

# The Value of Golf in an Urban Ecosystem: A Natural Capital Project case study

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5th Golf Innovation Symposium

USGA®

An aerial photograph of a city at sunset. The sky is filled with vibrant orange and red clouds, with the sun low on the horizon. The city below is densely packed with buildings, including several tall skyscrapers. A river flows through the city, crossed by a bridge. The overall scene is a mix of modern urban architecture and natural beauty.

58% of  
global  
population  
lives in  
cities

# Challenges of Urban Landscapes



air pollution  
water pollution  
urban heat  
flooding  
mental & physical health

energy consumption  
water security  
food security  
biodiversity protection...

CONNECTING PEOPLE TO THE NATURAL WORLD

# Planned Urban Landscapes



# Urban Ecosystem Services

Crop pollination



Stormwater retention



Carbon sequestration



Recreation, scenic quality



Urban cooling



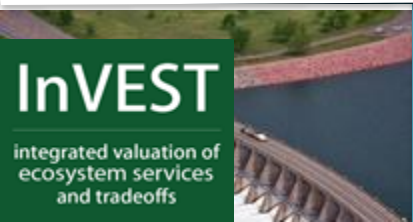
Climate change mitigation



Flood mitigation



Air purification, noise attenuation



Mental health



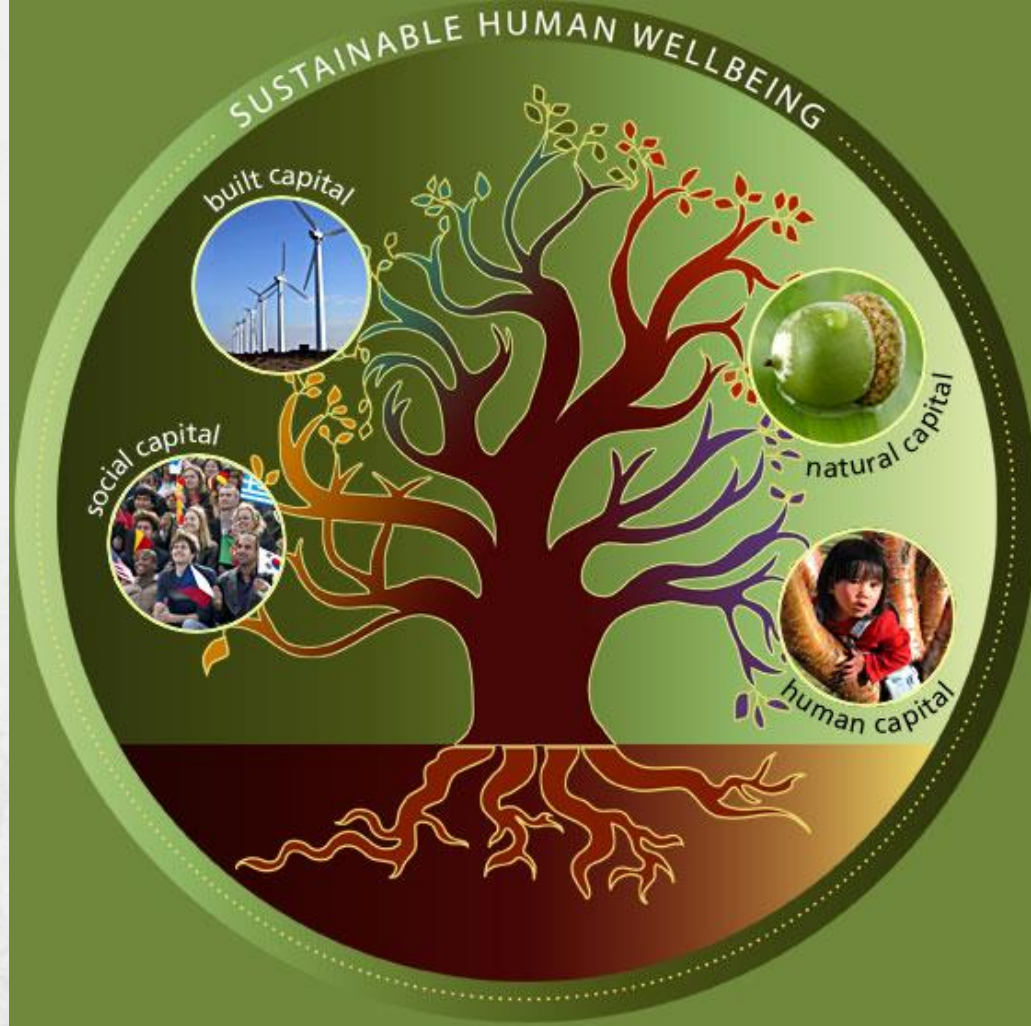
Biodiversity conservation



**InVEST**  
integrated valuation of  
ecosystem services  
and tradeoffs







Source: Gund Institute for Ecological  
Economics, Univ. of Vermont





Stanford  
**WOODS**  
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ENVIRONMENT



The Nature  
Conservancy

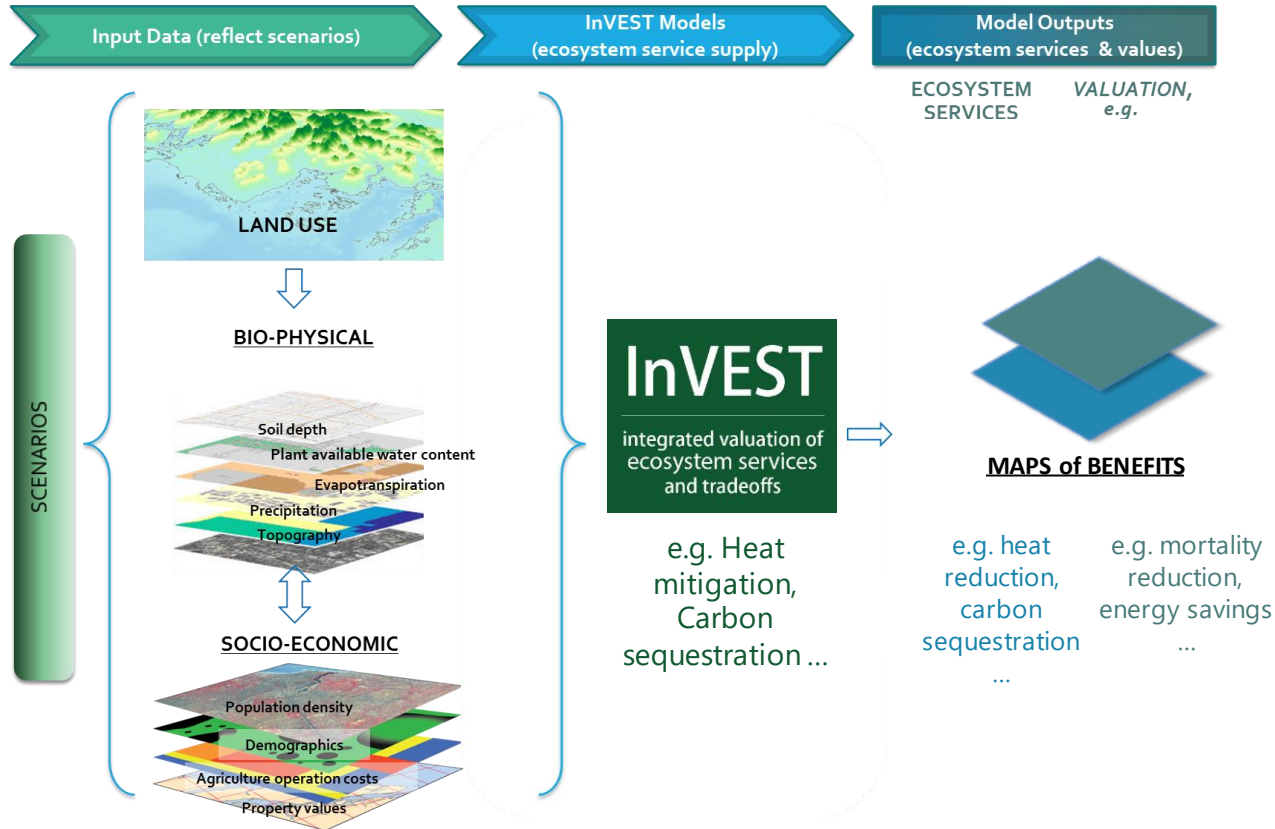


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Driven to Discover™



natural  
capital  
PROJECT

# InVEST translates scenarios into changes in services



# Urban Integration of Natural Capital

- Given growing urban natural capital challenges:
  - Storm water management and pollution
  - Heat island effects
  - Urban pollinators
  - Recreational activities
- How can golf courses be managed to contribute natural infrastructure to enhance well-being in urban areas?
- How should any urban space be managed for natural capital?

**InVEST**

integrated valuation of  
environmental services  
and tradeoffs

**USGA**®

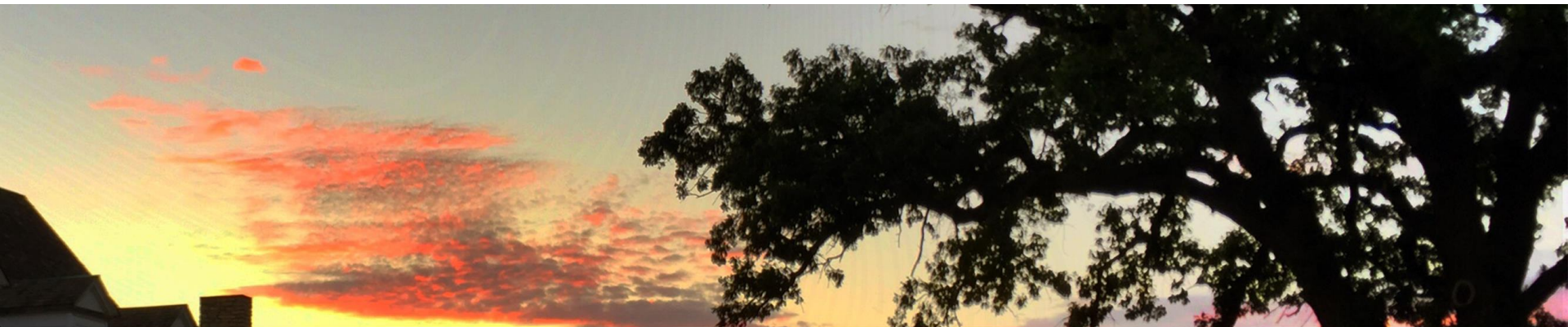
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# Urban Integration of Natural Capital



