SDG13

The amount of low-carbon energy used by NCUE in 2020 is 579,960 KWH = 2087.84 GJ, and all the low-carbon energy used was from solar energy.

The total electricity consumption of Jin-De Campus in 2020 was 10,035,600 kWh and of Bao-Shan Campus in 2020 was 3,505,700 kWh. Total electricity consumption for the two campuses in 2020 was 13,541,300 kWh = 48,748.29 GJ

Definition: Total energy used in 2020 is measured in gigajoule (GJ).

Total energy used in 2020 in gigajoule (GJ)

Total energy used from low-carbon resources

Total energy used from low-carbon sources

1. NCUE's Jin-De Campus has installed a solar photovoltaic power generation system with a total power generation of 579,960 kWh in 2020, and a cumulative total power generation of 2,046,300 kWh = 7366.6 GJ by 2020.

2. It is estimated that in 2021-2022, Jin-De Campus will add 2,360,626 kWh (8,498.25 GJ) of electricity generation from solar energy annually, and Bao-Shan Campus will add 914,063 kWh (3,290.63 GJ).

3. According to the current plan, in 2023–2024, Jin-De Campus will add 1,203,600 kWh (4,332.96 GJ) of electricity generation from solar energy annually, and Bao-Shan Campus will add 2,036,775 kWh (7,332.39 GJ).

4. It is expected that NCUE's total solar power generation will reach 7,095,024 kWh (25,542.09 GJ) by 2024, which is more than 50% of its total electricity consumption in 2020.

The following is the master planning table of NCUE's additional solar power capacity from 2021 to 2024.

Campus	Year	Additional capacity (kWp)	Cumulative installed capacity (kWp)	Cumulative annual electricity generation (kWh)
Jin-De Campus	Before 2020	467	467	579,960
	2021–2022	1888.5	2355.5	2,940,586

Campus				
	2022–2024	962.88	**3,318.38**	**4,144,186**
Bao-Shan Campus	Before 2020	0	0	0
	2021–2022	731.25	731.25	914,063
	2022–2024	1629	**2360.25**	**2,950,838**

The following is the breakdown of additional solar power capacity by NCUE building from 2021 to 2022:

Campus	Building name	Estimated capacity of the installation (kWp)	Total.	Estimated electricity generation (kWh/year)	Total.
Jin-De Campus	Qiao Si Building	157.5	1888.5 kWp	196,875	2,360,626 kWh
	Hong Dao Building	118.125		147,656	
	Bai Sha Building	251.25		314,063	
	Zhi Shan Building	48		60,000	
	Ming De Building	64.125		80,156	
	Teaching Building	96.375		120,469	
	Eighth Dorm	199.5		249,375	
	Seventh Dorm	181.5		226,875	
	Sixth Dorm	88.5		110,625	
	Hu Bin Building	123		153,750	
	Library	133.5		166,875	
	Comprehensive Centre	115.5		144,375	
	Canteen	212.25		265,313	
	Sheng Yang Building	99.375		124,219	

Campus		Location	Capacity	Total	Generation	Total
Bao-Shan Campus		Ninth Dorm	100.5	731.25 kWp	125,625	914,063 kWh
		Tenth Dorm	127.5		159,375	
		First Teaching Building	101.25		126,563	
		Second Teaching Building				
		College of Engineering Building	139.5		174,375	
		Jing Shi Building	114.375		142,969	
		Li Xing Building	148.125		185,156	

The following is the breakdown of additional solar power capacity by NCUE building from 2023 to 2024

Campus	Location of installation	Estimated capacity of the installation (kWp)	Total.	Estimated electricity generation (kWh/year)	Total.
Jin-De Campus	Stands around the stadium	112.2	Provisional estimate 962.88 kWp	140,250	1,203,600 kWh
	Roof of the substation for the stadium				
	Old activity centre	134.3		167,875	
	Wang Jin-pyng Activity Centre	99.96		124,950	
	Wang Jin-pyng	226.1		282,625	

	Swimming Pool				
	East entrance's motorcycle parking lot	98.6		123,250	
	Car parking lot in front of Yi Hui Building	291.72		364,650	
	West entrance's motorcycle parking lot				
	Car parking lot for the Family Quarters				
Bao-Shan Campus	Car parking lot for Yu Cheng Centre	107.1	Provisional estimate: 1,629 kWp	133,875	2,036,775 kWh
	Before the Tenth Dorm	283.56		354,450	
	Behind the Ninth Dorm	134.64		168,300	
	Car parking lot 1, by the side of Bao-Shan Road	116.62		145,775	
	Car parking lot 2, by the side of Bao-Shan Road	109.14		136,425	
	Car parking lot for the Second Teaching	93.84		117,300	

