Title – A tale of ten zones

An investigation to analyse the temperature of ten different surfaces

Organization: Gozo College, San Lawrenz Primary School aka The Friendly School

Student(s): (Please refer to list on page 14)
Grade Level: Grades K-2 (Lower Primary, ages 5-8)
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Report Type(s): International Virtual Science Symposium Report
Protocols: Atmosphere
Presentation Type: Poster
Optional Badges: I am a Data Scientist, I am a STEM storyteller, I make an Impact

Summary

This investigation was conducted using the GLOBE Surface Temperature Protocol to analyse the surface temperature of ten different zones within one complex- San Lawrenz Primary School. The research was based on the fact that darker surfaces absorb heat energy at a faster rate than lighter ones, resulting in a raised temperature. Observations were done in various conditions from dry to wet ground.

The research was adopted by the whole school community, the pupils, teachers and the ancillary staff. Parents were planned to be involved, but due to COVID-19 mitigation measures they were not allowed inside the school. Nine samples from ten different zones were collected on five days each having different weather conditions.

Though the data supported the hypothesis, the graphs led to several interesting conclusions.

Figure 1 Ancillary staff involved in data collection

Research Question

Our school covers a large area. It is surrounded by fields. The building consists of the administration block, the classes and the hall, spread over three wings. Pupils and staff often comment that while one wing is very warm, the opposite one is cold compared to the former. During winter, one prefers to stay in the sunny block, however, during summer, pupils prefer to visit the area of the cooler block.

Figure 2 Aerial view of San Lawrenz Primary School, Gozo

Our school has been actively participating in the GLOBE project. It was interesting to continue discovering more information about our school via the Urban Head Island/Surface Temperature Campaign. Thus, it was natural to start this investigation by collecting data from a variety of zones with different surfaces. In all, ten different zones within the school were identified. The GLOBE Surface Temperature Protocol was used. The ten different zones were: tarmac; shade; synthetic turf; even surface concrete; rough surface concrete; soil in direct sun; soil under the trees; soil in the shade; soil facing south direction; soil facing north direction.

Hypothesis

It is predicted that surfaces of different colours and materials absorb heat at different rates. Thus, it is assumed that the darker the surface, the larger heat absorption. But this is further complicated by type of surface (whether it is flat or rough) and the surrounding conditions, whether it is shaded and exposed to currents of winds. Weather conditions also play a part, in increasing/decreasing the rate of absorption. Therefore, it is predicted the tarmac surface will register the highest temperatures while the shaded zone will have the lowest temperatures.

Research Methods

First, a short meeting ensued with all the participants, i.e. the whole school community. They were instructed about how to use the GLOBE Surface Temperature Protocol. Attention was given to the position of the hand and the direction which the infra-red thermometer was pointing at.

On five different days, at 10.45am, data was collected from ten different zones within the school. The ten different zones were: tarmac; shade; synthetic turf; even surface concrete; rough surface concrete; soil in direct sun; soil under the trees; soil in the shade; soil facing south direction; soil facing north direction. Nine (9) different temperature samples from each zone were collected during each occasion. On each day, the total amount of data collected was 90 surface temperatures to analyse. 450 surface temperatures were collected over five different days to be analysed. The weather conditions of each day were also recorded.

Materials used

- Digital infrared Thermometer
- School Plan with the 10 sites marked
- Datasheet
- Laptop for documentation

