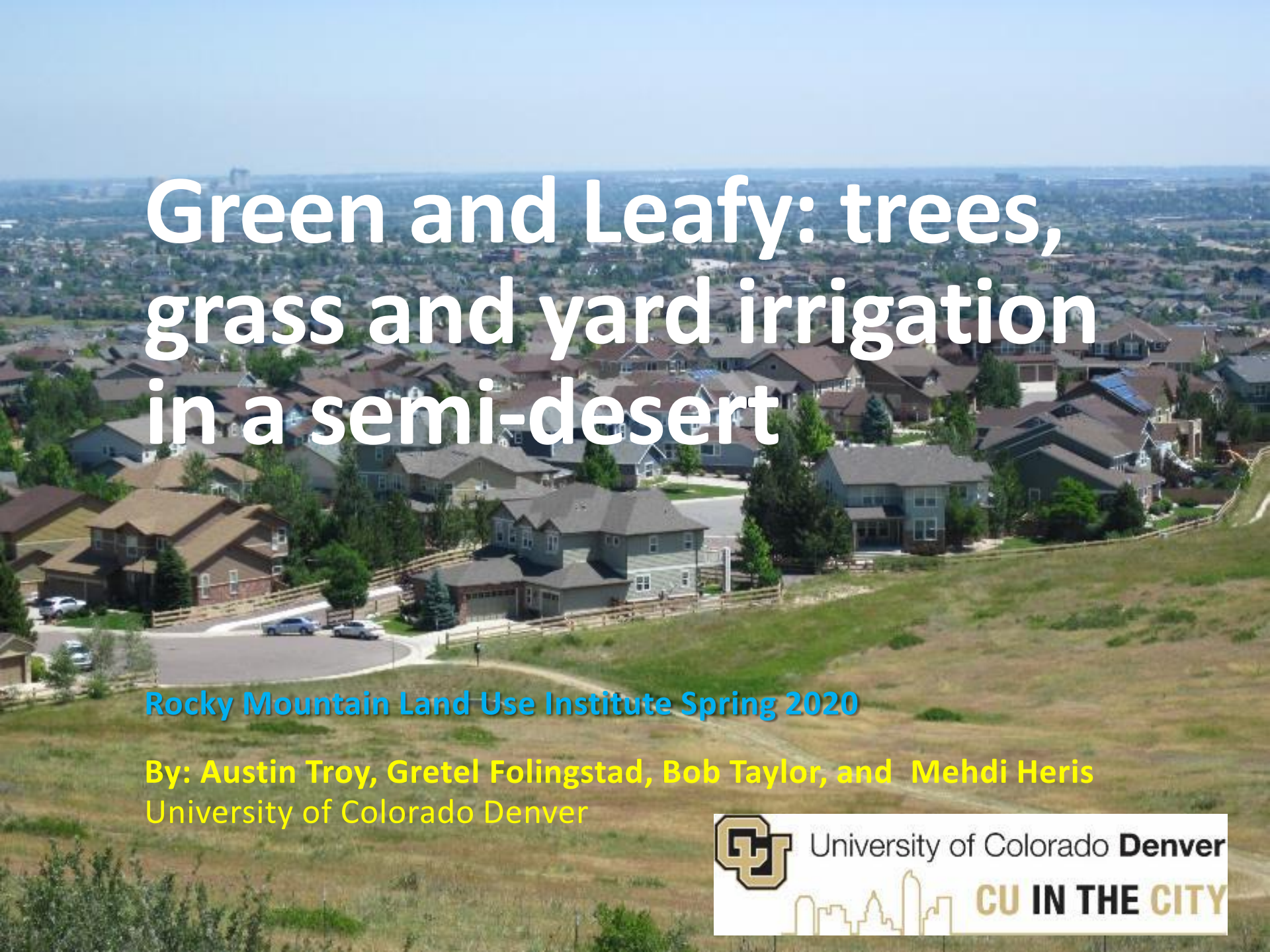


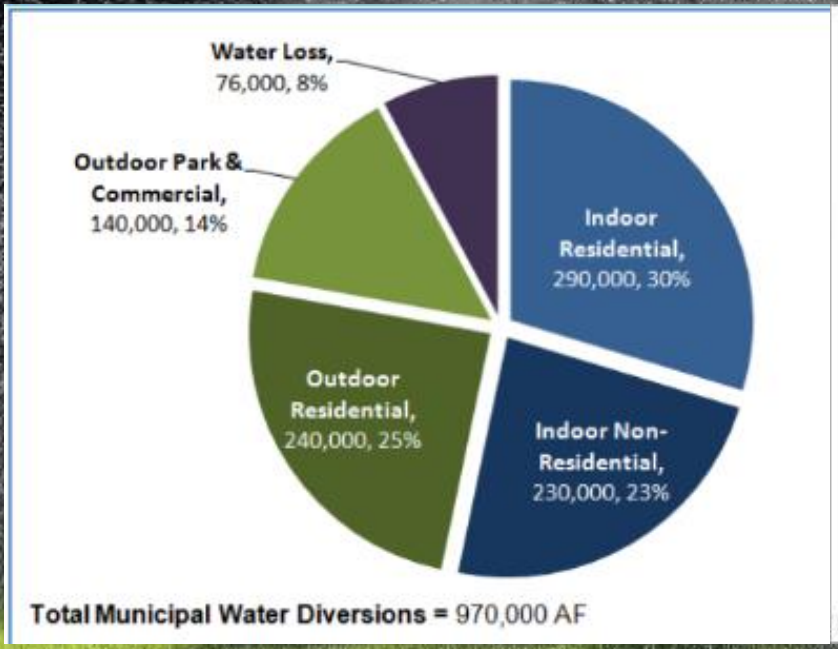
Green and Leafy: trees, grass and yard irrigation in a semi-desert

Rocky Mountain Land Use Institute Spring 2020

By: Austin Troy, Gretel Folingstad, Bob Taylor, and Mehdi Heris
University of Colorado Denver

University of Colorado **Denver**
CU IN THE CITY

Importance of outdoor irrigation



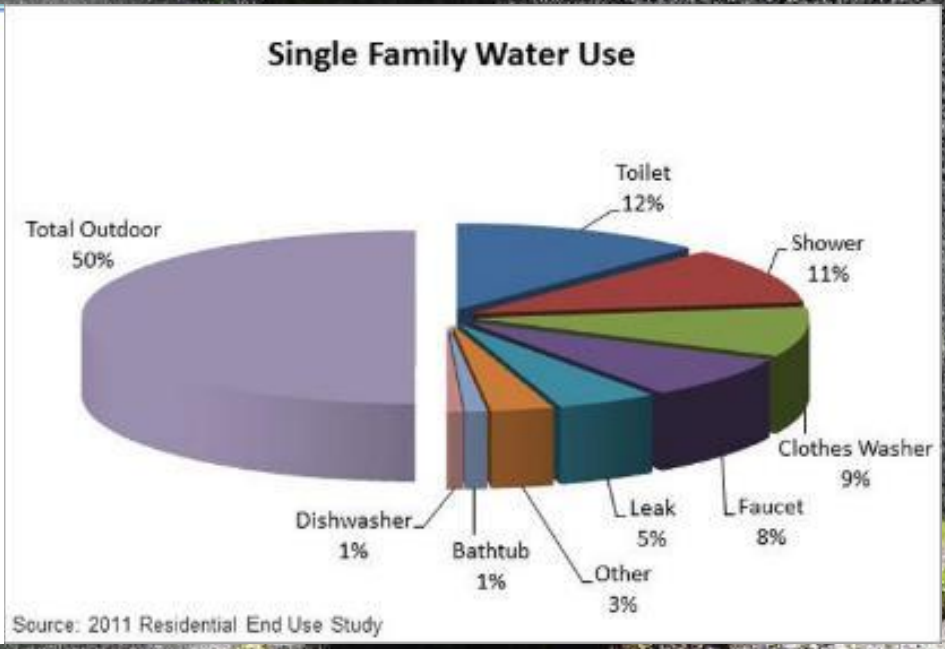


Image source: Eric Sonstroem (https://www.flickr.com/photos/sonstroem/), Data: Denver Water and CO state water plan

Yard irrigation is variable

Table ES.10 Summary of annual and outdoor water use for landscape group (n=838)

Site	Sample Size (n)	Average Annual Use (kgal)	Average Outdoor Use (kgal)	% Outdoor
Clayton County	103	62	19.2	31%
Denver Water	95	125	77.0	62%
Ft. Collins	88	111	55.9	50%
Peel	69	87	24.1	28%
San Antonio	98	112	62.0	55%
Scottsdale	111	186	120.4	65%
Tacoma Water	107	73	27.0	37%
Toho	95	93	33.1	36%
Waterloo	72	58	13.0	22%
Total (9 sites)	838	100.8	50.5	50 %

Source: Water Research Foundation 2016

Factors behind variation?

