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Managing Water in the West

Can Parks Inhibit Outdoor Water Use?

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U.S. Department of the Interior
Bureau of Reclamation

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- Faculty Advisors:
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- Data Provider: Tom Arnold, Tucson Water
- GIS Data: Pima County
- Bureau of Reclamation, especially
  Lynne Fisher, Eric Holler and Bob Michaels

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Underlying Theory

- Rachel Kaplan:
  - built-up cities cause psychological stress
  - creating a need for a “restorative environment”
  - specifically, a place with healthy vegetation

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How can we measure the benefits of green space?

"Green" environments are associated with:

- Better physical health
  (Cohen, et al., 2007; Maller et al, 2006)
- Better psychological health
  (Mowen, et al., 2007)
- Faster healing
  (Ulrich, 1984)

as well as

- Higher property values
  (Anderson and West, 2006; Lutzenhiser and Netusil, 2001; Morancho, 2003)

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Applications to Arid Cities

- Green vegetation is scarce, found at
  - Higher altitudes
  - Some riparian areas
  - Irrigated areas
- Landscape irrigation consumes scarce water resources (no potential for reuse)
- Target for conservation programs

Application to Tucson

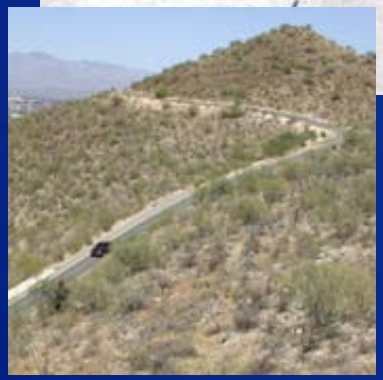
- 45% of water served to single-family residences (SFR) is used outdoors
- Estimated 2007 Tucson Water SFR outdoor use: 31,000 acre-ft
- Potential for future scarcity

Tucson homes vary widely in “greenness”



…as do Tucson’s parks



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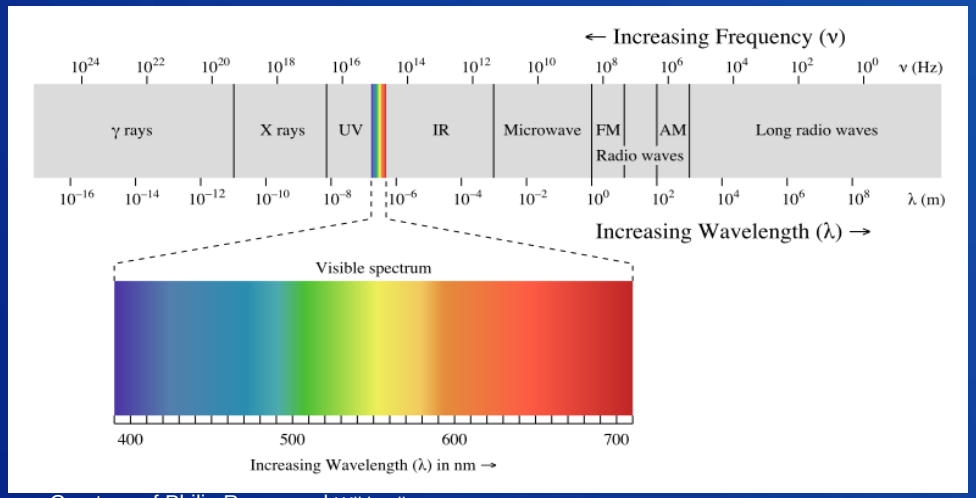
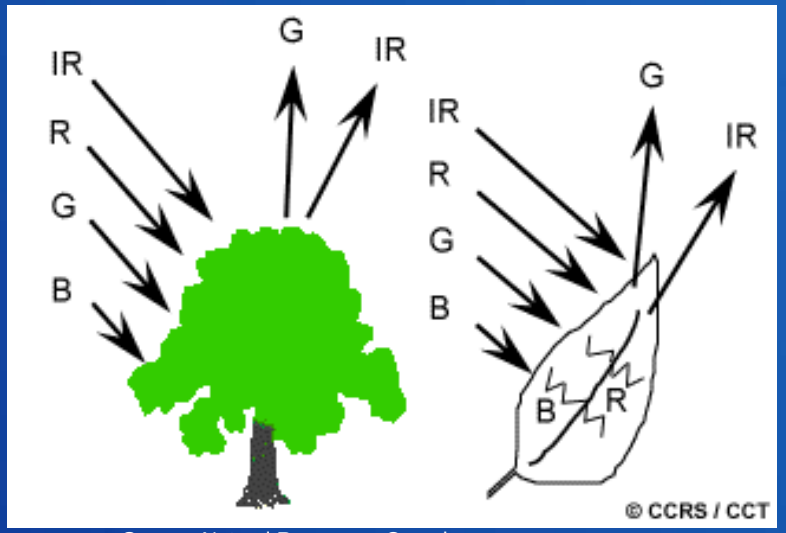
How to measure “greenness”?

- “Normalized Difference” Vegetation Index (NDVI) derived from red and infrared bands, ranges from 0 to 1
- I meter resolution aerial photography, acquired 6/25/2007



