



Times Higher Education
**Sustainability
Impact Ratings**

SDG

13

Climate
Action



SDG 13.2.1 Low carbon energy tracking

1. NCUE's 2024 Low-Carbon Energy Usage Statistics

(1) NCUE is committed to promoting green campus construction and actively introducing low-carbon energy systems. The 2024 energy usage statistics are as follows:

- (a) NCUE's total energy consumption in 2024, which is equivalent to the total electricity consumption, was 13,265,887 kWh = 47,757.19 GJ
- (b) NCUE's low-carbon energy usage in 2024 amounted to 3,998,415 kWh = 14,394 GJ
- (c) All low-carbon energy used by NCUE is entirely from photovoltaic solar systems installed on campus.

(2) Overview of Solar Power Generation Facilities

NCUE has installed photovoltaic solar systems at both Jinde and Baoshan campuses:

- (a) Jinde Campus installed capacity: 2,558.375 kWp
- (b) Baoshan Campus installed capacity: 571.5 kWp
- (c) Total installed capacity: 3,129.875 kWp

(3) Power Generation Calculation Basis

Based on the average daily sunlight duration of 3.5 hours in the Changhua region of Taiwan, the total solar power generation in 2024 was: $(2,558.375 + 571.5) \times 365 \times 3.5 = 3,998,415 \text{ kWh} = 14,394 \text{ GJ}$

2. NCUE's Low-Carbon Energy Usage Development Trend from 2022-2024

NCUE's low-carbon energy usage has continued to grow over the past three years, as detailed in Table 1.

Table 1: NCUE's Low-Carbon Energy Usage Statistics from 2022-2024

Year	Low-Carbon Energy Usage (GJ)	Total Energy Usage (GJ)	Low-Carbon Energy Usage Ratio (%)
2022	2101.5	46756.12	4.49%
2023	8,586	45871.88	18.72%
2024	14,394	47757.19	30.14%

3. Low-Carbon Energy Development Performance

NCUE's low-carbon energy usage from 2022-2024 has grown from 2,101.5 GJ to 14,394 GJ, with the proportion increasing from 4.49% to 30.14%, showing a significant growth trend as illustrated in Figure 1. This demonstrates NCUE's continued expansion of solar power generation equipment, progressively increasing renewable energy self-sufficiency, and steadily advancing toward the low-carbon campus goal.

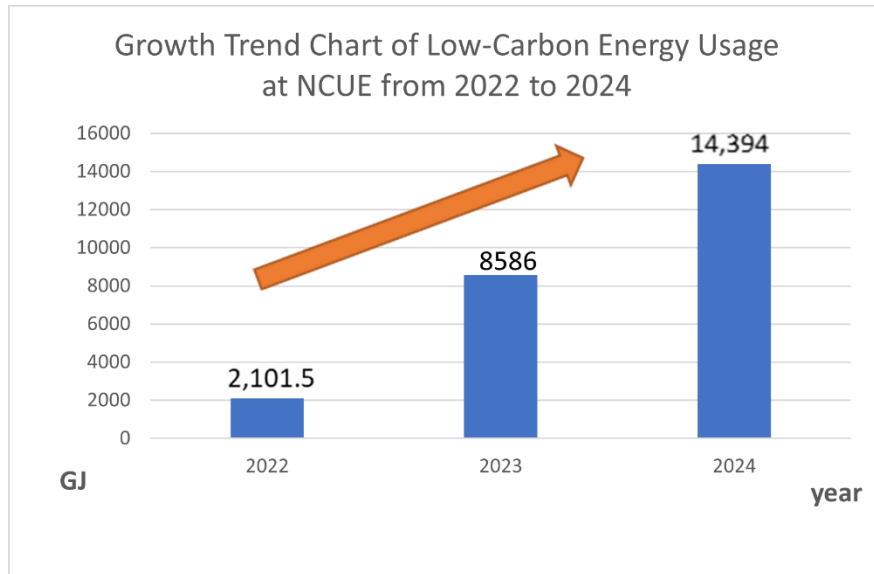


Figure 1. NCUE's Low-Carbon Energy Usage Shows an Increasing Trend from 2022-2024

4. Real-Time Monitoring and Data Transparency of Low-Carbon Energy

To effectively manage and track NCUE's solar power generation efficiency, NCUE accesses real-time power generation data, historical statistical information, and system operating status of photovoltaic equipment at all campuses through real-time monitoring systems, ensuring stable operation of solar equipment and maximizing power generation benefits.

(1) NCUE Gymnasium Solar Power Real-Time Monitoring System

System website: <https://tatungolarweb.azurewebsites.net/tv/5000011/>

This system specifically monitors the rooftop solar power generation equipment of the gymnasium, providing key data such as real-time generation power, cumulative power generation, and system efficiency to help management personnel monitor equipment operation status in real-time.

(2) Other Building Solar Power Monitoring System in NCUE

System website: http://solarsystem.cyberpower.com/solarV4/id_login.aspx

This system covers the major building solar power generation equipment at NCUE's Jinde and Baoshan campuses, providing daily, monthly, and annual power generation data queries and statistical report generation functions.

Figures 2-5 respectively show the site lists and annual power generation data screens for each location. Please also refer to attachment: 13.2.1A Building Solar Power Monitoring System Query Interface Diagram.

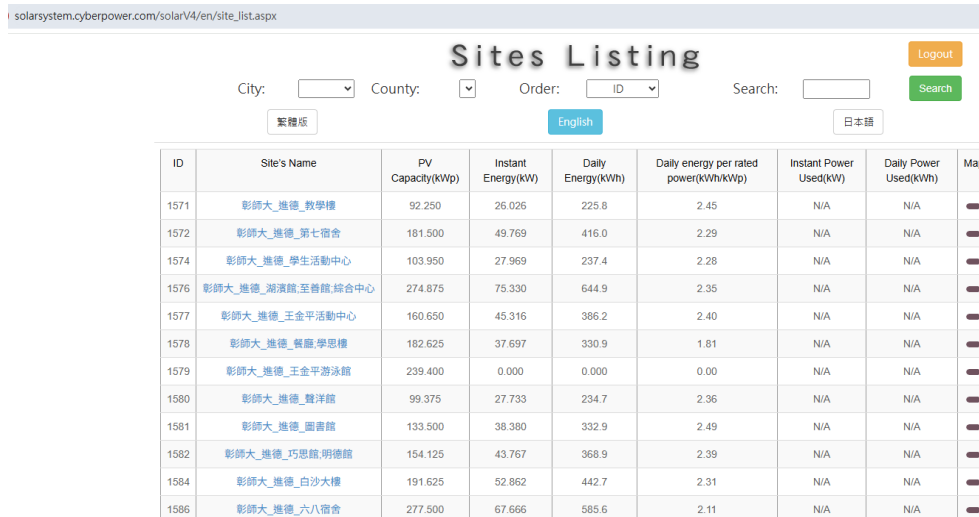


Figure 2. Building Solar Power Monitoring System Website Information - Jinde Campus Site List Management Interface

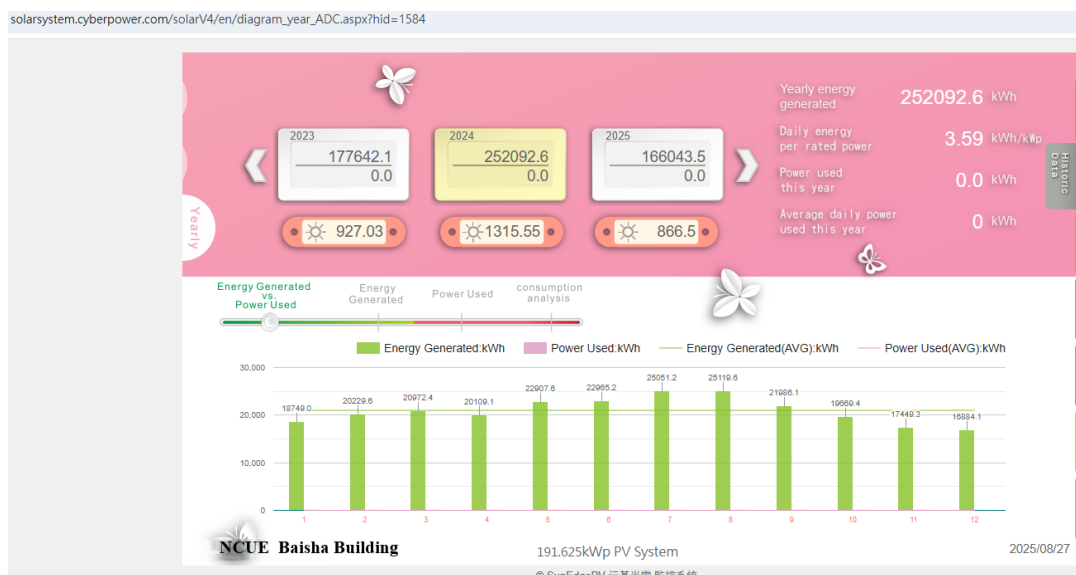


Figure 3. Jinde Campus Baisha Building 2024 Annual Power Generation Data Query Screen

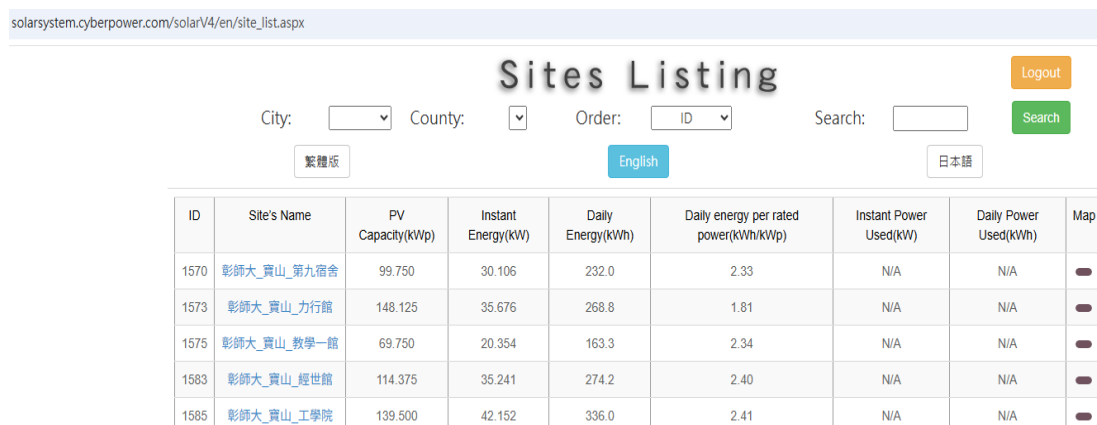


Figure 4. Building Solar Power Monitoring System Website Information - Baoshan Campus Site List

Management Interface

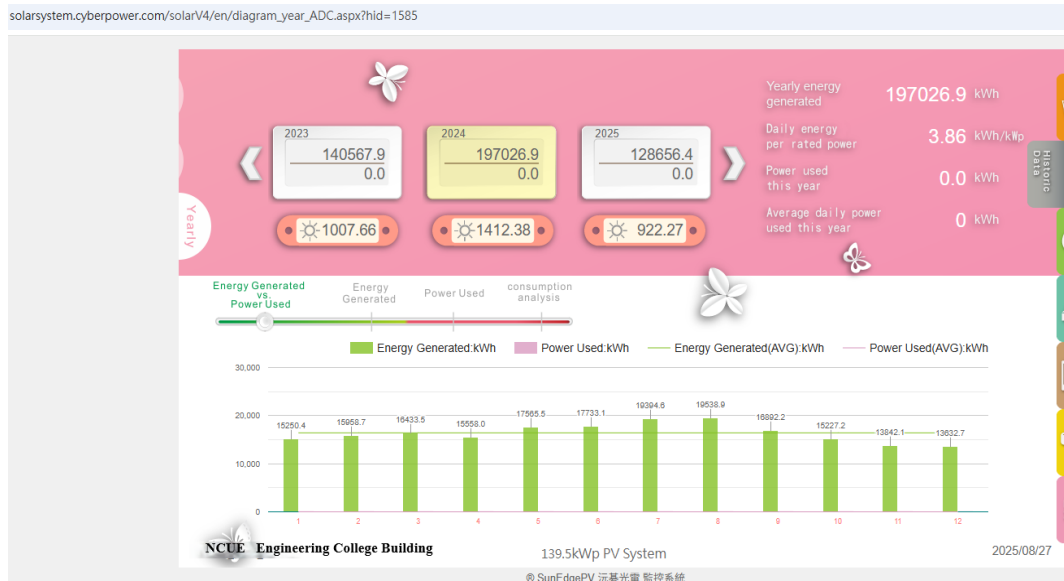


Figure 5. College of Engineering, Baoshan Campus 2024 Annual Power Generation Data Query Screen

SDG 13.2.2 Low-carbon energy use

Total energy used

On NCUE's Jinde Campus, the total electricity consumption for 2024 was 8,988,411 kWh, while on the Baoshan Campus, the total electricity consumption for 2024 was 4,277,476 kWh. The total electricity consumption for the entire University in 2024 was 13,265,887 kWh, equivalent to 47757.19 GJ.

Total energy used from low-carbon sources

1. In 2017, Jinde Campus installed a photovoltaic solar power system that generated 467kwp of power, with an average annual power generation of 583,750 kWh (2101.5GJ), accounting for 4.4% of the total power consumption of the University in 2024.
2. From 2021-2022, NCUE's Jinde Campus increased solar power annual generation to 3,197,968 kWh (11,512 GJ), and Baoshan Campus increased to 714,375 kWh (2,572 GJ), accounting for 29.44% of the university's total electricity consumption in 2024. (as detailed in Table 1)
3. NCUE is currently planning for 2026-2030, with Jinde Campus expected to further increase solar power annual generation to 3,478,433 kWh (12,522 GJ), and Baoshan Campus expected to increase to 1,636,875 kWh (5,893 GJ).
4. It is estimated that by 2030, NCUE's total solar power generation will reach 5,115,308 kWh (18,415GJ), exceeding 38% of the university's total electricity consumption in 2024, as detailed in Table 1. Table 1 presents NCUE's 2021-2030 Total Low-Carbon Energy Usage.

Table 1. NCUE's 2021-2030 Total Low-Carbon Energy Usage.

