

A STUDY OF THE SURFACE TEMPERATURES OF
SIX GROUNDCOVERS ON THE FROSTBURG STATE
UNIVERSITY CAMPUS

By:

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Heat Session I

Urban Heat Island Session 1

- We measured the surface temperatures of six different types of groundcovers on Frostburg State University's Campus.

Climate

- Average weather of an area over a period of time
- Madagascar is a country that has a tropical climate
 - Hot all year
 - Humid
 - Rainy
- Desert is a region that has a dry climate
 - Hot all year
 - Little precipitation

What are Microclimates

- Microclimates
 - Small areas
 - Climate varies from surrounding areas
 - Elevation, moisture, sun/shade, wind, and groundcover

Example of a Microclimate

- Urban Heat Island
 - City areas
 - Higher air and surface temperatures than rural and suburban areas

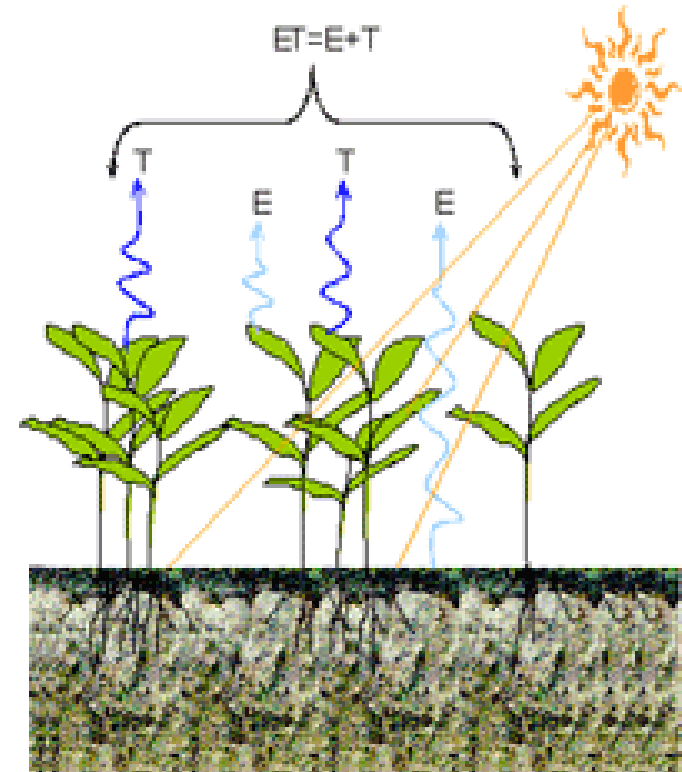
Vegetated groundcovers

- Contain vegetation (plant life)
 - Gardens
 - Grass
 - Parks
- Cooler than non-vegetated areas



Why Are They Cooler?

- Evapotranspiration
 - Energy from the sun
 - Evaporates water
 - Transports water into the atmosphere
 - Soil and Plants
 - Energy
 - Not converted into heat



Why Are They Cooler?

- Photosynthesis
 - Energy from sun
 - Makes sugar
 - Makes Nutrients
 - Energy
 - Not converted into heat



Non-vegetated Groundcovers

- Do not contain plant life

- Examples

- Sand
- Asphalt



- Main factors that affect the surface temperature
 - Color
 - Specific heat capacity of a material

Color

- Darker colors
 - Warmer
 - Absorbs energy
- Lighter colors
 - Cooler
 - Reflects energy



