THE IMPACT OF HOMEOWNERS ASSOCIATIONS ON RESIDENTIAL WATER DEMAND MANAGEMENT IN PHOENIX, ARIZONA

V. Kelly Turner and Dorothy C. Ibes
School of Geographical Sciences and Urban Planning
Arizona State University

Abstract: In regulating residential landscaping and maintenance practices, homeowner associations (HOAs) are potentially important institutional actors in urban climate adaptation and water demand management. One view posits that HOAs will use outdoor landscaping and scarce water resources to maintain the aesthetic appearance and hence property values of homes in their domain. An alternative view from commons theory suggests that they will behave in a variety of ways and have diverse environmental resource management outcomes. This research compares water consumption in single-family residential communities with and without HOAs in Phoenix, Arizona. Findings reveal there is not a significant correlation between water consumption and presence or absence of HOAs, after accounting for other relevant variables. HOAs did not co-opt a disproportionate share of urban water use, lending credence to the claims of commons theory that similar institutional types may result in diverse resource outcomes, depending upon geographical and social context. Results suggest the potential to utilize HOAs as an entry point for water demand reduction strategies. [Key words: water management, residential landscapes, common properties, homeowners associations.]

INTRODUCTION

Water resources are the paramount environmental concern in the arid cities of the U.S. Southwest, where the coupled pressures of population growth (Gammage et al., 2008) and climate change increasingly stress limited existing supplies (Karl et al., 2009; Balling and Goodrich, 2010). Recently, there has been heightened awareness that the supply-side strategies currently favored for balancing supply and demand have reached a point of diminishing returns. For example, Colorado River supplies are overallocated, so the construction of larger dams does not appear to be a viable solution for increasing supply to meet current demands (Gober et al., 2010; Morehouse, 2000). Instead, new and innovative demand management strategies will be necessary if Southwest cities are to meet the water needs required to sustain large metropolitan regions (Gober et al., 2010; Gober and Kirkwood, 2010). Such innovation requires greater recognition of the relationship between water consumption and urban form, identifying the co-benefits of coordinating urban planning with water management. For example, implementing the urban growth boundary (UGB) in Portland, Oregon generates density—at least within the UGB—associated with lower

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2Correspondence concerning this article should be addressed to V. Kelly Turner, School of Geographical Sciences and Urban Planning, Arizona State University, P.O. Box 878209, Tempe, Arizona 85287-8209; telephone: 480-965-3367; fax: 480-965-8383; email: vkturner@asu.edu

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water consumption (Chang et al., 2010). In the past, demand management strategies in Phoenix have targeted individual households as well as municipal providers but, in so doing, have neglected the wide range of institutional actors that make decisions that impact urban water consumption. One set of neglected actors are the Homeowners Associations (HOAs) that have come to dominate new residential developments. This research explores the implications of the presence of HOAs for single-family residential water demand management in Phoenix, Arizona.

Reducing residential water consumption is a critical component of any demand management program. In the City of Phoenix, residential uses account for approximately half of all municipal water demand (Wentz and Gober, 2007), 70% of which can be attributed to outdoor uses, largely for pools and yard maintenance (City of Phoenix, 2010). In the past, passive demand management strategies such as educational campaigns and tax incentives (ibid.) have been favored over more aggressive policies such as water use bans and pricing mechanisms (Gober, 2006; Hirt et al., 2008). Residential water demand management policies and programs are predominantly voluntary and target individual households. In reality, decision-making occurs at multiple scales and among a variety of institutional actors, including HOAs, which heavily influence decision-making at the neighborhood scale.

HOAs have emerged as a dominant institution in the residential landscape across the United States. The presence of HOAs in the U.S. has increased dramatically—from 500 in the 1960s to 305,000 in 2009, a 600-fold increase in five decades (Community Associations Institute, 2010). The majority of new residential developments in Phoenix since 1985 have been governed by HOAs, defined as “a common interest organization to which all the owners of lots in a planned community … must belong” (Arizona, 2010). Property owners are dues-paying members of the HOA and are contractually obliged to follow the rules and regulations specified in a set of governing documents. These documents include covenants, codes, and restrictions (CCRs) that are legally enforceable, and the provisions contained in their text run permanently with the land. Modifying a CCR is difficult because changes usually require a supermajority of all property owners—not just those that actually vote—which is particularly problematic given investor-owners that do not actually reside in the community (McKenzie, 1994). In practice, therefore, CCRs are virtually immutable.

HOAs developed as a mechanism to control individual home aesthetics and preserve property values; as such, their CCRs may stipulate landscape structure and maintenance practices. For example, CCRs often contain clauses that require, permit, or prohibit a specific percentage and type of ground cover, particular plant species, and weed-free or green lawns (Cook et al., 2011). Such rules have implications for the water required to maintain particular structures. A non-random survey of HOAs (N = 35) in the Phoenix metropolitan area found that the number of CCRs containing clauses relating to landscape structure and management has increased since the 1960s; of the HOAs sampled, 77% regulated vegetation and pest management, 69% regulated water management, and 38% regulated species composition (Larson et al., 2008). HOAs, therefore, appear to exert

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3The process has been spurred in Phoenix by the desire of local developments to maintain a distinctive architectural appearance, thereby distinguishing them from neighboring areas from which they may be separated by walls, gates, and fences (e.g., Romig, 2010, p. 1067).
influence on landscape design and resource uses beyond the purview of public institutions and personal preference.  

