABSTRACT

To mitigate the loss of life and property caused by natural disasters, it is essential to understand disaster causation and strengthen preparedness through advanced technologies. This study evaluates the integrated application of GeoAI and AIoT within Emergency Operations Centers (EOCs) across two distinct environments: metropolitan Taipei City and non-metropolitan Hualien County.

In the urban context of Taipei, the T-SAGE platform addresses seismic risks by incorporating the city's unique Taipei Basin geological structure and site amplification effects. The GeoAI engine integrates 153 localized GIS datasets, including more than 230,000 detailed building records (e.g., number of stories, construction permit year, and building type), VS30 site characteristics (average shear-wave velocity within the upper 30 meters), and seismic microzonation data. Within 10 minutes following an earthquake, the platform combines observed and partially estimated seismic intensity information with building vulnerability and liquefaction potential assessments to generate high-resolution building damage risk heat maps. This methodology was validated during the 2024 Hualien Earthquake (0403 event), where the predicted high-risk zones closely matched the locations of officially designated red-tagged buildings. Furthermore, the platform integrates the Gemma 3 27B Large Language Model (LLM), which synthesizes spatial intelligence and municipal disaster response standard operating procedures (SOPs) into actionable decision-support recommendations, including prioritized rescue routes and shelter activation plans.

In the non-metropolitan environment of Hualien, the EDP platform focuses on enhancing the diversity and reliability of environmental monitoring data collected from AIoT sensors during major disasters. Using the Mataian River barrier lake incident as a case study, the platform facilitates cross-agency data integration by combining real-time water-level APIs from the Forestry and Nature Conservation Agency with multi-temporal satellite imagery provided by BigGIS (pre-disaster imagery from 0808 and post-disaster imagery from 0925). AI algorithms analyze IoT time-series data and generate early warning and decision-support recommendations. Through visualization of potential dam-breach inundation areas, priority evacuation zones, and spatially referenced evacuation registries, the EDP platform assists EOCs and fire departments in understanding the spatio-temporal distribution of casualties and missing persons. Information is updated every four hours through a responsive web interface, enabling frontline commanders to maintain a “Mobile EOC” capability even in remote areas.

This study concludes that the synergy between real-time AIoT sensing and high-precision GeoAI spatial analytics is essential for modern disaster management. The demonstrated implementations advance the vision of “Shared Disaster Safety”, enabling rapid, data-driven situational awareness and decision-making that reduce disaster impacts regardless of geographic context.

Keywords: GeoAI, AIoT, Large Language Models (LLMs), Seismic Disaster Resilience, Emergency Operations Center (EOC), Disaster Intelligence Accuracy, Decision Support Systems

Enhancing Debris Flow Monitoring through Scenario-Based Kinematic Routing: A Case Study at Yusui Stream

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ABSTRACT

While current on-site sensors allow for the rapid detection of debris flows, they often struggle to predict downstream hazard impacts. As a result, decision-makers can confirm an event has occurred but may not fully understand its scale or the available lead time. To address this operational gap, this study develops a scenario-based kinematic routing framework to quantitatively assess downstream impact scales and warning lead times. To establish the initial boundary conditions, the Difference-of-DEMs (DoD) method was applied to quantify the volume of loose sediment from existing landslides, while multi-temporal imagery was utilized to identify tension cracks and gully expansion for estimating potential new failure volumes. These parameters were then integrated into the DEBRIS-2D numerical model to conduct the debris flow simulations. To validate this framework, Yusui Stream was selected as the case study site. For this specific watershed, we constructed a scenario matrix with initial debris flow volumes ranging from 1.24×10^6 to 12.44×10^6 m³, calibrating and validating the numerical routing against the 2021 Typhoon Lupit event. Our simulations show that the source location strongly influences downstream dynamics. Under maximum volume scenarios, a midstream failure significantly reduces the lead time to just 11.4 minutes, compared to 47.9 minutes for upstream sources. Building upon these simulation results, we derived logarithmic transfer functions that link mid-stream flow depth to downstream arrival time and event scale, achieving high predictive reliability ($R^2 > 0.96$). Ultimately, combining real-time sensor data with this pre-computed physical database transforms standard monitoring into a more proactive early warning system.

Keywords: Debris flow, Kinematic routing, Early warning system

A Solid-Fluid Coupled Approach for Modelling the Breach Evolution of Overtopping Dams

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ABSTRACT

The breach of Matai'An natural dam on 23 September 2025 represents a typical example of a catastrophic flood characterized by high sediment concentrations. The resulting flood caused severe inundation in downstream townships, and the substantial sediment deposition elevated the riverbed and induced migration of the flow path. From the perspective of hazard mitigation, the hydrographs of outflow discharge and the associated sediment concentration constitute key inputs to the assessment process. In addition to the reservoir capacity, the outflow discharge is highly related to the embankment erodibility, yielding a wide variety of existing peak charge formulas regressed from historical case studies. In the present study, a solid-fluid erodible model (Wong et al., 2024) is applied to mimic the evolution of the breach notch. In the preliminary study, three initial notches are considered, the V-shape, Trapezoid shape and Jagged-bottom shape, with respect to various scenarios (dam compositions, reservoir capacities, etc.). The feasibility of the proposed method will be numerically demonstrated by the resulting outflow discharges, sediment concentration hydrographs, and the evolution of the breach notch.

Keywords: dam-breach, solid-fluid two-phase approach, erodible model, breach notch evolution, outflow hydrograph, sediment transport

Multi-Satellite Observations of the Influence of Island Wakes on the Island Mass Effect

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ABSTRACT

The Island Mass Effect (IME) refers to the enhancement of primary productivity around islands caused by interactions between currents and topography, commonly associated with vertical mixing and upwelling. This study focuses on Green Island and Orchid Island off southeastern Taiwan and integrates 300 m chlorophyll-a concentration (Chl-a) data from Sentinel-3 OLCI, approximately 2 km sea surface temperature (SST) data from Himawari-8/9, and 4 km multi-satellite products to investigate the spatiotemporal characteristics and possible mechanisms of IME from 2016 to 2025. The results reveal a clear and seasonally dependent IME signal around Green Island. In summer, downstream Chl-a was approximately 26% higher than upstream Chl-a (0.39 vs. 0.31 mg m⁻³), while Chl-a on the right side of the island was more than twice that on the left side (0.52 vs. 0.25 mg m⁻³). In winter, this pattern was reversed, with higher upstream than downstream Chl-a (0.57 vs. 0.22 mg m⁻³). Similar large-scale spatial patterns were observed in the 4 km dataset, indicating that the major IME signal is identifiable across different spatial resolutions. In contrast, the IME signal around Orchid Island was weaker, with only a small summer difference between downstream and upstream Chl-a (0.13 vs. 0.10 mg m⁻³). SST observations further show that the downstream region of Green Island was cooler than the upstream region in summer (29.57°C vs. 30.20°C), which is consistent with enhanced Chl-a. These results suggest that vertical mixing and localized upwelling may contribute to the observed IME. Overall, this study demonstrates that local topographic effects and island wake dynamics can produce different bio-geophysical responses under similar Kuroshio-dominated conditions. Future work will incorporate SWOT sea surface height and current data to better resolve island wakes and submesoscale dynamics.

Keywords: Island Mass Effect, Kuroshio, Multi-satellite observation

Tracking Marine Heatwave Evolution during Tropical Cyclones through Satellite Observations.

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ABSTRACT

Tropical cyclone (TC) passage systematically disrupts pre-existing marine heatwave (MHW) conditions across the Northwestern Pacific (NWP), with MHW category reductions scaling from 0.1 units under tropical storms to near-complete termination under the most intense TC passages. This thermal reset and how it scales with TC intensity and regional ocean structure are quantified for the first time using 33 years (1993–2025) of NOAA Coral Reef Watch (CRW) CoralTemp v3.1 daily 5-km sea surface temperature (SST) and operational MHW category, an archive originally designed for coral reef stress monitoring. TC-relative composites of an SST cooling ratio (ΔSST) and MHW category are constructed for 2,402 TC positions in five intensity classes across three NWP sub-domains: the Western Pacific (WP), South China Sea (SCS), and East China Sea (ECS), using GLORYS12V1 mixed-layer depth reanalysis and Japan Meteorological Agency (JMA) Best Track records. TC-induced SST cooling scales monotonically with intensity across all sub-domains and is consistently greater in the marginal seas than the open WP: at tropical-storm intensity, SCS cooling exceeds the WP by 47%, and peak domain-mean cooling reaches 5.2% at very-strong-typhoon intensity in the SCS. This domain hierarchy reflects shallower pre-TC mixed layers (ECS 16.4 ± 5.5 m, SCS 17.8 ± 3.9 m, WP 20.1 ± 3.3 m) and sharper thermoclines that amplify turbulent entrainment under equivalent wind stress. MHW disruption mirrors this pattern, reaching near-complete termination within 48 hours under the most intense passages, where the highest pre-TC MHW baselines co-occur with the strongest TCs, consistent with a self-limiting oceanic feedback. A right-of-track asymmetry of up to 1.8% in SST cooling and MHW disruption constitutes a coherent, satellite-detectable signature of resonant near-inertial forcing. These results demonstrate that TCs systematically erode MHW persistence through stratification-controlled entrainment and establish the CRW archive as a precision instrument for monitoring TC-ocean interactions across the NWP.

Keywords: Marine Heatwaves, Tropical Cyclones, Satellite Remote Sensing.

Multi-Satellite Assessment of Cumulative Thermal Stress Across Coral Habitats in the Waters Adjacent to Aceh

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ABSTRACT

As regional warming accelerates across the dynamically complex and highly susceptible waters adjacent to Aceh in the eastern tropical Indian Ocean, the use of advanced ocean observation technologies is critical for tracking shifting environmental baselines and identifying localized coral vulnerabilities. This study presents a multi-satellite assessment evaluating cumulative thermal stress across sixteen coral habitats in this region from 1985 to 2025. The primary methodology integrates high-resolution remote sensing data, including Sea Surface Temperature, ocean currents, surface heat fluxes, and optical parameters, to spatiotemporally quantify thermal stress and marine heatwave exposure. The major findings reveal a chronic regional warming trend of 0.15°C to 0.30°C per decade, severely degrading the ocean's thermal baseline. This long-term escalation culminated in a catastrophic anomaly in 2024, recording an unprecedented basin-wide average of 432 MHW-weighted days. Spatial analysis demonstrates that northern habitats are mechanically buffered by energetic hydrodynamic flushing, maintaining persistent thermal fronts with gradient magnitudes exceeding 0.008°C/km. Conversely, western coastal habitats function as intense thermal traps, enduring extreme accumulations of 450 to 490 MHW-weighted days. In these western zones, a highly negative net freshwater flux develops as massive precipitation exceeding 10 to 14 mm/day heavily outpaces critically weak evaporative cooling, where Latent Heat Flux is limited to -40 to -80 W/m². This results in severe negative net freshwater flux, lowering surface salinity below 31.5 psu and establishing a highly buoyant surface layer. This freshwater-induced stratification traps incoming net surface heat fluxes exceeding 100 W/m² on the shallow continental shelf, subjecting habitats to lethal, slow-burning thermal exposure, such as the 103 consecutive days of stress recorded at Point H, and further compounding the effects of optical degradation. In conclusion, the catastrophic cumulative thermal stress threatening these coral ecosystems is fundamentally driven by localized hydrodynamic stagnation and thermodynamic surface trapping rather than global climate modes.

Keywords: ocean warming, marine heatwaves, thermal stress, coral habitats, Aceh waters

Contrasting Monsoon-Driven Chlorophyll-a and Sea Surface Temperature Variability in the Gulf of Tonkin and South-Central Vietnam

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ABSTRACT

This study compares three representative marine regions along the Vietnamese coast during 1998–2025: the Gulf of Tonkin (GoT), the Nearshore Coastal Upwelling (NCU), and the Offshore Upwelling (OFU). Satellite chlorophyll-a (Chl-a) and sea surface temperature (SST) data, together with surface winds and ocean currents, were used to quantify long-term trends through linear regression and to evaluate seasonal mechanisms across the Northeast, Southwest, and transitional monsoon periods. Results reveal consistent SST warming across the GoT ($0.272\text{ }^{\circ}\text{C decade}^{-1}$), NCU ($0.197\text{ }^{\circ}\text{C decade}^{-1}$), and OFU ($0.213\text{ }^{\circ}\text{C decade}^{-1}$), but contrasting Chl-a responses. The GoT exhibits the highest Chl-a concentrations, with an annual mean of approximately 1.35 mg m^{-3} , particularly during the Northeast monsoon. The NCU exhibits strong seasonality, with elevated Chl-a during the Southwest monsoon (May–Sep mean: $\sim 0.44\text{ mg m}^{-3}$; peak: $\sim 0.66\text{ mg m}^{-3}$ in August) and moderate concentrations during the Northeast monsoon (Nov–Mar mean: $\sim 0.41\text{ mg m}^{-3}$). In contrast, the OFU shows lower Chl-a concentrations, with an annual mean of 0.129 mg m^{-3} , and weaker seasonal amplitude, indicating reduced direct local wind forcing and stronger modulation by offshore transport and mesoscale circulation. Spatially, Chl-a in the NCU is characterized by a pronounced coastal maximum associated with wind-driven upwelling, whereas the OFU represents the offshore extension of this signal, where Chl-a anomalies propagate seaward as an elongated plume modulated by offshore advection and mesoscale circulation. In contrast, the GoT is characterized by strong nearshore enrichment and a steep offshore decline, consistent with river-plume forcing and monsoon-enhanced vertical mixing. This study highlights the role of physical–biogeochemical interactions in shaping marine productivity and identifying key productivity hotspots relevant to fisheries.

Keywords: Chlorophyll-a; Sea surface temperature; Monsoon.

Satellite-Based Analysis of Island Mass Effect and Coral Thermal Stress Variability in the Natuna Reef System

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ABSTRACT

The Natuna Archipelago, located in the southern South China Sea (SCS), is characterized by shallow bathymetry and dynamic oceanographic conditions that may support the development of the Island Mass Effect (IME). Meanwhile, marine heatwaves (MHWs) have intensified in recent decades, posing increasing threats to coral reef ecosystems. Through interactions between islands and the surrounding ocean, the IME can enhance biological productivity and generate localized oceanographic variability, including thermal variations around coral reef environments. The study focuses on 18 coral sites in Bunguran Island, the main island in Natuna, which hosts an estimated reef area of approximately 530 km². To investigate these conditions, multi-satellite Level-4 datasets were utilized, including Sea Surface Temperature (SST), HotSpot, and Degree Heating Weeks (DHW) from NOAA Coral Reef Watch to assess marine heatwaves and coral bleaching risk. Chlorophyll-a concentration, surface current, and wind data from the Copernicus Marine Environment Monitoring Service (CMEMS) were employed to characterize IME-related oceanographic conditions. The results indicate progressive intensification of MHWs around Bunguran Island, marked by more frequent and longer-lasting events, particularly during major warming years such as 1998, 2010, 2016, and 2024. However, the detected coral bleaching signal remained low, with Level 1 coral bleaching alerts recorded for the first time at four coral reef sites in southern Bunguran in 2024. The discrepancy between increasing MHW activity and low bleaching signals indicates that most MHW events in Natuna consist of warm-water anomalies that rarely exceed the critical bleaching threshold, limiting the accumulation of HotSpot values and DHW. Additionally, consistently high chlorophyll-a concentrations around the islands indicate increased biological productivity and dynamic oceanographic conditions, likely associated with enhanced water-mass mixing and local upwelling, which may reduce heat accumulation and contribute to spatial variations in coral reef thermal stress.

