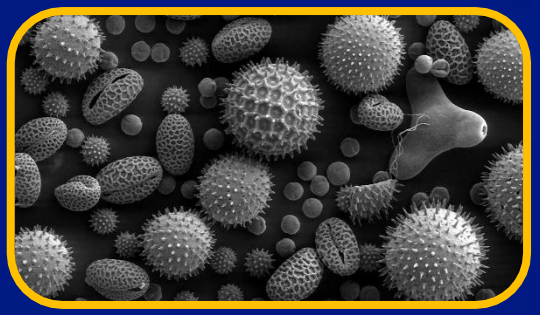
Climate Change, Urbanization and Urban Design





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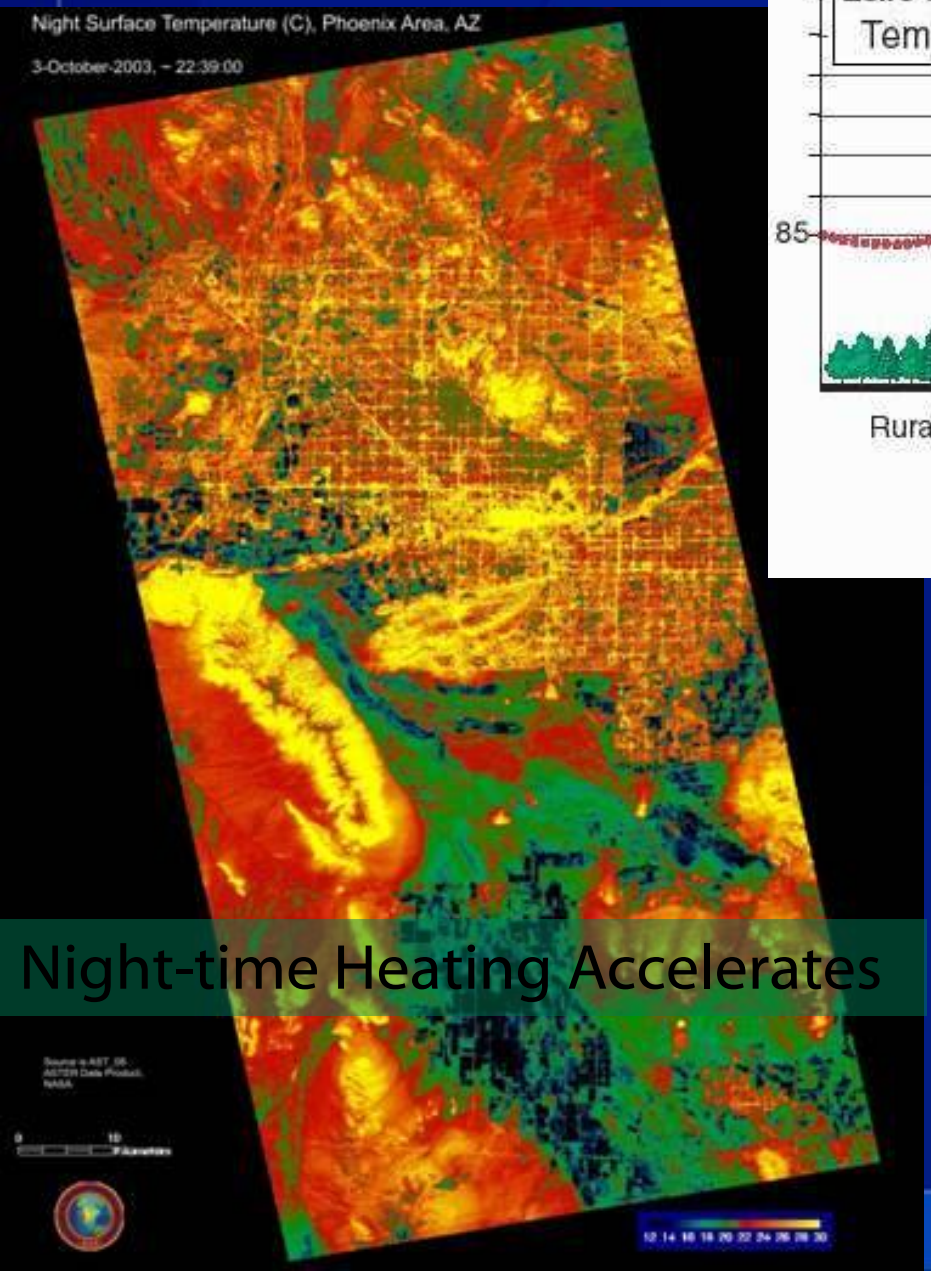
National Center for Environmental Health
Centers for Disease Control and Prevention

National Academy of Sciences, Roundtable on Science and Technology for Sustainability
December 6, 2013

