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

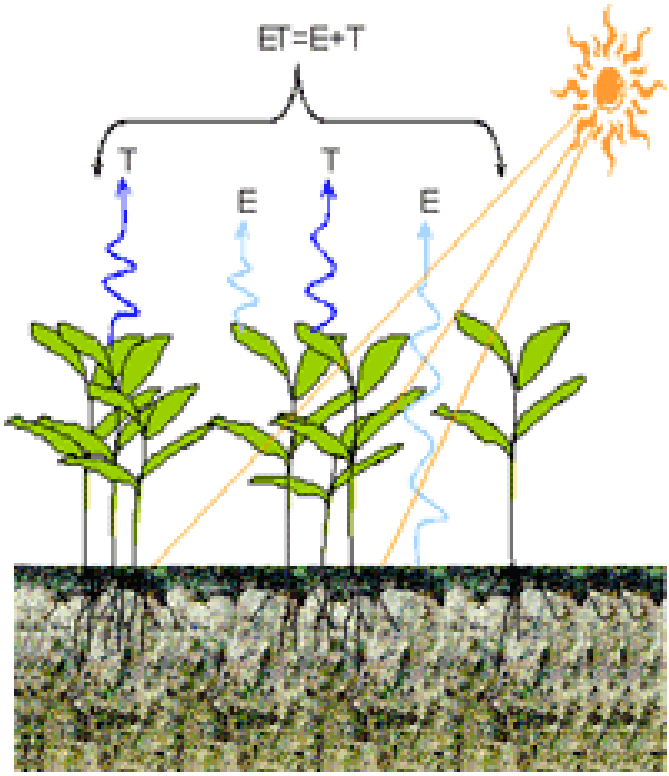
- Urban Heat Island
  - City areas
  - Higher air and surface temperatures than rural and suburban areas