Keywords: Marine heatwaves; Island Mass Effect, Coral Bleaching

Potential Effects of Droughts and Wildfires on Geomorphic Processes in Japanese Mountains

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ABSTRACT

The major agents of erosion and sediment transport in Japan are rainfall-driven hydrological processes. A common recognition among Japanese researchers is that heavy storms combined with abundant antecedent rainfall lead to the most significant consequences, including landslides and debris flows. The ongoing climate change driven by global warming will exacerbate this due to more frequent heavy storms. In addition, the change appears to significantly increase the frequency of dry periods in Japan, as indicated by recent wildfires. Therefore, it is necessary to assess the combined effects of two extreme conditions: droughts and heavy storms. Droughts can exacerbate slope erosion and sediment disasters, even as they reduce antecedent rainfall and soil moisture. First, droughts alter soil surface conditions and may reduce land permeability, leading to increased surface runoff if rainfall occurs. Second, droughts may increase wildfires that damage vegetation, making land surfaces more susceptible to erosion.

To address the issues above, we launched a project to survey and monitor land surfaces affected by recent wildfires in Japan. The first investigation site is Mount Ogiyama, Yamanashi Prefecture, about 70 km west of Tokyo. The mountainous terrain experienced a wildfire in January 2026, which burnt approximately 400 ha, including steep slopes. We analyzed Sentinel satellite imagery to detect burnt areas using the dNBR metric. Then we conducted a field survey in one of the most affected areas. The results indicate that the distribution of burnt areas is patchy, reflecting the mosaic distribution of more-burnable conifer trees and less-burnable broadleaf trees. We also used two drones: one with a multispectral sensor and the other with a LiDAR sensor to obtain high-resolution topographic and land-cover data. We additionally surveyed the more detailed topography and vegetation using a portable terrestrial LiDAR. We plan to survey the site repeatedly after a heavy storm to detect topographic changes.

Keywords: Drought, Wildfire, Mountain slope, Topography, Vegetation, Japan

Understanding Green-Blue Space Inequalities in a Rapidly Urbanizing City: Evidence from Hanoi, Vietnam

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ABSTRACT

Urban green and blue spaces (UGBS), including parks, vegetation cover, lakes, rivers, and other water bodies, are essential components of sustainable urban ecosystems, providing critical environmental, ecological, and social benefits. However, rapid urbanization in many Southeast Asian cities has resulted in significant spatial disparities in the distribution of these resources, potentially undermining urban resilience and residents' quality of life. This study investigates the spatial distribution, heterogeneity, and accessibility of urban green and blue spaces across Hanoi, Vietnam, using an integrated remote sensing and spatial statistical approach. Multi-temporal Sentinel-2 imagery was employed to derive vegetation and water indices for mapping urban green and blue spaces. A grid-based framework was developed to quantify the density and spatial configuration of vegetation and water resources at a fine spatial scale across the city. Hanoi was partitioned into regular spatial units to facilitate detailed assessments of spatial inequalities and landscape patterns. Spatial statistical analyses, including clustering and autocorrelation techniques, were applied to identify hotspots and cold spots of green and blue infrastructure and to examine their relationships with urban development intensity and population distribution. The results reveal substantial spatial heterogeneity in the distribution of green and blue spaces. Areas characterized by large parks, lakes, and river corridors exhibit significantly higher ecological resource availability, whereas densely urbanized central districts show fragmented vegetation cover and limited water features. Spatial clustering patterns indicate that deficiencies in green-blue infrastructure are concentrated in rapidly developing urban neighborhoods. The analysis further highlights priority zones where strategic interventions could improve environmental equity and strengthen climate adaptation capacity. The proposed framework provides a scalable and transferable approach for monitoring urban green and blue infrastructure in rapidly urbanizing cities. The findings offer valuable insights for sustainable urban planning and support evidence-based strategies aimed at enhancing ecological resilience, environmental justice, and the long-term livability of Hanoi.

Keywords: Urban heat, land surface temperature, greenspace, public accessibility, spatial regression, environmental equity, satellite data

Hyperspectral Imaging for 12U CubeSats via Attention-Based HSI–MSI Fusion: An EnMAP–Sentinel-2 Case Study

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ABSTRACT

Spaceborne hyperspectral imaging from CubeSat platforms is fundamentally constrained by optical physics: achieving fine ground sampling distance (GSD) demands a long focal length, a large aperture, and tight manufacturing and alignment tolerances—mechanism precision below 1 μm , optical centration below 10 μm , and mirror surface roughness on the order of $\lambda/10$ —that conflict with the standardized size, mass, and cost envelope required for low-cost launch. This work proposes shifting part of the spatial-resolution burden from the optical bench to a calibrated data-processing chain. We apply ARC-NET, an Attention-Based Residual Convolutional Neural Network, to fuse low-spatial-resolution hyperspectral imagery (LR-HSI) with high-spatial-resolution multispectral imagery (HR-MSI), reconstructing high-resolution hyperspectral data. ARC-NET integrates channel, self-, and fusion attention so that spectral content is anchored to the radiometrically calibrated hyperspectral source while spatial structure is supplied by the multispectral guide. Using a real EnMAP scene acquired on 10 August 2022 (11:24:29 UTC) fused with coincident Sentinel-2 imagery, we demonstrate 30 m $\rightarrow$ 10 m reconstruction and evaluate it within a metrology-aware framework combining Wald's reduced-resolution protocol with no-reference quality assessment and spectral-fidelity checks. Placeholder results indicate a PSNR of 39.2 dB, RMSE of 1.92, ERGAS of 2.41, and SAM of 2.88° at reduced resolution, outperforming SSR-NET, ResTFNet, TFNet, SSFCNN, and MSDCNN. We discuss how the fusion gain translates into relaxed optical tolerances and lower mission cost for a 12U CubeSat, while preserving the physical traceability of the spectral measurement.

Keywords: Hyperspectral Imaging, Image fusion, Attention Mechanisms, CubeSat, Deep Learning, and EnMAP

Assessing Typhoon Track Curvature in the Western North Pacific Using the Normalized Difference Sinuosity Index

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ABSTRACT

Typhoon track geometry is an important but underutilized indicator of storm behavior, especially for those storms whose recurvature or meandering motion makes forecasting and hazard assessment difficult. This study proposes the Normalized Difference Sinuosity Index (NDSiI), a direction-based metric that quantifies the curvature of typhoon tracks by analyzing the maximum and minimum turning angles along each track. The method was applied to 1,064 mature typhoons in the Western North Pacific (WNP) using the IBTrACS best-track records from 1977 to 2020. The NDSiI values obtained were classified into four classes: straight, semi-straight, sinuous, and highly sinuous. Results show large inter-storm variability in track curvature but no clear long-term monotonic trend over the study period. Typhoons with larger NDSiI tend to have longer lifetimes, longer travel distances, higher winds, and lower central pressures, implying that more curvy tracks are generally associated with more persistent and possibly more dangerous systems. The spatial analysis further shows that highly sinuous storms are more likely to affect areas in East Asia (e.g., Taiwan, Korea, and Japan), while straighter tracks tend to be associated with impacts in China, Vietnam, and the Philippines.

Climate variability is also relevant in this study, as warm phases of El Niño–Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) tend to displace cyclogenesis eastward and favor more recurving or sinuous tracks, whereas cold phases concentrate genesis farther west and are associated with straighter trajectories. The results indicate that NDSiI can be applied as a practical geometric descriptor for the interpretation of typhoon motion, regional risk characterization, and seasonal forecasting and disaster preparedness in the WNP.

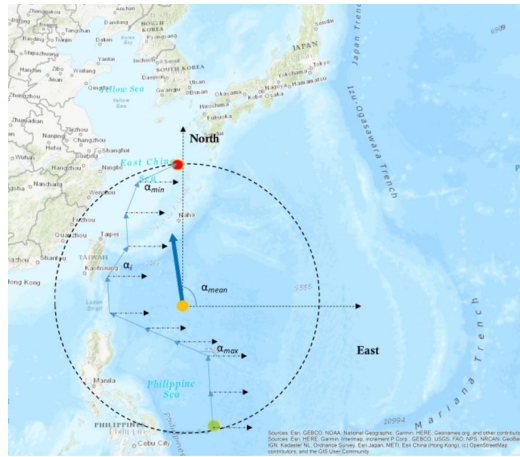


Figure 1. Schematic illustration of the Normalized Difference Sinuosity Index (NDSiI), showing how turning angles along a typhoon track are used to quantify trajectory curvature from genesis to dissipation.

Keywords: typhoon track curvature, Normalized Difference Sinuosity Index (NDSiI), Western North Pacific

Machine Learning-Based Scenario Simulations of Land Cover Change and Climate Warming for Policy-Relevant Urban Heat Mitigation

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ABSTRACT

Rapid urbanization and climate change are intensifying the urban heat island (UHI) effect, posing major challenges to public health and livability in tropical cities. This study applies a Random Forest (RF) machine learning framework to simulate land use/land cover (LULC) change scenarios and their interaction with climate warming, providing policy-relevant insights for urban heat mitigation in Hanoi, Vietnam.

Landsat 8 data were used to derive Land Surface Temperature (LST) and key spectral indices, including the Normalized Difference Vegetation Index (NDVI), Relative Surface Evapotranspiration Index (RSETI), and Normalized Difference Built-up Index (NDBI), while Digital Elevation Model (DEM) data were incorporated as an additional predictor. A high-performing RF regression model was developed for both winter and summer seasons. Scenario simulations were conducted by modifying key remote sensing indices (NDVI, RSETI, and NDBI) to represent 5% and 10% vegetation gain (increased vegetation indices with corresponding NDBI reduction) and vegetation loss scenarios. These LULC scenarios were further combined with assumed climate warming increments of +1 °C and +1.5 °C.

Results show that a 10% vegetation increase reduces mean LST by −0.56 °C (summer) and −0.30 °C (winter), while a 10% decrease raises LST by +0.58 °C and +0.36 °C, respectively. Under a +1.5 °C warming scenario, the cooling benefits of vegetation gains are offset, resulting in net increases of approximately +0.94 °C in summer and +1.2 °C in winter. Evaluation using the Urban Thermal Field Variance Index (UTFVI) shows that vegetation expansion improves thermal comfort, increasing thermally comfortable areas (UTFVI < 0) from 50–55% to 60–65%, whereas vegetation loss expands thermal stress zones (UTFVI > 0) to 55–60%.

Overall, this machine learning-based scenario framework provides practical guidance for urban planning. Increasing green cover can effectively reduce heat and improve thermal comfort but must be complemented by broader climate adaptation strategies to address future warming. The framework is transferable to other rapidly urbanizing cities facing similar challenges.

Keywords: Urban Heat Island, Land Surface Temperature, Machine learning, LULC change, Climate Warming, Scenario Simulation, Vietnam

Cross-System Translation and QC of HF Radar Radial Velocity Data

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ABSTRACT

High-frequency radar (HF Radar) has been widely used for coastal surface current observations. However, HF Radar systems differ in hardware configuration, direction estimation methods, data formats, and quality control workflows. These differences often cause inconsistent field definitions, insufficient metadata, and limited traceability of quality flags during cross-agency data integration and downstream applications. Applying a single QC test or fixed threshold across systems may further distort quality assessment results and affect data interoperability and reliability.

This study focuses on existing HF Radar radial velocity data in Taiwan and proposes a localized standard translation and quality control framework centered on Level 1 radar spectra (L1) and Level 2 radial velocity (L2) data. Differences in data fields, spectral quality indicators, and radial velocity outputs between Direction Finding (DF) and Beam Forming (BF) systems are reviewed. With reference to the U.S. IOOS QARTOD framework, CMEMS, EuroGOOS, and the NetCDF/CF Metadata Conventions, a common semantic field framework and QC Test Matrix are developed. The framework follows a “translate first, then QC” principle: original fields from different systems are mapped and semantically aligned into commonly interpretable L1/L2 standard fields, and applicable QC tests are then executed according to system type and field availability.

The quality of HF Radar radial velocity data depends not only on final velocity values, but also on upstream spectral processing, Bragg Peak identification, signal-to-noise ratio (SNR) estimation, direction estimation methods, and system configuration parameters. Therefore, this study recommends a metadata-driven HF Radar L1/L2 QC Test Matrix that links spectral-level diagnostic information with L2 radial velocity quality flags, improving anomaly traceability and supporting cross-system reprocessing and long-term quality management.

At the L1 stage, SNR is used as a common cross-system quality concept to evaluate whether the Bragg Peak signal is sufficiently above the background noise to support reliable radial velocity estimation. Since noise floor estimation, spectral sampling ranges, and preprocessing workflows may differ among systems, SNR thresholds should be defined according to system type, station environment, and historical data characteristics, and recorded in metadata. For DF systems, DOA Metrics, DOA Function Widths, cross-spectra matrix eigenvalues, and the 2×2 Signal Matrix can support direction estimation diagnostics. For BF systems, the left–right Bragg Peak energy symmetry index (rLR) and Bragg Peak range can serve as auxiliary spectral quality indicators.

At the L2 stage, Syntax, Max Threshold, and Valid Location are defined as common required QC tests for checking data format completeness, physical plausibility of radial velocity, and validity of observation locations. Suggested or optional tests are then applied according to the DF/BF system characteristics. DF systems can directly use Radial Count and Average Radial Bearing, whereas BF or gridded-output systems should translate Radial Count into a valid grid count, non-missing grid ratio, or valid coverage ratio. Spatial Median Filter, Temporal Gradient, and Radial Stuck Value tests further support spatial and temporal consistency assessment, with thresholds defined according to station-specific data characteristics.

The proposed framework also establishes aggregation logic for individual QC test flags and aggregate quality flags, and recommends recording threshold values, threshold versions, applicable stations or regions, processing versions, and related QC metadata. This design helps distinguish missing data, unevaluated tests, suspect data, and failed quality checks, while avoiding the misclassification of missing fields or system-inapplicable tests as data errors. Overall, the proposed standard translation and L1/L2 QC Test Matrix framework can support quality traceability, cross-system translation, and quality flag generation for multi-system HF Radar radial data in Taiwan, serving as a foundation for national ocean radar data standardization and future data governance.

