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
May. 2022

SC+NTU

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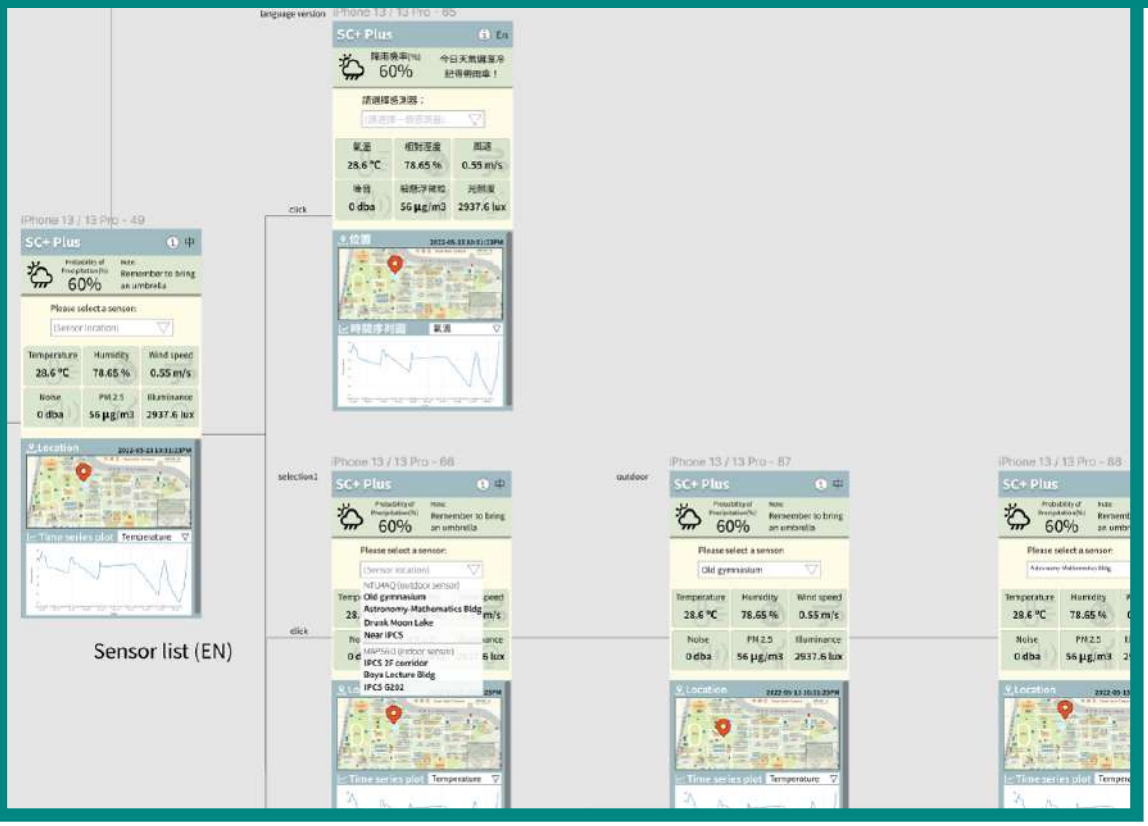
SC+NTU Work Team



In order to solve many major and increasingly complex challenges facing society today, it is necessary to integrate the expertise, methods, tools and technologies of different disciplines through interdisciplinary communication and collaboration. The SC+ team uses the measurement of environmental comfort, along with analysis and presentation of data as a bridge for communication between environmental science and other related fields. Since the implementation of the project, the early discussion of ideas across various fields has extended to the beginnings of cooperation between them. We hope that through the integration of knowledge between these disciplines, we can jointly create new, innovative, and collaborative solutions to the complex environmental and social problems related to climate change. The theme of this newsletter is "Outdoor-Off-Campus Cooperation". This month's announcements will share with readers the differences in NBIoT signal strength of different brands on the campus of National Taiwan University, as well as a preliminary exploration of marathon-scale environmental parameters. Comfort + Common Sense will introduce the Belmont Forum which is centered on international partnerships to support interdisciplinary scientific research, and discusses the role the SC+ team plays in it.

