



# Vegetation in the Denver Metro Area

By Adam Lehman

Natural Color



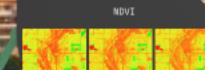
## Introduction

- How much has Denver's growth changed vegetation over the years?
- Changes have been over the years
- Impression of parks and vegetation
- LandSat 5 and Landsat 8 Data
- Located at the years 1985, 2013, and 2019
- All Data in WGS 1984 UTM Zone 13N

## Methods

Method	Description
NDVI	Normalized Difference Vegetation Index
False-Color Infrared	False-color infrared imagery
NDVI Difference	Difference between NDVI values
Conclusion	Conclusion

False-Color Infrared



NDVI Difference



## Sources

- USGS Earth Explorer
- ESRI
- NASA
- https://eve.gsfc.nasa.gov/31196/
- Image from Visit The USA
- https://www.visittheusa.com/experience/10-urban-adventures-and-around-denver-colorado
- https://www.usgs.gov/
- https://www.esri.com/
- https://www.visittheusa.com/experience/10-urban-adventures-and-around-denver-colorado



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# Introduction

- How much has Denver's growth changed vegetation over the years?
- Changes I've seen over the years
- Preservation of parks and vegetation
- Landsat 5 and Landsat 8 Data
- Looked at the years 1991, 2013, and 2023
- All Data in WGS 1984 UTM Zone 13N

# Methods

1. Downloaded Landsat data from Earth Explorer
2. Used the "Composite Bands Data Management Tool" to create composite images of all bands for each year
3. Set ROI to Downtown Denver with a ~3.5 mile radius
4. Created Natural Color images
  - 4-3-2 for Landsat 8 and 3-2-1 for Landsat 5
5. Created NDVI Images
  - "Indices Tool" using corresponding bands
    - 5-4 for Landsat 8 and 4-3 for Landsat 5
6. Created False Color Infrared images
  - 5-4-3 for Landsat 8 and 4-3-2 for Landsat 5
7. Created NDVI Difference image
  - "Difference Tool" comparing 1991 to 2023
8. Analyzed results

Landsat 4-5 Thematic Mapper (TM)	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Blue	0.45-0.52	30
	Band 2 - Green	0.52-0.60	30
	Band 3 - Red	0.63-0.69	30
	Band 4 - Near Infrared (NIR)	0.76-0.90	30
	Band 5 - Shortwave Infrared (SWIR) 1	1.55-1.75	30
	Band 6 - Thermal	10.40-12.50	120* (30)
	Band 7 - Shortwave Infrared (SWIR) 2	2.08-2.35	30

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) Launched February 11, 2013	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Coastal aerosol	0.43 - 0.45	30
	Band 2 - Blue	0.45 - 0.51	30
	Band 3 - Green	0.53 - 0.59	30
	Band 4 - Red	0.64 - 0.67	30
	Band 5 - Near Infrared (NIR)	0.85 - 0.88	30
	Band 6 - SWIR 1	1.57 - 1.65	30
	Band 7 - SWIR 2	2.11 - 2.29	30
	Band 8 - Panchromatic	0.50 - 0.68	15
	Band 9 - Cirrus	1.36 - 1.38	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100

LC08\_L1TP\_034032\_20230711\_20230718\_02\_T1\_B1.TIF  
 LC08\_L1TP\_034032\_20230711\_20230718\_02\_T1\_B2.TIF  
 LC08\_L1TP\_034032\_20230711\_20230718\_02\_T1\_B3.TIF  
 LC08\_L1TP\_034032\_20230711\_20230718\_02\_T1\_B4.TIF  
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 LT05\_LTTP\_033032\_19910712\_20200915\_02\_T1\_B7.TIF

