Investigating Urban Heat Islands Using Mathematical Models, Satellite Data, and On-Site Measurements

Kummel, Kathryn (School: William J. Palmer High School)

The urban heat island is an area of elevated temperature that is a result of fluxes that bring in or shed energy. During the day the energy input is radiation from the sun and the atmosphere and energy exits in five ways: into the ground, the atmosphere, evaporation, radiation, and reflection. Different surfaces will shed heat at different rates, each affecting surface temperature to a different extent. This project investigated the ways in which surface properties changed the balance of energy fluxes and thereby the surface temperature, predicting that the latent (evaporative) heat flux would be the largest driver of surface temperature on all scales. In the analysis of satellite data, the surface temperature of Colorado Springs was analyzed with respect to the vegetative cover, albedo (reflectivity), and elevation. On the scale of the city, all three factors were negatively related to surface temperature, but vegetative (evaporative) cover had the largest effect. A smaller scale analysis yielded similar results: evaporative surfaces were significantly cooler than non-evaporative ones. In this study reflectivity had no significant effect on temperature. Mathematically modeling surface heat fluxes once again resulted in evaporative surfaces being coolest. The model was built to explore how surface temperature and heat fluxes result in thermodynamic equilibrium. A fourth study investigated the merits of having a green/vegetated vs reflective roof. The green roof was cooler, but the reflective one was more cost effective and still decreased temperature. The results of the four studies could inform strategies to mitigate severe urban heat islands.

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