# Urban greenery and land surface temperature

*NASA Landsat Satellites*

Landsat 5 and 8 are modern iterations of NASA's flagship optical Earth observation satellites. Landsat 5, launched in 1984, and Landsat 8, launched in 2013, provide time series data of the Earth's surface reflectance and land surface temperature at approximately two-week revisit intervals. Their surface reflectance and land surface temperature data allowed us to calculate trends in urban greening and heating over the San Francisco Bay Area for the duration of our study period (1990 - 2020). Trends for greening and land surface temperature were calculated at 30- and 120-meter spatial resolution, respectively.

- Landsat 5 DOI: https://doi.org/10.5066/P9IAXOVV
- Landsat 8 DOI: https://doi.org/10.5066/P9OGBGM6

*USDA NAIP & ESA Sentinel-2*

NAIP stands for the National Agricultural Imagery Program and is acquired every 3-years in California by the United States Department of Agriculture. This program provides visible and near-infrared aerial imagery at 1-meter spatial resolution. Sentinel-2 is the European Space Agency's (ESA) flagship optical Earth observation satellite. Sentinel-2 launched in 2015 and provides time series data of the Earth's surface reflectance in visible and near infrared at approximately two-week intervals. Sentinel-2 data is available at its native 10-meter spatial resolution.

NAIP and Sentinel-2 were used together to perform green space classification in the San Francisco Bay Area. Sentinel-2 time series starting in 2015 and NAIP survey imagery from 2020 and 2022 were used for the classification. To reconcile the varying spatial resolutions, we implemented a geographic object-based image analysis (GeOBIA) segmentation to collect spatial statistics of like-segments in our study area. We then performed image classification using statistics from these segmented images and resampled our final classification to 5-meter spatial resolution.

*Distinction between "Greenness level" and "Green space"*

In our webtool, there are several display layers with seemingly similar names, specifically layers referring to "Greenness level" and "Green space". We (the authors) would like to clarify that layers labeled with "Grenness level" refer to Landsat NDVI trends. Furthermore, layers labeled with "Green space" refer to pixels classified as green space by our GeOBIA image classification algorithm, which utilizes NDVI for classification in addition to several other spectral indices and satellite image band data. We would like to explicitly state that while these layers contain similar information, they are not the same.

## Socioeconomic indicators

The vector layers on the map aim to illustrate relationships between environmental variables (either greenness level or land surface temperature) and socioeconomic indicators. The socioeconomic variables are as follows:

1. **Social Vulnerability Index:** The CDC's 2018 Social Vulnerability Index assigns scores to tracts based on 15 variables from the U.S. census, including unemployment, minority status, and disability.
2. **Displacement risk:** This data comes directly from the Urban Displacement Project's Estimated Displacement Risk Model for California. The levels of displacement risk shown in this webtool correspond with the 'Overall Displacement' layer shown in the map on UDP's website. The highest level of displacement risk represents the '2 income groups' category; the middle level represents the '1 income group' category, and the lowest level of displacement risk represents the 'Probable Displacement' category. See the link above for more information about the methodology for creating the model.
3. **Housing price trend:** Zip code-level housing price trend data comes from the Zillow Home Value Index (ZHVI), which is a *"measure of the typical home value and market changes across a given region and housing type"* and *"reflects the typical value for homes in the 35th to 65th percentile range."* The percent change in yearly average housing price between 2000 and 2020 was calculated by subtracting the average monthly ZHVI in 2000 from the average monthly ZHVI in 2020, and dividing that value by the average monthly ZHVI in 2000.