Title: Explore the relationship between surface temperature at different times and locations

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Date:2023/3/10

Abstract:
We selected seven locations on campus with different surface conditions to observe the surface temperature at 12:00 noon and 17:00 pm, and observed that the sun is the main factor affecting the temperature. Among other things, cloud cover and varying land surface conditions can affect temperatures. There is a high negative correlation between cloud coverage and air temperature, and the surface temperature of the runway is higher than other surface conditions such as asphalt roads and grass at 12:00 noon.

Research Question and Hypothesis:

Our research Questions

1. What are the differences in air temperature and surface temperature at different times and in different surface conditions?
2. Does cloud cover affect air and surface temperatures?

Our Hypothesis:

We want to explore the differences in surface temperature at different times in different parts of the campus. We selected seven different locations on the campus to measure the surface temperature at 12:00 noon and 5:00 pm. We wanted to understand how the surface temperature differs under different surface conditions. We believe that the sun is the most important key factor affecting the temperature, so we choose two different times to measure the surface temperature. We want to observe whether the surface temperature across the campus is higher at noon and lower in the afternoon, just like the diurnal variation of air temperature . In addition, we also want to know the difference in surface temperature in different surface conditions across the campus. We believe that in addition to sunshine, water and cloud coverage may also affect the measured surface temperature, because water absorbs heat and evaporates to take away heat, and when cloud coverage is high, it will shade the sun and cause cooling.

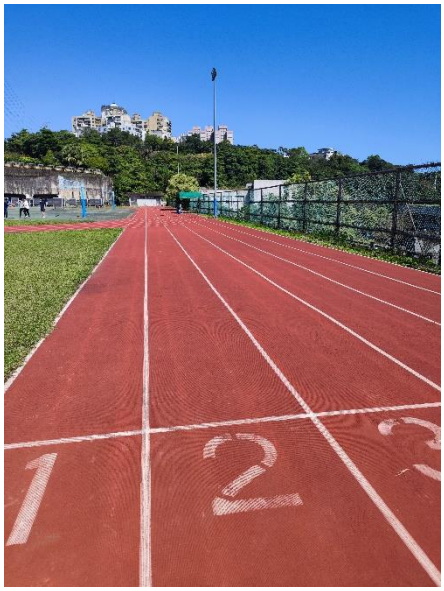
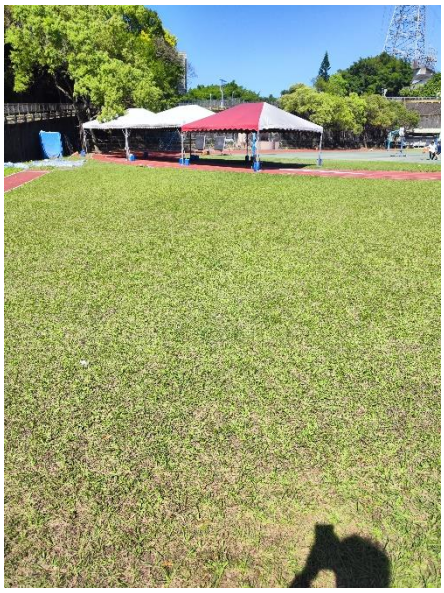
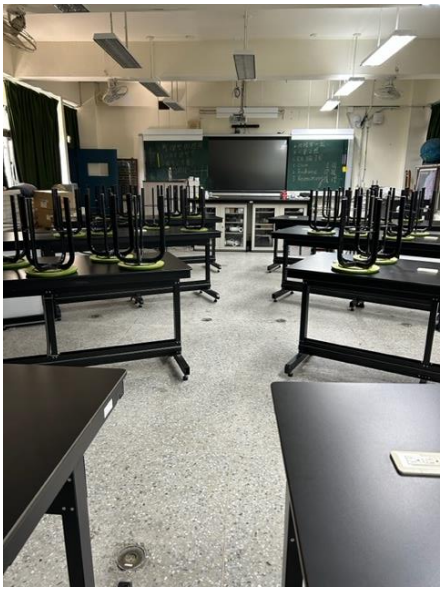
Introduction and Review of Literature:

We read the research on the relationship between land use types and environmental microclimate in Taipei area in the works of National Primary and Secondary Science Exhibition. We know that different land use types have different changes in surface temperature and temperature, and artificial pavement such as asphalt heats up faster. The higher the water content, the slower the temperature rise, and the landform will affect the microclimate.

