Can grass cool the city? Comparison of concrete and grass surfaces

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ABSTRACT

Global warming causes an increase in average temperatures and more frequent heat waves, especially affecting urban areas. Artificial surfaces, such as concrete, contribute to the urban heat island effect, while vegetated areas can have a cooling effect. The aim of this study was to investigate whether grass surfaces can mitigate the effects of global warming in urban environments compared to concrete surfaces.

The study measured the average surface temperatures of concrete and grass according to the GLOBE protocol. Data were analyzed using a graphical representation that allowed comparison of temperature changes throughout the year. Results show that concrete surfaces have higher surface temperatures than grass for most of the year, particularly in warmer months. Lower temperatures of grass surfaces indicate their role in reducing the warming of air above the ground. The study confirms the importance of green areas as a strategy to mitigate the effects of global warming in urban environments.

QUESTION / HYPOTHESIS

Research Question

Can grass surfaces mitigate the effects of global warming in urban environments compared to concrete surfaces?

Hypothesis

We hypothesize that grass surfaces have lower average surface temperatures than concrete surfaces and thus contribute to reducing air warming in urban areas.

Rationale

This research question can be addressed by analyzing GLOBE data on surface temperature. Surface temperature is a key factor influencing the warming of near-surface air and varies depending on surface type. Concrete and grass have different physical properties, such as albedo, thermal conductivity, and moisture retention, leading to differences in heating.

The research question addresses the current scientific problem of global warming and its impact on urban areas. It has local relevance because it relates to conditions near the school environment, but also global significance as similar issues are present in cities worldwide. The study builds on existing scientific research on urban heat islands and the role of green areas in regulating environmental temperature.

INTRODUCTION

Global warming is one of today's greatest challenges, manifested through rising average air temperatures, changes in climate patterns, and more frequent and intense heat waves. Urban areas are particularly affected due to the high proportion of artificial surfaces that enhance local warming, a phenomenon known as the urban heat island effect.

Concrete and asphalt strongly absorb solar radiation and retain heat for long periods, causing urban temperatures to be higher than in surrounding rural areas. In contrast, grass and other vegetated surfaces can mitigate heating through higher albedo, shading of the ground, and water evaporation, which consumes thermal energy.

Surface temperature directly affects near-surface air temperature because air is heated from the ground through radiation, conduction, and convection. Therefore, differences in surface temperature between different surface types are an important indicator of their impact on local microclimate.

The aim of this study was to compare the surface temperatures of concrete and grass and investigate whether grass surfaces can mitigate the effects of global warming in urban environments. The study followed GLOBE protocols, ensuring scientific reliability and comparability with research worldwide.

RESEARCH METHODS

PLANNING INVESTIGATIONS

The study was planned to compare surface temperatures of two types of surfaces in the same urban environment: concrete and grass. Locations at the school playground were selected, one with a concrete surface and one with grass, both exposed to similar environmental conditions.

The study plan included measuring surface temperatures at different times of the year to cover seasonal variations. This allows observing differences in heating during colder and warmer months, which is especially relevant in the context of global warming.

Surface temperature measurements followed the GLOBE protocol using appropriate instruments. Measurements were conducted at approximately the same time of day to reduce the impact of daily temperature fluctuations. Data were recorded in the GLOBE database and later analyzed using graphical representation.

The plan also included comparing the results with known scientific knowledge about heat transfer and urban heat islands, so that results could be interpreted in a broader climate context.