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

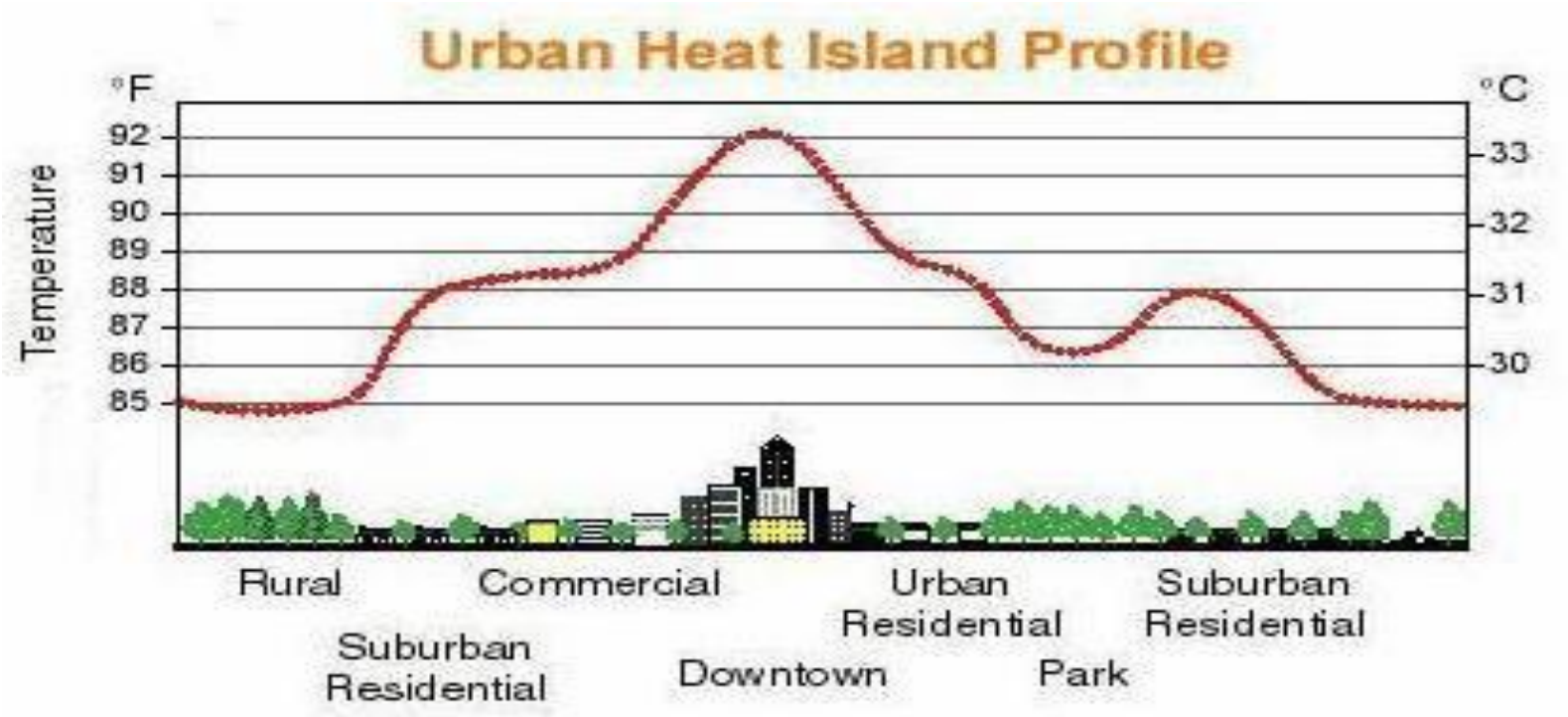
Specific Heat Capacity of a Material

- Specific Heat Capacity
  - The amount of kilocalories (energy) it takes to heat up a kilogram of an object 1 ºC
  - Lower Specific heat capacity = higher temperature
  - Higher Specific heat capacity = cooler temperature

- Examples of specific heat capacity
  - Diamond-0.16kcal/kg ºC
  - Aluminum Foil-0.21kcal/kg ºC

An Urban Heat Island

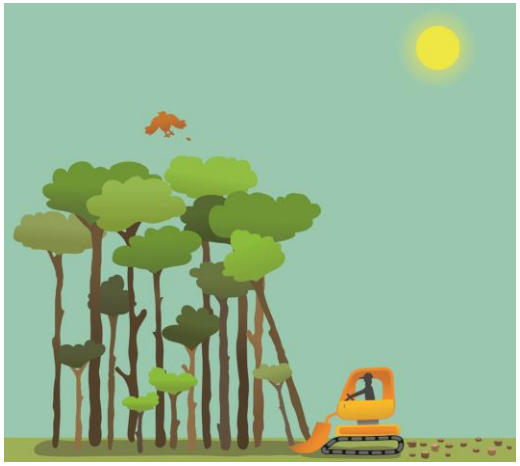
- Example of a Microclimate
  - small amounts of vegetation
  - large areas of pavement
- Areas with dark roof tops and asphalt