Courtesy of Philip Ronan and Wikipedia



Source: Natural Resources Canada

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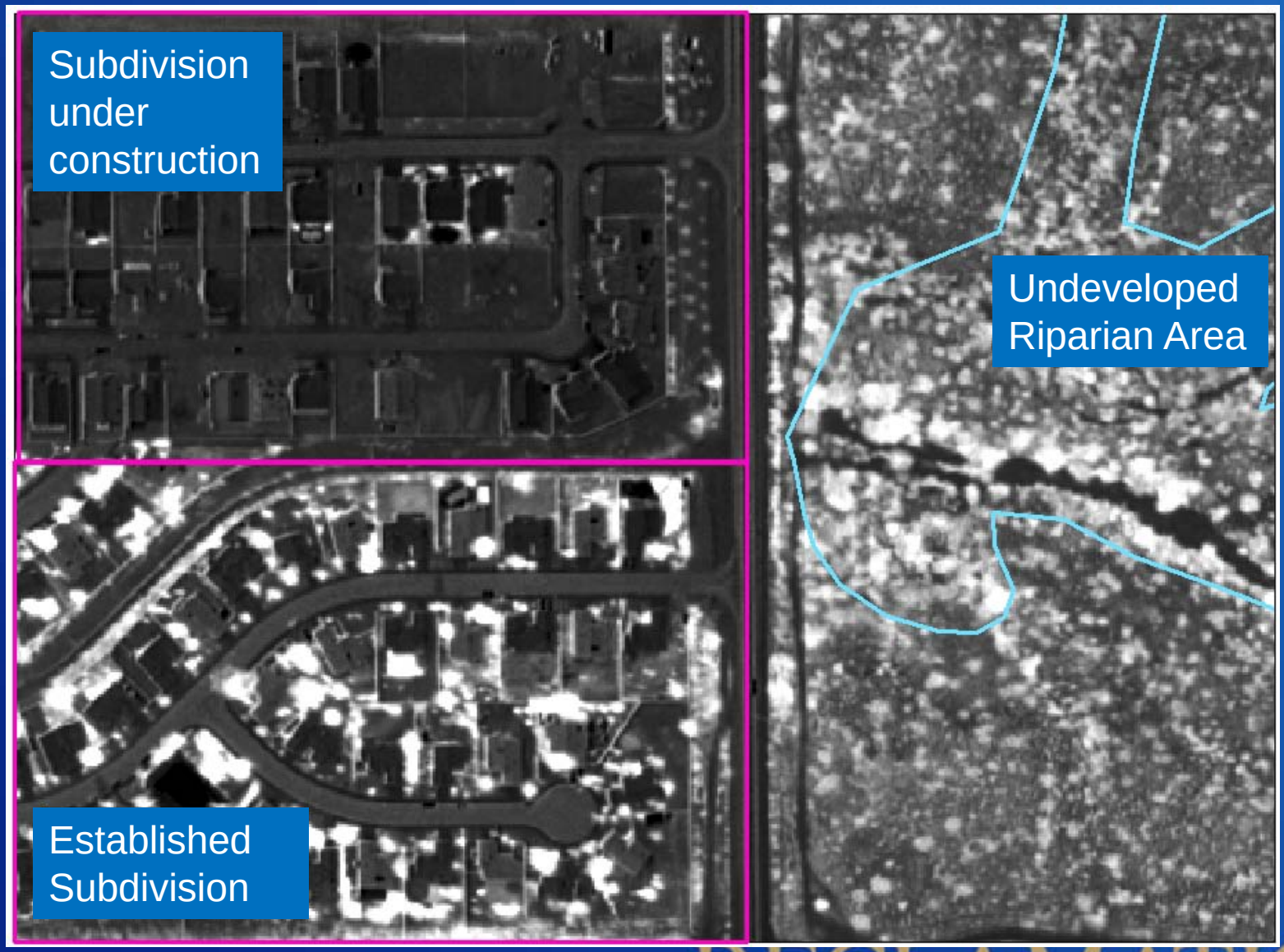
Example 1m NDVI Image



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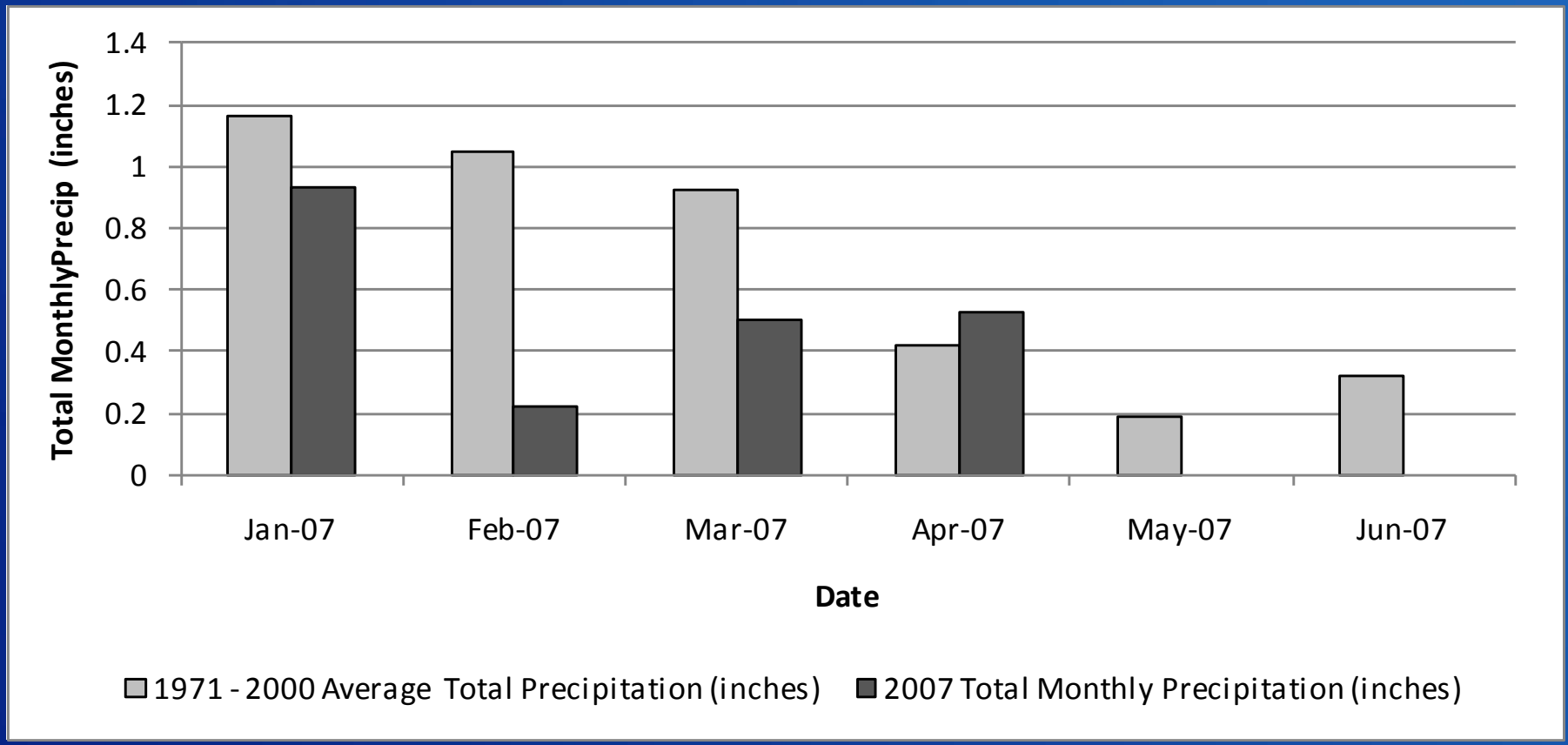
Use of Dry Season Image to Isolate Irrigated Areas



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Swimming Pools

- Another “quality-of-life” feature
- In especially high demand in hot, arid climates
- Consumes potable water resources

How to meet the need for green space / swimming pools?

