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Using Satellites to Map the Urban Heat Island Effect and Using Products to Generate Public Action in Harrisonburg

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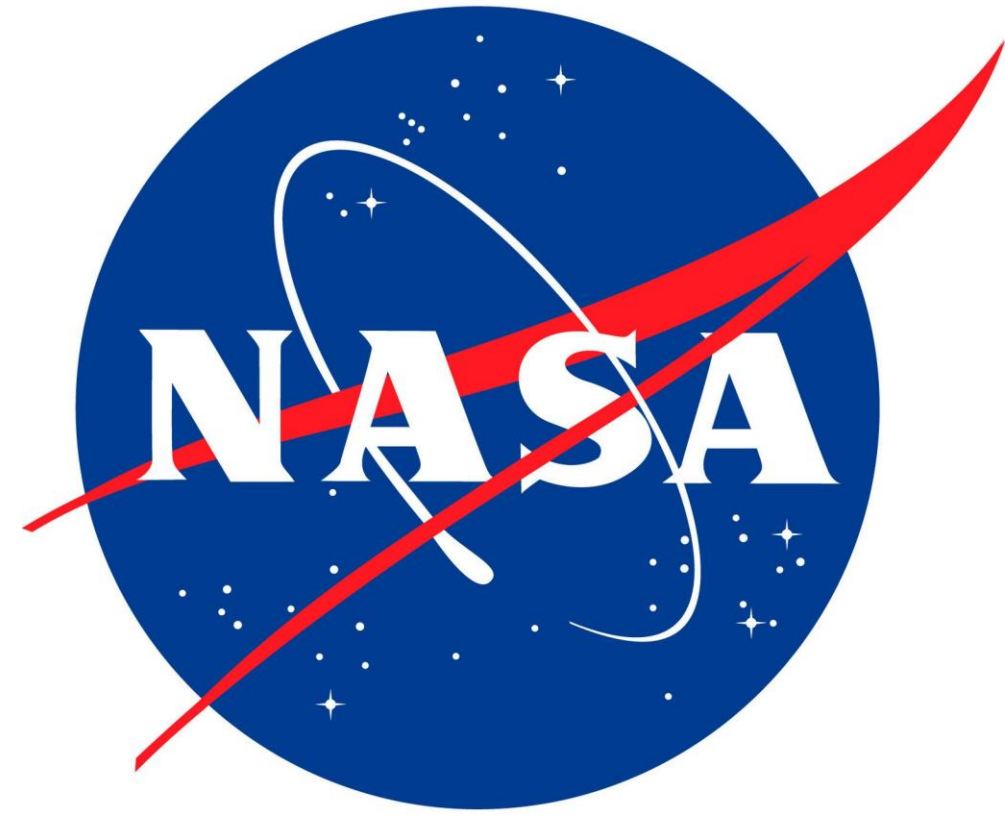
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Using Satellites to Map the Urban Heat Island Effect and Using Products to Generate Public Action in Harrisonburg



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Introduction

- The urban heat island (UHI) is the term used to describe the phenomena where urban centers heat up and remain hotter than their rural counterparts.
- Historically, this has been measured by picking one point defined as urban and one point defined as rural and subtracting them.
- The surface urban heat island (SUHI) is described as the difference in temperature between urban and rural areas. Areas are selected using Satellite imagery rather than terrestrial sensors.
- The difference between urban and rural is felt most intensely during night owing to different cooling rates of surfaces. (Oke et al, 1991).
- The goal of this project is to examine the pros and cons of different satellite data sets through examining the UHI of Harrisonburg and Bridgewater

Comparison of Satellite Resources

MODIS

- Two Satellites called the Aqua and the Terra
- The Terra launched in 1999 but the Aqua was not launched until 2002
- For LST data resolution is at 1 km per pixel
- The two satellites will image the same area (one during the day and one at night) at the same angle every day
- Large temporal data allows for greater sample size and more accurate representative images

ECOSTRESS

- ECOSTRESS is a radiometer attached to the International Space Station (ISS)
- It has a resolution of 70 meters
- Launching in 2018 there is comparatively few datapoints compared to MODIS
- ECOSTRESS has a unique orbit, allowing for different images during the day. However, it does not always cover the same area each day, nor is it consistent in where it images
- Highly susceptible to cloud interference

