

It's Heating Up: How the Salt River Pima-Maricopa Indian Community Reservation Impacts the Urban Heat Island Effect in Phoenix

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Research Question

Has the Salt River Pima-Maricopa Indian Community (SRPMIC) Reservation impacted the urban heat island (UHI) effect in the Phoenix metropolitan area during the summers of 2017-2021?

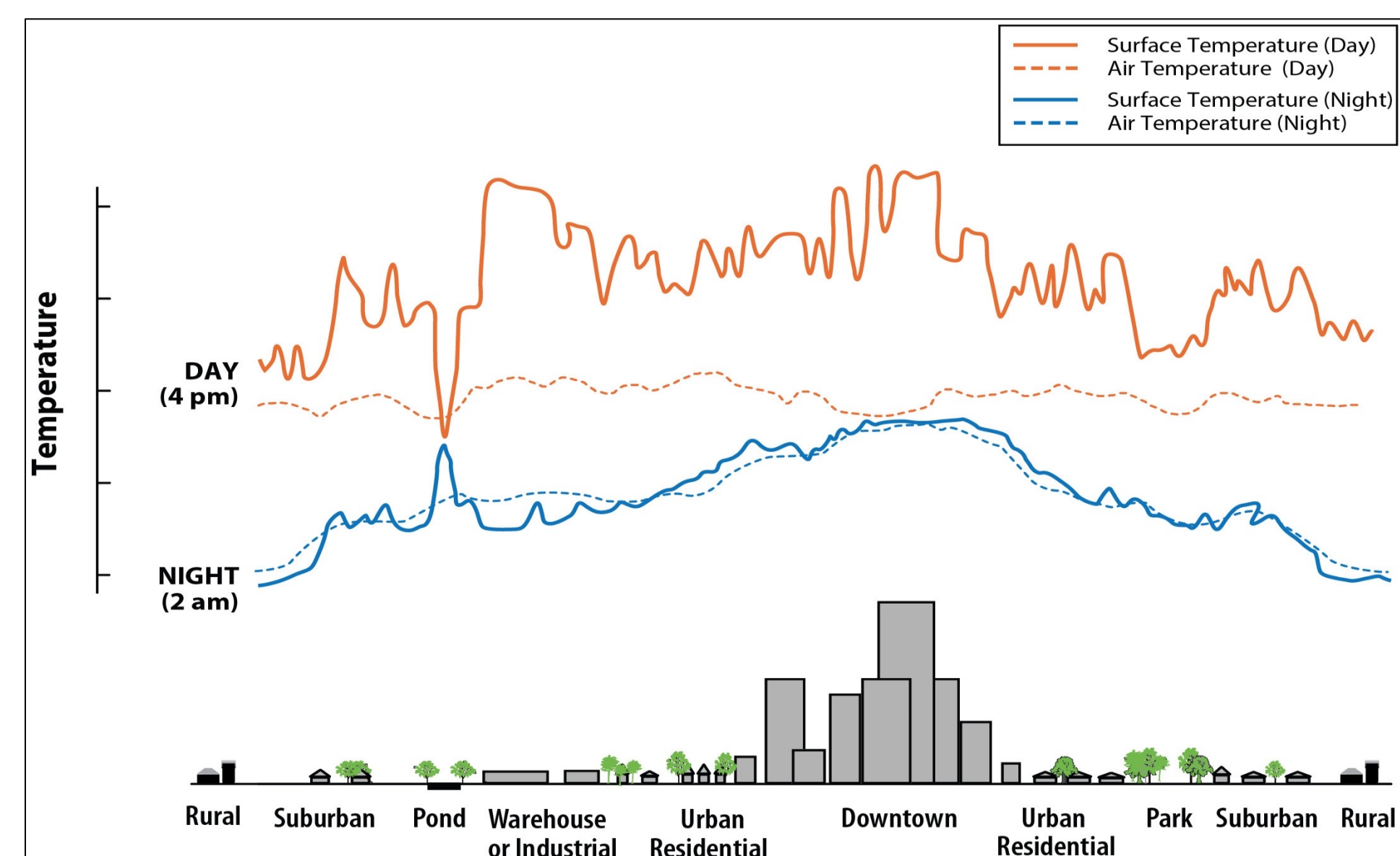


Figure 1. Different land cover types within a city have varying temperatures based on time of day. (EPA)