Specific Heat Capacity of a Material

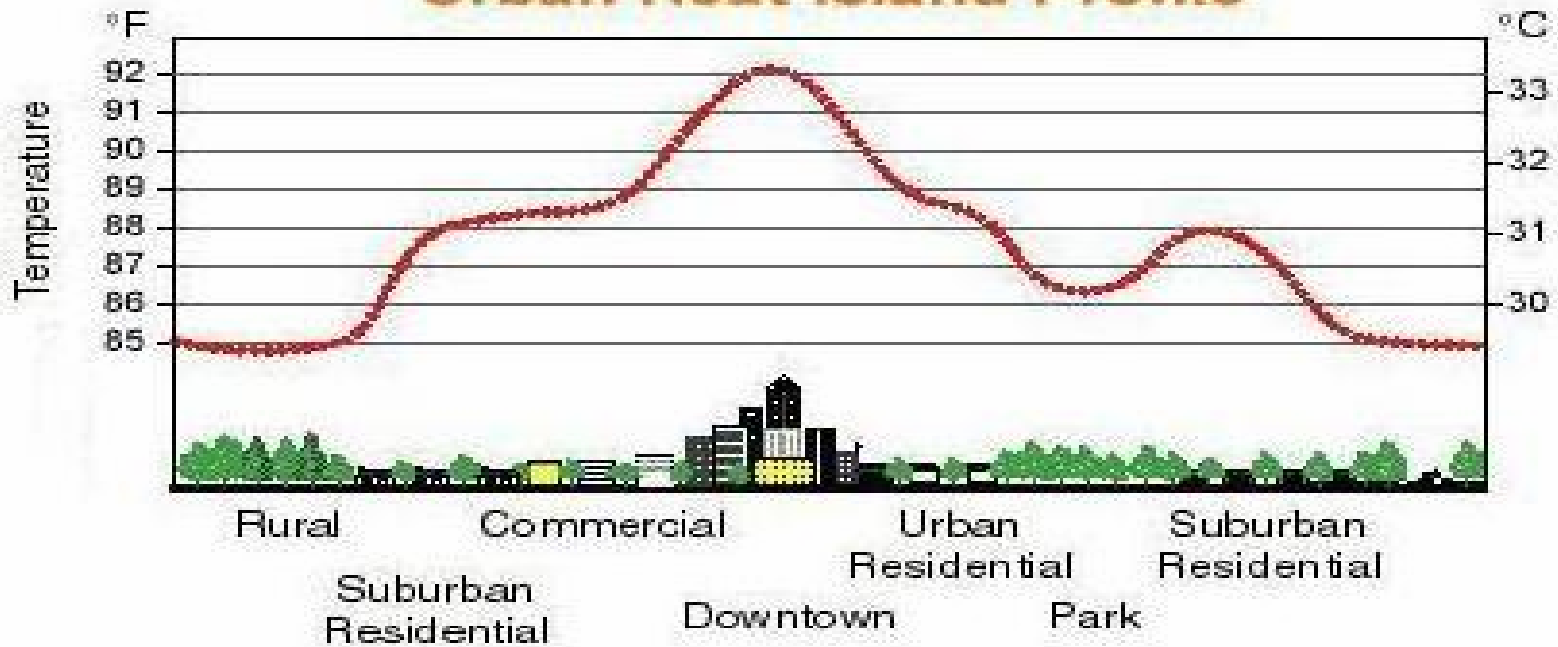
- Specific Heat Capacity
 - The amount of kilocalories (energy) it takes to heat up a kilogram of an object 1 °C
 - Lower Specific heat capacity = higher temperature
 - Higher Specific heat capacity = cooler temperature
- Examples of specific heat capacity
 - Diamond-0.16kcal/kg °C
 - Aluminum Foil-0.21kcal/kg °C



An Urban Heat Island

- Example of a Microclimate
 - small amounts of vegetation
 - large areas of pavement
- Areas with dark roof tops and asphalt

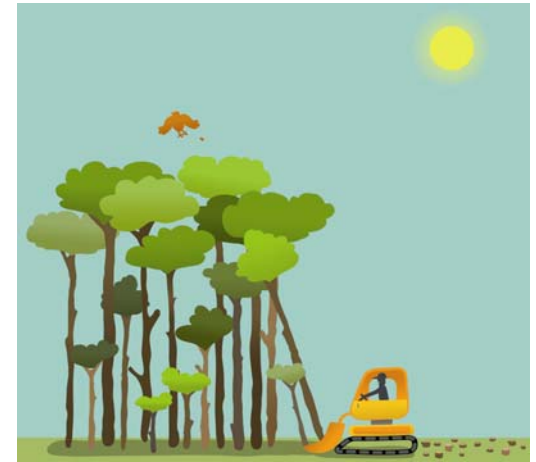
Urban Heat Island Profile



Rural and Suburban areas cooler than Urban areas

How Heat Islands are Formed

- Removing natural resources
 - Displacing trees
 - Removing plants
- Replacing natural resources
 - Pavements
 - Buildings