# Natural Capital Value of Golf Courses



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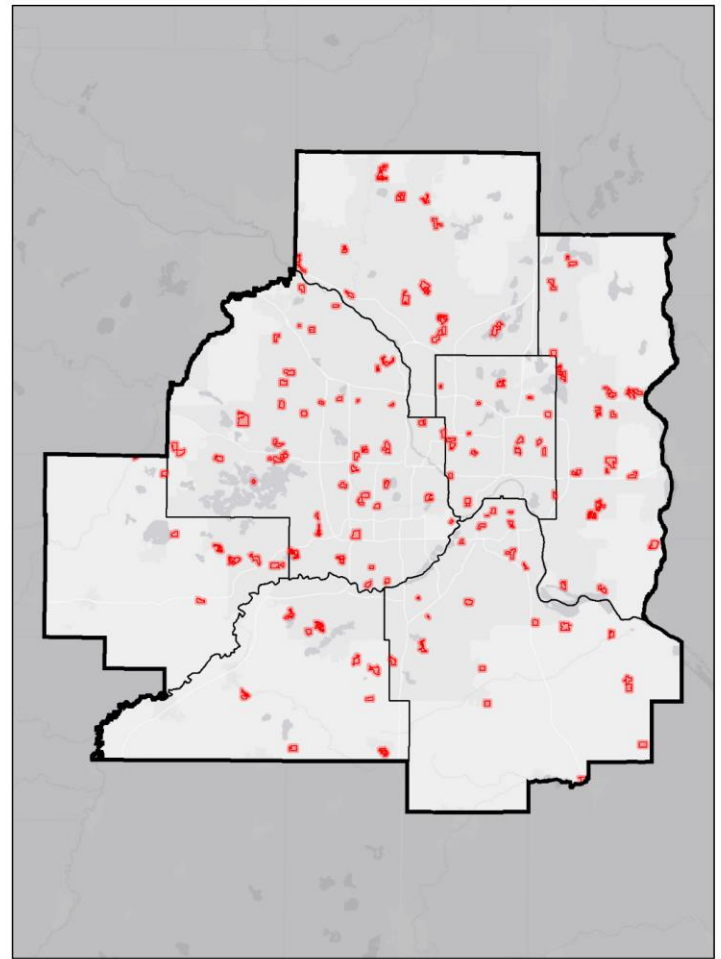
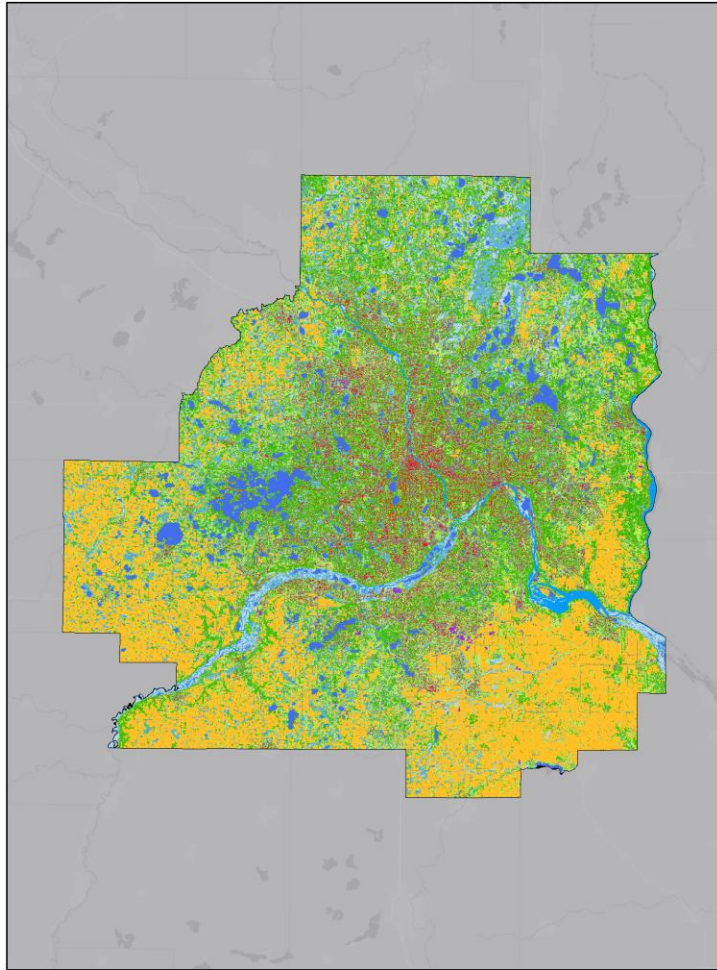
natural  
capital  
PROJECT



# General Approach to Value of Golf Courses

- Estimate Marginal Value
  - Estimate baseline value of a golf course for each ecosystem service
- Change the golf course
  - Change land use
  - Management practice
- Recalculate service value and compute difference
  - Allow model to help determine serviceshed

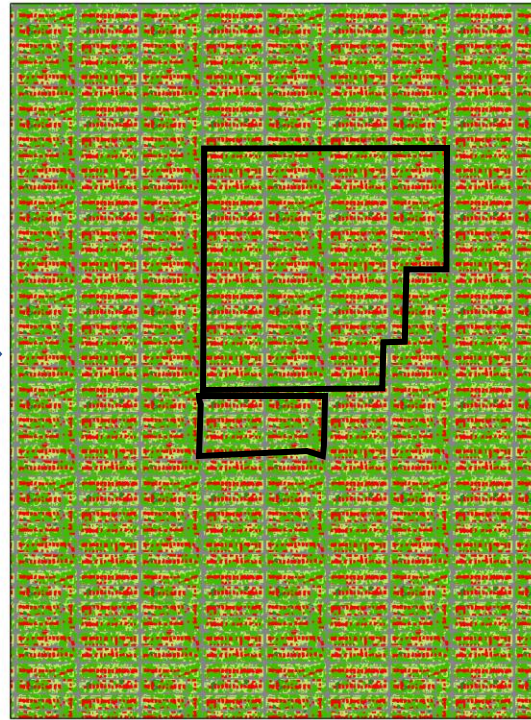
# Minneapolis and St. Paul Metropolitan Area



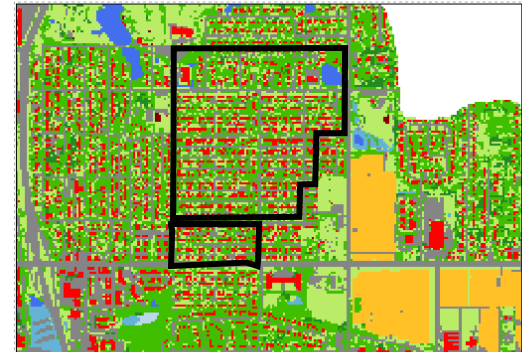
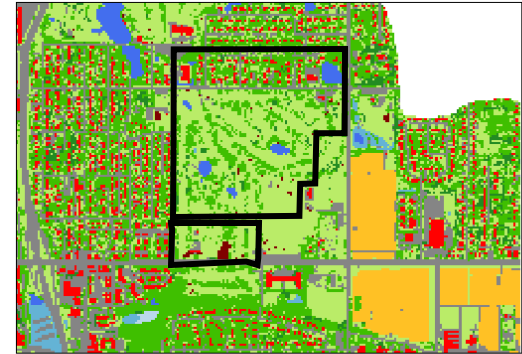
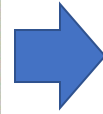
# Wallpapering: A parcel-based approach to simulate land use change



Residential Zoning



Residential Wallpaper



Residential Scenario



# Example of Wallpapering Scenarios

Agriculture



City Park



Commercial



Coniferous Forest



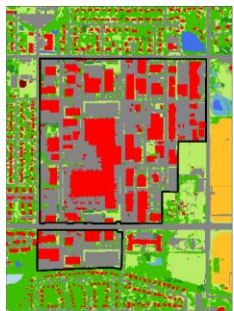
Deciduous Forest



Downtown



Golf Course



Industrial



Natural Area



Neighborhood Office



Office



Neighborhood Commercial



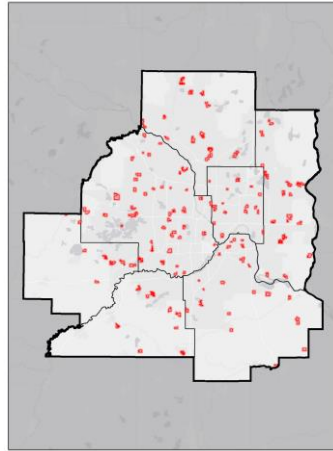
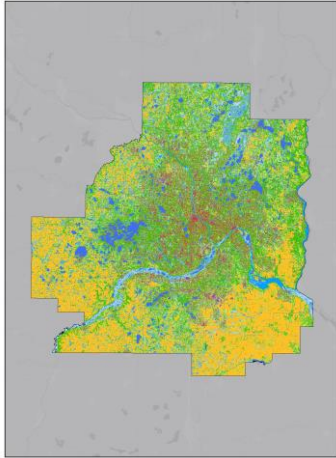
Residential



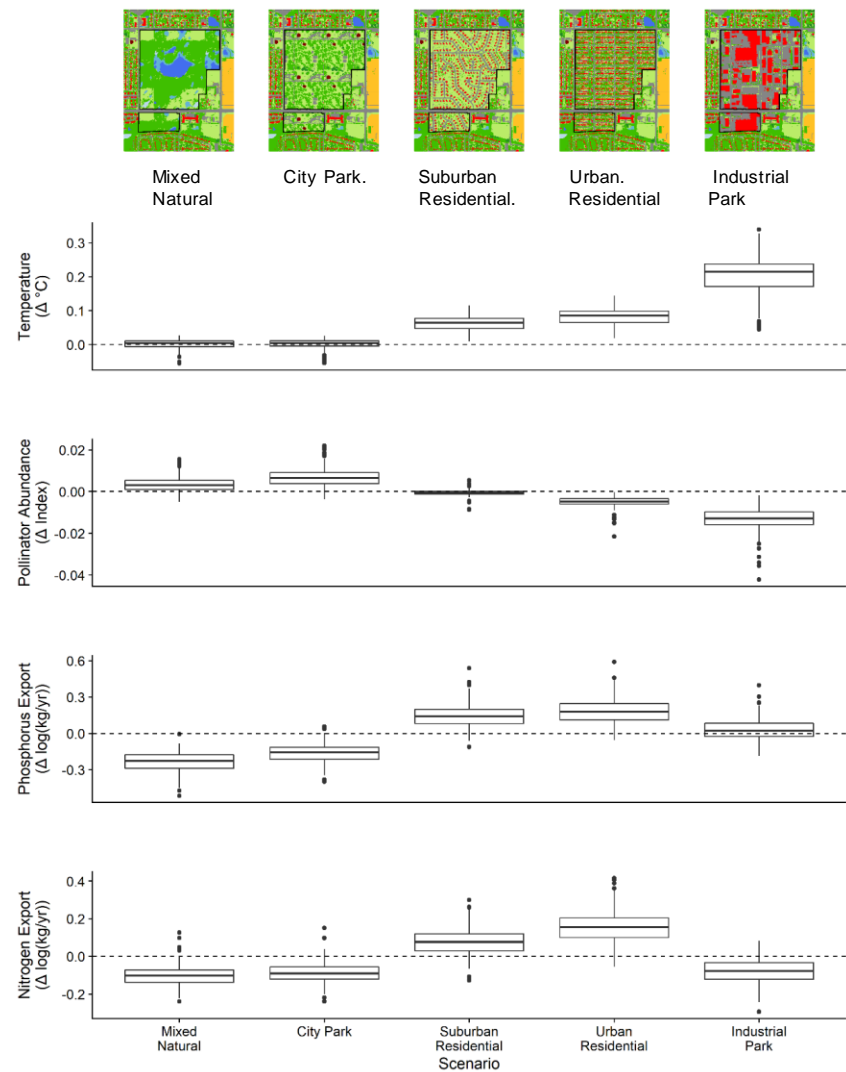
Suburban Residential

# Results

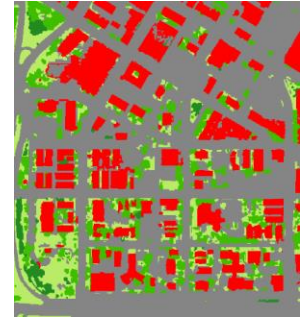
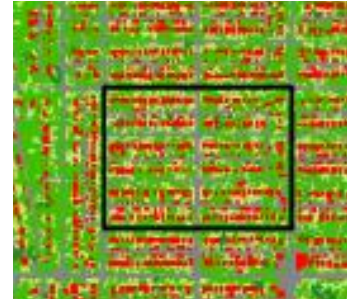
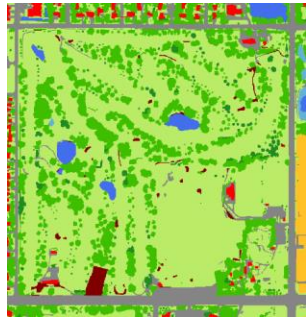
- While the comparison is to golf courses – applies to any land use change scenario
- If not a golf course, then what and the concurrent impact on nature