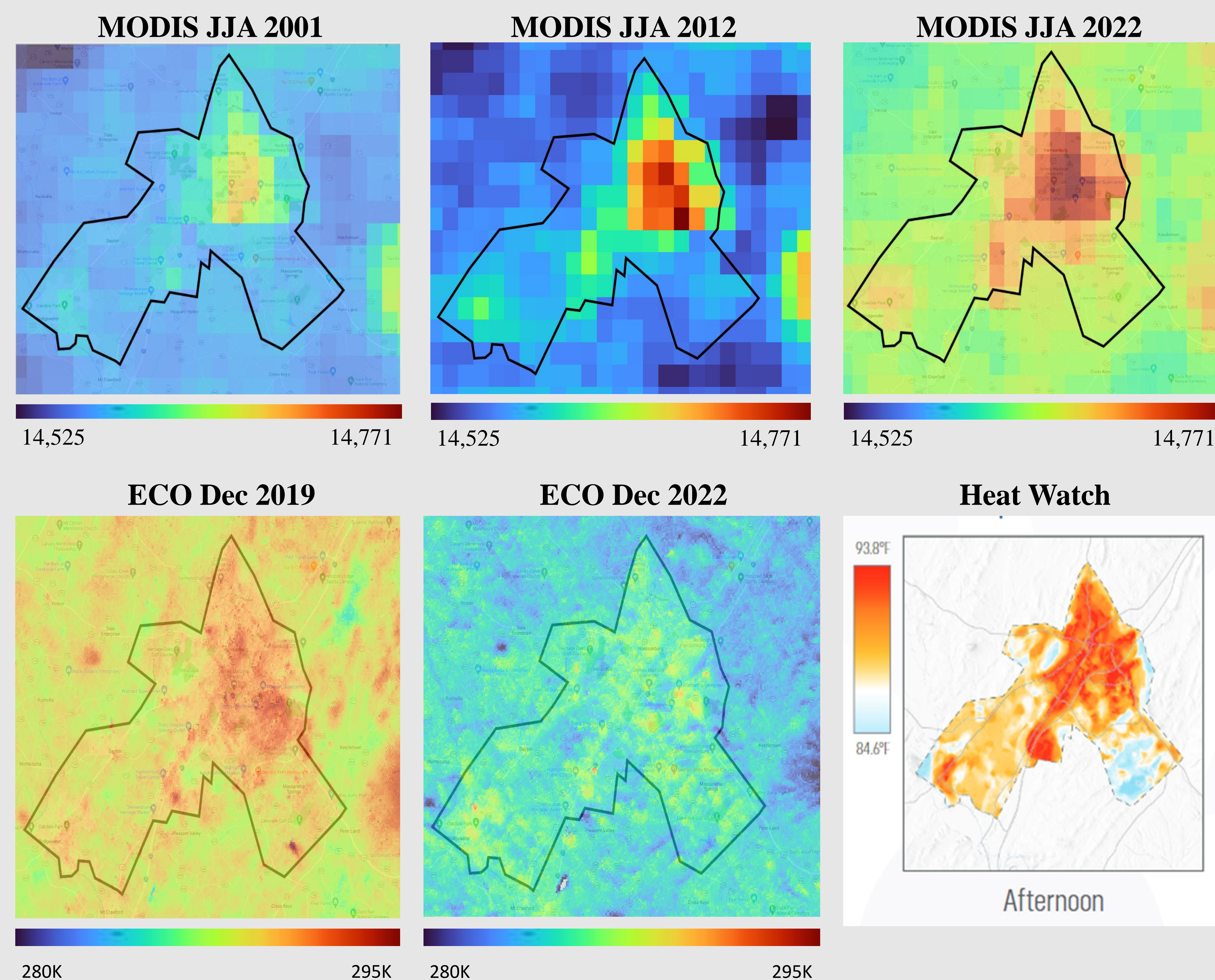
Heat Watch and Mobile Terrestrial Sensors

- Community driven mapping campaign that involved attaching sensors onto vehicles and driving along predetermined routes.
- Offers a good snapshot of the air urban heat island (AUHI) which is more akin to human experience
- Data can be corrupted by weather, and data not directly collected by sensors is then estimated with Sentinel-2 data

Methods

- Heat Watch data was previously collected in a separate study in the summer of 2021
- Study area included the Harrisonburg city limits, Dayton, and Bridgewater
- Raw data was sourced from NASA's Earth Explorer and Atmosphere Archive & Distribution System Distributed Active Archive Center (LAADS DAAC)
- MODIS data was imported into Google Earth Engine, a new tool which allowed MODIS data to be reprojected, averaged, and then composited into a new detailed image. Data was averaged seasonally for the years 2001, 2012, and 2022
- Composite images were then brought into QGIS for interpretation and analysis
- ECOSTRESS raw data was segregated between geolocations and data files, these files had to be combined
- Data was then combed through manually to filter out data that was corrupted by clouds or an incomplete coverage of the study area
- Due to temporal issues averaging ECOSTRESS data was impossible
- Data snapshots were then loaded into QGIS
- All ECOSTRESS and MODIS data was then overlaid onto a google map of the study area to determine specific locations that demonstrated UHI characteristics

Results



Application and Next Steps

Trees planted at Spotswood Elementary as part of project to offset heat islands



Trevor Brooks and participants will plant 100 trees at Spotswood Elementary.

- Collaboration with the city has already resulted in over 100 trees being planted at Spotswood Elementary School
- MODIS images are being supplied to Vice Mayor Laura Dent with the intention of informing new building code changes to make Harrisonburg more resilient
- Some of these changes may be carrot stick incentives for businesses
- Both abiotic and biotic mitigation techniques should be pursued
- Other recommendations in the report will include adding trees or some other green areas to vast parking lots
- Data will also be supplied to residents of Harrisonburg through organizations such as Climate Action Alliance of the Valley, Sustainable Shenandoah Valley, and the Northeast Neighborhood Association with the intent on sparking community discussion and communication
- A new method for studying urban heat on a microscale could be used to better communicate UHI data
- Data should be re-looked at every few years to further show how the UHI has changed overtime.

Literature Cited

- Oke, The energetic basis of the urban heat island. 1982.
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