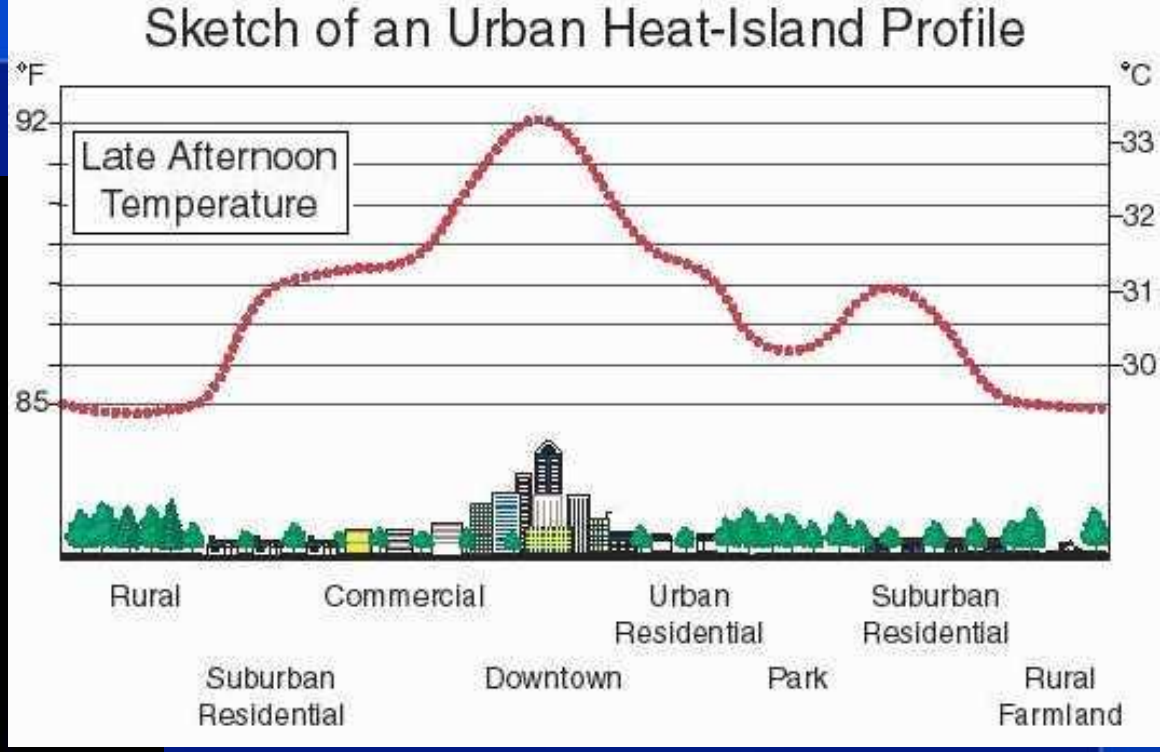
Climate Change and Urban "Built" Environments

Cities and climate are coevolving in a manner that will place more populations at risk:

- Intensification of exposures:
  - Urban heat islands amplify local warming
  - Air quality is degraded by warming and stagnant air masses
- Increase in vulnerable populations:
  - Today, more than half of the world's population lives in cities, up from 30% in 1950.
  - By 2100 there will be 100 million more people > 65 years old (relative to 2000) (Ebi et al. 2006).