Change in Ecosystem Service Relative to Golf Course Land Use

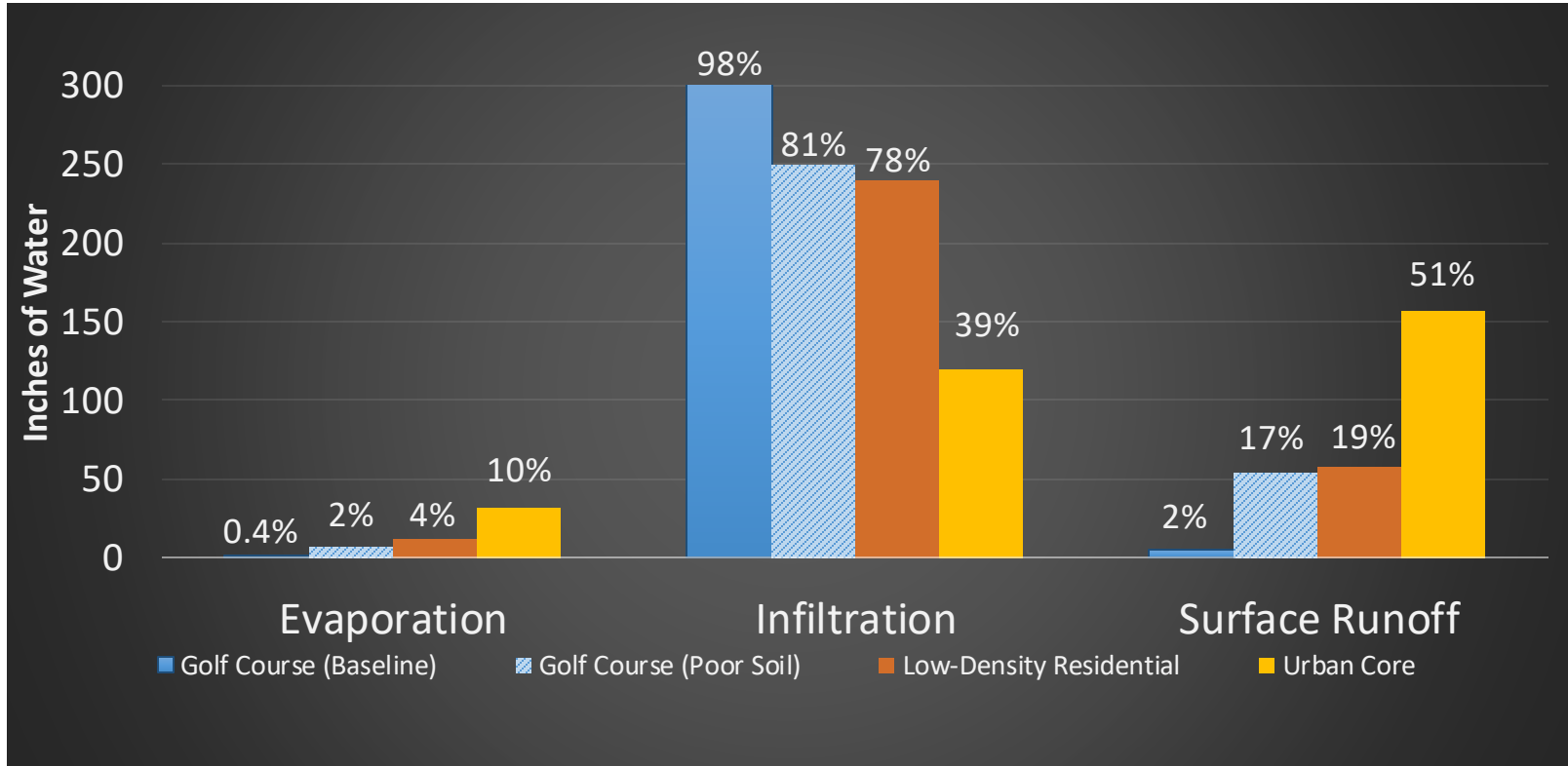


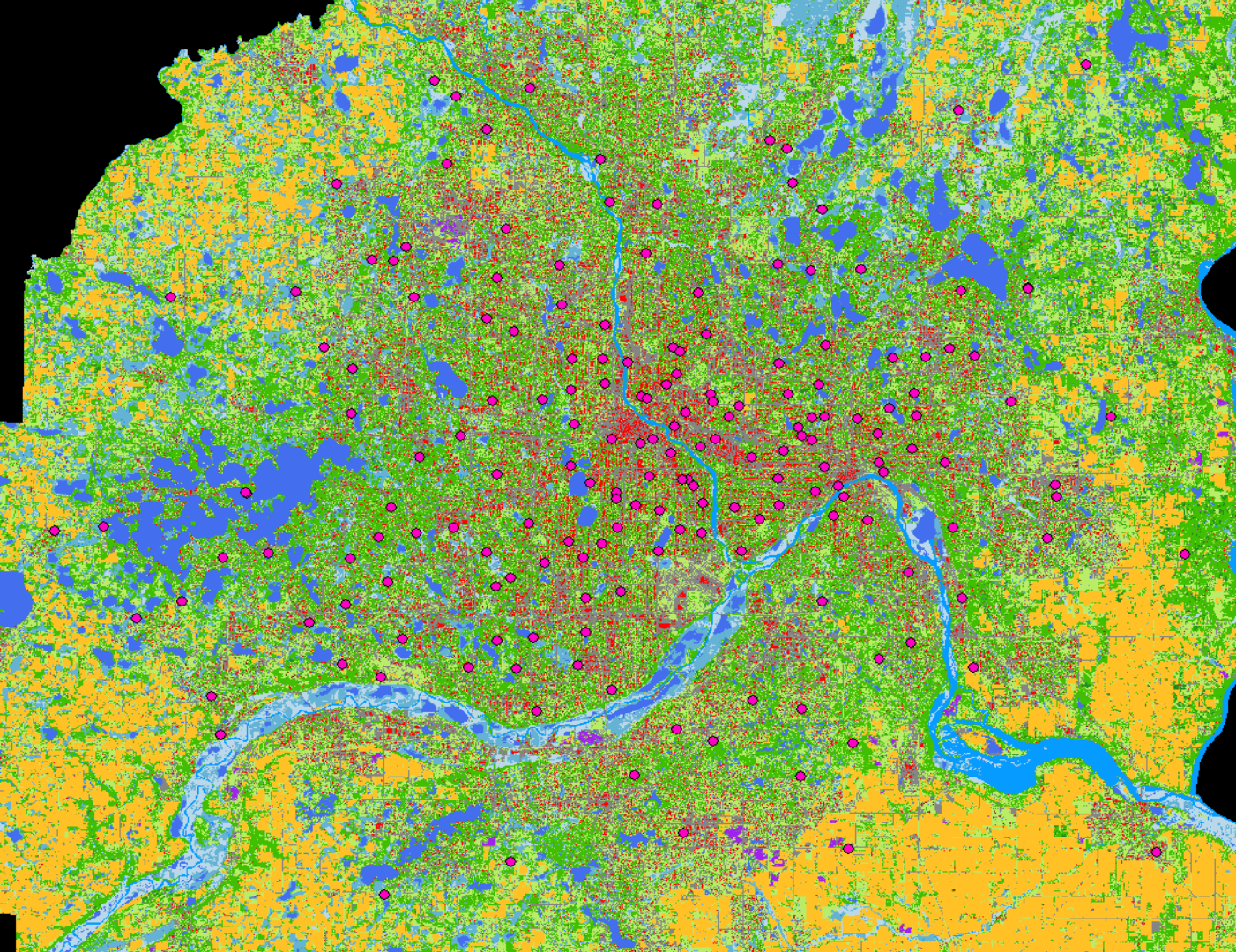
# Single Golf Course: Single ecosystem service, LULC



Parameter	Baseline (Bolstad GC)	Poor Soil Golf Course	Low-Density Residential	Urban Core (Downtown)
<b>Connected Impervious Area</b>	0%	0%	<b>20%</b> (mean for CRWD)	<b>60%</b> (conservative est. for MPRB site)
<b>Mean Flow Path Length</b>	Longest, by ArcHydro	Longest, by ArcHydro	<b>40 m</b> (typical lot length in Mpls/StP)	<b>61 m</b> (half-length of downtown block)
<b>Slope</b>	Mean along flow path	<b>2x Bolstad</b>	Unchanged vs. Base	<b>&lt; 3.3%</b> (by DEM)
<b>Soil Properties</b>	From SSURGO	<b>Clay/Loam</b>	Unchanged vs. Base	Unchanged vs. Base