Introduction

Phoenix is the second-fastest-growing city in America¹. The UHI effect occurs when impervious surfaces absorb heat and slowly release it through the night (Figure 1). This leads to higher temperatures in the city compared to the surrounding rural areas². Urban design and land cover types have a strong impact on the heat distribution throughout the city³.

Established in 1879, the Salt River Pima-Maricopa Indian Community Reservation (SRPMIC) encompasses 52,600 acres of developed, agricultural, and desert land (Figure 2) with a population of 9,000 people⁴. Both agricultural and desert land have been linked to cooler temperatures than urban land cover types⁵. Increased heat in Phoenix is a public health problem during the summer months⁵.

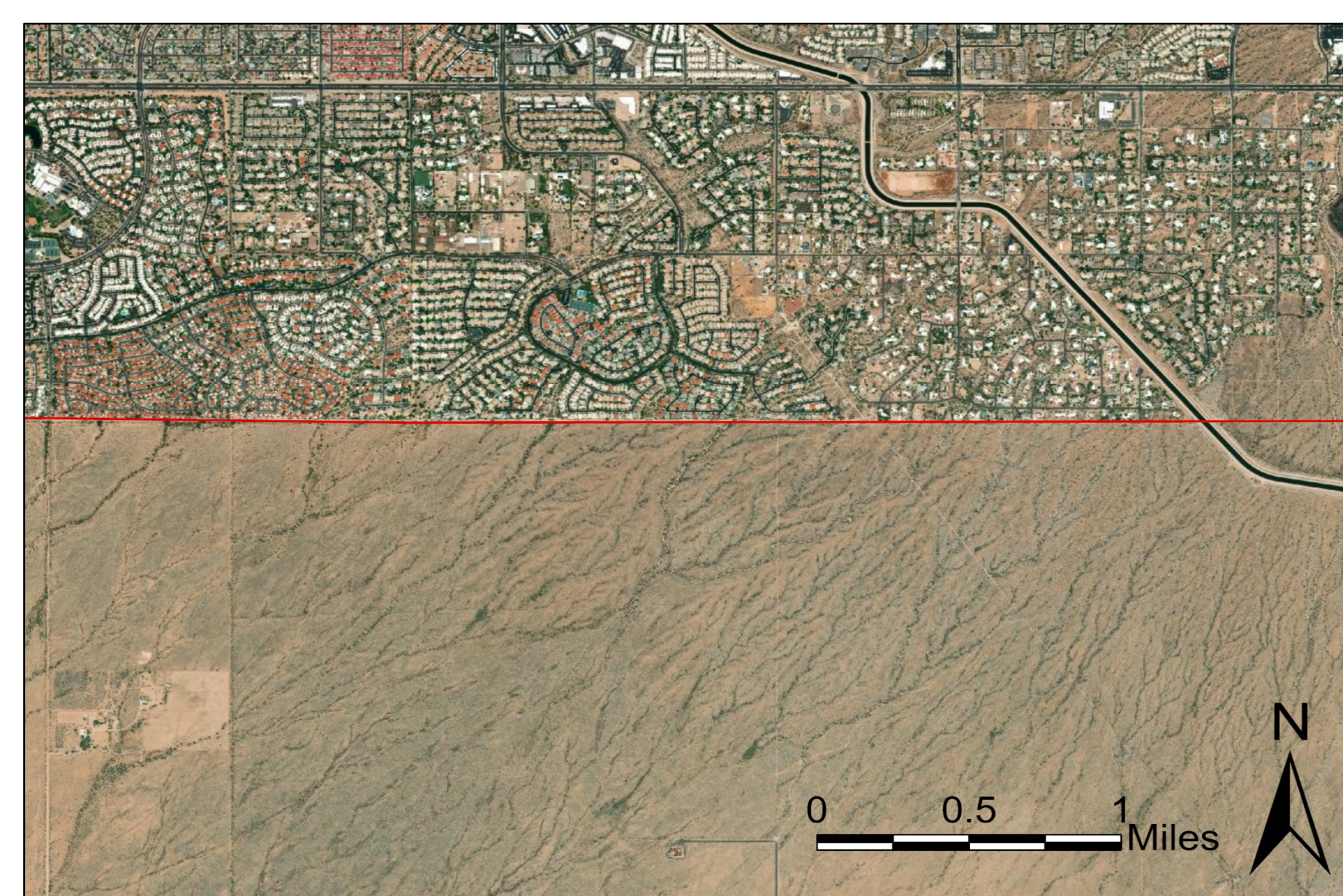


Figure 3. The City of Scottsdale juxtaposed against the natural environment of the SRPMIC Reservation.