Night-time Heating Accelerates



Urban Heat Island can add 7° – 12° F

Thermal Satellite Image of Phoenix, AZ Night Surface Temperature

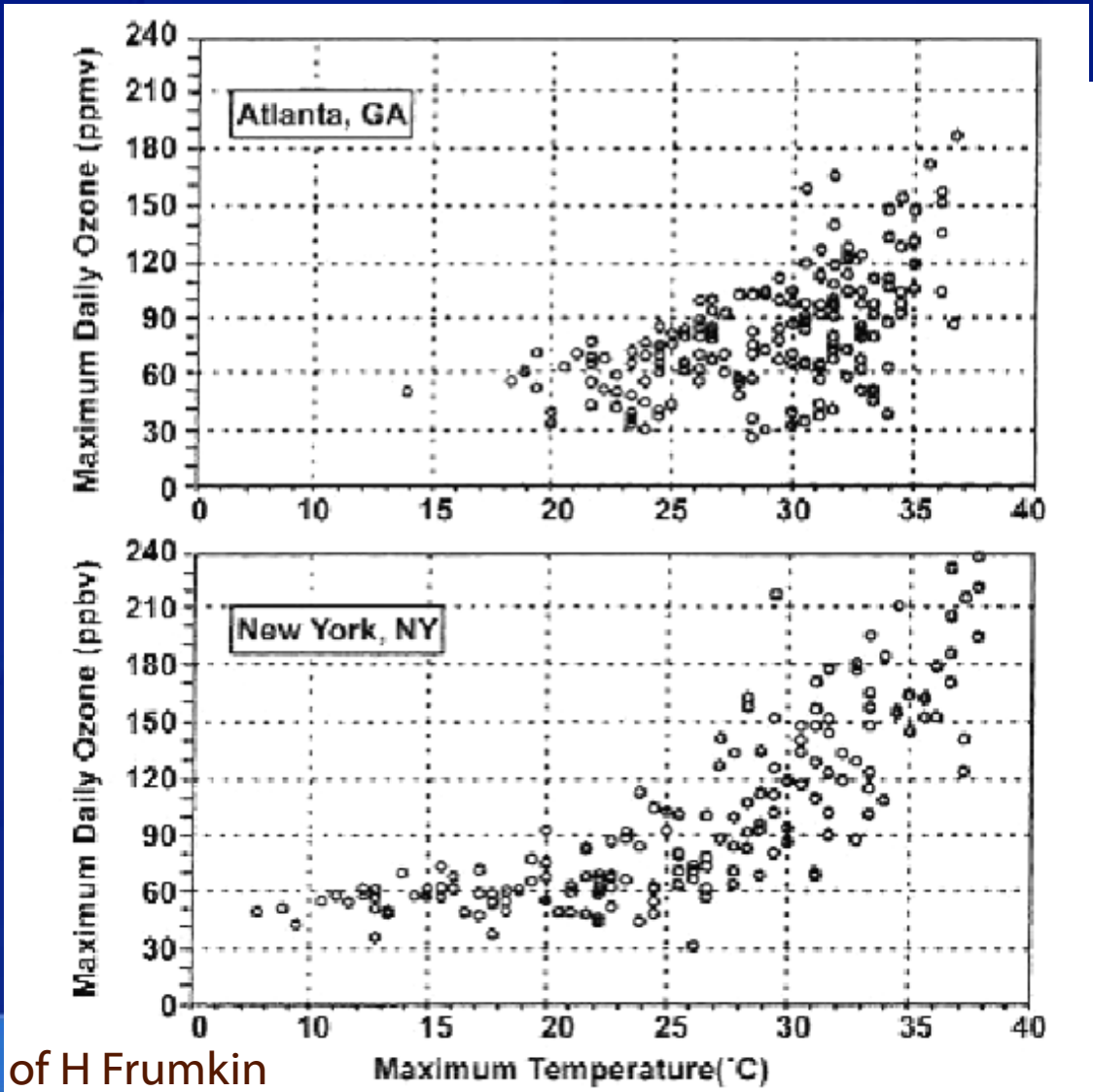
CDC
Environmental Health

Heat Island Impacts on Air Pollution

Maximum Daily Ozone Concentrations vs. Maximum Daily Temperature

Atlanta

New York

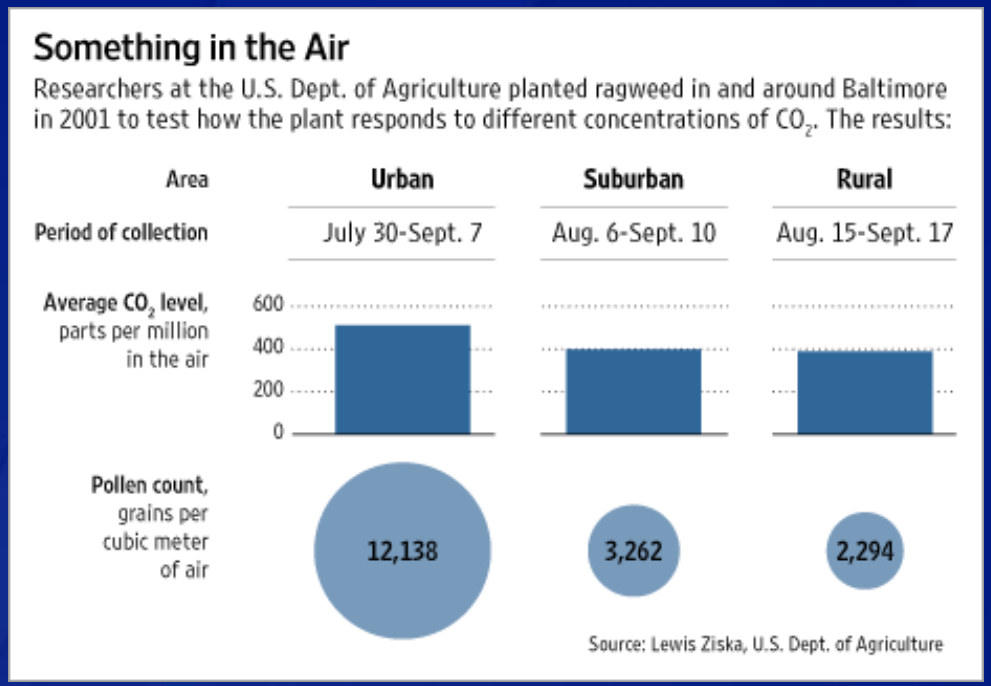


Atlanta

Slide Courtesy of H Frumkin

Heat Island and CO_2 Dome impact on Urban Aeroallergens

- Ragweed
- ↑ CO_2 and temperature → ↑ pollen counts, longer growing season



Source: Ziska et al., *J Allerg Clin Immunol* 2003;111:290-95;
Graphic: *Wall Street Journal*, 3 May 2007.

Slide Courtesy of H Frumkin

Benefits of Urban Greening Efforts

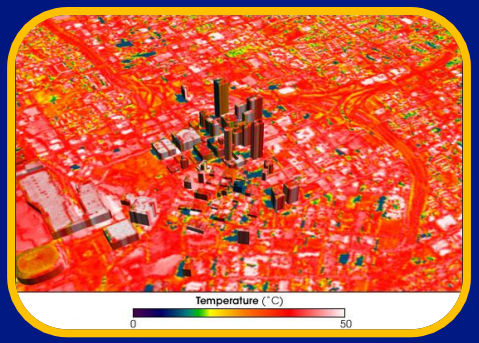


Image: NASA/Goddard

- **Capture Particulate Pollution**
  - Urban woodlands effectively trap and absorb airborne pollutants (Beckett et al., 1998)
- **Improve Water Quality**
  - Urban green spaces and trees reduce runoff and improve water quality (Xiao et al., 2003)
- **Mitigate Urban Heat Island Effect**
  - Urban green spaces and forests reduce heat and energy consumption due to cooling (Solecki et al., 2002)

Enhancing Albedo

Integrating construction materials that are reflective or lighter in color

- **Mitigates Urban Heat Island effect**
- **Reduces emissions from indoor cooling systems, improving air quality**
- **NYC pilot project: measuring the cooling effect of different colored building materials** (Gaffin et al., 2012)

http://r2.cygnuspub.com/files/cygnus/image/FCP/2011/NOV/600x400/cc_specialreportacpafeaturelea_10451769.jpg

Gaffin, S. R., et al., 2012. Bright is the new black: Multi-year performance of high-albedo roofs in an urban climate. *Environmental Research Letters 7*(014029), doi:10.1088/1748-9326/7/1/014029.

