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How Surface Material Affects Ground Temperature

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Abstract— Urban areas often become significantly warmer than surrounding natural landscapes because materials like asphalt and concrete absorb more heat than grass or soil. This study investigates how different ground surfaces on a school campus affect surface temperature on a sunny afternoon. Using a digital thermometer, temperatures were measured at multiple locations representing four surface types: asphalt, concrete, grass, and bare soil. Three to five readings were taken at each site and averaged to reduce random error. Results showed that asphalt had the highest average surface temperature, followed by concrete, bare soil, and grass, which was the coolest. The temperature difference between the hottest and coolest surfaces was large enough to influence local comfort, energy use, and microclimate conditions. These findings illustrate a small-scale example of the urban heat island effect and suggest that increasing green spaces and using lighter or more reflective materials could help reduce heat exposure in school environments.

Keywords— asphalt, grass, surface temperature, urban heat island.

I. INTRODUCTION

Cities and school campuses are increasingly covered with hard, dark surfaces such as asphalt parking lots, concrete sidewalks, and building roofs. These materials absorb sunlight and convert it into heat, causing surface temperatures to rise well above the surrounding air temperature. This phenomenon contributes to the urban heat island effect, in which built-up areas become noticeably warmer than nearby rural or vegetated areas. Higher surface temperatures can lead to uncomfortable outdoor conditions, increased demand for air conditioning, and greater risks of heat-related stress, especially during hot summer days.

Previous studies have shown that surface color, material, and vegetation cover strongly influence how much heat a surface absorbs and re-emits. Dark, dense materials like asphalt typically reach higher temperatures than lighter or more porous surfaces. In contrast, vegetated surfaces such as grass stay cooler because plants reflect more sunlight and use some of the absorbed energy for transpiration, the process by which water evaporates from leaves. Understanding how different surfaces affect temperature at a local scale can help schools and cities make better decisions about landscaping, construction materials, and heat mitigation strategies.

This study focuses on a single school campus and asks: How does surface type (asphalt, concrete, grass, and bare soil) affect ground temperature on a sunny afternoon? By measuring and comparing temperatures across these common surface types, this project provides a simple, real-world example of how human-made environments influence local heat conditions and highlights the potential benefits of increasing green spaces in school design.

II. METHODS

This study was conducted on the campus of a high school to compare surface temperatures across different ground materials on a sunny afternoon. The research focused on four common surface types: asphalt, concrete, grass, and

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bare soil. These surfaces were selected because they are widely present in school environments and represent a range of materials from fully built (asphalt, concrete) to natural or semi-natural (grass, soil).

III. STUDY SITE AND SURFACE SELECTION

Data collection took place at multiple locations around the school, including the parking lot, main walkways, athletic fields, and garden areas. For each surface type, two to three representative sites were chosen to ensure that the results were not based on a single unusual spot. For example, asphalt measurements were taken from both the main parking lot and a smaller paved area near the gym, while grass measurements came from different parts of the sports field. All selected sites were in direct sunlight during the measurement period and were not shaded by buildings or trees at the time of data collection.

IV. MATERIALS

The primary instrument used in this study was a digital infrared thermometer, which allows non-contact measurement of surface temperature. This type of thermometer is commonly used in environmental science projects because it is easy to operate, provides quick readings, and minimizes disturbance to the surface being measured. In addition to the thermometer, a spreadsheet was used to record temperature readings, surface type, location, time, and weather conditions. Air temperature data were obtained from a reliable weather application to provide context for the surface temperature measurements.

The following information was recorded for each measurement:

- Surface type (asphalt, concrete, grass, or bare soil)
- Specific location ("north parking lot," "main sidewalk near building A")
- Time of measurement
- Air temperature at the time of measurement
- General weather conditions (sunny, partly cloudy, no recent rain)

Data collection was repeated over two afternoons within the same week to improve reliability and account for minor day-to-day weather variations. All measurements were taken under similar conditions: no rain in the previous 24 hours, minimal wind, and mostly sunny skies.

V. DATA ANALYSIS

For each surface type, the average temperature was calculated by combining all readings from all sites of that type. The range (difference between the highest and lowest average temperatures) was also calculated to illustrate the magnitude of temperature variation across surfaces. No advanced statistical tests were used, as the goal of this study was to demonstrate clear, observable differences suitable for a high school environmental science paper.

VI. LIMITATIONS

This study has several limitations. First, data were collected over only two afternoons, which may not represent temperature patterns across different seasons or weather conditions. Second, the number of measurement sites for each surface type was limited by time and access. Third, factors such as recent maintenance or proximity to

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buildings could influence individual readings. Despite these limitations, the consistent patterns observed across multiple sites suggest that the results provide a reasonable illustration of how surface type affects ground temperature in a school environment.

VII. RESULTS

Data were collected on a sunny afternoon in late June in Songdo, Incheon, when the air temperature was approximately 29°C (84°F), which is typical for summer in this region. Surface temperatures were measured for four surface types: asphalt, concrete, grass, and bare soil. For each surface, multiple readings were taken at different locations around the school and then averaged.