# Natural Color



1991  
July 12th

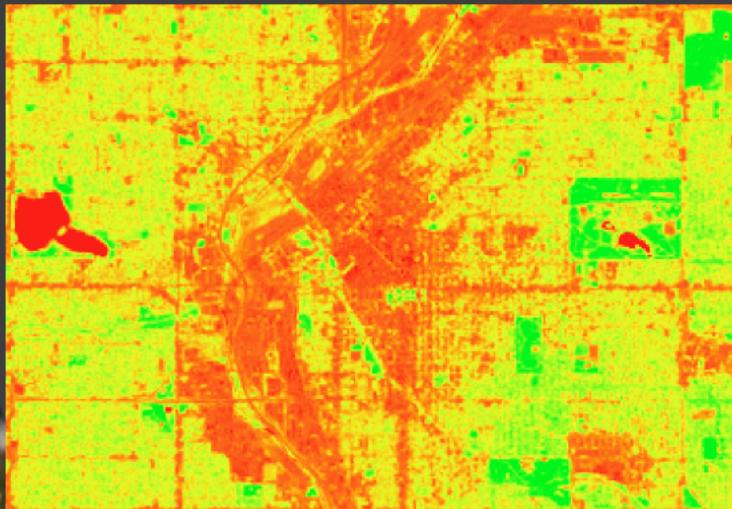


2013  
July 8th

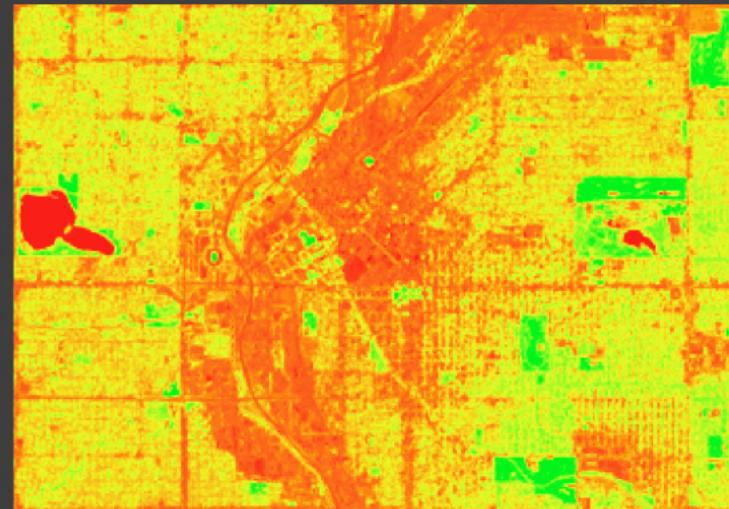


2023  
July 11th

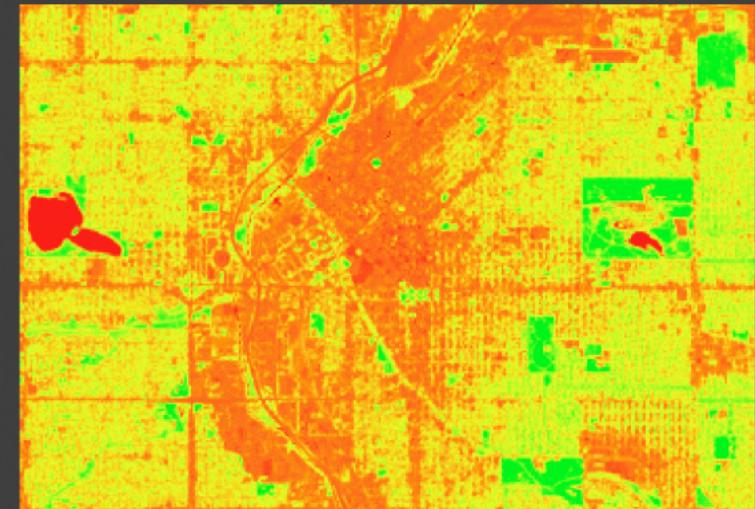
# NDVI



1991  
July 12th

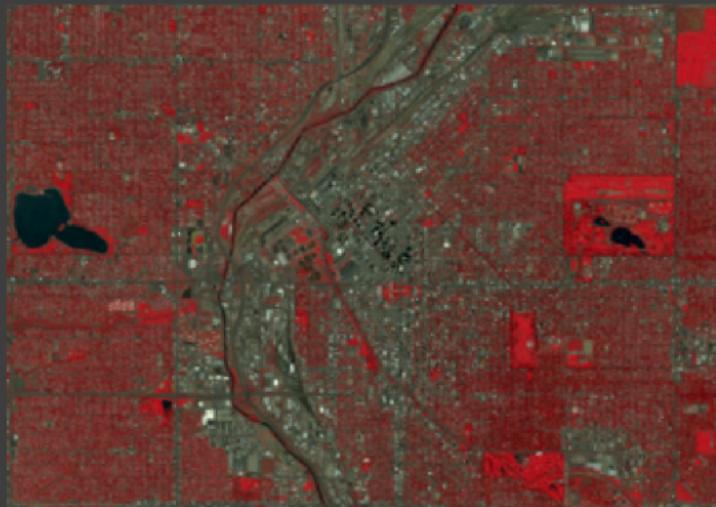


2013  
July 11th

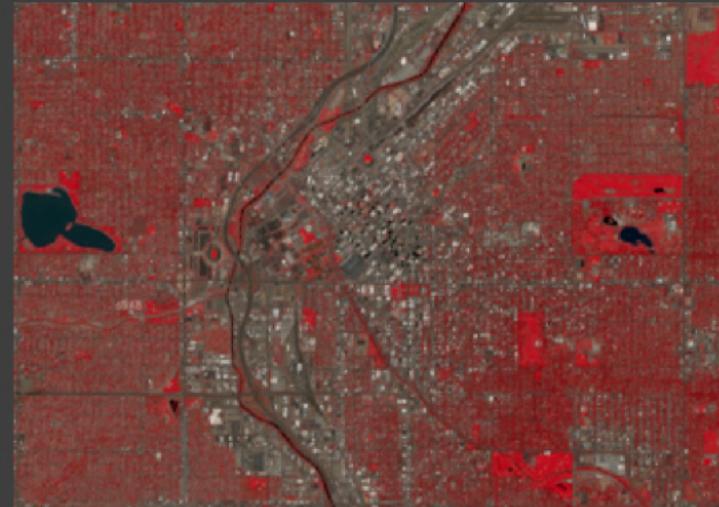


2023  
July 11th

# False-Color Infrared



1991  
July 12th

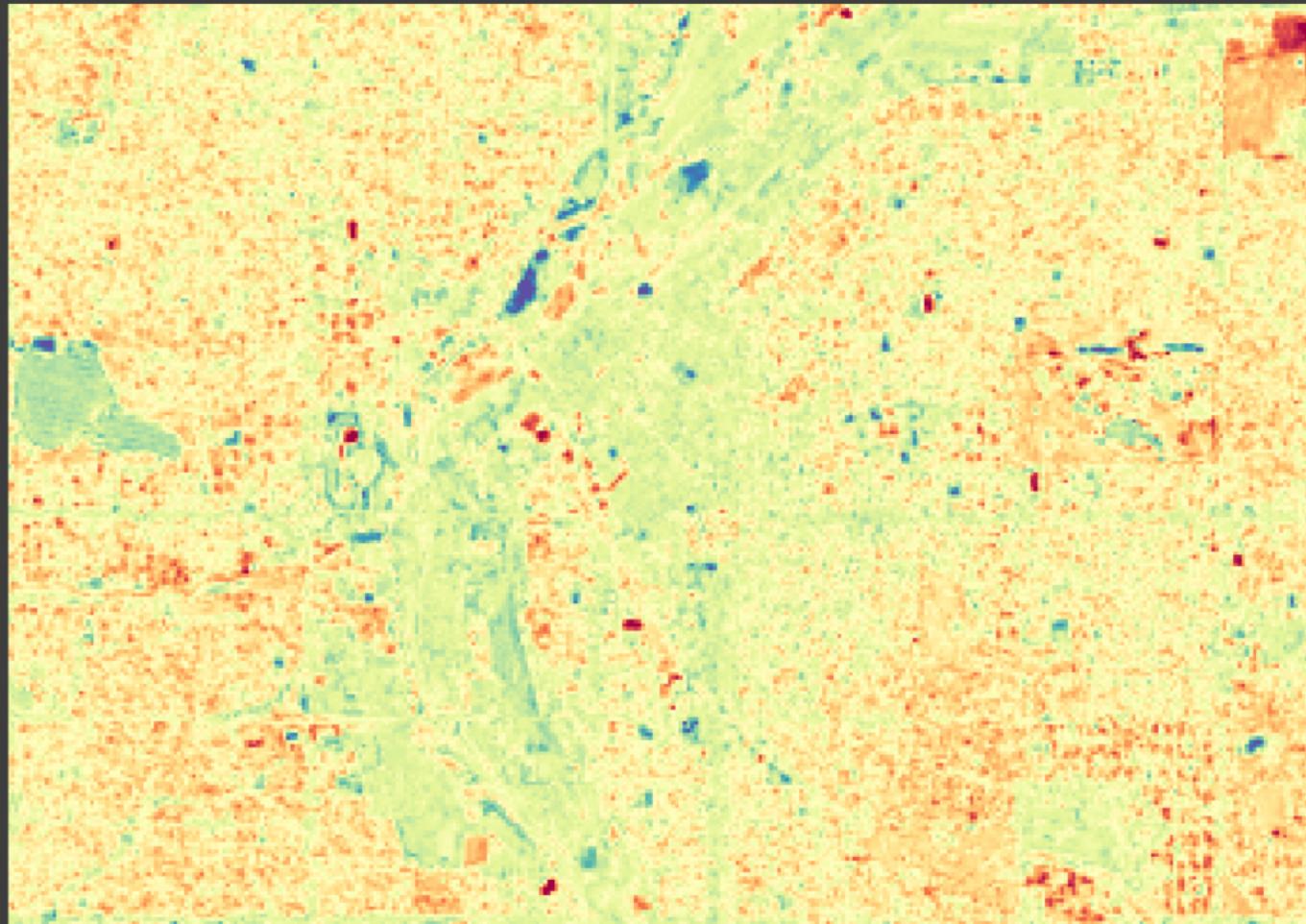


2013  
July 11th



2023  
July 11th

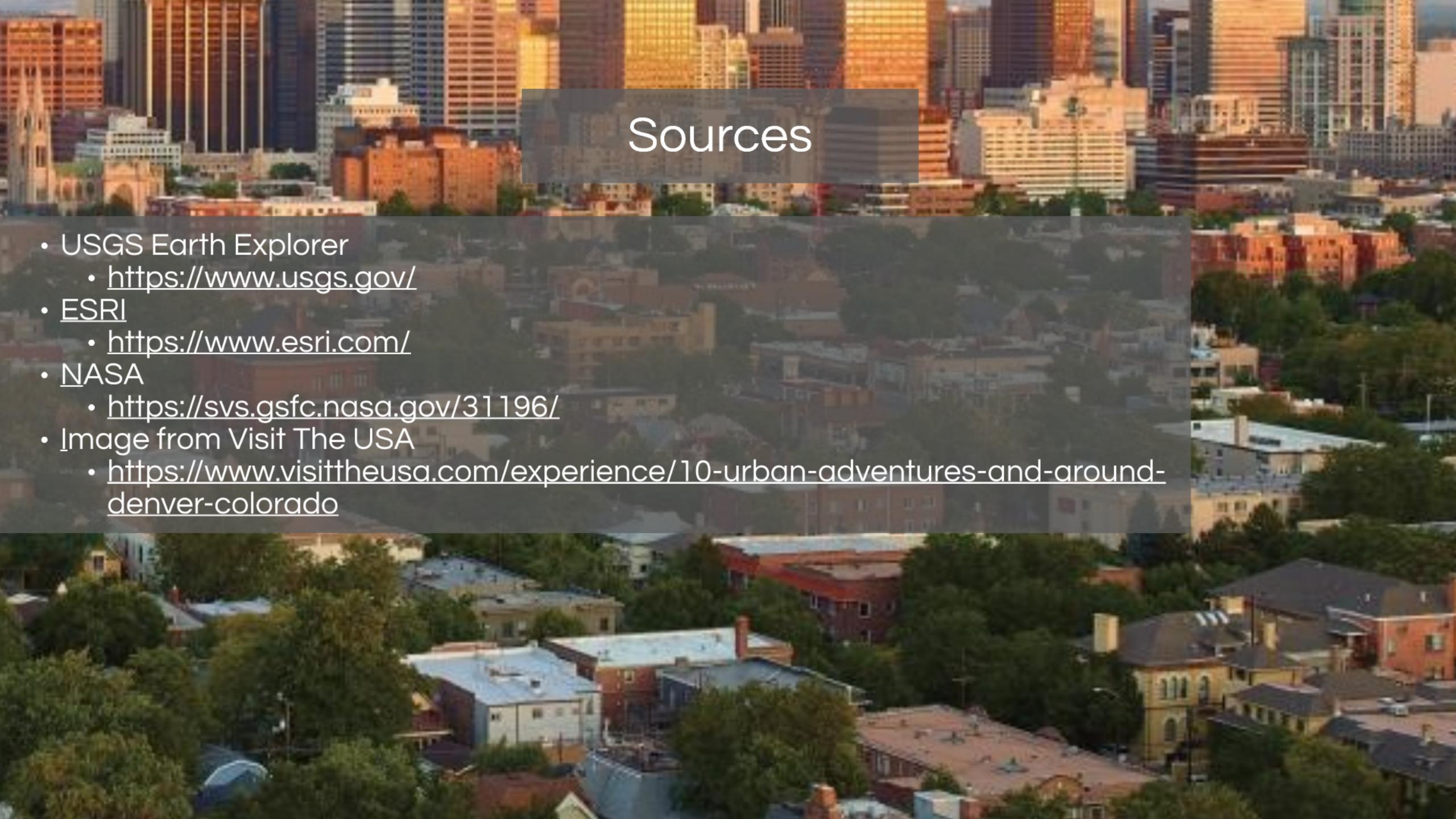
# NDVI Difference



July 12th, 1991 - July 11th, 2023