	Building		
	Car parking lot above the Bao-Shan Tennis Court	62.22		77,775
	Back alley of the Sewage Treatment Plant	104.04		130,050
	Motorcycle parking lot behind the Li Xing Building	121.38		151725
	Car parking lot by the side of Bao-Shan Road for the First Teaching Building	91.8		114,750
	Behind the Second Jing Shi Building	55.08		68,850
	Covered playground	340		425,000
	Bao-Shan Sewage Treatment Plant	10		12,500

In 2020, NCUE promoted two programmes as part of the local education

programmes or activities on climate change risk, impact, mitigation, adaptation, impact reduction, and early warning. They are the 'Green Energy in My Home' and 'Engaging Fangyuan and Dacheng: Industrial and Environmental Sustainability for Changhua's Twin Towns' from the 2020 to 2022 programmes. In 2020, three events were held:

Event	Date	Number of participants
Green Energy in My Home	May 2020	151
Home appliance maintenance knowledge and practices	18–19 October 2020	11
Environmental Education Personnel Certification Training - special class for Houliao Elementary School	July 2020	19

1. **In May 2020, 151 people participated in the 'Green Energy in My Home' programme funded by the Environmental Protection Agency. Photos taken during the 'Green Energy in My Home' event in May 2020.**

The web page for Green Energy in My Home:
https://www.facebook.com/media/set/?vanity=NCUEEEC&set=a.732854164118361

2. **Under the Ministry of Education's 'Engaging Fangyuan and Dacheng: Industrial and Environmental Sustainability for Changhua's Twin Towns Programme', the event 'Home Appliance Maintenance Knowledge and Practices' was held on 18–19 October 2020. A total of 11 people took part in the event.**

Photos taken during the event 'Home Appliance Maintenance Knowledge and Practices', 18–19 October 2020:

The web page for the Home Appliance Maintenance Knowledge and Practices event:
https://www.facebook.com/media/set/?vanity=NCUEEEC&set=a.852074075529702

3. **Under the Ministry of Education's 'Engaging Fangyuan and Dacheng: Industrial and Environmental Sustainability for Changhua's Twin Towns**

Programme', the event 'Environmental Education Personnel Certification Training - special class for Houliao Elementary School' was held in July 2020. A total of 19 people took part in the event.

Photos taken during an event of the 'Industrial and Environmental Sustainability for Changhua's Twin Towns Programme':

The web page for the 'Industrial and Environmental Sustainability for Changhua's Twin Towns Programme':
https://www.facebook.com/media/set/?vanity=NCUEEEC&set=a.776743466396097

NCUE's Research Centre for GIS and Disaster Prevention has a project named 'Impacts of Climate Changes on Lowland Ecology and Lowland Ant Problems Due to Community Changes: Discussion and Solutions', supported by the Ministry of Science and Technology. The research team visited lowland villages, such as Liugui and Meinong, and assisted residents to control exotic ant species. The team also examined the relationship between invasive species and habitat spatial changes caused by climate changes. The action guidelines for biological disaster adaptation under climate change could inform the local government's decision-making process.

Climate change and warming caused the overgrowth of honey insects (Planococcus citri), worsening ant problems in lowland areas (above: Technomyrmex albipes and Planococcus citri).

The phenomena of natural landscape fragmentation, ecological loss, and habitat destruction caused by debris avalanches in Taiwan's lowland areas due to extreme rainfall (above: collapsed slope in lowland areas).

Taiwan is located at the boundary of the 'Eurasian Plate' and the 'Philippine Sea Plate'; therefore, earthquakes are very frequent. According to seismic data from the Seismic Information Centre (Central Weather Bureau) from 1991 to 2015, about 3,000 earthquakes occur in Taiwan every month on average, and 102 major earthquake 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 Bureau, NCUE has installed strong motion observation apparatuses on the two campuses and in the Family Quarters as well as the Bai Sha weather station.

1.　Below are some more details about the seismic observation apparatuses.

Above: Strong motion observation station in Jin-De 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.

