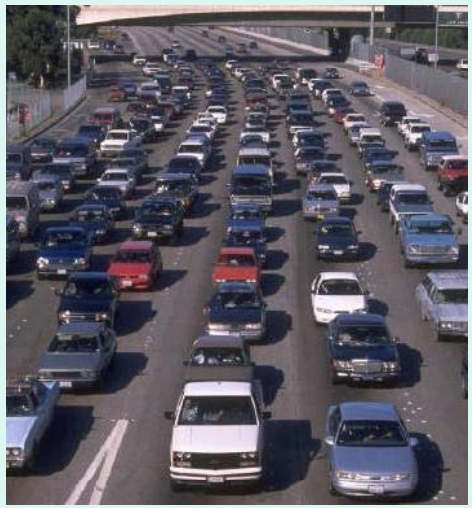
Heat Island Infrastructure Effects on Climate Change



ENGR 597 Climate Change
Dr. Chen
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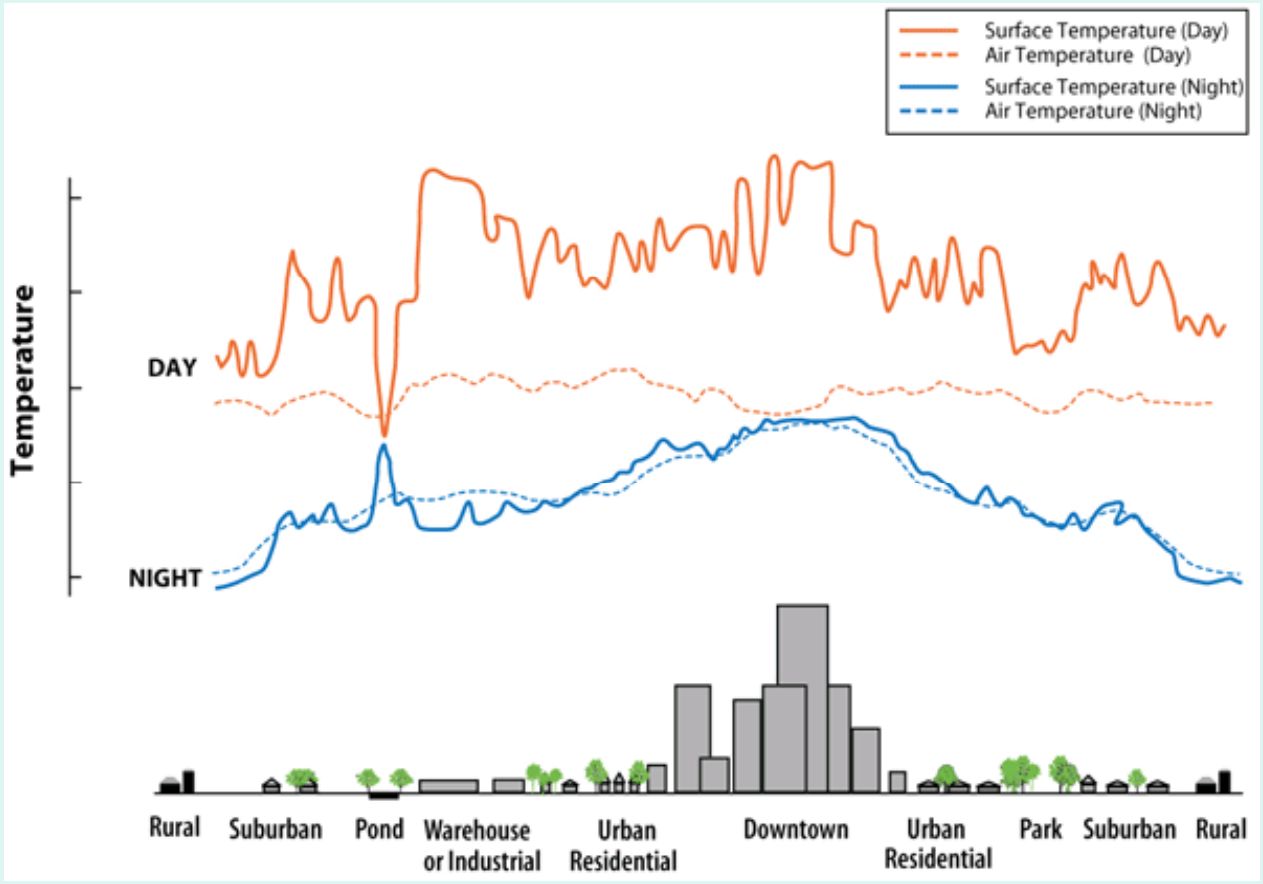
Katherine Osborne

Heat Island Effects

- Urban Areas are particularly susceptible to the planet's rising temperatures
- Concrete and Asphalt –main contributors
- The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings.
- In the evening, the difference can be as high as 22°F (12°C).
- Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.