- Climate
- Yard sizes
- Technology
- **Yard composition choices**
- **Irrigation behavior**

Yard composition drives consumption

Denver Water Study of 425 yards

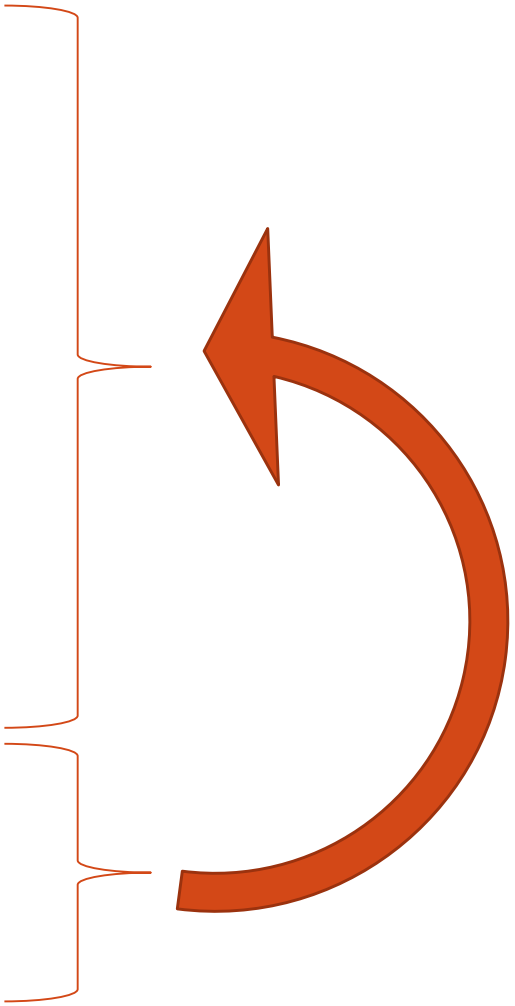
- 18% of pervious area – no irrigation (sidewalks, rock, mulch etc.)
- 29% of pervious area – alternative landscape types (xeriscape, native, low-use) – 9 GPSF
- 53% of pervious area – bluegrass turf – 18 GPSF

- But the role of trees is less clear!

Yard characteristics that may predict variability

1. Grass area and greenness
2. Tree canopy area
3. Tree size/age
4. Tree and building shade on growing space
5. Species grown

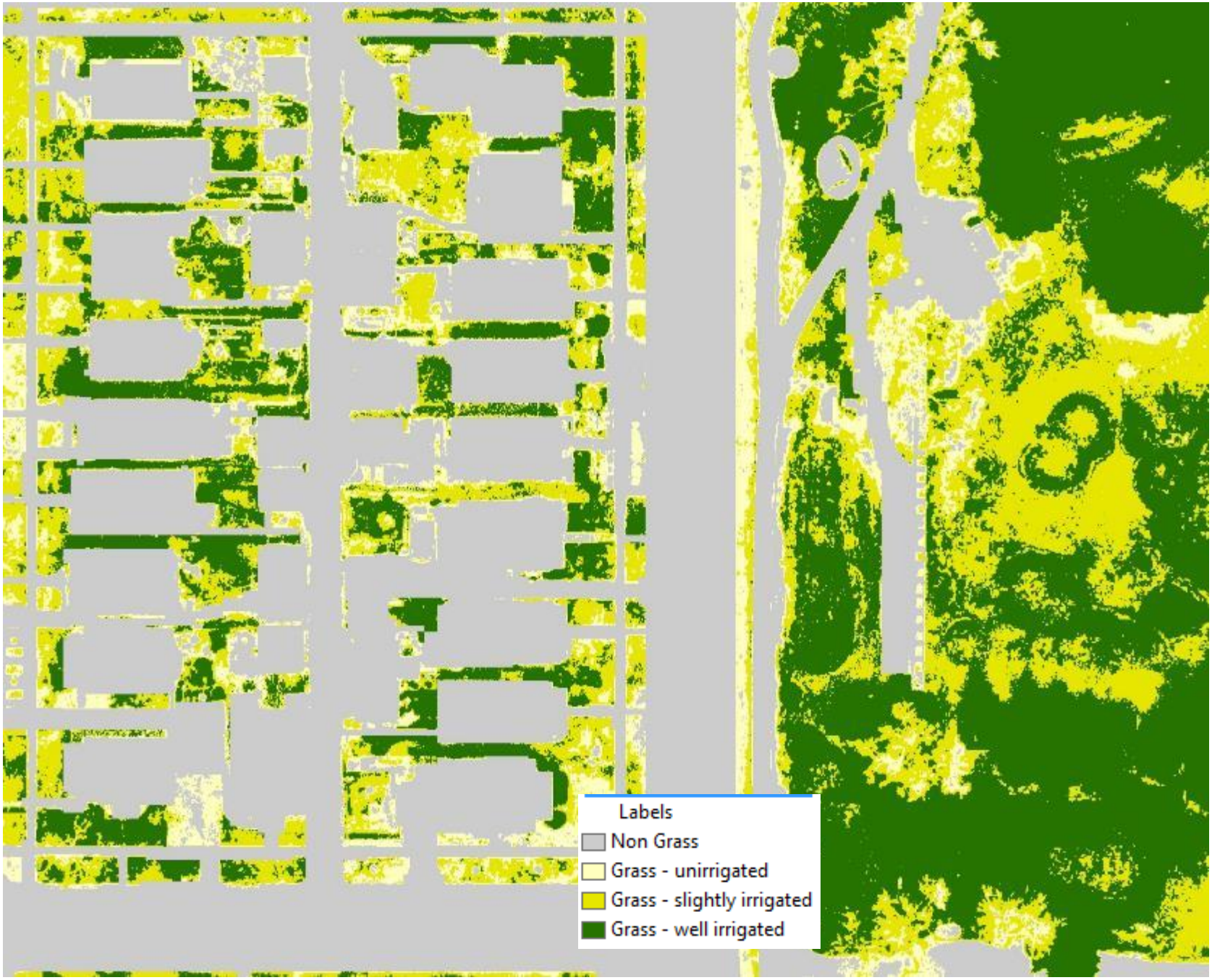
- **HOA rules?**
- **Housing/subdivision age**