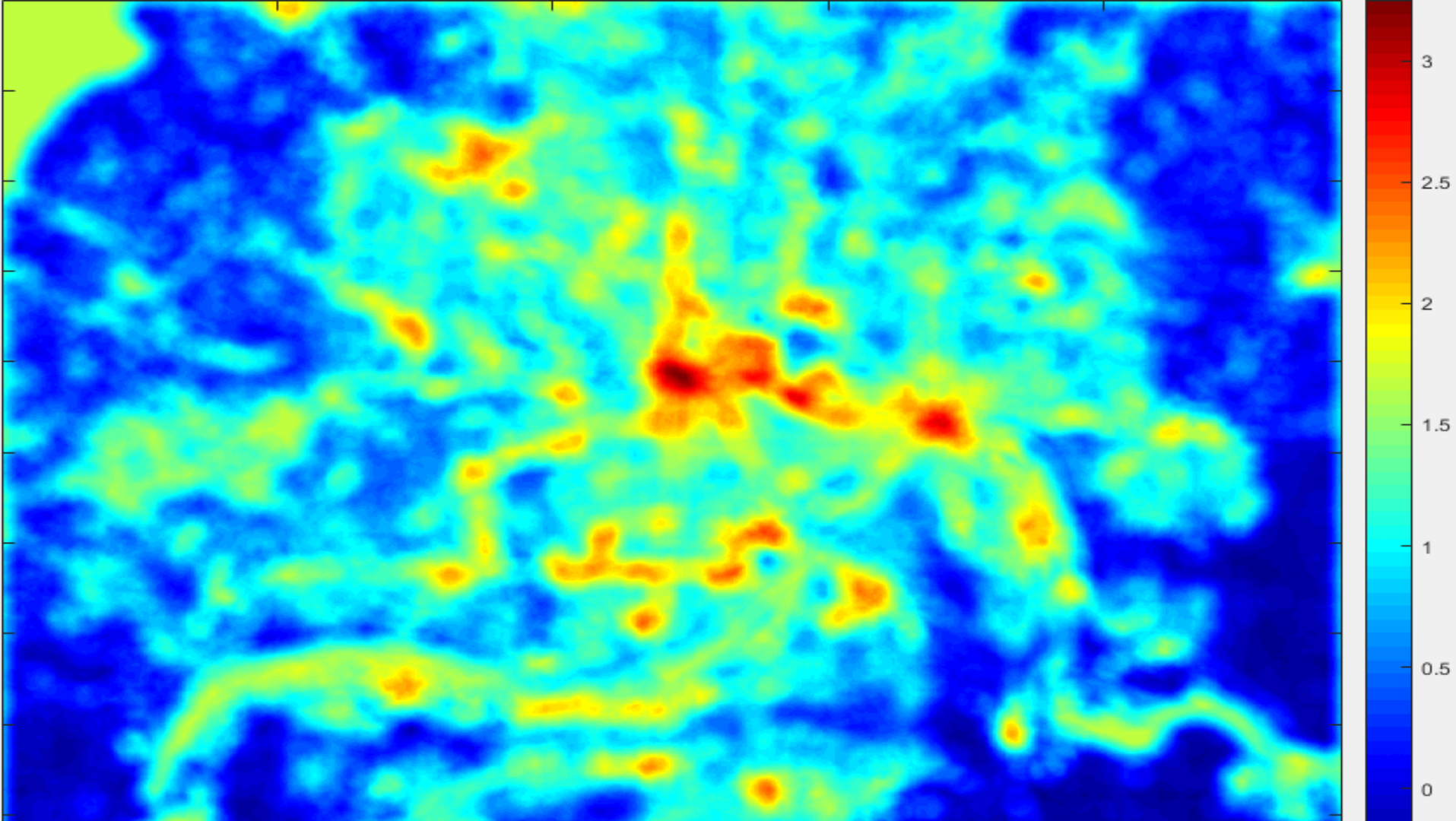
# Single Golf Course: Single ecosystem service, LULC

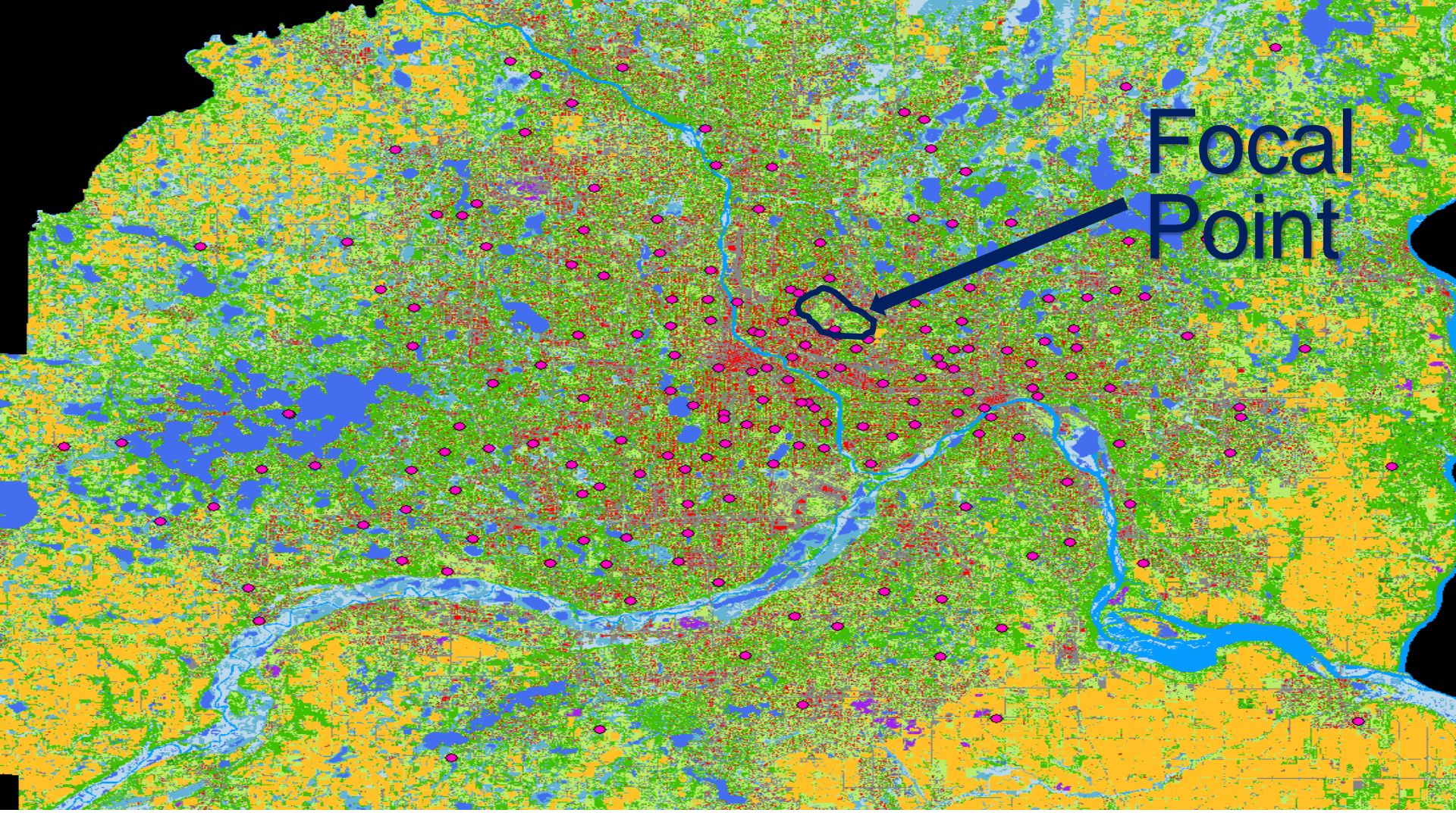




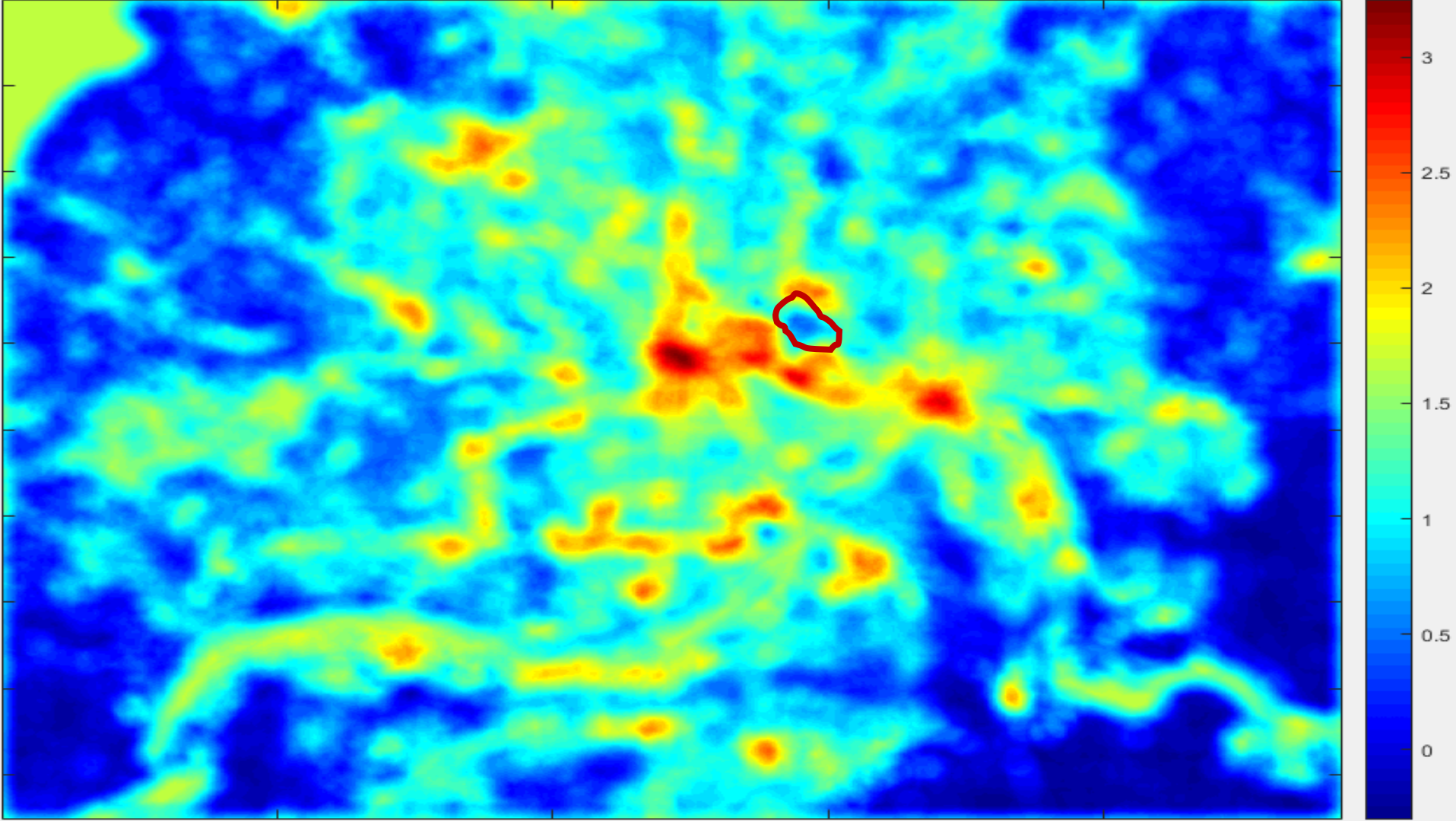
# Urban Heat Island (UHI)

- What is the effect of land cover on UH?
- Determine how change in LU from GC would impact UH?