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LANDSAT Data

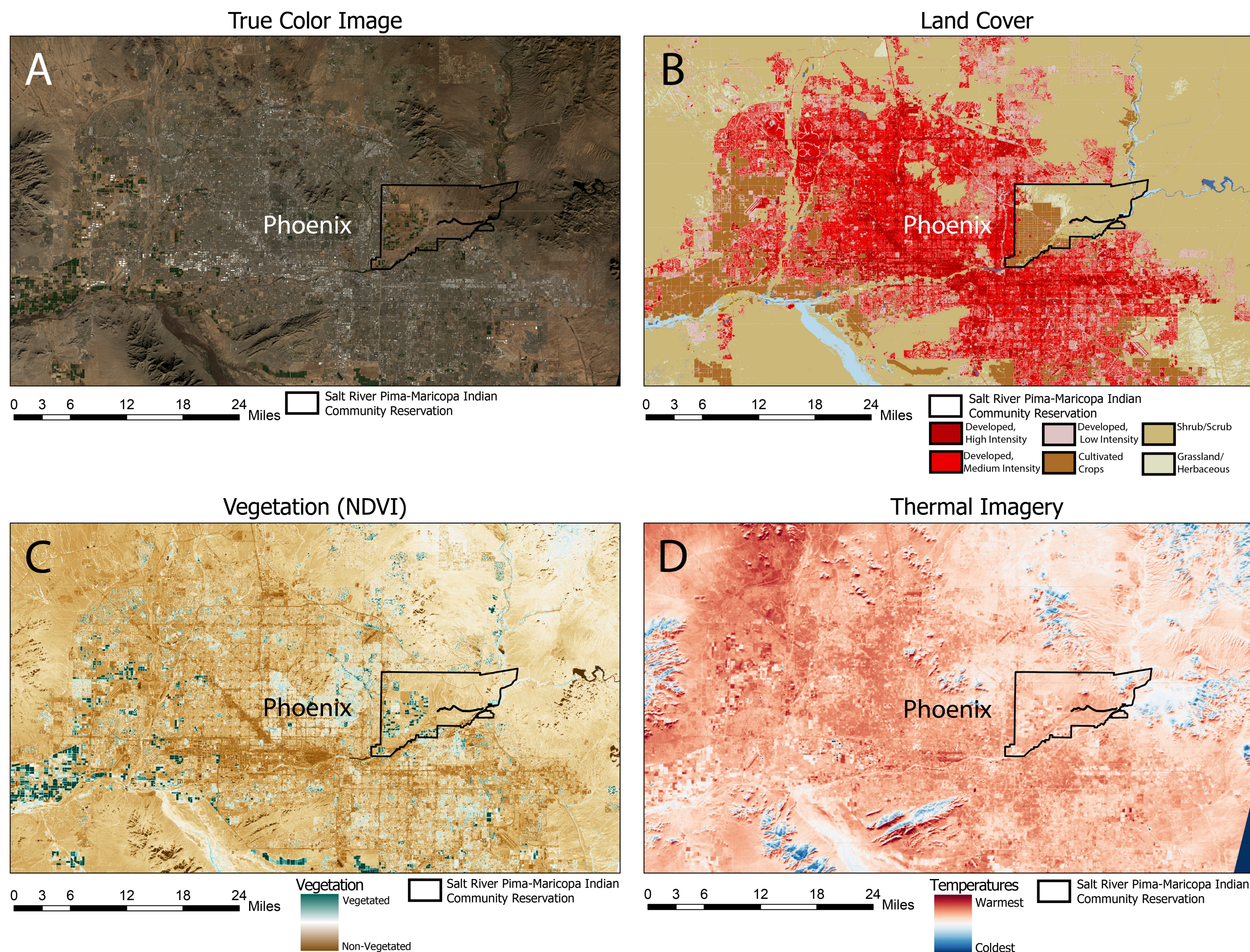


Figure 2. This data was collected in 2021, by LANDSAT 8. Map A is a true-color image of the Phoenix Metropolitan area. Map B is data from the National Land Cover Database, displaying land cover types in the Phoenix Metropolitan area. Map C was created with LANDSAT 8 data and demonstrates where vegetation is present throughout the city. Map D is a surface temperature map displaying energy levels given by interactions of the sun with the land surface. All data is courtesy of the US Geologic Survey and NASA.

Methods

Data Collection: For this project, there will be two main modes of data collection, one being remote sensing data, and the second being the Weather Research and Forecasting (WRF) model. The remote sensing data will be collected from LANDSAT 8 and the TIRS instrument data will be utilized to detect land surface temperatures. In addition to LANDSAT data, I will also use ASTER data from the MODIS satellites to provide a better temporal resolution than LANDSAT with the downside being spatial resolution. The WRF model will run hypothetical models to see how the UHI effect would impact the Phoenix metropolitan area if the Salt River Pima-Maricopa Indian Community Reservation had different land cover types, such as urban core or suburban fringe.

Data Analysis: Remote sensing data will be analyzed using statistical modeling to see how the reservation distributes and reflects heat. WRF data will be analyzed in QGIS and will also be thrown through some statistical models to see how the hypothetical scenarios have played out, and whether the current land cover configuration on the reservation is providing cooling effects on the city.

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Urban Expansion