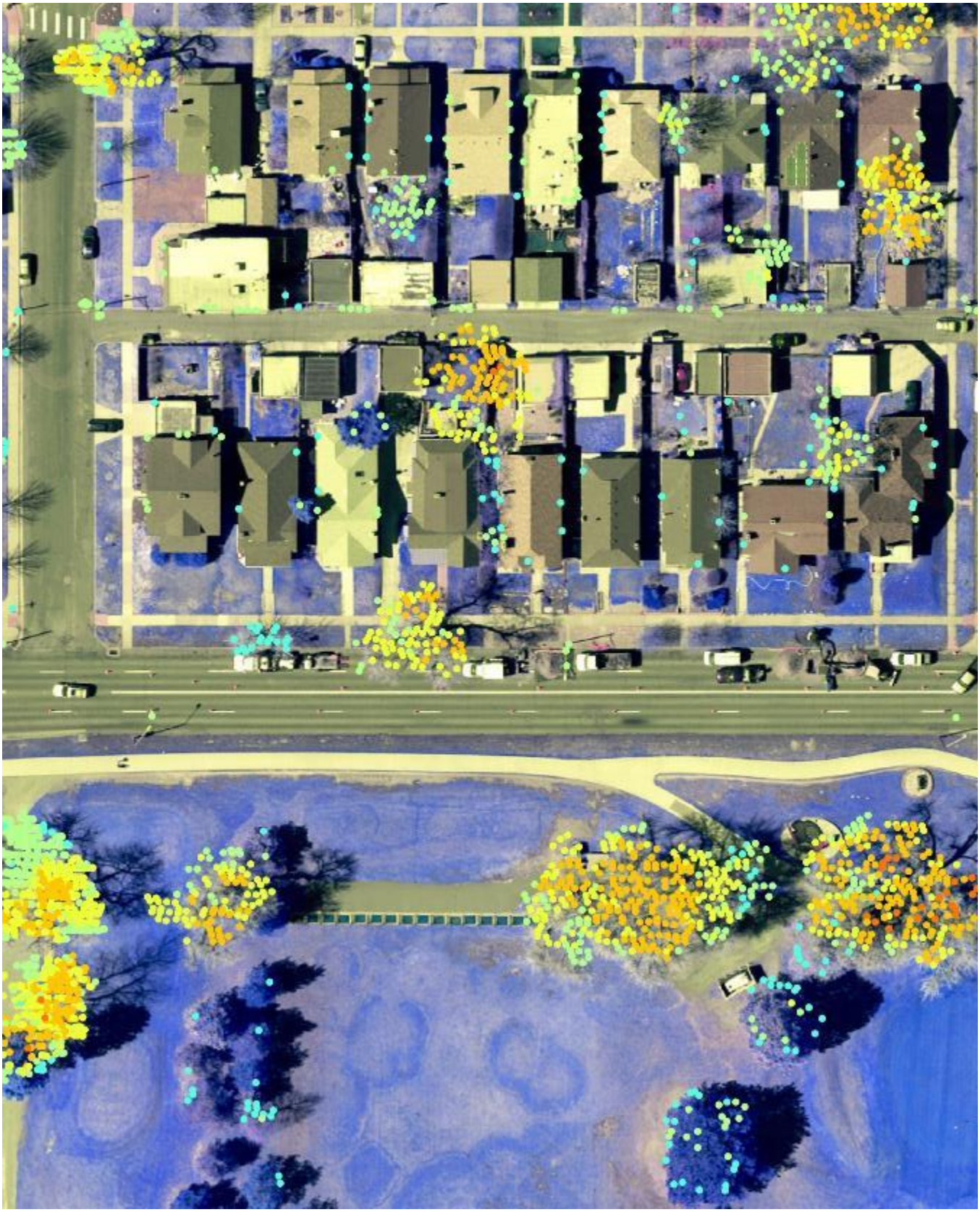


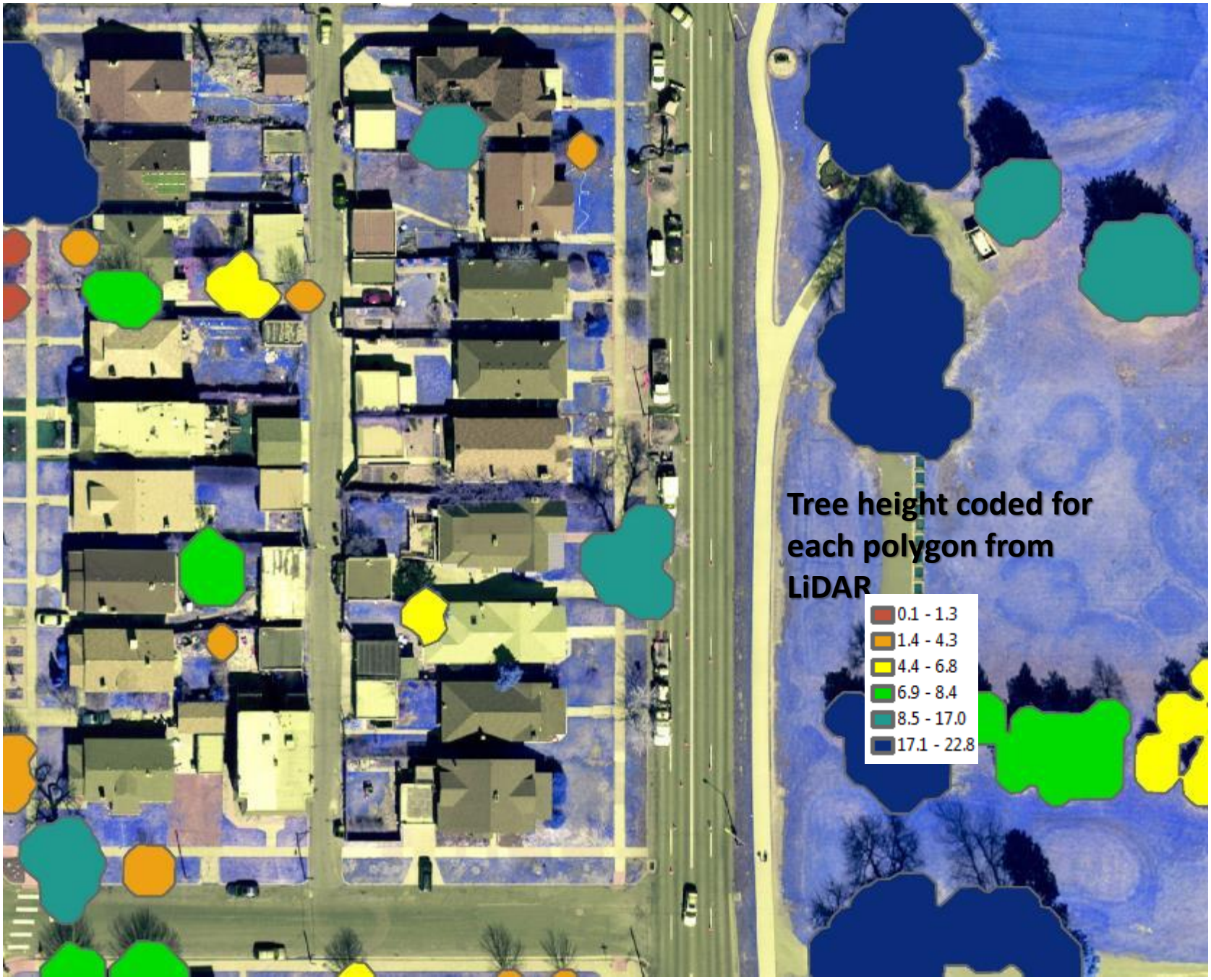
Methods Overview

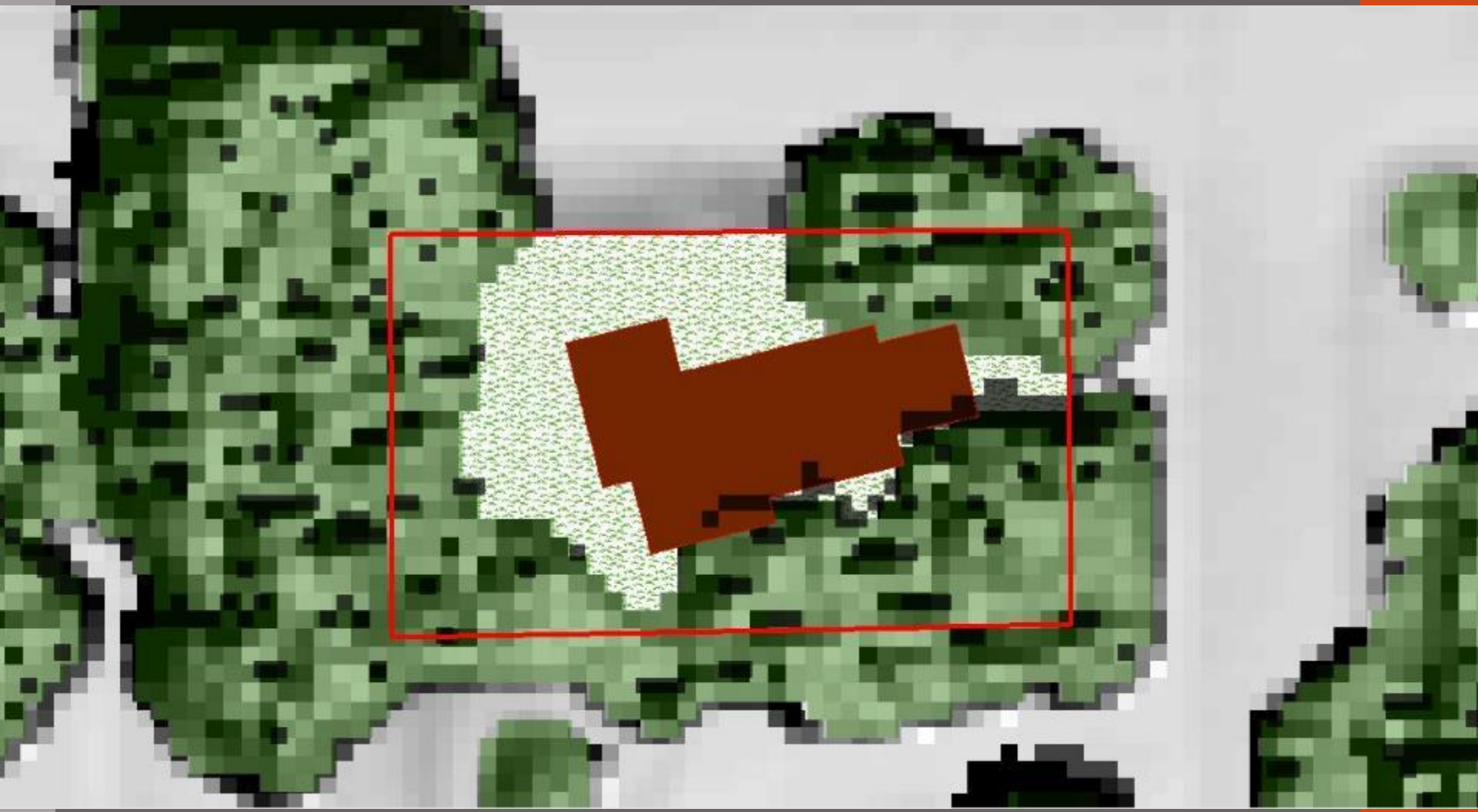
- Regress **annual water consumption** by parcel for Denver, Engelwood, Littleton against:
  - Total **lawn area**
  - Area of **non-irrigated lawn** (very low greenness)
  - Area of **slightly irrigated lawn** (low-medium greenness)
  - Area of **irrigated lawn** (high greenness)
  - Area of **tree canopy**
  - % of tree canopy accounted for by **low trees** (<6 m)
  - Mean hours of **shade** cast on lawn
  - Whether the property is from a **post-1950** subdivision
  - Whether the property is part of **HOA**
- Did descriptive stats for HOAs
- Quadratic form regression for subdivision age, regression for NVDI