Figure 3 Students measuring surface temperature from selected sites

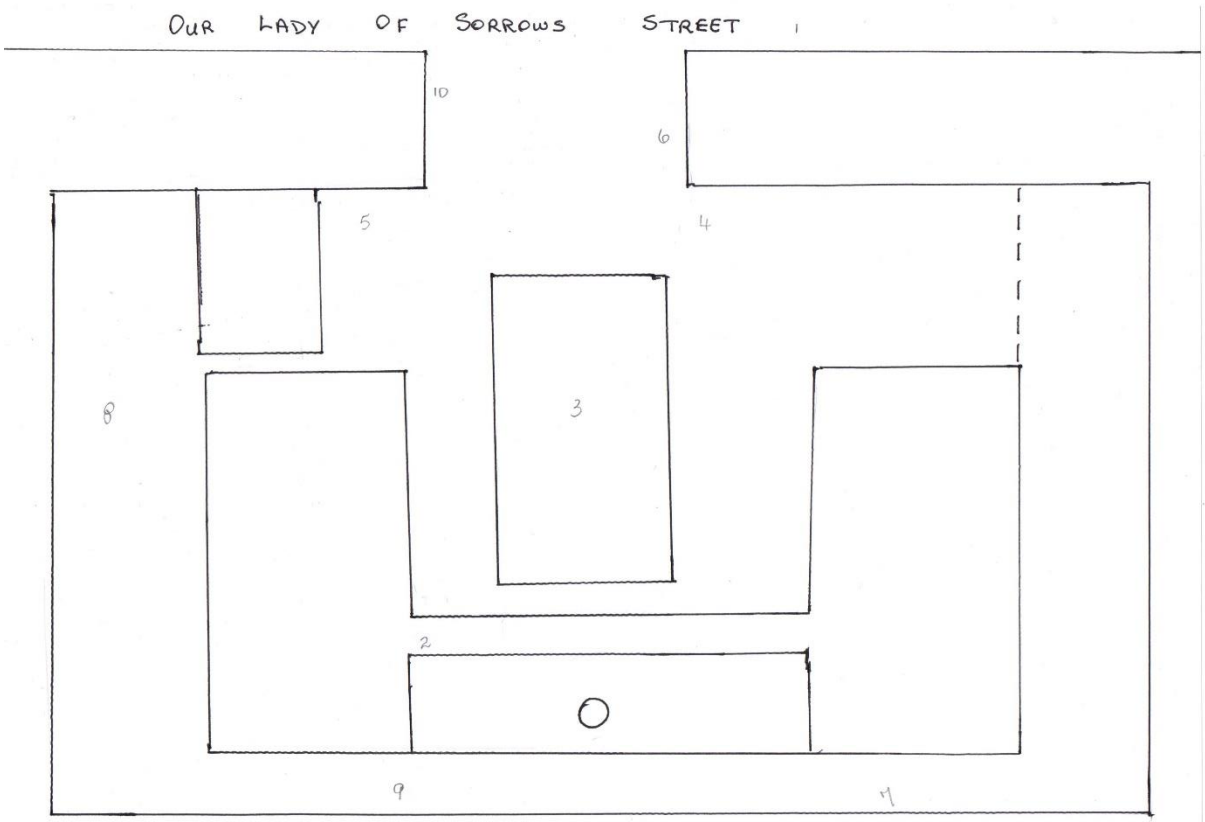

Figure 4 School plan with the 10 selected zones

DATE WEATHER CONDITIONS TIME

Surface Temperature IVSS Project										
	R1	R2	R3	R4	R5	R6	R7	R8	R9	Average
1 Tarmac										
2 Shade										
3 Synthetic Turf										
4 Even surface concrete										
5 Rough Surface Concrete										
6 Soil in the Sun										
7 Soil under the trees										
8 Soil under the shadows										
9 Soil facing South										
10 Soil facing North										

Figure 5 Datasheet used to record surface temperature readings

Results and Data Analysis

Once all the data was collected, the average value for the temperature of each zone for each day was used for comparison reasons. Ten sites were created on the GLOBE website and all data was uploaded.

The screenshots below show data uploaded on GLOBE website during observation period.