Keywords: HF Radar; L1/L2 Quality Control; Radial Velocity Standardization

Monitoring features of nearshore currents by X-band marine radars

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ABSTRACT

Taiwan's vibrant coastal tourism and marine ecosystems are increasingly threatened by marine debris and hazardous rip currents. To address these critical environmental and safety challenges, this study leverages shore-based X-band marine radar for intelligent, continuous, and all-weather coastal monitoring. By analyzing radar echo signals, the system dynamically tracks drifting debris and identifies rip current formations, automatically logging their precise spatiotemporal coordinates to streamline emergency responses and cleanup operations. Furthermore, drifting marine litter serves as a natural tracer for mapping localized surface currents and small-scale coastal eddies. By capturing wave breaking and wave-current interactions, this radar imaging approach effectively maps large-scale circulation patterns, offering a robust data-driven framework for sustainable coastal management. To achieve high-fidelity current detection, the X-band radar exploits the complex relationship between hydrodynamic forces and radar backscatter from the sea surface. The system relies on the detection of capillary and short gravity waves—often referred to as Bragg waves—which modulate the radar echo signals. By processing these spatial and temporal variations through Time-average and Time-variance algorithms, the radar system can extract accurate surface current features over a wide spatial range without requiring physical sensors in the water. Furthermore, the radar's high sampling frequency enables the continuous tracking of sub-mesoscale eddies and shear zones close to the surf zone. Because the radar captures the entire wave-current field in real time, it can detect the subtle modifications that underlying current shears impose on the phase velocity of incoming swell waves. Consequently, this allows the system to reconstruct spatial current distributions. By transforming raw backscatter intensity into actionable hydrodynamic data, shore-based X-band radar serves as an invaluable, non-contact utility for both real-time hazard mitigation and the long-term empirical study of coastal morphodynamics.

Keywords: X-band marine radar, nearshore currents, wave-current interactions.

Vessel Detection and Tracking Using the Spatial Beamforming of Antenna-Arrayed HF Coastal Radar

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ABSTRACT

Two antenna-arrayed HF coastal radars are installed on the northern and southern protecting embankments of Taichung Harbor, Taiwan (~24°18.591'N, ~120°31.389'E) to measure the ocean currents and wave fields in the vicinity waters. Monitoring the vessels navigating around the harbor is also one of the objectives. The northern radar, which transmitted frequency-modulated continuous waves (FMCW) centered on the frequency of 27.75 MHz and with a bandwidth of 300 kHz, was used in this study. Sixteen vertical dipole antennas are arranged linearly and connected to sixteen receiving channels. We examined the capability of monitoring vessels using a radar beamforming method that transforms temporal radar signals into range-angle (RA) brightness, making ship detection and tracking easier in the spatial domain. To suppress the sidelobe echoes effectively, the beamforming method, norm-constrained Capon method (NC-Capon), was employed. The produced RA brightness distribution is different from the conventionally used range-Doppler (RD) spectra. With auxiliaries of a band-stop filter to suppress the first-order sea echoes and several well-functioning processes to validate the echo centers, we can locate the ship positions and estimate the ship velocities through merely the RA brightness. Automatic Identification System (AIS) information was used to validate the radar-determined ship locations and velocities. Although some ships having the AIS information were not observed by the radar owing to the conditions of long range, small size, and large arrival angle, the radar detected some targets without AIS information. In terms of this complementary detection, the HF coastal radar and the proposed approach are believed to be potential auxiliaries in monitoring the ships navigating around the harbor.

Keywords: HF coastal radar, vessel detection, NC-Capon method

Microwave Radar for Ocean Observation in Taiwan: From Technology Development to Practical Applications

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ABSTRACT

Coastal ocean environments are characterized by strong spatial and temporal variability driven by waves, currents, winds, bathymetric changes, and human activities. Continuous and high-resolution monitoring of these dynamic processes is therefore essential for coastal disaster prevention, maritime safety, environmental management, and sustainable ocean use. Microwave marine radar provides a promising remote sensing approach because it can observe sea surface signatures over broad coastal areas with high temporal resolution, day-and-night availability, and relatively low dependence on in situ deployment. This study presents the development and practical implementation of microwave radar technologies for ocean observation in Taiwan, with emphasis on the transition from research-based algorithms to operational coastal monitoring capability.

A national-scale radar observation framework has been progressively established through collaboration between Taiwan's public-sector agencies and academic research institutions. The framework integrates radar station planning, coastal infrastructure design, power and communication systems, raw signal acquisition, analog-to-digital conversion, data quality control, and long-term operation and maintenance. At present, a network of coastal radar stations has been deployed and maintained to support continuous sea-state observation and coastal hazard monitoring. Rather than relying only on commercial radar displays, the developed system digitizes raw radar signals and applies physics-based and data-driven processing methods to extract oceanographic information from radar image sequences.

The technical basis of the system is the transformation of spatio-temporal radar image sequences into the spectral domain. By applying three-dimensional spectral analysis and filtering based on the wave dispersion relationship, wave-related signals can be separated from background noise and non-oceanic echoes. The resulting spectra provide information on wave energy, significant wave height, wave period, wavelength, wave direction, wave celerity, group velocity, surface current velocity, and nearshore bathymetry. These capabilities demonstrate that microwave radar is not limited to qualitative visualization of sea clutter, but can serve as a quantitative ocean remote sensing platform.

Several field applications are summarized to demonstrate the practical value of the radar-based observation system. For sea-state monitoring, the radar network provides continuous spatial observations of wave and current conditions that are difficult to obtain using conventional point-based instruments alone. For coastal hydrodynamics, high-resolution current estimation from radar image sequences enables the identification of complex circulation patterns in semi-enclosed bays and nearshore waters. Beyond oceanographic parameters, radar imagery also supports maritime target detection and tracking, shipborne environmental observation, rip current monitoring in the surf zone, offshore aquaculture facility tracking, and oil spill detection. These applications indicate that microwave radar can function as a multi-domain monitoring platform for both scientific research and operational decision support.

Overall, this study demonstrates how microwave radar technology can be transformed from a research instrument into an operational ocean observation service. By integrating coastal radar infrastructure, raw signal acquisition, spectral analysis, multi-parameter inversion, and long-term maintenance, Taiwan has developed a practical framework for high-resolution coastal monitoring. The results suggest that microwave radar can play a central role in strengthening national ocean observation capability, supporting coastal resilience, improving maritime safety, and advancing the scientific understanding of nearshore processes.

Keywords: Microwave radar, Coastal ocean observation, Sea-state monitoring, Operational remote sensing.

Environmental and Instrumental Controls on HF Radar Surface Current Observations in the Coastal Waters of Southern Taiwan

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ABSTRACT

High-Frequency Radar (HFR) systems provide continuous observations of coastal surface currents, yet the accuracy of derived current vectors is influenced by both environmental conditions and instrumental configurations. This study investigates the environmental and instrumental factors controlling HFR-derived surface current observations in Nanwan Bay, southern Taiwan, through comparisons with AIS-equipped surface drifters. Two field experiments were conducted under contrasting offshore and nearshore conditions to evaluate the influence of flow variability, radar geometry, and sampling density on the agreement between HFR and drifter observations.

Two validation approaches, including fixed-grid averaging and drifter-following analyses, were applied to examine the sensitivity of comparison results to spatial and temporal sampling schemes. Correlations between HFR-derived and drifter-derived currents generally ranged from 0.7 to 0.9, with root-mean-square differences typically below 0.2 m s^{-1} and estimated biases on the order of 0.1 m s^{-1} . Validation performance improved substantially when the number of drifter samples exceeded approximately 60–80 observations, depending on deployment location and radar geometry.

Analysis indicates that discrepancies between HFR and drifter observations arise primarily from two factors. The first is unresolved sub-grid flow variability associated with tidal forcing and complex coastal bathymetry, which contributes to local variability in drifter–radar comparisons. The second, and more influential, factor is the geometric configuration of measured radial velocities. In the offshore experiment, limited directional diversity of radial velocity measurements reduced the accuracy of reconstructed two-dimensional current vectors, resulting in weaker agreement for the zonal velocity component. In contrast, the nearshore experiment benefited from more favorable radar geometry and showed comparable performance for both velocity components.

These results indicate that radar geometry is a dominant factor influencing HFR-derived current accuracy, while adequate sampling density can partially mitigate geometric limitations. The findings provide practical guidance for the design and interpretation of HFR validation experiments in complex coastal environments.

Keywords: High-frequency radar; surface current measurements; drifter; data validation experiment; ocean circulation

Mooring-observed southward currents beneath the Kuroshio off eastern Taiwan

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ABSTRACT

The Kuroshio is a major western boundary current flowing northward along the east coast of Taiwan. Recent observations, however, have revealed the presence of subsurface southward currents beneath the surface-intensified Kuroshio. From 2018 to 2019, the Taiwan Ocean Research Institute (TORI) deployed multiple moorings equipped with 75 kHz ADCPs off eastern Taiwan to obtain velocity profiles in the upper 500 m. Analysis of these data shows that at offshore sites (approximately 70 km and 130 km from the coast), the observed southward currents were driven by mesoscale eddies, extending from the water surface to depths of at least 500 m. In contrast, at onshore sites (approximately 30 km from the coast), we identified southward currents with periods of 10–20 days that did not reach the surface, distinguishing them from the full-water-column eddy-induced flows shown in the data of the offshore sites. Comparison with annual mean velocity fields from the modeling results of Regional Ocean Modeling System (ROMS) reveals a distinct cyclonic circulation below around 500 m, south of the Ilan Ridge. The western flank of this circulation, which aligns with the onshore sites, suggests that these subsurface currents are topographically steered. Our ongoing work further investigates the relationship between these subsurface southward currents and sea surface height variations, aiming to identify causes of variations of the subsurface southward currents near the coast of eastern Taiwan.

Keywords: Kuroshio, mooring, ocean circulation model

Spatiotemporal Characteristics of Marine Heatwave Conditions During Local and Migrating Typhoons in the South China Sea

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ABSTRACT

This study investigates the spatiotemporal dynamics between typhoons and marine heatwaves (MHW) in the South China Sea from 1994 to 2024. Utilizing a dataset of 57 track points from 18 local and 9 migration typhoon cases, we employ an 11-day observation window (Days -5 to +5 relative to passage) to examine regional ensemble means across four geographic sectors: Northern (20.0°N–21.55°N), North Central (16.0°N–20.0°N), South-Central (10.8°N–16.0°N), and Southern (8.17°N–10.8°N). The analysis is stratified by typhoon intensity, categorized into Major Typhoon (VS/VI: ≥ 85 kt), Typhoon (STS/TY: 48 – 84 kt), and Storm (TS: 34 – 47 kt). Our findings indicate that track points reaching intensities of 85 kt or higher have become more frequent post-2010. During the pre-event phase (Days -5 to -1), MHW categories remain consistently elevated, fluctuating between 0.8 and 1.0 in the Northern and North Central hotspots, and near 0.7 in the South-Central region. Upon typhoon passage (Day 0), these values drop abruptly to approximately 0.3, 0.5, and 0.4, respectively, whereas the Southern region exhibits minimal interaction, with values consistently below 0.25. Furthermore, this ocean-cooling response is highly intensity-dependent. Major Typhoons induce the most significant thermal recovery, dropping MHW values from a pre-event mean of ~ 1.4 to below 0.1 within 24 hours of passage. Track points in the Typhoon and Storm groups show more moderate reductions, settling near 0.2 and 0.3, respectively. Across all hotspots, ocean heat levels remain suppressed near or below 0.2 throughout the five days following passage (Days +1 to +5). In conclusion, typhoon intensity determines the magnitude and speed of ocean thermal reduction in the South China Sea. High-intensity typhoons serve as an episodic regulatory mechanism that effectively terminates extreme marine heatwaves.

Keywords: South China Sea, Marine Heatwaves, Typhoon Intensity, Spatiotemporal Dynamics

Impacts of the Arctic Oscillation on Marine Heatwaves and Sea Ice Thickness in the Barents–Nordic Seas

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ABSTRACT

The Barents–Nordic Seas, located within 68–82°N and 5–60°E, is strongly influenced by the southward-flowing East Greenland Current (EGC) and the northward-flowing Norwegian Current (NC). Both current systems exhibit pronounced seasonal cycles, with stronger flow in winter and weaker in summer. Throughout most months, the EGC is approximately 0.02–0.03 m/s faster than the NC, indicating that the regional circulation structure remains relatively stable despite interannual variability. The Arctic Oscillation (AO) is one of the dominant modes of atmospheric circulation in the Northern Hemisphere. Its positive phase is generally associated with stronger westerly circulation and a more confined polar vortex, while its negative phase allows greater meridional exchange between Arctic and mid-latitude air masses. The results show a clear intensification of marine heatwave conditions over the study period. Based on annual mean marine heatwave (MHW) metrics across four decades, the decadal mean increased from approximately 0.05 in 1985–1994 to 0.38 in 2015–2025, representing about a sevenfold increase in background heatwave conditions. The interannual standard deviation also increased from about 0.04 to 0.15, suggesting that MHWs have become not only stronger but also more variable. Sea ice thickness estimates show substantial differences among the three datasets, primarily between satellite-derived and reanalysis-based products, with climatological mean values generally ranging from 0.5 to 1.4 m. During 1985–2025, the AO exhibited no clear long-term phase trend, but several pronounced wintertime events were identified. Strong positive AO phases occurred in 1989, 1990, 1993, and 2020, while strong negative phases occurred in 2009, 2010, and 2013. These events indicate that the AO acts primarily as an interannual atmospheric forcing mechanism, modulating wintertime variability in sea ice thickness and marine heatwave conditions rather than driving their long-term trends.

Keywords: Arctic Oscillation; Barents–Nordic Seas; Marine heatwaves; Sea ice thickness

Seasonal and Regional Variability of Ocean Warm Pools and Marine Heatwave Impacts

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ABSTRACT

This study investigates the spatiotemporal variability of the western Pacific warm pool during 1985–2024 and examines its relationship with Marine Heatwaves (MHWs) activity. In the western basin (120°E–155°E), the warm pool is largely confined south of 20°N during boreal winter but expands northward in summer, reaching approximately 30°–40°N. This seasonal migration provides favorable thermal conditions for the development of high-latitude MHWs. In the Kuroshio and Kuroshio Extension regions, the 28°C isotherm exhibits a long-term poleward shift during summer, indicating persistent warm-pool expansion and intensified warming. In the central Pacific (175°E–175°W) and eastern Pacific (170°W–120°W), the seasonal extent and spatial continuity of the warm pool are strongly modulated by large-scale climate modes, including the El Niño–Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Pacific Gyre Oscillation (NPGO). Periods of northward warm-pool expansion are characterized by broader, more continuous high-temperature fields, whereas enhanced equatorial cold-tongue conditions result in fragmented warm-pool structures and more spatially intermittent thermal anomalies. Statistical analyses further reveal a pronounced seasonal cycle in warm pool area, with maximum extent in August and minimum extent in February, together with a significant increasing trend on interannual timescales. Comparisons of representative years (1998, 2015, and 2024) further demonstrate the close linkage between warm pool variability and MHW activity. In 1998, following the decay of a strong El Niño event and the transition toward La Niña conditions, both the intensity and spatial extent of MHWs gradually weakened. In contrast, MHWs during the strong El Niño year of 2015 exhibited a pronounced zonal band-like distribution associated with the eastward transport of equatorial warm waters. In 2024, MHWs displayed a fragmented, multi-regional, and spatially extensive pattern, suggesting the combined influence of multiple ocean–atmosphere interaction processes.

