Office of Institutional Research and Social Responsibility, NTU
International Degree Program in Climate Change and Sustainable Development, NTU
Research Center for Future Earth, NTU

NEWSLETTER
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SC+NTU

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SC+NTU Work Team

Bringing sustainable environmental awareness to campuses and communities has always been a central focus of the SC+ team's efforts. Promoting this requires the collaborative efforts of multiple units, including interdisciplinary cooperation among various departments within the campus, as well as ongoing communication and assistance among different roles in the community. It is through these collaborations that we are able to achieve a greater social and environmental impact.

In this issue of our newsletter, we will be sharing research findings from our collaboration with the Information Management team. The research focuses on different electricity usage conditions, such as weekdays and non-working days, and aims to understand the impact of a three-day weekend on electricity consumption. Through data analysis and predictive modeling, we seek to provide insights for sustainable campus planning. In the Knowledge Sharing section, we will be introducing research on the use of climate services to mitigate the impact of climate change on agriculture. This research focuses on exploring adaptation strategies that can help alleviate the challenges faced by agriculture due to climate change.

Monthly Activities Summary

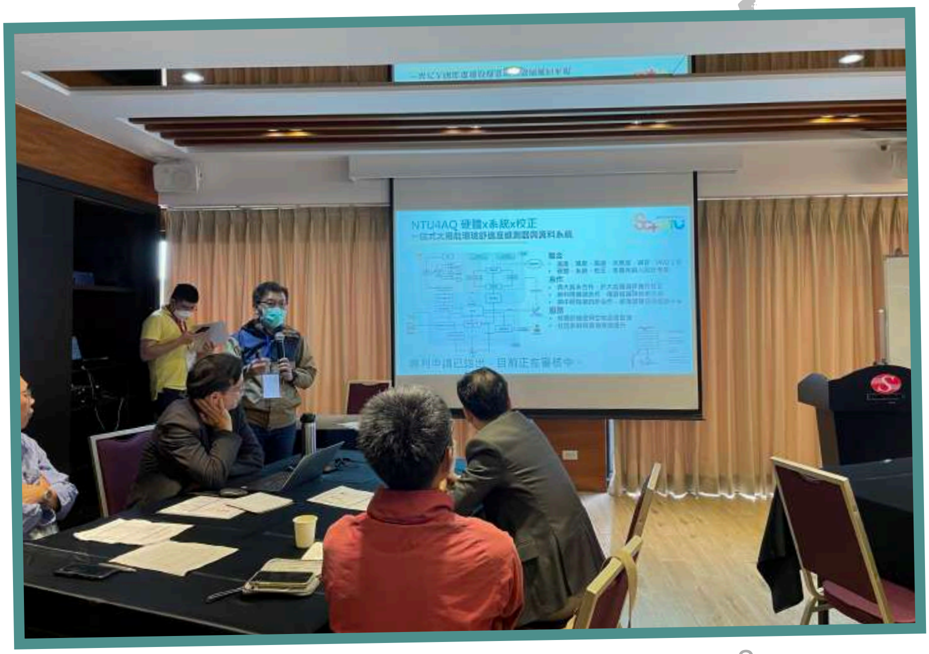
3/13

USR Project

The SC+ team applied for the USR project in corroboration with multiple departments including Atmospheric Sciences, Geography, Urban and Rural Planning, Mechanical Engineering, and Information Management. During questioning by the evaluation committee, they acknowledged that this project can address the community's needs with a people-centered approach. The interdisciplinary composition of the project team is beneficial for training students with cross-disciplinary expertise. As a result, the concept of a boundaryless university is being introduced by the university and the surrounding community, bringing students into contact with nearby communities for integration and establishing the community as a living laboratory. Expanding this concept further is essential to achieve greater social and environmental impact.