Campus	Year	Newly Added Capacity (kWp)	Accumulated Capacity (kWp)	Expected Power Generation (kWh)	Percent of Total Power Consumption in 2024
Jinde	Before 2020	467	467	583,750	7.04%
	2021-2022	2091.375	2558.375	3,197,968	38.57%
	2026~2030	230	2788.375	3,478,433 (12,522GJ)	38.7%
Baoshan	Before 2020	0	0	0	0%
	2021-2022	571.5	571.5	714,375	15.87%
	2026~2030	738	1309.5	1,636,875 (5,893GJ)	38.27%
Total	Before 2020	467	467	583,750	4.56%
	2021-2022	2657.25	3124.25	3,912,343	30.53%

	2026~2030	968	4097.875	5,115,308 (18,415GJ)	38.56%
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5. NCUE is striving for carbon neutrality. Prior to 2020, during peak hours, solar energy generated on Jinde campus was 467 kw, and low-carbon energy accounted for approximately 15.57% of total power consumption (3,000 kW); whereas Baoshan campus consumed 1,000 kw, which was not from low-carbon sources.
6. It was expected that in academic year 2021–2022, total solar energy generated on Jinde Campus would increase to 2558.375 kw during peak hours, whereas power consumption will reduce to 2,600 kw, which would push low-carbon energy sources to 98.18% of the total energy consumed. On Baoshan Campus, solar power generation was expected to increase to 571.5 kw during peak hours, whereas power consumption was expected to reduce to 900 kw, increasing low-carbon energy sources to 63.5% of the total power consumed.
7. In 2024, NCUE's Jinde Campus solar power peak generation reached 2558.375 kW, while peak electricity consumption was reduced to 2,200 kW, with low-carbon energy accounting for over 100%. Baoshan Campus peak generation reached 571.5 kW, with peak electricity consumption reduced to 785 kW, achieving a low-carbon energy ratio exceeding 72.8%, as detailed in Table 2. Table 2 presents NCUE's 2021-2030 Total Planned New Solar Power Installation Capacity.

Table 2. NCUE's 2021-2030 Total Planned New Solar Power Installation Capacity

Campus	Year	Solar Energy Generated during Peak Hours (kW)	Power Consumption during Peak Hours (kW)	Proportion of Solar Power to Power Consumption
Jinde	Before 2020	467	3000	15.57%
	2021-2022	2558.375	2600	98.18%
	2026~2030	2788.375	2200	>100%
Baoshan	Before 2020	0	1000	0%
	2021-2022	571.5	900	63.5%
	2026~2030	1309.5	785	>100%

- (1) The solar power generation device installation table for NCUE's Jinde and Baoshan campuses in 2022 (categorized by building) is shown in Table 3.

Table 3. Solar Power Generation Device Installation Table for NCUE's Jinde and Baoshan Campuses in 2022

Campus	Building	Estimated capacity (kWp)	Estimated power generation (kwh/year)
Jinde	Qiaosi Building	69	94,687

Campus	Building	Estimated capacity (kWp)	Estimated power generation (kwh/year)
Campus	Baisha Building	191.625	239,531
	Zhishan Building	48	60,000
	Mingde Building	85.125	80,156
	Educational Building	92.25	115,312
	No. 8 Dormitory	189	236,250
	No. 7 Dormitory	181.5	226,875
	No. 6 Dormitory	88.5	110,625
	Hubin Building	123	153,750
	Library	133.5	183,281
	Comprehensive Center	103.875	129,843
	Student Canteen	146.625	183,281
	Shengyang Building	99.375	124,218
	Xuesi Building	36	45,000
	Wang, Jin-Pyng Activity Center	160.65	192,187
	Wang, Jin-Pyng Swimming Pool	239.4	302,812
	Old Activity Center	103.5	129,375
Jinde Campus Total		2091.375	2,607,183
Baoshan Campus	No. 9 Dormitory	99.75	125,625
	First Educational Building	69.75	126,563
	College of Engineering Building	139.5	174,375
	Jingshi Building	114.375	142,969
	Lixing Building	148.125	185,156
Baoshan Campus Total		571.5	714,375

(2) NCUE accesses solar power generation information through real-time solar monitoring systems to effectively manage and track solar power generation efficiency. NCUE's solar monitoring system interface is shown in Figure 1.

System website: http://solarsystem.cyberpower.com/solarV4/id_login.aspx

Choose Year : 2024
 Choose Month : 7
 Yearly energy : 151664.4 kWh
 Total Energy : 329312.5 kWh

CyberPower Cloud Report Service

Date : 2024-08-01

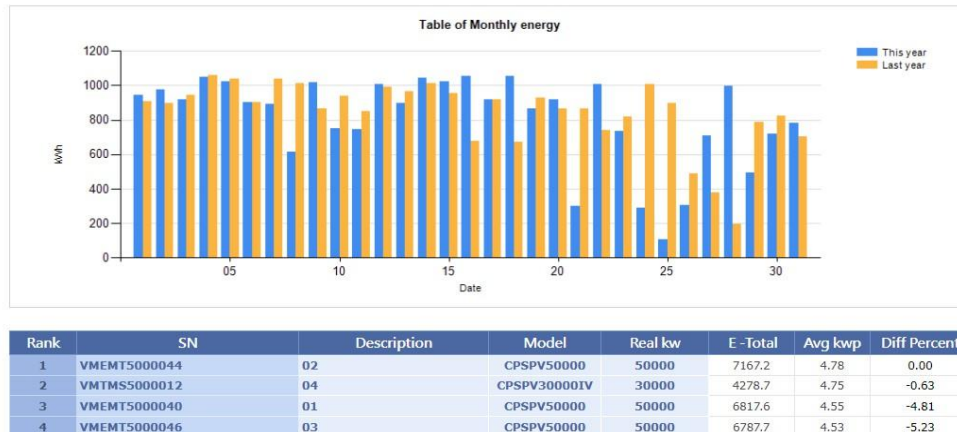


Figure 1: Solar Energy Monitoring System of NCUE

- (3) The proportion of solar power consumption during peak hours at NCUE's Jinde and Baoshan campuses in 2024 is shown in Figures 2-3.

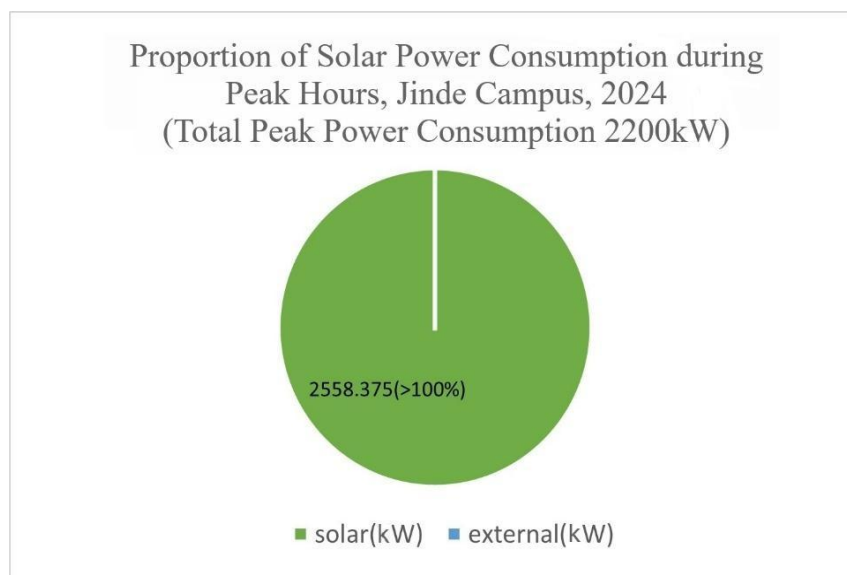


Figure 2: Proportion of Solar Power Consumption during Peak Hours, Jinde Campus, 2024

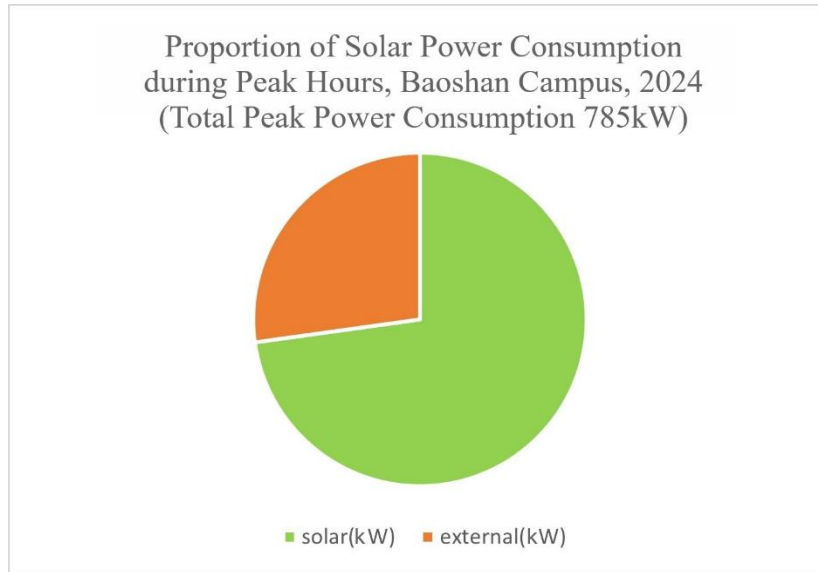


Figure 3: Proportion of Solar Power Consumption during Peak Hours, Baoshan Campus, 2024

(4) NCUE is currently planning new rooftop and ground-mounted photovoltaic solar devices for 2026-2030. Jinde Campus is expected to add 230 kWp, and Baoshan Campus is expected to add 738 kWp. The planned solar power generation device installation table for 2026-2030 is shown in Table 4.

For NCUE's complete 2026-2030 solar power planning and design concept diagram, please refer to Annex 13.2.2A - 2026-2030 Planned Expansion of Photovoltaic Solar Device Capacity

Table 4. NCUE's 2026-2030 Planned Solar Power Generation Device Installation Table

Campus	Location	Estimated Capacity (kWp)	Estimated Power (kWh/year)
Jinde Campus	College of Science Buildings 1 & 2	230	287,500
Baoshan Campus	Covered Court	306	382,500
	Volleyball Court	204	255,000
	Tennis Court	228	285,000
Campus-wide (Total)		968	1,210,000

SDG 13.3.1 Local education programmes on climate

1. NCUE actively promotes local climate change-related educational activities. In 2024, through the Ministry of Education, National Science and Technology Council, and USR (University Social Responsibility) projects, NCUE provided local educational programs and activities related to climate change risks, impacts, mitigation, adaptation, impact reduction, and early warning, covering curriculum design, field participation, community engagement, interdisciplinary research, and local action. The relevant projects are listed in Table 1. Additionally, NCUE offers related general education and professional courses such as "Environmental Change and Human Civilization" and "Hydrology" in the Department of Geography, which explore the impacts of climate change on the environment.

Course syllabus information:

- (1) https://webap0.ncue.edu.tw/DEANV2/UploadDEAN/SUBJECT/1122/00212_0CCGE0180020.pdf
- (2) https://webap0.ncue.edu.tw/DEANV2/UploadDEAN/SUBJECT/1131/43018_1ARGR0009230.pdf

Table 1. Project Number and Name

No.	Project Name
1	From Theory to Practice - Discussing Climate Change and Sustainability
2	Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition -- Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition
3	Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change
4	Ecological Homelands and Urban-Rural Sustainability : A Changhua Ecological Art

2. From Theory to Practice - Discussing Climate Change and Sustainability

This project, in the second semester of the 2024 academic year, promoted climate change-related content through the established "Climate Change and Environmental Sustainability" course. The course content included important topics and concepts such as "extreme climate," "carbon inventory," "carbon footprint," "circular economy," "net-zero emissions," "carbon neutrality," "carbon management," "greenhouse gas reduction and removal (carbon sinks)," "nature-based solutions," and "climate change adaptation and disaster prevention." Through classroom lectures, off-campus visits, special lectures, and practical activities (as shown in Table 2), students were guided to understand and practice climate action.

Table 2. Off-campus Visits, Special Lectures, and Practical Activity Content

Date	Activity Type	Course Content	Number of Participants
4/14	Field Visit	Content: Visit to Taichung Agricultural Research and Extension Station. (Figure 1) Effectiveness: Through field visits, understanding food local production (breeding, cultivation, management, strategies) in response to climate change, smart rice production, low-carbon rice production technology and rice carbon footprint, agricultural carbon reduction and sequestration strategies.	41
4/21	Practical Exercise (I)	Content: Greenhouse gas inventory experience sharing and practical exercise. Effectiveness: Through collaboration with practitioners, introducing carbon inventory methods and leading students to actually calculate carbon emissions for specific venues, helping students better understand carbon emission-related issues.	41
4/28	Special Lecture (I)	Content: Net-zero and carbon issue development. Effectiveness: Through expert lectures, helping students understand current global hot topics related to carbon economics.	41
5/12	Practical Exercise (II)	Content: Essential thinking for the carbon footprint of products- life cycle assessment. (Figure 2) Effectiveness: Through collaboration with practitioners, leading students to actually calculate product carbon footprints and emissions, helping students understand carbon footprint differences among different products and the importance of local production.	41
5/19	Special Lecture (II)	Content: Climate change risk assessment and adaptation - from disaster prevention and rescue to climate change adaptation. (Figure 3) Effectiveness: Through expert lectures, helping students understand climate change risks and how to conduct disaster risk assessment.	41



Figure 1. Visit to Taichung Agricultural Research and Extension Station in Dacun Township, Changhua County



Figure 2. Inviting Dr. Chien-Hung Kuo to introduce core concepts of carbon footprint and product life cycle assessment



Figure 3. Inviting Executive Director Kung-Yueh Chao from International Climate Development Institute to give a lecture

3. Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition:

This research promotes just transition strategies under climate resilience through a participatory approach, aiming to strengthen disaster adaptation governance.

- (1) In spring 2025, a "Climate Action Actors" workshop was held in Huwei Township, Yunlin County, introducing image analysis technology to explore urban development, industrial transformation, and heat risks, consolidating action directions. The research team established a comprehensive awareness system and completed spatiotemporal analysis of heat risks in Yunlin, Changhua, and Taichung, laying the data foundation for local climate justice; conducted comparative analysis of just transition literature and policies, discovering Taiwan's unique characteristics.
- (2) Regarding offshore wind power issues, pointing out that current compensation mechanisms fail

to implement fair participation, the research team combined routine collaboration with international exchange, establishing cooperation with Dartmouth College in the United States to promote long-term research on renewable energy issues. Research results are expected to develop methodologies for incorporating justice principles in climate decision-making and propose fair disaster prevention and adaptation policy recommendations.