Provided individually

Provided as a shared resource

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The first law of geography

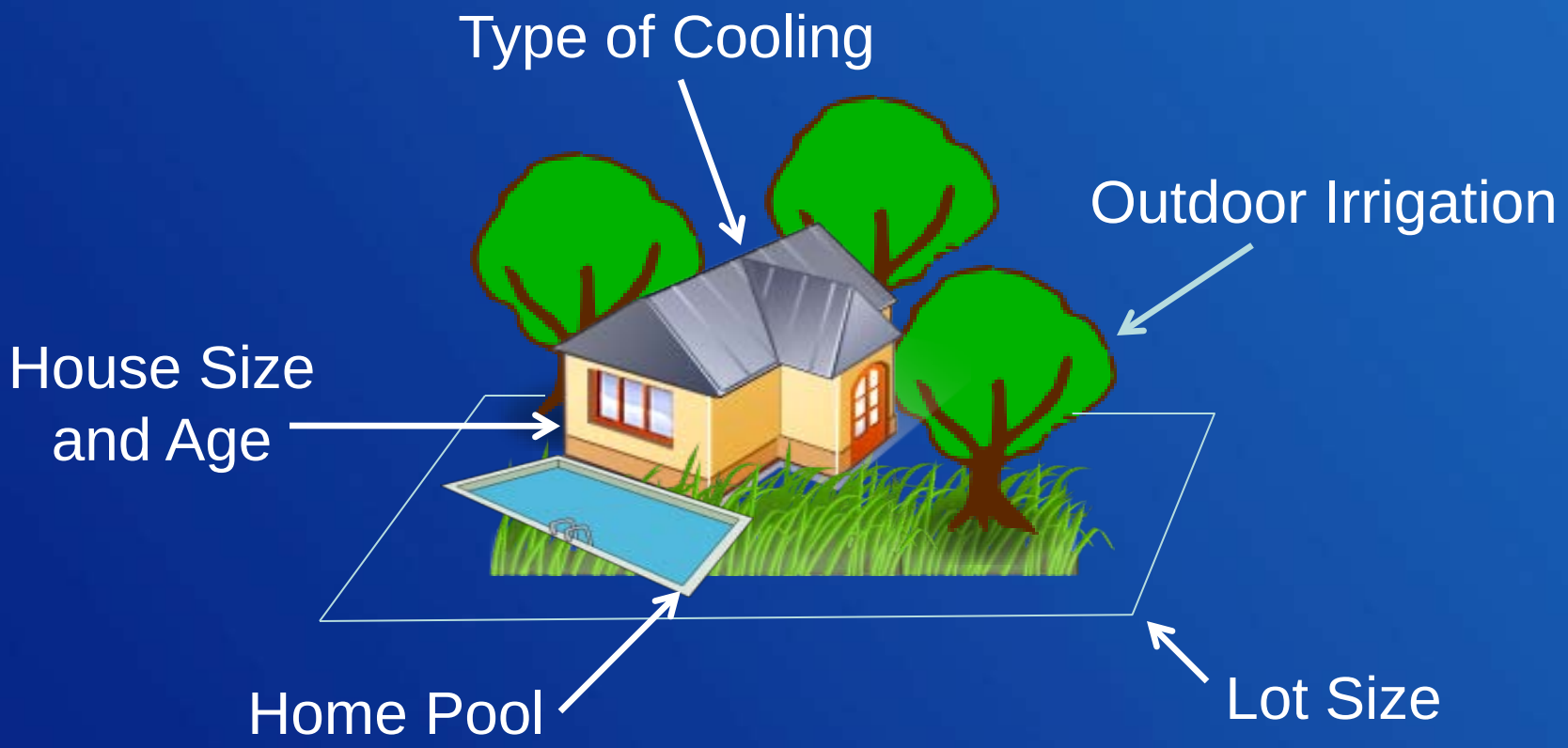
- "Everything is related to everything else, but near things are more related than distant things." (Tobler, 1970)

- If the presence of a park influence home water use behavior, homes close to a park should be subject to a greater influence than those further away.

Research Questions

- Do homes close to a “green” park use less water outdoors than those further away?
- What park characteristics affect residential outdoor water use?
- Do homes with private pools behave differently?
- Are public parks and pools net water savers?

Factors known to influence household outdoor water use



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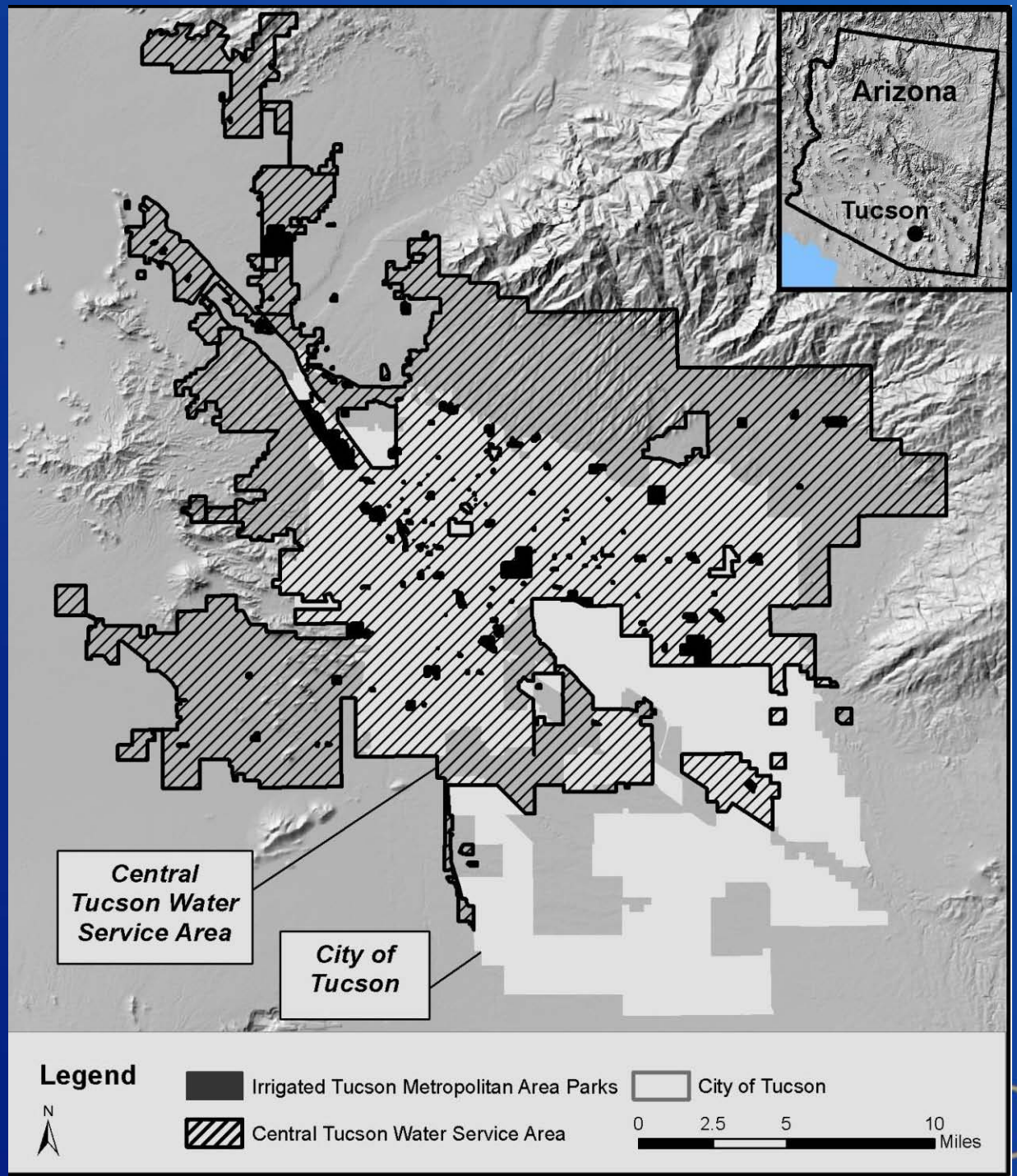