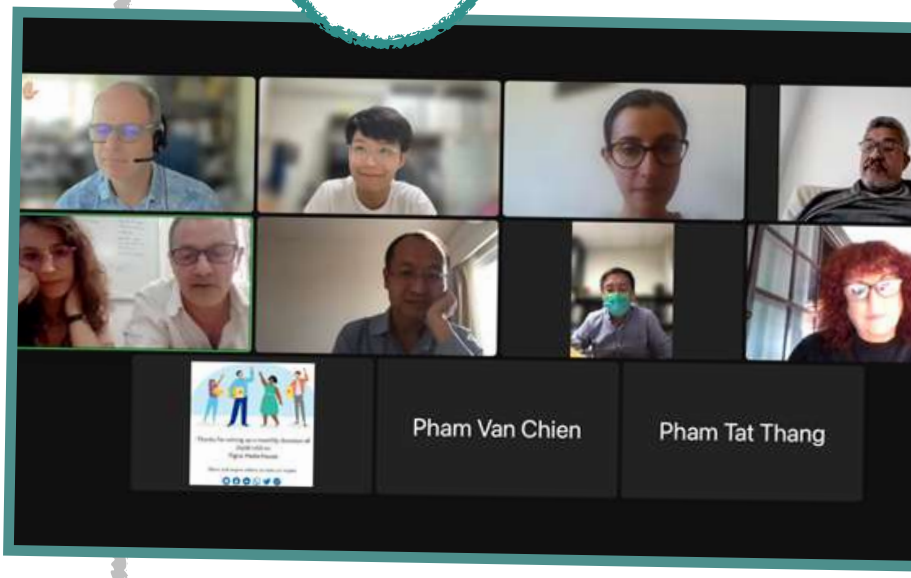
Issue No.21

Monthly Activities Summary

Belmont Workshop part II

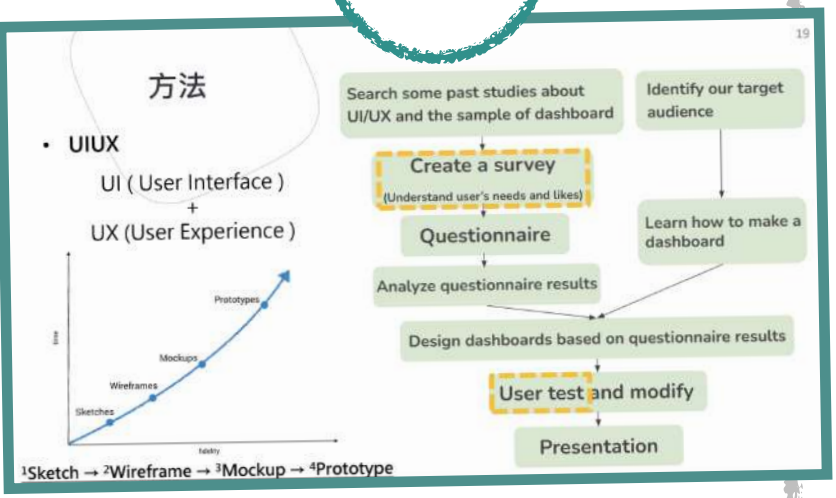
05/11

The Ministry of Education invited several members from In the last literature review, lecturer Lea Lugassy from the French team shared very useful literature review methods and tools. In this workshop, Lea was also invited to assist our team in organizing research plans and phased results reports. Lea effectively maintained the discussion sequence and clarified the stage goals, helped the team to align the information, and produced a great chemistry for the team discussion.



05/18

First draft of NileDawk



This semester, SC+ and IPCS have collaborated on the Workshop on Climate Change and Human Settlements, where small groups of students assisted in researching the existing NileDawk real-time dashboard in an attempt to improve its user-friendliness. Through questionnaires, students learned about the experiences of Taiwanese university students using the existing dashboards, and found that the disclosure and provision of environmental information can effectively help Taiwanese university students to make daily life decisions, such as the clothes they wear, use of an umbrella, whether to use anti-smog masks, etc.; in addition, the development of a mobile version of the dashboard can effectively improve the convenience of use. Therefore, the students in the group used the UI design software Figma to develop the mobile version of the dashboard wireframe, conducted tests and interviews with 15 users of the phased results, used feedback in the development of the next version, and finally produced the mobile version of the main dashboard. The first draft has been provided to SC+ project developers for programming.

05/31

Visit from Professor Kuei-Yuan Chan from the Department of Mechanical Engineering