Above: Crustal deformation observation station in Bao-Shan 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.

Above: Underground seismograph observation station in the Family Quarters. The seismograph installed at a depth of 300 metres 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.

2. The Central Weather Bureau works with academic institutions in Taiwan by installing weather facilities for teaching purposes. They can be used as practicing 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 24 years in 2021. The meteorological instruments and peripheral devices are used for real-time observation, and meteorological data are synchronised with the South District Weather Centre of the Central Weather Bureau. 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 researchers better understand regional climate characteristics and changes and allow them to conduct relevant studies.

Above: NCUE's Bai Sha weather station.

1. In 2020, our faculty members implemented Ministry of Science and Technology projects to provide advice and assistance to local and regional governments on the future planning of agricultural production systems, disaster prevention, and water resource allocation.

No.	Project leader	Project name

| 1 | Professor Lin Chung-Chi | Impacts of Climate Change on Lowland Ecology and Lowland Ant Problems Due to Community Changes: Discussion and Solutions (Annex 13.3.4A-Report of Outcomes) |
| 2 | Professor Tu Jien-Yi | Interannual to Interdecadal Changes in Typhoon Frequency in the Northwest Pacific Ocean (Appendix 13.3.4B-Report of Outcomes) |

Details of the project are provided below:

(1) The Ministry of Science and Technology's project was led by NCUE Professor Lin Chung-Chi. The project title is: 'Impacts of Climate Change on Lowland Ecology and Lowland Ant Problems Due to Community Changes: Discussion and Solutions'. Issues targeted by the project: given natural disasters due to climate change and development stress, lowland areas in Taiwan are ecologically fragile, with issues of landscape fragmentation, ecological barriers, and habitat loss. In recent years, the emerging problem of ant infestation has appeared in the lowland towns of central and southern Taiwan. Ants flood into houses like streams and flying ants invade houses like black fog. Such abnormal ecological phenomena are a warning of the gradual loss of health of Taiwan's ecological system. The project covered multiple areas, delving into the causes behind the ant infestation affecting lowland residents and identifying the issues of landscape fragmentation, ecological loss, and development stress. Within the framework of slope ecosystem services, the research team investigated key biologic facies in the habitats, analysed landscape changes, established relevant indicators, and analysed environmental vulnerability and ecological potential. Given the mechanism of the impact of ant problems on village industries and tourism, a lowland agricultural production system with ecosystem service potential and human welfare benefits was proposed under the context of climate change.

(2) The Ministry of Science and Technology's project was led by NCUE Professor Tu Jien-Yi. The project title is: 'Interannual to Interdecadal Changes in Typhoon

Frequency in the Northwest Pacific Ocean'. Issues addressed by the project: typhoons are the most severe weather phenomenon in tropical waters, and the typhoon climate is one of the most intensively studied subjects in the world. Because Taiwan is located in the northwestern Pacific and the South China Sea, a water area with the most frequent typhoon passage, 3–5 typhoons per year on average impact Taiwan, directly or indirectly. They constitute a major rainfall source for Taiwan; however, strong wind and heavy rain associated with typhoons could also cause life, property, and economic losses. The purpose of the project is to understand the characteristics of typhoons in the water area (including location of typhoon genesis and motion path), the characteristics of long-term changes over the past 50 years, and the impact of the changes on rainfall and water resources in Taiwan. Our results show that the frequency of typhoon passage over the waters near Taiwan (120–130 °E and up to 20 °N) in the early autumn months of September and October has increased since 1998. This result also coincides with the increase of rainfall in Taiwan in September and October. In summary, the research results not only enhance our understanding of the trend of long-term changes in typhoons but are also useful in evaluating the long-term impact of typhoons on regional rainfall. They could also inform the government's future disaster prevention planning and water resource allocation.
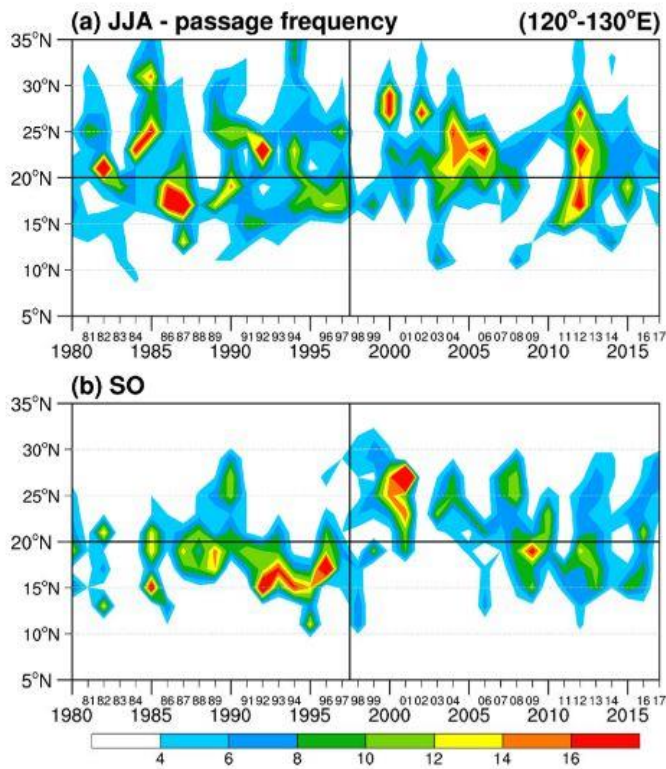
(a) JJA - passage frequency   (120°-130°E)