Keywords: Western Pacific Warm Pool; Marine heatwaves; Seasonal variability

Anomalous Nearshore Cooling in a Subtropical Bay: Cross-Shelf Intrusion of Kuroshio Subsurface Water Driven by Wind-Tidal Coupling during Tropical Cyclones

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ABSTRACT

Anomalous and abrupt nearshore sea temperature drops exceeding 6-7°C were observed at a small coastal bay in northeastern Taiwan during the passage of Typhoon Haikui (2023). To elucidate the underlying mechanisms behind this intense regional cooling, we utilized the Regional Ocean Modeling System (ROMS) configured for the southern East China Sea, complemented by in-situ buoy measurements, tide stations, and satellite-derived tracks of tropical cyclone. Numerical experiments reveal that local air-sea heat fluxes are insufficient to produce such drastic localized cooling. Instead, the primary driver is a multi-stage, remote dynamic process: (1) Topographic Upwelling & Shelf Intrusion: Kuroshio Subsurface Water (KSSW) is initially forced onto the northeastern Taiwan shelf via Kuroshio-topography interactions, modulated by large-scale wind fields during western-tracking typhoons; (2) Wind-Tidal Coupling (WTC): Once on the shelf, these cold, denser waters are further propelled landward through a synergistic mechanism where strong localized southeastern winds couple with flooding tidal currents; (3) Bay Intrusion (CSI): Aforementioned coupling acts as a "Trojan Horse," sequentially pumping the displaced subsurface cold water into the shallow coastal bay over multiple tidal cycles. Sensitivity experiments omitting tidal forcing (EXPNoTide) demonstrated a complete absence of the pulsed cross-shelf transport, failing to reproduce the observed 7°C temperature drop within the bay. Long-term observation indices establish a robust statistical correlation between the index of local cumulative southeastern winds (SE Wind Index) and coastal extreme cooling (CEC) events, corroborating the modeled WTC mechanism. Lagrangian particle-tracking experiments further confirm that particles originating from the outer-shelf break exhibit high-probability trajectories terminating inside the bay, driven by this synchronized wind-tide pumping. This study highlights how fine-scale coastal embayments can be dramatically regulated by open-ocean features through multi-stage wind tide current coupling.

Keywords: Wind-Tidal Coupling , Kuroshio Subsurface Water, Coastal Extreme Cooling

Assessing Drought and Extreme-Heat Risks under Climate Change for Resilient Adaptation: A Comparative Study of Taoyuan City and Hsinchu County, Northern Taiwan

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ABSTRACT

Northern Taiwan faces compounding hazards, with agricultural drought and extreme heat posing escalating risks to food production and population health. This study presents fine-scale disaster risk assessments—agricultural drought in Taoyuan City and extreme heat impacts on vulnerable populations in Hsinchu County—within a unified hazard–exposure–vulnerability (HEV) framework aligned with Taiwan’s Climate Change Risk Assessment Guidelines. Both assessments draw on AR6 statistical downscaling data from the Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) under Global Warming Level scenarios of +1.5°C (2021–2040) and +2.0°C (2041–2060) relative to the 1995–2014 baseline.

For Taoyuan, drought hazard is quantified by the three-month Standardized Precipitation Index (SPI3) and mean drought intensity; exposure is represented by cropland area; and vulnerability is proxied by irrigation water demand. For Hsinchu, heat hazard is the mean annual number of days exceeding 34°C, derived from TCCIP AR6 health hazard indicators; exposure reflects population density and built-up land use; and vulnerability encompasses elderly, young, and physically disabled populations, low-income households, outdoor agricultural workers, green/blue space coverage, and healthcare facility density. Risk is computed as the product of hazard, exposure, and vulnerability scores, classified into five levels.

Results indicate that drought risk in Taoyuan exhibits a southeast-to-northwest gradient, concentrating in agriculturally intensive plains of Xinwu, Guanyin, Zhongli, and Dayuan districts. In Hsinchu, heat-related disaster risk intensifies markedly under the +2.0°C scenario, with Zhubei city and Zhudong, Hukou, and Guanxi townships emerging as primary hotspots for 2021–2060. Both cases reveal spatial heterogeneity driven by the co-occurrence of increasing hazard, high exposure, and limited adaptive capacity. The results offer actionable guidance for regional adaptation policy: optimizing irrigation systems, promoting drought-resilient cropping, establishing heat early-warning systems, and delivering targeted support to at-risk populations.

Keywords: disaster risk assessment, climate change adaptation, agricultural drought, extreme heat, socially vulnerable populations

Impacts of Global Warming on Severe Drought in Northern Taiwan: A Future Projection Based on the Year 2021

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ABSTRACT

In 2021, Taiwan experienced its most severe drought in 56 years, resulting in substantial crop losses, estimated to be approximately NT\$1.65 billion due to insufficient water in reservoirs. According to an Intergovernmental Panel on Climate Change report, the frequency of such drought events is expected to increase in the future because of global warming. This study employed the pseudo-global-warming method to project changes in seasonal rainfall during future droughts in Northern Taiwan using a high-resolution (1 km) regional mesoscale model. The simulation was based on the severe drought event of 2021 and employed the Weather Research and Forecasting model driven by the global High-Resolution Atmospheric Model under the Representative Concentration Pathway 8.5 scenario for the mid-21st century (2040–2059). The modeling projections revealed significant variations in seasonal rainfall in Northern Taiwan, exhibiting a pattern described as “dry season gets drier, wet season gets wetter.” Notably, a more than 40% decrease (increase) in spring (Mei-yu season) rainfall was observed. During the dry season, rainfall intensity was expected to decrease significantly due to a reduction in heavy rain and an increase in light rain ($\pm 5\%$) in the rainfall intensity range, whereas the opposite trend was anticipated for the wet season. These findings indicate that changes in rainfall due to global warming will worsen drought conditions in Northern Taiwan if a severe drought reoccurs, particularly affecting major reservoir watersheds such as the Feitsui Reservoir, which was projected to experience 13% annual and 50% spring rainfall reductions.

Keywords: Drought, Global warming, Future projection, Pseudo-global-warming method, Seasonal rainfall

Assemblage Structure of megafauna in the Waters of Offshore Wind Farm (OWF)

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ABSTRACT

This study investigated the spatiotemporal variation of megafauna assemblage structure in offshore wind farm (OWF) waters of the Taiwan Strait. Fishery-independent surveys using otter trawl sampling and fishery-dependent data from gillnet and pole-and-line fisheries were integrated to evaluate ecosystem changes associated with offshore wind farm development. Environmental variables derived from satellite remote sensing and hydrological datasets, including sea surface temperature, salinity, current velocity, and chlorophyll-a concentration, were incorporated into multivariate analyses.

The results revealed significant spatial and seasonal differences in assemblage structure. In spring, assemblage patterns showed stronger geographic variation, whereas interannual differences became more pronounced during autumn, indicating that seasonal water masses and environmental variability strongly influence ecosystem dynamics in the Taiwan Strait. Biota analyses showed no obvious interannual changes in habitat composition; however, artificial hard-bottom structures associated with OWFs may gradually influence benthic and reef-associated species over time.

SIMPER analysis identified several dominant indicator species, including *Upeneus japonicus*, *Uroteuthis chinensis*, and *Mene maculata*, which may serve as representative ecological indicators for long-term monitoring in OWF areas. Fishery-dependent analyses also showed increasing CPUE trends in gillnet and pole-and-line fisheries, although the increase may mainly reflect low-value commercial species. Canonical Correspondence Analysis (CCA) further indicated that fish assemblages were more closely associated with chlorophyll-a concentration and ocean currents, while cephalopod assemblages were more related to temperature and salinity. Overall, this study provides an integrated framework for long-term ecological monitoring and fisheries management in offshore wind farm.

Keywords: Offshore wind farm, Megafauna assemblage, Fishery-dependent data

Coastal Land Use Change and Ecosystem Degradation in Kaohsiung Taiwan (2000–2024): A Multi-Source Satellite Data and GIS-Based Analysis

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ABSTRACT

Coastal regions in Taiwan are experiencing rapid land use transformations driven by urbanization, aquaculture expansion, and industrial development. These changes pose significant threats to critical ecosystem services, including coastal wetlands, mangroves, and marine habitats. South Taiwan, particularly Kaohsiung, represents a critical case study due to its high development pressure and ecological sensitivity.

This study aims to quantify temporal patterns of coastal land use change in South Taiwan (2000–2024), identify spatial hotspots of ecosystem degradation, and assess the primary driving forces of coastal transformation including urban expansion, aquaculture development, and natural disturbances (typhoons).

This research employs a multi-source satellite data integration approach utilizing Landsat, Sentinel-2, and MODIS imagery combined with in-situ validation data from Taiwan's government agencies (Ministry of Environment, National Land Survey Office, Fisheries Agency). Land use classification, change detection analysis, and driver identification will be conducted using Anthropic Earth Engine and QGIS-based GIS analysis. Classification accuracy will be assessed using confusion matrices and validation against official government land use maps.

This research provides methodologically rigorous, quantified evidence of coastal ecosystem degradation patterns essential for informing adaptive coastal management policies in Taiwan and providing methodological frameworks applicable to other coastal regions.

Keywords: Coastal Land Use Change, Ecosystem Degradation, Satellite Remote Sensing, GIS Analysis, Temporal Change Detection

Neural Ocean's Future towards Diverging Trajectories? Nowcast–Forecast Responses of Taiwan's Coastal Seabream Fisheries to Climate Forcing

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ABSTRACT

Climate-driven redistribution of marine species poses critical challenges for coastal fisheries sustainability, particularly for data-limited demersal species. This study quantifies the nowcast and forecast responses of six commercially important seabream species (Sparidae) in the Taiwan Strait under contrasting climate scenarios (SSP1-2.6 and SSP5-8.5). Using logbook-derived catch-per-unit-effort data (2014–2019) integrated with reanalysis and CMIP6 oceanographic variables, we developed species-specific artificial neural network models to characterize nonlinear habitat–environment relationships and project future habitat suitability. Results reveal strong species-specific thermal niche differentiation, with sea surface temperature emerging as the dominant driver of abundance. Threshold analyses indicate that several species exhibit declining catch rates beyond critical temperature ranges (~20–24°C), highlighting vulnerability to ongoing ocean warming. Future projections show widespread habitat contraction under both scenarios, intensifying under SSP5-8.5, with consistent northward (~0.15–1.4°) and westward (~55–164 km) shifts in distribution centroids. However, the magnitude and direction of changes vary among species, underscoring heterogeneous climate sensitivity within the assemblage. These findings demonstrate that climate impacts on coastal fisheries cannot be generalized across taxa and emphasize the need for species-resolved, adaptive management strategies. The integrated nowcast–forecast framework provides actionable insights for climate-resilient fisheries governance and contributes directly to Sustainable Development Goal 14.

Keywords: ANN, climate change, habitat displacement, regime shift, seabream fisheries, XGBoost

Bistatic HF Radar for Coastal Surface Current Mapping: Implementation and Validation of a Testbed in Taoyuan, Taiwan

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ABSTRACT

High-frequency (HF) radar is a well-established technology for coastal surface current monitoring. However, conventional monostatic configurations are constrained by viewing geometry, coastline configurations, and site availability, often resulting in observational blind spots and incomplete spatial coverage. To address these geometric limitations and expand observation coverage, this study implements a bistatic HF radar testbed in Taoyuan, Taiwan, based on an open-source architecture, and develops an integrated spatiotemporal data processing and cross-validation framework.

At the hardware layer, a hybrid synchronization strategy integrating GNSS-disciplined pulse-per-second (PPS) signals and direct digital synthesis (DDS) phase-lock feedback is deployed to establish the strict phase coherence essential for bistatic operations. On the processing side, a unified workflow is developed to transform raw data into physically consistent representations. This pipeline encompasses scattering-point localization via elliptical geometry, bistatic Bragg frequency identification, and channel calibration for both radar Doppler-range and antenna phase/gain.

In-situ validation demonstrates that the calibrated bistatic radial velocities exhibit strong agreement with the monostatic reference, achieving a high correlation coefficient and a low bias. Ultimately, by integrating the complementary viewing geometries of the co-located systems, we successfully synthesize an expanded, continuous two-dimensional vector surface current field. This work demonstrates the operational feasibility of bistatic HF radar and provides a reproducible foundation for future multi-station coastal monitoring networks.

Keywords: Please select at least 3 keywords to illustrate the subject of this paper and separate them by commas.

Ship Detection Performance Evaluation of HF Radar Based on Ocean-Current Filtering

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ABSTRACT

This study presents an ocean-current-filtering-based signal processing technique for high-frequency (HF) radar systems to identify and suppress ship clutter, thereby improving the detection accuracy of fast-moving maritime targets. The proposed method applies time-domain filtering to radar I (In-phase) and Q (Quadrature) signals, separating Doppler shifts caused by sea-surface currents from radar echoes. This process effectively removes first-order Bragg scattering and enhances target detection performance. The technique exploits the distinct characteristics of vessel echoes and ocean-surface returns to detect and isolate ship clutter from simultaneously observed sea echoes. Detected ship signals were validated using vessel information obtained from an Automatic Identification System (AIS) receiver. Results demonstrate that the proposed method can successfully identify the echo energy of fast-moving targets. Experimental evaluations were conducted using data collected at the Guanyin HF radar monitoring station on the Taoyuan coast of Taiwan. The system achieved an effective detection range of up to 10 km with an observation sector of approximately $\pm 30^\circ$ centered on the radar station. Detection performance was assessed for vessels of different lengths by comparing radar-derived target locations with AIS vessel tracks. Within the 10-km observation range, the matching success rate ranged from 50% to 70%. Detection accuracy decreased at ranges between 10 and 20 km, where success rates were limited to approximately 30%, primarily due to radar transmission power constraints, sidelobe interference, and local electromagnetic environmental effects. Overall, the results confirm that ocean-current-filtering-based signal processing provides a practical and effective approach for the preliminary detection and monitoring of fast-moving maritime targets.

Keywords: High-Frequency Radar, Ship Detection, AIS Spatial Verification

Quality-Controlled Generation of Level-3 High-Frequency Radar (HFR) Surface Current Fields in Northern Taiwan

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ABSTRACT

Level-3 HFR data provide geolocated vector fields derived from overlapping radar observations, yet they are often constrained by radial data quality, spatially uneven coverage, station geometry, and discontinuities introduced during quality screening. These limitations are critical in operational coastal monitoring, particularly in the transition from observational synthesis to gap-filled, value-added products. This study develops a quality-controlled framework for producing Level-3 HFR surface current fields in the northern Taiwan coastal region. The workflow begins with station-level radial velocity screening to exclude unreliable measurements based on signal quality, physical plausibility, and geometric consistency. To reduce unnecessary information loss before vector estimation, a radial repair procedure is applied to recover locally missing or degraded radial observations using surrounding valid measurements within constrained spatial criteria. The quality-screened and repaired radial data are then transformed into gridded vector currents through a multi-station radial-to-vector reconstruction procedure. After vector estimation, spatial consistency checks are applied to detect grid cells affected by weak geometric configuration, isolated artifacts, unrealistic direction changes, or abnormal current magnitude. A controlled interpolation stage is implemented as the final reconstruction step to improve spatial continuity while preserving the distinction between directly reconstructed, repaired, and interpolated regions. Quality and provenance flags are assigned to each grid cell to maintain explicit traceability across the processing chain, ensuring that the final current product remains physically consistent and spatially continuous. The proposed framework provides a transparent and reproducible pathway for converting incomplete HFR radial observations into analysis-ready, quality-assured Level-3 products. The resulting fields show progressive improvement in spatial coverage while remaining primarily constrained by direct HFR observations. The reconstructed currents also exhibit coherent temporal variability and spatial structure, with general consistency with tidal dynamics. These results support coastal circulation analysis, marine hazard monitoring, search-and-rescue applications, and operational use of HFR observations in northern Taiwan.

