How does the Urban Island heat effect impact Toledo, Ohio?

Miles Wharry and Dominic Timmers

10th grade

16 years old

2532 Evergreen Road

Ottawa Hills, Ohio 43606

USA

Dr. K.G.

Tuesday January 27th 2026

Table of contents

Abstract

The Urban Heat Island effect is present in many areas of life, and understanding it can help to improve city infrastructure and help to reduce heat-related injuries. This effect is when cities are warmer than rural areas, due to factors such as concrete and burning of fossil fuels that heats up the surrounding areas. We hypothesize that downtown Toledo will be slightly warmer than suburban Ottawa Hills. The methods used were using a thermometer to test the air temperature in 2 different areas, one suburban and one urban to demonstrate the urban heat island effect. The materials used were a thermometer, a computer for the data, and a box to stop environmental factors. The results of the experiment showed Ottawa Hills to be cooler than downtown Toledo by an average of 2.24 degrees. From the results, it can be concluded that the urban heat island effect is present in urban and suburban areas of moderately sized cities.

Intro

Question: How is how is the urban heat island present in Ottawa Hills vs Toledo

Hypothesis: We believe that the temperature will be higher in the urban area than the rural area because asphalt and other things found in cities affect the air temperature differently.

On a hot day, people often move into the shade to cool down, but how much colder is it actually in the shade does it make a difference. Temperature plays an important role because it affects human safety, and health. Since high temperatures can lead to heat exhaustion especially during long periods outdoors. Understanding how surroundings affect temperature can help people make safer decisions when spending time outside. Sunlight heats surfaces and air differently depending on the material. In addition the amount of heat transfer can differ based on

location and environmental factors like clouds. Learning how temperature varies between urban and suburban areas is important for understanding heat exposure and improving outdoor safety.

Sunlight is a major factor that influences temperature on Earth. When sunlight hits the Earth's surface, it is absorbed and converted into heat energy."The main cause of the urban heat island effect is modification of the land surface by urban development." (Baltimore office sustainability, 1, 2015) Also dark or solid surfaces, such as pavement or soil, often absorb more heat than lighter surfaces."The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat."(NASA, 1, 2025) Areas exposed to the sun for long periods tend to become warmer than areas not directly exposed to the sun. Heat from surfaces can warm the surrounding air raising the overall temperature of the area.

Heat transfer is the movement of heat from one object to another, and in this case, heat transfer comes from radiation in the sun and from the ground. "Urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas."(epa.gov,1, 2025) Concrete and asphalt spots receive a lot of heat from the radiation of the sun, transferred through the air. While dirt and grass don't receive as much of this radiation, causing lower temperatures in such spots. Heat can also be transferred through conduction. In urban areas more cars and people are walking around causing it to be slightly hotter because of exhaust. While in suburban areas it is slightly less since there is less going on.

In conclusion, temperature differences between urban and suburban areas are influenced by sunlight and the amount of heat transferred. Sunlight increases temperature by transferring

energy to surfaces and air, and motion and other factors in nearby areas also affect the temperature. Factors such as surface type clouds, and time of day also play a role. Understanding temperature differences between urban and suburban areas is important because it can help reduce heat-related health risks and improve outdoor comfort and safety. This experiment will measure and compare temperatures in urban and suburban areas using a thermometer over the same time period to determine how much they differ.

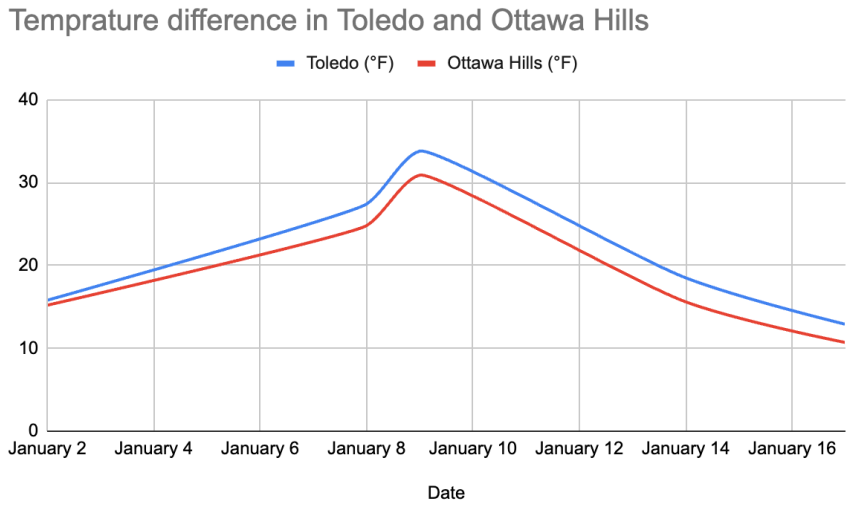
Methods and Materials

We are using the atmosphere air temperature globe protocol and before you start the experiment be sure you have a fahrenheit mercury thermometer; the brand doesn't really matter, a shoe box, a computer and a shady area outside to do the experiment. There could be danger of overheating or frostbite if not prepared for the weather outside.