Focal  
Point

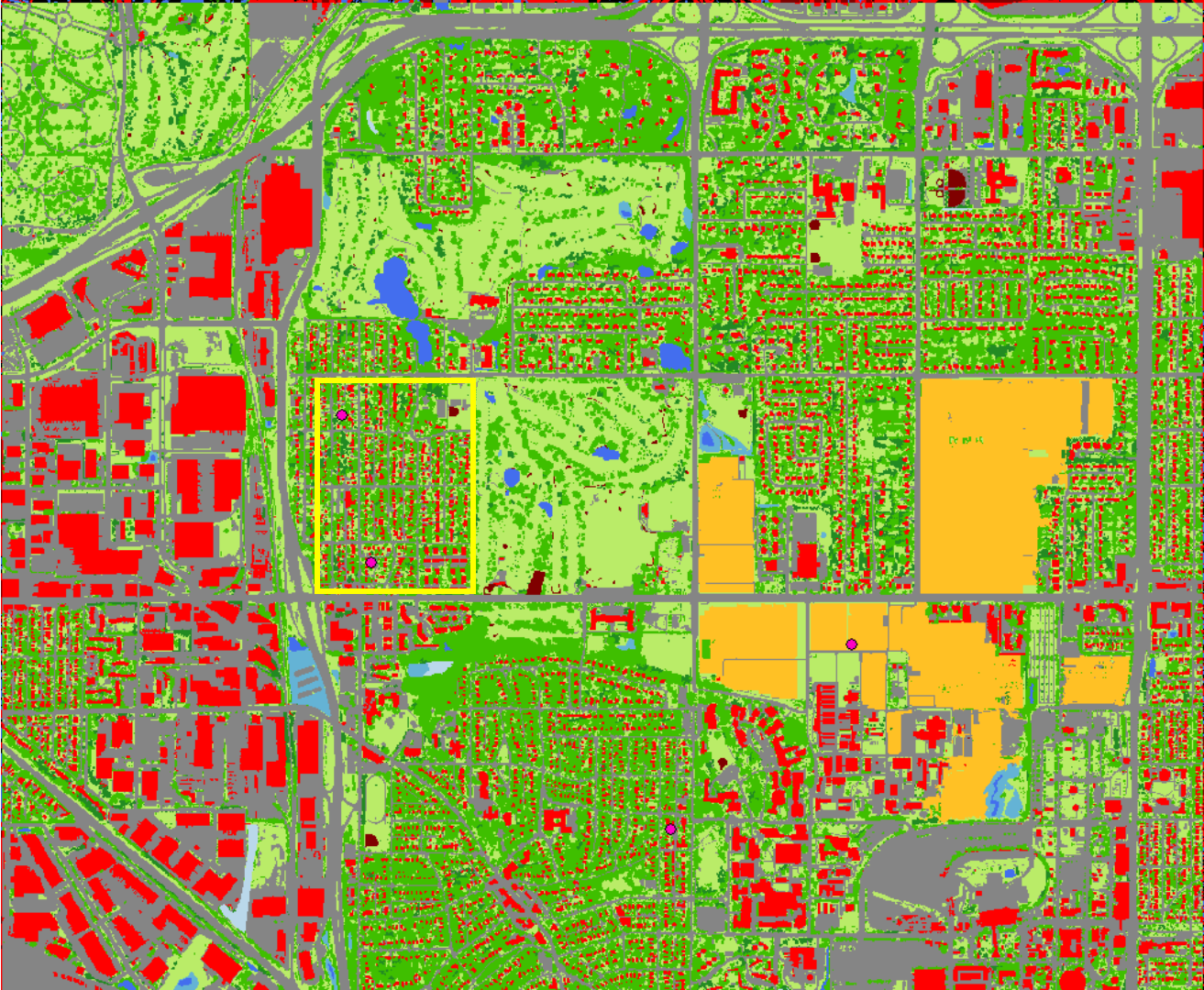




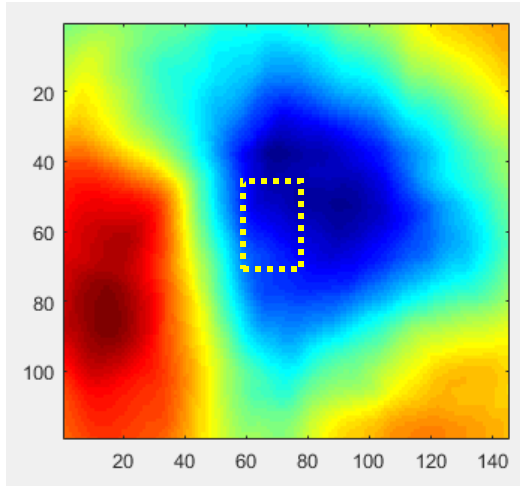
# Marginal Value of a Golf Course?

An aerial photograph of a city, likely Los Angeles, with a golf course highlighted by a black outline. The map shows a dense urban grid with various colors representing different land uses: red for buildings, green for vegetation, blue for water bodies, and grey for roads. The golf course is a large, irregularly shaped green area in the center-left of the image.

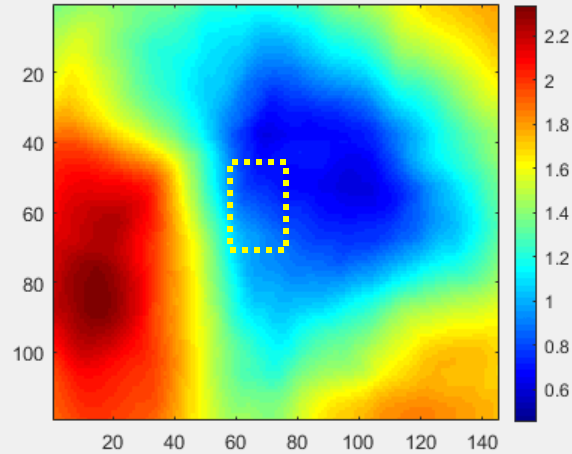
- Use UHI model
- Convert golf course into a housing development
- Compare UHI before and after



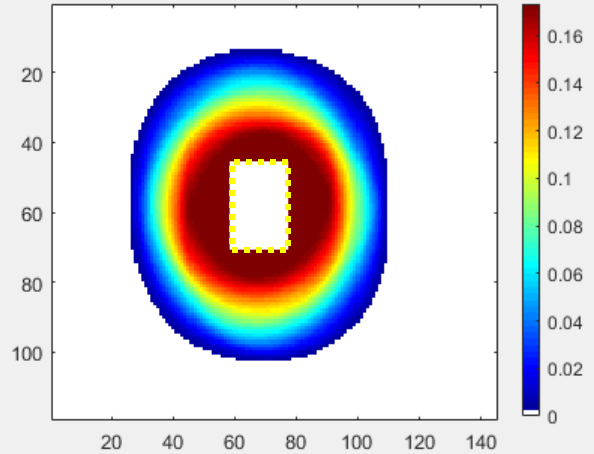
### UHI CURRENT



### UHI AFTER



### CHANGE IN UHI

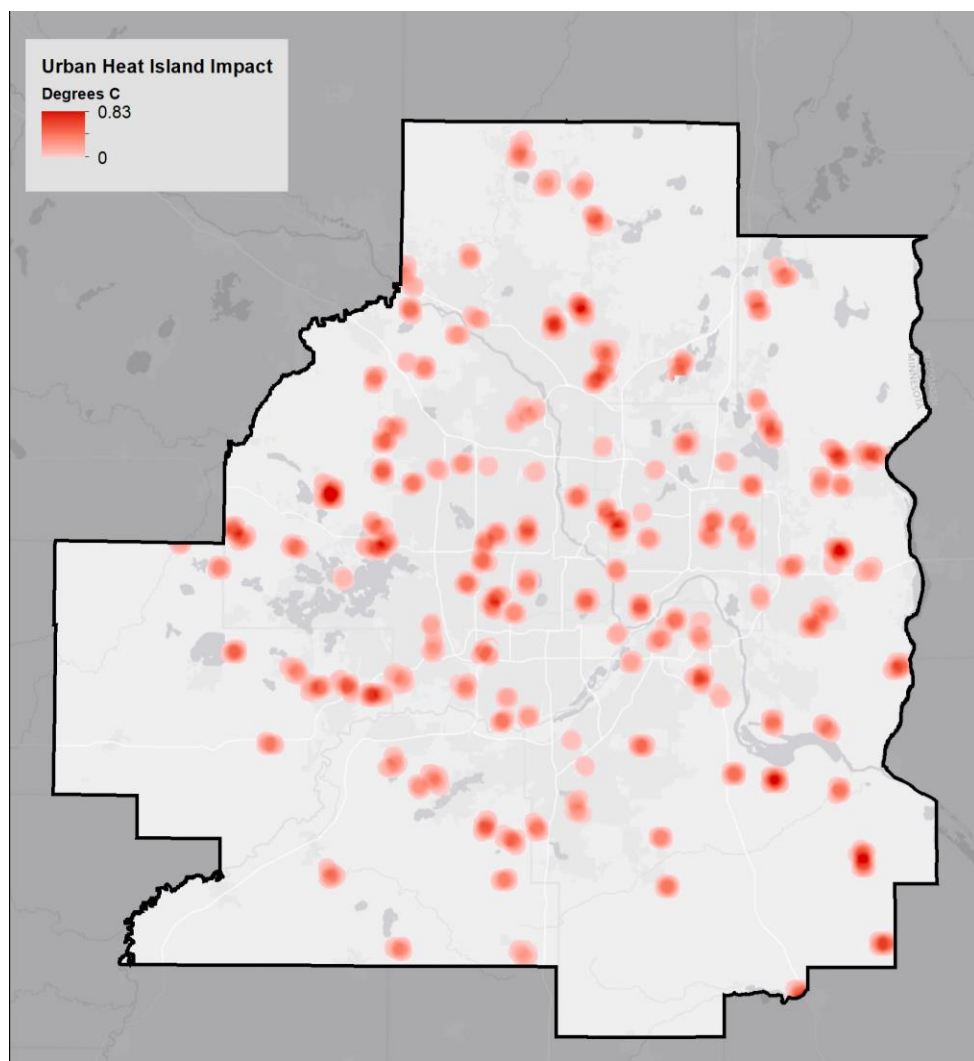


There is a 0.17 degree C increase per night for areas near the change.

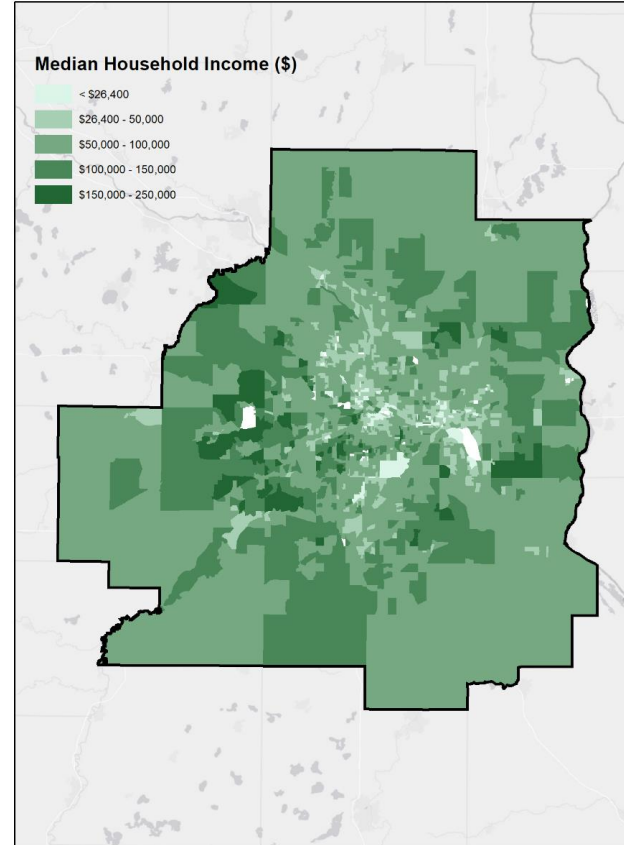
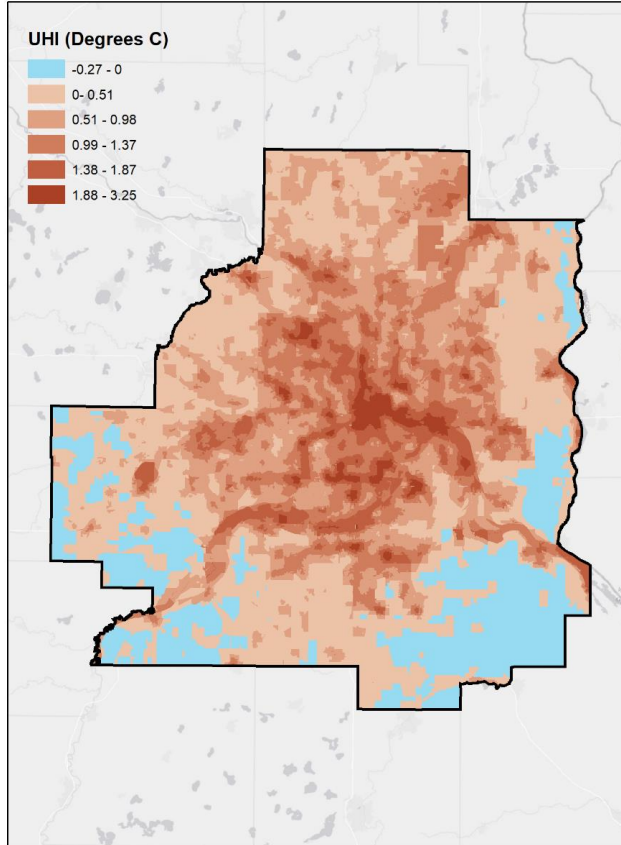
# Golf Facilities' Impact on UHI

