**Plant Hardiness in the Built Environment**

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An ASHS HortIM peer-reviewed instructional material

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**What Is Plant Hardiness?**

*Plant Hardiness* = ability of a given genotype to survive, grow, and fulfill its intended use in the landscape in a given geographic location

- Involves many interactions among genotype, environment, cultural practices, and intended use
- Critical concept for sustainable designs

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**Changes In USDA Plant Hardiness Zone Map**

Derived from 1990 version  
http://www.usna.usda.gov/Hardzone/ushzmap.html

Derived from 2012 version  
http://planthardiness.ars.usda.gov/PHZMWeb/imag es/300DPI/SIMP_US_lower48_fullzones_300dpi.jpg

True changes in climate versus changes in sample period?  
Urban impacts at some measurement sites?  
Natural cyclical variation versus human caused variation?

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**Cold Temperatures**

- A key factor for perennial plants, little meaning for summer annuals
- USDA Hardiness Zone Map
  - Based on *average annual minimum low temperature*
  - Says nothing about:
    - 100 or 1000 year low temperature
    - Duration or frequency of low temperatures
    - Fluctuations from low to growing temperatures
    - Fall acclimation / spring deacclimation conditions
    - Variation between measurement & planting sites

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**Lagerstroemia indica versus Lagerstroemia fauriei**
**Cold Temperatures**

Latitude versus altitude
- Temperature varies inversely with altitude & latitude
- Implications with global climate change

Maritime and Lake Effects
- Moderate seasonal fluctuations
- Depends on size, prevailing winds, and currents

Continental Effects
- Accentuate seasonal fluctuations

Topographical Variations
- Diversion of prevailing winds
- Trapping of air masses in depressions

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**Drought**

Year-Round Deficits
- Desert & semi-arid regions

Seasonal Deficits
- Summer, winter, cold / drought interactions

Soil moisture versus atmospheric humidity
- Significant water demand even at high relative humidity
- Interactions among wind, relative humidity, and soil moisture

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**Drought & Topographic Features**

Local wind patterns and topographic features influence moisture as well as temperature
(Wet versus dry sides of Island of Maui, HA)
Excess Moisture

Flooding
- Anoxia / hypoxia is problem, not excess H₂O
- Poor surface drainage = temporary flooding
- Monsoon rains
- Permanently wet soils
  - Swamps, bogs, etc.
  - Seasonal wetlands
  - Poor internal soil drainage is a major urban limitation

Heat

Daily maximum temperatures
High night temperatures
- Major limitation in southern USA
- Respiration is more temperature dependent than photosynthesis
  - Some genotypes essentially starve with long term high night temperatures

Reflected heat in built envirn.
High root zone temperatures
- Special concern in above ground planters

Elevated Soil Temperatures

- Major challenges in some settings
- Often combined with reflected heat and high night temperature conditions

Masonry Surfaces May Exacerbate High Soil Temperatures
**Misc. Soil & Atmospheric Factors**

Seashore conditions
- Soil salts &/or salt spray
- Smog / air pollutants
- Saline or alkaline soils

Coastal challenges are substantial

Smog in Dallas, TX

Shallow alkaline soil

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**Quality of irrigation water**
- Method of application

**Soil fertility**
- Interactions with various physiological processes

**Soil compaction**

Compaction during construction

Fertility affects leaf mass

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**Urban / Suburban Soil Challenges**

- High pH is a frequent challenge
  - Massive quantities of structures with calcium carbonate
  - Soil fertility & pH intimately intertwined

Mn chlorosis on *Acer rubrum*
Low Soil Oxygen

Compaction & poor drainage = lethal combination

Compaction mediated dieback on Catalpa speciosa

Construction damage!

Drainage lines must exit at lower elevation

Bathtub effect!

Other Urban Soil Challenges

- Lack of soil structure
- Limited volume of root zone
- High bulk density soils
- Poor fertility subsoil
- Imbedded foreign objects
- Low mycorrhizal inoculum

An alternative solution to urban soil problems is to use containers of various sizes

Informal setting

Informal setting, incorporate edibles

Formal setting

Any season
**Urban Heat Islands - Large Scale Implications**

- Fort Worth
- Dallas

Image courtesy of Dr. Derald A. Harp

Image courtesy of USDA

http://planthardiness.ars.usda.gov/PHZMWeb/InteractiveMap.aspx

**Micro Climates**

- Small scale lake, river, stream effects
- Shelter by buildings and other plants
- Exposure to prevailing wind
- Reflected heat
- Restricted root zones
- Road-side salts and pollution
- Air drainage patterns
- Buried utility lines
- Heated discharge water
- High traffic areas

(Daughter's/son's window?)

**Microsite Implications Of Urban Heat Islands**

- Light (irradiance) levels
- Air movement patterns
- Low humidity levels

**Hardiness Can Be An Issue Even In Interiorscapes**
Disease, Pest, and Environmental Interactions

• Unfavorable environments predisposes plants to diseases and pest infestations
• Diseases and pest infestations increase susceptibility to environmental stresses

Questions / Comments?

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