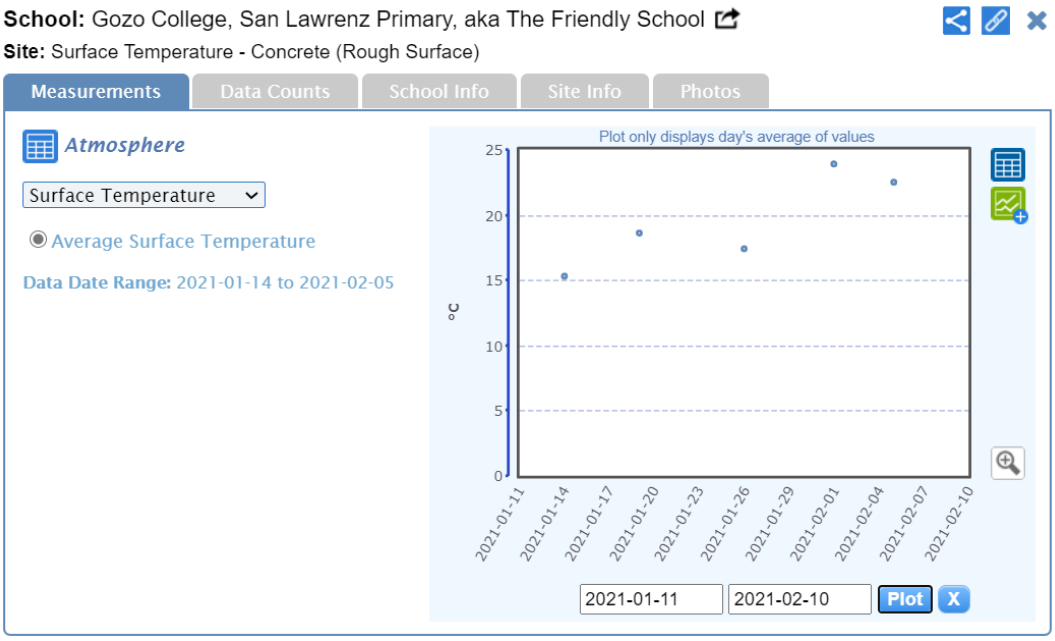

Figure 6 Surface Temperature Concrete (Rough Surface) plot of VIZ GLOBE

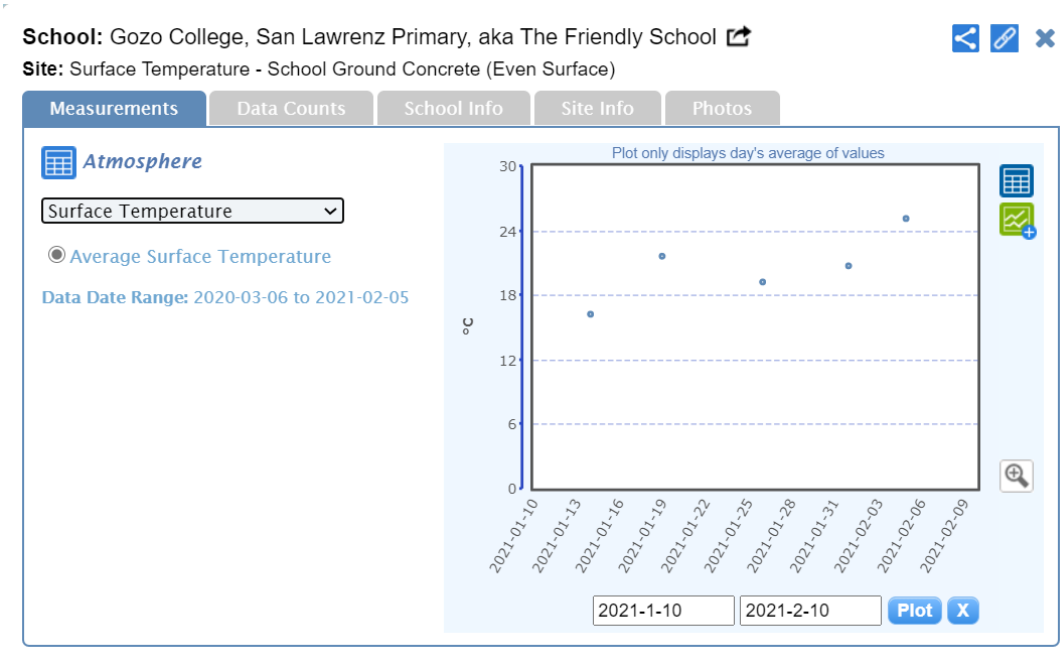

Figure 7 Surface Temperature Concrete (even surface) plot of VIZ GLOBE

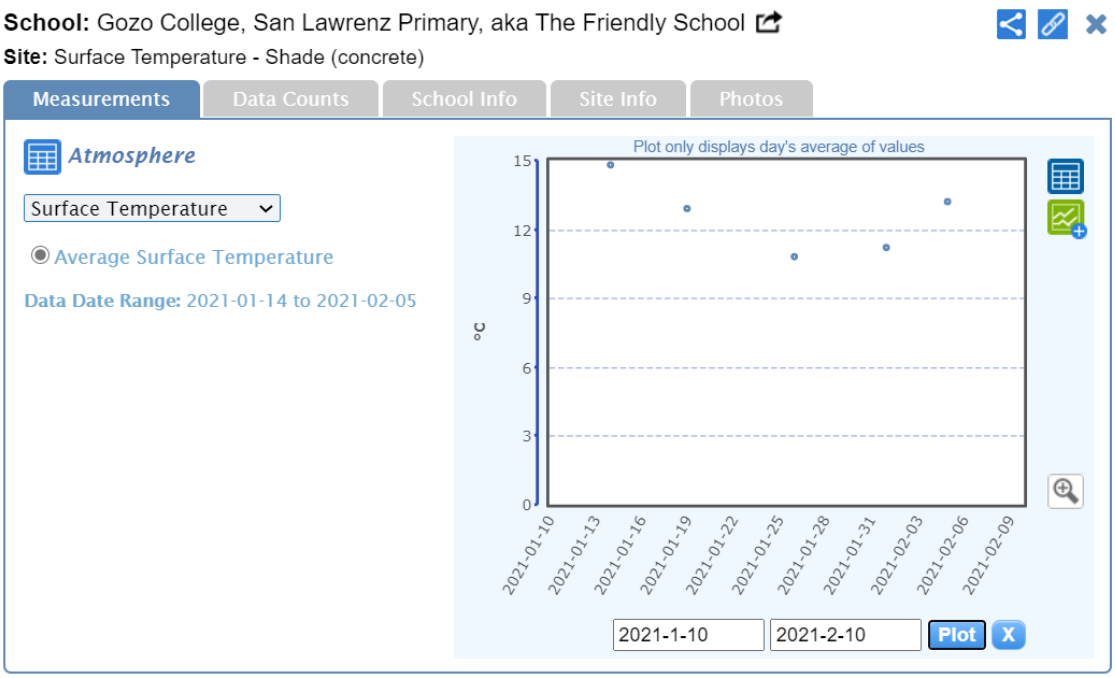

Figure 8 Surface Temperature Concrete (shade) plot of VIZ GLOBE

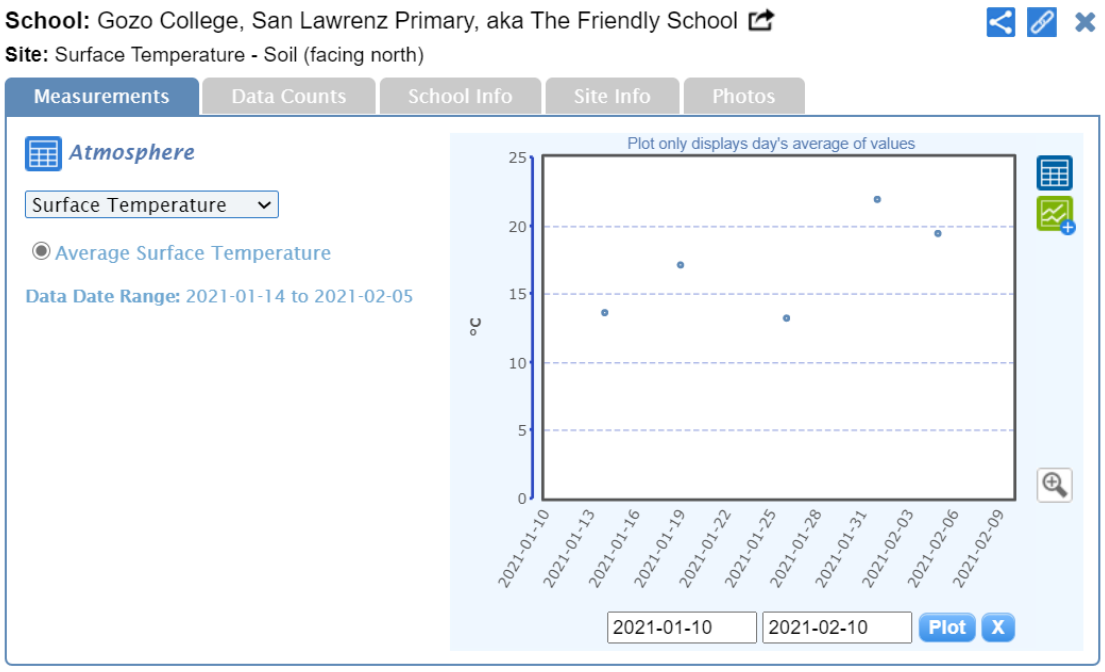