Source :http://www.epa.gov/hiri/

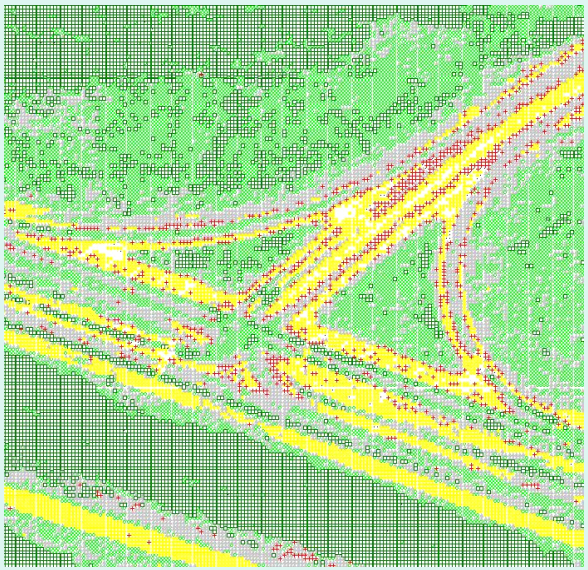
Measuring Heat Island Temperature



- Urban surfaces can be anywhere from 27-50 ^{o} C (50-90 F).
- Shaded and moist areas remain close to air temperatures.

Hwy 6

Figure 1. The IKONOS imagery of the intersection (courtesy of Space Imaging)



Surface Class	IMAGES Results	Ground-Truth
Asphalt	21.8%	22.9%
Concrete	1.0%	0.6%
Grass	32.4%	32.3%
Tree	27.5%	22.2%
Soil	13.3%	22.0%
Building/ Built-up Areas	3.8%	
Stream/ Watershed	0.0%	0.0%
Unknown	0.2%	0.0%
	100.0%	100.0%

Figure 2. The automatically classified map of the intersection area (by CAIT's program)

Surface Temperature Profile

- Surface class data are used to predict surface temperature using climatological data for the study area
- Hottest hour in Oxford in 2001
- 8km x 8km study area along the N-S and E-W cross sections
- Profile predicted from a series of predicted surface temperature on continuous sub areas
- 60% trees, avg. surface temp high –solar radiation, wind speed was low
- Average surface temp in the built-up area within the city has an average 9° C higher than ambient air temp.

Solutions

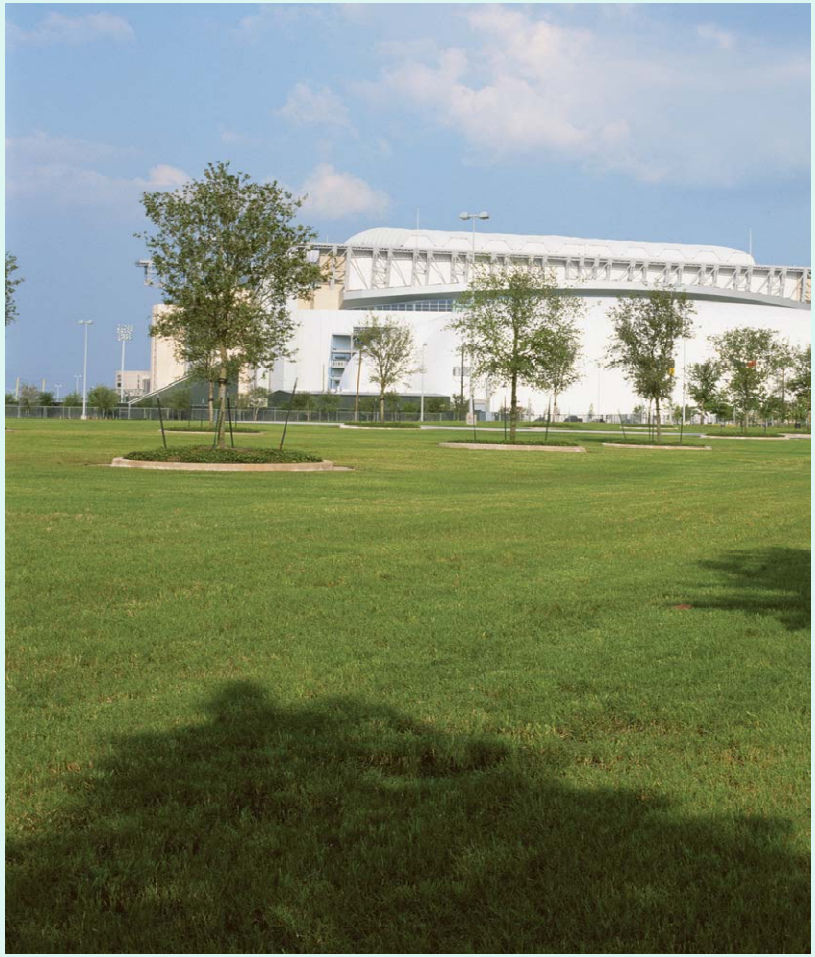
- Increase tree and vegetation cover
- Creating green-roofs
- Cool-roofs (reflective)
- Use cool pavements