Response data: Denver Water consumption records filtered for private OO-SFH, lot coverage< 30%, July water use> 0, grass area >0= 53,852 observations

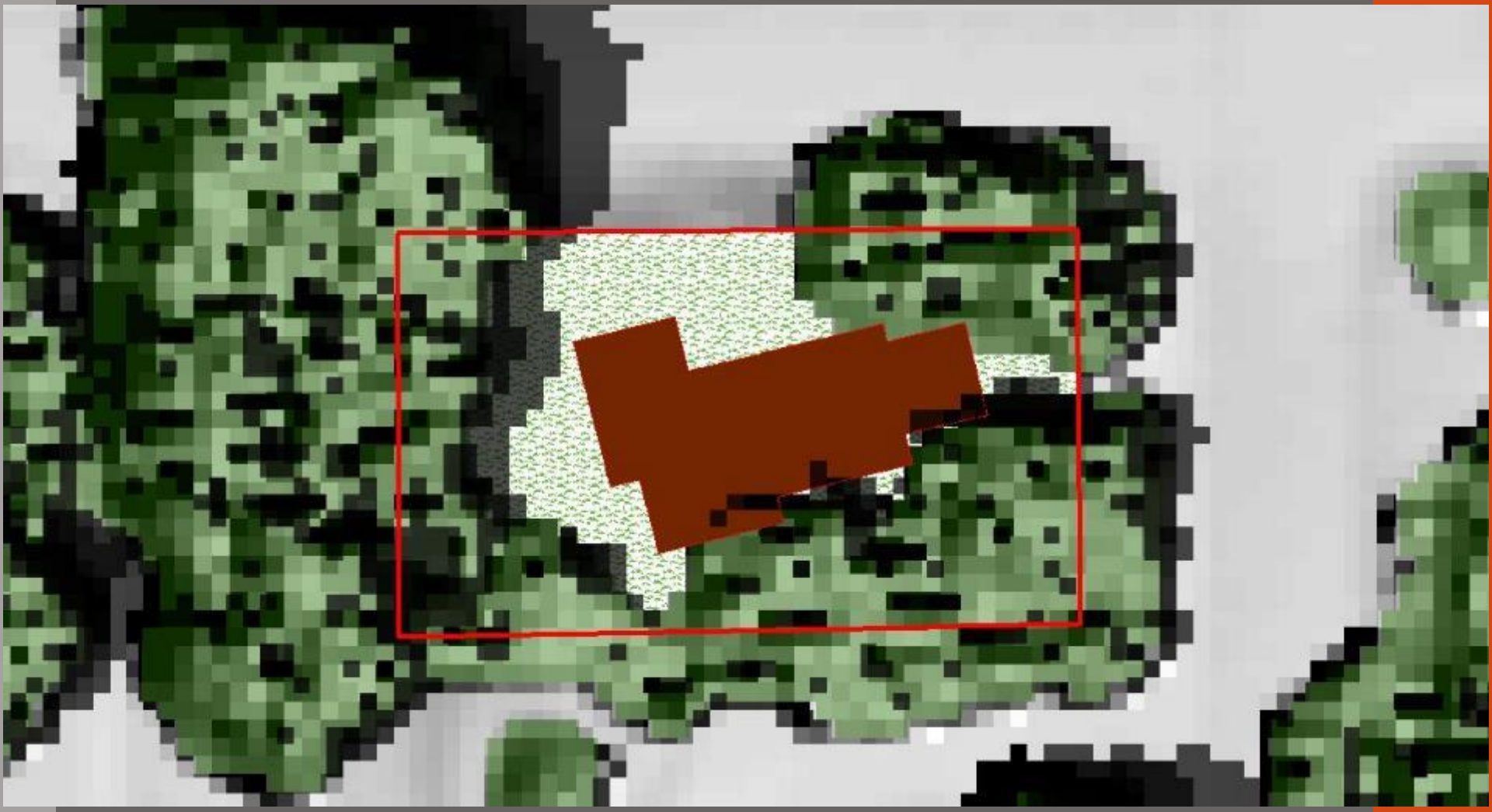

Labels
Non Grass
Grass - unirrigated
Grass - slightly irrigated
Grass - well irrigated