## SCENARIO

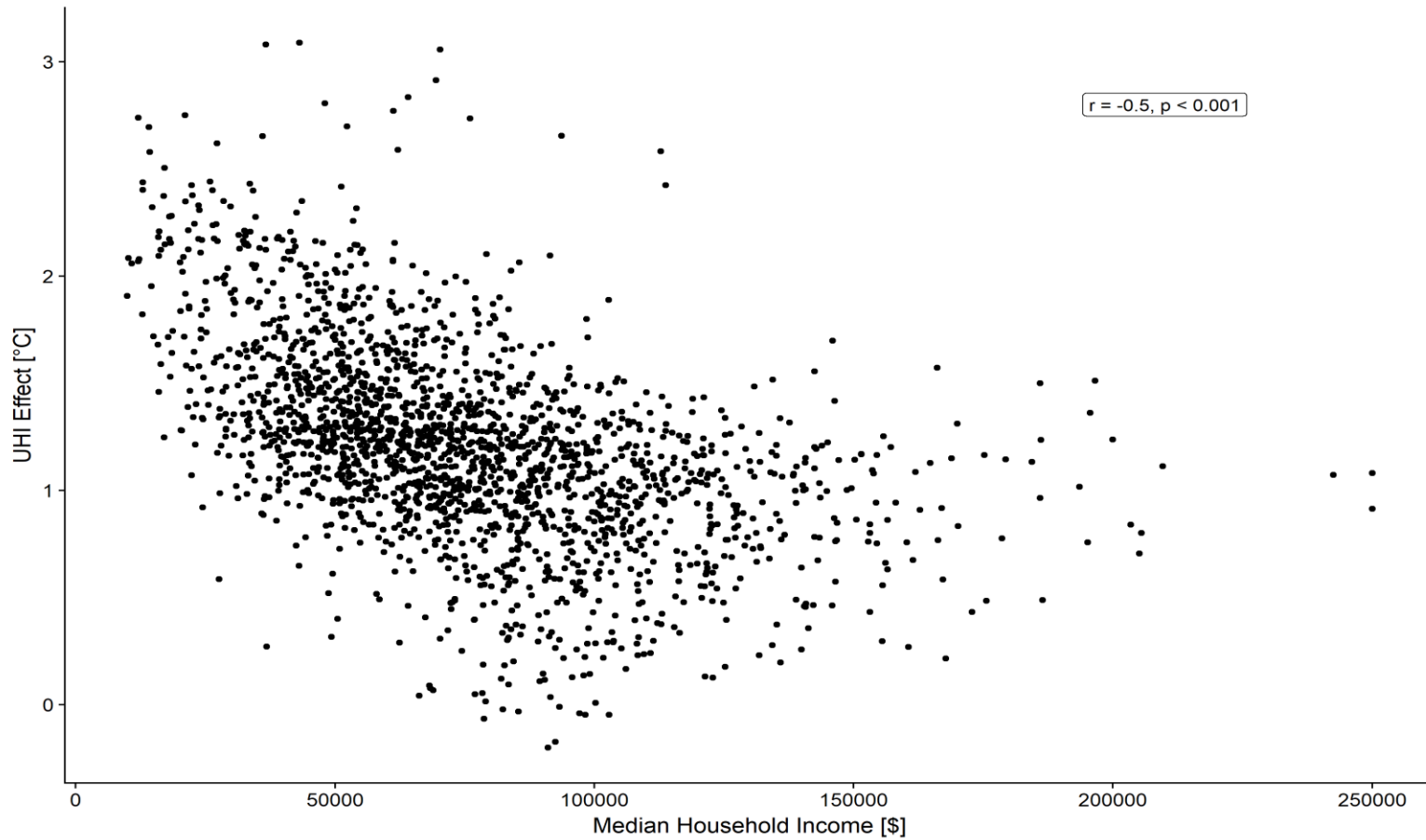
1. 135 golf facilities
2. Convert all golf courses to urban residential neighborhoods
3. Impact 907 km<sup>2</sup>
4. Maximum temperature increase of 0.83 degrees C per night