**Page 44 of Urban Meteorology book

Health Co-Benefits of Green Spaces

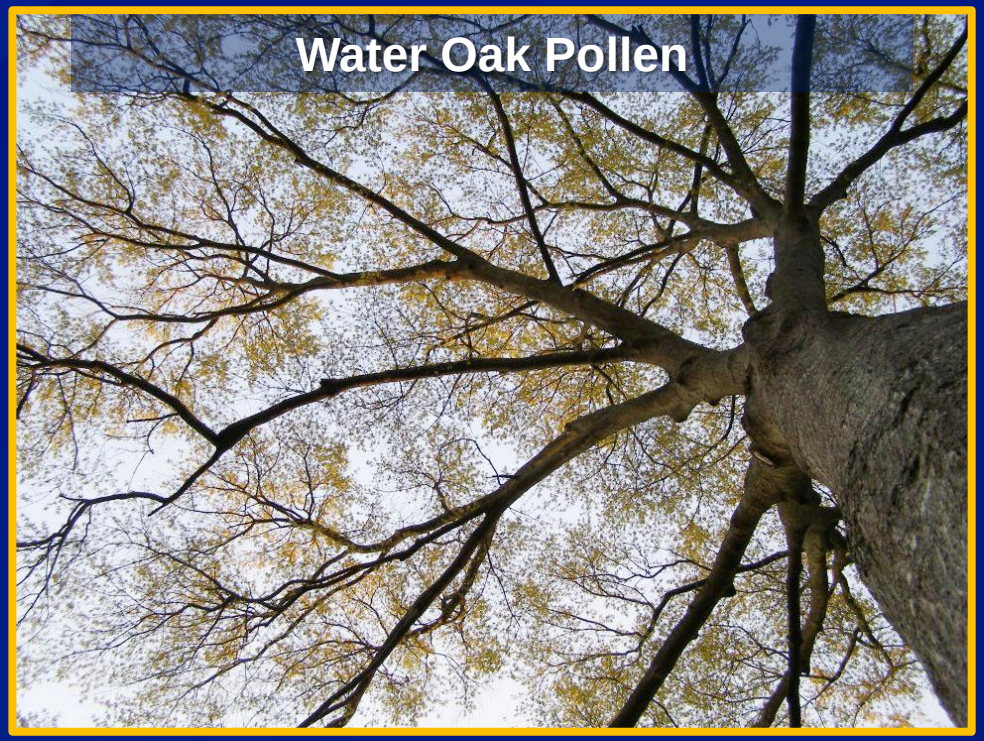
- **Promotes Active Lifestyle**
  - Green space promotes outdoor physical activity, especially among those in lower incomes (Brownson et al., 2001)
- **Hastened Recovery**
  - Green space views decreased length of hospitalization visits in postoperative patients (Ulrich, 1984)
- **Increased Longevity**
  - Walkable green spaces increased survival among seniors (Takano et al., 2002)

Mental Health Co-Benefits of Green Space

- **Improvement in ADD Children**
  - Children with greener play settings exhibited less severe ADD symptoms (Faber et al., 2001)
- **Stress Relief**
  - Greater stress relief in heavily forested parks as compared to treeless parks (Hansmann, 2007)
- **Depression**
  - Walking in green spaces and forests decreased depression and hostility (Morita, et al., 2007)

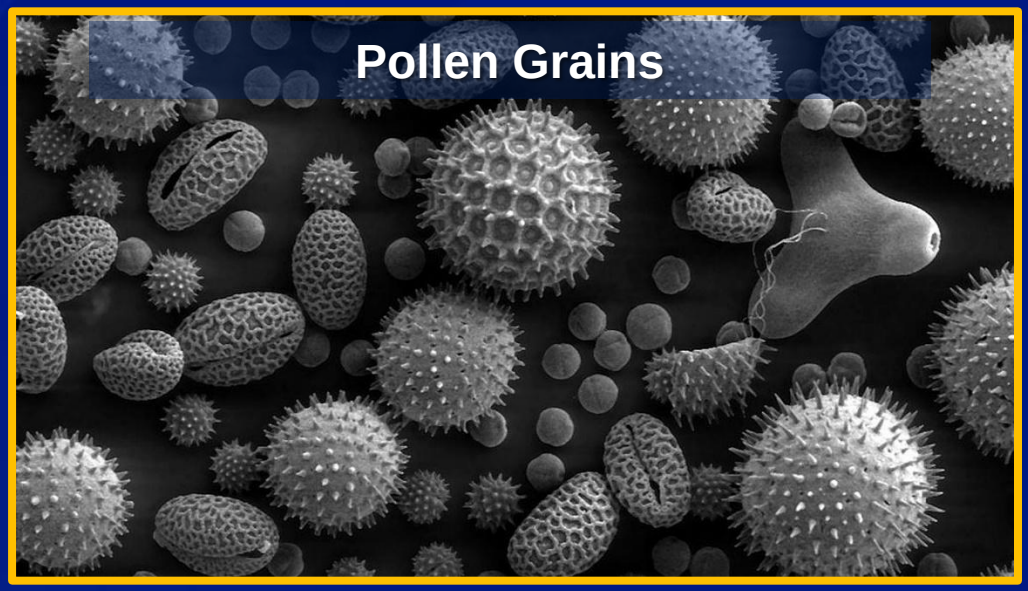
Health Considerations for Urban Forestry – A Source of Allergenic Pollen

- Urban greening projects are becoming increasingly popular
- Tree planting campaigns should consider species selection based on low allergy impact.