The urban heat island (UHI) effect is controlled by not only the amount of impervious surfaces in an urban region but also by the spatial arrangement of impervious surfaces⁶. Urban contiguity is the most important control of the UHI effect in comparison to other urban design elements such as urban development intensity or variation in land cover⁷.

The SRPMIC reservation preserves the natural landscape and prevents further degradation of nature into suburban and urban developments (Figure 3). Urban regions broken up by areas with no impervious surfaces, commonly filled with plants, are known as green spaces and they create a cooling effect⁷. I hypothesize the SRPMICR contributes cooling to the region because the reservation disrupts urban contiguity and has large spaces filled with pervious surfaces.

Land Cover

Land cover refers to what is present at the surface of the landscape. Some common land cover types include urban, water, and shrubland. The reason why land cover is so important to the UHI effect is that land cover controls how solar radiation interacts with the earth's surface. These interactions control heat distribution and the extent of the UHI.

Currently, a majority of the SRPMIC reservation is covered by desert/xeric shrubland, which features plants such as saguaro cactus, prickly pear cactus, and creosote bush. This land cover type behaves differently under the same sunlight as agricultural land cover, in which another significant part of the reservation is covered. Understanding the land cover types on the SRPMIC reservation will be important for running models and understanding heat distribution patterns in and around the reservation.



Figure 4. Red Mountain, located on the Salt River Community Reservation. (Courtesy of Mapio.net)

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