3/17

Belmont Forum Achievement Presentation and Sharing



The National Science and Technology Council's Sustainable Development Division convened the teams executing the Belmont Forum projects to share the achievements and experiences gained during the past two years of implementation. We sincerely appreciate the diversity of the Belmont Forum which has shared sustainable research in various fields and enabled exchange of challenges and solutions encountered in transnational research. Each team mentioned the difficulties of interdisciplinary collaboration and emphasized the importance of interdisciplinary research.

Monthly Activities Summary

3/29

Visit to Jianguo Village

During the visit to Jianguo Village, we observed that Yingge, as a satellite town within the Taipei metropolitan area, is undergoing rapid development. Returning to the temple at the center of Jianguo Village, which is a place of worship for the local residents, we noticed that the surrounding neighborhood has been transformed into a small park for residents to relax in. After the installation of the air quality monitoring devices, the village chief mentioned that some residents actually use the color-coded lights as an indicator to decide whether to enter the temple for worship. The village chief also shared the historical background of the temple and local culture, expressing support for our continued environmental monitoring and research efforts in Jianguo Village.

3/31

Local High School Students visit SC+

Students from Cheng Yuan High School had the opportunity to visit National Taiwan University, specifically the departments of Geography, Atmospheric Sciences, and IPCS (Interdisciplinary Program of Climate Studies), in order to learn about urban-scale microclimate and meteorological observation issues. They further explored the indoor and outdoor air quality and environmental comfort of our living spaces. The visit highlighted the need for interdisciplinary collaboration and the involvement of multiple professionals in areas such as instrumentation, systems, and data calibration to enable practical applications for decision-making in our daily lives.

Achievements and Announcements

From Three-Day Weekends to Energy Conservation: Data Analysis for a Sustainable Campus I - Exploring the Data

The team of Professor Kong Ling-Chieh includes Lin Li-qi, Lai Yi-zhen, and Li Yun-chen

"Energy conservation and carbon reduction" has been one of the most widely promoted slogans in recent years. In 2021, National Taiwan University also published its Social Responsibility and Sustainability Report, emphasizing the importance of smart sustainability on campus. As a leading institution in higher education in Taiwan, NTU has the potential to set a good example by demonstrating its efforts and achievements in this area. However, we are curious to know whether energy conservation and carbon reduction have truly been implemented in our daily lives, or, if it remains merely a slogan. As students from the College of Management (referred to as the College), we are particularly interested in how our own College performs in this regard. In light of this, we collaborated with Director Chien Shiuh-Shen and his team from the International Master's Program in Climate Change and Sustainable Development at NTU to conduct a study on the electricity usage in the College's Management Building 1 and Management Building 2 over the past few years.

First, we obtained the daily electricity consumption data for each building on the NTU campus from August 31, 2018, to August 31, 2022, using the "NTU Campus Digital Electricity Meter Monitoring System." The dataset consists of a total of 35,088 records. By simply aggregating the data, we quickly obtained the annual total electricity consumption for each of the four years (defined as August 31 to August 30 of the following year). Taking Building 1 as an example, the total electricity consumption for the four years was approximately 489,000 kWh, 449,000 kWh, 324,000 kWh, and 437,000 kWh, respectively. At first glance, there does seem to be a decreasing trend, but we immediately considered that this may be influenced by the campus closure during the COVID-19 pandemic. To address this, we defined periods of pandemic and non-pandemic based on the distance learning and campus occupancy regulations implemented in response to the pandemic in previous years. Furthermore, as electricity consumption is affected by ambient temperature, we merged the temperature data obtained from the "NTU Comfort+ Program" team's measurements in the Department of Atmospheric Studies with the electricity consumption data for further analysis.