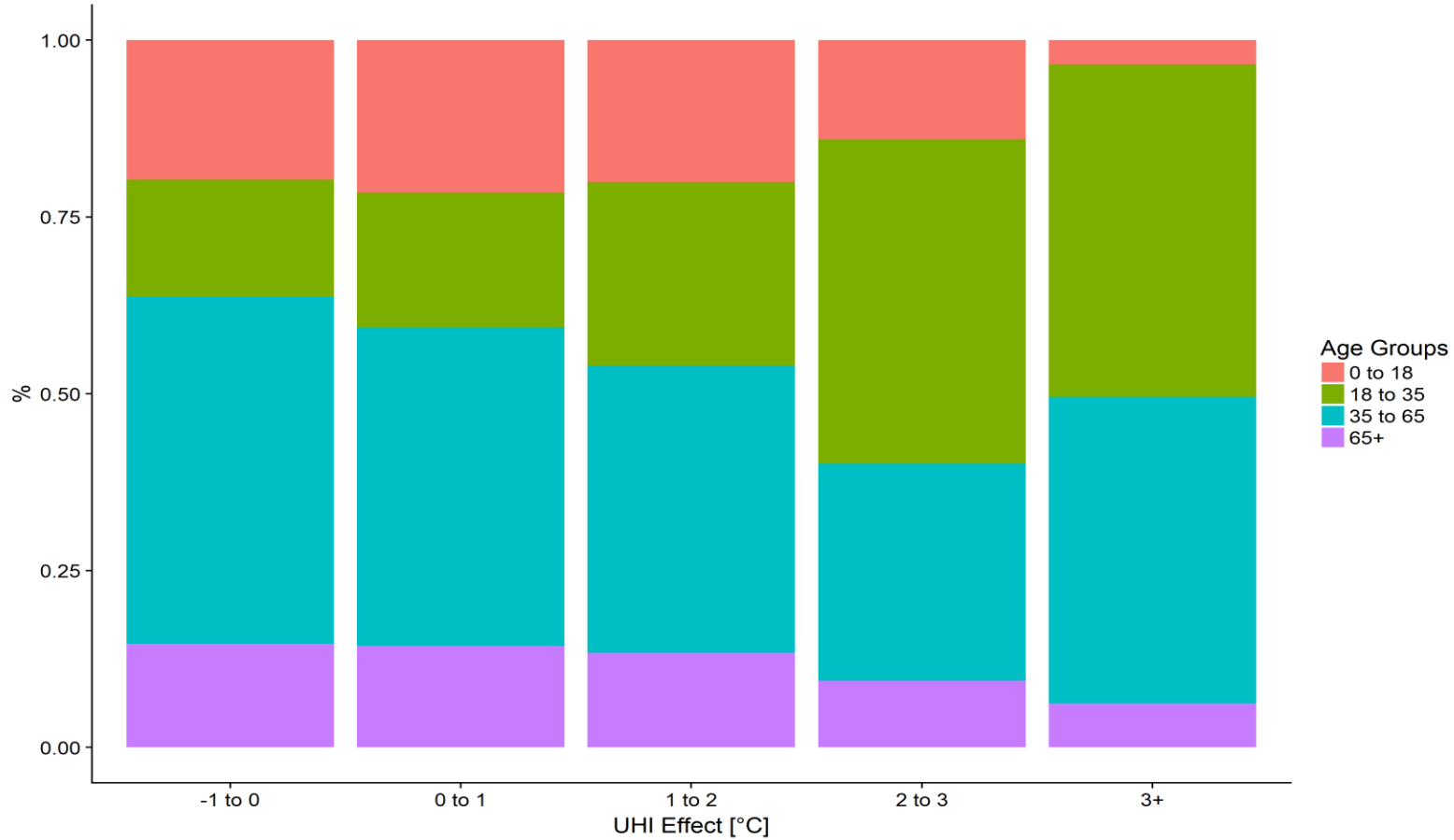
# UHI and Socioeconomic Factors



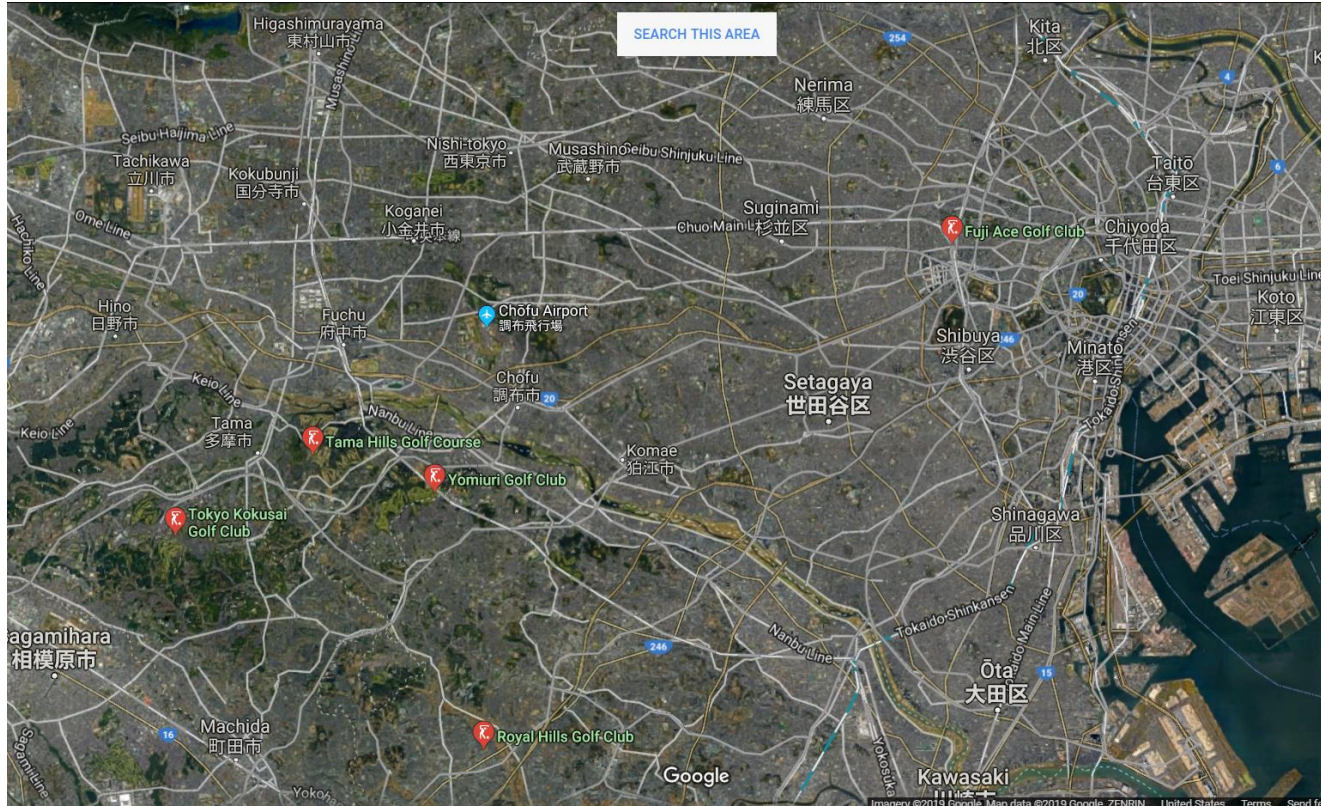
# UHI vs Income



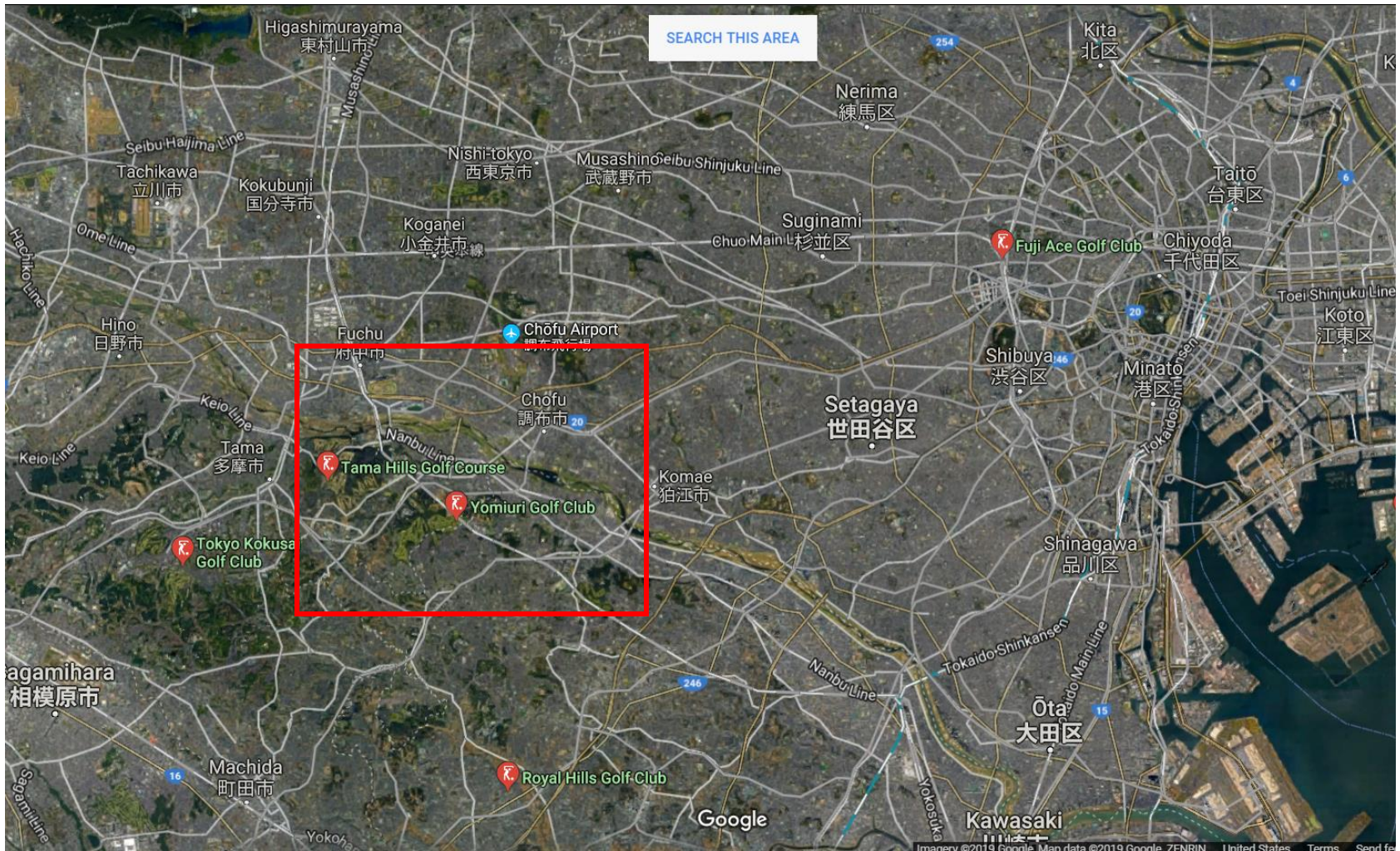
# UHI vs. Age Groups



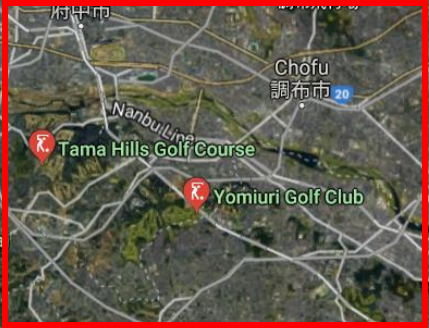
# Tokyo: Single ecosystem service – pollinator habitat



