

### **Spatiotemporal Variation of the Surface Urban Cool and Heat Islands in Erbil, Iraqi Kurdistan.**

Differences between the energy balance of cities and their non-urban surroundings exist due to modification of surface properties. In temperate and sub-tropical climates, these differences are manifest as the Urban Heat Island (UHI) effect. However, in more arid environments man-made modifications of the environment can cause urban cooling relative to the surrounding landscape, particularly during the dry season. This research examines the spatiotemporal formation of the Surface Urban Cool Island (SUCI) and the Surface Urban Heat Island (SUHI) effect of Erbil city in Iraq, as a case study of cities in semi-arid climates. Satellite images acquired by Landsat 5, 7 and 8 during the period from 1992 to 2013 and MODIS Aqua and Terra Land Surface Temperature (LST) are used to retrieve land surface temperature (LST), identify Land Use/Land Cover (LULC) classes and investigate the spatiotemporal variation of LST and the SUCI/SUHI intensity. In order to find out the key drivers of the observed patterns of LST, the relationship with wetness, brightness, bareness, built-up and vegetation index maps are examined. The results indicate that densely built-up areas, such as central districts of the city, green areas and water bodies, had lower LST acting as cool islands, compared to the non-urbanized area around the city. In contrast, open spaces and new low-density housing developments on the outskirts of the city, experienced higher LST and showed an SUHI effect. A very strong inverse relationship is evident between surface temperature and Wetness Index ( $r = -0.9$ ;  $p < 0.01$ ). A strong positive correlation ( $r = 0.75$ ;  $p < 0.00001$ ) is apparent with the Brightness Index.