(3) Related activity photos are shown in Figures 4-5.

Table 3. Two Activities and Participants

Item	Activity Name	Participants
1	Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition	Tzu-Ping, Lin, Distinguished Professor, Department of Architecture, NCKU Yang-Ting, Shen, Associate Professor, Department of Architecture, NCKU Pei-Wen, Lu, Associate Professor, Department of Geography, NCUE Sheng-Yu Yang, Assistant, Department of Geography, NCUE Yu-Fei, Lin, Assistant, Department of Geography, NCUE Yi-Zhen, Wu, Assistant, Department of Architecture, NCKU Yo-Hao, Chen, Assistant, Department of Architecture, NCKU Zhen-Huan, Chen, Assistant, Department of Landscape Architecture, CYCU Zhi-Tao, Peng, Doctoral Student, Department of Landscape Architecture, CYCU
2	Taiwan Just Transition Strategy Analysis	Zhon-Gen, Liu, Associate Professor, Department of Sociology, NTU Shun-Nan, Jiang, Postdoctoral Researcher, Department of Sociology, NTU Yi-Zhen, Huang, Postdoctoral Researcher, Department of Sociology, NTU Shan-Pei, Su, Full-time Assistant, NYCU Hua-Mei, Qiu, Associate Professor, Department of Sociology, NSYSU Yun-Zhi, Su, Researcher, Department of Sociology, NSYSU Dong-You, Shi, Researcher, Department of Sociology, NSYSU Wei-Cheng, Chen, Master's Student, Graduate Institute of Building and Planning, NTU Yu-Xin, Xu, Full-time Researcher, Center for Innovative Democracy, NCCU



Figure 4. Wind and Solar Power Survey on Fangyuan Coastline

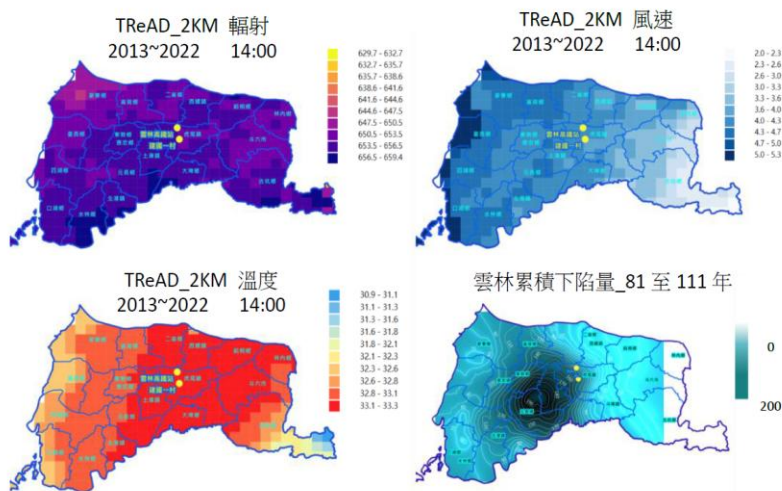


Figure 5. Yunlin County Radiation Map (upper left), Temperature Map (lower left), Wind Speed Map (upper right), Land Subsidence Map (lower right)

4. Ministry of Education's "Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change" Project

(1) In recent years, NCUE has actively integrated SDG 13 Climate Action with SDG 14 Life Below Water, deeply engaging with Changhua's coastal areas, particularly Fangyuan Township and Dacheng Township. In collaboration with aquaculture associations and clam farmers, NCUE has promoted carbon inventory, carbon footprint calculation, and sustainable development courses (Figure 6). Teachers and students not only assist communities in establishing carbon rights inventory processes and promoting blue carbon ecosystem protection, but also design interdisciplinary courses such as smart green living planning, emphasizing the integration of theory and practice to cultivate students' innovative thinking and social engagement capabilities. Through industry-academia collaboration, volunteer work, and internship activities, NCUE not only promotes community sustainable development but also enhances youth retention rates and local cohesion, demonstrating NCUE's core values of fulfilling social responsibility and giving back to the community.



Figure 6. May 30, 2024 - Joint organization of Sustainable Production and Responsible Consumption: Aquatic Product Low-Carbon Supply Chain Workshop with Changhua County Fishermen's Association and Fisheries Research Institute

- (2) The Environmental Education Center cultivates relevant environmental education talents, complementing the "Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change" project. From July to October 2024, relevant education courses were provided for local and national communities, with information shown in Table 4 and activity photos in Figures 7-8.

Course image information links:

(a) <https://www.facebook.com/media/set/?set=a.1080081833905178&type=3>

(b) <https://www.facebook.com/media/set/?set=a.1082290977017597&type=3>

Table 4: Environmental Education Course Activities

Course Activity	Date	Number of Participants
Environmental Education Personnel 24-hour Certification NCUE Special Class	July 2024	20
Environmental Education Personnel 100-hour Class	July-October 2024	8



Figure 7. Environmental Education Personnel NCUE Special Class



Figure 8. Environmental Education Personnel 100-hour Class

5. In response to the ecological crisis of global warming, NCUE's Department of Fine Arts proposed the USR project "Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project" in 2023-2024, focusing on "local care" as the main theme to achieve the United Nations Sustainable Development SDGs "13 Climate Action" goal. Related **free** activities were held in 2024 as shown in Table 5, with activity descriptions as follows:

Table 5. Related **Free** Activities in 2024

No.	Activities
1	NCUE Campus Tree Planting Day Activity - Free Distribution of Indoor Potted English Ivy
2	"Curatorial Theory and Practice" Course Conducting Neighborhood Green Survey
3	Organizing Multiple Horticultural Therapy Workshops On and Off Campus
4	Organizing Ecological Art Exhibition " Eco Art & Eco Ark " Ecological Art Exhibition
5	Organizing Multiple Ecological Workshops & Lectures

(1) NCUE Campus Tree Planting Festival Activity - **Free** Distribution of Indoor Potted English Ivy:
To enhance campus community awareness of climate change mitigation and greening actions, the Environmental Education Center collaborated with the Department of Biology to jointly organize the "NCUE Campus Tree Planting Festival Activity - **Free** Distribution of Indoor Potted English Ivy," promoting greening concepts and carbon footprint reduction awareness through practical planting activities. The activity attracted enthusiastic responses from faculty and students on campus, with 60 English ivy plants distributed during the early bird phase and an additional 137 plants distributed through lottery drawings, totaling 197 plants. By bringing plants into classrooms, offices, and living spaces, the activity practiced "inside-out" environmental adaptation and mitigation strategies while improving air quality and individual connections with nature. This activity not only responded to the needs for greening, cooling, and environmental adaptation under climate change but also deepened faculty and students' understanding and practice of sustainable lifestyles. (Figure 9)



Figure 9. Teachers and students enthusiastically participating in the tree planting festival distribution activity

(2) "Curatorial Theory and Practice" Course Conducting Street Green Survey:

To respond to challenges brought by global warming and climate change, a street green survey was incorporated into the Department of Fine Arts' "Curatorial Theory and Practice" course in the 2024 spring semester, with 53 students participating. The course guided students to various locations in Changhua, using black globe thermometers and thermal imaging cameras for field measurements, analyzing temperature differences in different street areas and further exploring the causes and current status of urban heat island effects. Through field surveys and data collection, students learned about the relationship between urban green canopy coverage and temperature regulation, understanding the important role of tree planting and green space planning in mitigating climate change impacts. This course not only enhanced students' sensitivity to local environmental issues but also cultivated their use of evidence-based methods to focus on ecological sustainability and climate action, implementing SDGs climate action goals and promoting youth generation participation in local environmental adaptation and transformation. (Figure 10)



Figure 10. "Curatorial Theory and Practice" course leading students into Changhua locations for street green surveys

(3) Organizing Multiple Horticultural Therapy Workshops on and off Campus:

Using "greening for cooling and carbon reduction" as a practical mitigation strategy for urban heat island effects, multiple on-campus and off-campus horticultural therapy workshops were planned and promoted, emphasizing the dual benefits of green plants for environmental regulation and mental health. Through actual participation in planting and gardening activities, participants understood the relationship between green spaces and climate change. Collaborating with external organizations including Changhua Christian Hospital, Changhua Lifelong Learning Center, Zhongzhang Veterans Home, Changhua County We Care Association, David Lan Presbyterian Church, and Huatan Church to deeply promote ecological and climate education in communities; on campus, students from "Horticultural Therapy" and "Art and alternative Therapies" courses engaged in hands-on operations and independently designed courses, organizing workshops including "Green Spirit – Plant-Inspired Mirror: Five Senses Self-Portrait Active Aging Workshop," "Green Spirit - Memory of Wind: Wind Chime Handcraft Active Aging Workshop," "Green Spirit - Natural Imprints: Leaf Printing Life Workshop," "Green Seeds: Horticultural Therapy Workshop," and "Green Healing: Horticultural Therapy Active Aging Workshop." This project not only deepened green living awareness but also combined local practice with educational action, cultivating fundamental civic literacy for climate change mitigation and adaptation. (Figures 11-14)



Figure 11. Elderly residents at Zhongzhang Veterans Home engaged in creation during "Green Spirit – Plant-Inspired Mirror: Five Senses Self-Portrait Active Aging Workshop"



Figure 12. Group photo with works from "Green Spirit - Memory of Wind: Wind Chime Handcraft

Active Aging Workshop"



Figure 13. Students independently designing lesson plans for "Green Seeds: Horticultural Therapy Workshop" and conducting field teaching at Changhua Christian Hospital



Figure 14. Group photo with elderly residents at Lifelong Learning Center after students completed lesson plan teaching for "Green Healing: Horticultural Therapy Active Aging Workshop "

(4) Organizing " Eco Art & Eco Ark " Ecological Art Exhibition:

Through participation in the O-Bank Education Foundation's selected exhibition " Eco Art & Eco Ark - Ecological Art Exhibition," Department of Fine Arts student Hong-Qi, Xu's work "Green Ark" was collected by the O-Bank Education Foundation during the exhibition period. The collected work "Green Ark" was a "climate action" from the November 2023 Changhua "Green Companionship - Ecological Art Exhibition," where the creator mobilized 32 NCUE Department of Fine Arts participants to walk the boat from National Changhua University of Education to Changhua Christian Hospital, connecting the two institutions based on their local ecosystem alliance concept. This boat sailed north to the O-Bank Education Foundation through the 2024 " Eco Art & Eco Ark " and became a symbol of permanent alliance between the two institutions through the collection opportunity. Transcending time and space through ecological concepts, this is not only a practice of "climate action" but also an expectation for the global future, hoping that this Noah's Ark loaded with green plants can preserve a precious plant seed bank of current ecology for the future world. (Figures 15-16)



Figure 15. " Eco Art & Eco Ark " exhibition, exhibitor Hong-Qi, Xu's work "Green Ark"



Figure 16. " Eco Art & Eco Ark " exhibition, exhibitor Bi-He, Cai's work "Artificial Heat Island - AI Forest"

(5) Organizing Multiple Ecological Workshops & Lectures:

Grey-faced buzzards and purple crow butterflies are representative migratory species in central Taiwan, whose activities are closely related to local climate conditions. Climate change will lead to increased frequency of extreme weather events such as droughts and heavy rains, which may not only change their migration routes and timing but also affect their habitat and foraging conditions. Incorporating the ecological phenomena of grey-faced buzzards and purple crow butterflies into courses, lectures including "The Ecological Beauty of Baguashan Mountain," "Baguashan Mountain and Grey-faced Buzzards," and "Phantom Dance of Purple Crow Butterflies" were organized. Through collaboration with Providence University's Department of Ecology and Humanities, using wool felt art creation and other methods, students were guided to focus on biodiversity and climate issues, responding to "Climate Action" in the SDGs. Through interdisciplinary integration of ecology, art, and humanities practice, students' perception and identification with local ecological environments were cultivated, deepening their understanding and action capacity regarding global environmental change. (Figure 17)



Figure 17. Cultural and historical ecology speaker Wei-Han, Li explaining migratory raptor-related surveys

6. In the first semester of the 2024 Academic Year, a hydrology course was offered in the Department of Geography with approximately 43 students enrolled. The course content covered understanding of water cycles and water resource balance, along with field investigations. The investigation site was the Zhongguakeng Creek watershed in Nantou County (as shown in Figure 18), observing the crises faced by mountain streams under the impact of climate change and possible actions to take. Nature-based solutions are an adaptive strategy option for responding to climate change. The activity explained the advantages and disadvantages of nature-based solutions for stream governance, while helping students understand sustainable wild stream governance strategy options available for consideration today.

Zhongguakeng Creek is a tributary of Wu River. In the past, traditional engineering caused damage to the stream environment. Now, concrete is being removed to create a naturally friendly environment, seeking a win-win outcome for both humans and natural ecology. Students on-site can fully appreciate the pleasure that natural streams bring to people and observe water flow velocity, water depth, and aquatic organisms. This field investigation activity allows reflection on how individuals and society should respond to climate change impacts and the possible effects of response strategies from a sustainable perspective.



Figure 18. Group discussions at Zhongguakeng Creek Stream site

SDG 13.3.2 Climate Action Plan, shared

1. NCUE actively participates in and promotes climate action-related research and application projects (as shown in Table 1), collaborating across ministries and industries to combine scientific research, environmental education, industry guidance, and disaster prevention technology to assist local communities in facing climate change challenges and promoting sustainable development. These actions encompasses climate science research, water resource and agricultural planning, disaster prevention monitoring, invasive species control, and local industry low-carbon transition, providing policy recommendations, scientific data, and technical support. These project outcomes not only strengthen local governments' climate response capabilities but also promote environmental awareness and participation among community residents, forming a shared action model that integrates research, education, and practical application.