Keywords: HF radar, surface currents, Level-3 product, quality control, interpolation, northern Taiwan

Possible Generation Mechanism of Large Rogue Waves Measured in the Philippine Sea

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ABSTRACT

Rogue waves are sudden, extreme events whose heights exceed twice the significant wave height of surrounding waves. Their generation has been related to mechanisms such as linear superposition, dispersive focusing, and modulational instability. Recently, the nonlinear Fourier transform (NFT), a generalization of the classical Fourier transform, has emerged as a powerful tool for analyzing rogue waves by revealing hidden nonlinear spectral modes. In this study, we use twelve years of buoy measurements from the Philippine Sea to apply the NFT based on the nonlinear Schrödinger equation (NLSE) (so-called NLSE-NFT) to a large dataset of deep-water rogue waves. This represents the first application of NLSE-NFT to extensive rogue wave field data. We categorize rogue waves into four spectral types, stable, small breather, large breather, and soliton, based on the dominant nonlinear mode. All four types are observed at a single site. We found that rogue waves with large wave heights are mostly of the large breather or soliton types. The findings provide new insight into the possible generation mechanisms of large rogue waves in the Philippine Sea and highlight the role of nonlinear spectral characteristics in the real-world ocean.

Keywords: Rogue waves, Nonlinear Fourier transform, Nonlinear Schrödinger equation, Ocean buoy measurements

A CYGNSS DDM-Based Approach for Inland Water Level Monitoring over Large Lakes

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ABSTRACT

Global Navigation Satellite System Reflectometry (GNSS-R) has emerged as a promising remote sensing technique for environmental monitoring. Among various GNSS-R observables, Delay-Doppler Maps (DDMs) contain valuable information on surface scattering characteristics and have shown considerable potential for inland water level retrieval. However, DDM-based altimetry remains challenging due to coarse delay resolution, waveform contamination from surrounding land surfaces, limited observations over narrow water bodies, and inconsistencies among waveform retracking methods. This study develops a complete inland water altimetry processing framework using Level-1 Science Data Record (SDR) v3.2 observations from the Cyclone Global Navigation Satellite System (CYGNSS). The processing workflow includes spatial filtering, water masking, conversion of two-dimensional DDMs into one-dimensional delay waveforms, specular point determination, quality control, waveform retracking, relative delay estimation, and water level retrieval. Three commonly used retrackers, namely the Offset Center of Gravity (OCOG), Half-Peak (HALF), and Derivative (DER) methods, were implemented and evaluated. Lake Victoria in Africa was selected as the initial test site for algorithm validation. The results indicate that the HALF retracker outperforms the DER method, achieving an internal precision of 1.874 m and a root mean square error (RMSE) of 3.228 m when compared with satellite altimetry products, whereas the DER retracker yields an RMSE of 4.991 m. The OCOG retracker was found to be more susceptible to leading-edge misidentification and was therefore excluded from detailed performance assessment. This study confirms the potential of CYGNSS DDM observations for inland water altimetry and establishes a practical framework for future applications over diverse inland water environments.

Keywords: GNSS-R, DDM, CYGNSS, Inland Water Bodies, Waveform Retracking

Deep Learning-based Sea Surface Wind Speed Retrieval for the TRITON GNSS-R Mission

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ABSTRACT

Accurate sea surface wind speed retrieval is essential for global weather forecasting and marine disaster mitigation. Taiwan's TRITON satellite mission delivers full-resolution Delay-Doppler Maps (DDMs), offering an unprecedented high-resolution dataset for advanced ocean remote sensing.

This study presents a high-performance, orbit-dynamic-informed deep learning framework designed to maximize the accuracy of wind speed estimation from TRITON observations. We developed a hybrid deep learning architecture combining a Residual Convolutional Neural Network (ResNet) for spatial feature extraction with a Bidirectional Long Short-Term Memory (Bi-LSTM) network to model structural variations. The framework was trained and rigorously evaluated using approximately 2.3 million quality-controlled TRITON DDM records collected from May to November 2024, utilizing hourly ERA5 reanalysis data as the environmental reference. To optimize retrieval fidelity under dynamic orbital configurations, the model explicitly ingests transmitter-receiver relative velocity alongside 2D Bistatic Radar Cross-Section (BRCS) maps.

The retrieval results demonstrate remarkable precision. The proposed deep learning model achieves a Root Mean Square Error (RMSE) of 1.88 m/s and a minimal bias of 0.07 m/s, representing a 11.4% accuracy improvement over baseline methods. Geophysical and spatial validations confirm that the model successfully reproduces complex regional wind gradients and large-scale atmospheric structures over major ocean basins. Furthermore, model explainability verified via the Integrated Gradients method demonstrates that the network correctly prioritizes the high-power glistening zone of the DDMs for its predictions.

These findings establish the exceptional capability of the proposed deep learning framework for robust, operational GNSS-R wind retrieval. By delivering reliable ocean wind field estimations, this model contributes to enhancing societal resilience and early-warning capabilities against severe oceanic hazards.

Keywords: GNSS-R, TRITON Satellite, Sea Surface Wind Speed Retrieval, Delay Doppler Map, Deep Learning

High-Resolution GNSS-R Observations of Arctic Sea Ice Using Taiwan's Triton Satellite

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ABSTRACT

Taiwan's Triton satellite provides a new opportunity to investigate polar sea ice using spaceborne Global Navigation Satellite System Reflectometry (GNSS-R). With its high-inclination orbit, Triton is able to acquire reflected GNSS signals over high-latitude Arctic regions. In addition, its improved delay-Doppler resolution allows the structure of L-band reflected signals to be examined in greater detail, offering a useful basis for exploring sea-ice-related scattering characteristics.

In this study, Triton delay-Doppler maps (DDMs) acquired from late 2025 to early 2026 are analyzed together with passive microwave sea ice concentration (SIC) products. After quality control and normalization, DDM-derived profiles, including averaged delay waveforms and Doppler profiles, are examined under different SIC ranges. The analysis focuses on how the shape and distribution of reflected signal power vary with changes in ice cover, particularly across open-water, mixed ice-water, and high-concentration sea-ice regimes.

Preliminary analysis suggests that Triton DDMs contain meaningful information related to sea-ice scattering behavior. Variations in waveform shape and signal spreading indicate the potential of high-resolution GNSS-R observations for characterizing the transition between water-dominated and ice-covered surfaces. These results also suggest that Triton may provide complementary information to existing passive microwave sea-ice products.

Although the initial findings are encouraging, several challenges remain, including mixed ice-water scenes, noisy DDMs, and possible effects from observation geometry. Future work will focus on improving data quality control, examining seasonal and regional variability, and further evaluating whether Triton GNSS-R waveform features can support sea-ice detection, SIC-related analysis, or broader characterization of Arctic sea-ice conditions.

Keywords: GNSS-R, TRITON satellite, Delay Doppler Map, Arctic region, sea ice concentration, sea ice detection

Marine AI and Earth Observation for Coastal Hazard Monitoring and Smart Ocean Safety

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ABSTRACT

Recent advances in Earth Observation (EO) technologies and Artificial Intelligence (AI) have created unprecedented opportunities for intelligent coastal and ocean management. This study proposes an integrated Marine AI framework that combines multi-source Earth Observation data, including satellites, coastal radars, ocean buoys, UAVs, and optical cameras, to enhance coastal hazard monitoring and marine safety management.

The proposed framework incorporates machine learning and deep learning techniques to analyze complex marine environments and support various applications, including coastal freak wave prediction, rip current detection, marine dynamic target recognition, drowning event monitoring, and marine debris identification. Generative AI and advanced optimization strategies are further introduced to improve model robustness and generalization capability.

By integrating environmental monitoring, intelligent surveillance, real-time information services, and emergency response systems, the framework establishes a Smart Ocean Safety architecture capable of automated monitoring, dynamic early warning, and rapid response. The results demonstrate that the synergy between Earth Observation and Marine AI has significant potential to transform traditional marine management into a more intelligent, resilient, and sustainable paradigm, providing scientific support for future coastal governance and ocean safety applications.

Keywords: Artificial Intelligence (AI), Coastal Hazard, Ocean Safety

Preliminary Field Test Results of an Underwater Target Localization Buoy System

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ABSTRACT

This study presents the development and field evaluation of a buoy-based system for underwater acoustic target localization. The proposed system is designed to support long-term, real-time acoustic monitoring and passive sound source localization in offshore environments. It integrates a buoy platform, a multi-channel data acquisition unit, onboard signal processing, and satellite-based telemetry for transmitting acoustic information to an onshore station, where post-processing and localization analysis are performed. The buoy platform was developed by the Coastal Ocean Monitoring Center at National Cheng Kung University. A four-element vertical hydrophone array was deployed beneath the buoy, with sensors positioned at depths of 30, 50, 70, and 90 m. This configuration enables depth-dependent sampling of the underwater acoustic field and provides the spatial information required for passive localization. Acoustic signals acquired by the hydrophone array are first processed onboard through spectral analysis and are then transmitted in near real time to the onshore station via satellite communication. At the onshore station, a passive time-reversal mirror (PTRM) approach, combined with ray-theoretical acoustic propagation modeling, is applied to estimate the range and depth of underwater acoustic sources. The system was deployed in the southwestern offshore waters of Xiaoliuqiu, Taiwan, in August 2025 and remained in continuous operation through April 2026. During this period, the buoy experienced several severe ocean conditions associated with Typhoon Yangliu from August 13 to 14, 2025, Typhoon Haggasa from September 22 to 24, 2025, and Typhoon Phoenix from November 11 to 13, 2025. The system's sustained operation under these conditions demonstrates its structural robustness and operational suitability for long-term offshore deployment. The dataset analyzed in this study was collected from January 1 to January 16, 2026. Following data quality control and screening procedures, 198 valid localization results within a depth range of 0–200 m were selected for analysis. The estimated source depths were primarily concentrated between 90 and 130 m, indicating a distinct clustering of acoustic activity within this depth interval. In the horizontal direction, two dominant range clusters were identified at approximately 1000–1200 m and 1900–2000 m from the buoy. These results suggest that the proposed buoy-based localization system is capable of resolving consistent spatial patterns of underwater acoustic sources and has potential for long-term passive monitoring applications in complex offshore environments.

Keywords: Underwater acoustics, localization, time-reversal mirror, buoy system, hydrophone array, field experiment.

Abstracts: Poster

Argo-Based Evidence of Subsurface Atlantification near Svalbard

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ABSTRACT

The weakening of the Atlantic Meridional Overturning Circulation (AMOC) is a critical climate tipping point. While historically attributed to sub-polar freshwater forcing, Overturning in the Subpolar North Atlantic Program (OSNAP) data reveal a paradigm shift: AMOC variability is predominantly controlled further upstream in the Nordic Seas and Fram Strait, where water masses are modified before sub-polar entry. As the sole deep-water conduit to the Arctic Ocean, the severely under-observed Fram Strait is experiencing profound "Atlantification"—the progressive northward advance of warm, saline Atlantic waters.

To robustly quantify these upstream signals, this study analyzes a 25-year dataset (2000–2025) of bias-corrected Argo float profiles and buoy trajectories near Svalbard. We implemented equal-cell weighting to mitigate historical spatial clustering, rigorously testing apparent trends against sampling redistribution. Underlying hydrographic shifts were validated using the Modified Mann-Kendall (MMK) Test to correct for autocorrelation, alongside Sen's Slope Estimator to extract robust linear trajectories.

Crucially, partitioning diagnostics into upper (75–200 dbar) and lower (400–700 dbar) layers reveals localized dynamic responses. While statistically significant warming occurs consistently across the vertical profile, the physical expansion of Atlantic Water is heavily concentrated in the deeper 400–700 dbar layer, whereas upper-layer thickness remains stagnant. Concurrently, multidecadal salinity trends remain weak across all subdivisions, driving a decisively thermal-dominant density reduction.

This thermal-dominant density reduction couples with a significant multidecadal shoaling of the Mixed Layer Depth (MLD). This indicates an increasingly stratified upper ocean that caps vertical heat release while amassing an expanding thermal reservoir below. Supported by modern trajectories confirming a bifurcated dual-domain circulation, this depth-resolved evidence definitively reconfirms subsurface thermal Atlantification, delivering vital observational constraints on upstream AMOC forcing mechanisms for forthcoming IPCC AR7 assessments.

Keywords: Atlantification, Atlantic Meridional Overturning Circulation (AMOC), Fram Strait, Argo Floats, Subsurface Warming, Modified Mann-Kendall (MMK) Test, Mixed Layer Depth (MLD)

Near-Surface Cooling in the East Greenland Current and Its Strait-Wide Expression: A Drifter-Based Assessment of Fram Strait Variability During 2016–2020

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ABSTRACT

The East Greenland Current (EGC) constitutes the principal export pathway for Arctic Polar Water and sea ice along the western margin of Fram Strait, yet its interannual near-surface variability remains poorly constrained relative to the well-monitored West Spitsbergen Current (WSC).

McPherson et al. (2026) documented a cold regime shift in the WSC around 2019, motivating the question of whether a coherent cooling signal exists across the hydrographically distinct western branch. Using International Arctic Buoy Program (IABP) drifter records and ERA5 sea-surface temperature (SST) and wind stress fields over 2016–2020, we first characterized near-surface thermal evolution within the EGC domain (20°W–0°, 75°–81°N), then extended the analysis to the full strait (20°W–15°E, 75°–81°N) to assess the spatial coherence of the signal. Analysis was restricted to open-water grid cells, as ERA5 SST is unreliable in ice-covered regions.

Within the EGC domain, near-surface temperature anomalies exhibit a coherent decline over the study period, accompanied by a westward shift and intensification of summer wind stress and accelerated southward sea-ice drift in 2019 and 2020. Strait-wide analysis further indicates that the cooling signal extends coherently across both the western and eastern Fram Strait. The concurrent westward shift and intensification of wind stress suggest that enhanced wind-driven export of Arctic surface water may have contributed to the observed cooling, though the relative roles of atmospheric forcing and upstream advection remain to be determined.

These findings suggest that the 2016 to 2020 cooling represents a strait-wide phenomenon, highlighting the need for coordinated observations across both margins of Fram Strait to disentangle the competing mechanisms driving air–sea–ice interactions.

Keywords: Please select at least 3 keywords to illustrate the subject of this paper and separate them by commas.