(b) SO

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823   Figure 1. Latitudinal distributions of TC passage frequency averaged over the 120°-
824   130°E for 1980-2017: (a) June-August (JJA), (b) September-October (SO).
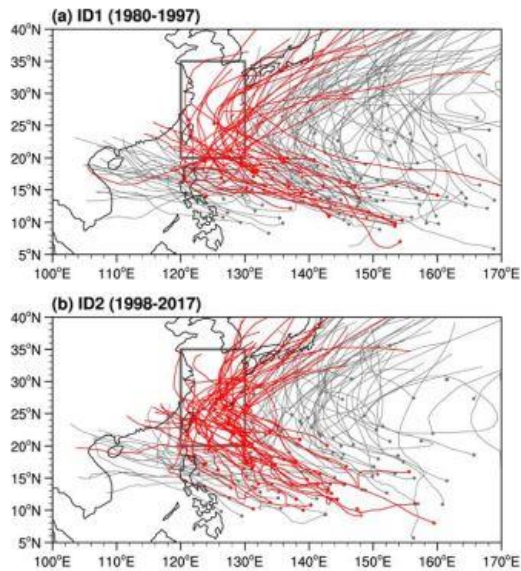825
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(a) ID1 (1980-1997)

(b) ID2 (1998-2017)

844   Figure 2. Tracks of all TCs during SO in (a) interdecadal period 1 (ID1; 1980-1997) and
845   (b) interdecadal period 2 (ID2; 1998-2017). The northwestern North Pacific
846   domain (120°-130°E, 20°-35°N) used for analyses of TC passage frequency is
847   indicated by a rectangular box.

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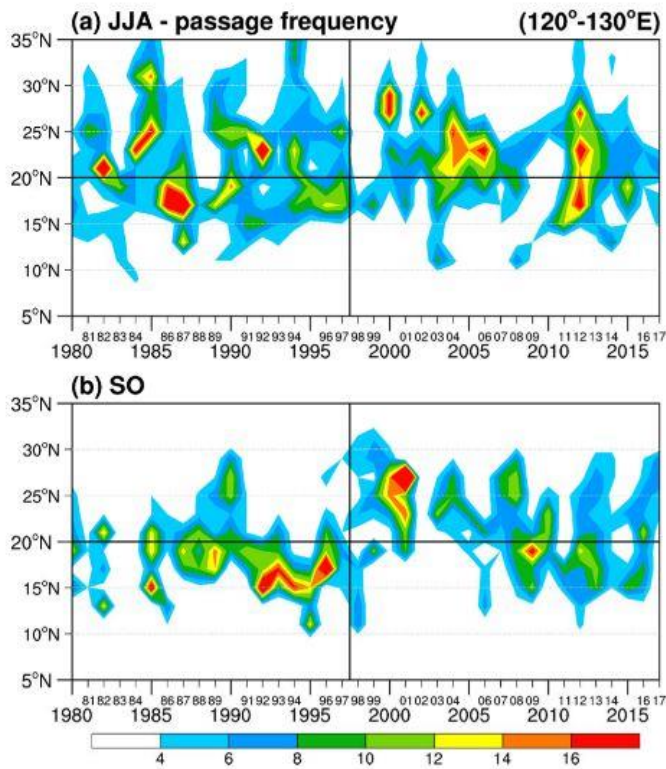| No.	Project leader	Project name
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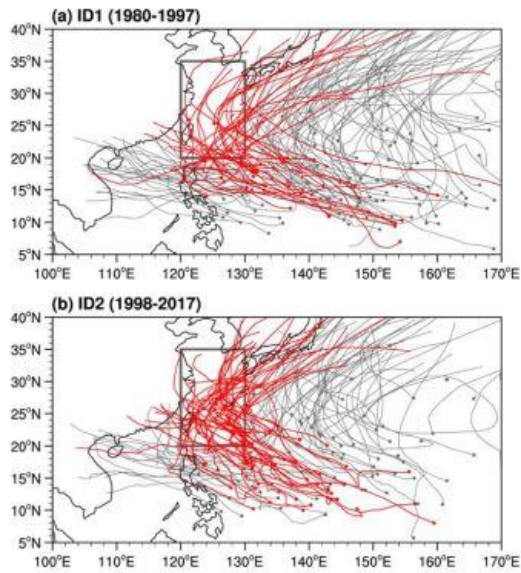824 130°E for 1980-2017: (a) June-August (JJA), (b) September-October (SO).
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There are seven environmental education programmes at NCUE in collaboration with NGOs. Each is described in detail, below.