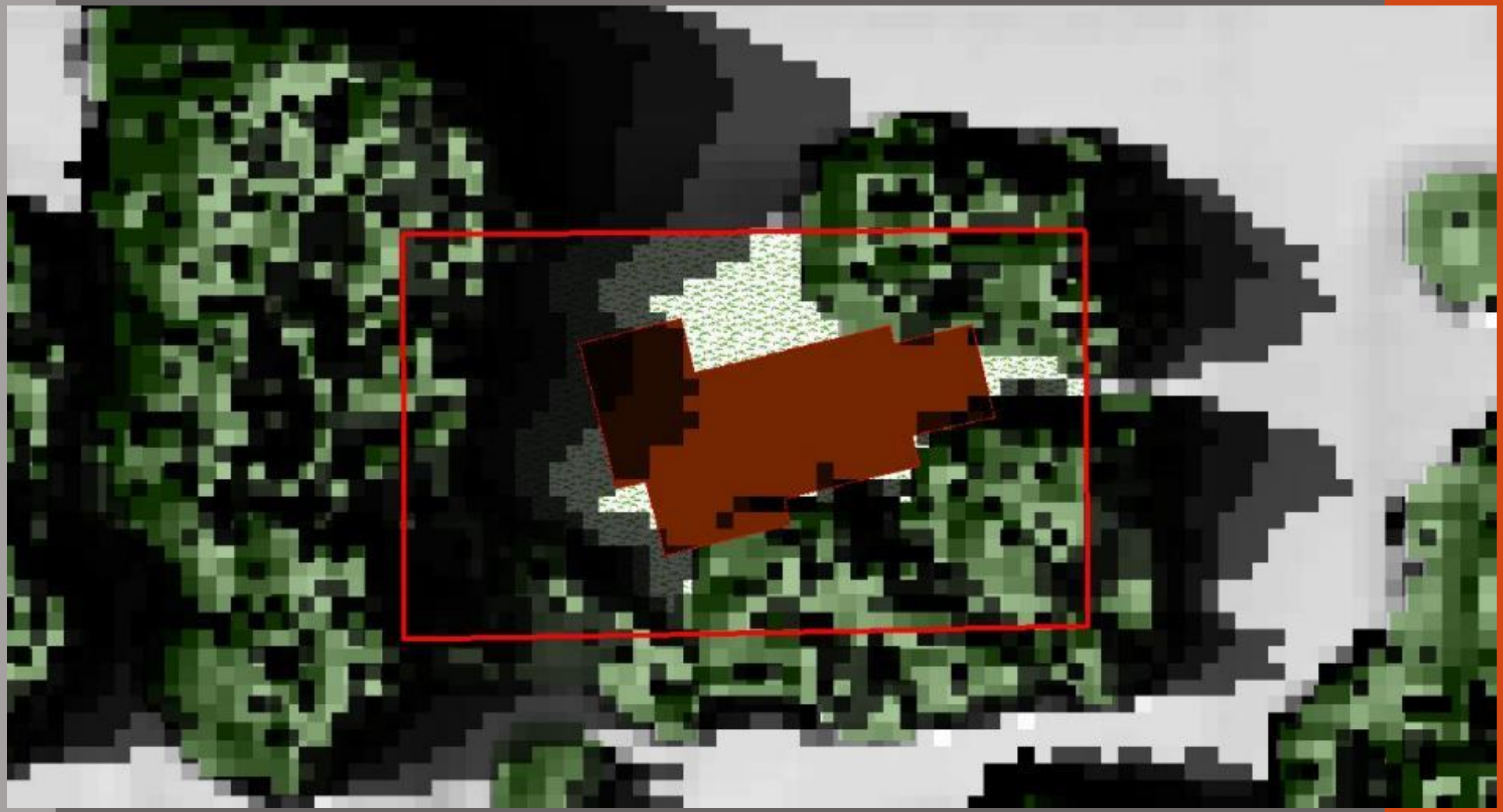

Tree height coded for each polygon from LiDAR
0.1 - 1.3
1.4 - 4.3
4.4 - 6.8
6.9 - 8.4
8.5 - 17.0
17.1 - 22.8



