Climate Sensitivity of Residential Water Consumption for the City of Phoenix, Arizona

Robert Balling[1], Patricia Gober[1,2] and Nancy S. Jones[2]
[1]School of Geographical Sciences
[2]Decision Center for a Desert City, Arizona State University

Introduction:

Water remains an essential ingredient for the rapid population growth taking place in metropolitan Phoenix. Depending upon the municipality, between 60 and 75% of residential water is used outdoors to maintain non-native, water-intensive landscapes and swimming pools [Mayer and DeOreo, 1999]. Residential water use in Phoenix should be especially sensitive to meteorological and climatic variations because of the strong emphasis on outdoor water use. *This study explores the intra-urban spatial variations in the sensitivity of residential water consumption to atmospheric conditions.*

Objective:

Our goal is to better understand the sensitivity of local water use to variations in climate.

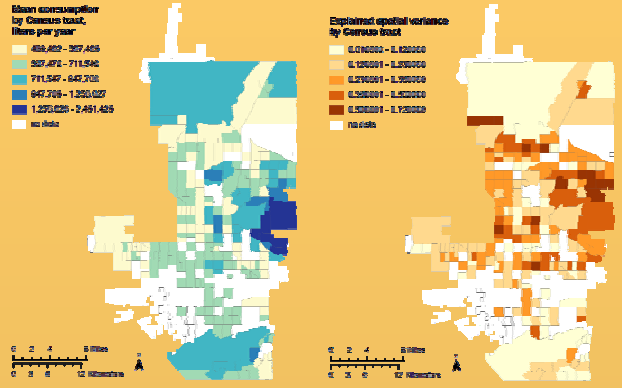
Methods:

For 230 census tracts in the city, we developed times series of monthly water-use anomalies and compared them to monthly anomalies of temperature, precipitation, and the Palmer Drought Hydrological Index.

1) Temperature, precipitation and drought data were examined for normality;
2) We examined data by census tract comparing monthly water consumption to temperature anomalies, transformed precipitation anomalies (result of step one), and PHDI
   a) temperature anomalies explain 10% of variance
   b) lower than normal precipitation results in higher water use
   c) more severe drought stimulates higher water use;
3) Multiple regression analysis was used to determine the climate sensitivity of each census tract;
4) Spatial variation in climate sensitivity was related to six socio-economic variables.

Results:

Spatial Variation in Water Use and Climate Sensitivity



Socio-economic Determinants of Climate Sensitivity

Predictor	Total Variance	Temp	Prec	PHDI
Income / Household	**0.23**			**-0.53**
Percent Mesic	**0.18**			**-0.26**
Number in Household				**0.22**
Lot Size	**0.2**		-0.15	**-0.29**
Pool Percent	**0.32**	**0.16**		**-0.62**
Percent Hispanic	**-0.27**			**0.49**
Component #1	**0.3**	**0.17**		**-0.63**

Non-parametric Spearman rank-order correlation coefficients between socio-economic predictors for 230 census tracts and (a) the total temporal variance in water consumption explained by all three climate variables, and the sensitivity of water consumption to changes in (b) temperature, (c) precipitation, and (d) PHDI (values significant at the 0.05 level are in plain text and those significant at the 0.01 level are in bold text)

Lot Sizes in Phoenix Declined After 1970 with Ramifications for Climate Sensitivity

Year	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Lot Size (m^2)	604	639	639	654	692	699	701	763	725	625	608

Conclusions:

Our study revealed that some census tracts have little-to-no sensitivity to weather and climate while in others 75% of the monthly variance in water use is explained by atmospheric conditions. Greater sensitivity to atmospheric conditions occurred in census tracts with large lots, many pools, a high proportion of irrigated mesic landscaping, and a high proportion of high-income residents. Low climatic sensitivity occurred in neighborhoods with large families and many Hispanics. Results suggest that more affluent, non-Hispanic neighborhoods will be disproportionately affected by increasing temperatures due to urban-heat-island effects and the buildup of greenhouse gases.

Policy Implications:

Factors that may lower climate sensitivity and make the city's water use more resilient in the face of climate change and urban heat island effects include:

- Higher densities
- Restrictions on irrigated landscaping
- Limitations on pools

Citation:

Balling, R.C., Jr., P. Gober, and N. Jones (Submitted). Sensitivity of residential water consumption to variations in weather and climate: An intra-urban analysis of Phoenix, Arizona, *Water Resources Research*.

Acknowledgment:

This material is based upon work supported by the National Science Foundation under Grant No. SES-0345945 Decision Center for a Desert City (DCDC). Any opinions, findings and conclusions or recommendation expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).