Due to the limited difference in temperature and electricity consumption between adjacent hours, we divided a day into three time periods: "morning," "midday," and "evening." The morning period is from 00:00 to 08:00, the midday period is from 08:00 to 16:00, and the evening period is from 16:00 to 24:00. The electricity consumption for each period is the sum of the electricity consumption for the hours within that period, while the temperature is the average temperature for the hours within that period. During data processing, we encountered some issues of missing real-world data. The main problem was the occasional interruption of sensor operation due to power outage or malfunction, resulting in consecutive hours with no recorded electricity consumption or temperature. If there was any missing electricity consumption data for a specific period, we would exclude that period from the analysis. If there was missing temperature data, we would average the temperatures of the same hour from one day before and one day after the day with missing data to fill in the gap. After data cleaning and aggregation, taking Building 1 as an example, we ended up with 4,386 data points for analysis. The number of data points for other buildings was roughly similar.

In order to control for factors such as temperature, time period, working days, and the presence of the pandemic, we conducted a multiple linear regression analysis. During the process, we also attempted to include interaction terms between time period, working days, and temperature. The resulting model had a coefficient of determination (R-squared) of 0.696. In the regression model, we defined the variable "index" as the sequential number from 1 to 4,386 representing the time periods. The goal was to observe whether the coefficient of the index variable in the most explanatory multiple regression model was significantly negative. If so, it could indicate a decreasing trend in the "reasonable" electricity consumption of the analyzed buildings over the past four years. Taking Building 1 as an example, the analysis results showed that after controlling for other influencing factors, the regression coefficient of the index variable was -0.0013, which was indeed negative. This indicates a slight downward trend in the reasonable electricity consumption of Building 1 (an expected annual decrease of 1.42 kWh per year). Although the numbers may not be statistically significant, the fact that electricity consumption did not increase in the face of global warming reflects the efforts and effectiveness of the College in energy conservation. However, there is still room for further improvement.

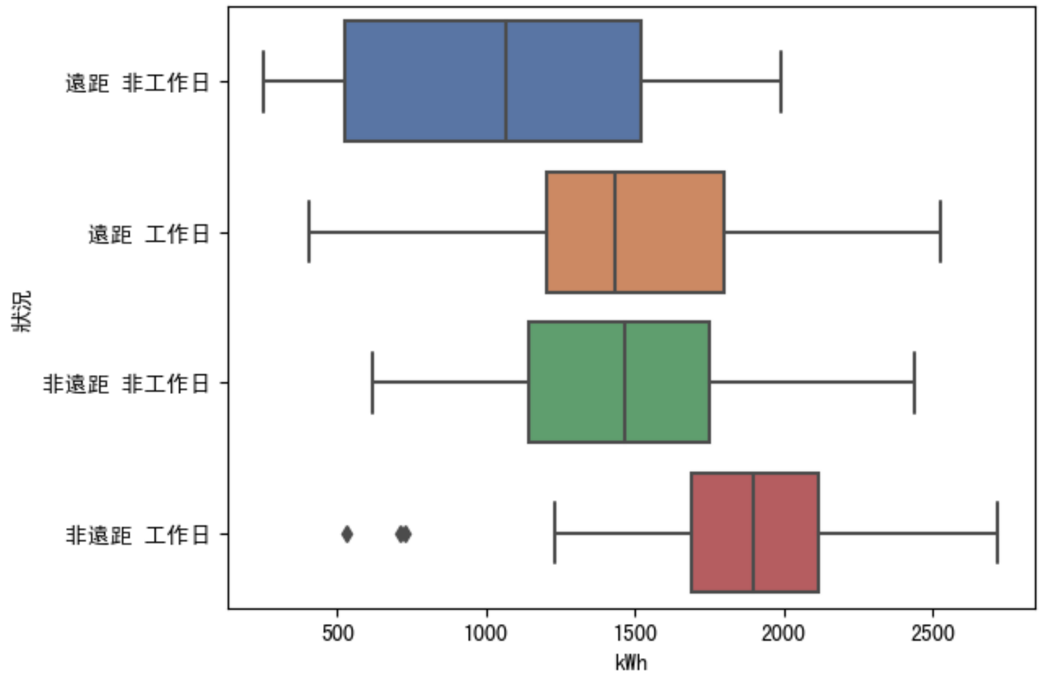


Figure (1) Remote/Non-Remote and Working/Non-working Days electricity consumption box plot