Table 1. Related Research and Application Projects

No.	Principal Investigator	Project name
1	Professor Jien-Yi Tu	National Science and Technology Council Project/ Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming (III)
2	Professor Chuian-fu Ken	Ministry of Education/ Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change project
3	Professor Ling Jiang	Changhua Coastal Clam Habitat Survey and Conservation Education Promotion Project
4	Professor Chung-chi Lin	Taoyuan International Airport Corporation Project / Commissioned Planning and Design for Invasive Red Fire Ant Control Operations
5	Professor Chung-chi Lin	Ministry of Economic Affairs Project / Smart Development of Novel Environment-Friendly Control Technology Applied to Ant Pest Control Commercial Development Project
6	Professor Chung-chi Lin	Animal and Plant Health Inspection Agency, Ministry of Agriculture Project / Expansion of Drone-Based Management System for Invasive Fire Ant Control and Agricultural Pesticide Application
7	Professor Chung-chi Lin	National Park Service, Ministry of the Interior, Kenting National Park Headquarters / 2024 Kenting National Park Yellow Crazy Ant Control Project

2. Project content descriptions are as follows:

- (1) Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming (III)

- (a) Government Research Information System: <https://www.grb.gov.tw/search/planDetail?id=16551737>
- (b) Analysis of changes in autumn tropical cyclone activity in the South China Sea from 1979-2023, revealing the causes of interdecadal variations to provide scientific basis for disaster prevention policies and climate prediction.

The South China Sea, located southwest of Taiwan within the Asian monsoon region, generates typhoons that frequently bring abundant moisture to Taiwan, the Indochina Peninsula, and China's southeastern coast, increasing rainfall. From 1979 to 2023, the frequency of tropical cyclone (TC) activity in the South China Sea (SCS) during autumn (September to November) showed clear interdecadal variation characteristics around the year 2000, with fewer occurrences in later periods. This is related to reduced formation within the South China Sea itself and decreased numbers of tropical cyclones moving from the Northwest Pacific (WNP) into the South China Sea. Data analysis revealed that low-level anticyclonic anomalies extending from the Bay of Bengal through the South China Sea to the tropical Northwest Pacific effectively suppress tropical cyclone formation and subsequent movement frequency in the South China Sea and tropical Northwest Pacific, potentially causing interdecadal-scale variations in South China Sea tropical cyclone activity frequency. (Figures1-2)

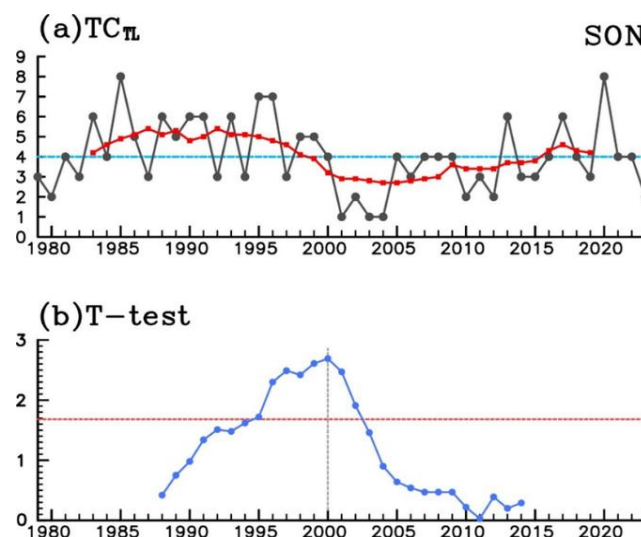


Figure 1. (a) Annual and interdecadal (9-year moving average) time series of total tropical cyclones (TC) generated in the South China Sea during autumn from 1979 to 2023. The long-term average of this time series is 4.1 (indicated by horizontal line). (b) t-values of mean difference between two interdecadal periods before and after each year from 1988 to 2014. If a year's t-statistic exceeds 1.68 (marked by horizontal line), the difference between the two interdecadal periods bounded by that year is statistically significant at the 0.05 level

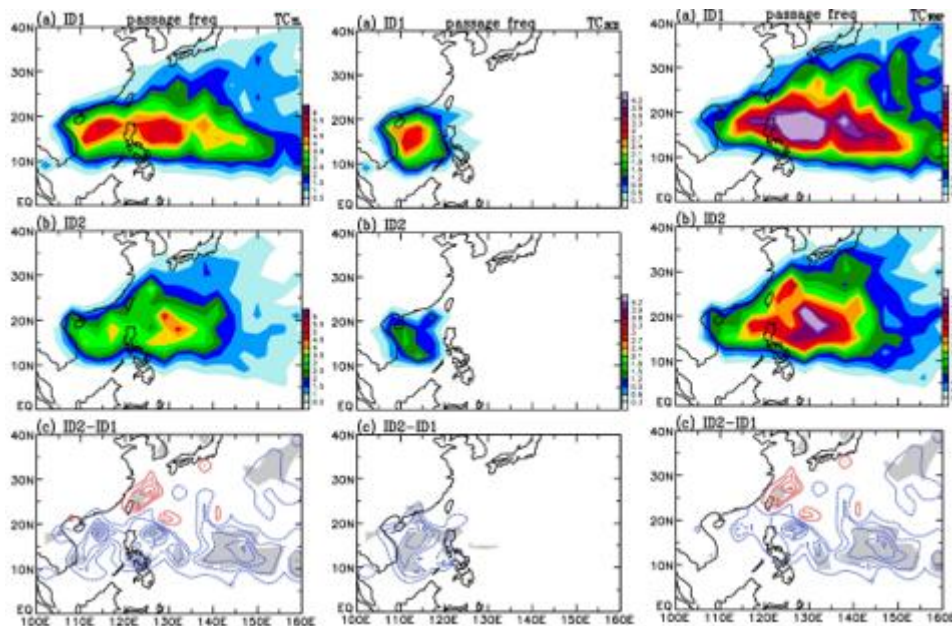


Figure 2. Mean values of autumn total tropical cyclone (TC) passage frequency: (a) ID1 (1979-1999), (b) ID2 (2000-2023), and (c) the differences (ID2-ID1). In (c), areas with statistical significance above 0.1 level are shaded. Contour intervals in (a), (b), and (c) are all 0.5. Left panel shows total passage frequency, middle panel shows typhoons generated only in the South China Sea, right panel shows typhoons generated only in the Northwest Pacific

(2) "Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change"

Focusing on the coastal areas of Fangyuan and Dacheng in Changhua, combining environmental education, ecological conservation, air pollution awareness, beach cleaning actions, wetland protection, energy conservation and carbon reduction, and green energy promotion to assist local communities in enhancing resilience under climate change. The project promotes aquaculture industry upgrading through product packaging and marketing research, while introducing intelligent monitoring and community participation to strengthen water quality management and biodiversity, committed to dual sustainability of industrial development and ecological environment, creating new paradigms for local characteristics and sustainable development.

- (a) This research project collaborates with the Changhua Aquaculture and Fisheries Development Association to develop a series of services and surveys for aquaculture industry adaptation strategies in Changhua under climate change. In addition to assisting association members with water resource safety testing for fishponds, coastal water intake channels, and groundwater wells, based on stakeholder feedback collected from the USR project, services have been expanded to golden clam operators and survey areas have been increased to include the upper, middle, and lower reaches of rivers serving as water sources for fishponds. All the above services are provided **free** of charge, aiming to maintain sustainable safety of water resources for aquaculture operators and coastal areas. Related activity photos are

shown in Figures 3-4.



Figure 3. Conducting field investigation activities to strengthen practical aquaculture experience



Figure 4. March 2024 - Water Quality Investigation Team: The 2024 Department of Biology USR project implementation, adding or changing investigation sites based on stakeholder feedback, testing not only upper, middle, and lower reaches of rivers but also drainage from factories and livestock farms with pollution concerns

- (b) "Sustainable Development and Practices of Coastal Biological Resources": The course includes workshops on "The Application of Beneficial Bacteria in Aquaculture" and "Aquaculture and Greenhouse Gases". Participants include course students, teachers, local aquaculture operators, and organizations, working together to maintain the health and sustainability of local aquatic ecosystems. Related activity photos are shown in Figure 5.



Figure 5. 2024/04 "Aquaculture and Greenhouse Gases" course, with participants including students, teachers, local aquaculture operators and organizations, promoting environmentally friendly low-carbon production strategies to jointly maintain the health and sustainability of local aquatic ecosystems

(c) Project activity Facebook fan page link: https://www.facebook.com/NCUEUSR/photos/?tab=album&ref=page_internal

(3) Changhua Coastal Hard Clam Habitat Survey and Conservation Education Promotion Project

(a) NCUE promotes the "Changhua Coastal Hard Clam Habitat Survey and Conservation Education Promotion Project," implementing a series of marine citizen scientist courses at Xinbao Wetland and Wanggong Harbor through industry-academia cooperation, including "Volunteer Investigator Training," "Seed Teacher Training," and "Hard Clam Detective Squad" activities. Course content covers water quality testing, biodiversity surveys, bivalve classification, and coastal tourism and conservation education promotion, integrating with Caohu Junior High School, Hanbao Elementary School, and Lukang Elementary School to closely combine scientific investigation with local education, enhancing environmental protection awareness among faculty, students, and communities.

(b) The same project also emphasizes practical operations in ecological restoration and climate adaptation. Through "Hard Clam Habitat Surveys" (conducted once each in winter, spring, summer, and autumn, including sediment improvement experiments), it was discovered that sediment improvement can effectively promote the growth of indicator species such as hard clams and corbicula, suppress the dominance of ring clams, and enhance carbon sequestration potential and benthic biodiversity. (Figure 6)

(c) Through extensive participation of citizen scientists, not only has the volume of survey data significantly increased, but community conservation awareness has also been effectively enhanced, forming a demonstration cooperation model that combines scientific research, educational promotion, and climate adaptation.

(d) Project activity Facebook page link: https://www.facebook.com/NCUEUSR/photos/?tab=album&ref=page_internal



Figure 6. Winter joint sampling and investigation of hard clam habitats by NCUE team and Changhua Marine Food Research Center

- (4) Invasive Ant Species Control: Conducting ecological monitoring, control technology research and development, and application for red fire ants and yellow crazy ants to assist airports, national parks, and agricultural areas in reducing invasive species damage.
- (a) Taoyuan International Airport Corporation Project / Commissioned Planning and Design for Invasive Red Fire Ant Control Operations (Figure 7).



Figure 7. NCUE Taoyuan International Airport Fire Ant Control Team using fire ant detection dogs to assist in searching for invasive red fire ants at Taoyuan Airport

- (b) Ministry of Economic Affairs Project / Smart Development of New Environmentally Friendly Control Technology for Commercial Application in Ant Control (Figure 8).

Addressing the increasingly severe problem of harmful ants in agricultural environments, the team focuses on environmentally friendly ant control technology as the overall research and development axis, and commercializes these ant control technologies for practical application in ant control operations. Environmentally friendly ant control technology applications can be divided into four major categories: pesticide carrier technology (crystal gel baits can replace existing liquid baits), biochemical ant control technology (bee repellent can be added to baits to solve the problem of ant intrusion in apiaries), physical ant control technology (insect repellent films can be applied to street lights to reduce flying ant disturbance to the public), and harmful ant identification technology (detection dogs and image recognition can assist frontline personnel in rapidly identifying ant species).

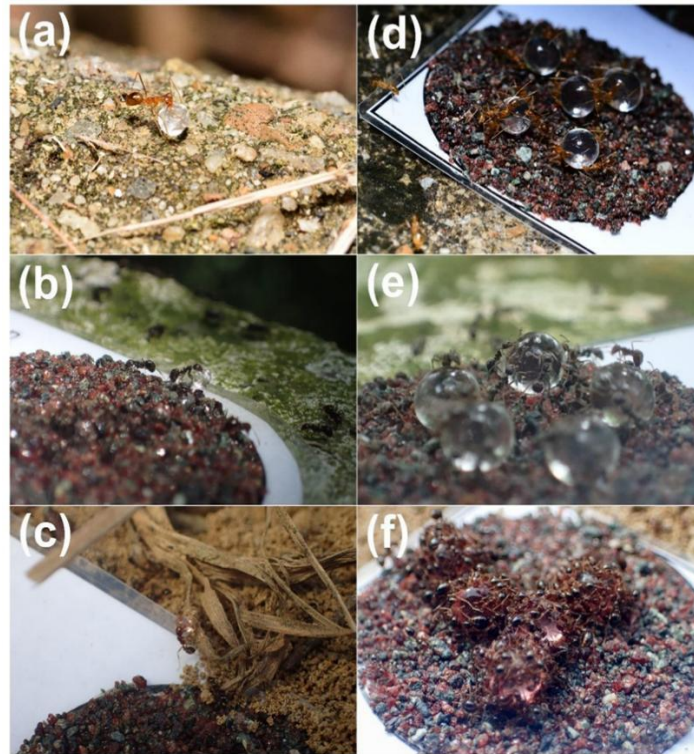


Figure 8. Research on the effectiveness of crystal gel baits in controlling various harmful ants

(c) Animal and Plant Health Inspection Agency, Ministry of Agriculture Project / Strengthening Hualien County Red Fire Ant Control Project (Figures 9-10).



Figure 9. Using drones for comprehensive bait application across 3,200 hectares of control areas, with specialized enhanced control for peripheral isolated outbreaks, coordinated with garbage truck promotion of fire ant control operations



Figure 10. Drone pesticide application operations showing bait loading and aerial distribution

(d) Kenting National Park Project / 2024 Kenting National Park Yellow Crazy Ant Control Project.

In areas where yellow crazy ant super colonies severely threaten land crabs in the park, this project will conduct large-scale bait control applications in major land crab hotspot areas (Banana Bay and Gangkou Coastal Forest) to control yellow crazy ant super colony population density, monitor yellow crazy ant population dynamics in control sample areas, understand the effectiveness of bait control applications, and evaluate long-term control strategies and recommendations for yellow crazy ant populations in Kenting National Park (Figure 11).



Figure 11. Artificial Ant Colony Trap Box devices placed in soil surface layers, near tree roots, or in leaf litter layers where yellow crazy ants prefer to nest. These can be used for population monitoring of yellow crazy ant super colonies in the environment and also have the control effect of directly removing reproductive nests (containing queens) from the environment.

SDG 13.3.3 Co-operative planning for climate change disasters

NCUE actively collaborates with government and related research institutions, participating in multiple climate change and disaster adaptation projects (Table 1), committed to enhancing Taiwan's response capacity when facing extreme weather and disasters through basic research, technological applications, and local participatory actions. The following presents three representative collaborative examples covering large-scale climate dynamics, coastal environmental changes, and disaster observation.