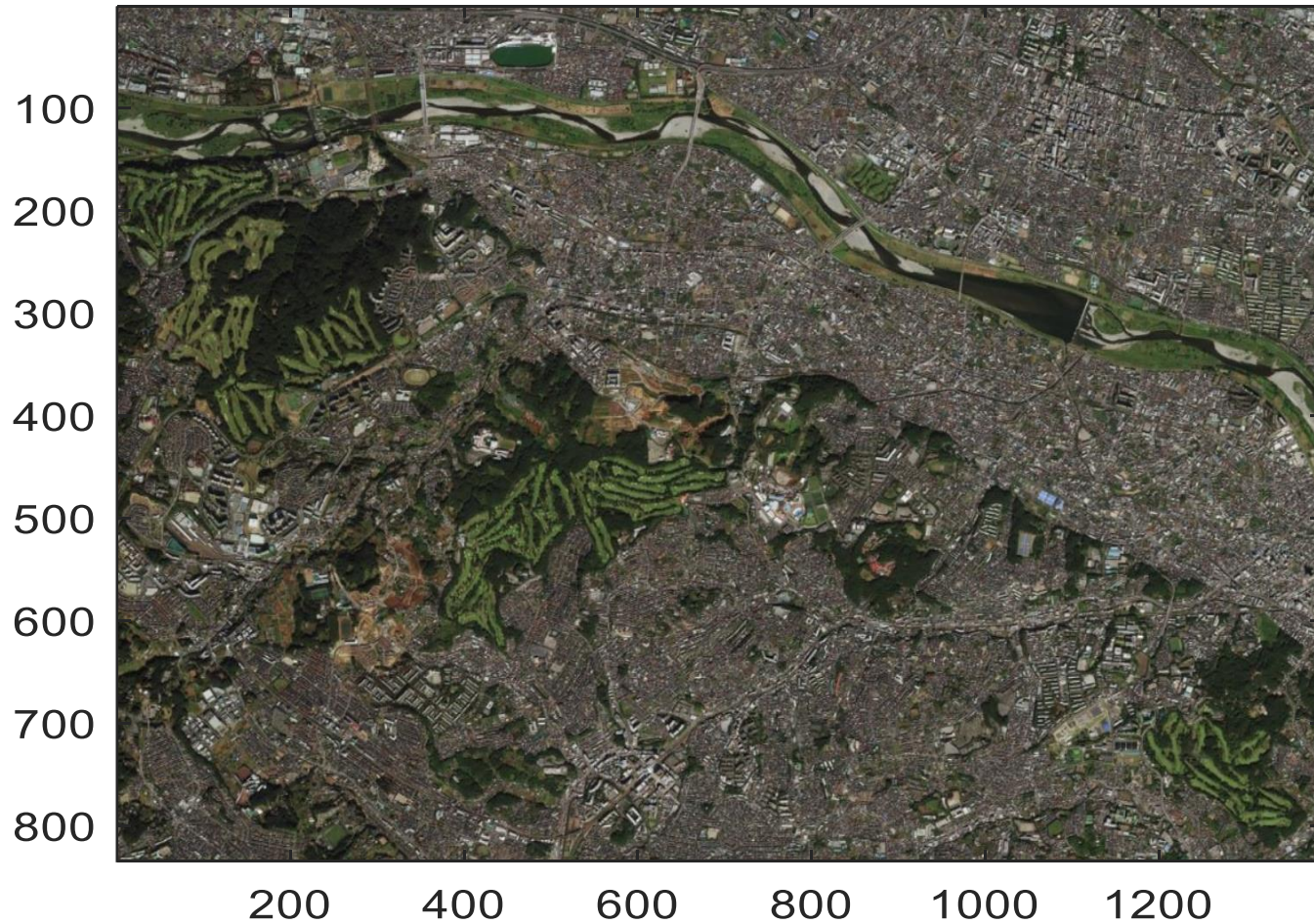




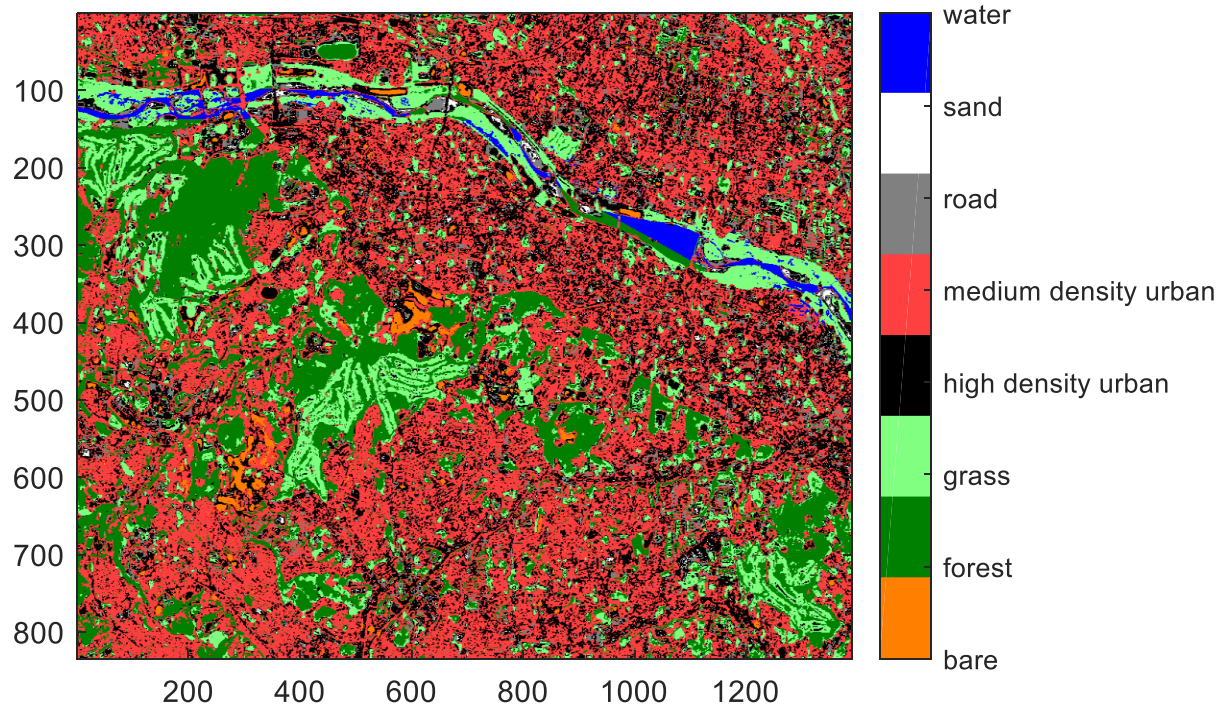
SEARCH THIS AREA



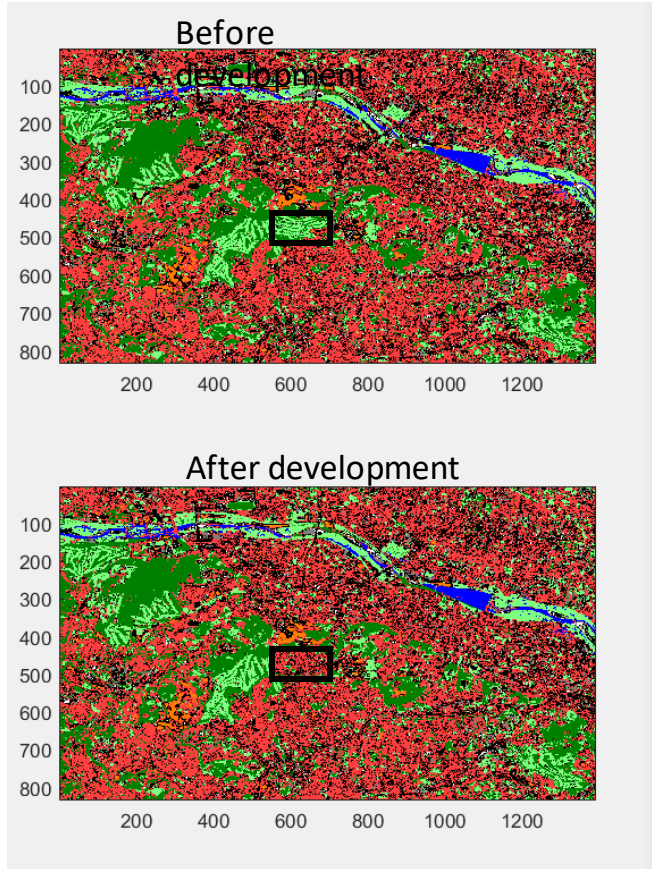
Google



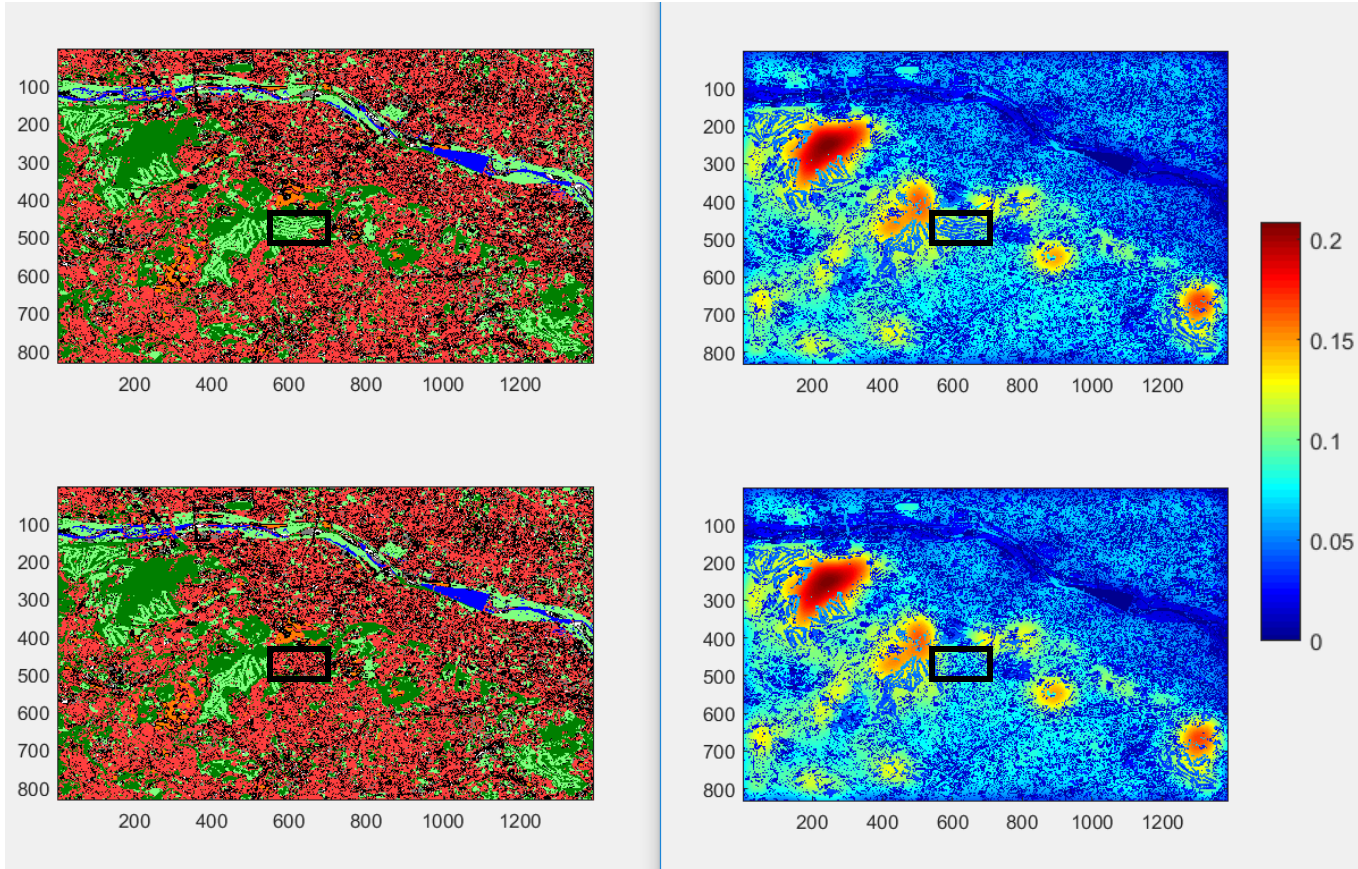
# Classify photo into basic land cover types



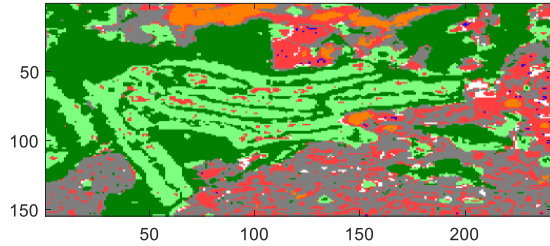
# Select golf course area for development



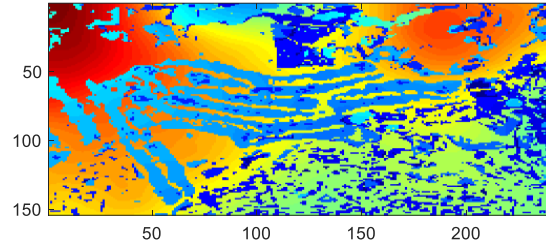
# Run pollinator model before and after development



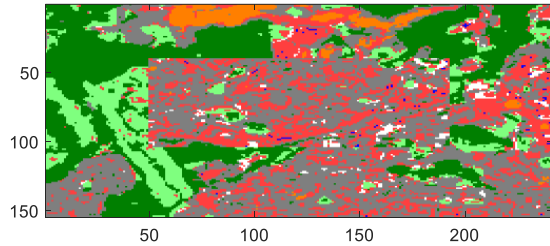
Before development



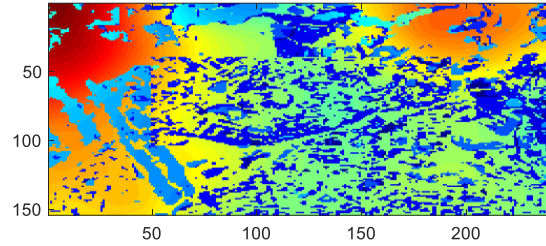
Before development



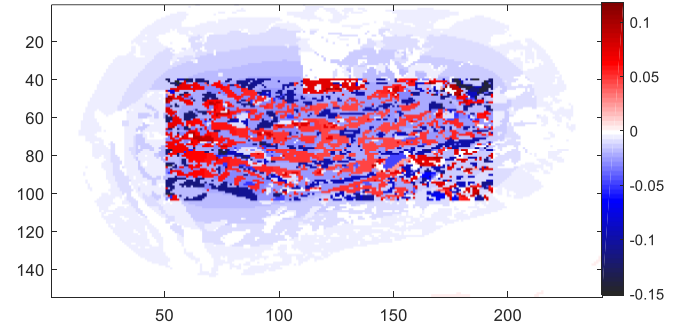
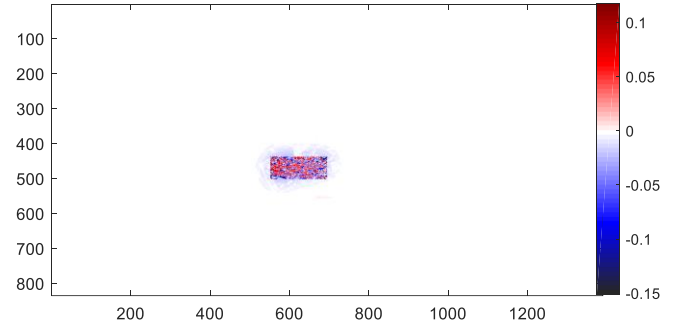
After development



After development



Change in pollinator habitat



- By developing the golf course, pollinator habitat became fragmented with reduced forage quality
- Golf courses are engaged stewards within the community and provide critical habitat for pollinators

# Future Work

- Expand to: San Francisco, Phoenix, Dallas, Atlanta, Philadelphia and Chicago
- Connect natural capital metrics with demographic and socio-economic attributes
- Add economic and non-economic value
- Collaborate with urban planners to integrate natural capital assessments into existing tools
- Build dashboard to allow golf industry to determine their community value (social and economic)

# Thank you!

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5th Golf Innovation Symposium

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