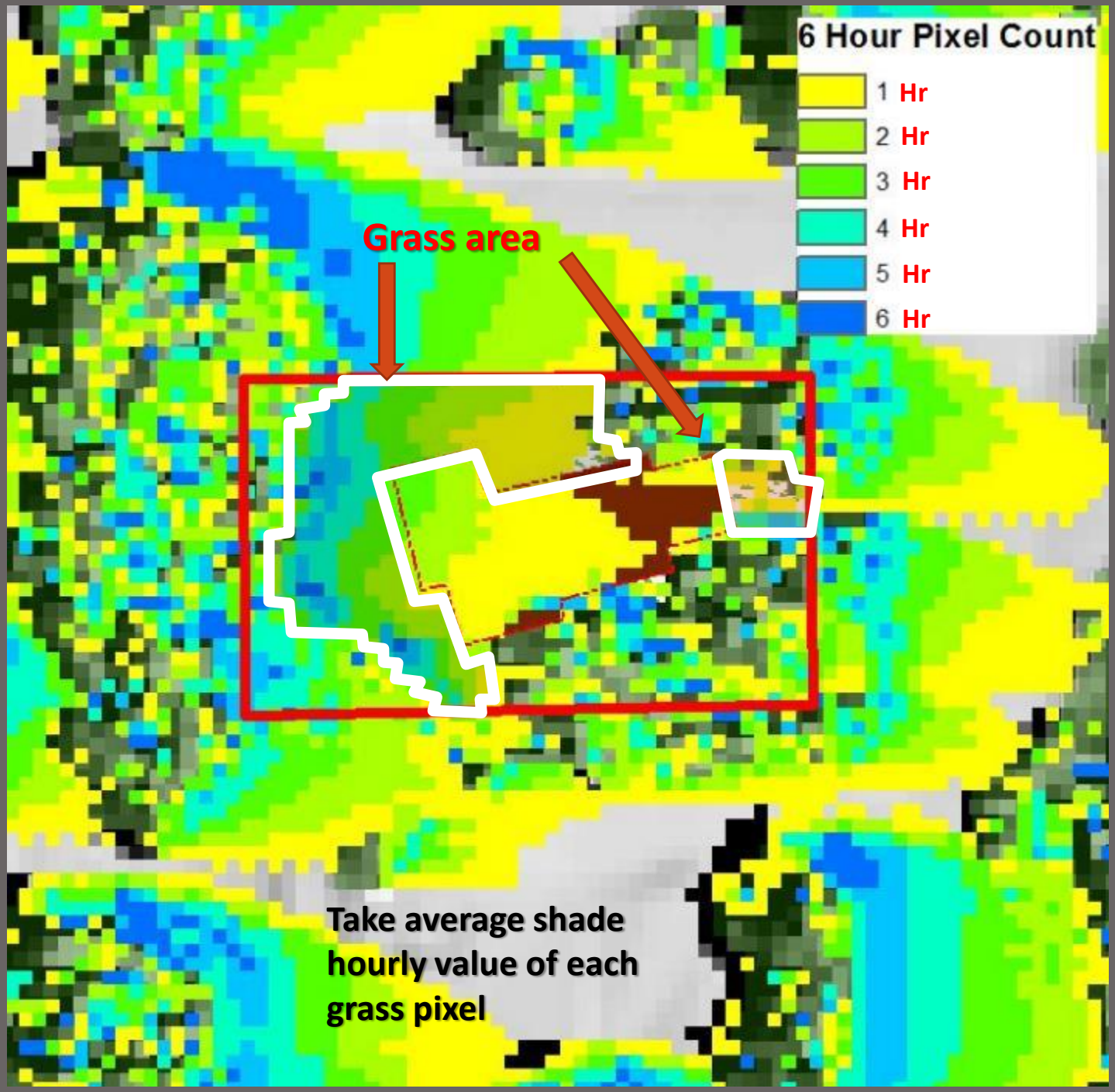
12 PM Shade Area = 728 m^2/1hr

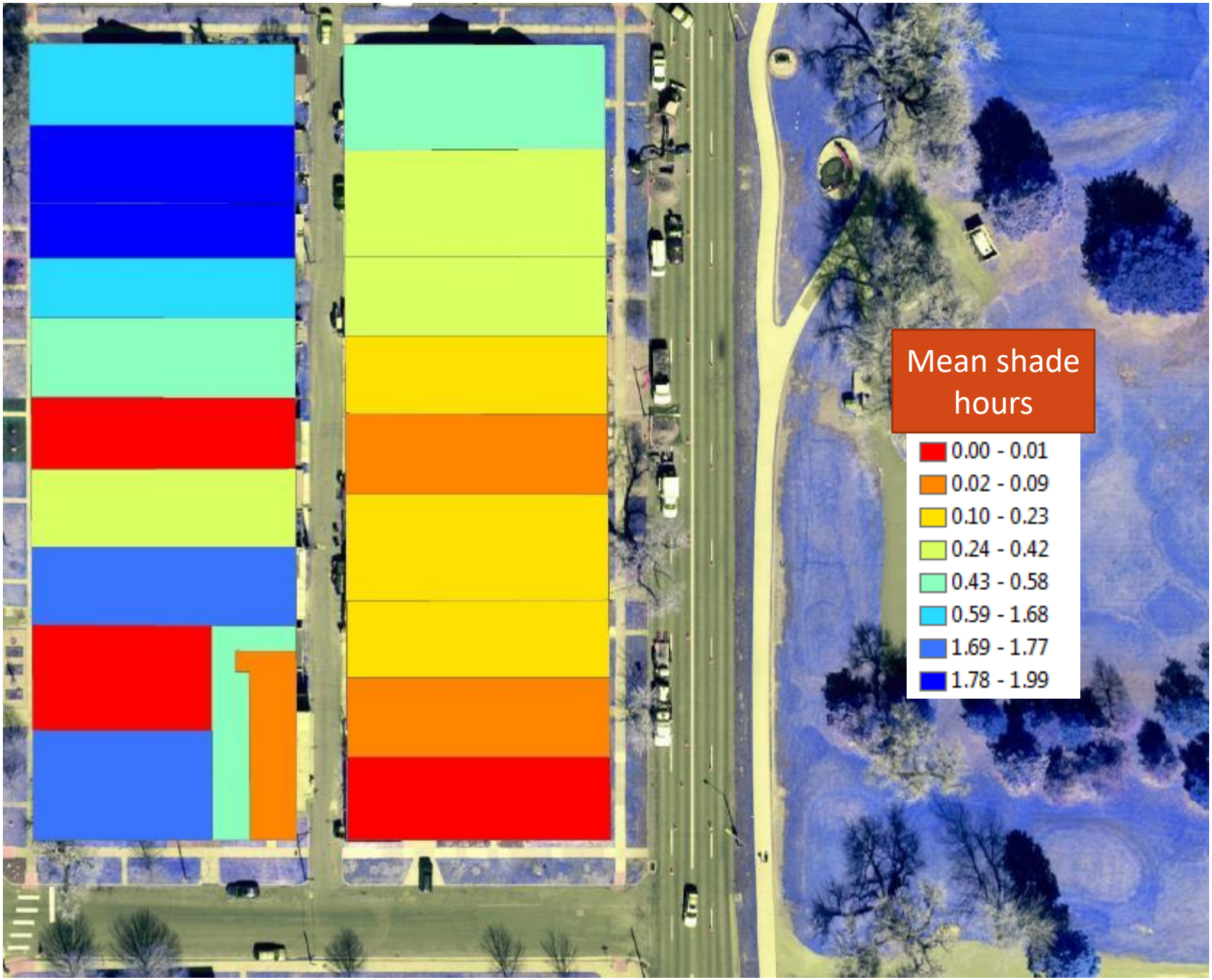


2 PM Shade Area = 3393 m^2/3hr

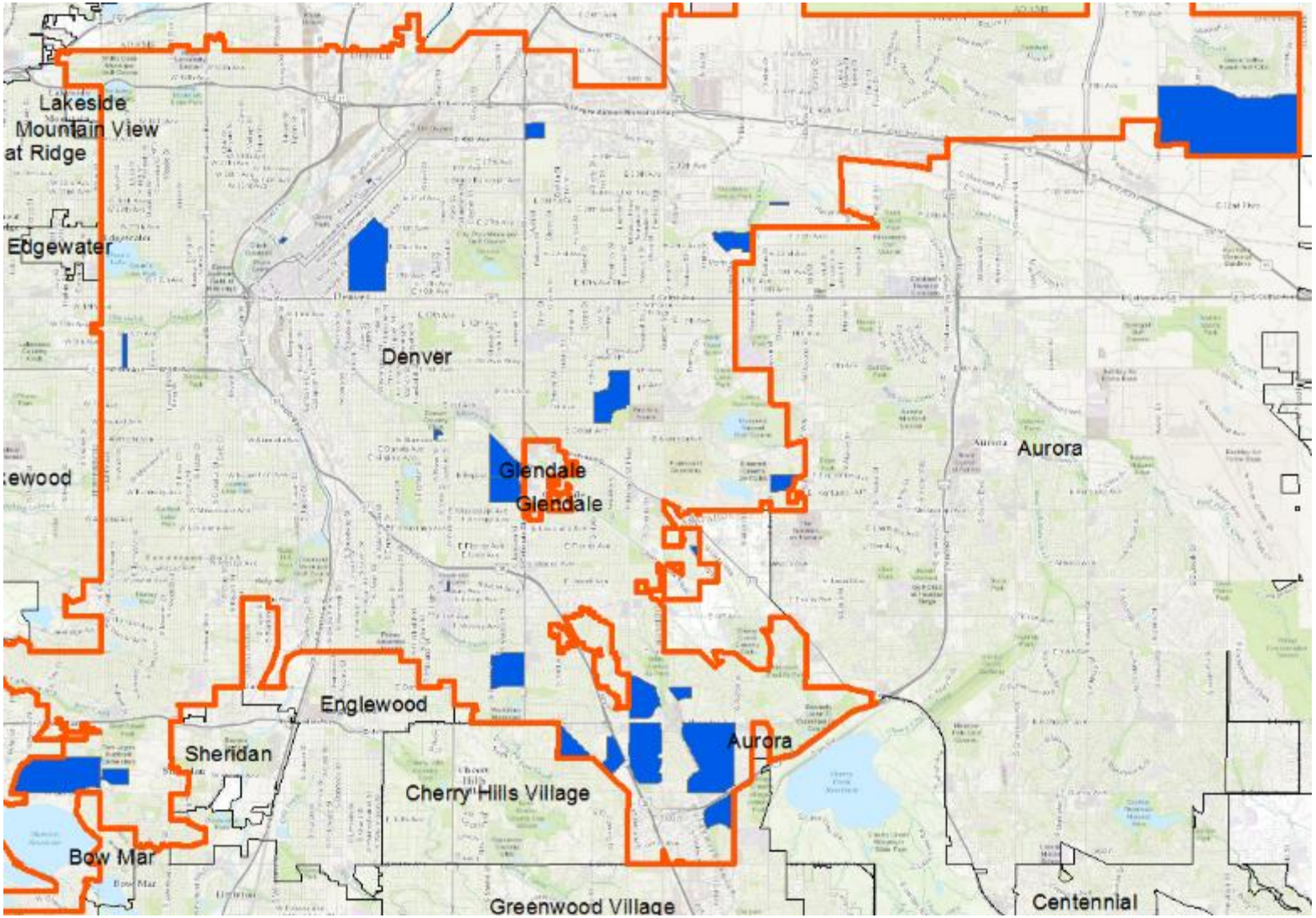


4 PM Shade Area = 13613 m^2/5hr

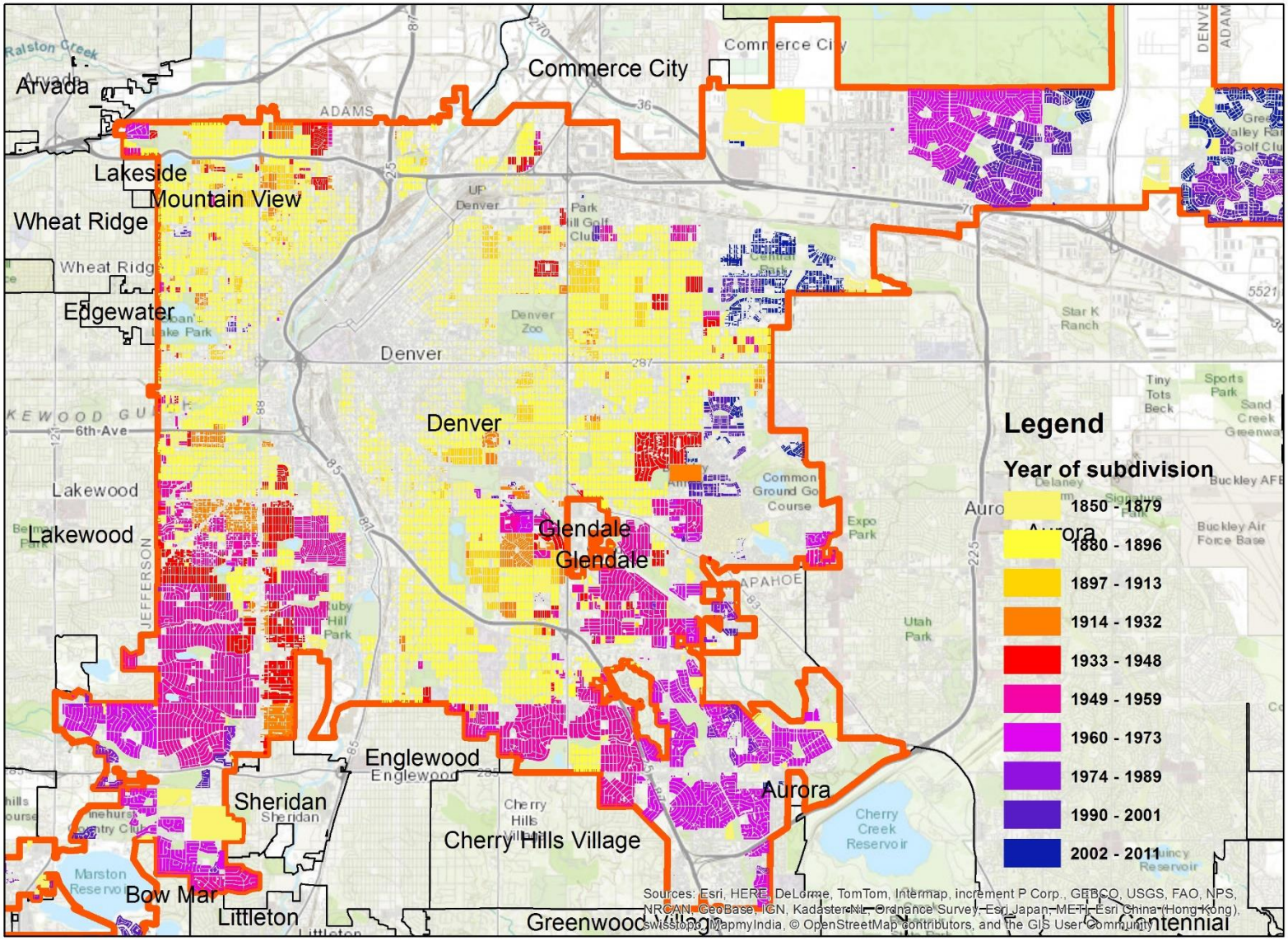

6 Hour Pixel Count
1 Hr
2 Hr
3 Hr
4 Hr
5 Hr
6 Hr
Grass area
Take average shade hourly value of each grass pixel


Mean shade hours
0.00 - 0.01
0.02 - 0.09
0.10 - 0.23
0.24 - 0.42
0.43 - 0.58
0.59 - 1.68
1.69 - 1.77
1.78 - 1.99

