Modeling the anthropogenic heat flux of Hong Kong using remote sensing data

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Anthropogenic heat is man-made heat generated by electricity inputs to buildings, fuel combustion of traffic and industrial activities, and is an important contributory factor to urban heat islands. Estimates of anthropogenic heat discharge can be calculated by totaling the energy consumptions from the power grid network and from GIS spatial and census data, such as the number of buildings and population. While the temporal and spatial scales of these data are always limited, their coarse resolution prohibits their widespread use for urban heat island studies at a detailed level. This study demonstrates an alternative methodology using remote sensing to estimate the magnitude of anthropogenic heat in Hong Kong. The net radiation (R_n), sensible heat flux (H), latent heat flux (LE), and ground heat flux (G) were estimated using the satellite images coupled with meteorological data and a digital elevation model (DEM). The anthropogenic heat discharge is then deemed to be the residual of the heat balance equation. Three Landsat images were acquired on 30-Dec-1995, 03-Mar-1996, 14-Sep-2000 and used for this estimation. The results reveal that urban development and land reclamation increased the anthropogenic heat flux over the period 1995-2000 and this is shown on three images at Kowloon west, the new airport, Hung Hom Bay and Cheung Sha Wan. In addition, due to the large heat capacity of dense tall buildings, heat fluxes discharged into city downtown areas were 1.5, 1.3, and 2.2 times larger than those in the sub-urban towns on those three dates. It is obvious that the contribution of anthropogenic heat is small in sub-urban, and approximate zero in rural areas, but becomes much larger in the city. However, in the city, anthropogenic inputs are not usually large enough to be a dominant factor in summer time urban heat island formation, but have a more significant impact on winter time urban heat islands.