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

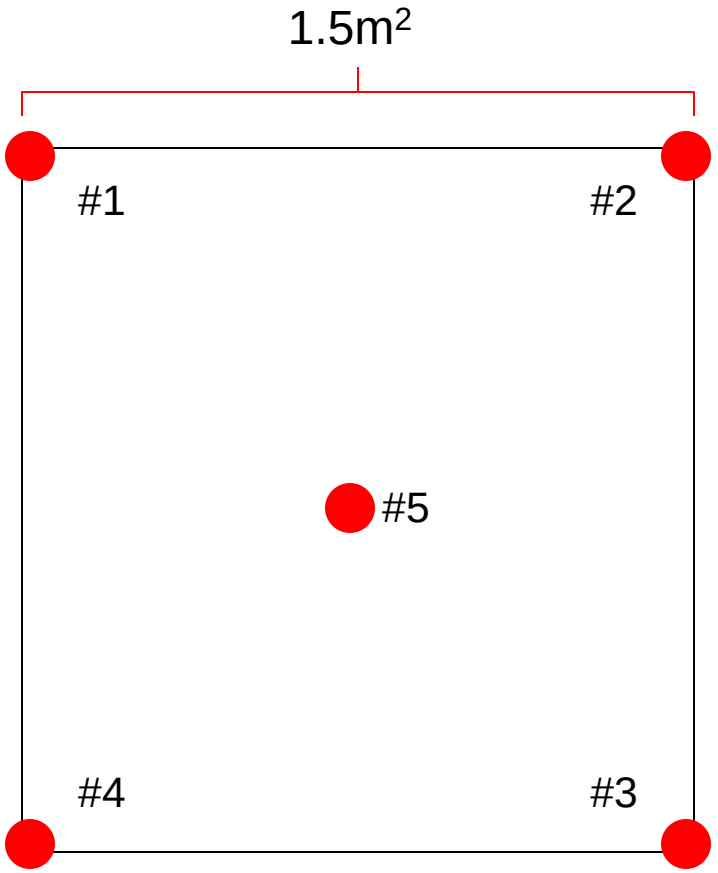
Instruments

- 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

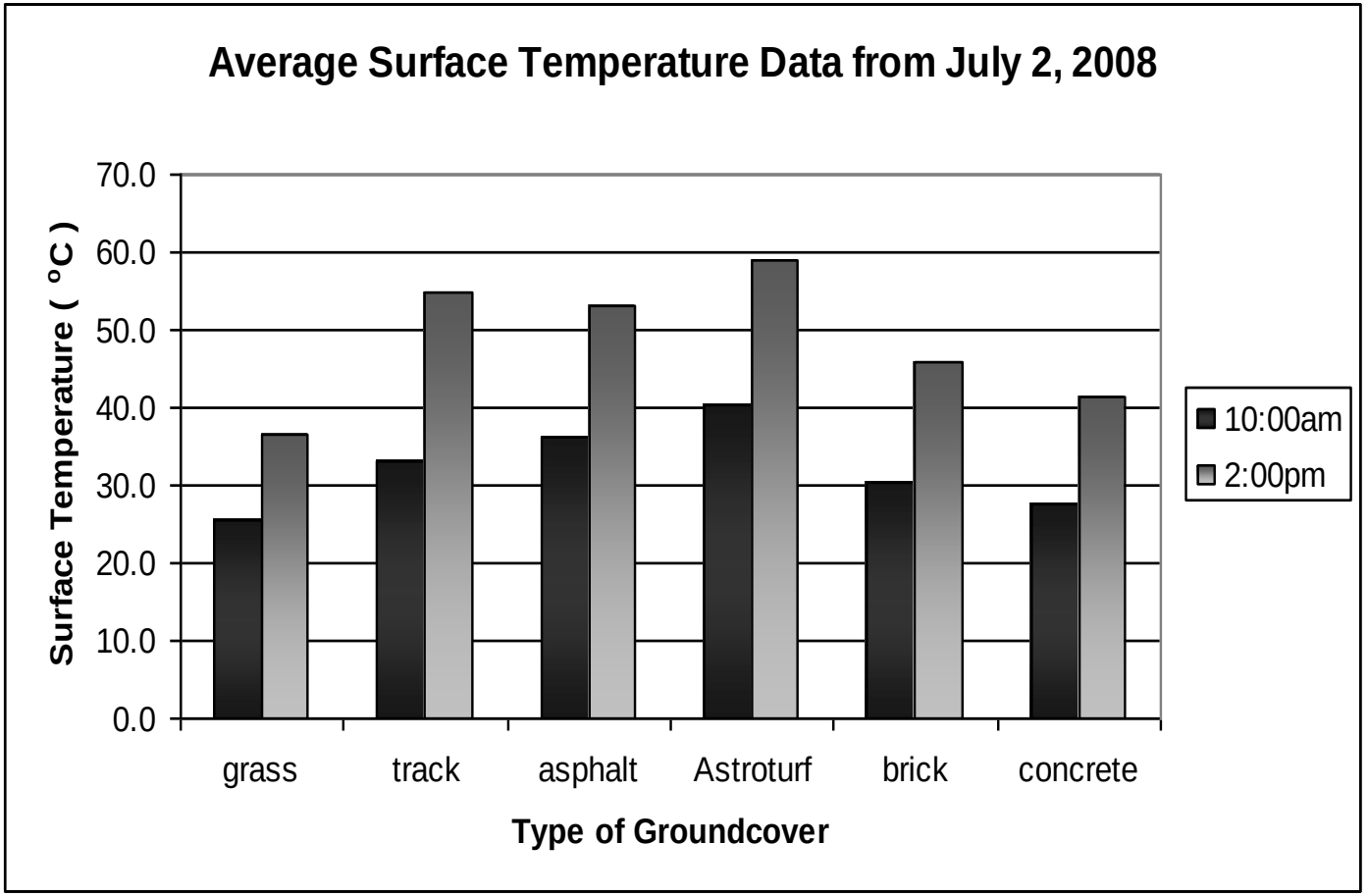
$$\bar{x} = \frac{x_1 + x_2 + x_3 + ...x_n}{n}$$

