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Social–Spatial Analyses of Attitudes toward the Desert in a Southwestern U.S. City

Riley Andrade, [*] Kelli L. Larson, [†] David M. Hondula, [*] and Janet Franklin [‡]

[*]*School of Geographical Sciences and Urban Planning, Arizona State University*
[†]*School of Geographical Sciences and Urban Planning and School of Sustainability, Arizona State University*
[‡]*Department of Botany and Plant Sciences, University of California, Riverside*

Land change due to urbanization often results in the loss of desert ecosystems. The loss of desert land affects ecological and social processes in arid cities, such as habitat provisioning, the extent and intensity of the urban heat island, and outdoor recreation opportunities. Understanding the human–environment dynamics associated with environmental change is critical to understanding and managing the implications of urban growth. Few studies, however, have empirically examined people's attitudes about hot, arid environments such as deserts. The primary objectives of our study are to (1) identify how patterns of attitudes are spatially distributed throughout neighborhoods in metropolitan Phoenix, Arizona, and (2) determine how attitudes toward the desert are shaped by social and environmental attributes. We found that desert attitudes are spatially clustered throughout neighborhoods. Positive views of the desert are fortified in high-income areas and those near preserved desert parks, whereas negative attitudes are clustered in areas associated with lower socioeconomic status and in neighborhoods with relatively grassy landscaping. Negative perceptions toward the desert are stronger among Latino residents and in low-income neighborhoods, where environmental hazards, especially extreme heat, and the perceived risks associated with such hazards are more prominent. Overall, we found that factors shaping attitudes in arid landscapes, including socioeconomic status and social identity, are similar to those that shape attitudes toward urban forests and greenspace in more temperate environments. Understanding attitudes toward the desert can help strengthen the connection between the regional environment and the local community, ultimately encouraging land preservation in arid cities. *Key Words: deserts, environmental attitudes, extreme heat, open space, vulnerability.*

由城市化造成的土地变迁，经常导致沙漠生态系统的丧失。沙漠土地的丧失影响乾燥城市的生态与社会过程，诸如栖地供给、城市热岛的范围与程度，以及户外休憩的机会。理解与环境变迁相关的人类—环境动态，对于了解并管理城市成长的意涵而言至关重要。但在经验上检视人们对于诸如沙漠的乾热环境之态度却相当少见。我们研究的主要目标在于（1）指认态度模式如何在空间上分佈于亚利桑那凤凰城大都会的邻里，以及（2）判定对沙漠的态度如何通过社会与环境属性形塑之。我们发现，对沙漠的态度在所有的邻里空间上产生聚集。对于沙漠的正面观点，在高所得地区与邻近保存的沙漠公园地区中证实，而负面态度则聚集在较低社会经济地位的地区和相对而言较多草原地景的邻里中。对沙漠的负面观点，在拉丁裔与低所得邻里中较强，而环境灾害——特别是极端酷热，以及与该灾害相关的风险认知亦较强。总体而言，我们发现形塑乾燥地景中的态度之因素，包括社会经济身份与社会身份认同，与形塑较温和的环境中对于城市森林和绿地空间的态度之因素相似。理解对沙漠的态度，有助于强化区域环境和邻里社区之间的连结，最终并鼓励乾燥城市中的土地保育。 *关键词：沙漠，环境态度，极端酷热，开放空间，脆弱性。*

La transformación de la tierra originada en la urbanización a menudo resulta en la pérdida de los ecosistemas del desierto. La pérdida de tierra del desierto afecta los procesos ecológicos y sociales en las ciudades de climas áridos, tales como la provisión de hábitat, la extensión e intensidad de la isla de calor urbano y las oportunidades de recreación al aire libre. Entender las dinámicas humano–ambientales asociadas con el cambio ambiental es crítico para entender y manejar las implicaciones del crecimiento urbano. Pocos estudios, sin embargo, han examinado empíricamente las actitudes de la gente acerca de entornos cálidos y áridos como los desiertos. Los objetivos primarios de nuestro estudio son (1) identificar cómo los patrones de actitudes se distribuyen espacialmente a través de los vecindarios en el área metropolitana de Phoenix, Arizona, y (2) determinar cómo se configuran las actitudes hacia el desierto por atributos sociales y ambientales. Hallamos que las actitudes hacia el desierto están aglomeradas espacialmente a lo largo y ancho de los vecindarios. Las visiones positivas del desierto se fortifican en las áreas de alto ingreso y en aquellas

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cerca de parques preservados del desierto, en tanto que las actitudes negativas se agrupan en áreas asociadas con estatus socioeconómico más bajo y en vecindarios dotados de paisajes relativamente herbosos. Las percepciones negativas hacia el desierto son más fuertes entre los residentes latinos y en los vecindarios de ingreso bajo, donde los riesgos ambientales, en especial calor extremo, y los riesgos percibidos asociados con tales riesgos, tienen mayor prominencia. En general, descubrimos que los factores que configuran las actitudes en paisajes áridos, incluyendo el estatus socioeconómico y la identidad social, son similares a los que configuran las actitudes hacia los bosques urbanos y el espacio verde en entornos más templados. Entender las actitudes hacia el desierto puede ayudar a fortalecer la conexión entre el medio ambiente regional y la comunidad local, finalmente estimulando la preservación de la tierra en las ciudades áridas. *Palabras clave: actitudes ambientales, calor extremo, desiertos, espacio abierto, vulnerabilidad.*

Urban development has led to changes in land use and land cover, often resulting in the loss of native ecosystems and increased fragmentation of habitat patches (Foley et al. 2005). This trend exists in rapidly growing cities in the southwestern United States (York et al. 2011), where development has increasingly occurred in fringe areas of a metropolitan region (Kane, Connors, and Galletti 2014). For example, in the southwestern city of Phoenix, Arizona, rural residences were built out in a "leapfrog pattern"—preserving open desert land at intermediate stages of development—followed by the infill of urban land use in desert open space over time (Keys, Wentz, and Redman 2007). This pattern of development allowed large swaths of desert land to be preserved at intermediate periods of growth. More recently, however, conversion of land to urban uses has shifted to the desert, including low-density residential development along the fringe areas of the metropolitan region, leading to high rates of land and habitat fragmentation (Shrestha et al. 2012). These shifts in land development are crucial because the associated environmental changes affect ecological and social processes and outcomes (van Vliet et al. 2016), including habitat provisioning (Seto, Güneralp, and Hutyra 2012), the extent and intensity of the urban heat island (Brazel et al. 2000; Zhang et al. 2013), and opportunities for outdoor recreation (Metzger et al. 2006). In general, understanding the human–environment dynamics associated with environmental change and land preservation in cities is critical to understanding and managing the implications of urban growth.