Systematic assessments of the impact of HOAs on resource uses and the environment at large, especially as compared to non-HOA residences, are few. This situation is somewhat surprising given: (1) the large body of research in the social sciences linking HOAs—and the types of communities they govern—to the capture of a disproportionate share of municipal resources (Kennedy, 1995; Barry, 2002; Vesselinov et al., 2007); and (2) the rise of social-ecological perspectives in the study of urban residential landscapes (Robbins, 2007; Cook et al. 2011; House-Peters and Chang 2011). Each research domain offers a set of empirical and theoretical insights that implies the effects of HOA rules on environmental resource consumption. From urban social geography, we may conclude that the HOA is a monolithic institution created by and for the elite to protect property values through the control of municipal resources including, by extension, environmental resources. Recent developments in environmental commons research offer an alternative perspective, in which resource management reflects the complexity of the coupled systems of which they are a part (Ostrom, 2007, 2009). The so-called “commons perspective” predicts variability in environmental management and hence water demand among HOAs. This study offers a systematic, quantitative comparison of water demand by residences within and outside of HOAs in Phoenix. It asks: Do HOA households generate larger water demand than non-HOA households? Furthermore, it attempts to synthesize the advances of two relatively discrete domains of knowledge in the pursuit of a more robust theoretical guide for urban social-ecological research.

**HOA AND ENVIRONMENTAL RESOURCE MANAGEMENT**

With few exceptions, scholarly attention has ignored the role of HOAs as environmental resource management institutions. The authors are aware of only one published empirical example. Martin et al. (2003) found that residences with CCRs in Phoenix tended to have landscape designs associated with lower water use, although nearly half of the respondents in the associated HOAs expressed a preference for landscaping that included some portion of turf (ibid.). More generally, others have written about the wide range of actors and influences that shape residential outdoor space. Most notably, Robbins (2007) argues that the normative values of homeowners and the lawn care industry mutually construct a political ecology of lawn care with sometimes dubious environmental repercussions. Cook et al. (2011) synthesize the broad array of human and ecological factors that exert influence on residential landscapes as social-ecological systems, noting the potential impact of formal institutions, such as HOAs, on landscape management practices. In the absence of research that specifically addresses the environmental resource implication of HOAs, we turn to two discrete conceptual perspectives—social geography and environmental commons—to guide our empirical analysis of HOAs and water use in Phoenix.

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4 Although in theory, by deciding to purchase housing in HOA x or y one is exhibiting a preference, it is common for individuals to purchase a home without reading the CCRs of an HOA carefully. Furthermore, as fewer and fewer residences do not have HOAs, individuals are increasingly constrained in their choices in this matter.
HOAs and Public Goods

A wealth of literature across the social sciences and urban planning posits that HOAs, and the types of communities they govern, organize the urban landscape in ways that facilitate the capture of municipal resources. They do so by organizing residential areas in ways that enhance property values and offer protection from the volatility of the city at large. Flight from urban blight is certainly not a new phenomenon—social scientists have chronicled the ways in which the wealthy have sought to spatially distance themselves from urban ills since the beginning of the industrial revolution. Blakely and Schneider (1999) posit that private communities in general, and gated communities in particular, are the most recent and extreme manifestation of this recurrent theme. Private communities enhance segregation by controlling access, privatizing amenities, and erecting physical barriers in the pursuit of exclusivity (ibid.), protection of property values (McKenzie, 1994), and escape from perceived danger (Low, 2003).

Social scientists have documented several spillover effects associated with private residential communities, including the creation of informal subsidies, urban decline, and secession from civic responsibility. Often built at the city periphery, planned communities require an extension of municipal infrastructure and services such as roads, plumbing, firefighting, police, and schools, the cost of which is not always recovered through property taxes. In effect, the tax dollars of the inner city subsidize the development of these communities (Kennedy, 1995; Duany et al., 2000). This filtering of the wealthy into the periphery often leads to urban decline, as cities lack a sufficient tax base to provide the funds to maintain infrastructure and municipal services (Vesselinov et al., 2007; Duany et al., 2000). Increasingly, this conceptualization of the urban core declining as the wealthy move to the suburbs is too simplistic. Private communities are often situated adjacent to unprivatized properties; however, the effect on the distribution of municipal resources is similar. Members of private communities are taxed via HOA dues which fund services and amenities that financially strapped municipalities are less equipped to provide. Some municipalities actively encourage the development of private communities as surrogate providers of amenities such as parks and open space, yet there is a fundamental difference in that such places exclude the public at large and potentially discourage the development and maintenance of public civic spaces (Kennedy, 1995; Webster, 2001). Furthermore, a secessionist spirit has been documented among individuals in private communities, in which they retreat from civic responsibilities such as paying taxes and coalesce under the auspices of an HOA to rally against undesirable municipal decisions (Purcell, 1997).

By extension, it is reasonable to suppose that an additional, if not yet documented, effect might be that these communities command a disproportionate share of a city’s environmental resources as well. The HOA, acting as a monolithic arbitrator for the wealthy, facilitates the capture of resources for their needs. From a social geographic perspective, HOAs can be expected to positively correlate with resource use, commanding large quantities of municipal resources to maintain consumptive living conditions associated with wealth. HOAs, therefore, might be expected to demand a higher than average share of municipal water resources to maintain water-consumptive residential landscapes in order to elevate property values.
HOAs as Regulators of the Commons

Research on the governance of the commons suggests a more complex relationship between HOAs and environmental resources. HOAs can be conceptualized as managers of the commons. An environmental commons is a “natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use,” (Ostrom, 1990, p. 30). In this instance, the resource system is the municipal water supply, which is distinct from the resource units, which are quantities of water. There may be many individuals or firms that are beneficiaries, or “appropriators” of resource units, with access to the resource system. In Phoenix, these beneficiaries include industrial, agricultural, and residential users with access to municipal water resources. As a manager of the commons, HOAs influence the quantity of water appropriated to a particular beneficiary, the residential community, within the broader set of beneficiaries with access to the municipal water resource system.