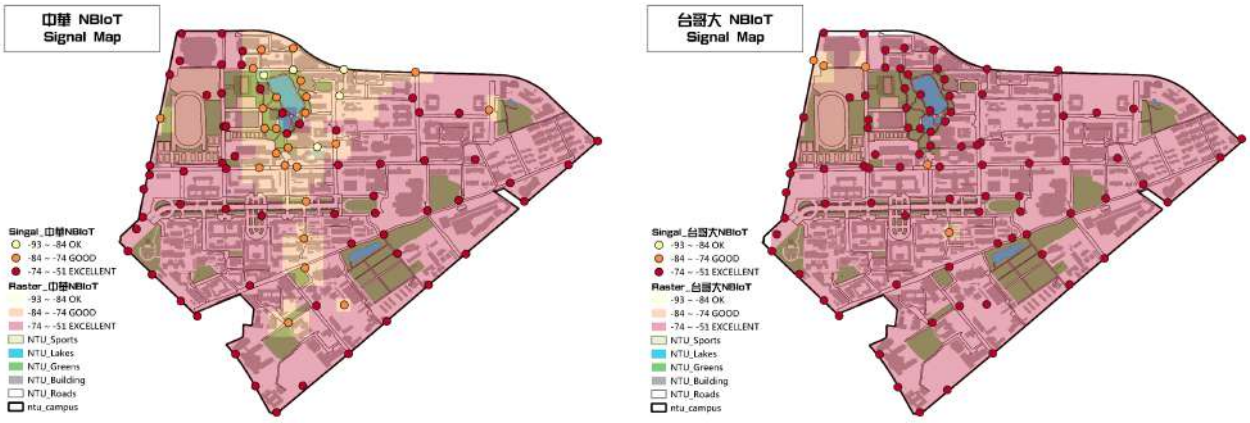
Dr. Kuei-Yuan Chan from the Department of Mechanical Engineering came to SC+ Lab to share his experience. We raised the prior problems on the NTU4AQ sensor hardware that we have encountered; primarily power, communication, and calibration among other issues. Dr. Chan shared relevant experience and helped with relevant resources. He also committed that he would further carry out relevant cooperation to increase the stability and quality of the sensors.

Achievements and Announcements

NTU Campus Telecom Signal Strength Map

SC+ Work Team and IPCS Rong-Cih, Chang
SC+ Work Team Wei-Jhe, Chen

Do you know how the NTU4AQ, which is usually seen on campus, transmits the observed data back to the SC+ database? The NTU4AQ developed by the project team is based on Internet of Things (IoT) technology. By transmitting data through the network, the observed data can be automatically sent back to the database to digitize the real world. The Internet of Things mainly transmits signals through Narrowband Internet of Things (NB-IoT). NB-IoT is one of the types of low-power wide-area network (LPWAN) technologies. Its technical advantages include that it can connect a large number of IoT. The device has wide coverage, low power consumption, can prolong battery life, a low cost and other advantageous characteristics. Because the bandwidth used by NB-IoT is a single narrow frequency of 200kHz, it will not be compatible with the 4G frequency bands we use every day 700MHz, 900MHz. Competing between 1800MHz and 2600MHz, NTU4AQ transmits data through NB-IoT signals, while indoor monitoring instruments MAPs6.0 transmits data through 4G signals. Therefore, the stability of the network signal at the location where the instrument is installed will affect the ability of data to be sent back. If the signal at the location where the instrument is installed is poor, it will easily lead to data interruption, resulting in dilemmas during subsequent data analysis. To this end, team members made a map of the NB-IoT and 4G signals of different telecom operators outside the campus by actually going to the National Taiwan University campus to measure signals.



Figure(1) The left is the NB-IoT signal map of Chunghwa Telecom, and the right is the NB-IoT signal map of Taiwan Mobile.

RSSI is the abbreviation of Received Signal Strength Indication. Its value will show a negative dBm, and when RSSI is closer to 0, it means the connection quality is better. For example, if one is -60 and the other is -70, the former signal is stronger than the latter. The team uses GIS to perform IDW (Inverse Distance Weighting) spatial interpolation of the values measured at each point. IDW is the most commonly used method for spatial interpolation estimation. It uses the numerical weighting of adjacent known points, estimating the variable value of the current position to draw a grid of the campus signal distribution.

From Figure 1, we can see that the RSSI values measured by Chunghwa Telecom's NB-IoT signals around Drunken Moon Lake, the common teaching hall, the agricultural complex, the lawn of the School of Management and the lawn of the Department of Atmospheric Sciences are in the orange, GOOD range; while the Drunken Moon Lake RSSI measured at 5 points around the lake is -93 ~ -84, which is the yellow OK range. The NB-IoT signal of Taiwan Mobile only measured an orange GOOD signal in the sports gymnasium and agricultural complex. The signals in the rest of the range are all red, indicating EXCELLENT. We subtracted the grids of the two maps to obtain the spatial difference of signals in Figure 2. The red to orange colors represent the better NB-IoT signals of Taiwan Mobile, and the blue and green colors represent the better NB-IoT signals of Chunghwa Telecom. The difference map can be used as a decision-making reference for the NTU4AQ signal at different points. For example, the NB-IoT signal of Taiwan Mobile can be used around the Drunken Moon Lake, and the NB-IoT signal of Chunghwa Telecom can be used around the sports gymnasium.