As a result of global climate change, a growing proportion of people in cities will be exposed to extreme heat, drought, and cascading hazards (Turner et al. 2003; McCarthy, Best, and Betts 2010), with vulnerable groups being disproportionately affected (Boone 2010; Malakar and Mishra 2017). Heat, flood, drought, and other measures of climate variability are already viewed as being among the largest risks to livelihood strategies in arid environments (Bunting et al. 2013). Socioecological shifts caused by land use and land cover conversion are significant in the context of global climate change, because they structure the impacts of extreme environmental conditions (Jenerette et al. 2011; Lindberg and Grimmond 2011; Li et al. 2017). Although land change research has shown that low-income and minority groups experience heightened exposure to environmental risks such as heat stress (Harlan et al. 2013), little is known about what people—including underrepresented groups—think about hot, arid environments such as deserts.

People might not be receptive to the creation of open space in their neighborhoods if they hold negative attitudes about the desert—despite the importance of desert lands for the overall ecosystem functioning of an arid landscape. Although deserts are often seen as harsh wastelands devoid of life (Nash 1967), these arid biomes support important ecosystem services (Kroeger and Manalo 2007). In the context of biodiversity conservation and land preservation, attitudes have been shown to act as a moderator (but not a direct driver) between experiences and environmental decisions (Barr and Gilg 2007; van Vliet et al. 2015; Soga et al. 2016). Therefore, understanding the attitudinal patterns of urban residents is a step toward providing more equitable desert open space in ways that benefit and are supported by the local community (Pincetl and Gearin 2005; Fainstein 2018). Geographers have long contributed to understanding environmental attitudes and, in particular, are uniquely poised to study such human–environment interactions due to integrated consideration of social, ecological, and spatial dynamics that affect them (Brown et al. 2004; Kates, Parris, and Leiserowitz 2005; Larson and Santelmann 2007).

Research on desert landscapes, including people's attitudes or interactions with them, is underrepresented in geography literature compared to more temperate systems (Ibes 2016). In addition, the human–environment geography literature has paid far less attention to cities in the United States compared to research in rural areas outside of North America and in the Global South (Robbins 2002; Walker 2003; Gustafson et al. 2014). Therefore, we fill this research gap by examining attitudinal patterns toward the desert, specifically by asking these questions: (1) How do spatial patterns of neighborhood characteristics affect the distribution and orientation of attitudes toward the desert throughout a metropolitan region? (2) How do social legacy, social differentiation, heat vulnerability, and access to open space shape attitudes toward the desert between individuals and across neighborhoods in a desert city?

Based on research done by human–environment geographers and transdisciplinary scholars, we hypothesized that attitudes are unevenly distributed throughout the city and variability in attitudes between neighborhoods are driven by four key theories focused on human–environment interactions, including social legacy (familiarity with a landscape; Yabiku, Casagrande, and Farley-Metzger 2008), social differentiation (social hierarchies and identity; Grove and Burch 1997), vulnerability to environmental risk (specifically extreme heat; Harlan et al. 2006), and access to open space (opportunity and proximity; Payne, Mowen, and Orsega-Smith 2002). We tested these four theoretical constructs in the context of attitudes toward desert environments. In the following section we review the work that has been done to understand people's interactions with deserts and then explain each of the four theoretical propositions in light of the relevant literature that justifies our expectations.

Attitudes toward the Desert

Ecosystems or landscapes with mountain vistas, open water, and green vegetation are commonly seen as beautiful or desirable, whereas arid landscapes are perceived more negatively (De Lucio and Múgica 1994). Deserts have been viewed as wastelands for a variety of reasons, including aesthetic disdain and concerns about them being unsafe (Nash 1967). Time spent in the desert has also led people to a strong appreciation for its beauty (Abbey 1968). For example, painter Frederick Samuel Dellenbaugh spent a summer in southeastern Utah, after which he returned to amaze East Coast Americans with paintings of the canyon that is now Zion National Park. After spending an extended period of time in the desert working for the park service, Abbey (1968) famously penned, "There are mountain men, there are men of the sea and there are desert rats. I am a desert rat" (298–99).

Although little empirical research has focused on attitudes and experiences with desert ecosystems, a few studies from the 1980s and 1990s have informed

Table 1. Description of four key theories hypothesized to be important in shaping attitudes toward the desert in Phoenix, Arizona

Theoretical model	Hypothesis	Key citations
Social legacy	Familiarity of an individual with a specific landscape type and regional landscapes more broadly will result in more positive attitudes toward that landscape type (desert).	Yabiku, Casagrande, and Farley-Metzger (2008), Larson et al. (2009), Larson, Hoffman, and Ripplinger (2017)
Social differentiation	An individual's placement within social hierarchy based on socioeconomic status and identity as a cultural or ethnic minority will affect attitudes toward the desert.	Grusky (1994), Grove and Burch (1997), Schultz, Zelezny, and Dalrymple (2000)
Heat vulnerability	An increased potential for heat stress as measured by exposure, perceptions, and abilities to adapt to extreme heat will be associated with negative attitudes toward the desert.	Turner et al. (2003), Harlan et al. (2006), Jenerette et al. (2007)
Access to open space	The aptitude for visiting desert parks based on proximity, transportation, and perceived quality will affect attitudes toward the desert.	Tobler (1970), Dee and Liebman (1970), Kearney (2006)

Notes: Included in the table are definitions we employed for the purposes of this study and key citations from human–environment geography and interdisciplinary literature used to formulate the hypotheses.

our research. Zube, Simcox, and Law (1986) found that residents of Phoenix and Tucson appreciated the regional desert landscape in which their cities were situated. Tucson residents were also found to favor protection of desert open space, viewing its development unfavorably (Sell, Zube, and Kennedy 1988). Likewise, residents of the small town of Safford, Arizona, favored wilderness preservation of their nearby desert riparian area (Zube and Sheehan 1994). Other research, however, emphasizes more negative views of the desert. For example, Arizona residents and land managers prioritize agricultural land use over desert open space on the Upper Gila River (Zube and Simcox 1987). Another empirical study conducted in Arizona found that although 86 percent of respondents lived within 40 km of desert open space, only 11 percent included deserts when prompted to list landscapes in which they had a memorable experience (Law 1985). Beyond the few studies on land use in desert environments, more research has focused on attitudinal preferences for desert-like landscaping in private, residential parcels, specifically in metropolitan Phoenix, Arizona.

Extensive research examining preferences and practices in residential yards looks at desert-like landscaping—with gravel ground cover and plants adapted to the arid climate (commonly referred to as xeric yards; Martin, Peterson, and Stabler 2003; Larsen and Harlan 2006; Larson, Hoffman, and Ripplinger 2017). Although xeric yards mimic the native environment, desert landscaping in residential ecosystems does not replicate the desert in undeveloped areas (Stiles and Scheiner 2008). Desert enthusiasts sometimes refer to these xeric dreamscape yards as a "Disney Desert" (Larsen and Harlan 2006). This phrase reflects the prevalence of arid but nonnative plants in xeric yards compared to undeveloped Sonoran Desert. When compared to regional precipitation, these residential landscapes also typically depend on high levels of irrigation for their growth and survival. Regardless, several studies have shown substantial appreciation of these landscapes; for example, 35 percent of Phoenix residents prefer xeric landscaping to greener, mesic vegetation for front yards (Larson et al. 2009).