HOAs


Lakeside
Mountain View
at Ridge
Edgewater
Denver
Glendale
Glendale
Aurora
Englewood
Sheridan
Cherry Hills Village
Aurora
Bow Mar
Greenwood Village
Centennial

Year of subdivision



Results: Water consumption

Variable	Coefficient	T stat
Constant	-.096	-.075
MeanShadeHours*	-1.576[a]	-4.044*
TreeArea *	.022	9.389*
Grass-unirrigated	.000	-.068
Grass—semi-irrigated	-.005	-2.838*
Grass—irrigated	.069	26.713*
BuiltArea*	.316	60.804*
STORIES*	28.359	45.072*
PShortTree*	7.275	4.291*
After1950*	3.769	7.569*
HOA*	10.493	10.435*

Dependent Variable: TOTAL_QTY
R-squared= 0.267
*= significant at the 99% confidence level.
a. MeanShadeHours=-1.136 when only tree shade modeled

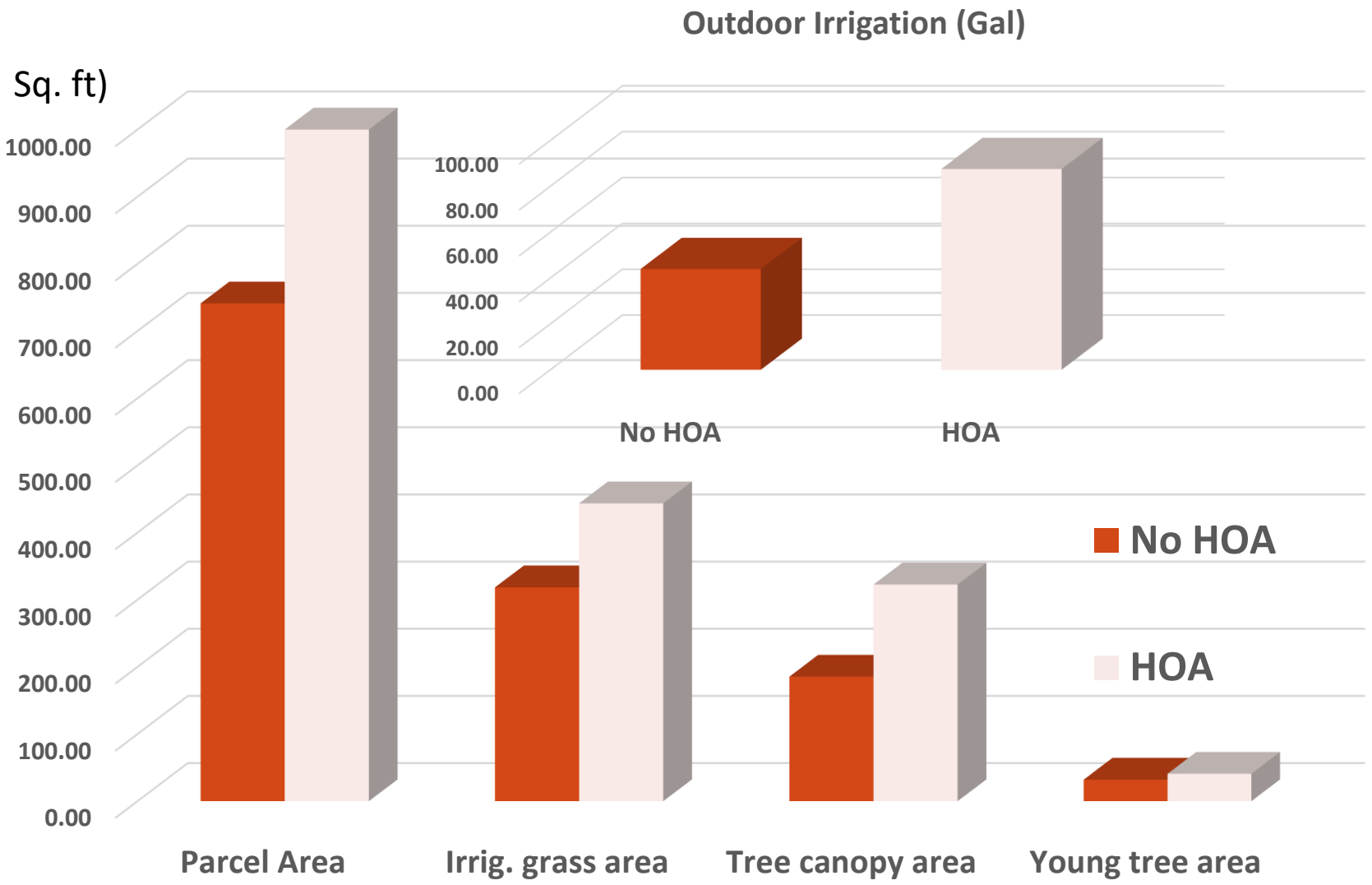
Interpretation of results

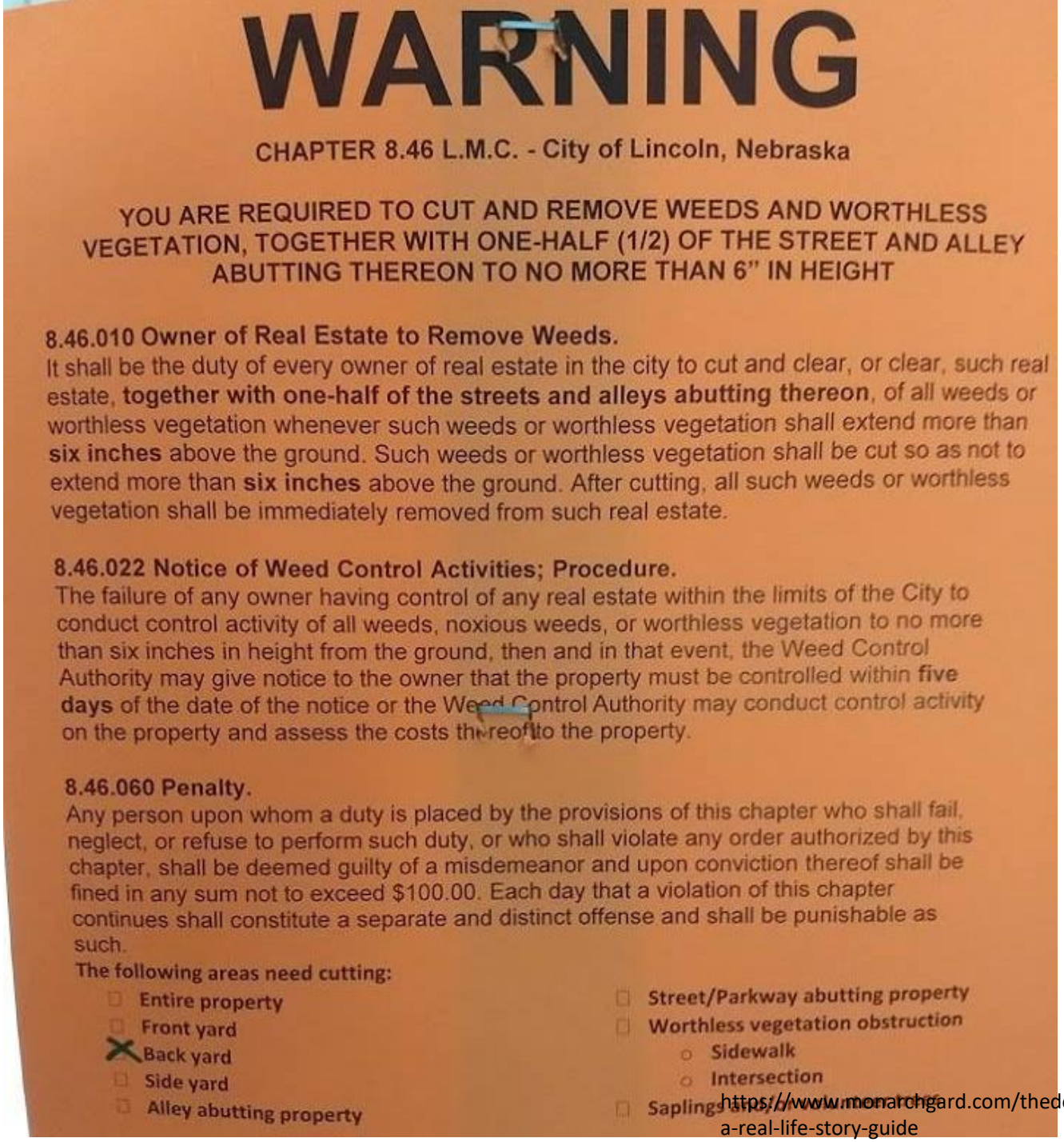
- Each additional 100 m ^{2} of **irrigated grass** (Grass3) is associated with 6000 additional gal of irrigation per year
- **Trees** use irrigation, but less than grass. Each additional 100 m ^{2}of **tree canopy** is associated with 2,200 more gallons or irrigation.
- For each 10% increase in the proportion of **trees that are short**, there is a 726 gal increase in water use. i.e. old, mature trees use less proportionally.

