**Seasonal Variations in the Determinants of Outdoor Residential Water Consumption in Yuma, Arizona**

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**Overview**

Yuma, Arizona - a desert city located at the meeting grounds of the Arizona, California, and Mexico borders – is facing a shift in its water-use pattern from agricultural to semi-urban and residential. This transition, coupled with population growth and an uncertain climatic future, necessitates a better understanding of the new determinates of water consumption. Studies conducted in a nearby sprawling desert city – Phoenix – have shown that up to 60-70% of residential water consumption is determined by outdoor uses (Wentz & Gober 2007). Outdoor residential water consumption varies seasonally and reflects the presence of pools, landscaping type, and lot size. This study uses household level water consumption data from 2005 to 2009 to map variations over time and space. Specific results answer the following research questions:

1. What is the relationship between residential consumption and variations in temperature?
2. How are these variations reflected in specific determinants of residential demand such as pools and lot size?

**Water and Surface Temperature**

- **Summer 2009**
  - The average water usage will decrease the local surface temperature by .004°F per Cubic Foot per Minute (CFM) and is equivalent to 7.48 gallons per minute. ** denotes a significant correlation.
  - Only 30% of this decrease is due to the presence of a pool. A single family residential household analyzed.

- **Winter 2009**
  - The average water usage will decrease the local surface temperature by .016°F per CFM. ** denotes a significant correlation.

**Pools, Water, and Temperature**

- **In the Winter (Jan-Feb)**, the presence of a pool can increase household water consumption between 10.47 to 17.31 CFM, and decrease the local surface temperature between .38 to 1.01°F.
- **In the Summer (Jul-Aug)**, the presence of a pool can increase household water consumption between 19.52 to 31.76 CFM and decrease the local surface temperature between 1.2 to 1.67°F.
- The presence of a pool is positively correlated with water usage and negatively correlated with surface temperature. Pools are significantly spatially clustered in areas with high water usage and cooler temperatures.

**Water and Lot Size**

- **Winter**
  - The average water usage will decrease the local surface temperature between .1 to .3 CFM.
  - In the Winter (Jan-Feb) every 100 sq. ft. of Lot Size can increase water consumption up to .1 CFM.
  - In the Summer (Jul-Aug) every 100 sq. ft. of Lot Size can increase water consumption between .1 to .3 CFM.

**Conclusions, Further Work, and Informing Decision Making**

- Warmer temperatures increase water usage and increasing outdoor water use decreases local temperature. A threshold exists where a collective increase in outdoor water use could actually decrease household water usage.
- Surface temperature, pools, and lot size are all significantly correlated with outdoor residential water consumption and more so in the Summer than in the Winter.
- Preliminary test results show that the presence of a pool is the largest influence on outdoor residential water consumption in Yuma, AZ in the winter and summer, followed by local surface temperature and lot size.
- Further research will include the addition of air temperature, vegetation, and indoor water consumption variables.
- The applicable result of this work is the creation of a system that allows water managers and decision makers to create a water scarce region to understand water-use patterns with better precision.

**Sources**


**The Rapid Urbanization of Yuma**

According to a Brookings Institute Report (2001), Yuma was the fifth fastest growing metropolitan area by percent change in urbanized land between 1982 and 1997. The cities population in 2000 was 77,115, and current projections estimate a population of over 90,000.

**Table 2.** The average water usage will decrease the local surface temperature from .09 to .16 degrees Fahrenheit

<table>
<thead>
<tr>
<th>Month</th>
<th>Water Use (CFM)</th>
<th>Sig.</th>
<th>Relationship</th>
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<tr>
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<td>.52</td>
<td>.093**</td>
</tr>
<tr>
<td>2007</td>
<td>75.02</td>
<td>.52</td>
<td>.093**</td>
</tr>
<tr>
<td>2008</td>
<td>61.23</td>
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</tr>
<tr>
<td>2009</td>
<td>57.68</td>
<td>.37</td>
<td>.079**</td>
</tr>
<tr>
<td>Aug. 2005</td>
<td>90.1</td>
<td>.37</td>
<td>.079**</td>
</tr>
<tr>
<td>Aug. 2006</td>
<td>94.47</td>
<td>.37</td>
<td>.079**</td>
</tr>
<tr>
<td>Aug. 2009</td>
<td>130.16</td>
<td>.37</td>
<td>.079**</td>
</tr>
</tbody>
</table>

**Table 3.** The blue points represent pools. This is an example from August of 2009 displaying the clustering of pools in high water usage areas.