Table 1. Related National Science and Technology Council Research Projects

No.	Principal Investigator	Project Name
1	Professor Jien-yi Tu	Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming (III)
2	Associate Professor Yi-ching Chen	Changing Changhua Coastal Landscapes: Artificial Object-Driven Cross-Scale Spatial Development and Social-Ecological System Analysis--Multi-scale Remote Sensing Technology for Observing Changhua Coastal Topographic Changes and Environmental Control Factors (III)

1. Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming (III)

(1) Government Research Information System: <https://www.grb.gov.tw/search/planDetail?id=16551737>

(2) Project Highlights: Research indicates that from 1979 to 2023, autumn tropical cyclone (TC) activity in the South China Sea showed significant interdecadal variations. Changes in typhoon genesis numbers are closely related to monsoon circulation anomalies, particularly low-level anticyclonic anomalies that suppress typhoon formation and movement. These research findings have high reference value for government disaster prevention and prediction system construction and help accurately predict precipitation patterns and disaster risks.

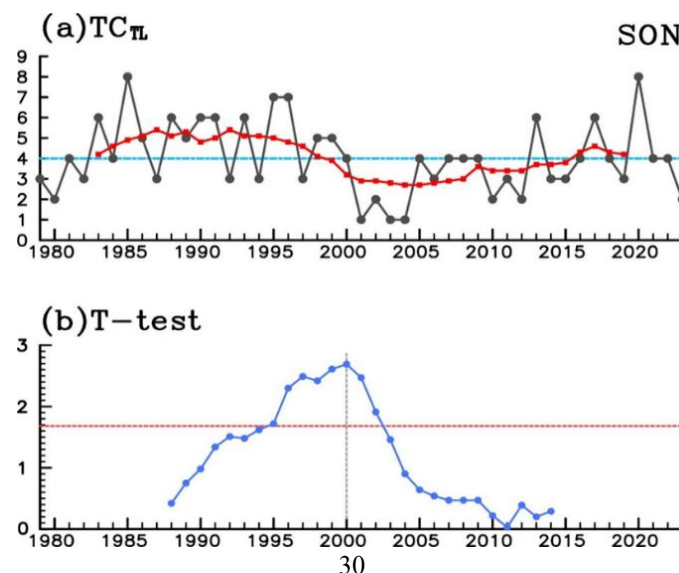


Figure 1. (a) Annual and interdecadal (9-year moving average) time series of total tropical cyclones (TC) generated in the South China Sea during autumn from 1979 to 2023. The long-term average of this time series is 4.1 (indicated by horizontal line). (b) t-values of mean difference between two interdecadal periods before and after each year from 1988 to 2014. If a year's t-statistic exceeds 1.68 (marked by horizontal line), the difference between the two interdecadal periods bounded by that year is statistically significant at the 0.05 level

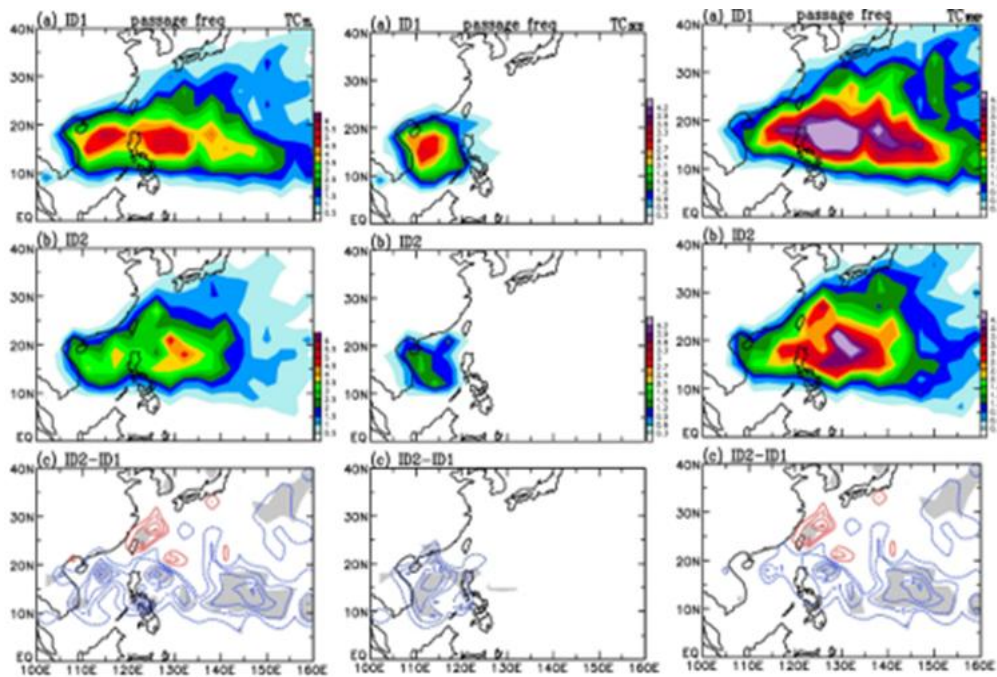


Figure 2. Mean values of autumn total tropical cyclone (TC) passage frequency: (a) ID1 (1979-1999), (b) ID2 (2000-2023), and (c) their difference (ID2-ID1). In (c), areas with statistical significance above 0.1 level are shaded. Contour intervals in (a), (b), and (c) are all 0.5. Left panel shows total passage frequency, middle panel shows typhoons generated only in the South China Sea, right panel shows typhoons generated only in the Northwest Pacific

2. Changing Changhua Coastal Landscapes: Artificial Object-Driven Cross-Scale Spatial Development and Social-Ecological System Analysis--Multi-scale Remote Sensing Technology for Observing Changhua Coastal Topographic Changes and Environmental Control Factors (III)

(1) Government Research Information System: <https://www.grb.gov.tw/search/planDetail?id=16727418>

(2) Project Highlights: Through satellite and drone observations from 2001 to 2023, the project reconstructed the process of Changhua tidal flat topographic changes, discovering significant north-south barrier island accumulation and identifying the impacts of artificial structures and climate events (such as typhoons) on micro-topographic changes. The research findings assist local governments in decision-making for coastal disaster prevention, land use planning, and ecological conservation strategies.

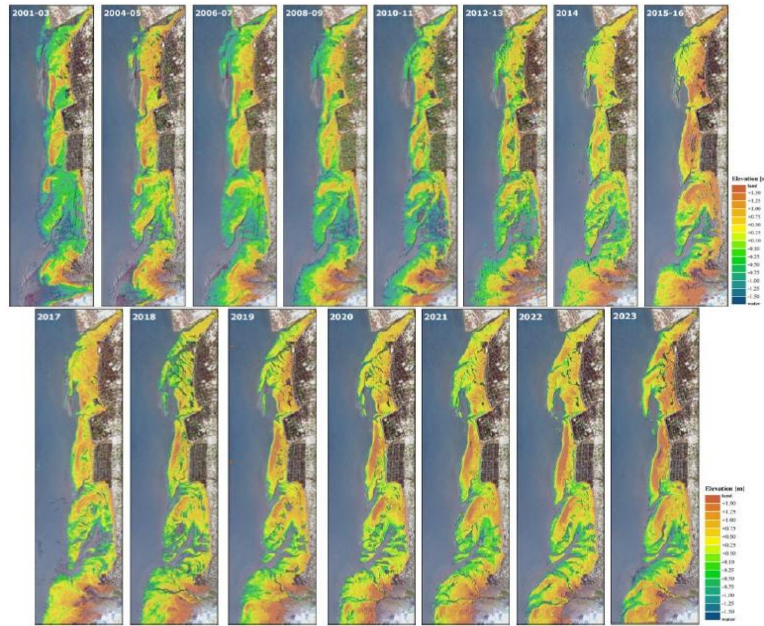


Figure 3. Construction of Changhua Coastal Tidal Flat Topographic Changes from 2001-2023

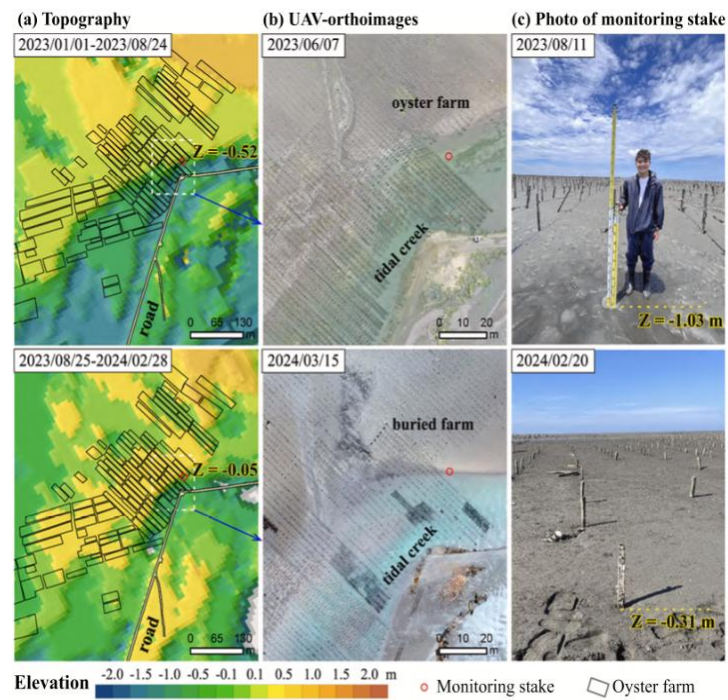


Figure 4. Impact of Hanbo Tidal Flat Topographic Changes on Oysters

3. Collaboration with the Central Weather Administration for earthquake observation and meteorological monitoring: Enhancing national disaster warning and long-term climate data construction
 - (1) Taiwan is located at the boundary of the ‘Eurasian Plate’ and the ‘Philippine Sea Plate’; therefore, earthquakes are frequent occurrences in Taiwan. According to data from the Seismological Center of the Central Weather Administration from 1991 to 2015, about 3,000 earthquakes

occurred in Taiwan every month on average, and 102 major earthquake-related disasters occurred from 1901 to 2016.

The director of the Seismological Center stated in March 2022 that it was highly likely that the “active seismic period” has begun in the Pacific Ring of Fire, which included Taiwan.

Although an accurate earthquake prediction technology is not available yet, increasing seismic observation data are rather helpful in improving the efficiency of disaster relief and reducing the loss of life and property during earthquakes. In cooperation with the Central Weather Administration, NCUE has installed strong motion observation apparatuses on the two campuses and in the residential areas as well as the Baisha weather station.

(2) Below are some more details about the seismic observation apparatuses (Figures 5-7).



Figure 5. Strong motion observation station in Jinde Campus. The observation station houses the strong motion observation apparatus. The time, location, and size of an earthquake can be calculated when many stations are connected to form a seismograph network



Figure 6. Crustal deformation observation station in Baoshan Campus. The station continuously receives signals emitted from the global satellite positioning system and, with the signals received simultaneously by other stations, it can accurately calculate its location relative to other stations. Long-term observation data can reflect significant surface displacement due to major earthquakes. In addition, data on small crustal deformation during earthquakes are very helpful in understanding crustal movement and earthquake potential



Figure 7. Underground seismograph observation station in the residential areas. The seismograph installed at a depth of 300 meters in the well can significantly reduce interference from surface noise and obtain high quality ground motion signals, improving the accuracy of seismic locating and the ability to monitor small-scale, regional earthquakes

(3) The Central Weather Administration works with academic institutions in Taiwan by installing weather facilities for teaching purposes. They can be used as practice areas by students. The automatic meteorological observation station run by NCUE's Department of Geography is one such facility. It is also the only such station in central Taiwan under the partnership. This automatic meteorological station was built in the attic of the Geography Department Building. It was commissioned in November 1997 and will have run for 27 years in 2024 (Figure 8). The meteorological instruments and peripheral devices are used for real-time observation, and meteorological data are synchronized with the Southern Region Weather Center of the Central Weather Administration. Real-time data are useful for disaster prevention units. The features of the observation station are shown in the photo below. In addition, a sufficiently long observation time also means that the station could help researchers better understand regional climate characteristics and changes and allow them to conduct relevant studies. Related website: https://geo.ncue.edu.tw/res_02.php



Figure 8. NCUE's Baisha weather station

Through interdisciplinary research and multi-level government collaboration, NCUE covers scientific understanding of climate disasters, local actions, and policy impacts, effectively strengthening society's response and adaptation capacity to climate change and disaster risks, contributing concrete and substantial results to the implementation of SDG 13 "Climate Action" goals.

SDG 13.3.4 Inform and support government

1. NCUE's faculty members actively participate in various research and practical projects, addressing the challenges brought by global warming, providing concrete suggestions, and supporting relevant planning and management for local or regional governments. As shown in Table 1, Professor Jien-yi Tu conducted in-depth research on the "Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming", providing scientific basis for future climate adaptation and water resource management.

Furthermore, the Department of Fine Arts USR project "Ecological Homelands and Urban-Rural Sustainability" promotes campus green surveys and organizes faculty community horticultural therapy workshops through inter-level campus collaboration, cultivating students' ability to observe climate and environmental changes; organizing lectures and observation activities related to grey-faced buzzards and purple crow butterflies to strengthen understanding of species migration and habitat changes; and implementing street green surveys and urban heat island effect observations, transforming them into ecological art exhibitions. These actions gradually establish community foundations for local climate risk perception and monitoring.

Concurrently, Professor Chuian-fu Ken from our university has been promoting the "Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change" project. This initiative assisted local governments in facing climate change challenges, encompassing environmental education, raising air pollution awareness, wetland conservation, and more. Through interdisciplinary collaboration and the promotion of green energy technologies, the project fostered sustainable development of local industries and the environment, supporting local government efforts in climate change risk management.

Table 1. Serial No., Principal Investigator, Project Title

No.	Project Leader	Project Name
1	Professor Jien-Yi Tu	Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming (III)
2	Associate Professor Yi-ching Chen	Changing Changhua Coastal Landscapes: Artificial Object-Driven Cross-Scale Spatial Development and Social-Ecological System Analysis--Multi-scale Remote Sensing Technology for Observing Changhua Coastal Topographic Changes and Environmental Control Factors (III)
3	Professor Su-fen Wang	Taiwan Western Coastal Wetland Agricultural and Fisheries Social-Ecological System Monitoring
4	Associate Professor Man-ping Wang	University Social Responsibility Implementation Project: "Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project"

5	Professor Chuian-fu Ken	"Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change" project
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2. Project content descriptions are as follows:

(1) Professor Jien-yi Tu, NCUE / National Science and Technology Council Project / Impacts of Large-scale Circulation Changes on Precipitation in the Asian Monsoon Region under Global Warming (III).