From Three-Day Weekends to Energy Conservation: Data Analysis for a Sustainable Campus II - Model Predictions

The team of Professor Kong Ling-Chieh includes Lin Li-qi, Lai Yi-zhen, and Li Yun-chen

Through our model, we can also quantify the impact of a one-degree temperature increase on the electricity consumption of buildings. Using the example of Building 1, the regression coefficient for temperature is 26.93, indicating that for every one-degree increase in average temperature, the expected daily electricity consumption of Building 1 (sum of the three time periods) will increase by 80.78 units. We have also observed some interesting phenomena regarding other buildings, such as the different electricity consumption patterns between graduate dormitories and undergraduate dormitories. For instance, in the case of the freshman female dormitory and the first-year graduate female dormitory, their temperature regression coefficients are 29.36 and -0.32, respectively, and both coefficients are statistically significant. This suggests that for the freshman female dormitory, electricity consumption increases with rising temperatures, while for the first-year graduate female dormitory, electricity consumption unexpectedly decreases with rising temperatures. We believe this phenomenon may be attributed to the fact that graduate students, during hotter periods, choose to go to their air-conditioned laboratories to save money, whereas most undergraduate students do not have dedicated laboratories and thus have to rely on air conditioning in their dormitories, resulting in this difference in coefficients.

The model we have developed can also provide valuable information for campus governance policies. During the pandemic, National Taiwan University (NTU) had to resort to remote teaching and remote work, which revealed that remote learning and remote work are not entirely infeasible and can significantly reduce campus electricity consumption. Considering that many countries, such as the United States and the United Kingdom, are experimenting with a "three-day weekend" to improve work efficiency, we have also envisioned a possibility: NTU could designate Fridays as "remote teaching days," where all courses scheduled from Monday to Thursday would follow the traditional approach determined by the instructors, but if a course is scheduled on Friday, it must be conducted entirely through remote means. We are curious whether this type of model, similar to a three-day weekend concept, could reduce electricity consumption and carbon emissions on campus. While NTU would not mandate remote teaching solely for the purpose of energy saving and carbon reduction, estimating the potential reduction in electricity consumption and carbon emissions resulting from such a policy can provide valuable information for campus governance decision-makers to consider when making policies. By leveraging the developed model, NTU administrators can assess the potential impact of implementing the proposed policy and make informed decisions based on the estimated reduction in electricity consumption and carbon emissions. This way, the University can take steps towards achieving its sustainability goals while considering factors such as energy efficiency, carbon footprint, and the overall well-being of the campus community.

Looking back, NTU implemented comprehensive remote teaching and work arrangements from June to August 2021 in response to the pandemic. Using the data from this period, we conducted regression analysis and combined it with the calculated impact of temperature on electricity consumption from the previous model to estimate the electricity consumption of buildings if remote teaching were implemented every Friday during the past four years. We compared the estimated annual electricity consumption with the actual consumption. Taking Building 1 as an example, the results are shown in Table 1. It can be observed that by designating Fridays as remote teaching days, there would be approximately an 8% reduction in electricity consumption each year, equivalent to around 50,000 kWh of electricity and 28 metric tons of carbon dioxide emissions.

Year	Original annual electricity consumption (kWh)	Annual electricity consumption under three-day weekend	Percentage Decrease
2018	489,917	449,469	8.3%
2019	449,491	414,932	7.7%
2020	324,934	300,002	7.7%
2021	437,331	401,426	8.2%

Table 1

In this project, we have found that the College of Management has indeed made efforts and achieved results in energy conservation under the challenging conditions of climate change. In addition, we were able to quantify the impact of temperature on electricity consumption and use the model to estimate electricity consumption under different campus governance policies. We look forward to more people participating in this research, analyzing open campus data, and jointly working on the development of energy-saving and carbon reduction programs. By formulating more suitable campus governance policies and extending them to every building on campus, we can effectively implement campus energy conservation and sustainable development goals.