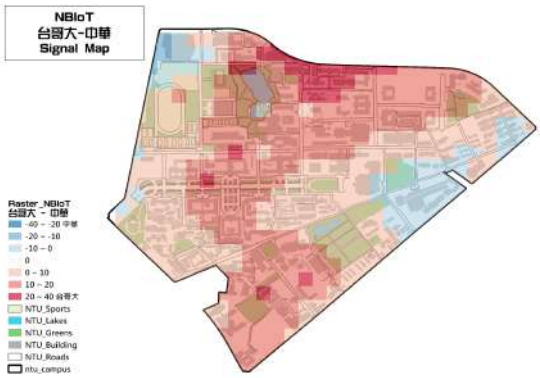


Figure (2) The difference between the NB-IoT signal of Taiwan Mobile and Chunghwa Telecom's NB-IoT signal

In the 4GLTE signal portion, as can be seen from Figure 3, Chunghwa Telecom only measured the orange GOOD signal in the agricultural complex, and the red EXCELLENT signal in the rest of the campus. Taiwan Mobile measured the signal in the entire campus. The outdoor signals are all red EXCELLENT, which shows that both Chunghwa Telecom and Taiwan Mobile have good signal strength outdoors, but MAPs6.0 is an indoor monitoring instrument, and the indoor 4GLTE signal will be affected by the shading and coverage of buildings, and will also be subject to signal differences in various locations and floors within the building, which is presently a major limitation in measuring indoor signals.

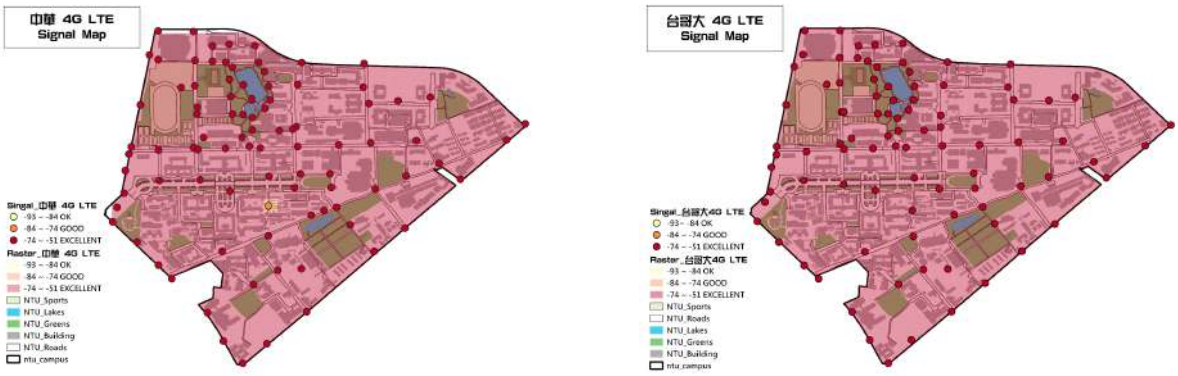


Figure (3) The left is the 4GLTE signal map of Chunghwa Telecom, and the right is the 4GLTE signal map of Taiwan Mobile

All in all, according to the data collected by the team, the NBIoT signals of different brands have different spatial strengths on campus. When setting up sensors and IoT systems, we can make up for the weak areas of NBIoT signals in space by choosing from different telecom brands, so as to achieve stable collection of wireless transmission data from the sensor. Among them, we originally used Chunghwa Telecom's NBIoT around Drunken Moon Lake, and after switching to Taiwan Mobile NBIoT, the data sending and receiving rate has been significantly improved. The outdoor 4G telecommunication signal strength is very high. This result allows the mobile version of the MAPS sensor to have stable and good data transmission, helping the team to establish an important foundation for mobile sensing.

A preliminary study on the environmental conditions of the Taipei Marathon

SC+ Work Team and Department of Geography Cheng-En, Lin

Participating in a marathon is a symbol of athletic ability and self-actualization. In recent years, urban marathons have been held in major cities in combination with urban marketing, attracting tens of thousands of participants. However, does running on the road really increase health? Will there be health concerns, or even immediate risks due to different environmental factors during the running process? Could there be an increased risk of thermal hazards when running a marathon in a different season or within a different built environment? In addition, for competitive runners, an overheated environment may also affect performance. Therefore, it becomes particularly important to grasp the environmental conditions that runners may perceive during the process. From the perspective of the runner, we initially analyzed several environmental parameters, including temperature, humidity, PM2.5 and CO2.