(a) Government Research Information System: <https://www.grb.gov.tw/search/planDetail?id=16551737>

(b) This year's project, part of the results focused on research regarding typhoon-monsoon interactions. The South China Sea, located southwest of Taiwan, falls within the Asian monsoon region. Typhoons formed in this sea area often bring abundant moisture to Taiwan, the Indochina Peninsula, and China's southeastern coast, increasing rainfall amounts. Between 1979 and 2023, the frequency of tropical cyclone (TC) activity in the South China Sea (SCS) during autumn (September to November) showed distinct interdecadal variation characteristics around 2000, with fewer occurrences in the later period. This is related to the decreased number of tropical cyclones generated within the South China Sea itself and the reduced number of tropical cyclones moving from the Western North Pacific (WNP) into the South China Sea. Through data analysis, it was also discovered that low-level anticyclonic anomalies extending from the Bay of Bengal through the South China Sea to the tropical Western North Pacific effectively suppressed tropical cyclone formation and subsequent movement frequency in the South China Sea and tropical Western North Pacific, potentially serving as the cause regulating South China Sea tropical cyclone activity frequency variations on interdecadal timescales (Figures 1-2).

(c) Professor Tu also participated in writing the scientific report jointly published by the National Science and Technology Council and the Ministry of Environment - National Climate Change Science Report 2024. Report content URL:

<https://www.nera.gov.tw/upload/cmNormalFile/2024-08-28/ba34cb61-5d7a-4305-b8bc-87e49a9d5fa4/%E5%9C%8B%E5%AE%B6%E6%B0%A3%E5%80%99%E8%AE%8A%E9%81%B7%E7%A7%91%E5%AD%B8%E5%A0%B1%E5%91%8A2024.pdf>

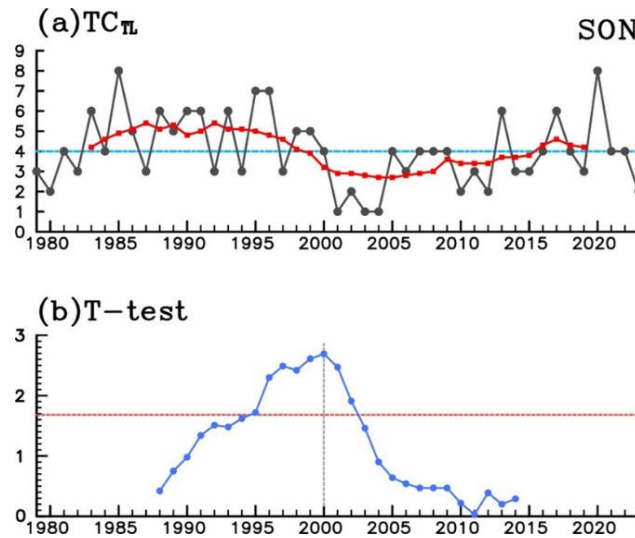


Figure1. (a) Annual and interdecadal (9-year moving average) time series of total tropical cyclones (TC) generated in the South China Sea during autumn from 1979 to 2023. The long-term average of this time series is 4.1 (indicated by horizontal line). (b) t-values of mean difference between two interdecadal periods before and after each year from 1988 to 2014. If a year's t-statistic exceeds 1.68 (marked by horizontal line), the difference between the two interdecadal periods bounded by that year is statistically significant at the 0.05 level

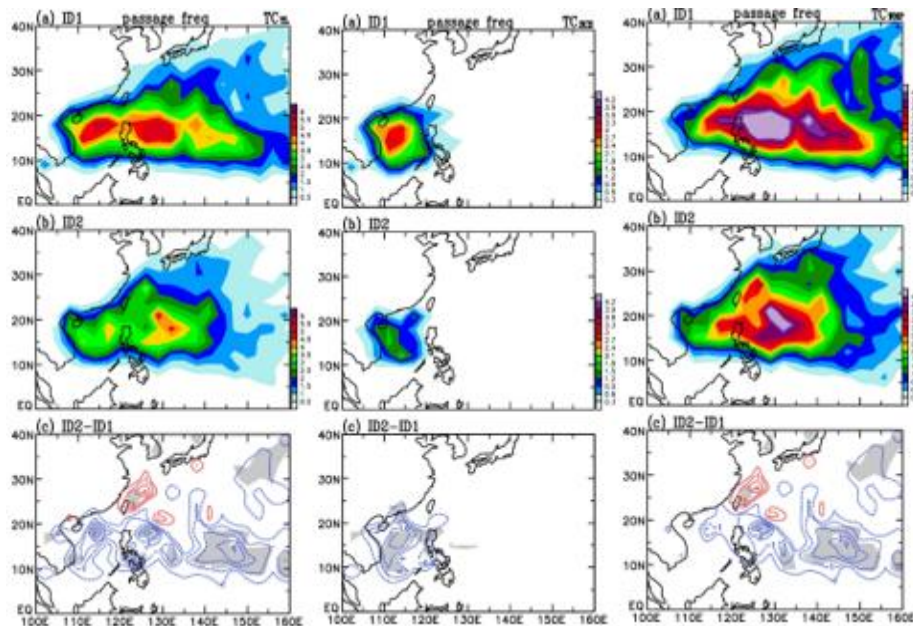


Figure2. Mean values of autumn total tropical cyclone (TC) passage frequency: (a) ID1 (1979-1999), (b) ID2 (2000-2023), and (c) their difference (ID2-ID1). In (c), areas with statistical significance above 0.1 level are shaded. Contour intervals in (a), (b), and (c) are all 0.5. Left panel shows total passage frequency, middle panel shows typhoons generated only in the South China Sea, right panel shows typhoons generated only in the Northwest Pacific

(2) Associate Professor Yi-ching Chen, Department of Geography, NCUE / Changing Changhua

Coastal Landscapes: Artificial Object-Driven Cross-Scale Spatial Development and Social-Ecological System Analysis--Multi-scale Remote Sensing Technology for Observing Changhua Coastal Topographic Changes and Environmental Control Factors (III)

(a) Government Research Information System: <https://www.grb.gov.tw/search/planDetail?id=16727418>

(b) Changhua tidal flat topographic changes serve as an important foundation for studying coastal social-ecological systems, particularly medium- to long-term coastal monitoring. Clarifying the relationships between tidal flat topography and river and coastal geomorphological processes is crucial for understanding the impacts of natural forces, human activities, and climate change. This project utilized multi-scale remote sensing technology to observe Changhua coastal tidal flat topographic changes from 2001-2023, reconstructing medium- to long-term topographic changes using satellite imagery and combining UAV photogrammetry technology to produce high-resolution orthoimages and digital terrain models for observing micro-topographic changes in tidal flats and their relationships with artificial structures. The second-year research proposed an innovative MNDWI+LGM method that can produce more detailed tidal flat topography than traditional shoreline methods. Analysis results show that Changhua tidal flat coasts exhibit distinct seasonal variations: overall erosion occurs during the winter half-year, while deposition occurs during the summer half-year. The movement pattern of north-south barrier islands outside the tidal flats involves north-south accretion and inland migration, with particularly evident siltation phenomena from 2019-2023, including overall topographic elevation accumulation of approximately +0.6 meters in both barrier islands and inner lowlands.

Sediment discharge analysis indicates that Zhuoshui River sediment transport did not decrease due to the Chi-Chi Weir from 1987-2023; instead, it increased following the 1999 Chi-Chi earthquake, but showed no significant relationship with Changhua coastal topographic changes. In contrast, annual variations in Dadu River sediment discharge were more closely related to Changhua tidal flat topography, indicating that coastal littoral drift in Changhua tidal flats primarily originates from the northern Dadu River. Grain size analysis showed that the 2023 typhoon events caused a reduction in average sand grain size in tidal flats, particularly evident north of the Fangyuan crab trails. UAV photogrammetry produced centimeter-level orthoimages and digital elevation models, revealing that topography north of the crab trails was approximately 5-10 cm higher than the south side, confirming the influence of artificial structures on tidal flat micro-topography. The results of this sub-project are integrated with the main project "The Changing Coastal Landscape in Changhua: Objects Driving Cross-scale Spatial Development and Social Ecological System Analysis" to assess the impacts of artificial objects and climate change on Changhua's social-ecological (Figures3-4).

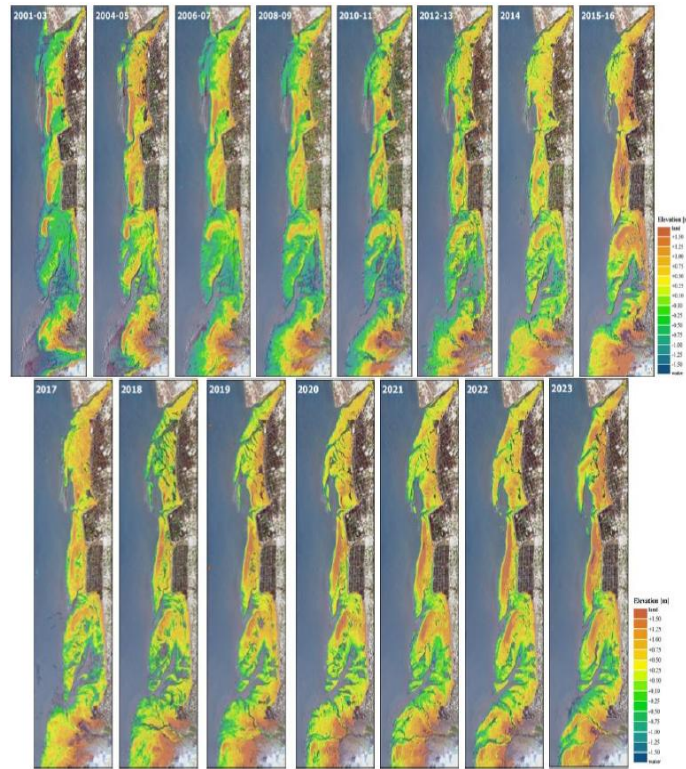


Figure 3. Construction of Changhua Coastal Tidal Flat Topographic Changes from 2001-2023

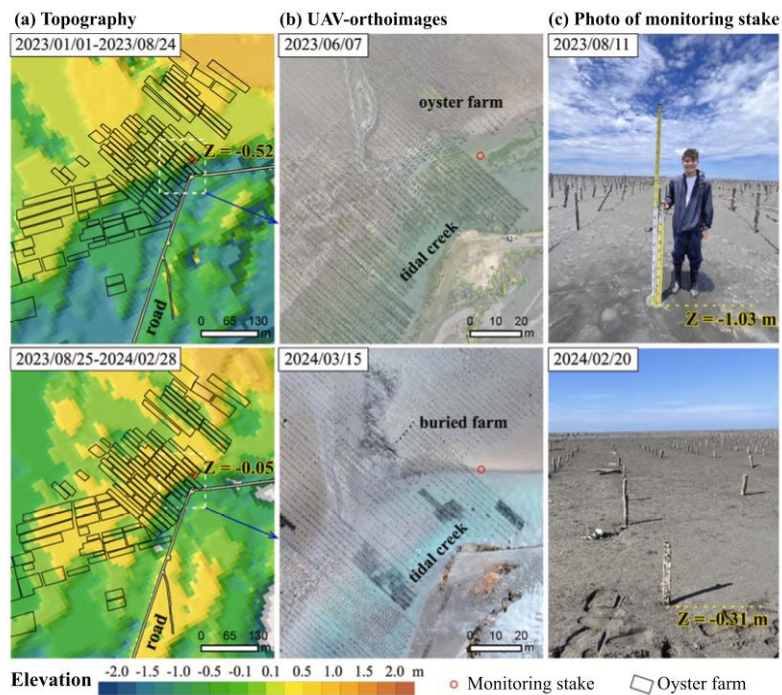


Figure 4. Impact of Hanbo Tidal Flat Topographic Changes on Oysters

(3) Professor Su-fen Wang, Department of Geography, NCUE / Taiwan Western Coastal Wetland Agricultural and Fisheries Social-Ecological System Monitoring

(a) Government Research Information System:

- i. <https://www.grb.gov.tw/search/planDetail?id=15634481>
 - ii. <https://www.grb.gov.tw/search/planDetail?id=17132541>
- (b) The project aims to establish long-term ecological observation core data for the semi-agricultural and semi-fisheries social-ecological system in Taiwan's southwestern coastal areas, selecting Fangyuan as the observation core to establish locally-based demonstration observation research, providing baseline data for long-term social-ecological system changes and understanding the impacts of related green energy policies on coastal social-ecological systems. Through the Press-Pulse Dynamics (PPD) framework to identify key monitoring indicator items, the long-term social-ecological changes and human-environment interactions can be understood.
- (c) Establishment of Long-term Social-ecological Core Observation Changhua Station
- The observation station conducts water quality, ecological, and topo graphic surveys at Fangyuan Wetland, Hanbao Wetland, and Wanggong Wetland. The complete annual survey was completed in 2024, with continuous monitoring planned for the future. In-depth interviews with key local stakeholders constitute an important component of social and cultural data in the observation station's social surveys, helping to expand the platform's local social networks. Information regarding different roles, functions, and stakeholder relationships, as well as their experiences and observations of local social and ecological complex changes, is systematically organized and collected, forming an important social-ecological data foundation for the LTSEER platform. The observation station designs questionnaires through in-depth interviews and local literature to further understand local residents' perceptions of environmental and green energy issues. Station personnel also actively participate in local activities to identify related issues and attempt to collaborate with localities, expecting that long-term observation data can simultaneously respond to local needs. Activity photos are shown in Figures 5-6. Long-term Social-ecological Core Observation Changhua Station webpage: <https://www.ltsertwchanghua.org/about/background-and-purposes>



Figure 5: Changhua Coastal Wetland Conservation Wetland Seminar



Figure 6: Hanbao Wetland Topographic Monitoring

(4) "Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project"

In response to the ecological crisis of global warming, NCUE proposed the Department of Fine Arts USR project "Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project" in 2023-2024, focusing on "local care" as the main theme to achieve the UN SDGs "13 Climate Action" goal.

- (a) Starting from the university, connecting university, middle school, and elementary school teaching venues, collaborating with Changhua Industrial High School's interdisciplinary teacher community "Four Seasons Elegance: Dialogue between Herbal Tea and Solar Terms," Changhua Arts High School's "My Home Also Has a Small Forest - Horticultural Therapy Workshop," and assisting Nanguo Elementary School in organizing "Campus Green Survey" ecological teaching through cross-school curriculum co-preparation.
- (b) Planning 4 ecological lectures on "Grey-faced Buzzard and Purple Crow Butterfly Ecology" (Figure 7) and 2 hands-on experience sessions of "Grey-faced Buzzard Ecological Observation: Wool Felt Workshop" (Figure 8), establishing cross-school exchange with Providence University USR in central Taiwan and building the foundation for "ecological geography."
- (c) Promoting "Street Green Survey" in the Department of Fine Arts' 2024 spring semester "Curatorial Theory and Practice" course, helping students understand the formation of urban heat island effects and further developing it into an ecological art exhibition.