# Conclusion

- Less vegetation, more urban
- I did not expect to see as many new parks
- Protection of greenspaces
- Incorporation of vegetation into urban landscape
  - One River North
  - Rooftop gardens
- Thinking more environmentally friendly in the future
- Continue to monitor vegetation and effects of urbanization



# Sources

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- ESRI
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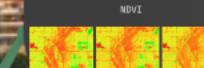
## Methods

1. PREPARATION OF REMOTE SENSING DATA  
2. PREPARATION OF VECTOR DATA  
3. PROCESSING OF REMOTE SENSING DATA  
4. PROCESSING OF VECTOR DATA  
5. COMBINATION OF REMOTE SENSING AND VECTOR DATA  
6. ANALYSIS

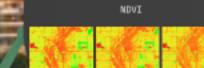
Table 1

Step	Process	Tool
1. PREPARATION OF REMOTE SENSING DATA	• Download remote sensing data	• USGS Earth Explorer
2. PREPARATION OF VECTOR DATA	• Download vector data	• ESRI
3. PROCESSING OF REMOTE SENSING DATA	• Process remote sensing data	• NASA
4. PROCESSING OF VECTOR DATA	• Process vector data	• https://eve.gsfc.nasa.gov/31196/
5. COMBINATION OF REMOTE SENSING AND VECTOR DATA	• Combine data	• Image from Visit The USA
6. ANALYSIS	• Analyze data	• https://www.visittheusa.com/experience/10-urban-adventures-and-around-denver-colorado

False-Color Infrared



NDVI



NDVI Difference



## Sources

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## Conclusion

- This report concludes
- Additional report to see all study results
- Comparison of different methods
- Comparison of different data sources
- Finding more environmentally friendly in Denver
- Coverage to monitor agriculture and effects of urbanization