CARRYING OUT INVESTIGATIONS

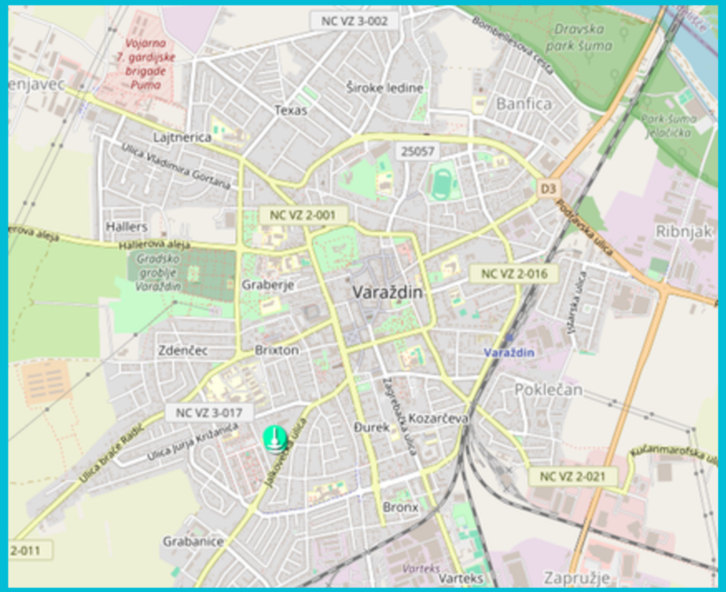
Surface temperature measurements were carried out according to the research plan and GLOBE protocol. Surface temperatures of concrete and grass were measured using appropriate instruments at roughly the same time of day to ensure comparability.

Measurements were conducted over several months, covering different seasons. Data were recorded in the GLOBE database and analyzed using graphs showing average surface temperatures over time, enabling visual comparison of temperature changes between concrete and grass.

During the investigation, potential sources of error were considered, such as weather changes or differences in sun exposure. Although all external influences could not be completely eliminated, consistent measurements over time allowed clear trends to emerge.

The collected data served as the basis for analyzing differences in heating of concrete and grass surfaces and interpreting their implications in the context of global warming and urban heat islands.

Figure #1 Display of measuring station locations



RESULTS

Analysis of graphical data on the average surface temperature of concrete and grass from December 2024 to November 2025 shows a clear and quantitatively noticeable difference between the observed surfaces throughout the year. In almost all measurements, concrete exhibited higher temperatures than grass, with differences varying seasonally and most pronounced during the summer.

Winter (December – February) is marked by the lowest absolute temperature values. In December and January, concrete mostly ranged between 2 °C and 8 °C, while grass was lower, generally between 0 °C and 6 °C. Minimum values at the beginning of January were approximately 0 °C for concrete and around –2 °C for grass, representing a difference of about 2 °C. Exceptionally, at the turn of January into February, a short-term deviation from the general trend was observed, where the grass surface temperature (around 9–10 °C) was higher than that of concrete (around 6–7 °C), with a difference of approximately 2–3 °C in favor of grass. However, in most winter measurements, concrete still showed higher values.

Spring (March – May) brings a pronounced temperature increase and a widening difference between surfaces. In March, concrete reaches approximately 22–24 °C, while grass simultaneously records 18–20 °C, a difference of 3–4 °C. In April, concrete temperatures reach 28–30 °C, while grass remains at 22–24 °C, increasing the difference to 5–6 °C. During May, concrete exceeds 30 °C on warmer days, whereas grass stays between 20 °C and 25 °C. Along with higher maximum values, concrete exhibits more pronounced daily fluctuations, indicating faster warming under solar radiation.