Figure 7. Ecological Lecture - Purple Crow Butterfly Introduction



Figure 8. Grey-faced Buzzard Ecological Observation: Wool Felt Series Workshop - Three-dimensional Wool Felt Creation

(5) The "Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change" project

Building upon the achievements of 2023, the project focuses on assisting local governments and aquaculture industries in the Fangyuan and Dacheng areas to respond to climate change risks and promote sustainable development of industries and the environment. The team has deepened collaboration with local communities, farmers, and local associations through regular communication and consensus workshops, enabling residents and youth to jointly discuss industrial adaptation strategies and gradually build consensus on local sustainable development. The project incorporates SDG 13 and SDG 14 indicators into quantitative tracking, with strengthened investigation of potential pollution sources at water quality monitoring sites. In terms of education, course content has been expanded and youth participation in community member internships has been encouraged, with both participation numbers and knowledge enhancement effectiveness showing significant improvement compared to the previous year. Multiple community achievement sharing sessions have been organized to present water quality monitoring, industrial adaptation recommendations, and ecological education promotion effectiveness, enhancing community participation and sustainability awareness. Based on these achievements, the team plans to continue expanding community participation this year and introduce more quantitative indicators and youth empowerment programs to promote win-win development of industries and ecology in Changhua's coastal areas.

Project Activity Facebook Fan Page Link:

https://www.facebook.com/NCUEUSR/photos/?tab=album&ref=page_internal

3. Taiwan is located at the boundary of the 'Eurasian Plate' and the 'Philippine Sea Plate', so earthquakes are very frequent. According to data of the Seismological Center, Central Weather Administration, from 1991 to 2015, about 3,000 earthquakes occurred in Taiwan every month on

average, and 102 major earthquake-related disasters occurred from 1901 to 2016. Although an accurate earthquake prediction technology is not available yet, increasing seismic observation data are rather helpful in improving the efficiency of disaster relief and reducing the loss of life and property during earthquakes. In cooperation with the Central Weather Administration, NCUE has installed strong motion observation apparatuses in the two campuses and in residential areas as well as the Baisha Weather station.

(1) Below are some more details about the seismic observation apparatuses (Figure 9-11).



Figure 9. Strong motion observation station in Jinde Campus The observation station houses the strong motion observation apparatus. The time, location, and size of an earthquake can be calculated when many stations are connected to form a seismograph network



Figure 10. Crustal deformation observation station in Baoshan Campus. The station continuously receives signals emitted from the global satellite positioning system, and with the received signals at the same time by other stations, it can accurately calculate the station's location relative to other stations. Long-term observation data could reflect significant surface displacement due to major earthquakes. Also, the data on small crustal deformation occurs during earthquakes are very helpful in understanding crustal movement and earthquake potential



Figure 11. Underground seismograph observation station in residential areas. The seismograph installed at a depth of 300 meters in the well can significantly reduce the interference from surface noise and obtain high quality ground motion signals, improving the accuracy of seismic locating and the ability to monitor regional small-scale earthquakes

(2) The Central Weather Administration works with academic institutions in Taiwan by installing weather facilities for teaching purposes. They can be used as practice areas by students. The automatic meteorological observation station run by NCUE's Department of Geography is one of such facilities. It is also the only station in central Taiwan under the partnership. The automatic meteorological station was built on the attic of the Geography Department Building. It was commissioned in November 1997 and has run for 27 years by 2024(Figure 12). The meteorological instruments and peripheral devices are used for real-time observation, and meteorological data are synchronized with the Southern Region Weather Center of the Central Weather Administration. The real-time data are useful for disaster prevention units. The features of the observation station are shown in the photo below. In addition, sufficiently long observation time also means that the station could help people better understand the regional climate characteristics and changes and researchers conduct relevant studies.

Related website: https://geo.ncue.edu.tw/res_02.php



Figure 12. NCUE's Baisha Weather Station

SDG 13.3.5 Environmental education collaborate with NGO

NCUE actively collaborates with multiple non-governmental organizations to promote environmental education and climate adaptation-related projects, covering ecological art promotion, fisheries and wetland sustainability, climate resilience governance, and invasive species control. Between 2023-2025, a total of 5 collaborative projects are ongoing (as shown in Table 1), not only promoting environmental sustainable development in communities and industries but also strengthening local adaptation capacity under climate change.

Table 1. NCUE's 2024 Collaborative Project List

No.	Programme
1	Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project
2	Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change
3	Changhua Coastal Clam Habitat Survey and Conservation Education Promotion Project
4	Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition -- Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition
5	Taoyuan International Airport Corporation Project / Commissioned Planning and Design for Invasive Red Fire Ant Control Operations

1. Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project

In response to the ecological crisis of global warming, NCUE proposed the Department of Fine Arts USR project "Ecological Homelands and Urban-Rural Sustainability: A Changhua Ecological Art Project" in 2023-2024, focusing on "local care" as the main theme to achieve the United Nations Sustainable Development SDGs "13 Climate Action" goal, organizing related **free** activities as shown in Table 2.

Table 2. **Free** Activities and Participation in 2024

No.	Activity	Number of Participants
1	Horticultural Therapy/Green Healing: Horticultural Therapy Active Aging Workshop	31
2	Horticultural Therapy/Green Seeds: Horticultural Therapy Workshop	38
3	Green Spirit - Memory of Wind: Wind Chime Handcraft Active Aging Workshop	22
4	Green Spirit - Natural Imprints: Leaf Printing Life Workshop - Active Aging Session	20

5	Green Spirit - Natural Imprints: Leaf Printing Life Workshop - Yi-Kang Care Association Session	43
6	Green Spirit - Plant-Inspired Mirror: Five Senses Self-Portrait Active Aging Workshop	25
7	Green Healing: Horticultural Therapy Active Aging Workshop	26
8	Four Seasons Elegance: Herbal Tea and Solar Terms Dialogue - Horticultural Therapy Workshop	20
9	My Home Also Has a Small Forest - Horticultural Therapy Workshop	26
10	Green Healing: Horticultural Therapy Active Aging Workshop - Active Aging Session	23
11	"Polar Green Ark" Ecological Art Exhibition	300

(1) Collaboration with O-Bank Education Foundation to organize the "Arctic Green Ark" Ecological Art Exhibition.

(a) On August 23, 2024, an opening event and guided tour were held, with ecological art experts and scholars invited to participate in an ecological-themed symposium.

(b) During the exhibition period, two ecological-themed horticultural therapy workshops were organized. One was conducted at Koo Foundation Sun Yat-Sen Cancer Center, inviting medical staff and patients to participate, and the other was an elementary school ecological education horticultural therapy workshop, inviting students from Neihs Elementary School to participate in hands-on experiences. During the exhibition period, ecological guided tours and online ecological-themed psychological testing games were conducted, providing more participants with understanding of how greening can cool temperatures and reduce carbon emissions, serving as the best solution to urban heat island effects.

(c) The exhibition period lasted over one month, from August 19 to September 27, 2024. More than 300 visitors attended. (Figures 1-2)

(d) Related news links:

<https://www.o-bankef.org/events/1142>

<https://artemperor.tw/tidbits/16892>



Figure 1. Group Photo from the Horticultural Therapy Workshop Results with Koo Foundation Sun Yat-Sen Cancer Center



Figure 2. Group Photo of Artists, Distinguished Guests, and Audience at the Opening

(2) Collaborating with Changhua Active Aging Center on "Horticultural Therapy/Green Healing: Horticultural Therapy Active Aging Workshop" with 31 participants (Figures 3-4). Additionally, 4 Green Spirit series workshops were organized (jointly held in collaboration with Changhua Active Aging Center, Changhua Christian Hospital, Changhua County Yi-Kang Care Association, David Lan Presbyterian Church, and YMCA Mayu Garden), with a total of 110 participants (Figures 5-6). Project Activity links: <https://www.youtube.com/@USR-p7m>



Figure 3. Students Instructing Participants



Figure 4. Group Photo of Teams with Participants



Figure 5. Participants happily sharing



Figure 6. Group photo of participants with their works

2. Beautiful and Treasured Clams in Fangyuan and Dacheng: Sustainable Industry and Environment Project of Changhua's Two Cities Amid Climate Change: This year's USR project continues from 2023 initiatives, actively promoting environmental education activities, including introducing ecological and environmental protection concepts, air pollution awareness, beach cleaning, and wetland conservation actions. Simultaneously, the project collaborates with non-governmental organizations on climate adaptation aspects, promoting energy conservation and carbon reduction, green energy applications, product packaging and marketing research and practical experiences to assist in addressing local environmental protection and aquaculture industry development issues, enhancing local community resilience and sustainable development capacity under climate change.
 - (1) The project collaborates with the Changhua Aquaculture Association, focusing on aquaculture industry adaptation strategies under climate change. In addition to assisting and investigating association-affiliated fishponds, coastal water intake channels, and groundwater wells, based on stakeholder feedback from the USR project, service scope has been expanded to include assistance for golden corbicula operators and additional survey area investigations. Investigation areas cover the upper, middle, and lower reaches of rivers serving as water sources for fishponds, conducting maintenance and safety testing of water resources for aquaculture operators and coastal areas. All services are provided **free** of charge. Related activity records are shown in Figures 7-8.



Figure 7: Conducting field investigation activities



Figure 8. March 2024 - Water Quality Investigation Team: The 2024 Department of Biology USR project implementation, investigating water quality in the upper, middle, and lower reaches of rivers

(2) Sustainable Development and Practices of Coastal Biological Resources: The course includes workshops on "The Application of Beneficial Bacteria in Aquaculture" and "Aquaculture and Greenhouse Gases" courses. Combined with the USR (University Social Responsibility) project, students are led into local friendly aquaculture sites for hands-on bacterial identification and water quality monitoring. Clam farming is a friendly aquaculture business that can absorb carbon dioxide to reduce greenhouse gases and lower carbon emissions. Ecosystem polyculture methods reduce feed, conserve water, and minimize waste; combined with smart aquaculture and cloud-based AI big data analysis, risks are reduced while quality and production are enhanced. Students not only learn professional biotechnology but also collaborate with clam farmers and local community associations to assist in promoting healthy, low-pollution aquaculture methods. The course emphasizes "knowledge localization" and "sustainable practice," allowing academic energy to benefit communities, promoting industrial upgrading and environmental protection, demonstrating universities and localities jointly promoting friendly ecology. Related activity photos are shown in Figure 9. Project activity Facebook page link: https://www.facebook.com/NCUEUSR/photos/?tab=album&ref=page_internal



Figure 9. April 2024 - Sustainable Development and Practices of Coastal Biological Resources, with participants including course faculty, students, and local aquaculture operators and residents, jointly learning techniques for detecting marine bacteria and beneficial bacteria cultivation methods, promoting low-pollution, low-carbon friendly aquaculture models.

3. Changhua Coastal Clam Habitat Survey and Conservation Education Promotion Project

- (1) NCUE promotes the "Changhua Coastal Clam Habitat Survey and Conservation Education Promotion Project," implementing a series of marine citizen scientist courses at Xinbao Wetland and Wanggong Fishing Port through industry-academia cooperation, including "Volunteer Investigator Training," "Seed Teacher Training," and "Clam Detective Squad" activities. Course content covers water quality testing, biodiversity surveys, bivalve classification, and coastal tourism and conservation education promotion, integrating with Caohu Junior High School, Hanbao Elementary School, and Lukang Elementary School to closely combine scientific investigation with local education, enhancing environmental protection awareness among teachers, students, and communities.
- (2) The same project also emphasizes practical operations in ecological restoration and climate adaptation. Through "Clam Habitat Surveys" (conducted once each in winter, spring, summer, and autumn, including sediment improvement experiments), it was discovered that sediment improvement can effectively promote the growth of indicator species such as venus clams and Asian hard clams, suppress the dominance of Chinese venus, and enhance carbon sequestration potential and benthic biodiversity. (Figure 10)
- (3) Through extensive participation of citizen scientists, not only has the volume of survey data significantly increased, but community conservation awareness has also been effectively enhanced, forming a demonstration cooperation model that combines scientific research, educational promotion, and climate adaptation.
- (4) Project activity Facebook page link: https://www.facebook.com/NCUEUSR/photos/?tab=album&ref=page_internal



Figure 10. Winter joint sampling and investigation of clam habitats by NCUE team and Changhua Marine Food Research Center

4. Climate Resilience Development and Disaster Prevention Adaptation Governance: A Participatory Approach with Just Transition Project

(1) This research promotes just transition strategies under climate resilience through a participatory approach, aiming to strengthen disaster adaptation governance. In spring 2025, the "Climate Action Actors" workshop was held in Huwei Township, Yunlin County, introducing image analysis technology to explore urban development, industrial transformation, and heat risks, consolidating action directions. The research team established a comprehensive awareness system and completed spatiotemporal analysis of heat risks in Yunlin, Changhua, and Taichung, laying the data foundation for local climate justice; conducted comparative analysis of just transition literature and policies, discovering Taiwan's unique characteristics. Regarding offshore wind power issues, pointing out that current compensation mechanisms fail to implement fair participation, the research team combined routine collaboration with international exchange, establishing cooperation with Dartmouth College in the United States to promote long-term research on renewable energy issues. Research results are expected to develop methodologies for incorporating justice principles in climate decision-making and propose fair disaster prevention and adaptation policy recommendations. (Figures 11-12)

(2) Related websites:

- (a) <https://justtransition.wordpress.com/team/>
- (b) <https://justtransition.wordpress.com/abstract/>
- (c) <https://eyesonplace.net/2025/03/31/27656/>



Figure 11. Wind and Solar Power Survey on Fangyuan Coastline

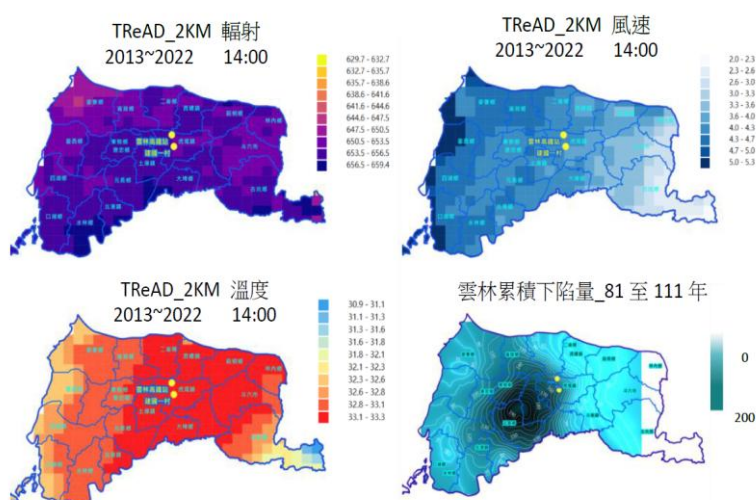


Figure 12. Yunlin County Radiation Map (upper left), Temperature Map (lower left), Wind Speed Map (upper right), Land Subsidence Map (lower right)

5. Taoyuan International Airport Corporation Project / Commissioned Planning and Design for Invasive Red Fire Ant Control Operations (Figure 13).