Figure 9 Surface Temperature Soil (facing north) plot of VIZ GLOBE

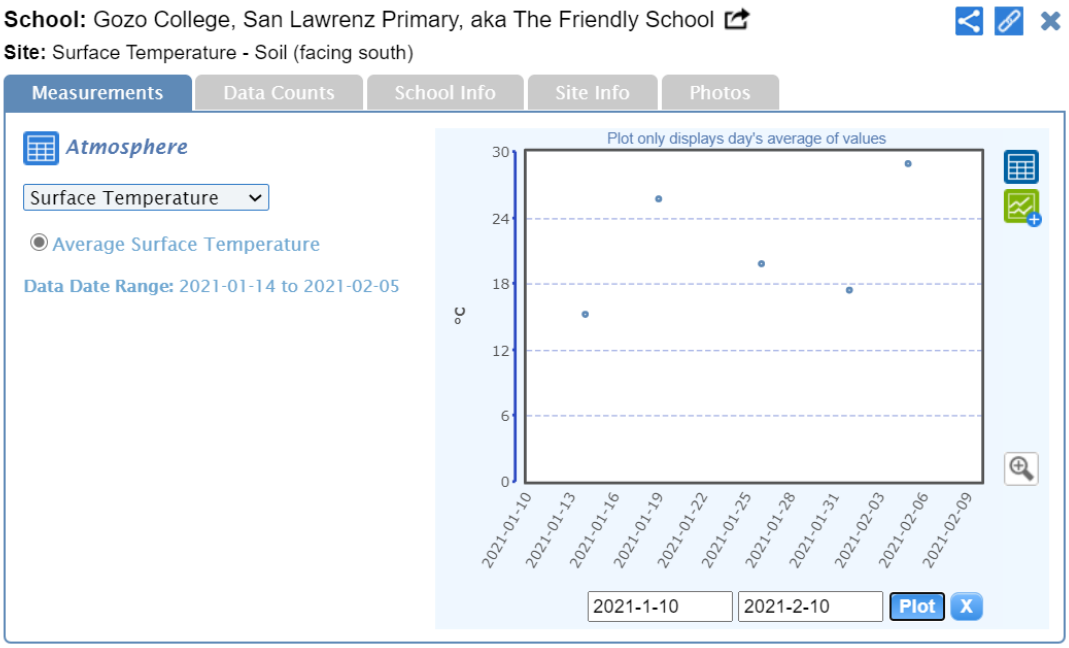

Figure 10 Surface Temperature Soil (facing south) plot of VIZ GLOBE

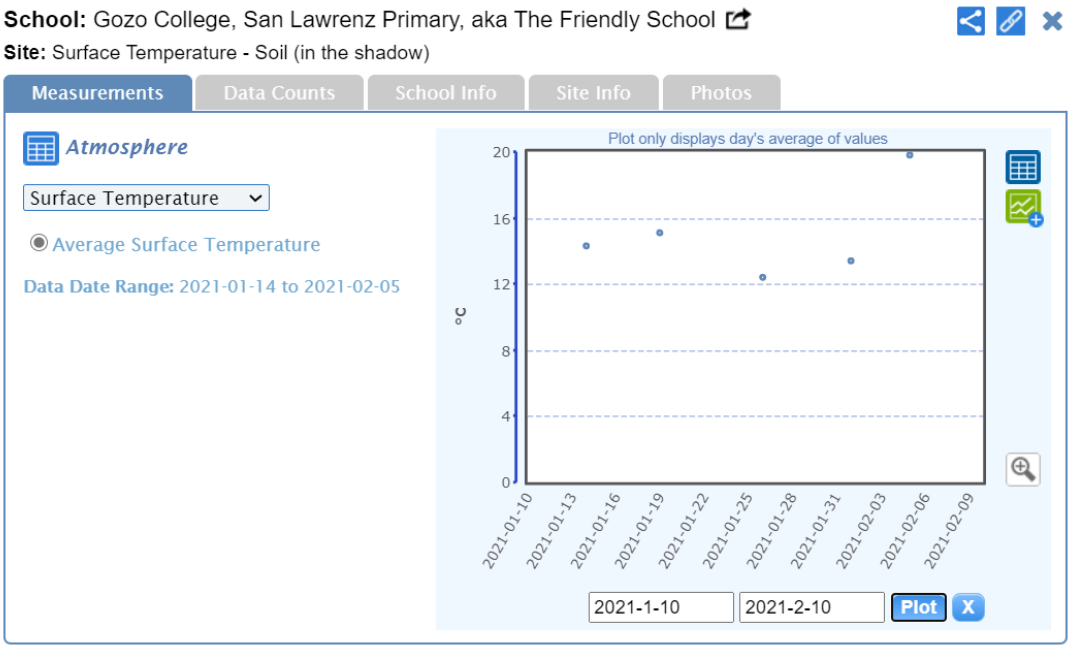

Figure 11 Surface Temperature Soil (in the shadow) plot of VIZ GLOBE

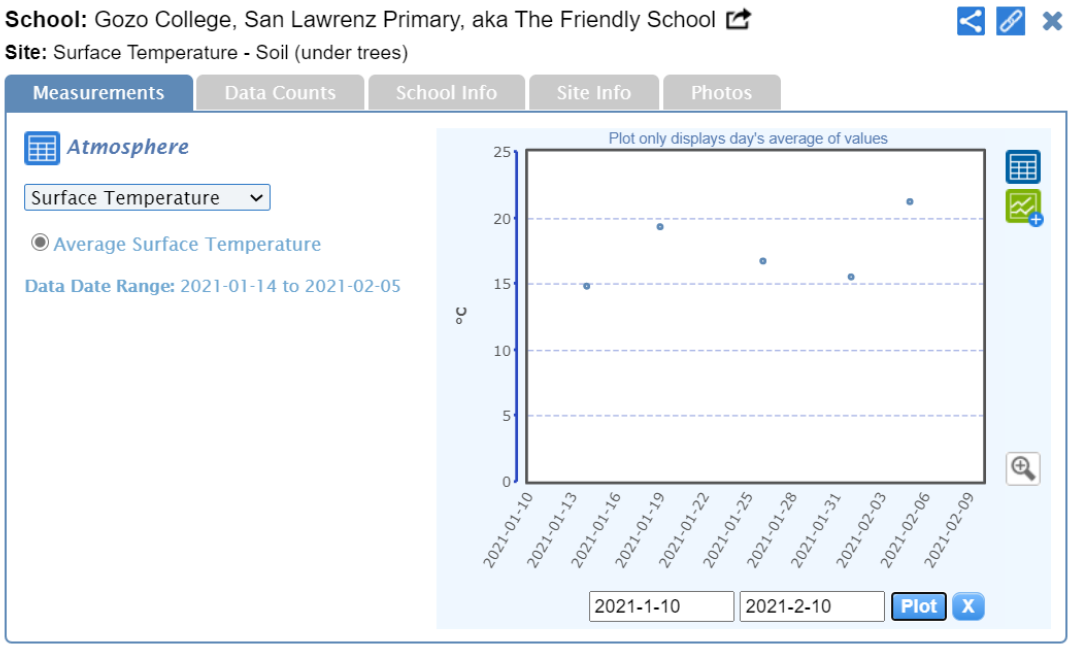

Figure 12 Surface Temperature Soil (under trees) plot of VIZ GLOBE

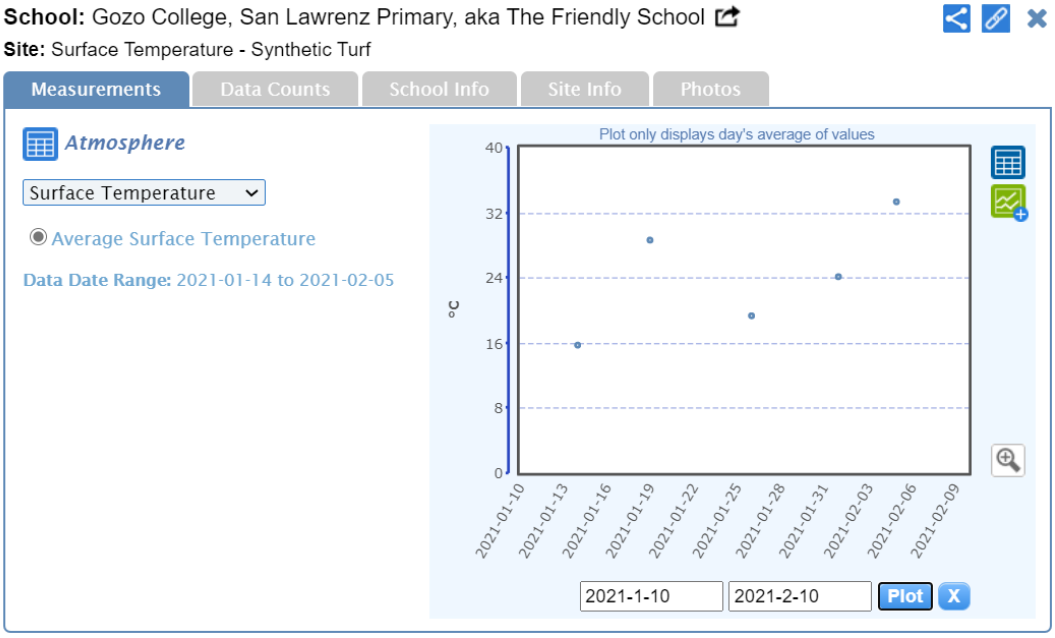

