A vegetation change detection approach to analyzing the prevalence of urban irrigation in Phoenix, Arizona

BACKGROUND

Phoenix, Arizona and its satellite cities are some of America’s fastest growing desert areas. A suburban growth model fueled by water redirection and irrigation strategies has allowed the metropolitan region to sprawl across over 2,000 square miles of arid land. Desert ecologies are fragile and highly volatile. Climate change will exacerbate precipitation unpredictability, placing even greater stress on the city’s current water resource management portfolio. Over half of the water managed in Arizona’s Sun Corridor is linked to the Colorado River, a politically contentious supply. As populations continue to grow, limited water resources will force development to adapt, ultimately shaping a new urban character and way of life in the desert region.

Growth is characterized by master planned communities and housing developments. For the past few decades, much of this development took place on agricultural land. In Applied Remote Sensing for Urban Planning, Governance, and Sustainability, Mark Nethband and William Stefanov point out that “land taken out of agriculture is quickly covered with housing.” It is estimated that 53% of Maricopa county’s water use is residential, while 70% of Arizona’s total water use is agricultural. This demonstrates a shift in the distribution of water resources, where residential water use gradually replaces agricultural usage in urbanizing areas. More than 50% of the water used in a typical household is associated with landscaping (Johnson and Belitz, 87). Identifying areas that utilize irrigation to replace agricultural usage in urbanizing areas is agricultural. This shows a shift in the distribution of water resources, with residential water use gradually replacing agricultural usage in urbanizing areas.

The layout of cities, that is, the relationship between buildings, vegetation, landscape, streets, and solar orientation has a substantial effect on UHI. Planting desert appropriate vegetation, creating structural shade strategies, encouraging water use reduction, and supporting more balanced approaches to mitigating UHI and responsible management of water resources. Ultimately, identification of irrigated pixels should also be applied to approximate water use rates. This would provide policy-makers and city planners with information critical to creating strategies for curbing water use in specific geographies and neighborhoods.

RESULTS

23% of the pixels in the resulting image are classified as irrigated vegetation according to the density slice. The method has mixed results, both due to issues inherent to the method and to distortion that occurred in image differencing. The most obvious inaccuracy occurs in some areas that exhibit a very high NDVI value in the NDVI index images. These areas, mostly golf courses, may have experienced negative NDVI change while still remaining irrigated. In the logic of the original hypothesis, this is an inherent flaw. Still, this information does demonstrate that vegetation dependent on irrigation experiences water and heat stress in Arizona’s hot and dry summer climate, regardless of whether or not it is irrigated. A vegetation change approach may be helpful in identifying vegetation prone to water stress.

DISCUSSION

Ultimately, identification of irrigated pixels should also be applied to approximate water use rates. This would provide policy-makers and city planners with information critical to creating strategies for curbing water use in specific geographies and neighborhoods.

DATASETS

Two Landsat 8 CDR images (Path/Row 37/17) from the year 2014 were acquired from the US Geological Survey (USGS) Earth Explorer. CDR images are preprocessed for terrain and geospatial correction to minimize spatial distortion, although significant elevation changes remain cause for error. Image date selection was informed by climate history data, gathered from the National Oceanic Atmospheric Administration (NOAA) Applied Climate Information System (ACIS). The following tables from NOAA detail the monthly total precipitation and monthly mean average temperature for Phoenix, Arizona in a 30 year period between 1984 and 2014.