

Terrestrial Sequestration: An Adaptation and Mitigation Strategy



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The World is a Complex System



Climate change is 500 million times more complicated than any other environmental problem we have faced. – Daniel Esty

What are the vulnerabilities of human systems to global environmental change?

- Flood control systems
- Climate control
- Increased frequency of severe weather events
 - compromise flood control systems
 - compound the UHI effect



How can vulnerabilities be reduced?

Flexibility is Key to Addressing Climate Change

Mitigation

Adaptation



Integrating the forestry sector, EPA, carbon sequestration research, and urban planning communities to improve management plans and national policies would generate a flexible approach.



No Single Approach Will Work



Benefits of Protecting, Enhancing, and Reintroducing Terrestrial Carbon Stores

- Improves water infiltration for storm-water management
- Stabilizes land for erosion control
- Reduces urban energy demand
- Improves air quality
- Sequesters carbon for atmospheric CO₂ reduction
- Maintains and creates habitat for biodiversity



Photo courtesy of the U.S. Fish and Wildlife Service



Terrestrial Carbon Sequestration

- Four major pathways for terrestrial carbon sequestration could allow for dual mitigative and adaptive roles:
 - Protect and manage existing native ecosystems
 - Improve land reclamation processes and reforestation
 - Extend the use of “carbon friendly” agricultural practices
 - Increase forest and other vegetative cover in metropolitan and urban areas

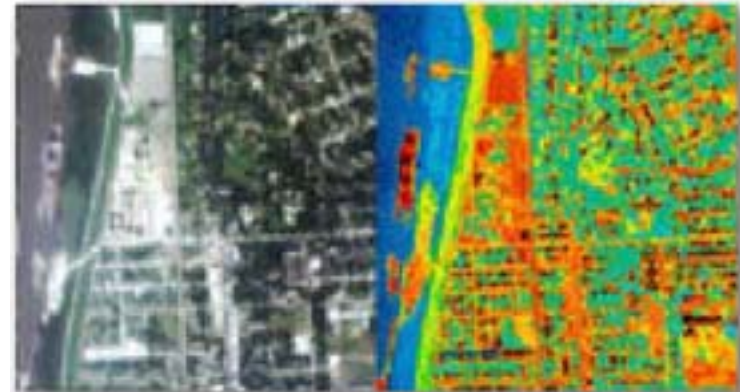
Terrestrial sequestration actions taken to mitigate adverse effects of urban warming are both reactive and anticipatory of climate change.



What Causes the Urban Heat Island Effect

Temperatures in urban areas are rising 1.5 times faster than the global average and cities are 10 degrees warmer than rural areas—Why?

- Tall buildings block infrared radiation from escaping and slow the cooling process
- Waste heat from air conditioners can add as much as 2 degrees to outdoor urban temperatures
- Additional heat is produced by cars, trucks, and factories



Visual and Thermal images of Baton Rouge

Urban Terrestrial Sequestration Efforts

- The USDA Forest Service
 - research on urban tree carbon storage, annual sequestration, and reductions in CO₂ emissions from power plants from efficient building energy use
- The DOE Carbon Sequestration Program
 - terrestrial systems that integrate energy production, conversion, and use with biotic sequestration activities
- The EPA Heat Island Reduction Initiative (HIRI)
 - promotes heat island reduction strategies
- Urban Forestry Councils



Potential for Carbon Storage in Urban Forests

- Tree density U.S. urban counties has been decreasing
- 700 million tons of carbon stored in urban trees in the contiguous U.S.
- 22.8 million tons of per year carbon sequestered
- Urban forest C storage density averages 25.1 tons C per ha vs. 53.5 tons in native forests