- 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

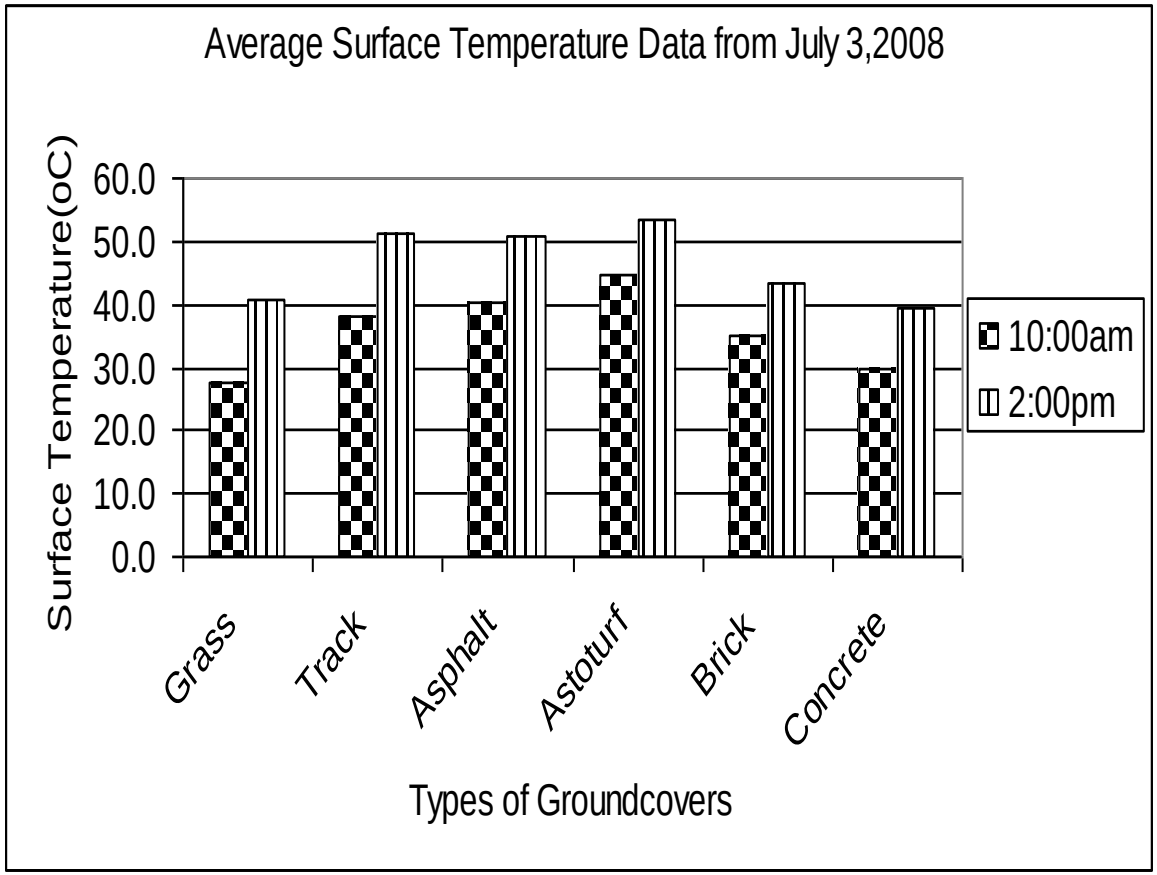
AstroTurf® Standard deviation 2.6˚C

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 excepted
  - 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