Interpretation of results

- **Shade** cast by trees and buildings on lawns serves to at least partially offset the water use of trees: for each additional hour of average shade across all grass pixels, 1,576 fewer gallons of water are used (1,136 with only tree shade). Consistent with Litvak et al (2013)
- If it were possible for a yard with 100 m^2 of tall trees to achieve a mean shading hours of **1.4** for lawn pixels , **water savings from the shade would outweigh water use of trees**

HOA differences in Denver





WARNING

CHAPTER 8.46 L.M.C. - City of Lincoln, Nebraska

YOU ARE REQUIRED TO CUT AND REMOVE WEEDS AND WORTHLESS VEGETATION, TOGETHER WITH ONE-HALF (1/2) OF THE STREET AND ALLEY ABUTTING THEREON TO NO MORE THAN 6" IN HEIGHT

8.46.010 Owner of Real Estate to Remove Weeds.
It shall be the duty of every owner of real estate in the city to cut and clear, or clear, such real estate, **together with one-half of the streets and alleys abutting thereon**, of all weeds or worthless vegetation whenever such weeds or worthless vegetation shall extend more than **six inches** above the ground. Such weeds or worthless vegetation shall be cut so as not to extend more than **six inches** above the ground. After cutting, all such weeds or worthless vegetation shall be immediately removed from such real estate.

8.46.022 Notice of Weed Control Activities; Procedure.
The failure of any owner having control of any real estate within the limits of the City to conduct control activity of all weeds, noxious weeds, or worthless vegetation to no more than six inches in height from the ground, then and in that event, the Weed Control Authority may give notice to the owner that the property must be controlled within **five days** of the date of the notice or the Weed Control Authority may conduct control activity on the property and assess the costs thereof to the property.

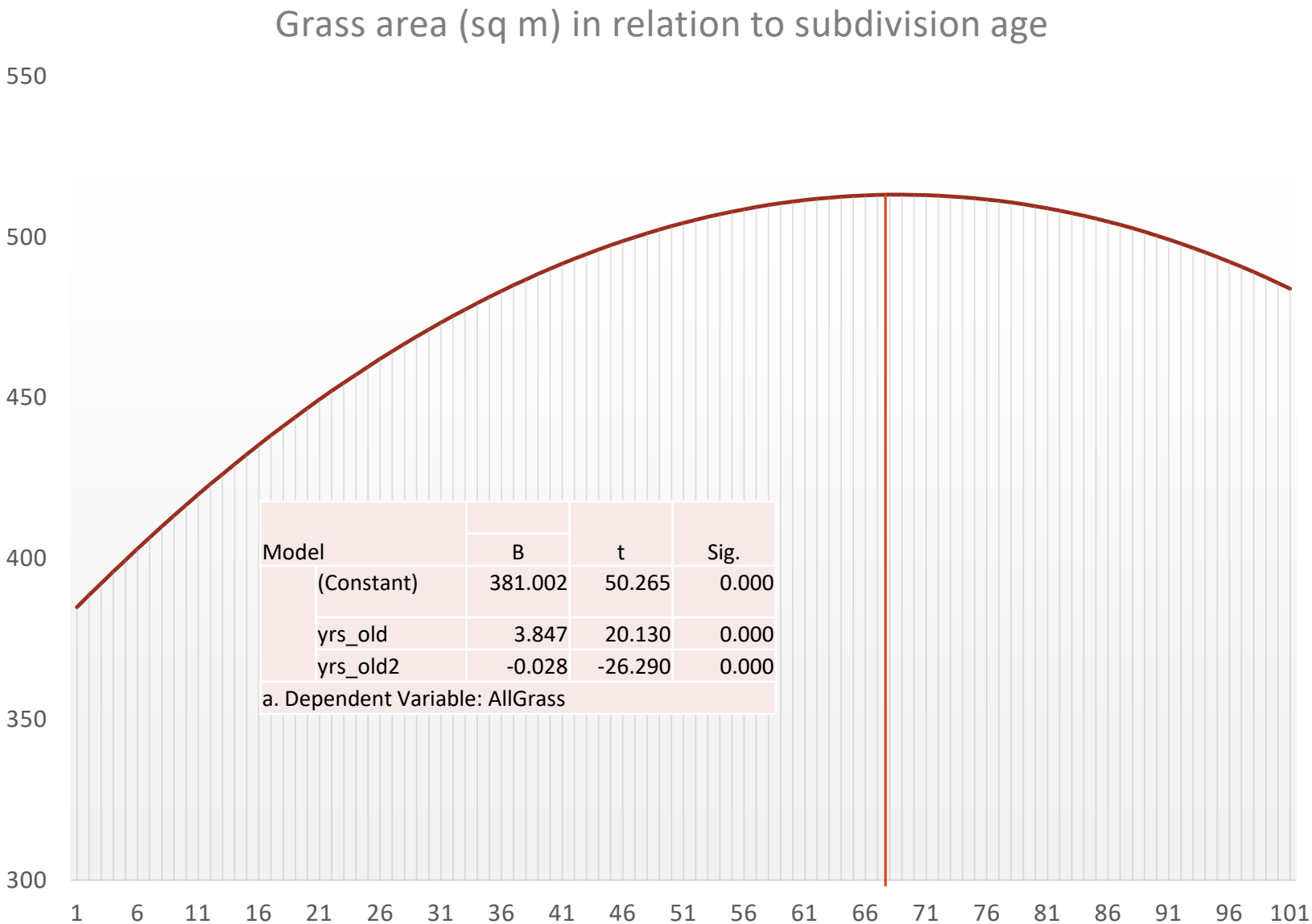
8.46.060 Penalty.
Any person upon whom a duty is placed by the provisions of this chapter who shall fail, neglect, or refuse to perform such duty, or who shall violate any order authorized by this chapter, shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not to exceed $100.00. Each day that a violation of this chapter continues shall constitute a separate and distinct offense and shall be punishable as such.

The following areas need cutting:

- ☐ Entire property
- ☐ Front yard
- ☒ Back yard
- ☐ Side yard
- ☐ Alley abutting property
- ☐ Street/Parkway abutting property
- ☐ Worthless vegetation obstruction
  - ○ Sidewalk
  - ○ Intersection
- ☐ Saplings

https://www.monarchgard.com/thedeepmiddle/how-to-pass-weed-inspection-a-real-life-story-guide

Subdivision age also drives grass area



Model		B	t	Sig.
	(Constant)	381.002	50.265	0.000
	yrs_old	3.847	20.130	0.000
	yrs_old2	-0.028	-26.290	0.000

a. Dependent Variable: AllGrass

Thanks/ Questions

Austin.troy@ucdenver.edu

University of Colorado Denver
CU IN THE CITY

Source: Eric Sonstroem (https://www.flickr.com/photos/sonstroem/)