The team members participated in the 2021 Taipei Marathon half-course (21km) on December 19, 2021. During the process, they wore MAPS6 environmental sensors with a time resolution of 1 data per minute to wear them around their waists. The whole measurement method was carried out as shown in Figure 4. The team was able to measure and record the temperature and humidity, PM2.5 and CO2 values during the marathon at any time, and the location information was recorded by the mobile phone using the Runkeeper app. According to the specified time of the event, the half marathon will start at 7:00 a.m. and finish within 3.5 hours. The temperature and humidity conditions on that day are shown in Table 1. It was sunny and without rain. The data were taken from the Taipei Station of the Central Meteorological Administration. Because the angle and time of the sun exposure may also affect the value of each road section, the sunrise time and azimuth of the sun in Taipei City on the same day were recorded at the same time. The sunrise time was 6:34, and the azimuth was 116 degrees.

Table (1) Temperature and humidity data at the Taipei Station of the Central Meteorological Administration from 7:00 to 10:00 on December 19, 2021

時間	氣溫(℃)	相對溼度(%)
7:00	15.2	64
8:00	15.6	63
9:00	17.3	57
10:00	18.4	49
平均	16.6	58

Figure (4) Sensor module worn during marathon

The route of the Taipei Marathon on the day is shown in Figure 5. The starting point is the Taipei City Hall Plaza, along Renai Road to Chiang Kai-shek Memorial Hall, then turn north to Zhongshan North Road, cross Zhongshan Bridge, and follow Bei'an Road, Mingshui Road, and Lequn Road to the embankment. On the top of the road, go to Maishuai 2nd Bridge to Jiankang Road, Sanmin Road and then Nanjing East Road to the end point of Taipei Arena. The built environment is variable along the way, including boulevards, high-rise buildings, river embankments and other environmental changes. There are also water stations, medical stations and sponge stations for cooling.

In terms of temperature, the average temperature of the entire road section is 21.25 degrees, the maximum is 23.4 degrees, and the minimum is 19.03 degrees. The temperature along the way is shown in Figure 6. There are three places where the temperature peaks. The first is at Taipei City Hall Plaza and the front section of Renai Road, and the second is around Chiang Kai-shek Memorial Hall, especially Aiguo East-West Road, Chongqing South Road and Kaida Between Grand Avenue, the third one appears at the section of Jiankang Road ramp at the foot of Maishuai No. 2 Bridge to Jiankang Road and Sanmin Road, and the peaks of the three are about 23 degrees. In addition, it was found that the temperature is lower in the second half of Ren'ai Road on the south side and Bei'an Road, Mingshui Road and Lequn Road on the north side.

Figure (5) Route map of the 2021 Taipei Half Marathon

Figure (6) Temperature distribution map of Taipei Marathon

Figure (7) Distribution of PM2.5 in Taipei Marathon

In terms of temperature, the average temperature of the entire road section is 21.25 degrees, the maximum is 23.4 In terms of pm2.5, the average concentration was 18.45 (μg/m3), and the maximum and minimum values were 39 (μg/m3) and 5 (μg/m3), respectively. The PM2.5 along the way is shown in Figure 7. In the Renai Road section, the detected concentration is generally low, mostly lower than 15 (μg/m3), but as the runners gradually approach the Jingfumen Circle, concentrations trended upward. When turning to Aiguodongxi Road, the PM2.5 concentration began to rise, the highest value was close to 40 (μg/m3), and the average concentration of this road section was above 20 (μg/m3). Then, following Ketagalan Avenue to return to Jingfumen Circle and turn to Zhongshan Nanbei Road, the concentration of the route was lower than 15 (μg/m3) before reaching Citizen Avenue, and then gradually increased. After passing Minzu East Road, the concentration of PM2.5 began to rise rapidly to about 37 (μg/m3), and the concentration began to decline after Zhongshan Bridge. The route went to Bei'an Road, Hushui Road, and Lequn Road. The running direction of these sections of the race is along the embankment. These sections mostly maintained concentrations at 10(μg/m3)-20(μg/m3) before the second Maishuai Bridge; except that the concentration increased slightly when passing through large intersections, such as the intersection of Diding Avenue Section 2 and Lequn 1st Road. And while the concentrations at some supply stations rose slightly, the air quality was still normal. It is about 25 (μg/m3) on the second bridge of Maishuai, but when the next bridge enters the road ramp, the concentration begins to soar to 39 (μg/m3), and the concentration does not start to decrease until the exit of the ramp.