No.	Programme
1	Fangyuan Reengineering USR Seed Programme and Sprouting Programme for Engaging Fangyuan and Dacheng: Industrial and Environmental Sustainability for Changhua's Twin Towns
2	Taoyuan International Airport Corporation Programme/entrusted to plan, design, and implement control measures against fire ants
3	The Ministry of Science and Technology's project/Impacts of Climate Change on Lowland Ecology and Lowland Ant Problems Due to Community Changes: Discussion and Solutions
4	The Ministry of Science and Technology's project/Reshaping Global Control Efforts for Invasive Species: Positioning Taiwan as the Hub of Control, Prediction, and Education of Asiatic Red Fire Ants
5	The Ministry of Science and Technology's project/Development of Microbiological Control Technologies for Harmful Ants in Farmland
6	The project of the Bureau of Animal and Plant Health Inspection and Quarantine, Council of Agriculture/Development of Core Technologies and Construction of a Safety Assessment Model for Industrial Chain Agricultural Spraying based on Unmanned Aerial Vehicles (UAV): Field Experiment of UAVs Used against Invasive Red Fire Ants and System Management of UAV Pesticide Spraying
7	Programme for Kenting National Park/Investigation on the Invasion and Control Strategy of Yellow Termites in Kenting National Park

1. Fangyuan Reengineering USR Seed Programme and Sprouting Programme for Engaging Fangyuan and Dacheng: Industrial and Environmental Sustainability for Changhua's Twin Towns in 2020–2022: included in the research project: cooperation with the Changhua Aquaculture Association to explore adaptive measures to climate change.

2. Taoyuan International Airport Corporation Programme/entrusted to plan, design, and implement control measures against fire ants.

Above: The NCUE-Taoyuan International Airport fire ant control team searches for imported red fire ants at Taoyuan Airport with the assistance of a fire ant detection dog.

3. The Ministry of Science and Technology's project/Impact of Climate Change on Lowland Ecology and Lowland Ant Problems Due to Community Changes: Discussion and Solutions.


Above: The project delved into the causes behind the ant infestation affecting lowland Zhongxing New Village residents in central and southern Taiwan and identified the issues of landscape fragmentation, ecological loss, and development stress. Within the framework of slope ecosystem services (supply, adapt, culture, and support), the research team investigated key biologic facies in the habitats affected by ant damage, and analysed environmental vulnerability and ecological potential. A lowland agricultural production system with ecosystem service potential and human welfare benefits was proposed under the context of climate change.

4. The Ministry of Science and Technology's project/Reshaping Global Control Efforts for Invasive Species: Positioning Taiwan as the Hub of Control, Prediction, and Education of the Asiatic Red Fire Ants

入侵紅火蟻偵測、鑑定、防治、監測處理流程
Fire ant detection, identification, control, monitoring and deregulate process

Above: Data model analysis and establishment of an innovative platform for invasive red fire ants. The project made significant contributions to the ongoing scientific debate on the causes of global invasive imported red fire ants as well as control measures for the fire ants, the impact on agriculture and economy, and the scientific development of Taiwan.