Environmental commons research has examined a wide variety of resource systems operating at different scales with very different social and biophysical contexts and managing institutions, although the bulk of the foundational research is associated with topics such as rangelands (Swallow and Bromley, 1995) and fisheries (Berkes, 2009) in a local, rural, or developing-nation context, and global climate change research (Ostrom et al., 1999). Application of commons theory to local urban resource systems in developed nations—a less frequent, nevertheless emergent literature (Schlager and Blomquist, 2001; Acheson and Brewer, 2003; Hanna, 2003)—indicates that commons theory is generalizable to such resource systems.

Systematic research on the environmental commons has revealed that no particular institutional type guarantees a positive or negative outcome; there is no “one-size-fits-all” strategy that works best for all commons (Ostrom, 2007, 2009). Rather, environmental resource management outcomes are facilitated by institutions that are imbedded in particular contexts and facilitated by a variety of “deeper tier” variables (ibid.). In contrast, other work postulates that small-scale environmental decisions made in the absence of a collective agenda (e.g., commons or HOA) may lead to a “tyranny of small decisions” that generate resource depletion and other unintended consequences at broader scales (Odum, 1982, p. 782; Cooper et al., 2007). This process may seem particularly applicable in urban landscapes that tend to be highly fragmented in terms of urban form, ownership, and management (Grimm et al., 2008a, 2008b).

The view that HOAs represent a diverse set of environmental resource management goals and outcomes compliments “green” residential planning and design practices and movements such as Smart Growth, New Urbanism (Duany et al., 2000), transit-oriented development, Leadership in Energy and Environmental Design (LEED) certifications (Green Building Council, 2010), biodiversity and open-space conservation subdivisions (Arendt, 1996), and the incorporation of organic agriculture as a subdivision amenity (Applebaum, 2009). Such planned development schemes also often utilize CCRs to codify sustainability goals. Unfortunately, little work has linked the environmental and resource implications of these interests to the resource management potential of HOAs more broadly. Empirical evidence of environmental claims is limited and is not yet substantiated by long-term monitoring. Furthermore, empirical research connecting “green” projects to environmental resource theory is limited and ambiguous at best. For example,
Hurley and Halfacre (2009) found that the impact of “green” planning schemes can be both a benefit to some while a detriment to other users of the resource system. Their case study of exurban growth in South Carolina illustrates the ways in which a conservation of sweetgrass via subdivision development limited access to a common resource through privatization, thus excluding the local rural poor from harvesting basket-making resources, jeopardizing both their livelihoods and the preservation of a long-standing cultural practice. Several authors offer a critical perspective on the emergent phenomenon of sustainable urban development, arguing that such projects focus on local communities at the expense of a larger environmental project (Bjelland et al., 2006), fail to consider the broader socio-economic processes that facilitate decision-making (Veninga, 2004), and deploy a limited conceptualization of environmental services and amenities closely associated with middle-class American values (Zimmerman, 2001; Hurley and Halfacre, 2009). Such research illuminates the ambiguous outcomes associated with environmental resource management in private communities—intentionally striving to achieve sustainable outcomes or not.

In this paper we explore the extent to which the presence of HOA governance has influenced water demand in residential subdivisions in Phoenix, Arizona. Our primary question asks: Does single-family residential water use (annual household consumption) among residences in HOAs in Phoenix differ significantly from use in non-HOA residences and, if so, is this difference registered in overall outdoor water use? To address this question we examined the spatial distribution and extent of HOAs in Phoenix in relation to a set of social and biophysical determinants of water use.

DATA AND METHODS

Study Area

The Phoenix Metropolitan Area is located in the arid northern Sonoran Desert of the U.S. Southwest. The City of Phoenix, the largest of the 28 municipalities, covers some 1,228 sq. km and houses over 1.5 million residents (U.S. Census, 2006). The region receives an average of 21.1 cm of precipitation annually (NOAA, 2010). This supply is augmented by groundwater, local surface water from the Salt and Verde rivers, and by the Central Arizona Project Canal that delivers water from the Colorado River. Trends in population growth, sprawling development, reliance on non-renewable groundwater supplies, high water use rates, and a historic preference for water-intensive landscaping (e.g., in residential yards) have stressed the region’s already scarce water resources (Hirt et al., 2008). Residential landscapes in the region are typically classified as mesic (high water-use vegetation and turf grass), xeric (low water-use plants on granite), oasis (a mixture of mesic and xeric), or native (native Sonoran vegetation) (CAP-LTER, n.d.). The water-consumptive species of mesic landscaping are often associated with elevated water demand. In some instances, however, inefficient water management practices elevate water consumption in other residential landscape types (Stabler and Martin, 2000). In this context, the rising number of HOAs that regulate residential landscape management practices raises concerns about their impact on water use in the region.
This study focused on HOAs zoned solely as single-family residential, as this dwelling type accounts for nearly three times the water demand of multi-family units (Wentz and Gober, 2007). Thousands of non-profit corporations are registered as HOAs in the City of Phoenix, but current listings of HOAs are not spatially explicit. Further, available contact information usually refers to the location of off-site management companies that are often responsible for multiple HOAs in different residential subdivisions. This lack of spatial information has therefore prevented the analyses of HOA locations in relation to patterns of household water demand. Therefore, the first task of this research required mapping the locations and extent of HOA communities across the region. Data used for this step included a GIS data layer, obtained through the Maricopa County Recorder’s Office, depicting subdivision boundaries for residential communities with and without HOAs as well as other subdivided land uses across the county (Table 1). Subdivisions with CCRs filed with the Maricopa County Recorder’s Office were tagged as HOAs.