Figure 13 Surface Temperature Synthetic Turf plot of VIZ GLOBE

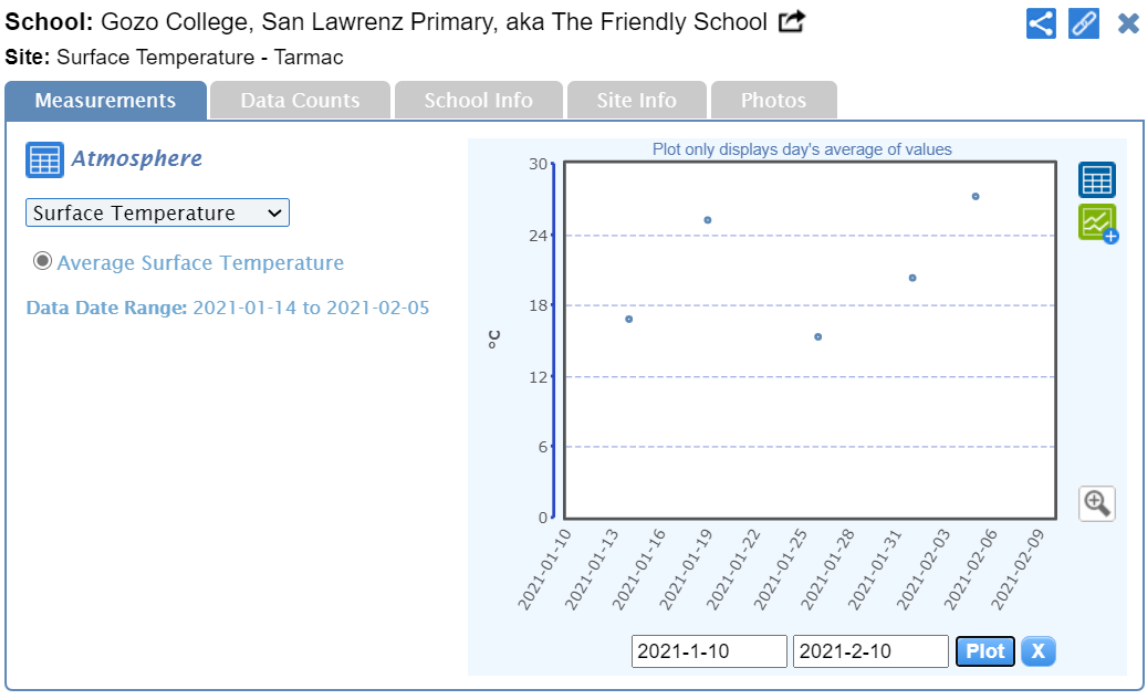

Figure 14 Surface Temperature Tarmac plot of VIZ GLOBE

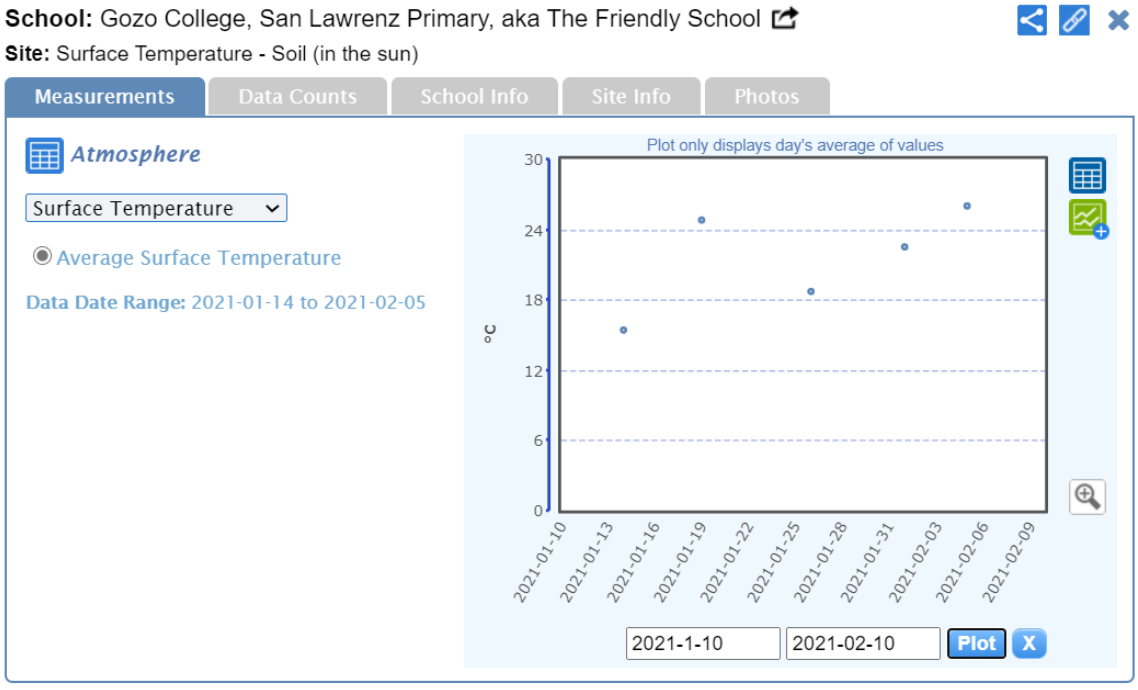

Figure 15 Surface Temperature Soil (in the sun) plot of VIZ GLOBE

A Wet Ground

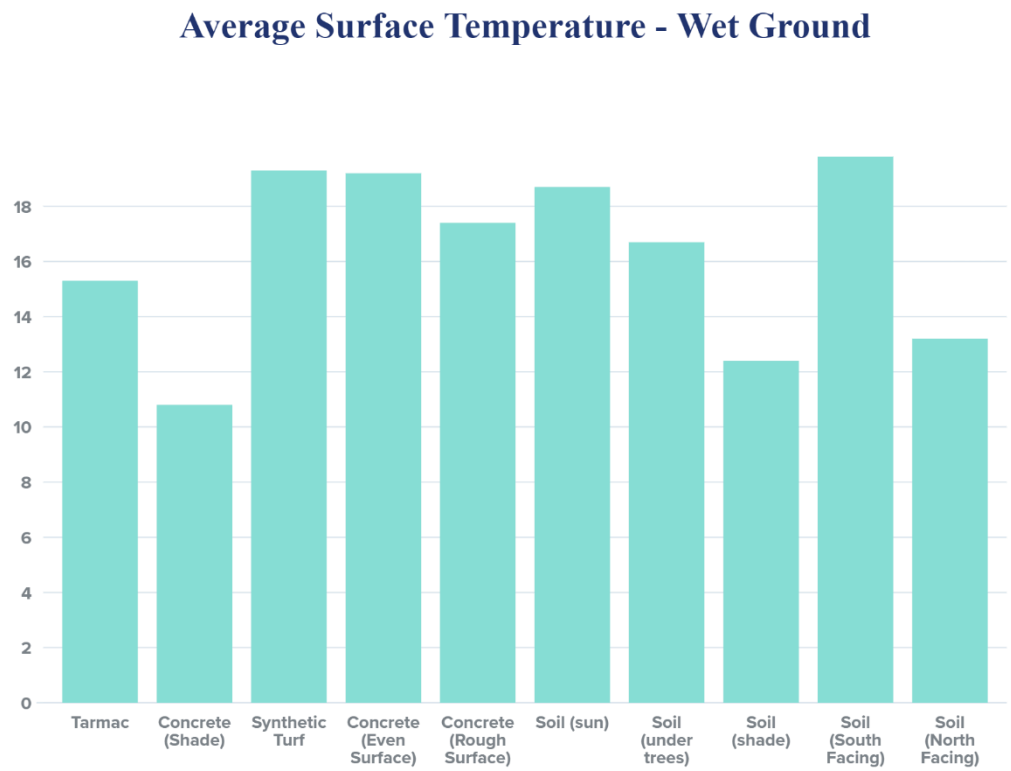

Figure 16 Bar Graph showing average surface temperature on a rainy day

The lowest average temperature recorded was that of concrete in the shade.

The highest average temperature recorded was that of the south facing soil.

Concrete: The concrete even surface registered the highest average temperature even more than the concrete with the rough surface. The patch of concrete in the shade registered the lowest temperature.

Soil: The soil's average temperature of the different zones followed a similar pattern like that of the concrete. But the south facing soil 's average temperature was a bit higher than that of the even surface of concrete

Tarmac: The tarmac's average temperature was high but not as high as that of concrete or the soil, though all three of them were in the sun.

Synthetic Turf: The synthetic turf registered a high average temperature as high as that of the concrete even surface.