Science Tips

Climate service driven adaptation may alleviate the impacts of climate change in agriculture

Preface by Yeh Yu-Hsin

This literature introduces the use of climate services as an adaptation approach to mitigate the impacts of climate change on agriculture. The research focuses on the cultivation of durum wheat crops in the Mediterranean region of Europe. Through climate services, the goal is to assist farmers in selecting the optimal crop varieties for planting, thus reducing yield losses.

In terms of research methodology, the study first collected 191 varieties of durum wheat from the Mediterranean region. The thermal requirements for flowering and maturation of these varieties were analyzed, and they were classified into three categories based on probability distribution function curves: shorter growth period, moderate growth period, and longer growth period. From these three categories, a random sample of 18 genotypes of durum wheat was selected for the study. The research was conducted under two conditions: one without climate services and the other with climate services.

Under the condition without climate services, the research findings indicate that genotypes with a shorter growth period are less affected by climate change, and the yield losses observed across different regions are relatively uniform. On the other hand, genotypes with a longer growth period show more pronounced yield reductions compared to those with a shorter period. However, their advantage lies in their higher spatial heterogeneity, allowing them to adapt to specific climatic conditions in certain areas and potentially increase yields.

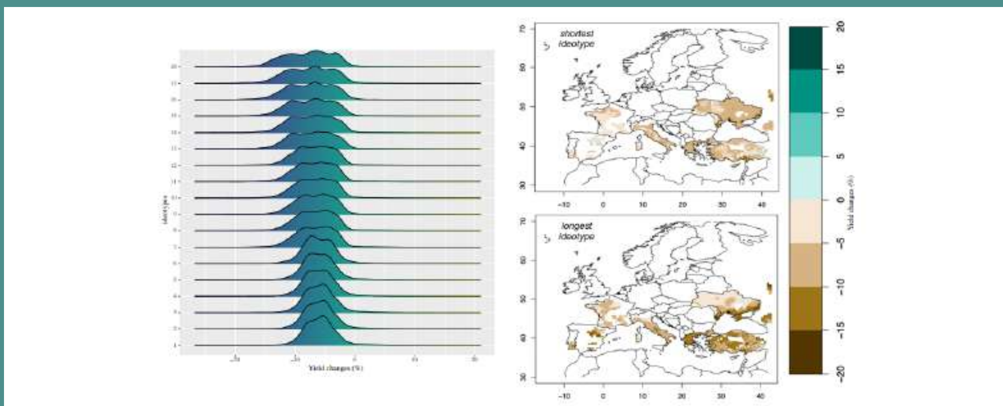


Fig. 2 Mean yield changes in 2021-2040 with no adaptation. Left Panel: Spatial probability density function of the ensemble mean yield changes in 2021-2040 (% w.r.t. to 1986-2005) for each ideotype (from the shortest 1 to the longest 18) with no adaptation being implemented. Right panel: Ensemble mean yield changes in 2021-2040 (% w.r.t. 1986-2005) of the shortest and longest ideotypes. Colours in the right panel are associated with the estimated changes,

From a regional perspective, there are differences in minimizing yield losses and the interannual variation of yields under the condition without climate services. If the shortest growth period genotypes are used for cultivation, although it can reduce crop yield losses, there will be significant interannual variation, leading to unstable harvests and potential price fluctuations. On the other hand, if the longest growth period genotypes are used, there will be significant variations in yields across different regions, but the interannual variation will be less pronounced. Therefore, the goal of climate services in this context is to strike a balance between minimizing yield losses and limiting interannual variations.