In addition, in the 60th Pingtung County Primary and Secondary School Science Fair, the title of the work is Earth. Have you taken your body temperature? Discussion on factors affecting surface temperature The article mentioned that the surface temperature of the surface with vegetation is higher than that without vegetation, and The presence of water lowers the soil temperature.

Research Methods and Materials (Including GLOBE Data!):

We apply the surface temperature protocol in GLOBE, use the same instrument to measure the surface temperature. We took surface temperature measurements at seven different locations on campus between 12:00 noon and 5:00 pm on five days during the school day (From December 19, 2022 to December 23, 2022). The following are maps and photos of our seven observation sites on campus. Surface conditions have been dry for five days

<table>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>PU runway</td><td>Asphalt + acrylic floor</td><td>Stone steps</td></tr>
<tr><td>  </td><td> 
</td><td>  </td></tr>
<tr><td>Turf</td><td></td><td>Asphalt road</td></tr>
<tr><td>  </td><td>Study sites in our school campus:
1. Asphalt road
2. PU runway
3. Turf
4. Classroom
(no air conditioning)
5. Toilet (wet floor)
6. Asphalt + acrylic floor
7. Stone steps</td><td>  </td></tr>
<tr><td>Toilet (wet floor)</td><td></td><td>Classroom</td></tr>
</table>

We use the GLOBE Observer app to observe cloud coverage and upload data at noon during the five days from December 19, 2022 to December 23, 2022. The following are the results of satellite observations and our observations on the ground.

1219 Satellite: GEO Broken 69.90%, NOAA20 Broken 66.54% My Observation: Scattered (25-50%)

N	E	S	W	U
				

1220 Satellite: GEO Broken 50.49%, Aqua Broken 67.56% My Observation: Scattered (25-50%)

N	E	S	W	U
				

1221 Satellite: GEO Overcast 100.00% My Observation: Overcast (>90%)

N	E	S	W	U
				

1222 Satellite: GEO Isolated 21.90%, Aqua Few 0.69%, NOAA20 Few 1.38% My Observation: Few (<10%)

N	E	S	W	U
				

1223 Satellite: My Observation: Overcast (>90%)

N	E	S	W	U
				

Results:

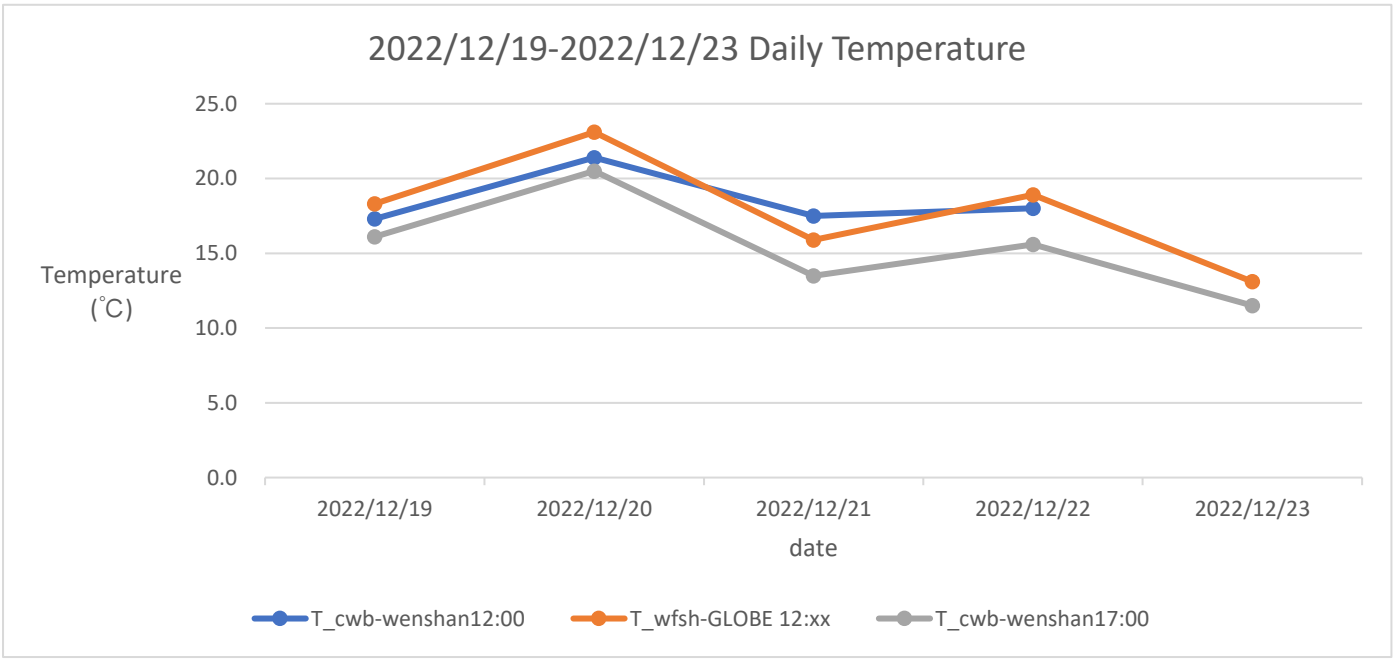
T_cwb-wenshan comes from the data of the Central Weather Bureau Wenshan Station in Taipei City, including two different times from December 19, 2023 to December 23, 2022 at noon 12:00 and 17:00, missing December 23, 2023 Information at 12:00 noon. T_wfsh-GLOBE is the observation data of Taipei Municipal Wan Fang High School GLOBE station, and the observation time falls between 12:47 and 12:54.(Table 1)

Table 1

	T_cwb-wenshan12:00	T_wfsh-GLOBE 12:xx	T_cwb-wenshan17:00
2022/12/19	17.3	18.3	16.1
2022/12/20	21.4	23.1	20.5
2022/12/21	17.5	15.9	13.5
2022/12/22	18.0	18.9	15.6
2022/12/23		13.1	11.5

From the figure (Figure 1), it can be seen that the temperature measured by the Wenshan Station of the Central Weather Bureau is mostly lower than the temperature measured by the GLOBE Station of Taipei Municipal Wan Fang High School. From December 19, 2022 to December 23, 2022, the temperature at the Wenshan station in Taipei City of the Central Weather Bureau at 12:00 noon was higher than the temperature at 17:00.

