

Quantification and Mitigation of Long-Term Impacts of Urbanization and Climate Change in the Tropical Coastal City of San Juan, Puerto Rico

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Urbanization, along with other cases of land cover and land use changes, has significant climate impacts in tropical regions with the added complexity of occurring within the context of global warming. The individual and combined effects of these two factors on the surface energy balance of a tropical city are investigated by use of an integrated atmospheric modeling approach, taking the San Juan Metropolitan Area (SJMA), Puerto Rico as the test case. To achieve this goal, an ensemble of climate and weather simulations is performed, with the climate scenarios combining urban development and sprawl with regional climate change over the past 50 years, and the short-term simulations designed to test the sensitivity to different urban vegetation configurations as mitigating alternatives. As indicator of change, we use the thermal response number (*TRN*), which is a measure of the sensible heating to the thermal storage of a surface or region, and the Bowen ratio, which is defined as the ratio of sensible to latent heat fluxes. The *TRN* of the area occupied by the SJMA has decreased as a consequence of replacing the low land coastal plain vegetation with man made materials, indicating that it takes less energy to raise the surface temperature of the urban area, whereas the *TRN* of forested regions has remained virtually unchanged. The global warming signal also has effects on the thermal response of the SJMA, where dryer current conditions generate lower *TRN* values. Differences due to global warming are more evident in the Bowen ratio pattern, mostly associated with the drier present conditions observed and its effects on sensible and latent heat fluxes. In terms of testing different mitigation strategies, the short-term simulations show that the urban area is more efficient in partitioning surface energy balance terms when green roofs are specified, as opposed to including vegetation inside the urban core.