Studies on the genetic diversity of Taiwanese hard clams (*Meretrix taiwanica*) in Taiwan

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ABSTRACT

The Taiwanese hard clam (*Meretrix taiwanica*) is an indigenous bivalve species naturally inhabiting the Tamsui River estuary and serving as a vital species for land-based aquaculture. This study utilized *cox1* and *cox2* gene sequences to analyze haplotype diversity, construct haplotype networks, and perform species identification. The *cox2* sequences confirmed that both wild and farmed populations belonged to *M. taiwanica*, with no detection of *M. petechialis* or *M. lusoria*. Analysis of the *cox1* gene revealed slight variations in genetic diversity among hard clams from different regions. The haplotype diversity values ranged from 0.608 to 0.715 for the wild population in the Tamsui River estuary, and from 0.598 to 0.800 for the farmed populations, indicating that the genetic diversity of the Taiwanese hard clam remains robust overall. In hard clam hatcheries, diversity values spanned from 0.446 to 0.848; notably, while two of the hatcheries exhibited values below 0.5, the remaining three maintained a healthy and high level of diversity. Currently, no significant impacts of extreme weather events on the genetic diversity of Taiwanese hard clams have been observed.

Keywords: aquaculture, hybridization, inbreeding.

An Integrated Approach for Identifying indicator Species in Coastal Trawl Ecosystems

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ABSTRACT

This study investigated fish assemblage dynamics in the coastal waters from Hsinchu–Miaoli to the Yun-Chang Rise in the Taiwan Strait, one of Taiwan’s major offshore wind farm development regions. Offshore wind turbine foundations and associated structures may alter hydrodynamic conditions and create new habitats within the sandy–muddy ecosystems of western Taiwan, potentially affecting fish assemblages and fisheries resources. Long-term bottom trawl survey data were analyzed using an integrated ecological approach combining the Index of Relative Importance (IRI), Indicator Value (IndVal), Bray–Curtis similarity, and multivariate statistical analyses, including PERMANOVA, ANOSIM, and PERMDISP, to evaluate spatial and temporal variations in fish community structure and identify representative indicator species.

The results indicated that interannual variation was the primary factor influencing fish assemblage structure, followed by seasonal and spatial differences. PERMANOVA and ANOSIM analyses showed that temporal variation had the strongest effect on community composition, suggesting that annual environmental variability plays a dominant role in shaping fish assemblages in the study area. However, significant differences in dispersion among years detected by PERMDISP suggest that part of the temporal effect may be associated with within-group variability and should therefore be interpreted cautiously. In contrast, spatial and seasonal factors exhibited weaker but consistent influences without significant dispersion differences, indicating that these patterns reflect genuine shifts in assemblage composition.

By integrating ecological and fisheries-related indices, this study identified representative ecological indicator species suitable for long-term environmental monitoring in western Taiwan. The findings provide important scientific references for offshore wind farm environmental assessment, ecosystem-based fisheries management, and sustainable marine resource development.

Keywords: Offshore wind farm, Indicator species, Bottom trawl survey

Analyzing Vulnerability Gaps in Local Resiliency and Disaster Prevention Under Climate-Induced Extreme Hazards

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ABSTRACT

In this study, to mitigate the threats posed by climate-induced extreme disasters to local governments, the National Science and Technology Council's the National Science and Technology Center for Disaster Reduction and 22 local research institutes, actively supported local governments in evaluating current and future disaster risks under climate change. This study aims to identify critical vulnerability gaps in local resiliency and disaster prevention, thereby providing a robust scientific foundation for formulating local resilience and disaster reduction adaptation strategies that integrate local climate change adaptation action plans, geographical characteristics, and practical disaster management operations.

The analysis of these vulnerability gaps in local resiliency and disaster prevention was predicated on a newly constructed "Resilience and Disaster Prevention Matrix." This systematic framework integrated hazard scenarios of climate change datasets and localized indicator maps, incorporated policy recommendations from the Disaster Prevention and Protection Expert Consultation Committee of the Executive Yuan, and synthesized disaster risk identification, emergency response intelligence, and historical disaster investigations.

The study results indicated that the identified vulnerability gaps in local resiliency and disaster prevention primarily span five dimensions: 1. Water Conservancy, Flood Control, and Coastal Defense Gaps (32.88%): Existing drainage infrastructure is inadequate to cope with extreme rainfall intensity, and coastal regions exhibit insufficient defense capabilities against sea-level rise and storm surges. 2. Critical Infrastructure and Lifeline Operational Gaps (23.29%): Key facilities—including transportation, power grids, medical services, and industrial zones—display vulnerable shock-resistance under extreme disaster stress, posing a critical risk of functional paralysis to emergency operation centers and rescue bases during crises. 3. Social Vulnerability and Evacuation Response Gaps (19.18%): Demographic aging has expanded the population of "disaster-vulnerable groups" and constrained evacuation mobility, a challenge compounded by the aging and depletion of community-based autonomous disaster prevention personnel, alongside an urgent need to review the capacity and suitability of emergency shelters. 4. Slope Safety and Isolated Island Effect Gaps (16.43%): Mountainous settlements situated in high-risk zones face potential isolation due to the susceptibility of access roads to climate-induced disruptions, while the coverage and precision of monitoring and early warning systems require further enhancement. 5. Extreme Climate and Environmental Adaptation Gaps (8.22%): Early warning, adaptation, and risk management mechanisms for slow-onset hazards, such as heatwaves and droughts, remain underdeveloped.

In conclusion, this study can assist local governments in formulating local resilience and disaster reduction adaptation strategies, thereby effectively narrowing the vulnerability gaps.

Keywords: climate-induced extreme disasters, vulnerability gaps in local resiliency and disaster prevention, local resilience and disaster reduction adaptation strategies

Species-specific responses of *Scomberomorus* catch rates to oceanographic variables: a GAM approach

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ABSTRACT

Scomberomorus species are among the most commercially important coastal fishery resources in Taiwan, providing substantial economic benefits to local fisheries. However, coastal fishery resources in Taiwan have experienced increasing pressures from climate change, overexploitation, and habitat degradation. Since the early 2000s, the production of *Scomberomorus* species has shown a declining trend, raising concerns regarding resource sustainability and fisheries management. Despite their economic importance, studies examining the relationships between catch rates and oceanographic conditions remain limited in Taiwan.

This study investigated the relationships between environmental variables and catch rates of three commercially important *Scomberomorus* species (*S. commerson*, *S. niphonius*, and *S. guttatus*) using generalized additive models (GAMs). Catch rate data were analyzed in relation to sea surface temperature (SST), sea surface chlorophyll-a concentration (CHL), sea surface height (SSH), and sea surface salinity (SSS). The results revealed significant nonlinear relationships between catch rates and environmental variables for all species ($p < 0.01$). SST explained the highest proportion of deviance for *S. commerson* and *S. niphonius*, whereas SST and SSS were more influential for *S. guttatus*. Species-specific environmental preferences were identified, with higher catch rates generally associated with moderate SST and lower CHL conditions. Distinct responses to SSH and SSS suggested potential habitat partitioning among species. The GAMs explained 11.2–18.3% of total deviance, indicating that oceanographic variability plays an important role in shaping the distribution and catchability of *Scomberomorus* species. These findings provide useful information for fisheries management and potential fishing ground prediction under changing oceanographic conditions.

Keywords: *Scomberomorus* species, GAM approach, Species-specific environmental preferences

Analysis of Resilience Disaster Data Applications in Local Decision Support System

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ABSTRACT

To enhance local governments' capacity to respond to extreme disasters under a changing climate, the National Science and Technology Council (NSTC) of Taiwan launched the Project of Township Resilience and Disaster Risk Reduction Adaptation of Extreme Weather Disasters. Through collaboration between the National Science and Technology Center for Disaster Reduction (NCDR) and 22 local research institutes, local decision support system for disaster management were developed to serve as digital bridges for interagency coordination and spatial decision-making. This study systematically inventories and compares the thematic structures of these platforms to identify regional characteristics and development trends in resilience-oriented disaster information applications, providing insights for future improvements in local disaster management services.

The results indicate that the thematic contents of the local decision support system can be broadly categorized into three groups: Disaster Information Assessment, Disaster Information Compilation, and Climate Change. Disaster Information Assessment category primarily integrates basic geographic information with critical facilities, and Disaster potential data to evaluate risk distributions and potential impacts under different disaster scenarios, thereby supporting preparedness and emergency management. The Disaster Information Compilation category focuses on historical disaster records, spatially documenting and visualizing past disaster events to identify areas of recurrent impacts and support disaster risk management. The Climate Change category demonstrates greater diversity and regional specificity, incorporating future climate risk assessment outcomes, adaptation strategies, and related research findings to illustrate regional variations in climate change risks and adaptation needs.

The findings indicate that the 22 local research institutes generally adopted a common set of basic geographical information as the foundation, while tailoring information content and presentation methods to local environmental, disaster risk, and priority issues. The findings of this study can serve as a reference for further enhancing the local decision support system and strengthening disaster information integration and decision-making support at the local level.

Keywords: local decision support system, disaster database, local research institutes

Reproductive Biology of the Chinese Silver Pomfret (*Pampus chinensis*) off the Southwestern Water of Taiwan

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ABSTRACT

The Chinese silver pomfret (*Pampus chinensis*) in the waters off western Taiwan is a highly valued commercial species, yet its production has been declining annually. This study investigates the reproductive biology of the *P. chinensis* population off the southwestern coast of Taiwan, providing crucial biological data for the future development of artificial propagation and aquaculture technologies. A total of 1,334 specimens were collected from the southwestern coast of Taiwan between January and November 2025. The fork length (FL) ranged from 130.6 to 445.0 mm for females and 131.0 to 345.0 mm for males. The samples comprised 440 females, 520 males, and 374 individuals of undetermined sex. The sex ratio was 0.458, showing a significant deviation from 0.5 ($P < 0.05$). The Gonadosomatic Index (GSI) in females began to rise in April, peaking at 3.1 in August. Based on GSI and histological analysis of gonads, the spawning season for this species is estimated to be from April to August, with a peak period in July and August. Males reached sexual maturity earlier than females, and larger-bodied females initiated spawning earlier than smaller ones. The size at first maturity (L_m) was 248.0 mm FL for females and 160.0 mm FL for males. The length at 50% maturity (L_{50}) was 313.6 mm FL for females and 258.7 mm FL for males.

Keywords: *Pampus chinensis*, Reproductive biology, Gonadosomatic Index (GSI), L_{50}

Seasonal Rainfall Variability in Reservoir Watersheds of Northern Taiwan

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ABSTRACT

The East Asian monsoon rainfall is crucial and serves as a sufficient water resource for reservoir watersheds in East Asia. Among them, the Feitsui Reservoir (FR) is the primary source of water supply in northern Taiwan, especially for Taipei City. As a result of global warming, Taiwan has experienced major droughts, resulting in insufficient water being stored in reservoirs, except in the FR. This study discovered that precipitation from tropical cyclones (TCs; 29.97% of annual rainfall) was not the dominant source of water in the Feitsui Reservoir Watershed (FRW); instead, the results indicated that the water resources of FRW were contributed by non-TC rainfall (~70%), where the northeasterly monsoon resulted in heavy rainfall in autumn–spring (48.24%) and the mei-yu and summer monsoon contributed to the others (21.79%). Due to the interaction between the monsoon and topography, asymmetric rainfall patterns were observed in this study. Specifically, rainfall from autumn to spring was concentrated in the eastern part of the FRW and northern Taiwan, while it was distributed on the opposite side during the mei-yu and summer seasons. Under global warming conditions, spring rainfall in the FRW has shown a decreasing trend from 1990 to 2020, whereas a significant increase was observed in mei-yu rainfall. Our findings explain the seasonal rainfall characteristics and regional climate variability in the FRW and northern Taiwan. This study can be used as a reference for evaluating strategies for adjusting water resources to achieve the ultimate goal of a stable water supply in Taiwan.

Keywords: asymmetric rainfall, East Asian monsoon, hydroclimatology, regional climate, tropical cyclone, water resource

Optical Earth Observation for Rip Current Detection

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ABSTRACT

Rip currents are among the most hazardous nearshore phenomena and are responsible for numerous drowning incidents worldwide. However, due to their transient nature and complex flow structures, rip currents remain difficult to identify using conventional visual observations. This study presents an Earth observation-based approach for rip current detection using coastal optical imagery and wavelet transform techniques. High-resolution satellite images and long-term coastal camera observations are employed to investigate rip current characteristics and their spatiotemporal variability. A wavelet-based edge detection method is first applied to enhance wave-breaking features and suppress background noise. Subsequently, image convolution and rip-current masks are introduced to automatically identify potential rip current locations. To improve the robustness and generalization of the detection framework, image augmentation and frame aggregation techniques are further incorporated.

The proposed method was validated using more than 10,000 satellite images collected around Taiwan and 4,211 hours of coastal video observations. Experimental results indicate that the Daubechies wavelet with two decomposition levels provides the best performance, achieving an interpretation accuracy of 88.3%, while the confusion matrix evaluation yields an overall detection accuracy of 83.0%. The developed framework demonstrates the capability of integrating Earth observation technologies with intelligent image analysis for marine hazard monitoring. This approach provides a promising tool for long-term coastal safety surveillance and supports the development of smart coastal hazard early warning systems.

Keywords: Rip current, coastal optical imagery, wavelet transform, wave breaking

Interaction between the Kuroshio Current and China Coastal Current in Yilan Bay: Evidence of Water Mass Intrusion

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ABSTRACT

In-situ hydrographic observations were conducted from March 12 to 17, 2022, using a chartered fishing vessel. Vertical profiles were captured by deploying a self-recording CTD (Idronaut ocean seven 310) to a maximum depth of 100 m to characterize the water mass structure of Yilan Bay, northeastern Taiwan. Raw CTD data were processed following manufacturer's standard protocols and vertically binned at 0.5 m intervals. The surface horizontal profiles (5-20m) revealed a significant hydrographic gradient, with minimum temperature and salinity concentrated in the northwest, transitioning to warmer, saltier conditions toward the southeast. This spatial pattern confirms the intrusion of the China Coastal Current (CCC) into the northwestern Yilan Bay, interacting with the prevailing Kuroshio waters. The spatial distribution of seawater density (σ_t) was primarily driven by temperature, with salinity playing a secondary role. Consequently, a distinct gradient was observed, with higher density values in the nearshore northwestern waters and decreasing density toward the southeast as water temperatures increased. Notably, a subsurface intrusion of the CCC was identified at 30 m depth, characterized by minimum salinity and temperature values. The intrusion path was localized at offshore stations, moving directly from Cape San-Diao toward Guishan Island without shifting landward. This subsurface tongue served as the primary carrier for high chlorophyll-a water, highlighting its role in the physical-biological coupling of Yilan Bay during March. The meridional section shows this CCC tongue subducting beneath warmer surface waters and shoaling southward from 40 m along an isopycnal path. This temperature-salinity compensation ultimately masks the intrusion's signature within the density field.