Figure 1

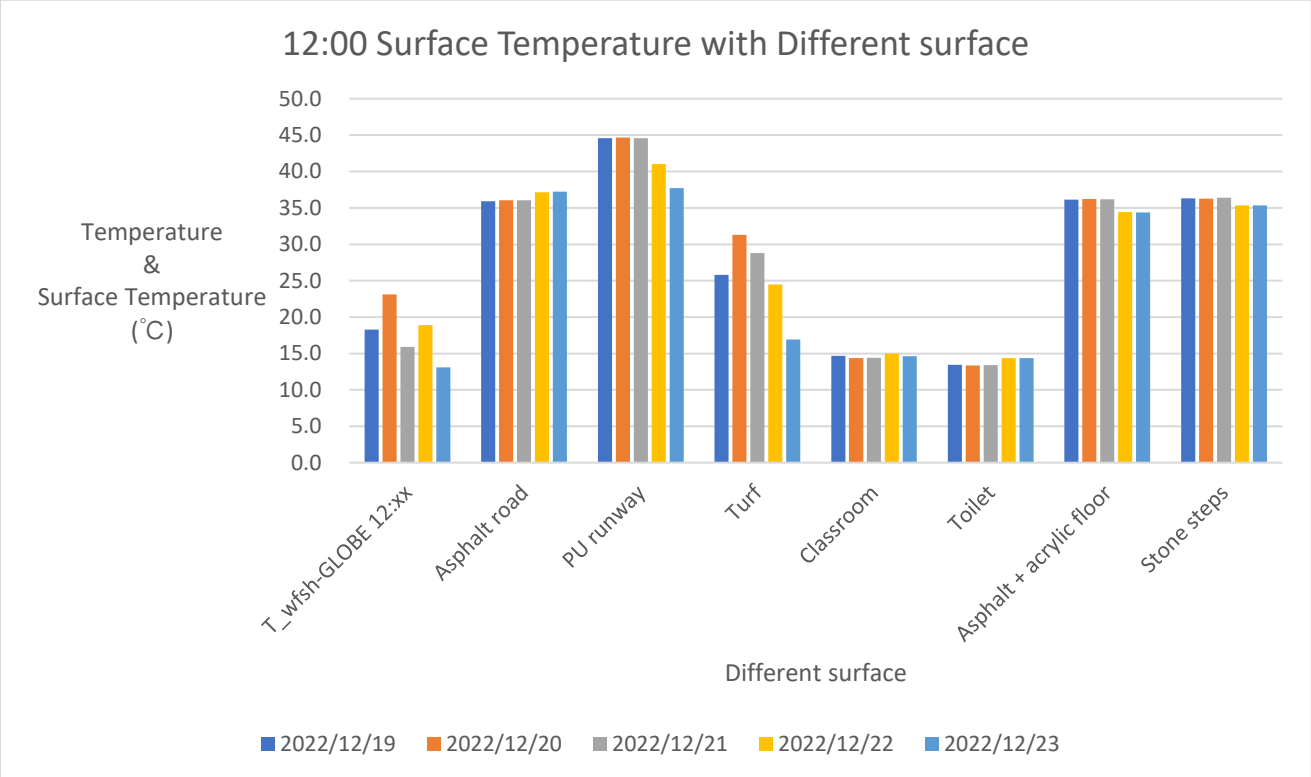


From the table and Figure (Table 2 & Figure 2) , we can see the surface temperature data of seven different surface conditions on the campus from December 19, 2022 to December 23, 2022 at noon 12:00. The uppermost value is the temperature measured by the GLOBE station of Taipei Municipal Wan Fang High School. The surface temperature of the PU runway is the highest, as high as 44.7°C. The temperature of asphalt roads, Asphalt + acrylic floor and stone steps is about the same, about 36°C. The temperature of the turf is the lowest, about 25°C, which is higher than the air temperature. Classroom and toilet are located indoors, and the surface temperature is almost lower than the air temperature in these five days. The observed values in these five days are also quite close, and there is no obvious change. The surface temperature of the toilet is lower than that of the classroom.

Table 2

12:00	2022/12/19	2022/12/20	2022/12/21	2022/12/22	2022/12/23
T_wfsh-GLOBE 12:xx	18.3	23.1	15.9	18.9	13.1
Asphalt road	35.9	36.0	36.0	37.2	37.2
PU runway	44.6	44.7	44.6	41.0	37.7
Turf	25.8	31.3	28.8	24.5	16.9
Classroom	14.7	14.4	14.4	15.0	14.6
Toilet	13.4	13.4	13.4	14.4	14.3
Asphalt + acrylic floor	36.1	36.2	36.2	34.4	34.4
Stone steps	36.3	36.3	36.4	35.3	35.3

Figure 2



As shown in the figure (Figure 3), because we did not record the temperature at 17:00 at the GLOBE station of Taipei Municipal Wan Fang High School, we selected the temperature data at 17:00 at the Wenshan station of the Central Weather Bureau, which is the closest to the school. The distance between the two places is about 1700 meters .