Urban Forestry - Pollen and Respiratory Illness

- **Seasonal Allergic Rhinitis affects 15%-20% of adults, and up to 42% of children.** (Grammer and Greenberger, 2009)
- **Increased allergy medication sales were associated with peaks in tree pollen** (Sheffield, et al., 2011)



Tree Planting for Low Allergy Impact

- **Increase species biodiversity in urban plantings**
- **Avoid overuse of male pollinating species**
- **Selection of species with low pollen production**

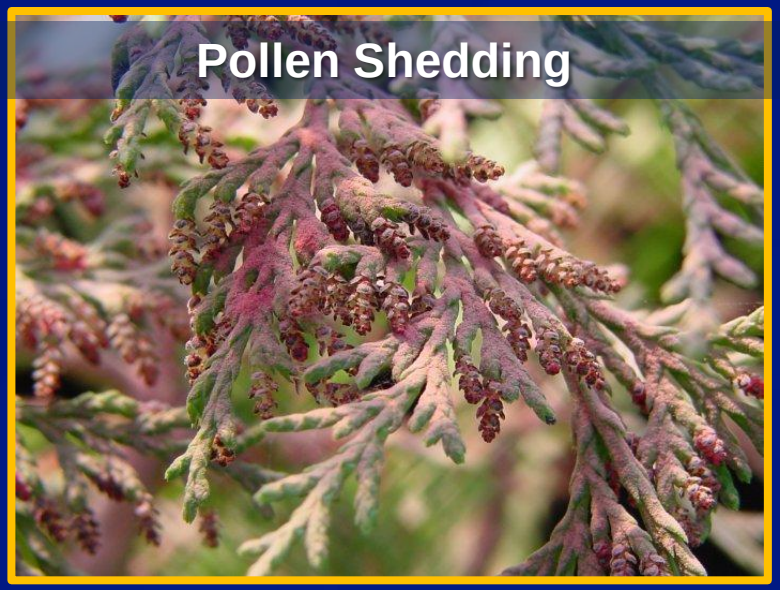


Photo: USDA/Forest Service

Allergenic Trees

- **Maple (*Acer spp.*) - male**
- **Box Elder (*Acer negundo*)**
- **Mulberry (*Morus spp.*)**
- **Juniper (Cupressaceae)**
- **Ash (*Fraxinus spp.*)**

Sources:

Carinanos and Casares-Porcel (2011)
Ogren (2000)

Sources: Ogren (2000), Le wis W, Vinay P, Zenger V (1983)

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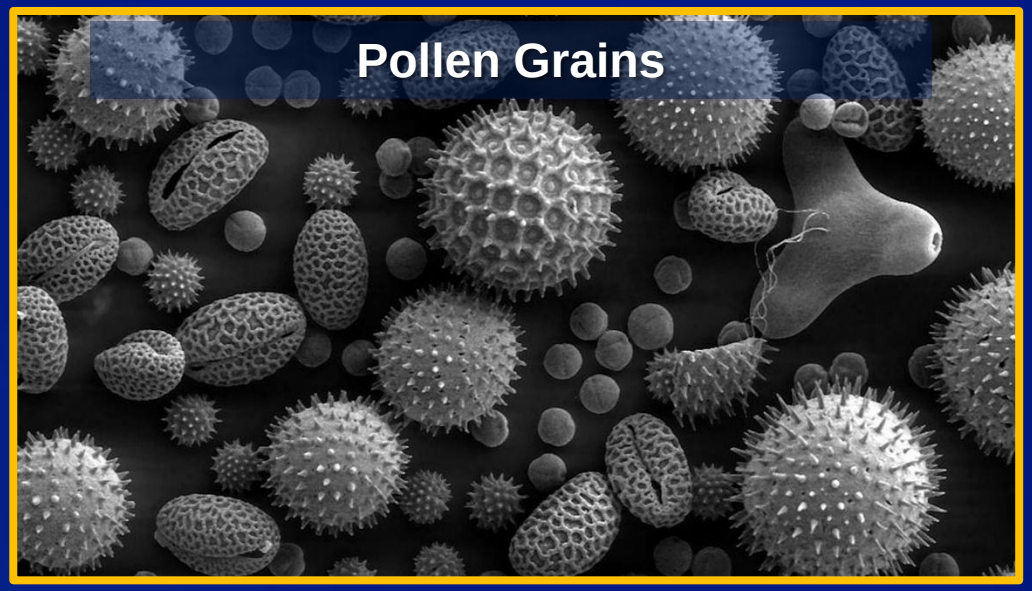


