Heat Island Impacts

Elevated temperatures from heat islands can affect a community's environment and quality of life in multiple ways.

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Increased Energy Consumption

Heat islands increase demand for air conditioning to cool buildings. In an assessment of case studies spanning locations in several countries, electricity demand for air conditioning increased approximately 1–9% for each 2°F increase in temperature. Countries where most buildings have air conditioning, such as the United States, had the highest increase in electricity demand.[1] This increase demand contributes to higher electricity expenses.

Heat islands increase both overall electricity demand, as well as peak energy demand. Peak demand generally occurs on hot summer weekday afternoons, when offices and homes are running air-conditioning systems, lights, and appliances. During extreme heat events, which are exacerbated by heat islands, the increased demand for air conditioning can overload systems and require a utility to institute controlled, rolling brownouts or blackouts to avoid power outages.[2],[3]

Elevated Emissions of Air Pollutants and Greenhouse Gases

As described above, heat islands raise demand for electricity in summer. Companies that supply electricity typically rely on fossil fuel power plants to meet much of this demand, which in turn leads to an increase in air pollutant and greenhouse gas emissions.

These pollutants are harmful to human health and also contribute to complex air quality problems such as the formation of ground-level ozone (smog), fine particulate matter, and acid rain. Increased use of fossil-fuel-powered plants also increases emissions of greenhouse gases, such as carbon dioxide, which contribute to global climate change.

In addition to their impact on energy-related emissions, elevated temperatures can directly increase the rate of ground-level ozone formation. Ground-level ozone is formed when nitrogen oxides and volatile organic compounds react in the presence of sunlight and hot weather. If all other variables are equal, such as the level of precursor emissions in the air and wind speed and direction, more ground-level ozone will form as the environment becomes sunnier and hotter.

Compromised Human Health and Comfort

Heat islands contribute to higher daytime temperatures, reduced nighttime cooling, and higher air-pollution levels. These, in turn, contribute to heat-related deaths and heat-related illnesses such as general discomfort, respiratory difficulties, heat cramps, heat exhaustion, and non-fatal heat stroke.

Heat islands can also exacerbate the impact of naturally occurring heat waves, which are periods of abnormally hot, and often humid, weather. Sensitive populations are particularly at risk during these events.

- *Older adults* are among the most vulnerable to extreme heat events. Many physiological, psychological, and socioeconomic factors contribute to this danger. Older adults are more likely to be in poor health, to be less mobile and more isolated, to be more sensitive to high heat, and to live on reduced incomes.[4]
- *Young children* tend to be more susceptible to extreme heat due to their small size and other characteristics. Children's more rapid breathing rates relative to body size, time spent outdoors, and their developing respiratory systems raise their chances of aggravated asthma and other lung diseases caused by ozone air pollution and smog, which usually increases during heat waves. [5]
- *Populations with low-income* are at greater risk of heat-related illnesses due to poor housing conditions, including lack of air conditioning and small living spaces, and inadequate resources to find alternative shelter during a heat wave.[5]
- *People who spend their working hours outdoors* are more prone to conditions such as heat exhaustion and heat stroke. They have higher exposures to ozone air pollution and heat stress, especially if work tasks involve heavy exertion.
- *People in poor health*, including people with chronic conditions, disabilities, mobility constraints, and those taking certain medications, are vulnerable to extreme temperatures. People with diabetes, physical impairments, and cognitive deficits are especially at risk during heat waves.[5]

Excessive heat events, or abrupt and dramatic temperature increases, are particularly dangerous and can result in above-average rates of mortality. From 2004 to 2018 the Centers for Disease Control and Prevention recorded 10,527 heat-related deaths in the United States, an average of 702 per year. These numbers include deaths where heat was the underlying cause and deaths where heat was a contributing cause. [6]

Impaired Water Quality

High temperatures of pavement and rooftop surfaces can heat up stormwater runoff, which drains into storm sewers and raises water temperatures as it is released into streams, rivers, ponds, and lakes. Water temperature affects all aspects of aquatic life, especially the metabolism and reproduction of many aquatic species. Rapid temperature changes in aquatic ecosystems resulting from warm stormwater runoff can be particularly stressful, and even fatal, to aquatic life.

One study found that urban streams are hotter on average than streams in forested areas, and that temperatures in urban streams rose over 7°F during small storms due to heated runoff from urban materials.[7]

Green infrastructure is one option to cool stormwater runoff and improve water quality. It can include the use of downspout disconnections, rain gardens, planter boxes, bioswales, permeable pavements, green streets and alleys, green parking, and green roofs; as well as land conservation efforts.

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