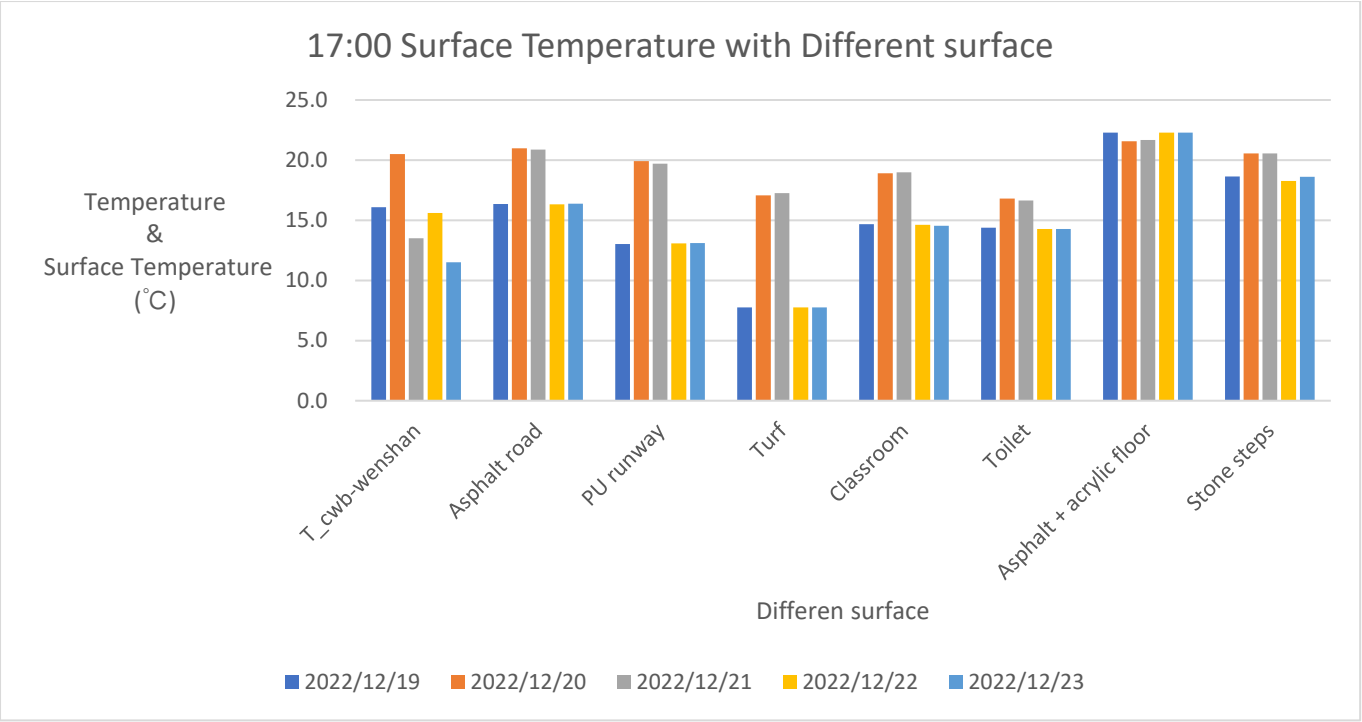
Figure 3

From the table and figure(Table 3 & Figure 4), we can see the surface temperature at 17:00 in seven different places on campus from December 19, 2022 to December 23, 2022, among which classrooms and toilets belong to the indoor environment. Its surface temperature is sometimes higher than the air temperature and sometimes lower than the air temperature, between 14.3 and 20 °C. The surface temperature of asphalt roads , Asphalt + acrylic floor and stone steps is higher than the air temperature. We found that the surface temperature of the PU runway and grass field was cooler than the air temperature, except on December 21, 2022. However, the surface temperature of the grassland has a low temperature of less than 10 °C in 3 out of 5 days.