Previous research has linked household water demand to household size (number of people that occupy home), lot size, the presence of pools, and type of landscaping (Wentz and Gober, 2007). The most consumptive households are those with relatively more people on larger lots that maintain a private pool and mesic yard (grass lawns and non-native vegetation, mostly shrubs and trees). Affluence also has been linked to increased household water consumption (Harlan et al., 2009; see also Balling et al., 2009), although this may be an indirect correlation as wealthier households tend to maintain swimming pools and larger lots (Wentz and Gober, 2007). Furthermore, HOAs have been linked empirically (La Goix, 2005) and qualitatively (McKenzie, 1994) to wealthy, white populations.

Based on these studies, we analyzed the following independent variables as determinants of our dependent variable, water demand: average household size (i.e., number of people living in a single residence), income, race, lot size, presence of pools, and landscaping type (Table 1). Home age was added because newer homes often possess drip irrigation systems that may significantly reduce water demand for landscaping (Gleick, 2000). The

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**Table 1. Variable Attributes**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Source</th>
<th>Spatial scale</th>
<th>Temporal scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Hispanic</td>
<td>U.S. Census Bureau</td>
<td>Census block group</td>
<td>2000</td>
</tr>
<tr>
<td>Percent white</td>
<td>U.S. Census Bureau</td>
<td>Census block group</td>
<td>2000</td>
</tr>
<tr>
<td>Median income</td>
<td>U.S. Census Bureau</td>
<td>Census block group</td>
<td>2000</td>
</tr>
<tr>
<td>Mean household size</td>
<td>U.S. Census Bureau</td>
<td>Census block group</td>
<td>2000</td>
</tr>
<tr>
<td>Mean home age</td>
<td>Maricopa County</td>
<td>Parcel</td>
<td>2006</td>
</tr>
<tr>
<td>Mean lot size</td>
<td>Maricopa County</td>
<td>Parcel</td>
<td>2006</td>
</tr>
<tr>
<td>Percent pools</td>
<td>Maricopa County</td>
<td>Parcel</td>
<td>2006</td>
</tr>
<tr>
<td>Mean NDVI&lt;sup&gt;a&lt;/sup&gt;</td>
<td>CAP-LTER, n.d. [2011?],</td>
<td>n.a.</td>
<td>2005</td>
</tr>
<tr>
<td>HOA coverage</td>
<td>original: digitized</td>
<td>n.a.</td>
<td>2009</td>
</tr>
</tbody>
</table>

<sup>a</sup>Normalized Difference Vegetation Index.

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**Data**

This study focused on HOAs zoned solely as single-family residential, as this dwelling type accounts for nearly three times the water demand of multi-family units (Wentz and Gober, 2007). Thousands of non-profit corporations are registered as HOAs in the City of Phoenix, but current listings of HOAs are not spatially explicit. Further, available contact information usually refers to the location of off-site management companies that are often responsible for multiple HOAs in different residential subdivisions. This lack of spatial information has therefore prevented the analyses of HOA locations in relation to patterns of household water demand. Therefore, the first task of this research required mapping the locations and extent of HOA communities across the region. Data used for this step included a GIS data layer, obtained through the Maricopa County Recorder’s Office, depicting subdivision boundaries for residential communities with and without HOAs as well as other subdivided land uses across the county (Table 1). Subdivisions with CCRs filed with the Maricopa County Recorder’s Office were tagged as HOAs.
first three variables were drawn at the level of the census block group from the 2000 United States census. Data for home age, lot size, and pools were obtained through the Maricopa County Assessor at the parcel level, and later converted to the census block group level. Landscaping type was drawn from extant examinations of NDVI (Normalized Difference Vegetation Index) derived from a 2005 Landsat TM image (Buyantuyev, 2007).\(^5\) NDVI is a measure of “greenness” capturing distinctions between areas dominated by grass, shrubs, and trees from, for example, desert, bare soil, and impervious surfaces.

Water demand data used in this study were obtained from the City of Phoenix and represent the average amount of water used (in CCF, or cubic hundred feet) by single-family households during 2006 by census block group \((n = 997)\). Demand data do not distinguish in- and outdoor use, although 70% of single-family residential water use involves outdoor uses such as landscaping and pools. The role of indoor water use is captured in the determinants of water demand, as there is evidence of a high correlation between the number of people in a household and indoor water use \((R^2 = 0.9994)\) (Mayer et al., 1999, p. 90); thus the inclusion of the variable household size can be said to act as a control for indoor use. Although nearly 40% of residential water consumption occurs during the summer months (Wentz and Gober, 2007), annual single-family water demand data capture total demand on water supply, inclusive of seasonal variations.