Tucson Water Service Area and "Green" Parks

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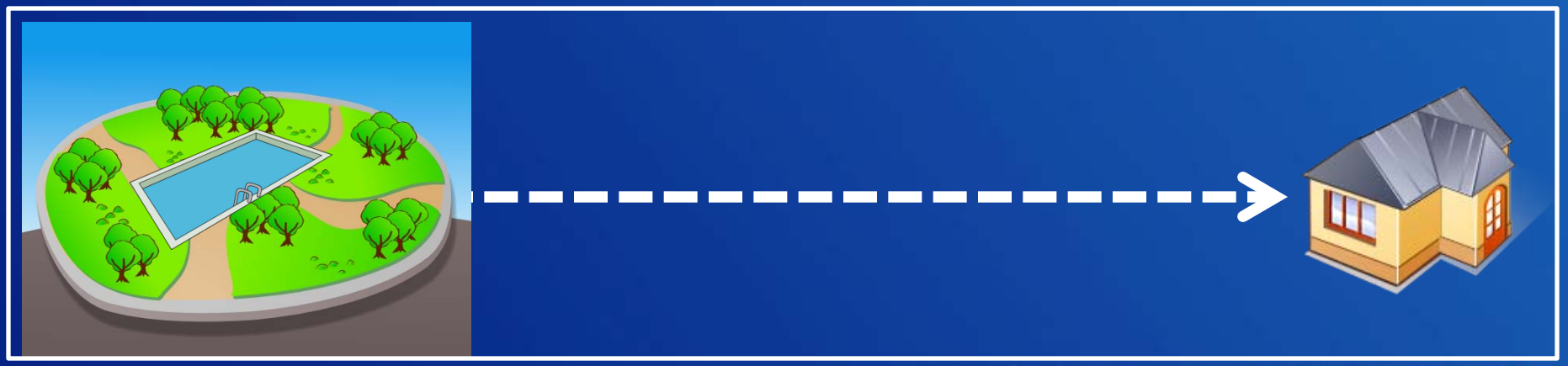
Effect of Park Proximity

vs.



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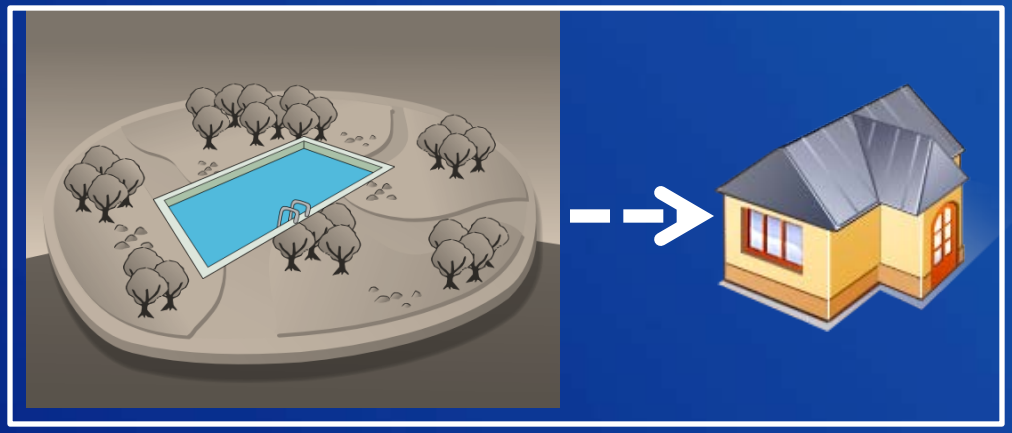
Effect of Park Greenness (NDVI)

vs.



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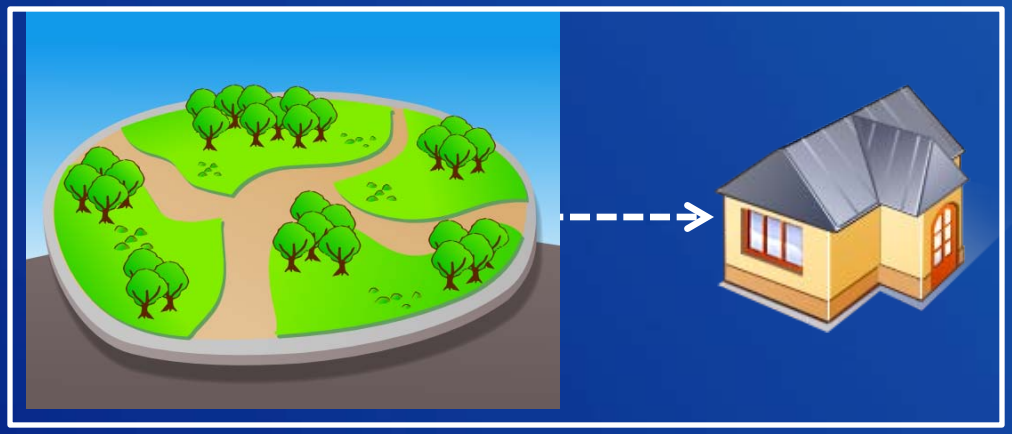
Effect of Public Pool

vs.