Keywords: china coastal current, subsurface intrusion, northeastern Taiwan, density compensation, daily egg production method

Integrating Satellite Ocean Observation, DNA Barcoding, and Lagrangian Particle Tracking to Reveal the Spawning Grounds of Bullet Tuna (*Auxis rochei*) in Yilan Bay, Northeastern Taiwan

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ABSTRACT

Identifying spawning grounds is essential for understanding fish reproductive ecology and supporting ecosystem-based fisheries management. This study integrated satellite ocean observation, DNA barcoding, and Lagrangian particle tracking to investigate the spawning grounds of Bullet Tuna (*Auxis rochei*) in Yilan Bay, northeastern Taiwan.

Ichthyoplankton surveys were conducted at 19 stations during 24–29 March 2024. Fish eggs were collected using vertical plankton net tows and identified by mitochondrial cytochrome oxidase subunit I (COI) DNA barcoding. A total of 53 *A. rochei* eggs were identified, including 41 Stage I eggs (77.4%) concentrated at Station 15 within the Lighthouse-Illuminated Area (LIA).

Oceanographic conditions were characterized using sea surface temperature (SST) and surface current products from the Copernicus Marine Environment Monitoring Service (CMEMS), together with fused satellite chlorophyll-a observations derived from NOAA ocean-color products. Station 15 was located near the transition zone between warm Kuroshio waters and relatively productive coastal waters.

To infer spawning origin, a 6-h backward-in-time Lagrangian particle-tracking simulation was performed using CMEMS surface current data. The estimated spawning center was located south of Station 15 within the core area of the LIA. The simulated transport pathway was consistent with the observed distribution of egg developmental stages and the prevailing northward Kuroshio flow.

The convergence of molecular identification, satellite ocean observations, and Lagrangian particle tracking consistently indicated that the Lighthouse-Illuminated Area represents a likely spawning ground of *A. rochei* in Yilan Bay. This integrative framework demonstrates the value of combining Earth-observation products with biological observations to identify critical spawning habitats of pelagic fishes.

Keywords: *Auxis rochei*, spawning grounds, satellite ocean observation, DNA barcoding, sea surface temperature, Lagrangian particle tracking

DNA Barcoding Reveals Species Composition of Whitebait Fishery Catches from the Northern Coast of Taiwan

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ABSTRACT

Whitebait fishery is one of the important coastal fisheries in Taiwan, and its catches are mainly composed of larval and juvenile fishes of Engraulidae and Clupeidae. To investigate the fish biodiversity of whitebait samples from the northern coast of Taiwan, fresh, unsorted commercial whitebait samples were collected from 2024 and 2025. A total of 15 sampling events were conducted, with approximately 600 g of samples collected each time. After preliminary morphological identification, DNA barcoding was further applied to analyze the species composition of larval and juvenile fishes. The obtained sequences were compared with those in the GenBank database to improve the accuracy of species identification. The results showed that a total of 32 species belonging to 29 genera and 23 families were identified from the samples. Most specimens could be identified to the species level using DNA barcoding. In terms of individual abundance, *Rhabdamia gracilis* was the most dominant species, with 157 individuals, accounting for approximately 47.3% of the total number of individuals, followed by *Scomber japonicus* and *Euthynnus affinis*. These results provide baseline information on fish species composition and biodiversity in whitebait samples from the northern coast of Taiwan. The findings also contribute to a better understanding of species diversity during the early life-history stages of coastal and nearshore fishes.

Keywords: DNA barcoding; whitebait fishery; species composition; early life-history stages

Mesh Selectivity, Catch Composition, and Preliminary VIAME Image Annotation for Future Image Recognition of Single-Vessel Bottom Otter Trawls in Yilan Bay, Taiwan

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ABSTRACT

This study focused on the single-vessel bottom otter trawl fishery in Yilan Bay, Taiwan. Mesh selectivity experiments were conducted in the northern and southern waters of Yilan Bay in May, June, July, and October 2025, with a total of 16 trawl hauls completed. A double-layer codend was used, consisting of an inner codend with a 4-cm mesh size and an outer cover with a 2-cm mesh size, to evaluate the effects of mesh size on catch composition and organism escape. Underwater cameras were also installed inside the codend to observe the activity and escape behavior of organisms during trawling. The results showed that escape rates ranged from 7.8% to 49.5% among hauls, with an average of 22.1%. A total of 117 catch taxa were recorded, including 90 fish species from 56 families, as well as crustaceans, cephalopods, and echinoderms, indicating high biodiversity in the bottom trawl fishing grounds of Yilan Bay. The dominant species included *Metapenaeopsis provocatoria longirostris*, *Benthoosema pterotum*, *Acropoma japonicum*, *Trichiurus japonicus*, *Abralia multihamata*, and *Muraenesox cinereus*. These six dominant species accounted for 81.4% of the total catch. In addition, this study preliminarily introduced the VIAME image annotation platform to classify organisms appearing in underwater videos into three major groups: fish, shrimp, and mollusks. This preliminary annotation provides a basis for the future development of image recognition models and further analysis of escape behavior. Overall, the 4-cm mesh size could balance catch retention and the escape of some small organisms. The results can serve as a reference for bottom trawl gear improvement, bycatch management, and image-assisted analysis in Yilan Bay.

Keywords: Mesh selectivity, Bottom otter trawl, Yilan Bay, Escape behavior, VIAME image annotation

Incorporating Satellite-based Oceanographic Data in Habitat Modeling for Economically Important Fish Species around Taiwan

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ABSTRACT

Satellite-derived oceanographic data provide broad spatial coverage and continuous environmental information for fisheries applications. Around Taiwan, variables such as sea surface temperature, sea surface salinity, and sea surface height can serve as useful indicators for evaluating potential habitat variability of coastal fish species. However, conventional fishery-dependent observations are often limited in spatial and temporal continuity, making it difficult to continuously monitor habitat variability and potential fishing grounds. This study developed a satellite-based habitat suitability forecasting system for common coastal fish species around Taiwan.

Daily forecast fields of sea surface temperature, sea surface salinity, and sea surface height were obtained from Copernicus Marine products through an automated Python/R workflow and processed into gridded environmental datasets for waters surrounding Taiwan. Species-specific suitability parameters were trained using more than ten years of fishery-reported data collected from coastal fisheries around Taiwan. For each target species, catch and effort records were linked with corresponding oceanographic conditions to evaluate fishery responses along environmental gradients. Nominal catch-per-unit-effort values were calculated within binned environmental intervals, standardized to a 0–1 suitability index, and used to fit species-specific environmental response curves through optimization procedures.

The standardized suitability indices for individual environmental variables were then integrated to calculate an overall habitat suitability index, which was rescaled from 0 to 1. Higher values indicate more favorable environmental conditions for the target species. The resulting framework was incorporated into a satellite fisheries information platform to generate and visualize short-term habitat suitability forecasts for multiple coastal fish species. This study demonstrates that integrating satellite-derived oceanographic forecasts with long-term fishery-reported data can provide a practical tool for identifying potential fishing grounds, supporting fisheries information services, and improving resource monitoring for coastal fisheries around Taiwan.

Keywords: satellite remote sensing, habitat suitability index, fisheries forecasting

Trophic Dynamics of Bullet Tuna (*Auxis rochei rochei*) in the Penghu Waters Revealed by Stable Isotope Analysis

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ABSTRACT

This study used stable isotope analysis to investigate the trophic dynamics of bullet tuna in the Penghu waters. Bullet tuna samples ($n = 50$) were collected from the Magong Fish Market and the Suogang set net fishery in Penghu. Fork length (FL) and body weight (BW) were measured, and white muscle tissues near the dorsal region were sampled for stable carbon and nitrogen isotope analyses. The collected specimens ranged from 21.75 to 33.69 cm in fork length and from 0.16 to 0.70 kg in body weight. Analysis of stable carbon and nitrogen isotope values in muscle tissues showed that the mean $\delta^{15}\text{N}$ value was $11.15 (\pm 0.61)\text{‰}$, while the mean $\delta^{13}\text{C}$ value was $-18.18 (\pm 0.57)\text{‰}$. Fork length showed no relationship with $\delta^{15}\text{N}$ values ($R^2 = 0.0002$), suggesting that trophic position remained relatively constant across body sizes. Fork length showed a negative relationship with $\delta^{13}\text{C}$ values ($R^2 = 0.1888$). The decrease in $\delta^{13}\text{C}$ with increasing body size suggests an ontogenetic shift in habitat use or carbon source, potentially reflecting increased reliance on offshore or pelagic food webs by larger individuals. While $\delta^{15}\text{N}$ values remained relatively constant across body sizes, $\delta^{13}\text{C}$ values decreased with increasing fork length, suggesting that individuals shifted habitat or basal carbon sources during growth without substantial changes in trophic position.

Keywords: Bullet tuna, Stable carbon and nitrogen isotopes, Trophic position

Nearshore Flow Variability off Eastern Taiwan Driven by the Kuroshio and Tides

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ABSTRACT

This study utilizes the MITgcm to investigate the dynamic mechanisms governing the flow field in the coastal waters off Hoping, eastern Taiwan. Long-term observational data reveal a distinct spatial asymmetry: the northern station exhibits a predominant southward flow, which opposes the main Kuroshio, whereas the southern station is dominated by a northward flow that aligns with the Kuroshio direction. A series of sensitivity experiments were conducted to evaluate the influence of various physical forcing factors on the flow variations at these two locations. The results indicate that this distinct flow asymmetry between the two stations persists across all simulated scenarios. The southward flow at the northern station reaches its maximum intensity under winter monsoon forcing but decreases significantly when tidal forcing is removed. Conversely, the northward flow at the southern station is strongest when the Kuroshio axis shifts shoreward. Mechanistically, the southward flow at the northern station is primarily driven by a coastal Kelvin wave, which causes an asymmetry between ebb and flood tides, resulting in a net southward transport. In contrast, the southern station is shielded by a prominent coastal cape, which obstructs the southward propagation of tidal waves, leaving the local flow field to be mainly controlled by the Kuroshio northward momentum.

Keywords: Hoping, Kuroshio, Tide, MITgcm, Kelvin wave

Using a Regional Ocean Model to Simulate Storm Surge Induced by Typhoon Haiyan (2013) and Assess the Impact of Track Variations

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ABSTRACT

Super Typhoon Haiyan (2013) caused catastrophic storm surge and coastal inundation along Leyte Gulf, Philippines. The devastating impacts of Haiyan highlight the importance of accurate storm surge forecasting. This study utilizes the Coastal and Regional Ocean Community Model (CROCO) to simulate the storm surge and inundation induced by Typhoon Haiyan. Seven numerical experiments were conducted using the high-resolution Cloud-Resolving Storm Simulator (CReSS) forecast wind fields produced by Wang et al. (2022). These wind fields were initialized at different times from November 6 to November 7. Additionally, idealized multi-track experiments were conducted by shifting the typhoon track based on the November 7 00:00 UTC case to examine how typhoon track variations affect storm surge along Leyte Gulf. The simulated results reproduced the spatial distribution of maximum sea surface height from the field survey data and matched well with the continuous water level records at the Cebu station. However, the magnitude, timing, spatial distribution, and inundation extent of storm surge varied among experiments due to differences in typhoon track, landfall timing, wind direction, wind intensity, and residence time near the gulf. In the multi-track experiments, the 1° northward-shifted track produced a higher storm surge than the original track, indicating that Haiyan's actual track was not the worst-case scenario for Leyte Gulf. These results suggest that high-resolution forecast wind fields combined with CROCO can provide useful storm surge prediction up to two days before landfall and early warning information for Leyte Gulf and other semi-enclosed coastal regions.

Keywords: Super Typhoon Haiyan (2013), Storm surge forecast, CROCO, Coastal Inundation, Track sensitivity

Reference

Wang, C.-C., Lee, C.-Y., Jou, B. J.-D., Celebre, C. P., David, S., & Tsuboki, K. (2022). High-resolution time-lagged ensemble prediction for landfall intensity of Super Typhoon Haiyan (2013) using a cloud-resolving model. *Weather and Climate Extremes*, 37. <https://doi.org/10.1016/j.wace.2022.100473>

The impact of oceanic changes during Typhoon Morakot (2009) on the abnormal rainfall in the mountainous areas of southern Taiwan

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ABSTRACT

During Typhoon Morakot in 2009, standard weather models did not predict how heavy the rain would be over the mountains of southern Taiwan. A big reason for this mistake is that older models thought the ocean temperature did not change. They ignored a huge energy source: the warm Kuroshio Current. To fix this, we used a model (WRF-ROMS) that links the ocean and the air together to see how they interact. Our study shows a clear chain reaction between the ocean, the air, and the mountains. It starts with the ocean. The Kuroshio Current is like a giant, deep underwater battery full of heat. Because Typhoon Morakot moved very slowly, its strong winds had a lot of time to pull a massive amount of warmth and moisture from this water. This transfer of heat and water from the ocean to the air is called Latent Heat Flux. The ocean gave away so much heat that it left behind a cold trail of water, while the air gained powerful fuel for the storm. Once this huge amount of energy from the Latent Heat Flux entered the air, it created a powerful "moisture highway." The extra energy changed the air pressure and made the southwest winds much stronger. These strong winds pushed a huge amount of wet air straight toward Taiwan. This process, where winds bring and pile up heavy moisture in one area, is driven by Moisture Flux Convergence (MFC). The MFC acted like a giant air pressure pump, locking the wet air directly over the island. The final step happened when this heavy, wet air hit the high Central Mountain Range. The mountains forced the wet air to rush straight up into the freezing high sky. In that cold air, a process called Microphysics took over. The moisture quickly turned into heavy ice particles, known as graupel. As this graupel fell back down to the warmer ground, it melted all at once, creating historic heavy rainfall. Our tests proved that the ocean's extra energy added over 62 million tons of water to the storm. This kept the heavy rain trapped over the mountains for almost 30 hours. In conclusion, the deep heat stored in the Kuroshio Current is the main engine that drives extreme mountain rainfall. We must look at the ocean, air, and land together to make accurate weather forecasts.

Keywords: Kuroshio Jump, Latent Heat Flux, WRF-ROMS Coupled Model, Topographic Rainfall, Typhoon Morakot

Ocean Heat Exposure and Coastal Food-System Resilience: Ichthyoplankton Assemblage Restructuring as an Early Warning Indicator in Southwestern Taiwan Waters

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ABSTRACT

Climate-driven extreme heat exposure is increasingly recognized as a major threat to ecosystem resilience, food security, and climate adaptation capacity in vulnerable coastal regions. However, the ecological pathways linking ocean warming to fisheries-related vulnerability remain poorly understood, particularly in rapidly warming marginal seas of the western Pacific that support highly productive coastal fisheries. Using long-term ichthyoplankton observations collected from southwestern Taiwan waters between 2007 and 2023, this study evaluated whether extreme ocean warming was associated with restructuring of larval fish assemblages and whether ichthyoplankton communities could serve as ecosystem-based early-warning indicators of coastal food-system stress. Thermal analyses revealed persistent upper-ocean warming signals throughout the study region, characterized by intensified warm-end temperature distributions, recurrent positive thermal anomalies, and enhanced vertical thermal stratification within the upper 50 m of the water column. Depth-year anomaly analyses further identified multiple extreme warm years exceeding the long-term 90th and 95th percentile thresholds, indicating recurrent extreme heat exposure during the recent warming period in southwestern Taiwan waters. Multivariate community analyses demonstrated that ichthyoplankton assemblages under high-temperature conditions (surface temperature $\geq 30.32^{\circ}\text{C}$; P90 threshold) differed significantly from those under normal thermal conditions. PERMANOVA and dbRDA analyses both revealed significant temperature-associated restructuring of community composition, while dispersion analyses indicated reduced assemblage heterogeneity under high-temperature exposure, consistent with ecological filtering effects. Species-level SIMPER analyses further showed that mesopelagic and pelagic-associated taxa, including *Diaphus* spp., *Myctophidae*, *Lampanyctus* spp., *Bregmaceros* spp., and *Vinciguerria nimbaria*, contributed disproportionately to between-group dissimilarity, suggesting that extreme warming may alter trophic connectivity and energy transfer within coastal pelagic food webs. Although individual family-level abundance responses were generally subtle after multiple-comparison correction, the observed community-wide restructuring suggests that extreme ocean heat exposure may modify early-life fish assemblages before detectable impacts emerge at higher trophic levels or in fisheries production. These findings highlight the potential of long-term ichthyoplankton monitoring as an ecosystem-based early-warning framework for detecting climate-driven perturbations to coastal food-system resilience in rapidly warming marginal seas.