Negative Effects of Urban Heat Islands

- Health problems
 - Heat stroke
 - Heat exhaustion
- Higher cooling cost
- Global warming

Purpose

- To compare the surface temperatures of different groundcovers around Frostburg State University's campus
- To learn about Frostburg State University's heat island

Hypothesis

- If surface temperatures vary due to differences in color and specific heat capacity then the groundcovers in our study can be ranked by their increasing surface temperatures.
 - The rankings from coolest to hottest are grass, track, AstroTurf®, concrete, brick, and asphalt

Methods

Groundcovers

Types

- Brick
- Concrete
- AstroTurf®
- Grass
- Asphalt
- Track

Why Selected

- All common groundcovers
- Moisture
- Sun exposure
- Wind exposure
- Elevation is less than 30m

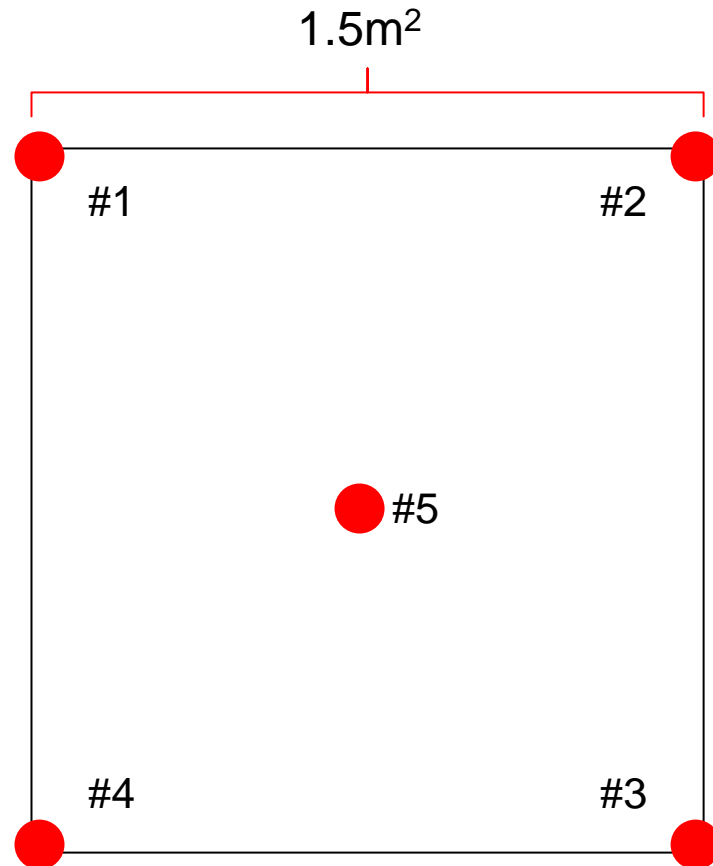
Instruments

- Raytek®STPro™ infrared thermometer (IRT)
- Magellan®ETrek™ Global positioning system (GPS)
- IRT used to get surface temperature
- GPS used to get coordinates and time



Procedure

- Temperatures measured
 - At 10:00 am and 2:00 pm
 - On July 2, 2008 and July 3, 2008



Data Analysis

- Averaged the five temperatures for each time
- Calculated standard deviation
- Found changes in temperatures