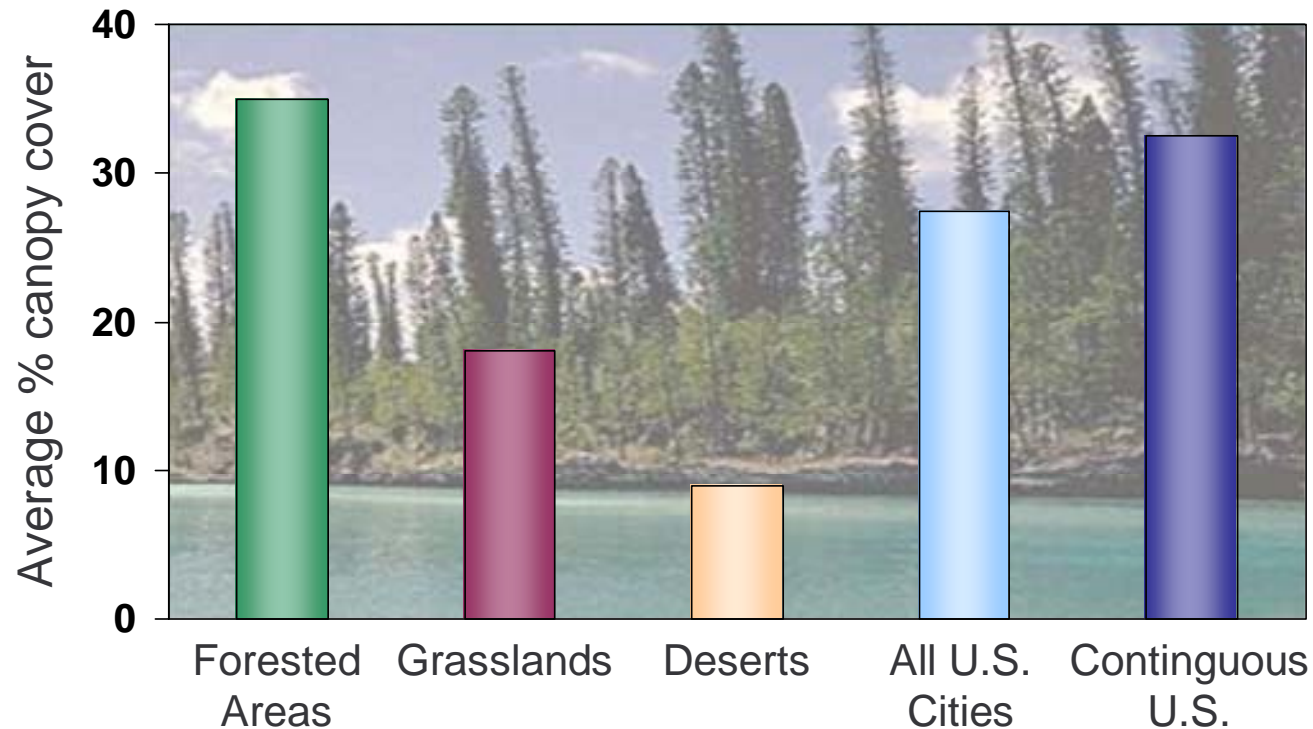
| % urban | Sq km | tC stored | % tree cover | tC/y | t/ha/y | 000s of trees |
|---------|---------|-------------|--------------|------------|--------|---------------|
| 3.5 | 281,000 | 704,397,000 | 27.1 | 22,845,000 | 0.8 | 3,820,491 |



Source: *Connecting People with Ecosystems: an assessment of our Nation's urban forests*, USDA Forest Service 2000

The Extent of the Urban Forest Resource

Urban Tree Cover in the U.S.

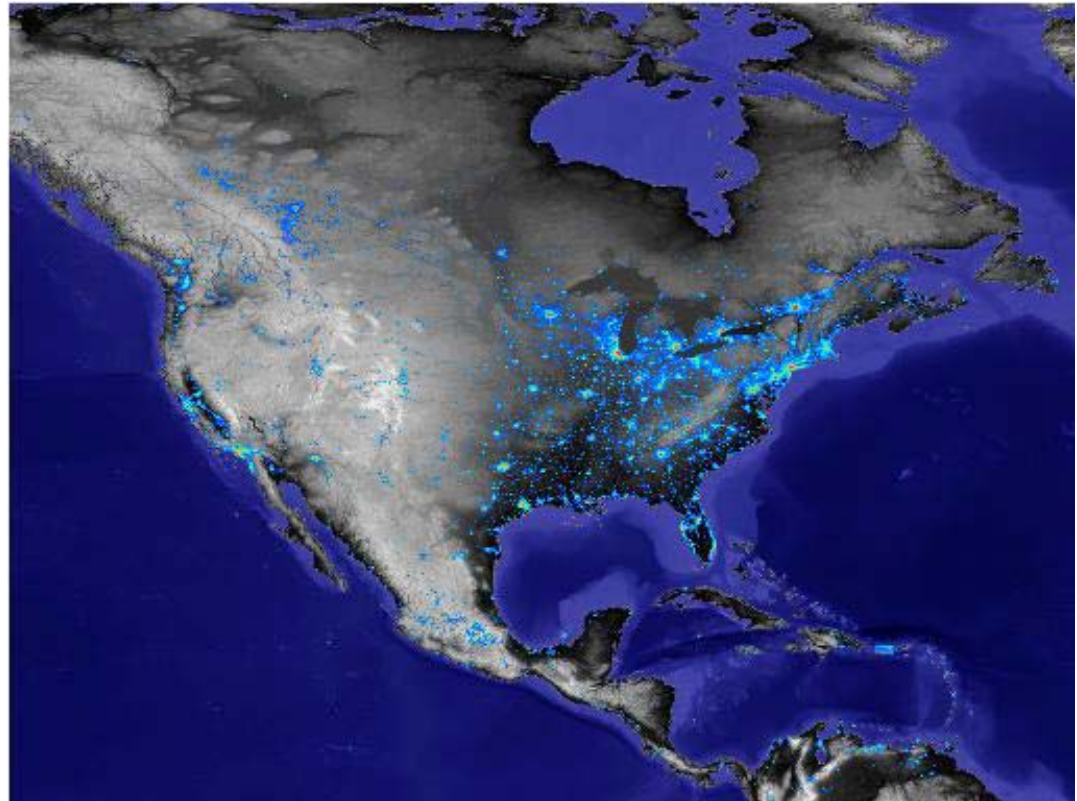


The non-profit organization American Forests recommends a 25% tree cover for urban areas in arid regions of the U.S.