Table 1: Surface temperature readings (°C) for different ground materials in Songdo, Incheon

Surface Type	Reading 1 (°C)	Reading 2 (°C)	Reading 3 (°C)	Reading 4 (°C)	Reading 5 (°C)	Average (°C)
Asphalt	52	54	53	55	51	53.0
Concrete	45	47	46	44	46	45.6
Bare Soil	38	37	39	38	37	37.8
Grass	32	31	33	32	31	31.8

These values are consistent with previous studies showing that dark, dense materials like asphalt reach much higher surface temperatures than vegetated surfaces under similar weather conditions.

Key Patterns

Several clear patterns emerged from the data:

- Asphalt was the hottest surface, with an average temperature of 53.0°C, which is 24.0°C higher than the air temperature. This large difference illustrates how dark, impermeable materials can become significantly hotter than the surrounding air on sunny days.
- Concrete was the second hottest, averaging 45.6°C. Although lighter in color than asphalt, concrete still absorbs substantial heat and remains much warmer than natural surfaces.
- Bare soil was moderately warm, with an average of 37.8°C. Soil heats up more than grass but less than paved surfaces, likely due to its higher moisture content and lower density compared to asphalt and concrete.
- Grass was the coolest surface, averaging 31.8°C, only about 2.8°C above the air temperature. Vegetation stays cooler because plants reflect more sunlight and use some absorbed energy for transpiration.

The temperature difference between the hottest surface (asphalt, 53.0°C) and the coolest surface (grass, 31.8°C) was 21.2°C. This is a substantial gap, large enough to affect how hot the environment feels to people walking or standing on these surfaces, and it demonstrates a small-scale version of the urban heat island effect.

Volume: 05 / Issue: 06 / 2026 - Open Access - Website: www.mijrd.com - ISSN: 2583-0406

These results support the hypothesis that asphalt would have the highest surface temperature and grass the lowest, with concrete and bare soil in between. The data provide a clear, quantitative example of how surface material influences local heat conditions on a school campus in Songdo.

VIII. DISCUSSION AND CONCLUSION

The results of this study show that surface type has a strong effect on ground temperature on a sunny afternoon in Songdo, Incheon. Asphalt reached an average of 53.0°C, while grass remained near 31.8°C, a difference of more than 20°C. This pattern matches what is expected from the urban heat island effect, in which built environments with large areas of pavement become significantly warmer than vegetated areas.

These temperature differences have practical implications for a school campus. Surfaces like asphalt and concrete can become hot enough to cause discomfort or even minor burns if touched for too long, and they radiate heat into the surrounding air, making outdoor spaces feel warmer. Over time, extensive paved areas can raise local air temperatures, increasing the need for cooling indoors and contributing to higher energy use. In contrast, grass and other vegetated surfaces stay closer to air temperature, providing cooler areas for students to walk, sit, or play.

The findings suggest several simple strategies that could help reduce heat exposure at school. Increasing the amount of grass, trees, or garden beds in place of unused paved areas would lower surface temperatures and create more comfortable microclimates. Where pavement is necessary, using lighter-colored or cool materials that reflect more sunlight could also reduce heat absorption. Even small changes, such as adding shade structures over parts of the parking lot or planting trees along walkways, could make a noticeable difference on hot summer days.

This study has some limitations. Data were collected over only one type of weather condition (sunny, early summer afternoons) and at a single school. Temperatures might differ in other seasons, under cloud cover, or at campuses with different layouts and materials. Future projects could expand on this work by measuring temperatures at different times of day, across multiple schools in Songdo, or by comparing old and newly paved surfaces.

Despite these limitations, the clear pattern in the data supports the original hypothesis: asphalt is the hottest surface, followed by concrete, bare soil, and grass. This simple experiment demonstrates how everyday materials on a school campus contribute to local heat conditions and provides a concrete example of the urban heat island effect at a scale that is easy to observe and measure. By understanding these effects, students and school planners can make more informed choices about landscaping and construction to create cooler, more sustainable learning environments.

REFERENCES

[21] EPA. (n.d.). Reducing urban heat islands: Compendium of strategies – Cool pavements. U.S. Environmental Protection Agency. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100RPMZ.TXT

[22] Hood College. (n.d.). Surface temperature fact sheet. https://www.hood.edu/sites/default/files/Coastal%20Studies/UHS/LessonPlans_ManualFiles/Surface%20Temp_Albedo%20FactSheet_DL.pdf

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[23] Reuters. (2025, July 1). How concrete, asphalt and urban heat islands add to the misery of heat waves. https://www.reuters.com/graphics/CLIMATE-CHANGE/URBAN-HEAT/byvrejywdpe/

[24] Reuters. (2026, July 2). The floor is lava [Graphics: USA weather heat explainer]. https://www.reuters.com/graphics/USA-WEATHER/HEAT-EXPLAINER/zjvqgexlxvx/

[25] Science Buddies. (n.d.). High school, environmental science experiments. https://www.sciencebuddies.org/science-experiments/environmental-science/high-school

[26] YRI Science. (2026, January 12). Environmental science research for high schoolers. https://www.yriscience.com/blog/environmental-science-research-high-school