Although research seems to show a growing appreciation for desert-like xeric yards (Larson, Hoffman, and Ripplinger 2017), landscaping preferences at the scale of private parcels might not reflect personal attitudes toward the regional desert landscape. Thus, this critical question remains: How do residents of modern cities view undeveloped desert landscapes, and what factors explain these attitudes toward desert ecosystems? We hypothesized that legacy effects, social differentiation, heat vulnerability, and access to open space will influence attitudes toward the desert (Table 1).

Social Legacy

Interaction and familiarity with a region's unique features are often associated with positive attitudes toward that place (Wohlwill 1976; Herzog, Kaplan, and Kaplan 1982). In the Phoenix metropolitan region, Yabiku, Casagrande, and Farley-Metzger (2008) suggested that familiarity with a landscape (as measured by length of residency) can result from socialization, which is a process by which people learn to live within a particular social group or cultural context. Although socialization is a complex phenomenon, previous research indicates that the time spent in the Phoenix area affects people's views on desert landscapes. For example, residents with extended residency in Phoenix reportedly get "sick" or "tired" of desert landscaping (Martin, Peterson, and Stabler 2003; Spinti, Hilaire, and VanLeeuwen 2004; Larsen and Harlan 2006; Larson et al. 2009). Likewise, but contrary to common assumptions, newcomers to the desert metropolitan area of Phoenix prefer and have desert landscaping in their private yards more so than longer term residents, who instead tend to choose the grassy landscapes to which they have become accustomed (Larson, Hoffman, and Ripplinger 2017). The negative relationship between preferences for desert landscaping and time spent in Phoenix appears to be counterintuitive, but the distribution of biophysical properties within the city helps to explain this phenomenon.

Phoenix is located in a dry climate; however, marketing campaigns in the height of its urban development cast the city as an "oasis in the desert," offering a lush refuge from the outlying desert (Larsen and Swanbrow 2006). This historical legacy has carried through to current residential landscaping preferences and practices. In the most recent study by Larson, Hoffman, and Ripplinger (2017), ecological and social legacies of the "Phoenix Oasis" were found over time, such that residents become accustomed to the lush green landscapes that have been the historic norm in metropolitan Phoenix. Among people who have not frequently experienced

the regional desert ecosystem within the city, some Phoenix residents are more familiar with, and therefore favor, more mesic landscapes (Yabiku, Casagrande, and Farley-Metzger 2008; Larson, Hoffman, and Ripplinger 2017). Similarly, studies of natural areas, preserves, and open space have shown that residents have an affinity for open spaces that match the environment to which they are accustomed (Dearden 1984).

Larson et al. (2009) outlined how the cognitive separation of the undeveloped regional landscape from human environments results in divergent attitudes toward desert-like private yards versus the undeveloped desert preserves. For example, one respondent in their qualitative study explained, "I've lived [in Phoenix] my whole life. I love the desert … [but] desert landscaping is a different story from going out into the real desert" (Larson et al. 2009, 933). Conflicting priorities are one of the reasons for the dichotomy; it is the dominant desire for comfortable and leisurely landscapes that largely controls residents' yard preferences but not their attitudes toward the desert.

In short, based on previous research, we hypothesized that familiarity with the study region of Phoenix, Arizona—specifically as measured by the portion of one's life spent in the desert region—will be positively related to attitudes toward the desert. We also expected that residents with xeric, desert-like landscapes in their private yards would have more positive attitudes toward the native desert.

Access to Open Space

Accessibility and ease of use for open space and wilderness areas affects environmental attitudes. Positive attitudes toward preserved green areas increase with closeness to home for both urban parks (Dee and Liebman 1970) and natural areas (Wilhelm Stanis, Schneider, and Russell 2009). Nevertheless, perceptions of proximity are mediated by ease of access, where areas that are easier to use are perceived as being spatially closer (Ryan 2006). Kearney (2006) surveyed individuals in residential subdivisions and found that proximity to natural areas was not as important as opportunities to visit those areas. Opportunities for outdoor recreation in cities can be a function of proximity, but in sprawling cities, lack of transportation might also impede access to urban green space. Accessibility and use of urban parks can vary from neighborhood to neighborhood, and some locations might even require a private vehicle to access because of the inequities in the spatial distribution of open space (Shanahan et al. 2014; Soga and Gaston 2016).

We define access based on the distance-decay theory of spatial connectedness that is commonly used to measure and explain human–environment interactions. Distance decay is based on a core geographical concept that asserts that as the proximity between two observations decreases, the strength of their relationship also decreases (Tobler 1970); in this instance, desert access is hypothesized to decrease with proximity to the nearest desert park. Therefore, we hypothesized that individuals will hold positive attitudes toward the desert if they live closer or are able to easily commute to desert parks that are desirable for recreation.

Social Differentiation

Social differentiation is another factor in determining environmental attitudes and landscape preferences. Social differentiation is an important component of urban communities, because it incorporates the concepts of social hierarchies (e.g., wealth or socioeconomic status) and social identity (e.g., ethnicity or culture) to explain why and how societies are differentiated (Grove and Burch 1997). In Phoenix, socioeconomic status has been tied to preferences and installation of desert-like landscaping, wherein more educated and affluent neighborhoods tend to have a higher prevalence of desert landscaping, whereas middle-income residents tend to prefer grassier yards (Larsen and Harlan 2006; Larson et al. 2009). Higher socioeconomic status is also associated with an increase in park and green space visitation (Mowen et al. 2007), largely because low-income communities face more barriers to using urban green space (Wendel, Zarger, and Mihelcic 2012). Moreover, in many cities, people with lower socioeconomic status and minority groups lack access to urban greenspace because they tend to live farther away from them (Dai 2011).

Social differentiation can also be seen among racial and ethnic minorities because they are more likely to experience environmental injustices (Grusky 2010). Of particular relevance to this study, negative attitudes toward open spaces often result from the fact that minority groups can both perceive

and experience natural areas as being dangerous or unsafe (Bixler et al. 1994; Wals 1994; Hong and Anderson 2006; Sharaievska et al. 2010; Finney 2014). In general, people from Latin American countries tend to view themselves as relatively interdependent with nature (Heyd 2004) and therefore more subject to associated risks such as extreme weather events. In contrast, the dominant social paradigm in white-dominated Western cultures positions humans in a place of superiority above nature (Dunlap and Liere 1984). Based on previous research that has shown the importance of social differentiation in shaping attitudes toward the environment (Schultz, Zelezny, and Dalrymple 2000), we hypothesized that people with lower income and education levels (as commonly used measures of socioeconomic status), along with those who identify as having a Mexican or Latino background, will have more negative attitudes toward the desert.