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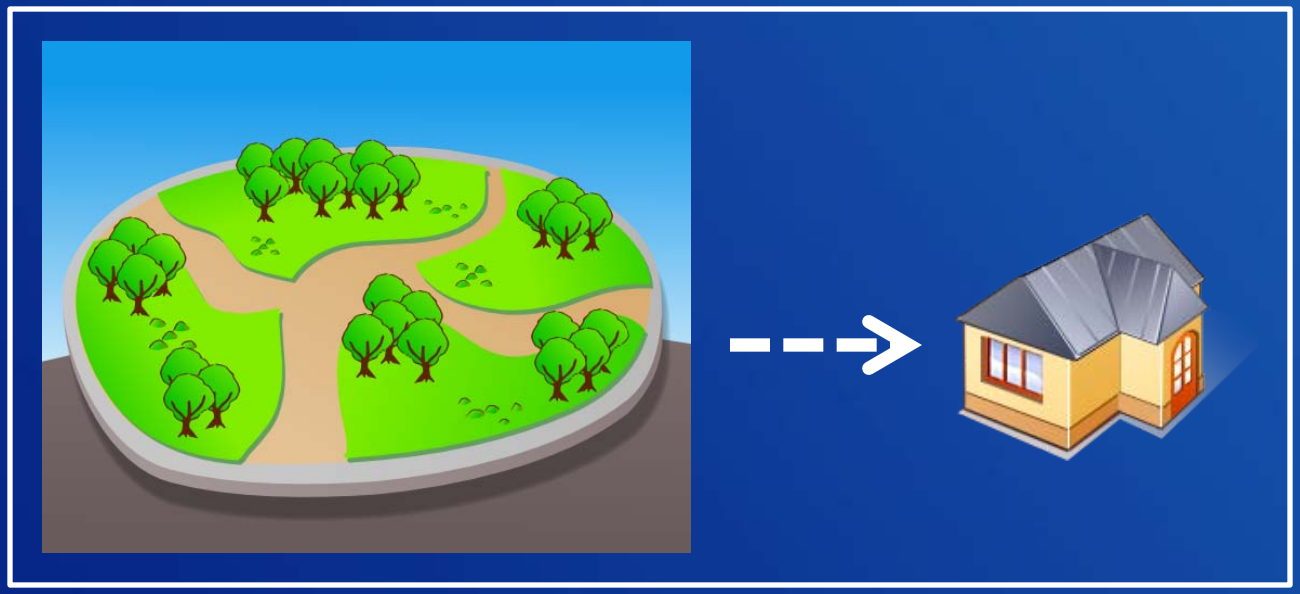
Effect of Park Size

vs.



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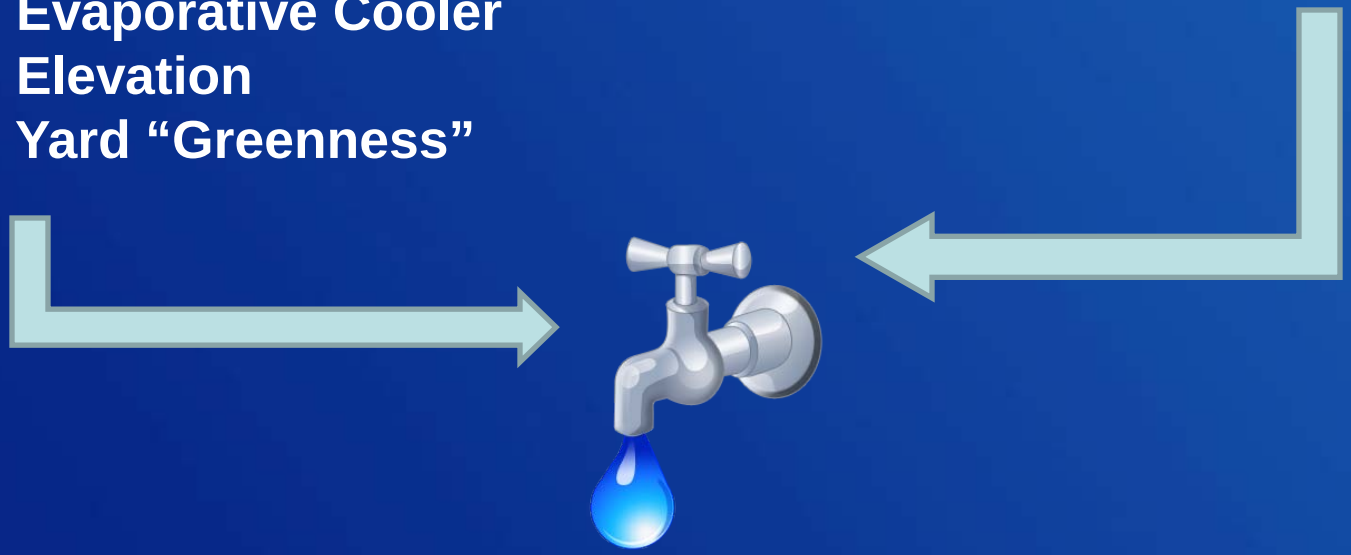
In conceptual terms, what factors influences SFR use, and how much?

“Property” Variables:

- **House Size**
- **House Age**
- **Yard Size**
- **Pool**
- **Evaporative Cooler**
- **Elevation**
- **Yard “Greenness”**

“Neighborhood” Variables

- **Distance to Park**
- **“Greenness” of Park**
- **Public Pool**
- **Size of Park / Facilities**



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Hypothesis in mathematical terms..

“Spring 2007 outdoor water use” is a function of:

Home Characteristics:

House Age, House Size, Yard Size, Yard Greenness, Elevation, Presence of Pool, Evap. Cooler

+

Park Characteristics:

Proximity, Greenness, Size, Presence of Pool

+

Error Term

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Data Sources

- **Homes and Parks Locations:** Pima County GIS Department
- **House Age and Size, Yard Size, Presence of Evaporative Cooling and Pool:** Pima County Assessor Database
- **Yard and Park Greenness:** NDVI derived from 2007 NAIP Aerial Photography, 1 m resolution, 6/25/2007
- **Elevation:** USGS National Elevation Data
- **Nearest Park, Distance to Nearest Park:** "Closest Facility" Function in ArcMap
- **SFR Water Use** – Tucson Water

Estimating Outdoor Water Use

(Average of April, May, June 2007 SFR water use, gphd)

–

(Minimum 2006 – 2007 winter water use or 349 gphd, whichever is smaller)

If winter water use was greater than 349 gallons per household per day, we assumed that watering occurred during winter months