Methods

Based on the spatially explicit dataset of all subdivision boundaries in Maricopa County, all single-family residential subdivisions with CCRs were coded as belonging to an HOA, while single-family subdivisions without a CCR were coded as non-HOA in kind. All other types of subdivisions (e.g., commercial, industrial, mixed-use, schools, churches) were removed from the dataset. The independent variable used in the regression model was the percentage area of HOA and non-HOA single-family residences within each census block group. All other data also were aggregated to the common scale of the census block group to allow for valid comparisons among variables.

Analysis

Our analysis consisted of several steps: Pearson’s correlations, factor analysis, stepwise regression, and validity tests. Again, all variables, including percent coverage of HOAs, were analyzed at the census block group level. We first ran two sets of bivariate correlations to determine if there was a relationship between the independent variables and (1) percent of the census block group zoned as single-family residential and belonging to an HOA, and (2) mean annual water demand (during 2006) for single-family households. Next, we conducted a factor analysis in order to address multicollinearity issues among our independent variables. We then created a stepwise regression model to quantify the added predictive capacity, if any, of HOAs in determining water consumption. Finally, we conducted a series of validity tests based on our data manipulation, aggregating all data to the census block group scale.

\(^5\)NDVI values (range –1 to 1) were computed as follows: \((\text{NIR} – \text{RED})/(\text{NIR} + \text{RED})\), where NIR (near infrared) is the TM band 4 (0.76–0.9 micrometers) and RED is Band 3 (0.78–0.82 micrometers).
Next, to address our principal question—do HOAs capture a larger share of water resources than their non-HOA counterparts—we employed a stepwise multiple regression model to examine the added predictive capacity of incorporating HOAs into a list of determinants of water demand. The dependent variable was defined as the mean annual water demand for single-family households within a given census block unit. The nine independent variables included percent HOA coverage, median income, mean NDVI value, mean home age, mean lot size, percent of homes with a pool, and the mean household size by census block group. For the purpose of analysis, all variables were aggregated to the census block. To avoid issues of multicollinearity, we ran a factor analysis on all of the independent variables excluding percent HOA coverage, because our primary purpose was to uncover its added predictive capacity. We then ran a second regression model using the extracted factors.

Recognizing that one of our data limitations involved translating the geographic boundaries of the HOAs into percentages per census block, the final step of the analysis was a validity test to determine if this data manipulation altered our results for the City of Phoenix as a whole. To test this we compared descriptive statistics for census blocks with 100% HOAs versus those without any HOAs in order to determine if our results were affected by the presence of HOA and non-HOA communities in the same census block. If we establish that mean water consumption in census blocks with 100% HOAs and no HOAs reflects our findings for all census blocks, we will have added confidence that our manipulation of the data did not impact the integrity of our results.

RESULTS

This study provides the first mapping of single-family HOA subdivisions for the City of Phoenix (Fig. 1), along with the following descriptive information. The City of Phoenix has approximately 6,000 single-family residential subdivisions, some 27% (\( n = 1,642 \)) of which are governed by HOAs. While HOAs comprise a minority of these subdivisions in number, they constitute a majority of the residential land area. Single-family residential subdivisions consume approximately 37% of the total land area in the City of Phoenix, 64% of which is governed by HOAs. Spatially HOAs tend to be located on the periphery of the city (Fig. 1). This study also classified census block groups by the percentage of residential subdivisions governed by HOAs (Fig. 2). Again, larger, more recently developed areas around the periphery of the city tended to contain relatively more HOA subdivisions than did more centrally located block groups. This observation raises concerns that the percent HOA variable is affected by spatial autocorrelation, which could amplify the observed relationships between independent variables and annual household consumption. In order to address this concern, we tested for spatial autocorrelation among census block groups with HOAs by calculating Moran's \( I \). We found that spatial clustering of census block groups by percent HOA was not statistically significant at a 0.05 significance level (\( z \)-score 0.397, \( p \)-value 0.691).

In a Pearson’s correlation test, percent HOA-governed residential subdivisions in each census block group (CBG) had a weak but significant correlation with annual single-family household water consumption (0.063), a moderate correlation with percent white (0.261) and median income (0.299), and a weak correlation with household size (0.186).
Percentage HOA area was negatively correlated with percent Hispanic (–0.292) and mean home age (–0.495) (Tables 2 and 3). The strongest relationship was the negative correlation between HOAs and older homes. These findings suggest that members of HOAs tend to be wealthier, white, non-Hispanic populations that live in newer homes with pools. The weak correlation between HOAs and more water-intensive lifestyles suggests that the relationship is less straightforward. HOAs were not significantly correlated with NDVI or “greenness,” nor were lots in HOAs significantly larger than lots in non-HOA neighborhoods.