Cool Pavements

- Researchers at LBNL have estimated that every 10 percent increase in solar reflectance could decrease surface temperatures by 7ºF (4ºC).
- Further, they predicted that if pavement reflectance throughout a city were increased from 10 percent to 35 percent, the air temperature could potentially be reduced by 1ºF (0.6ºC).

http://www.epa.gov/hiri/resources/pdf/CoolPavesCompendium.pdf

Grass Pavements



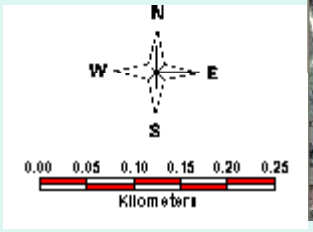
This 300,000-square-foot (28,000 m2) parking lot outside a stadium in Houston uses plastic grid pavers that allow grass to grow in the open spaces.

Grass Pavements

- It performs the functions of asphalt or concrete pavement, but with the aesthetics of a lawn – all while enhancing the environment.
- High void spaces within the entire cross-section enable excellent root development, and storage capacity for rainfall from storm events.
- Benefits:
- Pervious Load Bearing Surface
- Stormwater Pollution Filtration and Treatment
- Airborne Dust Capture and Retention
- Heat Energy Reflection Reduction, "Cool" Surface
- Tree Growth within Parking Areas

Oxford, MS

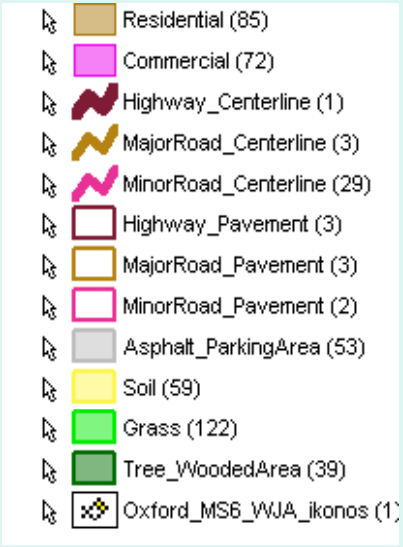
Imagery taken on March 27, 2000.

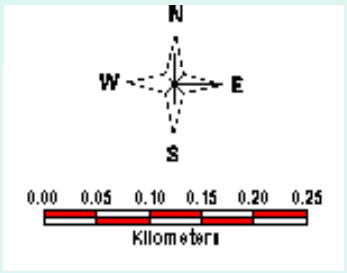


800-m

1,200-m

Oxford, MS with Completed Landuse Areas Extraction





800-m

1,200-m

Weighted Average Surface Temperature Prediction for the 800x120 sq m study area during the hottest hour in Oxford, 2001

Surface Class	Area	Percent Area	Predicted Surface Temp	temp distribution
asphalt parking	30,925	0.03	64.9	2.091
built area	50,592	0.05	64.9	3.420
tree	339,723	0.35	45.3	16.031
grass	376,944	0.39	46.8	18.376
pavement	41,155	0.04	64.9	2.782
soil	120,660	0.13	54.1	6.800
total	960,000.00			49.500
Note: air temp 34.8 deg C July 11, 2001 3-4 pm, hottest hour				

Weighted Average Surface Temperature Prediction when replacing all asphalt parking areas with grass

Surface Class	Area	Percent Area	Predicted Surface Temp	temp distribution
asphalt parking	0	0.00	64.9	0.000
built area	50,592	0.05	64.9	3.420
tree	339,723	0.35	45.3	16.031
grass	407,869	0.42	46.8	19.884
pavement	41,155	0.04	64.9	2.782
soil	120,660	0.13	54.1	6.800
total	960,000.00			48.916

Conclusions

- Constructed surface temp higher than natural surfaces
- CAIT research shows about a 3° increase due to the effects of constructed surfaces
- Electricity demand for cooling increases 1.5-2.0% for every 0.6°C, increase in air temperature, 5-10% electricity in used to compensate for the heat island effect

Benefits for Reducing the Heat Island Effect

- Reduce energy consumption
- Reduce air pollutants and greenhouse gases
- Improved human health and comfort
- Improved Water Quality