- Average Equation

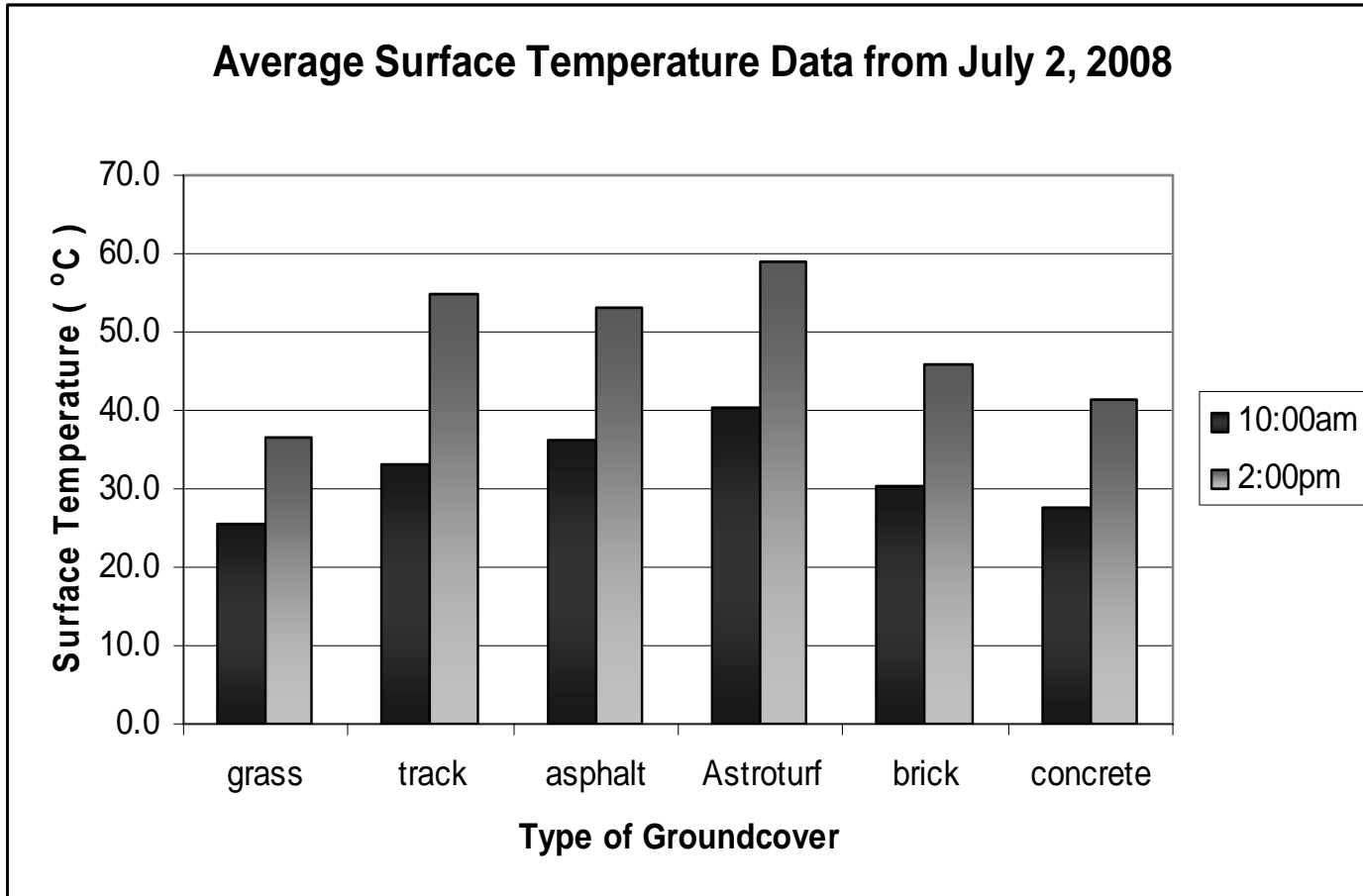
$$\bar{x} = \frac{x_1 + x_2 + x_3 + \dots x_n}{n}$$

- Standard deviation equation:

$$\sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Results

Results



10:00 am

Grass Standard deviation 1

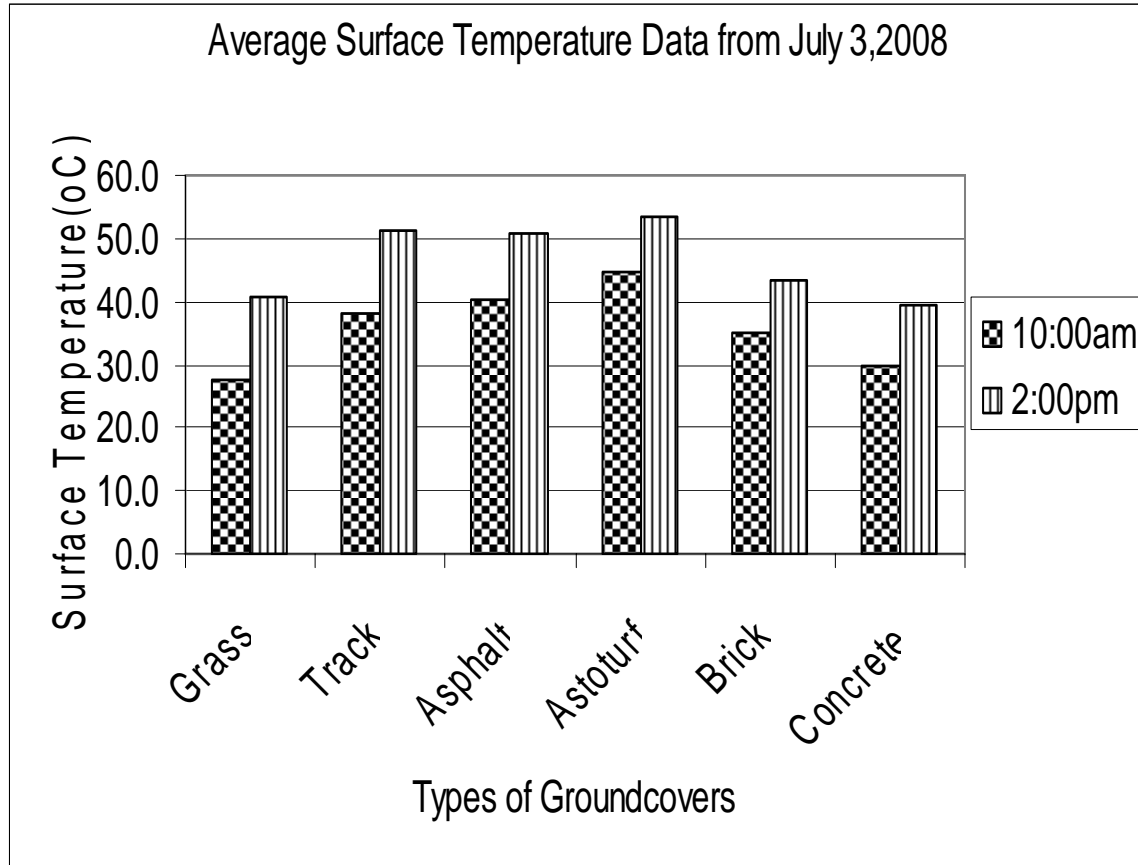
AstroTurf® Standard deviation 2.6°C

2:00 pm

Grass Standard deviation 0.9°C

AstroTurf® Standard deviation 4.1°C

Results



10:00 am

Grass Standard deviation 0.8 °C

AstroTurf® Standard deviation 0.7 °C

2:00 pm

Grass Standard deviation 1.2 °C

AstroTurf® Standard deviation 1.2 °C

Discussions and Conclusions

Hypothesis was rejected

Why?

- Hypothesis
 - Grass
 - Track
 - AstroTurf®
 - Concrete
 - Brick
 - asphalt
- Results
 - Daily changes in surface temperature order
 - AstroTurf® warmest in all four trials

Improvements

- More vegetated groundcovers
 - Flower beds
 - Parks
 - Fields
- Liquids and not just solids
 - Rivers, pools, and lakes
- More test days
- More temperature readings per day

Implications from AstroTurf® being the hottest

- potential for more heat related injuries
 - Heat exhaustion
- Contributing to Urban Heat Islands
 - Replacing park areas with AstroTurf®

Data Explanations

- Grass surface temperature hotter than concrete on the second day
 - less moisture in the grass
 - limiting evapotranspiration
 - causing energy to be converted into heat
 - lower specific heat capacities
 - wet grass(0.35 kcal/kg °C)
 - dry grass(0.19 kcal/kg °C)

Data Explanations

- Track hotter than expected and asphalt cooler than expected
 - Track in thermal contact with AstroTurf® making it warmer
 - Asphalt in thermal contact with vegetated areas making it cooler

Data Explanations

- concrete cooler than expected
 - color and age affect the surface temperature
 - old concrete darker
 - darker concrete absorbs more heat

Data Explanations

- Brick cooler than expected
 - specific heat capacity of brick inlays higher than concrete
 - brick (0.22 kcal/kg °C)

Something to consider

- Include the environmental effects when choosing groundcovers
 - Vegetated over non-vegetated
 - Lighter color pavements
 - High heat capacity