Fig. 1. Single-family residential subdivisions with and without HOAs.
In addition to the weak positive correlation with percent HOA (0.063), single-family household water consumption had a strong positive correlation with median income (0.687) and a moderate positive correlation with percent white (0.321), percent pools (0.264), and lot size (0.175). Demand was negatively correlated with percent Hispanic (−0.297), and the age of the home and household size were not significant determinants of household water consumption. These results indicate that higher water demand tends to be a characteristic of higher income, white populations with greener lawns, more pools, and larger lots, while lower demand is more characteristic of Hispanic populations (Tables 2 and 3).
Many of our independent variables are correlated. Therefore, to address issues of multicollinearity, we ran a factor analysis on all of our independent variables excluding percent HOA, because our primary research question seeks to discover its added predictive capacity. Our analysis generated two factors that appear to cluster those variables associated with socioeconomic status and also those associated with outdoor home features. Factor 1 included percent Hispanic (0.923), income (–0.775), household size (0.631), and home age (0.558) (Table 4). Factor 2 included lot size (0.651) and NDVI (0.503). Percent pools was not included in either factor. Next, we ran an additional regression model using Factor 1, Factor 2, percent pools, and percent HOA. We found that Factor 1 and Factor 2 explained

**Table 2. Pearson’s Correlations: Percent Coverage of HOAs and Social and Biophysical Determinants of Water Demand by Census Block Group (n = 992)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percent HOA</th>
<th>Household water demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent HOA</td>
<td>1</td>
<td>0.063*</td>
</tr>
<tr>
<td>Household water demand</td>
<td>0.063*</td>
<td>1</td>
</tr>
<tr>
<td>Household size</td>
<td>0.186**</td>
<td>–0.018</td>
</tr>
<tr>
<td>Income</td>
<td>0.299**</td>
<td>0.687**</td>
</tr>
<tr>
<td>NDVI</td>
<td>0.033</td>
<td>0.268**</td>
</tr>
<tr>
<td>Home age</td>
<td>–0.495**</td>
<td>–0.034</td>
</tr>
<tr>
<td>Lot size</td>
<td>–0.058</td>
<td>0.175**</td>
</tr>
<tr>
<td>Percent pool</td>
<td>0.165**</td>
<td>0.264**</td>
</tr>
<tr>
<td>Percent Hispanic</td>
<td>–0.292**</td>
<td>–0.297**</td>
</tr>
<tr>
<td>Percent white</td>
<td>0.261**</td>
<td>0.321**</td>
</tr>
</tbody>
</table>

*p > 0.05; **p > 0.01.

**Table 3. Pearson’s r Correlations for Census Block Groups (n = 992)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pct. HOA</th>
<th>Household water demand</th>
<th>HH size</th>
<th>Income</th>
<th>NDVI</th>
<th>Home age</th>
<th>Lot size</th>
<th>Pct. pool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pct. HOA</td>
<td>1</td>
<td>–</td>
<td>–</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Household water demand</td>
<td>0.063*</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Household size</td>
<td>–0.009</td>
<td>–0.060</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Income</td>
<td>0.299**</td>
<td>0.687**</td>
<td>–0.174**</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>NDVI</td>
<td>0.033</td>
<td>0.268**</td>
<td>–0.103**</td>
<td>0.288**</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Home age</td>
<td>–0.495**</td>
<td>–0.034</td>
<td>0.186**</td>
<td>–0.405**</td>
<td>–0.058</td>
<td>1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Lot size</td>
<td>–0.058</td>
<td>0.175**</td>
<td>0.037</td>
<td>0.080*</td>
<td>0.126**</td>
<td>0.042</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>Pct. pool</td>
<td>0.165**</td>
<td>0.264**</td>
<td>–0.066*</td>
<td>0.403**</td>
<td>0.162**</td>
<td>–0.093**</td>
<td>0.058</td>
<td>1</td>
</tr>
</tbody>
</table>

*p > 0.05; **p > 0.01.
a majority (65%) of the variance. Percent pools and our variable of interest, percent HOA, provided nominal explanatory value (less than 2 and 1 percent, respectively) (Table 5).

Our findings are potentially affected by the conversion of our variable of interest, HOA, into percent HOA per census block group unit. In doing so, our results may no longer reflect the influence of HOAs but may be more a reflection of characteristics associated with the block group boundary or heterogeneity caused by the presence of HOAs and non-HOAs together in a CBG. Therefore, to verify that our results with regard to household water demand were not skewed by the conversion from subdivision boundary to census block groups, we ran descriptive statistics and created histograms for two subsets of the data: (1) census block groups in which all residential subdivisions were governed by HOAs \( (n = 129) \); and (2) census block groups without any residential HOAs \( (n = 102) \) (Figs. 3 and 4). Only minor variations were found. The \( n \)-values and mean water use for both sets of data were similar and demand was highly variable in both cases. Mean water use in CBGs with 100% HOAs was 183 gallons per capita per day (GPCD) with a standard deviation of 43.9, and demand in non-HOA block groups was 168 GPCD with a standard deviation of 41.2. Water demand in non-HOA block groups were slightly more skewed and among HOA block groups the minimum unit of consumption \( (n = 87) \) was more than twice that of non-HOA block groups \( (n = 42) \). The minor variations in these two datasets therefore add validity to our findings with regard to the entire dataset.

**DISCUSSION**

Despite positive correlations between income and HOAs, income and water consumption, and the fact that income explains a large percentage of the variation in water demand, HOAs did not exhibit a strong significant correlation with water demand. This finding may be a function of differences between those determinants of water demand associated with wealth and those associated with HOAs. High income is associated with newer homes, more pools, and “greenness”; however, HOAs are only weakly correlated with more pools and are not correlated with NDVI, although they are correlated with newer homes. The weaker correlation between HOAs and pools compared to income and pools may reflect the prevalence of community pools—as opposed to private, backyard pools—in developments with HOAs. Second, unlike income, HOAs were not significantly correlated with NDVI.