Heat Vulnerability

In Phoenix, one specific environmental risk that vulnerable people face is heat exposure. Vulnerability to risks is often defined as an individual's exposure to hazards, measured through biophysical properties (e.g., land surface temperature or time spent working outdoors) and perceptions of his or her experiences (e.g., thermal comfort relative to others), in addition to his or her ability to adapt and respond to such hazards (Turner et al. 2003). Adaptive capacity is an important component of vulnerability because it is associated with a person's ability to mitigate and cope with environmental risks such as heat stress (Harlan et al. 2006; Smit and Wandel 2006).

In Phoenix, air and surface temperatures tend to be higher in low-income communities where residents also have fewer resources to manage the effects of extreme heat (Harlan et al. 2006; Jenerette et al. 2011). Moreover, minorities and linguistically isolated residents in Phoenix make up the largest percentage of heat distress calls (Uejio et al. 2011). Individuals who work outdoors are particularly exposed to extreme temperatures, resulting in increased rates of emergency department visits for cardiac-related illnesses for outdoor workers (Culp et al. 2011). The most common way to mitigate the effects of urban heat is through centralized air conditioning (Kilbourne 2002), in either a private residence or at a public facility such as a library (Eisenman et al. 2016). The people who are the most prone to live in neighborhoods with higher temperatures, however, are also less likely to have the social and material resources, such as centralized air conditioning, to cope with the heat (Harlan 2006).

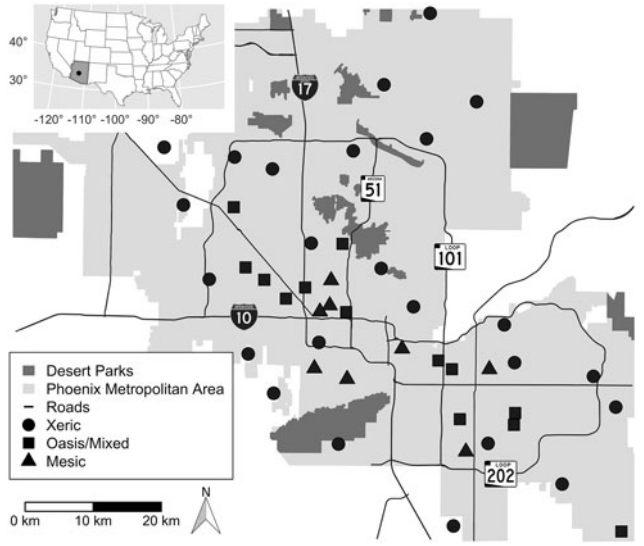

Figure 1. Study area map of the Phoenix metropolitan region, located in the southwestern United States, with the spatial distribution of the forty-five Phoenix Area Social Survey neighborhoods in 2011. Phoenix Area Social Survey neighborhoods are indicated by their centroid. Circles represent neighborhoods with predominately xeric landscaping, triangles represent mesic landscaping, and squares represent mixed xeric/mesic or oasis yard landscaping.

Given that certain residents are disproportionally affected by urban heat risks, and because heat exposure in desert environments can be high, we anticipate that those who are more vulnerable to heat stress will hold stronger attitudes toward the desert. Specifically, we hypothesized that vulnerability to heat—as measured by perceptions of local heat stress, exposures related to outdoor work, or a lack of air conditioning in one's home—will be associated with more negative attitudes toward the desert because people who associate the desert with extreme heat will also view it less favorably.

The preceding literature provides the theoretical foundation for the four hypotheses (legacy effects, social differentiation, heat vulnerability, and access to open space) we tested as explanations for attitudes toward the desert in the case study region of Phoenix, Arizona. In the section that follows, we lay out how data were collected and analyzed for our study.

Methods

Study Area

Located in the southwestern United States and within the northern limits of the Sonoran Desert, the Phoenix metropolitan area is home to more than 4.5 million residents (Figure 1). Temperatures in the Sonoran Desert can exceed 49 °C during the summer and precipitation totals typically range between 76 and 400 mm annually (Phillips and Comus 2000). The region harbors high biological diversity; common native plants include *Parkinsonia microphylla* (foothill palo verde), *Prosopis* spp. (mesquite tree species), *Opuntia engelmannii* (prickly pear cactus), wildflowers such as *Baileya multiradiata* (desert marigold), and the iconic columnar cactus *Carnegiea gigantea* (saguaro). Perennial and ephemeral rivers provide green riparian habitats in the arid region, although most have been diverted or dammed for anthropogenic purposes.

The urban mosaic of Phoenix is defined by heterogeneous neighborhoods with distinct social and physical features. Vegetation cover and primary productivity are higher within the city than the surrounding desert, and urban plant phenology exhibits damped seasonal variation (Buyantuyev and Wu 2009). Vegetation and related land surface temperature are inequitably distributed throughout Phoenix, however (Harlan et al. 2007; Jenerette et al. 2007), creating spatial patterns of heat vulnerability (Harlan et al. 2006). Patterns of land surface temperature interact with the distribution of socioeconomic status throughout the metropolitan area, where various socioeconomic status groups can be found at the urban core and at the edge of the city limits (Chow, Chuang, and Gober 2012). In addition to the outlying desert, Phoenix has more than 16,187 ha of desert parks and preserves and more than 1,500 ponds and lakes within city boundaries, providing the potential opportunity for outdoor recreation without leaving the metropolitan area.

Sampling Design and Data Collection

We used responses from a social survey questionnaire administered by the Institute for Social Science Research at Arizona State University to determine social and spatial factors influencing attitudes toward the desert (Harlan et al. 2017). The social survey questionnaire, known as the Phoenix Area Social Survey (PASS), was established as part of the Central Arizona Phoenix Long-Term Ecological Research (CAP LTER) program's long-term monitoring efforts. PASS was administered to forty-five neighborhoods in 2011 (Figure 1), the

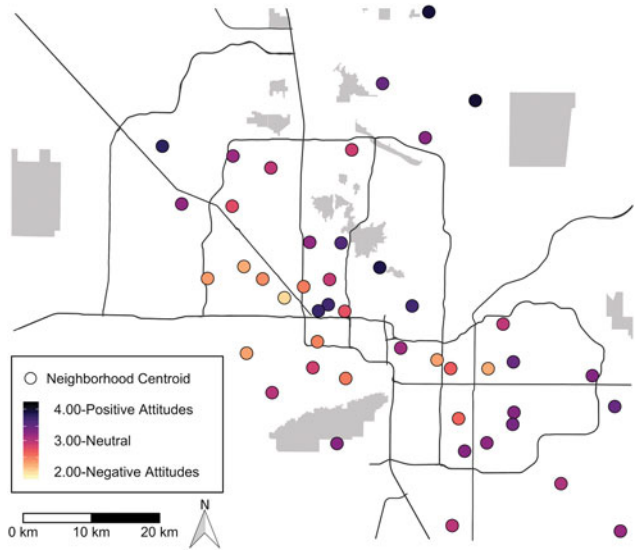

Figure 2. Average value and spatial distribution of attitudes toward the desert in forty-five neighborhoods located in Phoenix, Arizona. Color indicates attitudinal scale measuring attitudes toward the desert, where dark purple indicates positive attitudes toward the desert, pink represents neutral attitudes, and yellow-orange indicates negative attitudes toward the desert. (Color figure available online.)