Discussion of Results:

First of all, the temperature in Taipei City Hall Plaza is higher than that of other road sections. It may be because the crowd is denser at the start, and the body temperature of the crowd is not easy to dissipate, so the current temperature is about 2 degrees higher than the average temperature of the entire road section. As the race begins, the crowd gradually spreads out, and this phenomenon is less obvious. It can be seen that the temperature gradually decreases along Renai Road from the starting point. Also because of the earlier relationship, and the fact that Ren'ai Road is a more sheltered boulevard, the temperature in the middle and back sections of Ren'ai Road was relatively low. The second section with higher temperature is the Aiguo West Road and Ketagalan Road around the Chiang Kai-shek Memorial Hall. Aiguo West Road is densely populated with trees, and the vegetation has a shading effect. The temperature should be lower, but the temperature was in fact higher. According to the angle of the sun rising at 116 degrees, it is speculated that it may be that the sun rises directly onto the road, causing the temperature to rise. In addition, the reason why the temperature of Ketagalan Avenue is also high is that the road may be wider and caused by lack of roadside trees and shade. The third place with higher temperatures is at the Jiankang Road ramp where the Maishuai Second Bridge and the lower bridge meet. Although the temperature on the north side of the route should have risen slightly after the start of the race with the passage of time, the temperature of this section is lower than that of other sections. We speculate that it may be because the sun angle is skewed to the south in winter, which makes the embankment next to its route cast a long shadow and reduce the temperature. With regard to PM2.5, it was observed that around the Chiang Kai-shek Memorial Hall, especially Aiguo West Road, along the route from Zhongshan North Road to Zhongzheng Bridge, and the intersection of Maishuai Second Bridge and Jiankang Road, the concentration is higher. The route design on Aiguo West Road and Zhongshan North Road that day is that runners, cars and motorcycles share the road. People and vehicles are only separated by traffic cones, placing them closer to the source of pollution. It may also be caused by the high traffic flow on these roads. Additionally, there are many pollution points along the line, such as restaurants, breakfast shops, etc., which may contribute to the high concentration. Another location with a higher concentration is at the Second Maishuai Bridge, where the traffic flow shares the bridge deck with the runners. However, when the runners exit the road ramp, there are only runners, but this is the time when the PM2.5 is the highest. It is speculated that the wind direction may bring the pollutants from the bridge deck to the ramp, and the sound insulation wall of the ramp makes it difficult for the pollutants to dissipate. From the distribution of temperature and PM2.5 concentration, it was found that the route near Chiang Kai-shek Memorial Hall and the section of Maishuai Second Bridge are sections with high temperature and high PM2.5 concentration. On the north side, Beixin Road, Mingshui Road and Lequn 1st Road are roads with low temperature and low PM2.5 concentration. In this way, the hot and cold areas of temperature and PM2.5 are summarized, and the relative temperature and PM2.5 of each location are arranged in Table 2.

We also found that the temperature measured by the sensor is about four to five degrees higher than the average station temperature measured by the Central Meteorological Bureau. During the road running event, the characteristics of different road sections may cause direct sunlight, etc. In addition, the values measured by us may belong to the environmental information of the pedestrian scale. The official station cannot accurately capture the environmental information of each place, resulting in errors. The above results are only preliminary estimates of the temperature and PM2.5 conditions of the built environment that the runners pass through, as well as the emission of local pollution sources. Therefore, more detailed observations and measurements are required. Finally, although the Taipei Marathon is held during the winter, the heat index is not high, but such data is still meaningful, indicating that the temperature or PM2.5 of each road section may be different due to variation in the built environments. If we can find out the factors affecting areas with high temperatures, it will be very helpful for the prevention of thermal hazards in the future; if we can account for the concentration of PM2.5 along the way, it will also allow better consideration of the health of runners during route planning.

Table(2) Comparison of temperature and PM2.5 at various locations in Taipei Marathonn

地點	溫度	PM2.5
中正紀念堂周遭	高	高
麥帥二橋周遭	高	高
仁愛路前段	高	低
中山橋周遭	中	高
南京東路至小巨蛋(終點)	中	中
北安路、明水路、樂群一路	低	低

Remarks: PM2.5 value above 35(μg/m3) is high, 15(μg/m3)-35(μg/m3) is medium, less than 15(μg/m3) is low; the temperature value is greater than 22(℃) is high, 20(℃)-22(℃) is medium, less than 20(℃) is low

Science Tips

A Key Supporter of SC+ - The Belmont Forum

SC+ Work Team Yi-Huan Hsieh

We believe that friends who have been following the SC+ team for a long time should not be unfamiliar with the words "Belmont Forum". After all, we have also mentioned it in many communications; so, what is the significance of our continuing discussion about the "Belmont Forum"? The simple answer: Belmont Forum is one of the key supporters of the SC+ team. Therefore, in this newsletter, we would like to brief readers on the operations of the Belmont Forum, the Belmont Forum in Taiwan, and in what themes are SC+ participating in the Belmont Forum?