This finding indicates a diversity of landscaping treatments throughout the City of Phoenix. Such diversity reflects an increase in the popularity of desert landscaping aesthetics beginning in the late 20th century, as well as land use and water legacies. For example, some neighborhoods are able to maintain green lawns year round through flood irrigation or “grandfathered” water rights from previous, agricultural land uses. Furthermore, mid-century desert oasis (green lawns) aesthetics are protected in historical neighborhoods. These older neighborhoods may utilize voluntary neighborhood associations that are institutionally different than HOAs and were not included in our study. Alternatively, communities with HOAs may utilize common space as private parks in lieu of lawns on individual lots. Different correlations with pools and NDVI, both of which are determinants of water demand, may account for a lack of correlation between HOAs and water use via wealth.
Yet another potential explanation lies in the lack of association between HOAs and lot size. Larger lots are associated with higher water consumption. However, HOAs have a weak, but significant, negative correlation with lot size. This finding reflects the diversity of the built environment and urban forms now developed in communities with HOAs.
Furthermore, developers may have an incentive to create communities with smaller lot sizes in order to increase the number of units available for sale and, therefore, profit. Smaller lots may be supplanted with common space like pocket parks and community pools, therefore contributing to the lack of association between HOAs and NDVI (see above).

The strong relationship between HOAs and newer homes as well as income and newer homes, paired with a lack of significant correlation between new homes and water use, points to further distinctions. The average home in an HOA is younger than those in non-HOAs, and thus they may be more likely to possess water-efficient infrastructure, such as drip irrigation technology, as opposed to inefficient surface irrigation. The benefits of water-efficient technology, however, may be tempered by trade-offs with other factors that increase water consumption. Our results indicate that there is a preference for new homes, in HOAs, among wealthier individuals, but that high water demand in newer homes is more a function of wealth than location within an HOA. Further, water-saving technologies in newer homes may be offset by high water use among wealthier households as well as the fact that outdoor water use constitutes the majority of residential demand. Additionally, newer developments, especially those built on the periphery of the city, may be more likely to utilize native desert landscaping because of shifting consumer preferences, proximity to open-space desert preserves, and state and municipal regulations on plant material and land cover. On the other hand, desert landscapes also require water inputs and overwatering may be commonplace (Stabler and Martin, 2000). It is also possible that newer homes tend to be larger than older homes and therefore require more indoor water use. These questions offer potential for further research.

Fig. 3. Histogram of block groups in which 100% of the subdivisions are governed by HOAs.
HOAs consume a larger percentage of single-family residential land than non-HOAs and tend to be concentrated at the city periphery. Intuitively, this may reflect the fact that larger, less expensive tracts of land are available for development at the periphery than in the older, central city. Logic dictates that the typical residential development at the periphery is newer and wealthier, with larger lots and more amenities like pools and green space relative to typical residential areas in the central city. These would be expected to be older homes on small lots with fewer amenities such as pools and green space. There are several notable exceptions to such one-dimensional descriptions of urban form that may explain the weak correlations that create ambiguity in our findings. Examples of non-HOAs in the periphery include older, lot-by-lot “stick-built,” communities, retirement communities, large single-owner estates, and platted subdivisions that have not yet been completed and lack registered CCRs. Within the central city, there are 18 historic districts and many neighborhood associations that are voluntary and institutionally distinct from HOAs, but may function informally in ways that impact water demand. For example, in historic neighborhoods with a legacy of green lawns, residents may follow informal “rules” to maintain them rather than convert to desert landscaping in order to reduce water consumption. Such exceptions add to the complexity of the residential landscape in the city.

The possibility that some HOAs manage residential landscapes in ways that provide preferred outcomes through efficient use of water suggests that the HOA may be an important institution in water demand management in the future. For example, policies may be introduced that encourage the participation of HOAs in informational campaigns, retrofitting landscaping and irrigation infrastructure, halting winter seeding, and other water demand reduction strategies. While the potential for HOAs to act as an entry point for
residential water demand management is significant, there are several barriers. The most significant barrier, perhaps, is the difficulty in changing the CCRs commensurate with needed improvements or changes in resource and landscape use. Supermajority votes are likely to be especially difficult in changes involving financial costs, such as retrofitting lawns to deserts. The coupled effect of immutable CCRs and the legacy of the original “yardscapes” may constitute a significant obstacle for water demand reduction strategies. Finally, water demand management in HOAs potentially affects water supplies for the city at large. HOAs tend to be home to wealthy, white populations more capable of absorbing water costs than less wealthy populations, the lower socio-economic strata of which do not live in HOAs. This raises significant social and environmental justice questions. The City of Phoenix has a relatively diverse water portfolio, and water availability and price has not yet become a significant impending threat. In peripheral communities with less diverse portfolios and less availability, however, the water consumption habits of wealthy inhabitants, HOA members or not, is a potential concern.

This study found that census blocks with high percentages of HOAs are correlated with higher water use, but the correlation was weak and the variable did not surface in the step-wise regression. Furthermore, census blocks comprised entirely of HOAs exhibited high deviance from the mean water demand. These differences may reflect heterogeneity in the institutional structure and dynamics of different HOAs, as well as the importance of the broader social-environmental context in which landscaping and management decisions are made. Our finding that census blocks comprised entirely of non-HOAs also exhibit deviance from mean water demand may reflect a legacy of uneven development in historic, central Phoenix (Bolin et al., 2005). Downtown Phoenix is characterized by large, irrigated turf lots in wealthier neighborhoods and a lack of landscaping altogether in the less affluent South Phoenix neighborhoods. More research is necessary to characterize the diversity within both HOAs and non-HOAs and identify the mechanisms driving these differences.