B Dry Ground

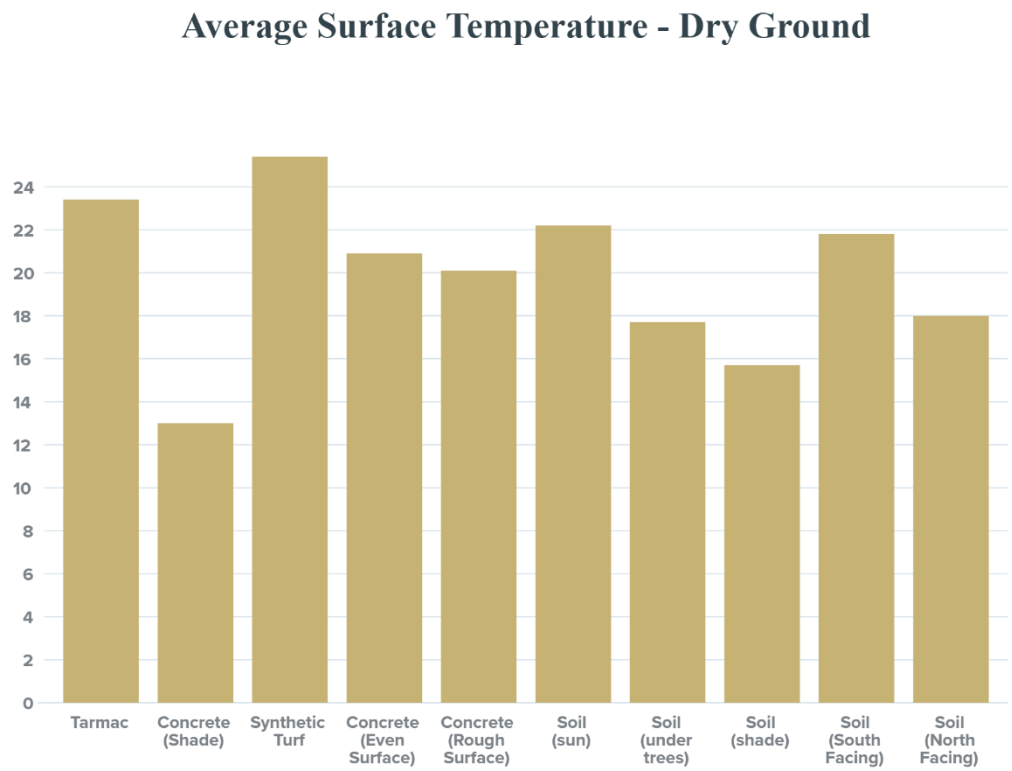

Figure 17 Bar Graph showing average surface temperature on sunny days

The lowest average temperature was registered by the concrete.

The highest temperature was registered by the synthetic turf.

Concrete: This followed the same pattern as that of the wet ground but registering slightly lower temperatures.

Soil: The average temperature of the soils registered a lower average temperature than that of the wet ground.

Tarmac: The tarmac's average temperature jumped up in these dry ground conditions.

Synthetic Turf: This registered the highest temperature.

Discussion and Conclusion

The fact that in wet conditions the soil registered a higher temperature than that of the concrete, could mean that this serves as the ideal conditions for plant food production.

The wet ground registered an overall lower average temperate than that of dry ground.

On dry ground, synthetic materials (turf and concrete) registered slightly higher average temperatures than natural occurring elements (soil). By extrapolation, one might deduce that built up areas should register higher temperatures than those in the countryside.

Black surfaces (tarmac and shredded black rubber tyres in the synthetic turf) absorb a lot more heat especially in dry conditions. This is the opposite case of the average temperature of naturally occurring material.

One can conclude that naturally occurring materials help in keeping low temperatures when the ambient temperature is high, while keeping a relatively high temperature when the ambient temperature is low, thus, promoting ideal conditions for living things.

Recommendations:

- It would be interesting to conduct a similar investigation, but this time, during different times in one whole year. This might give an indication how the temperature varies with the seasons or the months.
- A more intensive analysis of the same zones could take place by conducting the same action research, twice for each day: one in the morning and another one in the evening. In this way, one can analyse the heat retention of the different surfaces over a period of hours.

Acknowledgements

This research would not have been possible without the support of Ms Ramona Mercieca, GLOBE Deputy Coordinator.

The School community participated and helped along and believed in this project, even when the weather conditions were not ideal to go outside and take the surface temperatures.

Bibliography

GLOBE teacher guide https://www.globe.gov/ (Accessed October 2020)

GLOBE Science Data Visualization https://vis.globe.gov/GLOBE/ (Accessed February 2021)

Badge Descriptions/Justifications:

I am a Data Scientist

Students analysed their own data (from their measurements). They were able to analyse bar graphs to interpret the data. From the data analysis, the students answered their research questions and made suggestions for future research.

I make an Impact

The students shared their research with the local community and decided to take part in The GLOBE EDIC STEAM Challenge organised by GLOBE Malta. The challenge involved sowing seeds to increase the number of trees in the school garden and community. Once the trees grow they will help reduce the Urban Heat Island Effect.

I am a STEM storyteller

The research was shared on social media, school website and with the local council of San Lawrenz.

[San Lawrenz Primary - The Friendly School | Facebook]

Name of Participants:

Year 5 Shimmers

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Christabelle Caruana

Rowen Galea

Stephanie Attard

Year 4 Rainbows

Ms Michellene Grech

Faith V. Abdilla

Isaac Formosa

Jayden Buttigieg

Maraya Thewma

Year 3 Dazzlers

Ms Jennifer Farrugia

Ms Jacqueline Schembri

Louisa Cassar

Nathan Cauchi

Owen Micallef

Year 1 Shiners

Ms Marcelle Cassar

Ms Francelle Zammit

Alessandro Fava

Caia Mifsud

Dean Grima

Luisa Clausen

Renzo-Joe Micallef

Kinder 2 Little Stars

Ms Shannon Debrincat

Ben Sultana

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