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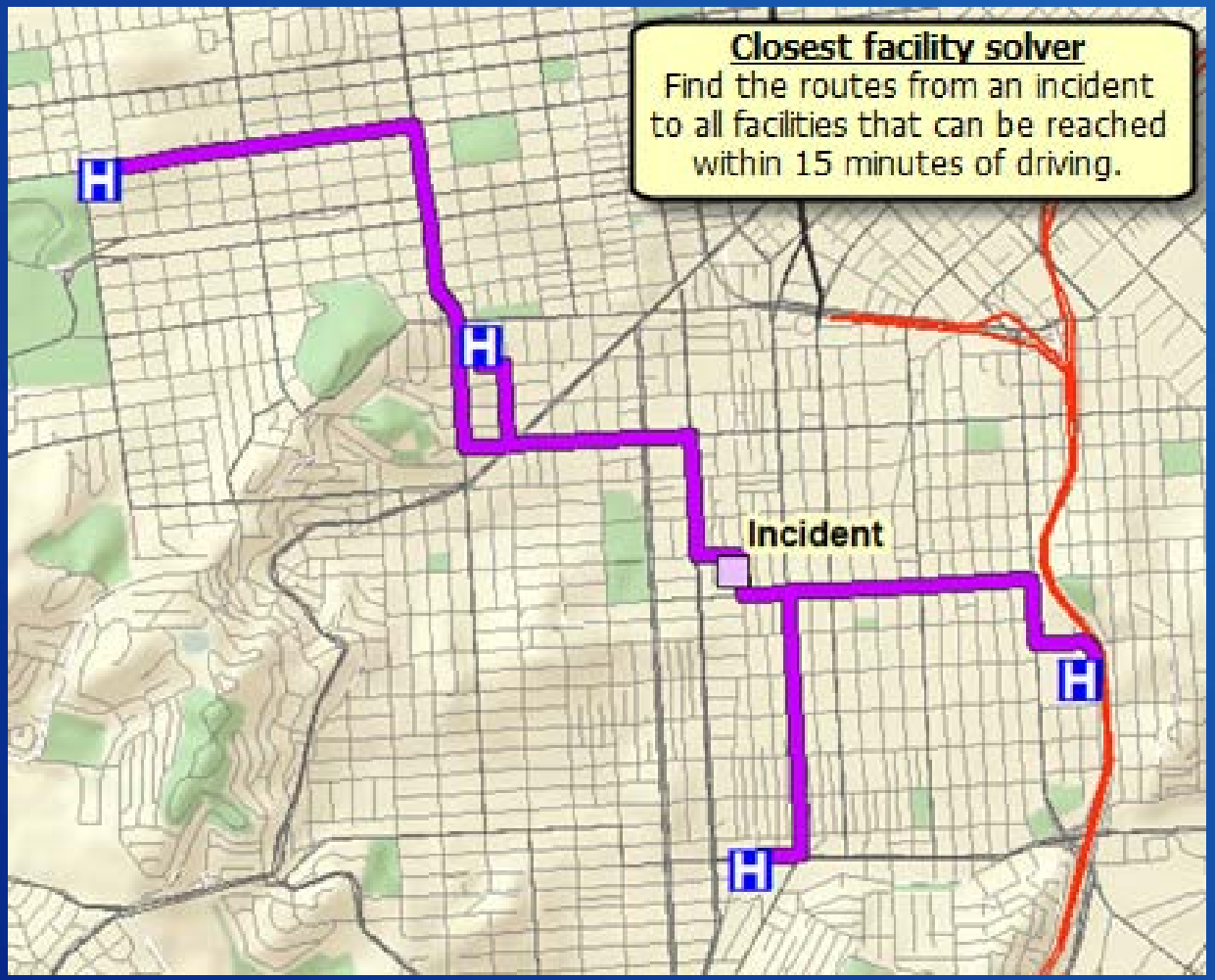
Example of “Closest Facility” Function



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Park Type	Acres	Typical Facilities
Mini	< 1 acre	Benches, Picnic Tables
Neighborhood	1 -15	Above plus Playground, Open Turf Area
Community	15 – 40	Above plus Restrooms, Swimming Pool, Sports Fields
Metro	40 – 200	Above plus one or more : Concert Area, Recreation Center, Sports Fields, Picnic Areas
Regional	200 +	Above plus one or more Campgrounds, Nature Center, Water Features, Zoo or Botanical Garden, Lake or Water Feature