Science Tips

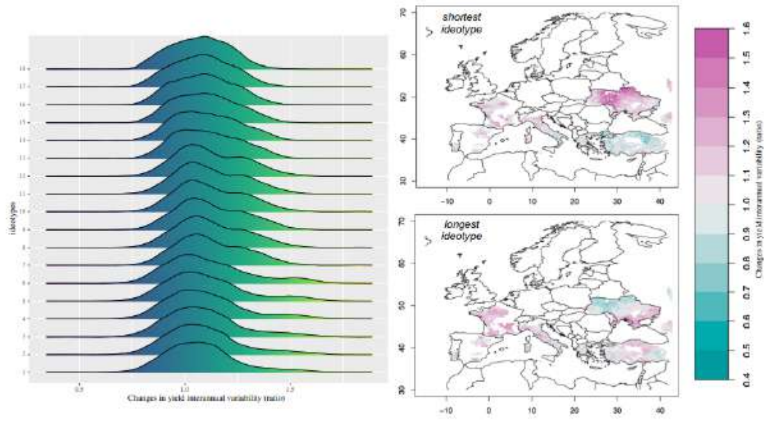


Fig. 3 Changes in yield interannual variability in 2021-2040 with no adaptation. Left Panel: Spatial probability density function of the ensemble changes in the yield interannual variability (ratio between 2021-2040 and 1986-2005) for each ideotype (from the shortest 1 to the longest 18). Right panel: Ensemble changes in the yield interannual variability (ratio between 2021-2040 and 1986-2005) of the shortest and longest ideotypes. Colours in the right panel are associated with the estimated changes.

Under the idealized climate services conditions, in terms of the impact on average yield, the overall simulation of climate services outperforms all previous results without climate services. However, regardless of the predictive capabilities used, the results still show greater interannual variations compared to the original conditions. As mentioned earlier, significant interannual variation implies larger differences in harvest yields, which can lead to price fluctuations and market instability. Therefore, there is a need to reduce interannual variations to ensure stability.

In conclusion, this literature highlights the significance of crop variety selection as an effective climate service in agriculture, enabling farmers to choose cultivars that are more suitable for the prevailing climate conditions, thus reducing unnecessary losses or increasing additional gains. However, such agricultural climate services require regular dynamic adjustments. Through monitoring and feedback from farmers' practical applications, improvements can be made, and local users can actively participate in the process while rectifying any initial errors.

Reference

Toreti, A., Bassu, S., Asseng, S. et al. Climate service driven adaptation may alleviate the impacts of climate change in agriculture. Commun Biol 5, 1235 (2022). https://doi.org/10.1038/s42003-022-04189-9

ABOUT OUR TEAM

SC+NTU Work Team

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International Degree Program in Climate Change and Sustainable Development (IPCS)

The International Degree Program in Climate Change and Sustainable Development, as its name suggests, is an interdisciplinary degree program that encompasses a global perspective. Established by the College of Science, the program is a joint effort among NTU faculty members from both scientific research and humanities backgrounds. In dealing with climate change and sustainable development, we instrument in-depth teaching in a wide range of topics. Students are required to bring their knowledge and skills to the table and approach environmental issues from a multi-angled perspective. They are encouraged to break free from traditional views on sustainability and think outside the box. Students are expected to be motivated learners, thinkers, analysts, and most important of all, practitioners. Our ultimate goal is to cultivate students' ability in interdisciplinary problem-solving in dealing with the complexity of climate change issues.

ABOUT OUR TEAM

Location Aware Sensing System (LASS)

The Location Aware Sensing System (LASS) is an important maker community in Taiwan, and it is also the creator of air boxes, water boxes, and other micro-sensing devices. LASS focuses on the integration of citizen technology and spatial information, aiming to design and implement an environmental sensing system with local characteristics through the integration of hardware and software. The community strives to promote open source and public welfare as the main axis, and to create customers instilled with a 'self-creator' spirit, develop low-cost environmental monitoring equipment with an open software and hardware architecture so that the public may build a set of sensing systems that meet their specific needs through a self-made process. At the same time, LASS also adopts and open attitude towards sensing data and allows volunteers to use environmental monitoring data uploaded to the cloud system by other partners in the community in order to build a real-time monitoring network.

PARTNERS ➤

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Transit-Hospital-Oriented Development(THOD) Work Team

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