Table 2. Descriptive statistics of attitudes toward the desert for respondents in Phoenix, Arizona ($n = 806$) measured in forty-five neighborhoods as part of the Phoenix Area Social Survey

Variable name	*Mean* ± *SE*	Range	Strongly agree	Agree	Disagree	Strongly disagree	Don't know	Refuse to answer
Attitudes toward the desert	3.22 ± 0.03	1–4	—	—	—	—	—	—
The desert is a wasteland	3.40 ± 0.03	1–4	5.5%	8.4%	25.3%	57.6%	3.1%	0.1%
The desert is not a special place to me	3.10 ± 0.03	1–4	9.1%	12.4%	37.2%	37.0%	4.0%	0.3%

Notes: The values displayed for the question "the desert is a special place to me" are shown as the inverse scale used to create the attitudes toward the desert index. The two questions were averaged per respondent to create the composite attitudes toward the desert index, with higher values indicating more positive attitudes toward the desert.

Table 3. Descriptive statistics and units of measurement of the thirteen explanatory variables collected for 806 Phoenix Area Social Survey respondents across forty-five neighborhoods during 2011 in Phoenix, Arizona

Model/variable	Description	Individual *Mean* ± *SE*	Neighborhood *Mean* ± *SE*
Social legacy			
Birthplace	Respondent born in Arizona (residency): binomial yes or no	0.20 ± 0.01	0.20 ± 0.02
Length of residency	Percentage of life spent living in Phoenix, Arizona (residency): range 0–1	0.47 ± 0.01	0.47 ± 0.02
Xeric yards	Percentage of yards in neighborhood with desert-like, xeric landscaping (landscape familiarity): range 0–1	0.30 ± 0.02	0.30 ± 0.04
Social differentiation			
Income	Income (social hierarchy): ordinal range 1–11	3.97 ± 0.10	3.19 ± 0.32
Education	Highest level of education obtained (social hierarchy): ordinal ranged 1–7	4.78 ± 0.06	4.74 ± 0.16
Mexican or Latino identity	Identifies as Mexican or Latino (social identity): binomial yes or no	0.21 ± 0.01	0.22 ± 0.04
Heat vulnerability			
Heat perceptions	Perception of temperatures in neighborhood relative to other areas (heat risks): binomial hotter or cooler neighborhood	0.83 ± 0.01	0.83 ± 0.02
Outdoor work	Amount of time spent working outdoors in the summer (exposure): ordinal range 1–4	1.48 ± 0.03	1.49 ± 0.04
Air conditioner use	No restrictions in using central air conditioning during the summer (adaptive capacity): binomial yes or no	0.55 ± 0.02	0.54 ± 0.03
Access to open space			
Desert park proximity	Distance from neighborhood centroid to the edge closest desert park (proximity): distance in kilometers	8.41 ± 0.18	8.44 ± 0.77
Mobility	Infrequent access to a private form of transportation (lack of mobility): binomial yes or no	0.10 ± 0.16	0.10 ± 0.02
Park desirability	Perception of the quality of parks and open spaces (desirability): ordinal range 1–4	3.10 ± 0.03	3.09 ± 0.06
New Ecological Paradigm index	"Pro-ecological" or biocentric worldviews constitute broad-based beliefs about people's relationship with nature: ordinal range 1–4	2.88 ± 0.02	2.88 ± 0.02

most recent year for which the survey is available, with the target population of the survey being the heads of all households aged eighteen or older. Surveys were given in either English or Spanish and were administered in person, online, or by telephone.

The forty-five neighborhoods, delineated by U.S. census block groups, were selected to create a balanced sample of five neighborhoods per nine groups stratified by income (low, middle, and high) and location within the urban matrix (core, suburban, or fringe). A sample goal of eighteen to twenty

respondents was set for each neighborhood to achieve a target response rate of 50 percent; the final sample size was 806 respondents, giving a total average response rate of 43 percent. Response rates ranged from 23 percent to 57 percent per neighborhood. The codebook describing the full survey design and history of the PASS is available through the CAP LTER data portal (Harlan et al. 2017).

We used a total of fourteen variables for our study, including one response variable (attitudes toward the desert) and thirteen explanatory variables that were grouped by the four hypotheses (Tables 2 and 3). All fourteen variables were derived from survey questions asked in the PASS. Our study is multiscalar; variables were analyzed on individual ($n = 806$) and neighborhood ($n = 45$) scales, and both scales used the same suite of variables for analysis. Variable values at the individual scale were directly derived from the survey question responses ($n = 806$). Variable values at the neighborhood scale were aggregated from the individual survey responses by taking the average response value per neighborhood (Σ survey response value/total respondents in each neighborhood).

We define attitudes as evaluative judgments that hold implications for potential action about urban and environmental planning (Larson 2010). Two closed-ended survey items measured attitudes toward the desert, "the desert is an empty wasteland" and "the desert is a special place to me," on a four-point scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*); respondents could also elect to not answer the question. The two survey questions were negatively correlated as expected ($r = -0.37$, $p < 0.0001$). To create a composite variable, the response scale for "the desert is a special place to me" was first reversed to establish a similar directionality of positive and negative values for the two variables. The responses to the two variables were then averaged for each respondent, and the resulting response variable is referred to as attitudes toward the desert (ATD), where higher values indicate more positive attitudes (Figure 2, Table 2).

Thirteen explanatory variables were collected from the survey to test our four relevant theories (Table 3). The first theoretical perspective, relating to the social legacies of the people living in the Phoenix region (social legacy), was captured by three variables: birthplace, length of residency, and the presence of xeric yard landscaping. Consistent with the literature related to social differentiation and environmental attitudes, we selected income and educational attainment (to measure social hierarchies through socioeconomic status) and Mexican or Latino identity (as a measure of social identity) as the three variables measuring social differentiation. Heat vulnerability (including perceptions, adaptive capacity, and exposure) was assessed using the following three variables: perceptions of neighborhood heat, the use of air conditioning within a respondent's home when the weather is hot, and amount of time spent working outdoors during the summer. The ability of individuals to access desert recreational space in Phoenix was measured using three variables representing proximity (distance to closest desert park), mobility (transportation abilities), and desirability (park quality). To control for variation in respondents' broad-based environmental values, we also included the New Ecological Paradigm (NEP) scale developed by Dunlap et al. (2000). Data were tested for normality and spatial autocorrelation prior to analysis.