Mini + Nbrhd

Com-munity

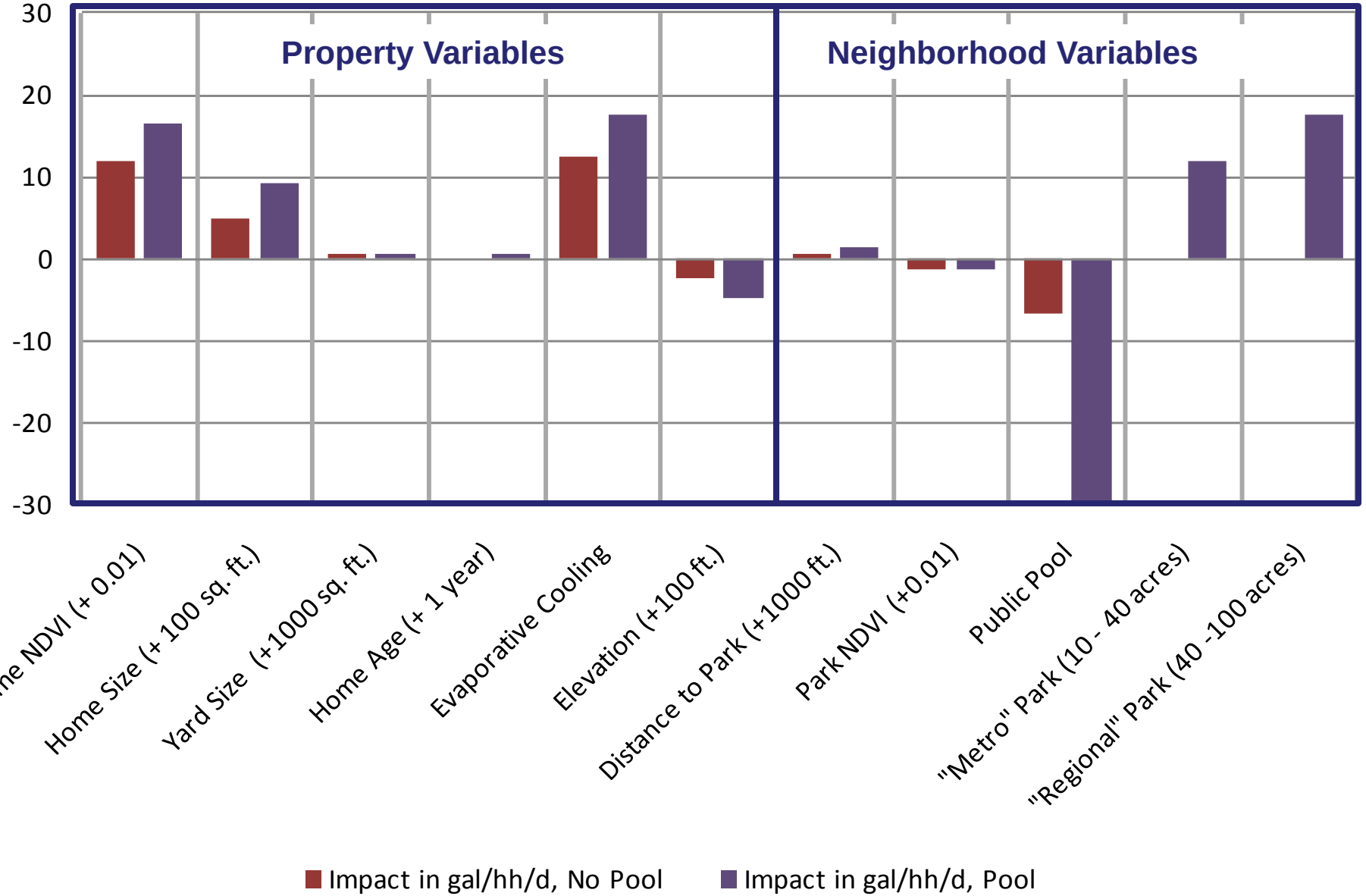
Metro + Regional

Source: Tucson Parks and Recreation Strategic Plan

Methods

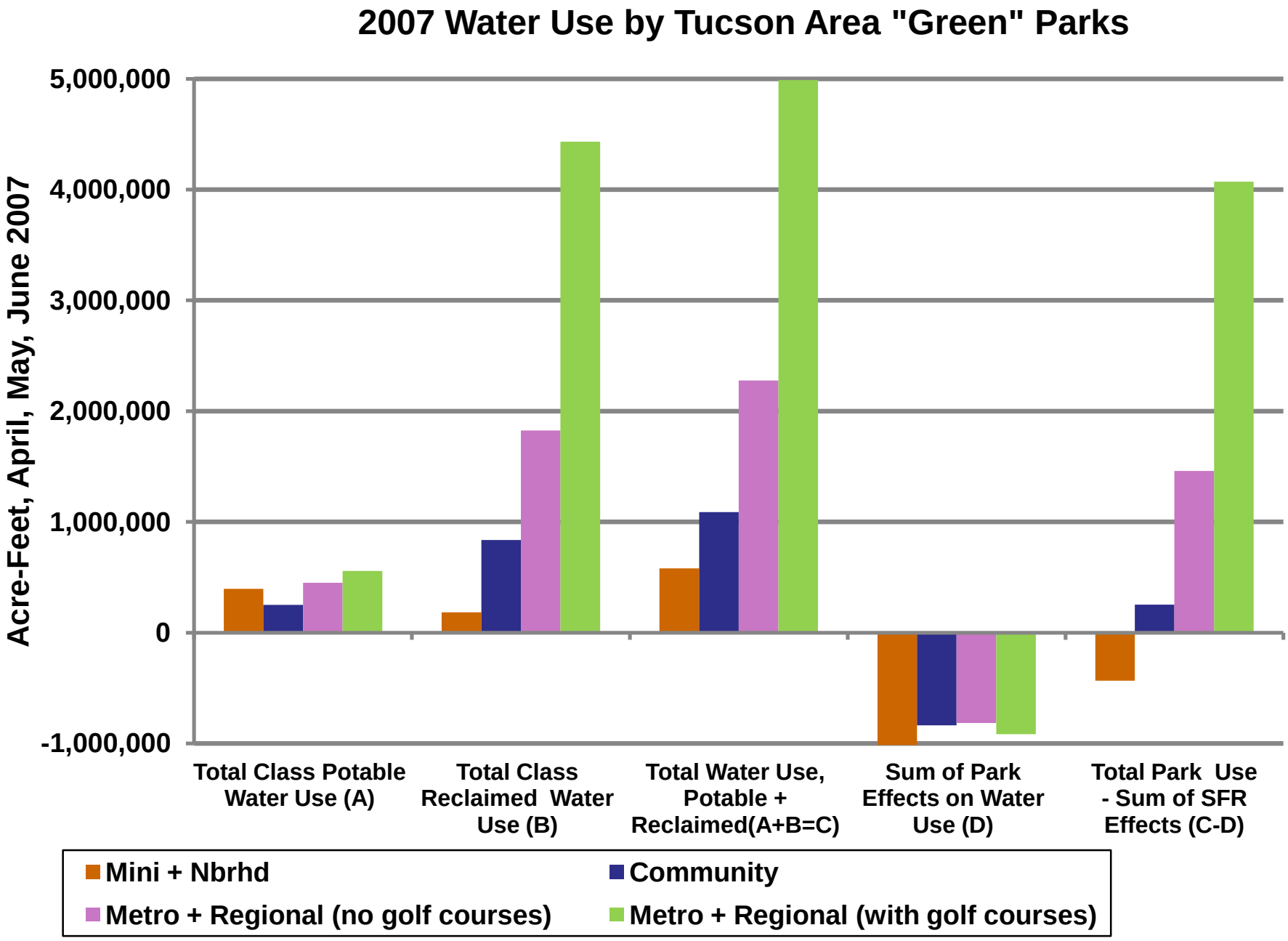
- Linear Regression Analysis (Ordinary Least Squares)
- N (number of data samples) = 110,111
- Analyzed homes with and without pools separately
- Used parks under 10 acres (no ool) as base case
- R^2 Full Model:
  - Without home pool = 0.169; With home pool = 0.207
- Variance Explained by Park-related Variables
  - Without pools: 0.13%; With home pool: 0.31%

Effect of Standard Changes on SFR Outdoor Water Use (Gallons per Household per Day)



