Agroforestry in the Urban Environment: Urban Heat Islands

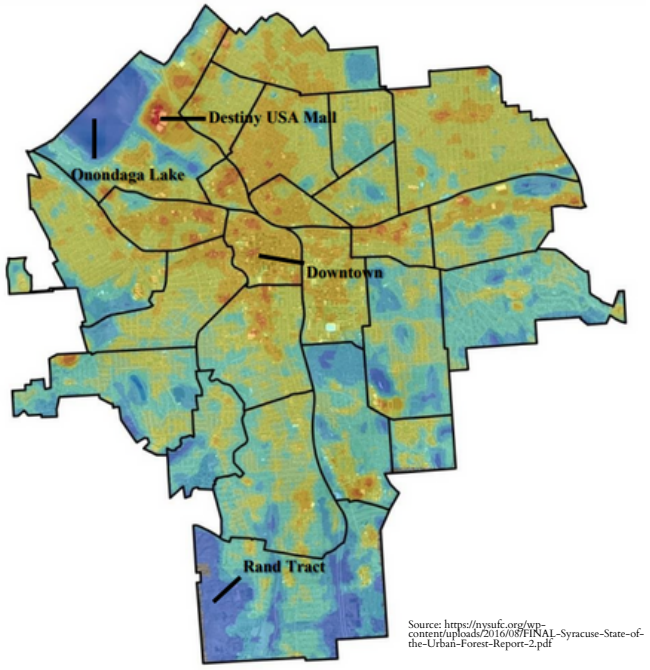
ATLANTIC STATES LEGAL FOUNDATION

What are Urban Heat Islands?

In urban areas, infrastructure, such as buildings and roads, absorb and re-emit heat from the sun much more than natural landscapes do. The high concentration of these structures cause cities, and even suburban areas, to become "heat islands". As a result, these landscapes have higher temperatures compared to those of surrounding areas. According to the EPA, this heat island effect causes urban areas to be 1-7°F higher than peripheral areas.[1] In Syracuse, summer temperatures in the city are up to 23°F hotter than in nearby rural areas, with the average being 2°F higher. Urban heat island effect will worsen as urban areas continue to expand and become more dense.

Causes of Urban Heat Islands

Minimized green spaces and natural landscapes is a primary cause of heat islands in urban areas. Trees, vegetation, and water bodies reduce air temperatures through the transpiration and evaporation of water and by creating shade. Urban materials, such as buildings, sidewalks, parking lots, and roofs, in contrast increase temperatures in urban areas through providing minimal shade and moisture. Additionally, these traditional materials poorly reflect solar energy and thus absorb more of the sun's heat.[2] How cities and other urban areas are designed and developed also contributes to heat islands. Tall and close together buildings obstruct natural wind flow and inhibit urban structures from releasing heat easily. As a result, significant thermal masses are created with limited pathways for cooling. Furthermore, various human activities help facilitate heat islands through the production of waste heat. Some examples of this include cars, air-conditioning appliances, and industrial facilities.



Source: https://nysufc.org/wp-content/uploads/2016/08/FINAL-Syracuse-State-of-the-Urban-Forest-Report-2.pdf

Impacts of Heat Islands

Urban heat islands create a number of impacts that are harmful for human and environmental health. One of the major affects of heat islands is increased energy demand and consumption. As temperatures rise in concentrated urban areas, electricity usage increases in order to power air-conditioning systems and units. Increased energy demand typically coincides with heightened fossil fuel emissions and air pollution. Most electrical companies utilize plants powered by fossil fuels. As a result, greenhouse gas emissions become elevated and the presence of air pollutants, such as fine particulate matter, rises. Urban heat islands also negatively impact waterbodies. The elevated surface temperatures of urban materials, especially roads and rooftops, heat up stormwater runoff.[3] The heated runoff flows into nearby waterbodies and can detrimentally affect aquatic species. Aquatic life is widely affected by water temperature. Dramatic shifts in water temperature and high temperatures can stress the metabolic and reproductive systems of aquatic species.[4]

1. "Learn About Heat Islands," U.S. EPA, August 28, 2023, https://www.epa.gov/heatislands/learn-about-heat-islands.
2. "Learn About Heat Islands".
3. "Heat Island Impacts," U.S. EPA, August 28, 2023, https://www.epa.gov/heatislands/heat-island-impacts
4. "Heat Island Impacts."

Furthermore, elevated temperatures worsen pre-existing health conditions and disproportionately affect populations. Older adults and children are the most vulnerable to extreme temperatures. This is primarily contributed to physiological factors. Additionally, low-income populations are more susceptible to the consequences of heat islands due to the absence of air conditioning and insufficient housing conditions.

Solutions

Communities are taking actions to reduce heat islands and mitigate their impacts. One strategy is to increase tree and vegetation cover in urban landscapes. Trees and varying vegetation cool the air by creating shade and through evapotranspiration. During evapotranspiration water vapor is released into the air by plants' leaves and rainfall is evaporated from the soil and off their leaves.[5] Added urban tree canopy decreases air and surface temperatures. For example, in Syracuse the coolest neighborhoods were associated with high tree cover. These neighborhoods were found to be 4-6°F cooler than the citywide average temperature.[6] In contrast, the warmest neighborhoods were 4-6°F hotter. These areas tended to have a higher concentration of impervious surfaces. Vegetation, such as shrubs and tall grasses, can also be planted on rooftops to create green roofs. Similar to regular plantings, the vegetation on green roofs cool the air through evapotranspiration as well as reduce stormwater runoff. Furthermore, utilizing materials that reflect more solar energy and absorb less heat than conventional materials also helps to lower temperatures in urban areas.

Did You Know?

- A green roof can lower indoor temperatures by 2.2-5.9°F [7]
- Syracuse's urban tree canopy reduces electricity usage by 2,600 megawatts. [8]
- Urban tree canopy can decrease overall temperatures by 20-45°F.

How Agroforestry Helps

As mentioned previously, trees and vegetation play a key part when it comes to mitigating urban heat islands. Trees and plants provide important shade and ecosystem services like transpiration and evaporation. Urban agroforestry practices often use smaller native species that are easily accommodated in city landscapes. The benefits of planting food-bearing trees and shrubs are multi-faceted. In this context, the implementation of agroforestry practices in urban landscapes help to mitigate the impacts of heat islands while also providing a critical and accessible food resource for communities.

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5. "Using Tress and Vegetation to Reduce Heat Islands," U.S. EPA, August 28, 2023, https://www.epa.gov/heatislands/using-trees-and-vegetation-reduce-heat-islands.
6. Davey Resource Group, Inc., "State of the Urban Forest Report," City of Syracuse, June 2016, https://nysufc.org/wp-content/uploads/2016/08/FINAL-Syracuse-State-of-the-Urban-Forest-Report-2.pdf
7. Synnefa, A., M. Santamouris, and H. Akbari, "Estimating the effect of using cool coatings on energy loads and thermal comfort in residential buildings in various climatic conditions," *Energy and Buildings* 39, (2007): 1167–1174.
8. Davey Resource Group, Inc., "Syracuse Urban Forest Master Plan," City of Syracuse, June 23, 2020, https://www.syr.gov/files/sharedassets/public/v/2/2-departments/parks-recreation/documents/forestry/urban-forest-master-plan.pdf