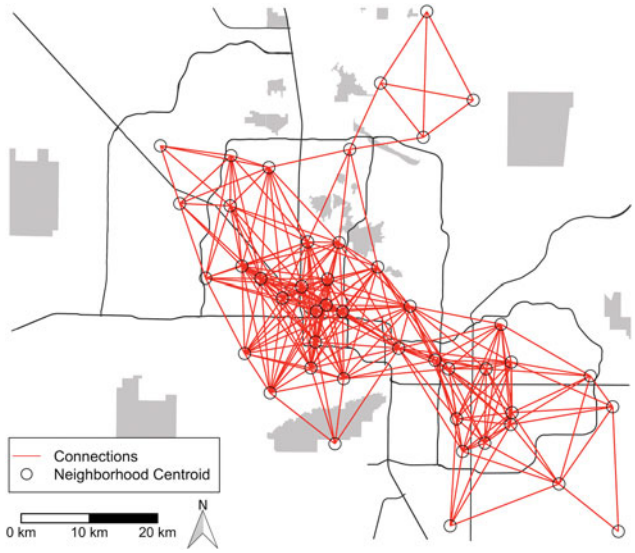

Figure 3. Neighborhood linkages (connections) for final bin size of 17 km, selected to maximize spatial relationship (Moran's *I*) of attitudes toward the desert where every neighborhood has at least two connections. (Color figure available online.)

Statistical Analysis Question 1: Spatial Patterns of Attitudes

Our first research question asked whether attitudes toward the desert were spatially related throughout Phoenix, Arizona. We tested the

distribution and orientation of attitudes based on the location of the forty-five surveyed neighborhoods. We used the neighborhood scale for spatial analysis because individual responses were not spatially explicit. We first calculated a weighted matrix defining the spatial relationship between neighbors (centroid of PASS neighborhoods) within a given threshold distance (Figure 3). We calculated the weighted neighbors list for a range of threshold distances between 5 and 25 km. The final weighted neighbors bin size was selected for the threshold distance of 17 km, so that each neighborhood had at least two neighbors and the spatial relationship between attitudes toward the desert was most significant, calculated using global Moran's *I* (Moran 1950).

To take the variation in the number of different neighbors per neighborhood into account, we calculated the weighted neighbors list using the row-standardization scheme, where the sum of each row in the link matrix was standardized to equal one (O'Sullivan and Unwin 2014). Using the weighted neighbors list, we calculated global Moran's *I*, global G (Getis and Ord 2010), and Geary's C (Geary 1954) to determine whether the response variable, attitudes toward the desert, was spatially autocorrelated (Fortin and Dale 2005).

Following the methodology of Carter et al. (2014), we calculated the Getis–Ord (local G_i^*) statistic for attitudes toward the desert in PASS neighborhoods to determine how attitudes were clustered in certain areas of the metropolitan region (Getis and Ord 2010). Significant clusters of neighborhoods with positive attitudes were those with a $G_i^* > 1.96$, whereas neighborhoods with significantly negative attitudes had a $G_i^* < -1.96$. We visualized clusters of positive and negative attitudes by mapping each neighborhood with its corresponding G_i^* statistic. We conducted spatial analyses using the R packages "spdep" and "rgeos" (Bivand et al. 2011; Bivand and Rundel 2013).

Statistical Analysis Question 2: Social and Environmental Models

After determining spatial patterns of attitudes toward the desert, we used linear regression models to determine how established social theories—specifically social legacies, social differentiation, heat vulnerability, and access to open space (Table 1)—shape attitudes toward the desert. For this second research question, we fit four linear models, one for each hypothesis, wherein each model was composed of a unique set of PASS variables (Table 3). The models were estimated for both individuals and neighborhoods to test for scale effects on environmental attitudes. The standardized beta coefficient (to account for different units of measurement) was calculated to determine the strength and directionality of the relationship between each of the explanatory variables and attitudes toward the desert.

Table 4. Global statistics used to determine whether attitudes toward the desert were spatially associated in Phoenix, Arizona, across ($n = 45$) neighborhoods

Test	Test statistic	Expectation	Variance	*p* Value
Moran's *I*	0.151	–0.023	0.004	0.003
Geary's C	0.836	1.000	0.004	0.006
Global G	0.263	0.271	0.000	0.015

Before estimating the models, we first checked for normality and homoscedasticity and then calculated a Pearson's product–moment correlation coefficient for each pair of variables to check for multicollinearity among the predictors. Because some of the covariates were correlated, we used variance inflation factor (VIF) scores to determine whether any variables needed to be dropped from a particular model. To meet statistical assumptions, per capita income (derived from the U.S. Census) was used in place of income measured via the PASS in the social differentiation model and percentage bachelor's degree was dropped from the full model at the neighborhood scale. We calculated the Moran's *I* statistic for the model residuals to verify that spatial relationships did not cause pseudoreplication of the samples (Hurlbert 1984); no spatial autocorrelation was present in the residuals of any model.

Results

Phoenix residents overwhelmingly held positive attitudes toward the desert (3.22 ± 0.03). Approximately 82 percent of survey respondents disagree or strongly disagree that "the desert is an empty wasteland" and 74 percent agree or strongly agree that "the desert is a special place" (Table 2). In support of our hypothesis, attitudes toward the desert and the explanatory variables evaluated in our study were spatially structured and clustered throughout the city (Figure 2).

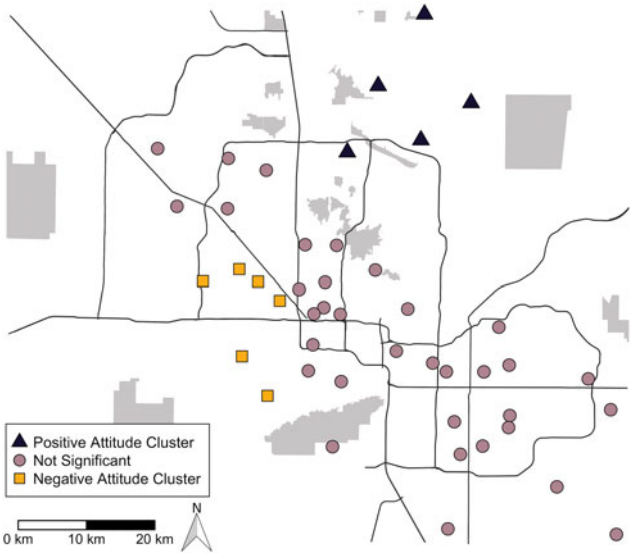

Figure 4. Spatial clusters of attitudes toward the desert measured across forty-five neighborhoods in Phoenix, Arizona, using the Getis–Ord local statistic. Color and shape indicate the significance of the clustering statistic within each neighborhood. Dark purple triangles indicate a hotspot, or clustering of more positive attitudes toward the desert ($p < 0.05$), and orange squares indicate spatial clustering of negative attitudes toward the desert ($p < 0.05$); the mauve-colored circles represent neighborhoods with no significant clustering of attitudes. (Color figure available online.)