Keywords: Extreme ocean heat; marine warming; ichthyoplankton; community restructuring; coastal food-system resilience; ecological sentinel; thermal stratification; mesopelagic fishes; climate change; southwestern Taiwan waters

Random Forest Approach for Subseasonal Rainfall Forecasting in the Riau Islands

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ABSTRACT

Subseasonal climate variability affects water resource management and environmental stability in vulnerable Indonesian archipelagos. In the Riau Islands, prolonged rainfall anomalies, ranging from severe deficits causing water scarcity to persistent wet spells overwhelming infrastructure, highlight an urgent need for reliable subseasonal predictions. This study introduces a predictive modeling approach that combines observational data, specifically global climate variables, with a random forest algorithm to predict local rainfall one to three months in advance. To capture complex climate teleconnections and ocean–atmosphere dynamics, information-theoretic metrics were utilized to filter out irrelevant noise. As a key preprocessing step, deseasonalization transformed raw rainfall observations into anomaly data. Removing seasonal patterns enabled the algorithm to learn exclusively from the underlying climate anomalies driving prolonged extremes. Deseasonalization significantly improved learning capacity and predictive accuracy compared to baseline models using the original observations. Furthermore, the performance of the proposed random forest model remained highly stable even when predicting several months ahead. By delivering reliable subseasonal predictions, this approach enhances operational water resource and risk management planning, ultimately strengthening societal resilience.

Keywords: subseasonal prediction; random forest; climate teleconnections; deseasonalization; rainfall anomalies

Applying LSTM and GAN to Risk Assessment of Monitoring Data in Large-scale Landslide Areas

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ABSTRACT

This study consolidates data from potential large-scale landslide warning zones announced by the Agency of Rural Development and Soil and Water Conservation in Taiwan, integrating actual monitoring data and warning records. Long-term monitoring data were used for deep learning techniques to develop management thresholds for cumulative rainfall, groundwater levels, and surface displacement using Fuzzy theory, Long Short-Term Memory (LSTM), and Generative Adversarial Networks (GAN). The Fuzzy theory is applied to process multi-source data for normalization. The LSTM model was employed for risk assessment in case studies of potential landslide areas. Data from typhoon and earthquake events between 2021 and 2023 were used for model training, supplemented by 591 simulated high-risk cases generated using GAN. The study utilizes LSTM neural networks to establish time-series prediction models for typhoon events. To enhance model robustness and address the scarcity of extreme event data, Conditional Generative Adversarial Networks (CGAN) are introduced for data augmentation. Results indicate that integrating CGAN significantly improves predictive accuracy, reducing the Root Mean Square Error (RMSE) from 5.765 to 1.376. Meanwhile, the model achieved the accuracy of a confusion matrix as 0.941 and the RMSE below 5, indicating high prediction accuracy. The study further develops a LSTM expert system that retrieves monitoring data hourly. This system calculates real-time risk scores to provide the three-stage criteria, which indicates normal stage for 0–50 scores, attention stage for 51–70 scores, and warning stage for 71–100 scores. The model predicts risk scores to assist decision-support disaster management. Overall, the integration of deep learning and risk assessment models provides value-added applications for large-scale landslide monitoring data.

Keywords: Landslide monitoring, Deep learning, LSTM, GAN

Spatiotemporal Groundwater Level Imputation Using CWGAIN-GP

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ABSTRACT

Long-term groundwater monitoring records often contain missing values caused by instrument malfunction, maintenance activities, or data transmission failures, which may affect subsequent hydrogeological analyses and modeling applications. This study employed a generative adversarial network (GAN)-based imputation model, Cue Wasserstein GAN with Gradient Penalty (CWGAIN-GP), to reconstruct missing groundwater level records in the Jhuoshuei River Alluvial Fan, Taiwan.

Monthly groundwater level data from 135 monitoring stations collected between 2013 and 2022 were used. Temporal hints were derived from adjacent observations at the target station, while spatial hints were obtained from neighboring stations within the same hydrogeological group. To improve the utilization of spatial information, monitoring stations were clustered based on aquifer type and inter-station distance.

The performance of CWGAIN-GP was evaluated under both continuous and random missing-data scenarios. Results showed that the proposed framework achieved an average MAE of 1.48 m, RMSE of 2.04 m, and NSE of 0.90. The model was evaluated under continuous missing periods ranging from 1 to 12 months and random missing ratios ranging from 10% to 50%, demonstrating its capability to reconstruct groundwater level records under varying missing-data conditions.

The results demonstrate that integrating temporal and spatial hints within the CWGAIN-GP framework can effectively recover missing groundwater level records and improve data completeness. The proposed approach provides a practical tool for improving groundwater data availability and supporting future hydrogeological studies.

Keywords: Groundwater Level, Data Imputation, Generative Adversarial Network, CWGAIN-GP

Exploring the Limits of Redundancy in Water Resource Systems through Reservoir Capacity Expansion

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ABSTRACT

Reservoir storage expansion is commonly regarded as a primary engineering strategy for enhancing redundancy within the water resilience framework. However, the extent to which additional storage can improve water supply resilience remains unclear. This study investigates the practical limits of redundancy in water resource systems using the Water Resources Allocation Simulation Model (WRASIM). A joint operation system consisting of the Renyitan, Lantan, Baihe, and Luliaoxi Reservoirs in southern Taiwan was represented as a hybrid serial–parallel multi–reservoir network. Thirty reservoir capacity expansion scenarios were evaluated through long-term simulations (1975–2023), and system performance was assessed using the shortage index, deficit percent days, and water supply reliability. The results indicate that reservoir expansion can alleviate water shortages but exhibits significant diminishing marginal returns. Although increasing storage capacity reduces shortage severity, water supply reliability converges to approximately 0.77–0.81 once capacity expansion exceeds a certain threshold. This limitation is primarily attributed to natural inflow constraints, suggesting the existence of an upper bound on redundancy that cannot be overcome through storage enlargement alone. Under extreme drought conditions, additional storage provides only marginal benefits, leaving a substantial portion of the expanded capacity underutilized. The analysis further reveals that downstream treatment and conveyance capacities can also constrain the effectiveness of redundancy. These findings demonstrate that reservoir expansion alone is insufficient to address water scarcity under severe drought conditions. Enhancing water resource resilience requires coordinated investments in storage, treatment, and conveyance infrastructure, as well as adaptive operational strategies. The study highlights a fundamental limit of reservoir-based redundancy and provides insights for resilient water resources planning under increasing climate uncertainty.

Keywords: water resources resilience; redundancy; reservoir capacity expansion; multi-reservoir system; extreme drought

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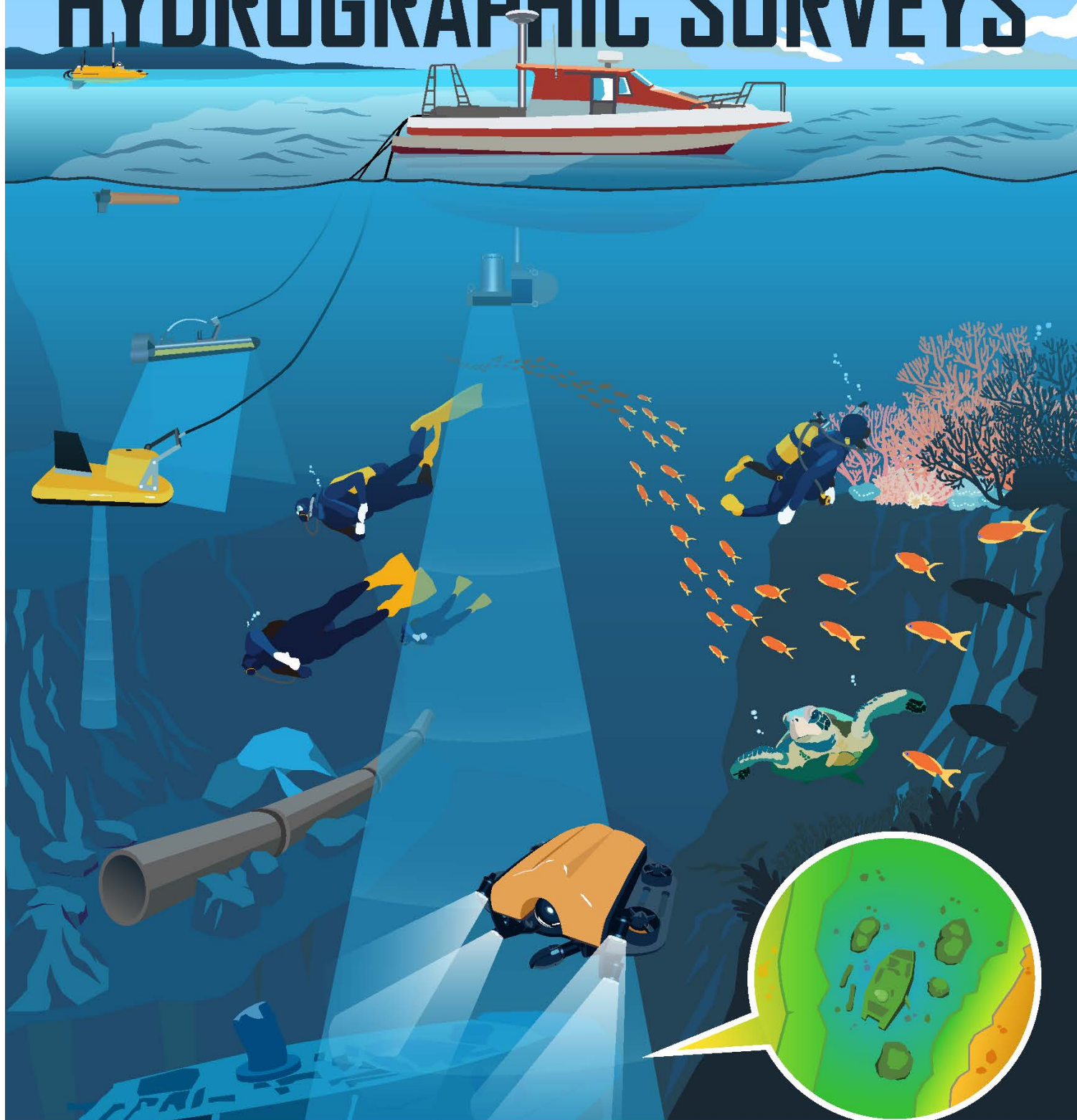
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廣告



PURDUE
KRANNERT
SCHOOL OF MANAGEMENT



台美頂尖大學共同培育國際高階人才

美國普渡大學 x 國立成功大學

Purdue MS-NCKU BS Dual Degree Program

水利及海洋工程學系

**首次
招生**

普渡雙聯組

115 年開始招生

Introduction 學程介紹

(3+1+1)

- 學生大一到大三於就讀成大，大四須前往美國普渡大學就讀，完成學士畢業規定，可取得成功大學水利及海洋工程學系學士學位。
- 符合普渡大學土木系碩士班申請規定並獲錄取者，將銜接就讀普渡大學碩士課程，完成畢業所需學分可取得普渡大學土木系碩士學位。

國立成功大學【大一～大三】

- 研修共同科目、水利系專業必選修及通識
- 參與普渡教授密集授課及暑期英語短課程

普渡大學【大四】

- 前往普渡大學修讀大四及部分碩士課程



普渡大學【碩士班】

- 獲錄取者就讀碩士班
- 預計一年完成碩士課程，取得碩士學位

大三前
須達普渡大學入學要求

- GPA 3.3 以上
- TOEFL iBT 88 (聽說讀寫 20)
- IELTS 6.5 (聽說讀寫6.0)

Degree Award 學位授予

國立成功大學工學學士 Bachelor of Science, National Cheng Kung University

普渡大學工學碩士 Master of Science, Purdue University

2026.04.17 更新

➡ 大學多元入學的「**個人申請**」

➡ 甄選：學測50%、書審25%、面試25% （詳見年度招生簡章）

Tuition & Other Fees 學費及其他費用

大一～大三 成功大學期間	約 TWD 26萬8千元 / 年 (含學費24萬5千元，雜費2萬3千元)
大四 普渡大學期間	約 USD 33,154 / 年
碩士班 普渡大學期間	約 USD 30,228 / 年 (每學期\$15,114 x 2學期)

- 1.金額二校均不含宿舍等個人生活費用，實際金額依入學當年度兩校公告為準。
- 2.普渡大學暑期密集短課(個人費用：機票、簽證等生活花費學生須另自付)。
- 3.普渡大學期間，費用估算可參考普渡大學官網。

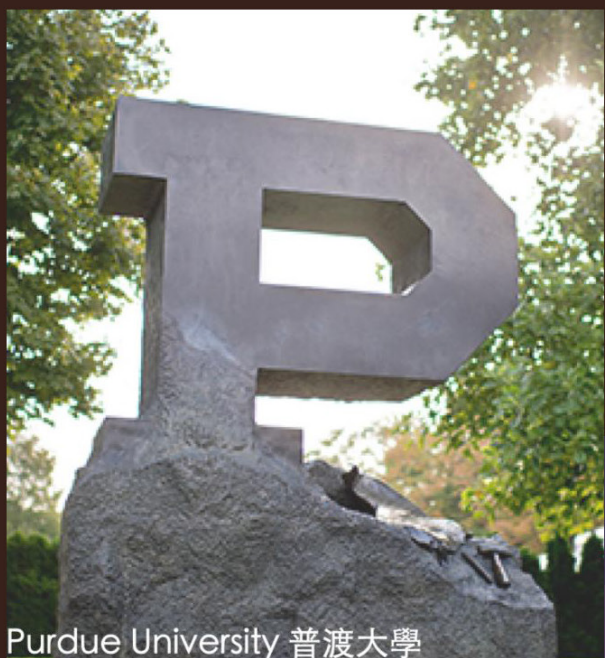
Information 聯繫方式及相關資訊



(06) 2757575轉63200



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Purdue University 普渡大學



美國普渡大學暨成功大學雙聯學位計畫

NCKU x PURDUE

2026.04.17 更新