First make sure you have a thermometer that is unaltered. Then take it and go outside to an open area away from buildings, cars, and direct sunlight. You should try to do it on days without snow since it can build up on the thermometer. Then place the thermometer in the shade above the ground about 4 feet up. Make sure to use a cardboard box to block wind from affecting the temperature like a shoe box with no lid. Next leave the thermometer there for 5 minutes.After the 5 minutes read the temperature without touching the thermometer stand as close as you can without having your breath or body heat affect it. Use your computer to record the temperature and date then repeat steps 1-5 on different days. For the other area repeat steps 1-8 in an urban area so you can compare data works best with 2 people one in each location at the same time.

Then compare the temperatures you got and the temperature in the city to find the average difference between the suburban and urban area

Presentation of Data and Results



The data also shows the two places having an average temperature difference of 2.24 degrees Fahrenheit, with the largest difference being 2.9 degrees and the smallest being 0.6 degrees Fahrenheit. In each test, downtown Toledo was warmer than Ottawa Hills. There was a slight heat increase on January 9th where both places jumped up a bit in temperature. The high for Toledo was 34 degrees fahrenheit and the high for Ottawa Hills was 31 degrees fahrenheit. The low for Toledo was 13 degrees Fahrenheit and the low for Ottawa Hills was 11 degrees.

Analysis and Results

Our findings suggest that on average due to urban heat island effect the temperature in urban areas is more than suburban areas because on average downtown Toledo was a few degrees warmer than Ottawa hills. This supports our hypothesis that the temperature will be higher in the

urban area than the rural area because asphalt and other things found in cities affect the air temperature differently. According to EPA Gov heat island, the heat island effect results in daytime temperatures in urban areas about 1–7°F higher than suburban areas. This information supports our hypothesis because on average the temperature also goes up in urban areas like our hypothesis. Some issues we faced while collecting our data were the snow. It was hard to keep it off of the thermometer . If we were to reconduct this experiment, we would do more trials and use better equipment and we would also test more locations. We believe our hypothesis was accurately tested because all of our data fell into the category needed to prove our hypothesis right.

Conclusion

In conclusion, our project accepted our hypothesis. Our successes were showing that there was a temperature difference between urban and suburban areas of Toledo, as well as utilizing our resources to be able to test our experiment. However, our experiment could have been improved by recording temperatures at different times, for example to see if temperatures at night have a greater or lesser effect on urban islands. Our data could help scientists understand the effect that densely populated areas have on temperature.

Discussion

Other studies report an average difference of 1-7 degrees fahrenheit higher in cities to rural areas according to (heatislands/what-are-heat-islands) our data fits into this range with an average of 2 degrees hotter in the city's. Our hypothesis was supported because on average the temperature was higher in the city and we predicted it would be slightly hotter in the city compared to the rural area. I think we obtained the results we did because cities have more materials in them that

heat differently like asphalt and concrete, and there is more motion and movement from cars and people. There were some errors in our experiment since they weren't all taken at the exact same time each day some were like 15 min apart for some days. We also could have used better equipment to stop outside factors from affecting our experiment. Even though our experiment wasn't perfect I do believe it still proved our hypothesis was accurately tested.

Acknowledgments

We would like to acknowledge Dr. KG for her help and support with our science fair and helping us find our project idea.

References

kmansfield. (2025, September 11). *What Is an Urban Heat Island?* NASA Science. https://science.nasa.gov/kids/earth/what-is-an-urban-heat-island/

Learn About Heat Island Effects | US EPA. (2024, August 2). US EPA. https://www.epa.gov/heatislands/learn-about-heat-island-effects

National Integrated Heat Health Information System. (2025, August 19). *Urban Heat Islands - Heat.gov*. Heat.gov. https://heat.gov/urban-heat-islands/

Urban Heat Island Sensors | Baltimore Office of Sustainability. (2015, December 10). https://www.baltimoresustainability.org/urban-heat-island-sensors/

Druckenmiller, H. (2023, March 14). *Urban Heat Islands 101*. Resources for the Future; Resources for the Future. https://www.rff.org/publications/explainers/urban-heat-islands-101/