Question 1: Spatial Patterns of Attitudes

Global spatial statistics indicate that attitudes toward the desert exhibited positive spatial dependence throughout neighborhoods in Phoenix, Arizona ($I = 0.15$, $p < 0.003$; Table 4). Local measurements of attitudes illustrated the metro-wide spatial patterns (Figure 2). Neighborhoods with positive and negative attitudes occurred both in the central city and in fringe neighborhoods. With the exception of a few neighborhoods in the southwestern part of the study region, though, neighborhoods on the fringe of the metro region tended to hold more positive attitudes. For more central neighborhoods, positive attitudes were colocated with desert parks. The exception is the two older, mesic neighborhoods near the city core that both held strongly positive attitudes; the higher than expected positive attitudes of these neighborhoods could be attributed to social differentiation (high income and education level). Neutral attitudes were interspersed throughout Phoenix but had a higher density in the northwestern and southeastern portions of the city, neither of which offers easy access to urban desert parks or exhibits strong clustering of social variables.

The local G_i^* statistic illustrated the spatial clustering of neighborhoods by identifying two distinct hotspots of positive and negative attitudes clustering in Phoenix neighborhoods (Figure 4). Five neighborhoods in northeastern Phoenix exhibited clustering of positive attitudes. These neighborhoods were all located in a high-income area at the edge of the McDowell Preserve system, a desert park with a total area of more than 12,140 ha and more than 80 km of accessible trails. None of these neighborhoods differed significantly from one another in terms of social and physical composition, creating a fairly homogenous distribution of neighborhoods that held positive attitudes. A statistically insignificant band of urban core and suburban neighborhoods separated positive and negative attitude clusters. All of the urban core neighborhoods were in close proximity to each other but were heterogeneous in attitudinal patterns. In contrast to neighborhoods of positively clustered attitudes, negative attitudes toward the desert were aggregated within the southwestern portion of the Phoenix metropolitan area.

Question 2: Social and Environmental Models

The regression models' results varied somewhat across the individual and neighborhood scales. Aggregating variables to the neighborhood scale increased the between-sample variation because the characteristics of nearby individuals were more likely to be related (Table 3). The increase in variation at the neighborhood scale translated to models that explained more variance in attitudes toward the desert (Table 5), despite a smaller sample size ($n = 45$ neighborhoods compared to $n = 806$ individuals). All four of the models explained more variation in attitudes toward the desert at the neighborhood than the individual scale, but model and variable importance were consistent between scales. For both scales, the theoretical models that were developed from literature in nonarid systems were all significant in explaining attitudes toward the desert (Table 5).

The social differentiation model—including income, education, and Mexican or Latino identity—best explained attitudes toward the desert in Phoenix for both individuals, ($F_{(4,\ 651)} = 11.63$, $R^2 = 0.06$, $p < 0.0001$), and neighborhoods, ($F_{(4,\ 40)} = 19.21$, $R^2 = 0.62$, $p < 0.0001$ [Table 5]). The next most significant models were access to open space for individuals, ($F_{(4,\ 758)} = 11.27$, $R^2 = 0.05$,

Table 5. Linear regression results from the four hypothesized models testing for the effects of social and environmental characteristics on attitudes toward the desert for 806 individuals in forty-five neighborhoods located across Phoenix, Arizona

	Model 1	Model 2	Model 3	Model 4
Variable	Social legacy	Social differentiation	Heat vulnerability	Access to open space
Individual scale				
Intercept	2.75	2.64	2.64	2.38
Birthplace	–0.02			
Length of residency	0.05			
Xeric yards	0.1**			
Income		0.03		
Education		0.12**		
Mexican or Latino		–0.15***		
Heat perceptions			–0.08*	
Outdoor work			0.02	
Air conditioner use			0.11**	
Desert park proximity				–0.11**
Mobility				–0.07*
Park desirability				0.17***
NEP index	0.08*	0.08*	0.14***	0.12***
R^2	0.01	0.06	0.03	0.05
F (df)	3.49 (4, 751)	11.63 (4, 651)	6.32 (4, 689)	11.27 (4, 758)
Neighborhood scale				
Intercept	1.98	2.96	2.05	1.20
Birthplace	–0.30			
Length of residency	0.01			
Xeric yards	0.31*			
Income		0.43**		
Education		–0.12		
Mexican or Latino		–0.58***		
Heat perceptions			–0.19*	
Outdoor work			–0.27*	
Air conditioner use			0.50***	
Desert park proximity				–0.32*
Mobility				–0.30*
Park desirability				0.40**
NEP index	0.24*	0.07	0.27*	0.26*
R^2	0.25	0.62	0.58	0.37
F (df)	4.63 (4, 40)	19.21 (4, 40)	16.08 (4, 40)	7.58 (4, 40)

$p < 0.0001$), and heat vulnerability for neighborhoods, ($F_{(4,\ 40)} = 16.08$, $R^2 = 0.58$, $p < 0.0001$). The difference in the explained variation (R^2) between individual and neighborhood models reaffirms the spatial clustering of the social and biophysical characteristics, whereby aggregating attitudes to the neighborhood level resulted in a much stronger relationship.

Social identity measured by individuals in Phoenix who identify with being Mexican or Latino was the strongest individual factor in explaining attitudes toward the desert, wherein individuals who identified as being Mexican or Latino were more likely to hold negative judgments toward the desert. Negative attitudes toward the desert were also significantly related to variables within the heat vulnerability and access to open space hypotheses. Perceptions of living in a hotter than average neighborhood were important at both scales; exposure to heat through outdoor work was only significant at the neighborhood scale. Within the access to open space hypothesis, the lack of mobility and longer distances to desert parks were both related to more negative attitudes toward the desert.

All four models also had variables that were associated with positive attitudes toward the desert. Xeric landscaping was the only social legacy variable that was significantly related to attitudes toward the

desert at both scales. As expected, residents with xeric landscaping at home viewed deserts more positively. Socioeconomic status was also related to attitudes toward the desert, where residents and neighborhoods with a higher socioeconomic status held more positive attitudes toward the desert. Unrestricted air conditioning use to mitigate high temperatures and park desirability were also related to more positive attitudes toward the desert in the less important models. As a control variable of ecological worldviews, the NEP index was strongly associated with positive attitudes toward the desert and was significant in all but one of the models.

Only two out of the thirteen variables were not significant at either scale in explaining attitudes toward the desert, which supports our approach to model specification based on our literature review. The two variables that were not significant, birthplace and amount of time residents have lived in the Phoenix metropolitan area, were both within the social legacy hypothesis and had the greatest amount of relevant literature to support their inclusion in the models, underscoring the difference between yard landscaping preferences addressed in previous studies and regional environmental attitudes addressed here.

Discussion

Our study establishes several key insights into evaluative attitudes toward desert landscapes. First, we establish the importance of the desert to the residents of an arid city. Deserts are home to a large portion of the global population and the urban residents of the Sonoran Desert hold strong, positive attitudes toward the desert. Contrary to historic accounts, many residents living in desert regions view these landscapes as having a special value and do not believe that they are desolate "wastelands" (Nash 1967). Instead, our study confirms the value of desert ecosystems to the residents who live in arid cities (Zube, Simcox, and Law 1986). Not all people view the desert in the same way, though, and our findings confirm the uneven social and spatial distributions of attitudes toward desert ecosystems.