5. The Ministry of Science and Technology's project/Development of Microbiological Control Technologies for Harmful Ants in Farmland
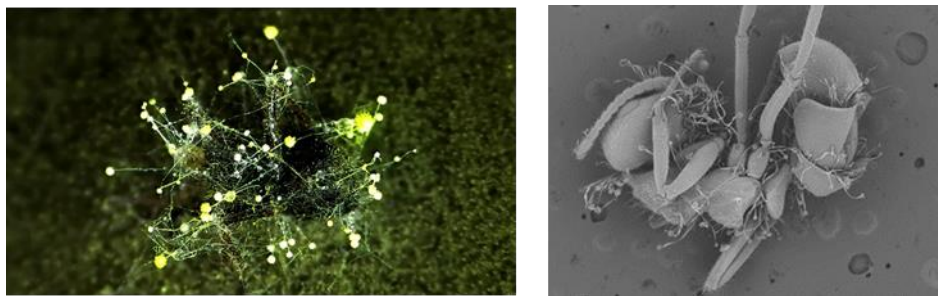
Above: Development and application of microbial control for the growing problem of harmful ants in the agricultural environment. Especially in the development of sustainable agriculture and organic agriculture, this research focuses on the design, development, and application of microbial agents on crops to control harmful ants as well as the valuable development of its practical value and commercial potential.

6. Project of the Bureau of Animal and Plant Health Inspection and Quarantine, Council of Agriculture/Development of Core Technologies and Construction of Safety Assessment Model for Industrial Chain Agricultural Spraying based on Unmanned Aerial Vehicles (UAV): Field Experiment of UAVs Used against Invasive Red Fire Ants and System Management of UAV Pesticide Spraying

Above: Assist in establishing a standard practice for pesticide application against invasive imported red fire ants on large areas or special terrains using agricultural drones.

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7. Programme for Kenting National Park/Investigation on the Invasion and Control Strategy of Yellow Termites in Kenting National Park. Assisted Kenting National Park to investigate the invasion status of Anoplolepis gracilipes, one of the most harmful invasive species in the world, in the land crab distribution concentration areas. This study is the first time that Anoplolepis gracilipes has been found to threaten land crab populations in East Asia. In addition to ant damage, land crabs also face threats from road killing, habitat destruction, and human harvesting.

Above: Anoplolepis gracilipes attack young crabs.

Our commitment to a carbon-neutral university is as follows:
1. The existing 467 kWp solar photovoltaic system is expected to be gradually expanded to 5,328 kWp (3,318 kWp at Jin-De Campus and 2010 kWp at Bao-Shan Campus) by the end of 2024, with an annual power generation of 6,588,674 kWh.
2. Building on the remarkable savings achieved over the past 15 years, with average annual electricity savings of nearly 18%, we have a plan to continuously invest more than NT$5 million annually over the next 10 years to reduce the total electricity consumption of existing facilities by 1% annually (saving more than 150,000 kWh of energy per year). By 2029, it is expected that the total annual electricity consumption of the existing facilities will be reduced by at least 1.3 million kWh compared with 2021.
3. On Bao-Shan Campus, the total installed capacity of solar power will reach 2360.25 kWp by the end of 2022, with an expected annual power generation of over 2.95 million kWh, accounting for about 80–90% of the campus's total annual power consumption. The capacity is higher than the peak hour consumption rate of 1,000 kWh. Considering the target of reducing NCUE's electricity consumption by 10%, compared to 2020 levels, by 2029, it is expected that Bao-Shan Campus could reach carbon neutrality before 2029.
4. On Jin-De Campus, the total installed capacity of solar power will reach 2,355 kWp by 2022 and then 3,318 kWp by 2024. Given the peak hour consumption of 2,800–3,100 kWh, and off-peak hour consumption of 2,000–2,400 kWh, the campus will achieve energy self-sufficiency during off-peak hours by 2022 and realise carbon neutrality during peak hours by 2024. Over time, with the implementation of energy conservation and carbon reduction policies, carbon neutrality could be realised for the entire year.

5. In conclusion, NCUE is expected to achieve preliminary carbon neutrality before 2029.

Your organisation's response: In conclusion, NCUE is expected to achieve preliminary carbon neutrality before 2029.