Urban Areas

- The Northeast:
 - most urbanized portion
 - highest proportion of urban tree cover
- Urbanization elongates the growing season, but decreases overall productivity of urban vegetation

North American City Lights: Satellite Image



Source: Nasa/Goddard Space Flight
Center Scientific Visualization Studio



Storm-Water Control

- Land development reduces the quantity of water that may infiltrate to the subsurface:
 - impervious surface area expansion
 - loss of vegetation and soil organic matter
 - decreased soil porosity
- In San Antonio:
 - tree loss increased the amount of storm-water flow by 73 million cubic feet
 - the vegetation-in-place saved \$146 million
- 3.86-ac. residential site:
 - 8% canopy cover provides 3% runoff reduction
 - 35% canopy cover provides 12.8% runoff reduction



Reduced Thermal Emissions

- Mid-day air temperature can be reduced by 0.04°C to 0.2°C per % canopy cover increase
- Reduced air temperatures lead to improved air quality and can reduce ozone formation
- 5-10% of the urban electricity demand is consumed by cooling buildings to compensate for the UHI effect
- UHI mitigation could reduce national air conditioning energy use by 20%



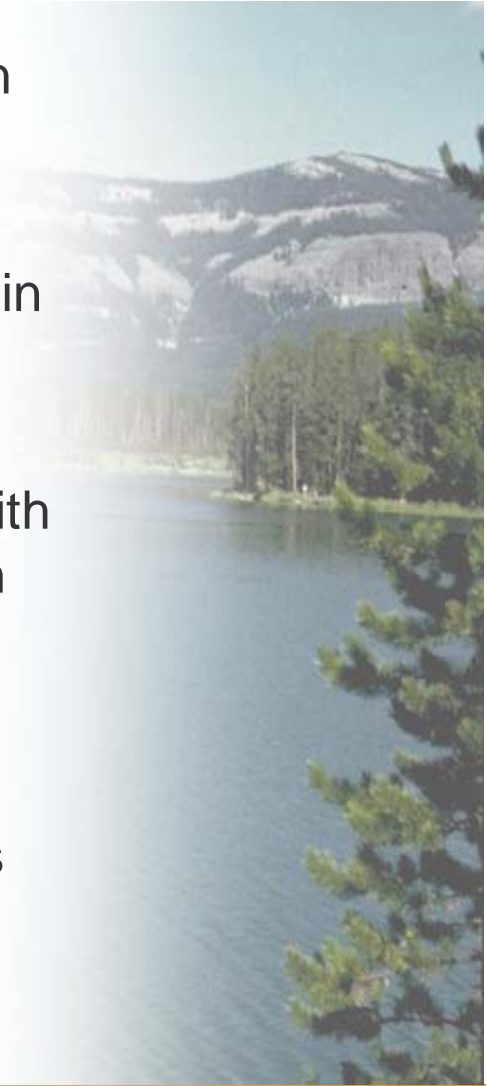
Terrestrial Solutions



- San Antonio residents could save an average of \$76 dollars per year by planting residential shade trees
- An 8-sq.-meter patch of lawn on a rooftop equals the same cooling effect as operating an air conditioner for one day (Tokyo study)
- Skyrise greening can reduce ambient air temperatures by 4°C (Singapore study)

State Legal Frameworks that Encourage Urban Terrestrial Sequestration

- Vermont requires new developments over a certain size to meet environmental criteria
- Portland, OR aggressively-plans development within an "urban growth boundary"
- Ashland, OR uses a performance-based system with a "bonus point" scoring system for increased urban forest densities
- Santa Barbara, CA has instated a conservation subdivision design where 40% of the subdivision is open space



Uncertainty is Inherent to Natural Systems

“We admit to uncertainty about the natural systems involved - all the while continuing to act as if the systems were simple and manageable by a centralized control mechanism like a treaty... Moreover, for this to work, we also need to believe that we understand the impacts of such treaties - on natural systems, on economic, political, and cultural systems. Both assumptions are most likely wrong and demonstrate a profound inability to understand the way complex systems evolve.”

-Braden Allenby



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