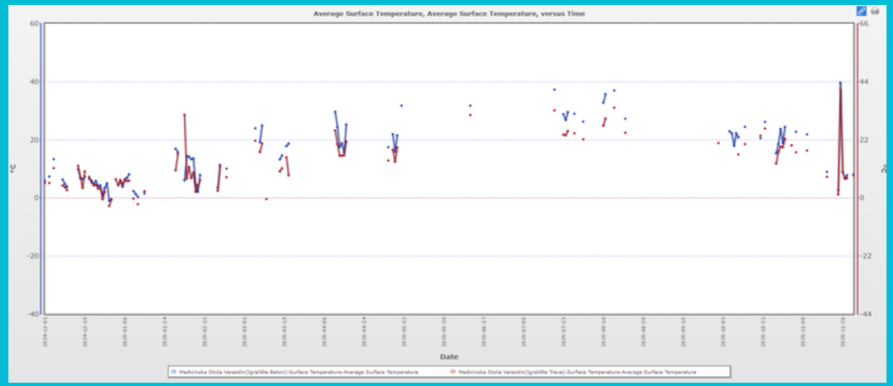
Summer (June – August) is characterized by the greatest temperature difference between surfaces. In July and August, concrete reaches 35–37 °C, while grass surfaces in the same periods record 28–30 °C. The maximum observed difference is approximately 6–7 °C. During heat peaks, concrete regularly exceeds 35 °C, while grass remains below 30 °C or only slightly surpasses it. Daily amplitude for concrete in summer often reaches about 10 °C, while grass fluctuates less, around 6–8 °C, indicating a more stable thermal dynamic of the vegetative surface.

Autumn (September – November) shows a gradual decrease in temperatures, but the difference between surfaces remains clearly visible. In October, concrete reaches approximately 20–23 °C, while grass ranges between 16 °C and 19 °C, with a difference of 3–4 °C. In November, an isolated thermal peak of about 40 °C for concrete and approximately 37–38 °C for grass was observed, again confirming higher maximum values for concrete. On colder November days, concrete ranges around 7–9 °C, while grass records 5–7 °C.

The annual temperature range for concrete is approximately 0 °C to nearly 40 °C, while grass ranges from about –2 °C to roughly 38 °C. Although total ranges are similar, concrete achieves higher maximum and average values for most of the year and shows more pronounced oscillations. The greatest differences, up to about 7 °C, occur during summer, while in winter they are minimal (around 2 °C), with a short-term exception in favor of grass.

The results clearly confirm that the type of surface significantly affects surface temperature. Concrete surfaces consistently reach higher values and exhibit more pronounced temperature peaks, while grass surfaces maintain lower and more stable temperatures, thereby contributing to the mitigation of local warming.

Figure #2 Surface temperature value graph



DISCUSSION

The results of this study clearly demonstrate a significant difference in surface temperatures between concrete and grass throughout the year. Concrete consistently exhibits higher temperatures, especially during summer months, when differences reach 6–7 °C. This phenomenon can be attributed to the higher thermal mass and faster heating of concrete under solar radiation, whereas grass, due to water evaporation and vegetative cover, maintains lower and more stable temperatures.

During winter, the differences are smaller, averaging around 2 °C, with a short-term trend reversal in February, indicating the potential influence of local climatic variations or microclimatic effects that occasionally favor grass surfaces. Spring and autumn show a gradual rise and fall in temperatures, respectively, with concrete consistently maintaining higher average values, which may have implications for urban planning and the selection of materials for outdoor surfaces.

Overall, the results confirm that surface type significantly affects local thermal dynamics. Concrete contributes to local heating and temperature fluctuations, whereas grass surfaces act as natural temperature regulators. These findings support the importance of integrating green surfaces in urban environments, particularly in the context of climate change and the increasing frequency of heatwaves.

CONCLUSIONS

The analysis shows that concrete exhibits higher temperatures and more pronounced daily fluctuations compared to grass, especially during summer. Grass surfaces maintain lower and more stable values, acting as a natural regulator of local temperature. These results highlight the importance of surface selection in urban environments – concrete contributes to increased local heating, while grass helps mitigate adverse thermal effects. In the context of climate change and increasingly frequent heatwaves, integrating green surfaces into urban planning becomes essential for maintaining comfortable microclimatic conditions and improving quality of life in cities.

GLOBE Program, 2025., Surface Temperature Protocol, https://vis.globe.gov/GLOBE/ (6.2.2026.)

NASA Earth Observing System Data and Information System (EOSDIS), 2025., Surface Temperature Data, https://earthdata.nasa.gov (6.2.2026.)