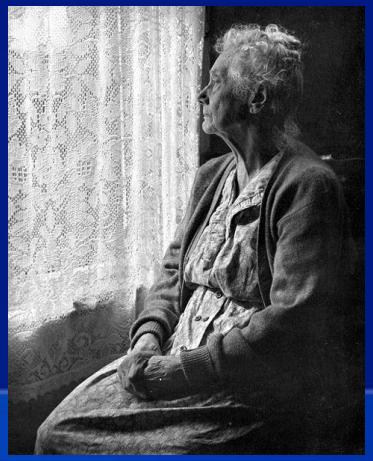
Sources:

Ogren (2000)
Lewis W, Vinay P, Zenger V (1983)

Engaging Climate Policy

Central Texas Climate Change Environmental Public Health Indicators Tracking Tool

- Partnering with the City of Austin Climate Protection Program to create health indicators related to local Climate Change mitigation strategies



AUSTIN'S ENVIRONMENTAL HAZARDS

Travis County, TX

	Mortality
FLOODING	29
SEVERE WEATHER	17
HEAT/DROUGHT	11
TORNADO	4
WINTER WEATHER	2
LIGHTNING	1

source: SHELDUS, 1970-2004

Pop: 1,026,158

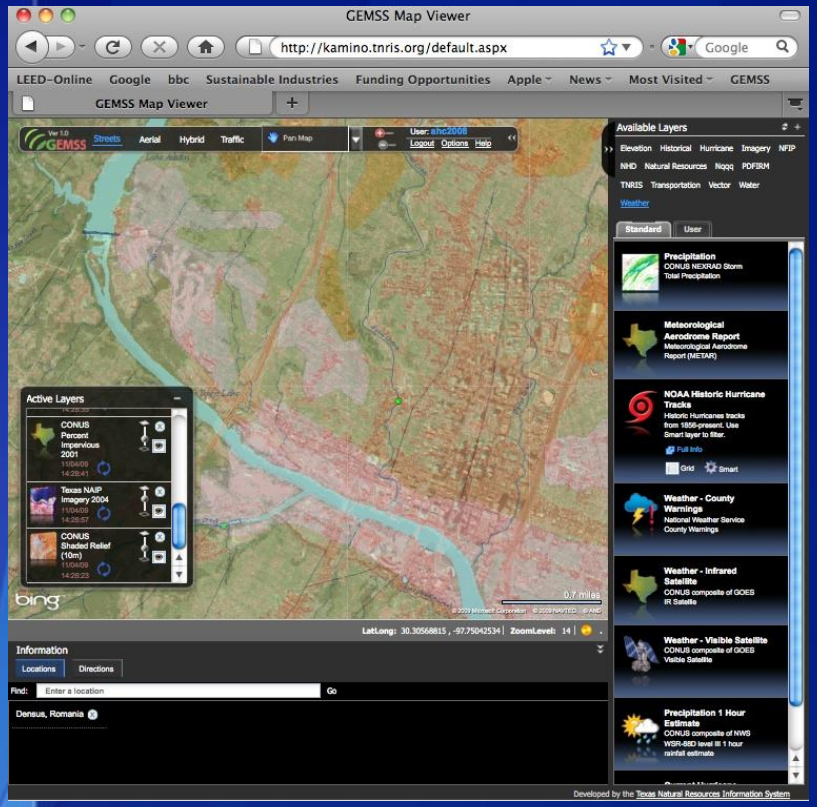
Texas: 24,782,302

(2009 U.S. Census est.)

Travis County Climate Change EPHI System

Incorporate Environmental Health Indicators into Austin Climate Protection Program

EPHLI fellowship project; funded by CDC



GEMSS – project of TNRIS, http://kamino.tnris.org

- Focus on Extreme Heat and Flooding
- Build Health Tracking infrastructure
- Simple GIS viewer

Objectives:

- Target policy-making priorities to vulnerable populations
- Raise public awareness of the connection between public health and climate change

EXTREME HEAT

EPHI tool baseline (1999-2005)

Exposure Indicator

- Date of extreme heat events (NWS definition)

Vulnerability Indicators

vulnerability map at census block group resolution

Built and Natural Environment

- Vegetative cover
- Average ambient surface temperature

Socio-Economic

- 65 years of age and above
- population density
- African-Americans

EXTREME HEAT

EPHI tool baseline (1999-2005)