Figure 13. NCUE and Taoyuan International Airport Fire Ant Control Team using fire ant detection

dogs to assist in searching for invasive red fire ants at Taoyuan Airport

In summary, through collaboration with diverse non-governmental organizations, NCUE has demonstrated cross-sector integration and substantial effectiveness in environmental education and climate adaptation fields. We not only deepen local community participation in climate action but also establish a sustainable development model that combines educational promotion, scientific research, and practical application through data monitoring, friendly industry promotion, and international collaboration, effectively strengthening societal resilience in facing climate change.

SDG 13.4.1 Commitment to carbon neutral university

1. NCUE's commitment to becoming a carbon neutral university is outlined as follows: National Changhua University of Education adheres to the Greenhouse Gas Protocol, implements management of various carbon emissions, and continuously promotes energy conservation and carbon reduction measures along with related curricula. The university is committed to achieving the concrete goal of carbon neutrality by 2045, with the aim of transforming our institution into a sustainable campus where faculty and students are equipped with the concepts and capacity for action in sustainable development, thereby becoming important advocates for Taiwan's sustainable development in the future. The Carbon Neutrality Declaration of NCUE is as shown in Figure 1.

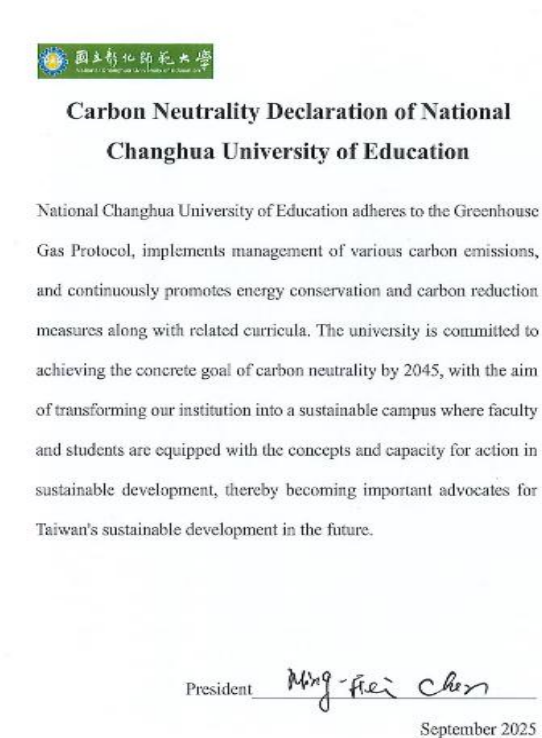


Figure 1. Carbon Neutrality Declaration of NCUE

2. NCUE has formulated the "Key implementation points for promoting energy saving and carbon reduction of National Changhua University of Education" that aims to implement management measures for electricity conservation, lighting energy conservation, air conditioning energy conservation, water conservation, and environmental education. The annual budget allocated for the replacement of high-energy-consuming equipment amounts to at least more than NTD\$5 million, with an expected annual target of achieving at least 1% improvement in total energy efficiency. It is estimated that by 2029, existing equipment will reduce total annual power consumption by at least 1.3 million kWh compared to 2022, progressively reducing carbon emissions. Please refer to Annex 13.4.1A Key implementation points for promoting energy saving and carbon reduction of National Changhua University of Education.

3. Additionally, NCUE has extensively installed solar power generation devices at Jinde and Baoshan campuses. Table 1 presents NCUE's 2021-2030 Total Planned New Solar Power Installation Capacity.

(1) Before 2020: Fundamental and Initial Stage

NCUE's Jinde Campus completed the installation of a 467 kWp solar power generation system, with peak generation accounting for approximately 15.57% of campus electricity consumption. Baoshan Campus had not yet installed solar power equipment, with a low-carbon energy usage ratio of 0%.

(2) 2021-2022: Major Expansion Stage

Jinde Campus solar power installation capacity expanded to 2558.375 kWp, with peak generation nearly equivalent to campus peak electricity consumption, achieving a low-carbon energy ratio of over 98%. Baoshan Campus newly installed a 571.5 kWp solar power system, raising the low-carbon energy ratio to 63.5%. Simultaneously, NCUE signed the Carbon Neutrality Declaration, clearly committing to achieving carbon neutrality by 2045.

(3) Around 2030: Comprehensive Renewable Energy Application Stage

The solar power installation capacity at Jinde and Baoshan campuses will expand to 4097.875 kWp, with annual power generation exceeding 5,115,308 kWh (18,415 GJ). By then, peak electricity consumption at both campuses can be completely supplied by solar power, with the low-carbon energy ratio exceeding 100%, achieving peak electricity carbon neutrality.

Table 1. NCUE's 2021-2030 Total Planned New Solar Power Installation Capacity

Campus	Year	Solar Energy Generated during Peak Hours (kW)	Power Consumption during Peak Hours (kW)	Proportion of Solar Power to Power Consumption
Jinde	Before 2020	467	3000	15.57%
	2021-2022	2558.375	2600	98.18%
	2026~2030	2788.375	2200	>100%
Baoshan	Before 2020	0	1000	0%
	2021-2022	571.5	900	63.5%
	2026~2030	1309.5	785	>100%

4. Energy Storage and Low-Carbon Technology Applications

NCUE's Baoshan Campus has installed a 1 MW/1.26 MWh energy storage system, with two additional 100 kW/50 kWh energy storage units in operation. This energy storage system achieves load shifting by storing energy during off-peak nighttime hours and releasing it during daytime peak periods, reducing the output of coal-fired power plants during peak hours while lowering maximum line currents and reducing power transmission losses by approximately 3%. Additionally, campus contract capacity has been further reduced from 835 kW to 785 kW, decreasing external power

purchases and continuously enhancing energy conservation and carbon reduction benefits.

5. In alignment with global net-zero greenhouse gas emission policies, NCUE assists industries in low-carbon transition by providing greenhouse gas inventory and reduction services to businesses. In 2024, NCUE executed 16 projects with a total budget of NTD\$3,380,000, involving 13 faculty members, as shown in Table 2, demonstrating NCUE's role in social responsibility and net-zero promotion.

Table 2. 2024 Carbon Inventory Project Statistics

Number of Faculty Involved	Number of Projects	Project Budget (NTD)
13	16	3,380,000

6. With the ultimate goal of achieving full carbon neutrality by 2045, NCUE progressively develops a sustainable campus model through energy conservation, renewable energy, energy storage, and industry-academia collaboration actions, continuing to contribute to Taiwan's sustainable development.

SDG 13.4.2 Achieve by date

1. NCUE expects to achieve the concrete goal of carbon neutrality by 2045, and establishes a sustainable campus. NCUE's low-carbon energy and carbon neutrality implementation plan is shown in Table 1, while Table 2 presents NCUE's 2021-2030 Total Planned New Solar Power Installation Capacity.

Table 1. NCUE's Low-Carbon Energy and Carbon Neutrality Implementation Plan

Time Period	Major Completed Measures	Indicators and Expected Results
Before 2020	Initial solar power system installation	Jinde Campus installed 467 kW solar power system, with 15.57% of peak electricity consumption supplied by low-carbon energy
2021-2022	Major solar power system expansion	1. Total capacity of 3129.875 kWp at both campuses 2. 98.18% of Jinde Campus peak electricity consumption supplied by low-carbon energy 3. 63.5% of Baoshan Campus peak electricity consumption supplied by low-carbon energy
2024	Net Zero Energy House demonstration site completion	1. Single building 100% renewable energy 2. Significant increase in low-carbon energy ratio at both campuses (1) 100% of Jinde Campus peak electricity consumption supplied by low-carbon energy (2) 72.8% of Baoshan Campus peak electricity consumption supplied by low-carbon energy
2026-2030	Solar power system expansion planning	Total capacity 4097.875 kWp, low-carbon energy ratio during peak hours >100% at both Jinde and Baoshan campuses
2029	Energy conservation targets achieved	Cumulative savings of at least 1.3 million kWh by 2029 compared to 2022 total annual electricity consumption
2030	Solar power installation completion	Annual power generation exceeding 5,115,308 kWh (18,415 GJ)
Before 2045	Campus-wide carbon neutrality achieved	Achieve preliminary carbon neutrality goal

Table 2. NCUE's 2021-2030 Total Planned New Solar Power Installation Capacity

Campus	Year	Solar Power Energy Generated during Peak Hours (kW)	Power Consumption during Peak Hours (kW)	Proportion of Solar Power to Power Consumption
Jinde	Before 2020	467	3000	15.57%

Campus	Year	Solar Power Energy Generated during Peak Hours (kW)	Power Consumption during Peak Hours (kW)	Proportion of Solar Power to Power Consumption
	2021-2022	2558.375	2600	98.18%
	2026~2030	2788.375	2200	>100%
Baoshan	Before 2020	0	1000	0%
	2021-2022	571.5	900	63.5%
	2026~2030	1309.5	785	>100%

2. Completed Before 2020 (Solar Power Generation Initial Stage)

- (1) Jinde Campus installed a 467 kWp solar power generation system with peak generation of 467 kW, with low-carbon energy accounting for approximately 15.57% of the campus peak electricity consumption of 3,000 kW.
- (2) Baoshan Campus had not yet installed solar power systems, with peak electricity consumption of 1,000 kW and a low-carbon energy ratio of 0%.

3. Completed in 2021-2022 (Major Solar System Expansion)

- (1) Jinde Campus: Solar power installation capacity expanded to 2,558.375 kWp, with solar peak generation increasing to 2,558.375 kW. Peak electricity consumption was reduced to 2,600 kW, achieving a low-carbon energy ratio of 98.18%.
- (2) Baoshan Campus: Newly installed 571.5 kWp solar power system, with solar peak generation increasing to 571.5 kW and peak electricity consumption reduced to 900 kW, achieving a low-carbon energy ratio of 63.5%.

4. Completed in 2024

(1) Enhanced Energy Conservation Performance

- (a) Jinde Campus: Solar power peak generation maintained at 2,558.375 kW, with peak electricity consumption further reduced to 2,200 kW, achieving a low-carbon energy ratio exceeding 100%.
- (b) Baoshan Campus: Solar power peak generation maintained at 571.5 kW, with peak electricity consumption reduced to 785 kW, raising the low-carbon energy ratio to 72.8%.

(2) Carbon Emission Reduction Benefits

- (a) Jinde and Baoshan campuses currently have installed 2,558.375 kWp and 571.5 kWp of photovoltaic systems respectively. Based on the average daily sunlight duration of 3.5 hours in the Changhua region of Taiwan, the total power generation amounts to 3,998,415 kWh $[(2,558.375+571.5) \times 365 \times 3.5 = 3,998,415 \text{ kWh}]$. According to the Ministry of Economic Affairs' published 2024 carbon emission factor for electricity of 0.474 kg CO₂/kWh, this represents approximately $3,998,415 \times 0.474 = 1,895,249$ kg of carbon emission reduction.
- (b) Combined with NCUE's 1,410 kWh energy storage system, excess solar power generation can be completely stored and renewable energy can be transferred for nighttime use.

Therefore, NCUE can not only achieve carbon neutrality during daytime using renewable energy but also increase nighttime carbon neutrality through large-scale energy storage systems, enhancing renewable energy utilization rates and carbon neutrality ratios.

(3) Net Zero Energy House Demonstration Site Construction

NCUE completed the construction of the Net Zero Energy House demonstration site in early 2024 (Figure 1). This building consists of rooftop photovoltaic systems, small wind turbines, and indoor energy storage systems, enabling a single building to achieve 100% renewable energy. This demonstration site promotes the policy goal of net-zero carbon emissions.



Figure 1. Net Zero Energy House Demonstration Site

5. 2026-2030 Planning

(1) Solar Power Generation Capacity Expansion

By the end of 2030, NCUE expects to progressively expand to 4097.875 kWp of installed solar photovoltaic system capacity (Jinde Campus will reach 2788.375 kWp, and Baoshan Campus will reach 1309.5 kWp), with annual power generation exceeding 5,115,308 kWh (18,415 GJ).

(2) Achieving Carbon Neutrality During Peak Hours

(a) Jinde Campus: Solar power installation capacity will expand to 2788.375 kWp, maintaining peak electricity consumption at 2,200 kW, with low-carbon energy ratio continuously exceeding 100%.

(b) Baoshan Campus: Solar power installation capacity will significantly expand to 1,309.5 kWp, maintaining peak electricity consumption at 785 kW, with low-carbon energy ratio exceeding 100%.

6. Energy Conservation and Carbon Reduction Advancement

Continuing the excellent achievements of saving nearly 18% of electricity consumption over the past 15 years, NCUE plans to continue investing more than NTD\$5 million annually over the next decade, with a goal of reducing total electricity consumption of existing facilities by 1% each year (saving more than 150,000 kWh of energy annually). It is expected that by 2029, existing equipment will reduce total annual power consumption by at least 1.3 million kWh compared to 2022.

7. Achieving Campus-wide Carbon Neutrality by 2045

- (1) Through the integration of photovoltaic expansion, energy-saving measures, and energy storage management, NCUE will progressively increase the proportion of renewable energy in total campus electricity consumption, expecting to achieve preliminary carbon neutrality by 2045 and establish a sustainable campus energy structure.
- (2) Building upon the 2045 carbon neutrality foundation, NCUE will continue to deepen renewable energy applications, intelligent energy management, and equipment upgrades, advancing toward comprehensive net-zero emissions by 2050, aligning with global sustainable development goals.