Data Limitations

We recognize that our research was limited by several data and analytical barriers. We were unable to use the physical bounds of the HOAs to determine correlations with the other variables, primarily because the scale at which they were reported was mismatched with our subdivision boundaries. It was not feasible to translate the parcel- and raster-level data to the scale of the subdivision given the large n-value for our HOAs and non-HOAs. Furthermore, water use represents politically sensitive information in the Southwest and, much like census data, reporting of water demand must be aggregated to protect the identity of the users. We compensated for these shortcomings by separating out those census blocks that were entirely composed of HOAs or non-HOAs. Our study is also limited by our scope. HOAs are a prominent fixture in the suburbs of sprawling metropolitan areas like Phoenix and differences between communities with and without HOAs may be more

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Footnote: While it is beyond the purview of this paper, it is worth noting that our findings empirically connecting HOAs to white, wealthy populations raises concerns about public service and amenity distribution. Municipalities often encourage the development of HOA communities as a mechanism to subsidize public services such as trash collection and pools via privately collected HOA dues. These services provided through HOAs are not necessarily extended to the broader community.
pronounced there. Further, this analysis focused only on single-family residential HOAs, excluding analysis of mixed-use or multi-family residential HOAs that may exhibit different relationships among the variables. Finally, given the variety of HOA governing documents and potential incompleteness of the Maricopa County Recorder’s Office records, our definition of HOAs as subdivisions with CCRs may have led to the exclusion of some HOAs.

CONCLUSION

Our findings appear to reject a conceptualization of HOAs as monolithic institutions driving high levels of resource consumption as evidenced in the weak, but significant, correlation between HOAs and water use. Our findings suggest that HOAs may not necessarily lead to increased water use by single-family home residents, despite speculation that they do, and despite significant relationships with determinants of water demand relative to non-HOA units. In order to explain this apparent contradiction we look to a conceptualization of HOAs as managers of the environmental commons in a coupled social-ecological system. In operation, HOAs are a diverse set of institutional actors that negotiate a complex set of trade-offs and synergies associated with the determinants of water demand in residential landscapes in the City of Phoenix. The ways in which specific rules and regulations associated with different types of HOAs facilitate or constrain water demand management merits further research.

The importance of HOAs as environmental resource management institutions on the residential landscape cannot be understated. Indeed, HOAs are spatially dominant in newly developed areas on the periphery of Phoenix and virtually all new residential developments utilize CCRs, providing an additional layer of governance to municipal and state regulations, including those applied to landscaping and maintenance practices. As managers of a common resource, our research suggests that, in aggregate, HOAs do not necessarily significantly alter water consumption as compared to communities without HOAs. This finding is consistent with recent developments in commons theory that state that no institutional type in of itself guarantees a particular management outcome. A more robust understanding of management outcomes lies in understanding a “deeper” set of variables associated with social-ecological systems. Despite the uncertain findings of our research, HOAs are nonetheless influential water demand management institutions as they govern some 64% of residentially zoned land in Phoenix (nearly 786 km$^2$) and will, most likely, continue to proliferate and include landscaping management clauses in their CCRs. It is critical, therefore, to explain the mixed results of this study: an increased percentage of HOA area only weakly correlates with higher levels of residential water demand and did not increase the predictive capacity of regression models in determining residential water demand. We argue that in order to explain this variance it will be critical to continuing incorporating insights from commons and social-ecological theory into the study of HOAs—a topic that has largely remained in the social science research domain—in order to unpack the specific rules and regulations that influence demand for water resources.

We offer several points of departure in this endeavor. Commons theory has identified a suite of variables related to resources, resource systems, resource users, and management as well as the ways in which they interact that have consistently proven important to understand environmental resource management outcomes in empirical research (Ostrom, 2009).
The CCRs pertaining to landscaping and management of HOAs are an important resource for such analysis. Additionally, commons scholars and social-ecological research more broadly have identified adaptive management strategies as the best institutional “fit” for resource management under prevailing uncertainty. Presuming water stress will continue to unfold in the southwestern U.S., the apparent uncertainty associated with water-climate models, and the relative difficulty in altering community CCRs, the quantification of their impacts on water consumption are of paramount concern. In this institutional climate, a greater understanding of the trade-offs associated with water consumption in residential landscapes may be necessary in order for individual HOAs to identify and target efforts toward the demand management strategies most applicable to their needs.

In addition, our finding that HOAs do not ubiquitously command a disproportionate share of water resources may reveal the untapped potential to utilize HOAs for neighborhood-scale water demand management. Municipalities could facilitate such opportunities in new developments by creating financial incentives for developers to incorporate water demand management into new CCRs. Because HOA developments are already dominant in Phoenix and in many other parts of the country, it is imperative to find creative ways to retrofit existing HOAs with water-efficient landscaping and infrastructure and to overcome legal barriers by redrafting CCRs where appropriate. Furthermore, HOAs might be targeted for partnerships with government agencies already involved in water demand management. Finally, HOAs can adopt principals associated with existing programs such as the Sustainable Sites Initiative (SSI) or Leadership in Energy Efficiency Design for Neighborhood Development (LEED-ND) that guide sustainable land use and management practices. These opportunities require that HOAs move beyond a narrow goal of protecting property values through aesthetics, and incorporate other quality-of-life components into their management agendas.

REFERENCES