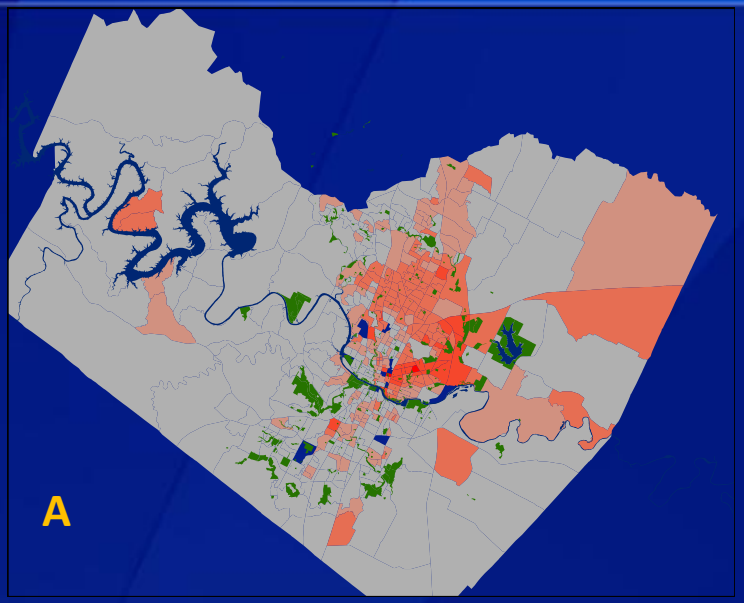
Age Adjusted Mortality Indicators

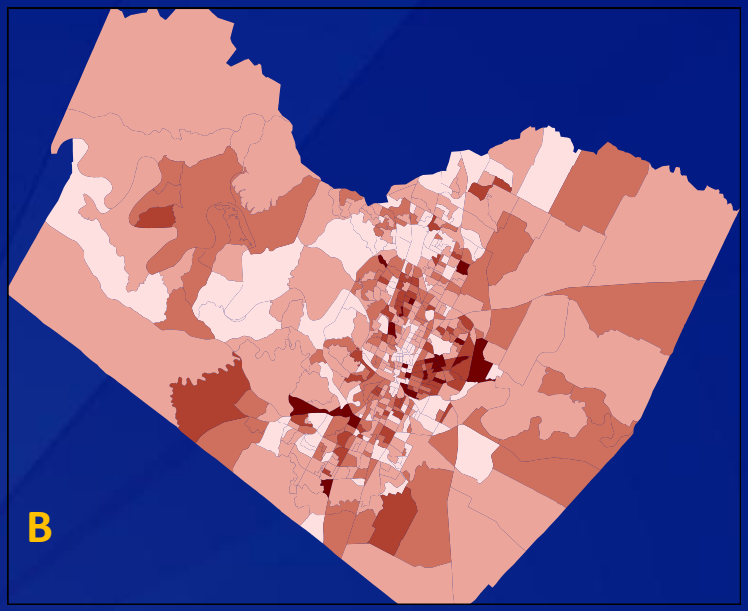
by census block group

- Cardiovascular – 35+ yrs

Future analysis

- Heat-related death density (exposure – related deaths/block group area)
- Respiratory
- Hypertension/Diabetes Mellitus
- Renal Failure
- Stroke

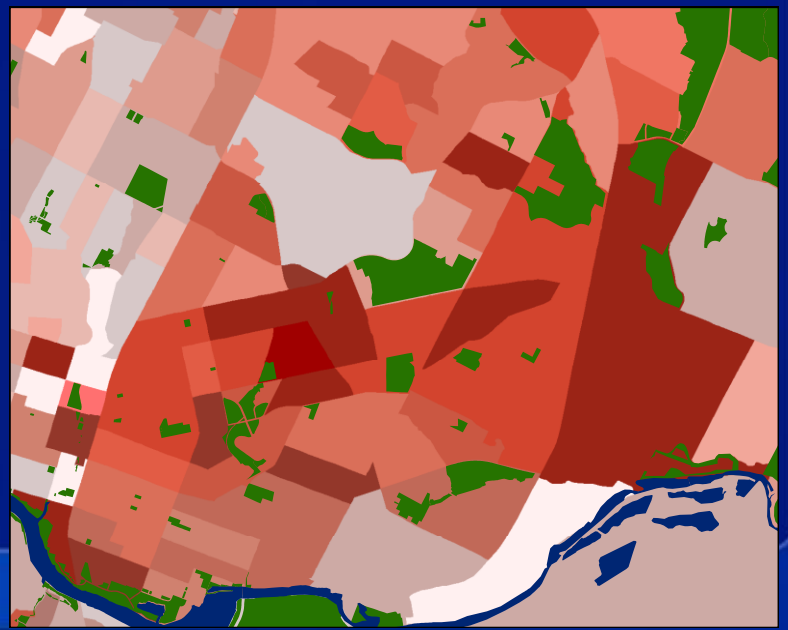




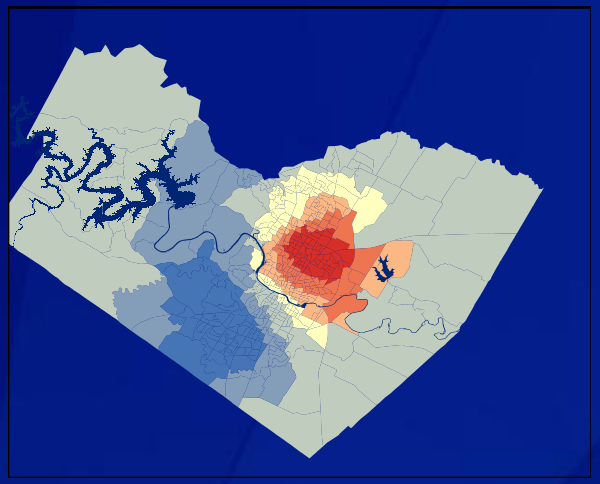
Extreme Heat & Health Overlay

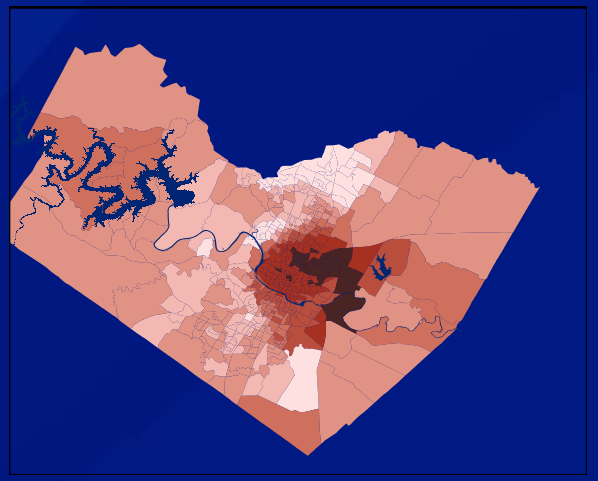
A: Social & Environmental Indicators
Elderly (% of individuals above 65 years of age)
Ethnicity (% of Blacks)
Pop. Density (# of individuals/sq miles)
Impervious Surface /Lack of Vegetative Cover (1 - % of deciduous forest, evergreen forest, mixed forest, shrub and herbaceous greenery)
~ Ambient surface temperatures