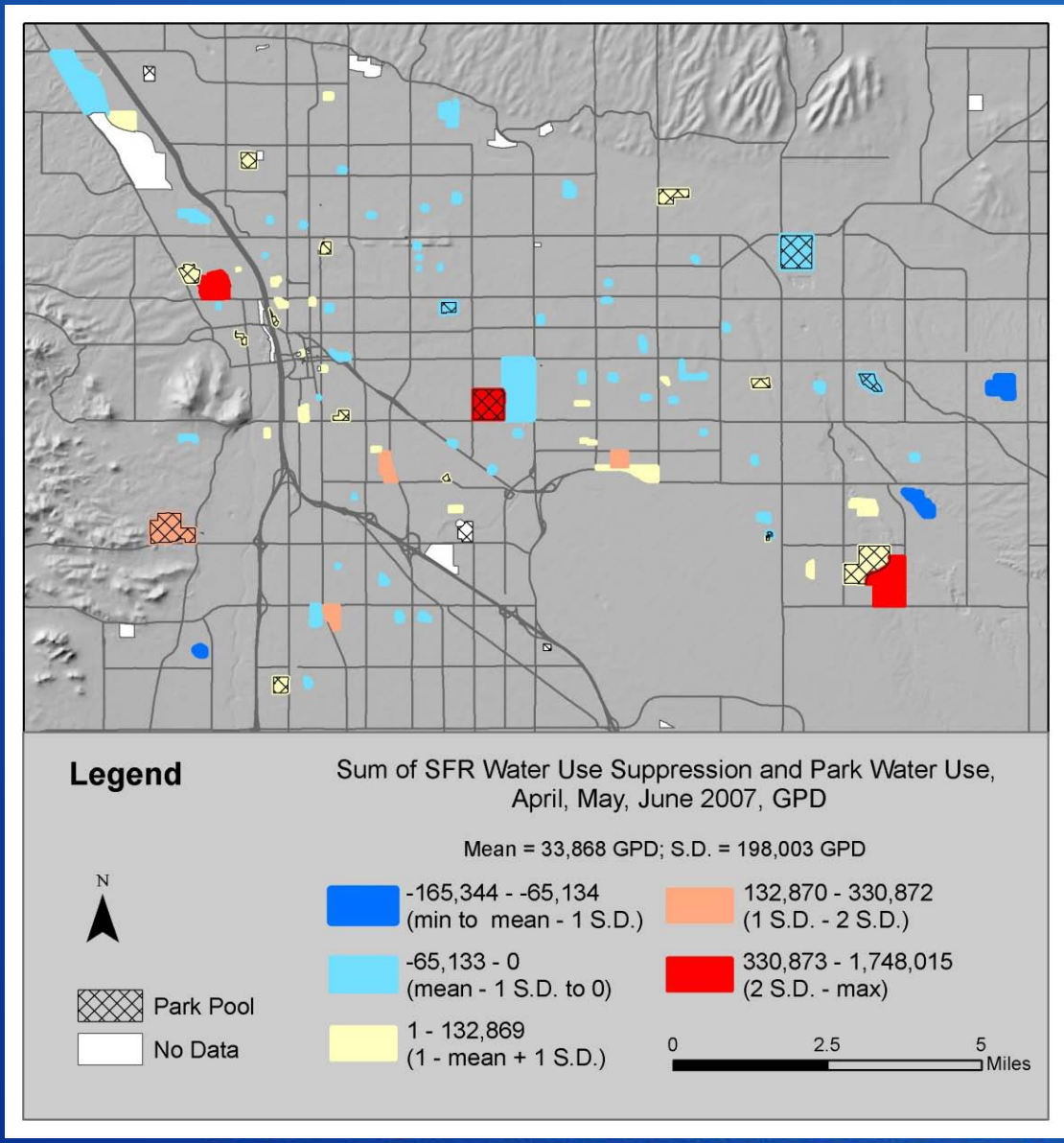
Observations

- Influence of all home characteristics behaved as expected.
- Homes with pools more sensitive to most factors
- Being close to a green park and a public pool inhibited outdoor water use in SFRs
- For homes with pools, proximity to larger parks appears to promote water use.


2007 Water Use by Tucson Area "Green" Parks
Acre-Feet, April, May, June 2007
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
-1,000,000
Total Class Potable Water Use (A)
Total Class Reclaimed Water Use (B)
Total Water Use, Potable + Reclaimed(A+B=C)
Sum of Park Effects on Water Use (D)
Total Park Use - Sum of SFR Effects (C-D)
Mini + Nbrhd
Community
Metro + Regional (no golf courses)
Metro + Regional (with golf courses)

Are parks net water savers?

- Estimated 2007 “park-induced” SFR water use changes
- Compared to data on 2007 park water use
- Most small parks appear to be net “savers”, larger parks may or may not be.

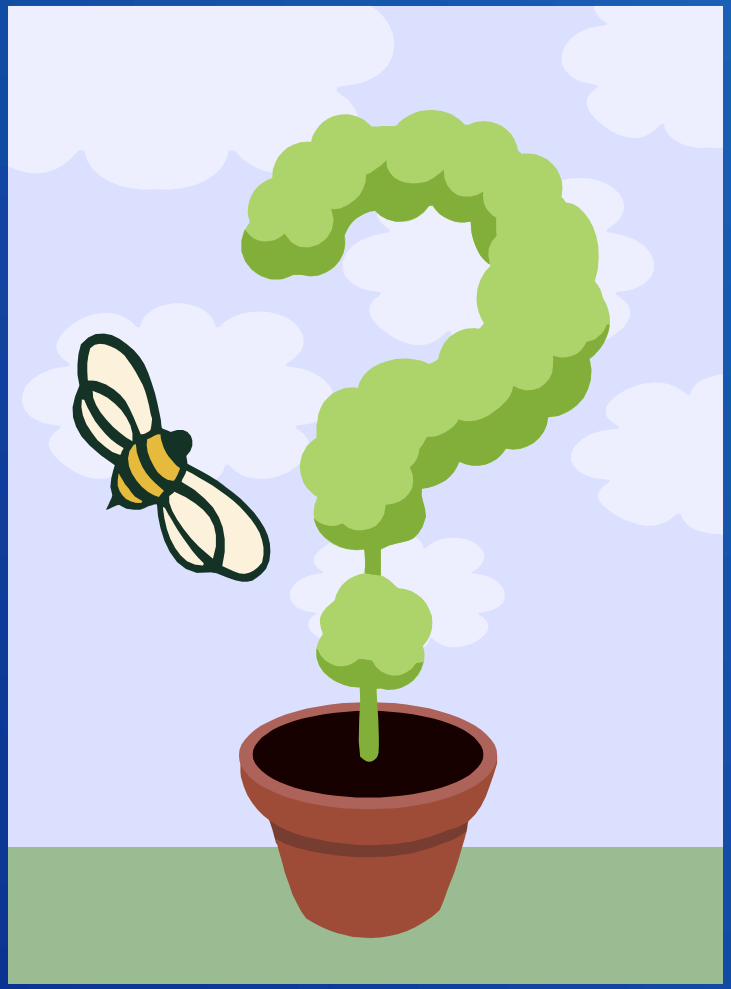


Do Parks Inhibit Outdoor Water Use by Tucson area SFRs?

- Proximity to a green park reduces SFR outdoor water use
- Proximity to a public pool reduces SFR outdoor water use, even for homes with pools
- Homes with pools appear to be more sensitive to most variation in home size and age, yard NDVI, elevation and presence of evaporative cooling

Can Parks Conserve Water?

- Small parks generally show net water savings
- Large parks may or may not generate net savings
- Greater proportion of reclaimed water use in large parks promotes conservation of potable supplies



Questions?

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