The Belmont Forum is a transnational scientific organization established in 2009. This organization mainly integrates various international grants, funds scientific committees or research organizations in various countries, and assists these research teams to form a new international and interdisciplinary research teams to promote knowledge and understanding, as well as mitigation and adaptation to environmental changes. Therefore, at this forum, research teams and research organizations from various countries can propose Collaborative Research Actions (CRA) to form a multinational research team with at least three countries and different research fields to obtain support from the Belmont Forum and national scientific committees. In addition to financial, additional forms of support include research results databases and cross-disciplinary training, and other research related and data accumulation. According to the information on the official website of the Belmont Forum, since its establishment, it has successfully solicited 17 research topics, of which 134 research projects have been supported in more than 90 countries, and including more than 1,000 scientists and related stakeholders. Taiwan's Ministry of Science and Technology became a member of the Belmont Forum in 2015, and established its counterpart in Taiwan in 2016 called the Belmont Forum Promotion Office (BFPO) of the Ministry of Science and Technology. Since 2017, the research team in Taiwan has a total of 11 plans that have passed review.

Table(3) A list of the projects of the Taiwan research team through the Belmont Forum so far. (Excerpted from the official website of Belmont Forum: https://belmontforum.org)

ACRONYM:	TITLE:	CALL
ABRESO	Abandonment and rebound: Societal views on landscape- and land-use change and their impacts on water and soils	Soils2020
AWARD-APR	Addressing Extreme Weather Related Diarrheal Disease Risks in the Asia Pacific Region	CEH2019
CRUNCH	Climate Resilient Urban Nexus CHoices: operationalising the Food-Water-Energy Nexus	Nexus2016
DUAL	Data-driven Disaster Response Systems Dependent on Time of Day, Season and Location for Megacities	DR32019
Eco2Health	Health and Agriculture Sustainability through Interdisciplinary Surveillance and Risk Assessment Platform of Global Emerging Zoonotic Diseases	Pathways2020
METABOLIC	Intelligent Urban Metabolic Systems for Green Cities of Tomorrow: an FWE Nexus-based Approach	Nexus2016
PREMISS	Partnership for Research to Enhance Methodologies In Sustainability Science	Pathways2020
RESIST	Resilient societies through smart-city technology: Assessing earthquake risk in ultra-high resolution	DR32019
INCLUSIVE	Stakeholder-supported decision making for sustainable conjunctive management of soil and groundwater	Soils2020
RREFlood	The Residual Risk of Extreme Floods: A Challenge for Achieving the Sustainable Development Goals	Pathways2020
Vertical Green 2.0	Vertical greening for liveable cities – innovation to facilitate the breakthrough of an old concept	Nexus2016

The SC+ team applied to join the Pathway2020 topic in 2020, passed the review of the Bemont Forum with the PREMISS (Partnership for Research to Enhance Methodologies in Sustainability Science) program, and officially started implementation in August 2021. The overall goal of the PREMISS project is to use existing environmental monitoring technologies (such as IoT) to allow stakeholders to easily obtain important environmental information, to understand the current environmental problems, to shape the vision of the future environment, and then develop possible execution paths towards that vision.

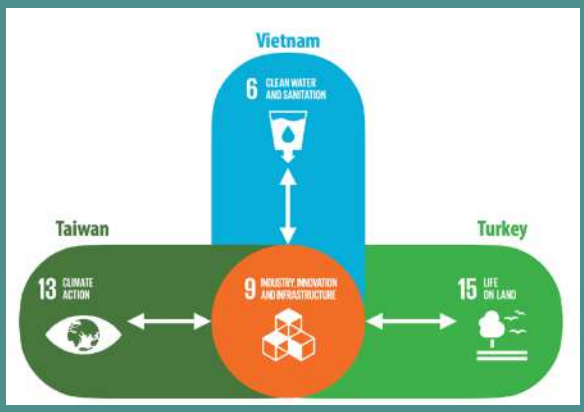


Figure (8) The iIn the PREMISS program, the SDG goals correspond to the research cases of teams in different countries.