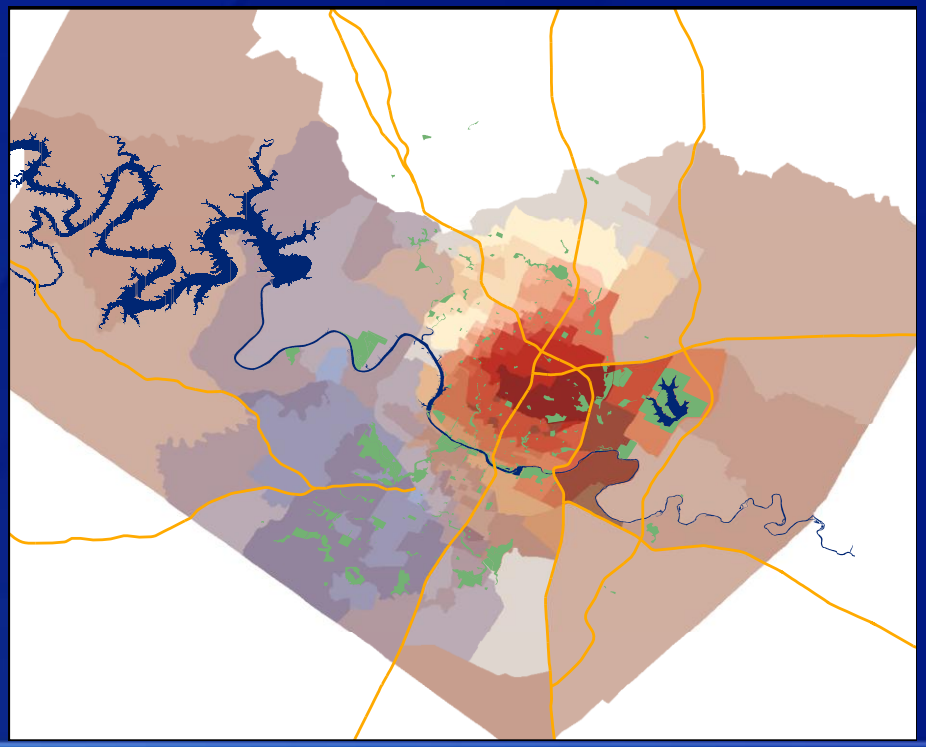
B: Age Adjusted Cardiovascular Mortality Rate per 10, 000



Hot Spot Analysis of Extreme Heat Index w/ baseline age adjusted mortality







Legend

HWYs

Cardiovascular GiZScore

- -3.49 - -1.88
- -1.88- -0.94
- -0.94 - 0.02
- 0.02- 1.28
- 1.28 - 2.83
- 2.83 - 4.11
- 4.11 - 6.70

Heat Index GiZScore

- -7.83 -5.06
- -5.06 - -2.23
- -2.23 - 0.75
- 0.75 - 3.93
- 3.93 - 6.69
- 6.69 - 9.49
- 9.49 - 13.20

Conclusions

- Urbanzation will enhance and intensify some climate change-related exposures such as extreme heat and degraded air-quality.
- Strategies for urban sustainability, such as urban canopy and albedo enhancement, can have positive health and sustainability benefits.
- However, these strategies should also be evaluated for their potential negative consequences for health.

Thank You

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References

- Brownson E et al., 2001. Environmental Policy Determinants of Physical Activity in the United States. *American Journal of Public Health*. 91(12). 1995-2003.
- Ulrich RS, 1984. View through a window may influence recovery from surgery. *Science*. (224) 420-421.
- Takano T et al., 2002. Urban Residential Environments and Senior Citizens Longevity in Megacity Areas: The Importance of Walkable Green Spaces. *Journal of Epidemiology and Community Health*. 56(12). 913-918
- Faber et al., 2001. Coping with ADD: The Surprising Connection to Green Play Settings. *Environment and Behavior.* 33(1). 54-77
- Hansmann R et al., 2007. Restoration and stress relief through physical activities in forests and parks. *Urban Forestry and Greening.* (6) 213-225
- Morita et al., 2007. Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. *Public Health.* (121)54-63
- Beckett, K et al., 1998. Urban Woodlands: their role in reducing the effects of particulate pollution. *Environmental Pollution.* (99) 347-360.
- Xiao, and McPherson, 2002. Rainfall interception by Santa Monica's municipal urban forest. *Urban Ecosystems.* (6) 291-302
- Soleck W et al., 2005. Mitigation of the heat island effect in urban New Jersey. *Environmental Hazards* (6). 39-49.
- Grammer L, Greenberger P, Eds. (2009). Patterson's Allergic Diseases. New York, Wolters Kluwer.
- Sheffield, P. E. et al., 2011. The association of tree pollen concentration peaks and allergy medication sales in New York City: 2003-2008. ISRN Allergy, 2011, 1-7, doi:10.5402/2011/537194.