Table 3

17:00	2022/12/19	2022/12/20	2022/12/21	2022/12/22	2022/12/23
T_cwb-wenshan	16.1	20.5	13.5	15.6	11.5
Asphalt road	16.3	21.0	20.9	16.3	16.4
PU runway	13.0	19.9	19.7	13.1	13.1
Turf	7.7	17.1	17.3	7.8	7.8
Classroom	14.7	18.9	19.0	14.6	14.5
Toilet	14.4	16.8	16.6	14.3	14.3
Asphalt + acrylic floor	22.3	21.6	21.7	22.3	22.3
Stone steps	18.6	20.5	20.6	18.3	18.6

Table 4



The information in the table (Table 4) shows the correlation between cloud coverage (Cloud coverage values are averaged by adding satellite observations and our observations.), air temperature and surface temperature. We found that the correlation coefficient between cloud coverage and air temperature is -0.7, indicating a high degree of correlation, indicating that the higher the cloud coverage, the lower the temperature. In addition, the correlation coefficient between the cloud coverage rate and the classroom surface temperature in the indoor environment is also -0.7, showing a high correlation. The correlation coefficients between cloud cover and surface temperature elsewhere are all lower than 0.3, which is a low correlation.

Table 4

12:00	cloud cover	T_wfsh-GLOBE	Turf	Asphalt road	PU runway	Classroom	Toilet	Asphalt + acrylic floor	Stone steps
2022/12/19	55.4	18.3	25.8	35.9	44.6	14.7	13.4	36.1	36.3
2022/12/20	47.6	23.1	31.3	36.0	44.7	14.4	13.4	36.2	36.3
2022/12/21	100.0	15.9	28.8	36.0	44.6	14.4	13.4	36.2	36.4
2022/12/22	5.9	18.9	24.5	37.2	41.0	15.0	14.4	34.4	35.3
2022/12/23	98.0	13.1	16.9	37.2	37.7	14.6	14.3	34.4	35.3
correlation		-0.7	-0.3	-0.2	-0.1	-0.7	-0.2	0.2	0.3

Conclusion:

1. The temperature at 12:00 noon is higher than that at 17:00, which means that the incident angle of the sun affects the air temperature.
2. At 12:00 noon, the surface temperature of the outdoor environment was higher than the air temperature, and the PU runway was the highest, followed by the asphalt road, Asphalt + acrylic floor and stone steps, and the grassland was the lowest. The surface temperature of the indoor environment is that the classroom is higher than the toilet, and the two values are similar.
3. The surface temperature of asphalt roads , Asphalt + acrylic floor and stone steps is higher than the air temperature. The surface temperature of the PU runway and grass field was cooler than the air temperature, except on December 21, 2022.
4. The higher the cloud coverage, the lower the temperature and the surface temperature of the classroom.

Discussion:

1. During the five days we observed, the surface conditions were all dry, so it is impossible to infer whether the surface temperature will be changed when water appears. In the future, we should also measure the surface temperature when the surface condition is wet, so as to discuss the impact of water on the surface temperature.
2. The angle of sun radiation, cloud coverage and air temperature have a high degree of correlation, but only a low degree of correlation with the surface temperature, so the surface material will affect the surface temperature.
3. We originally thought that the surface temperature of the asphalt road would be the highest at 12:00 noon. Unexpectedly, the surface temperature of the PU runway was the highest. Temperature will affect the speed of evaporation in the water cycle, which in turn affects the balance of the water cycle. If there is a large-scale change in the surface conditions on the earth, such as deforestation and replacement with artificial pavement, the local surface temperature may be increased and the environment will be affected. If the impact of different man-made pavements on the surface temperature can be understood in advance, and the appropriate material or composite pavement can be selected, the impact on the surface temperature and the impact of the environment should be mitigated.

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