Therefore, in the PREMISS project, there are three research teams from different countries, with different environmental monitoring topics that deal with issues of the respective countries. The three research teams and the corresponding themes are: Turkey (precision agriculture), Vietnam (irrigation system management), and Taiwan (local climate action). We hope that through the implementation of this research project, we can integrate knowledge from different fields, jointly create new solutions in an innovative and collaborative way, and serve as a model for sustainable science. We also hope that the results of PREMISS can help solve complex socio-environmental problems.

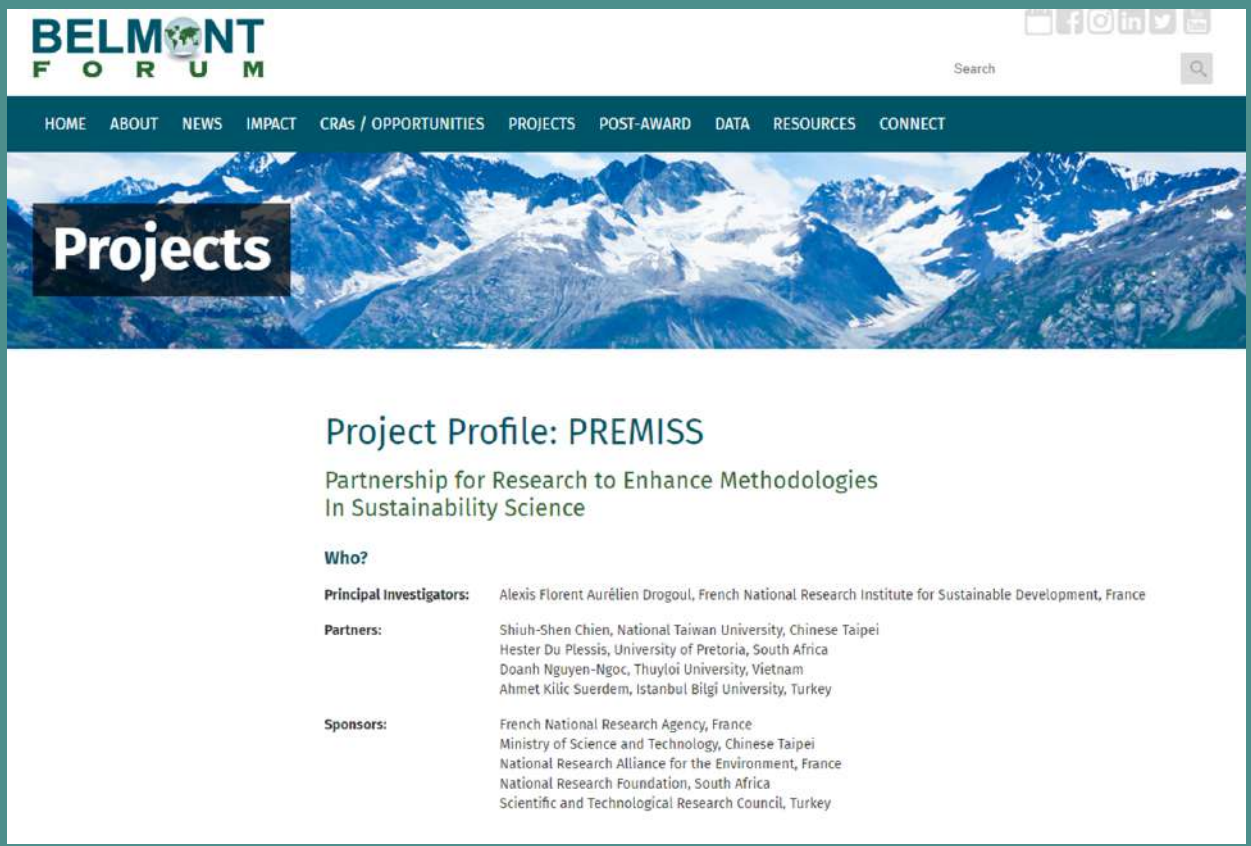


Figure (9) The introduction page of the SC+ team at the Belmont Forum, excerpted from: https://belmontforum.org/archives/projects/partnership-for-research-to-enhance-methodologies-in-sustainability-science

ABOUT OUR TEAM

SC+NTU Work Team

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Taipei Field Consultant: Jen-Ping Chen; Jehn-Yih Juang; Po-Hsiung Lin; Chih-Hao Hsieh; Chin-Lin Wei

THOD Consultant: Jen-Ping Chen; Sheng-Lin Chang; Horng-Huei Liou

Work Team: Miao-Jung Chien; Wei-Jhe Chen; Cheng-En Lin; Xin Yang; Tzu-Chun Chang; Rong-Cih, Chang; Tzu-Ya, Wang; Chieh-Hsiang, Fan

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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