Our study also confirms that the same processes shaping attitudes toward green space, parks, and wildlife in temperate climates are important in defining attitudes about more arid landscapes. Similar to the findings of Payne, Mowen, and Orsega-Smith (2002), Van den Berg and Koole (2006), and Carter et al. (2014), our study highlights how social differentiation shapes environmental attitudes. For our study, Mexican or Latino residents and socioeconomically marginalized groups in the Phoenix metropolitan area are the most likely to express negative attitudes toward the desert. The similarities between these studies, in different geographical locations with distinct attitudinal objects (i.e., deserts, nature development landscapes, and large carnivores), illustrate that environmental attitudes can share similar patterns that arise from processes of social identity and hierarchy.

Social–Spatial Patterns

Desert attitudes in Phoenix are clustered among neighborhoods in specific sections of the metropolitan region, and this clustering follows the spatial nature of the social and environmental variables we examined. Neighborhoods that hold more positive attitudes are largely located near desert parks or at the urban fringe. Owing to historical development patterns of outward sprawl, neighborhoods at the edge of the city and at the base of mountain parks—which are newer, more suburban, and wealthier—are especially positive about the local desert environment. Residents within these neighborhoods hold more positive attitudes likely due to relatively easy access to the aesthetic, leisure, and recreation opportunities of the regional desert parks and preserves.

As a result of the coupling of social and biophysical patterns in cities (Rademacher, Cadenasso, and Pickett 2018), the same neighborhoods in Phoenix that have more access to desert amenities also have higher social status and are less vulnerable to extreme heat. High-income neighborhoods closer to the desert have lower population density, leading to fewer sources of anthropogenic heat, more vegetation that provides shade, and less impervious surface (Jenerette et al. 2007), allowing nighttime temperatures to reach lower minima than in the urban core (Connors, Galletti, and Chow 2013). Jenerette et al. (2016) found that higher socioeconomic status groups are less likely to experience extreme heat conditions and are also less likely to consider heat exposure as a salient risk. Overall, advantaged groups simultaneously avoid the challenges of living in a hot, dry environment while benefiting from the aesthetic, recreational, and conservational roles of

the desert (Burgess, Harrison, and Limb 1988; Byerly 1996).

In contrast, more vulnerable communities that lack the ability to consistently choose or control their environment hold more negative attitudes about the desert. Individuals in these neighborhoods are restricted in their ability to use heat mitigation strategies, such as regulating indoor temperature (Harlan et al. 2013), as evidenced by the importance of central air conditioning for predicting attitudes toward the desert. The lack of control over the environment can indeed be key in shaping attitudes and might also translate to more negative attitudes toward the desert or, as shown in other research, heightened perceptions of risks (Slovic 1987; Larson et al. 2011). Additionally, individuals who do not have the economic or social means to control their environment are often spatially located in portions of the city with higher exposure to environmental risk factors and hazards (Harlan et al. 2006; Jenerette et al. 2011), causing an interaction between social and spatial characteristics that shapes negative attitudes toward the desert.

Social Identity

Mexican or Latino identity was a strong factor in the likelihood to express negative attitudes toward the desert. Minorities often feel—and are—more vulnerable to environmental risks (Flynn, Slovic, and Mertz 1994; Parker and McDonough 1999). Another study found, for example, that only 18 percent of white respondents felt as though heat is dangerous compared to 46 percent of Latino respondents; furthermore, 65 percent of Latino respondents perceived heat exposure to be their "biggest threat" living in a desert city (Kalkstein and Sheridan 2007).

In essence, Mexican and Latino respondents might feel more vulnerable to the extreme desert conditions, thereby explaining their relatively negative attitudes toward the desert compared to others. An additional underlying explanation for this could be that people who identify as Mexican or Latino tend to see themselves as more interdependent on the natural environment, as opposed to the dominant social paradigm that positions people as superior to nature (Heyd 2004; Larson et al. 2011). Overall, the ways in which social, cultural, and economic groups interact with and perceive their environmental conditions can cause fundamental differences in attitudes.

Residential versus Regional Landscapes

Surprisingly, place of birth and tenure of residency—which have been found to be critical in explaining residential landscaping preferences in previous studies—are less important for shaping attitudes toward the desert. Social legacy, or the familiarity and experience with a landscape type (Múgica and De Lucio 1996), is a well-supported proposition that explains yard landscaping ideals (e.g., Martin, Peterson, and Stabler 2003; Larson, Hoffman, and Ripplinger 2017), but it was relatively unimportant in relation to desert attitudes. In fact, the social legacy model tested in this research explained the least amount of variation in desert attitudes for both individuals and neighborhoods.

The social legacy hypothesis has been extensively tested in relation to residential landscape typology in the U.S. Southwest. Many of the studies we cited to develop the social legacy theory (e.g., Larsen and Harlan 2006; Yabiku, Casagrande, and Farley-Metzger 2008; Larson et al. 2009) shared neighborhoods and municipalities with our own study. Therefore, we contend that the distinction we find between attitudinal factors shaping residential versus regional landscapes is not simply an artifact of different study areas or geographical regions. As residents noted in a previous study, "I love the desert, in its place," and "The desert belongs in the desert" (Larson et al. 2009, 932–33). Together, these findings seem to suggest that interactions with landscapes in private homes versus in open space can lead to differential attitudes and drivers of them when comparing residential ecosystems to the surrounding environment.

Future Research

An interesting direction of research would be to extend the geographical scope of our study beyond a single city to include specific features of different deserts, such as biodiversity or landscape configuration, to test how different attributes of a desert affect attitudes. For example, the Sonoran Desert is the most biodiverse of the North American deserts (Phillips and Comus 2000); this could play a part in shaping attitudes about the desert because people

have the potential to recognize and value ecological biodiversity (Belaire et al. 2015; Botzat, Fischer, and Kowarik 2016). The spatial extent and configuration of parks within specific desert ecosystems, as well as urban development, could also influence cross-desert attitudinal patterns.

In terms of management implications, a more in-depth, qualitative study targeting people and places that are more likely to disdain their desert environment could highlight key drivers of how and why people hold more negative views toward the desert. Overall, our study has established a baseline for understanding attitudes toward the desert that could be used in future research to evaluate the drivers of geographic and temporal shifts in attitudinal patterns. Although attitudes tend to be steadfast and resistant to change, they do change in response to specific experiences or contexts (Heberlein 2012). Thus, comparative case study research as well as longitudinal studies are worthy of pursuit to advance understanding of general human–environment attitudes and place-specific views. Going forward, the social–spatial methodology used in this article (following that of Carter et al. 2014), coupled with the theoretical propositions we derived from an in-depth review of transdisciplinary literature for the specific attitudinal object, offers an effective direction for future research on other understudied environmental attitudes.

Conclusion

Attitudes toward the desert in Phoenix are largely positive but are dependent on the social differentiation of individuals, as well as the spatial placement of neighborhoods throughout the metropolitan region. Social identity (Mexican or Latino) and social hierarchy (income and education) were the most important factors predicting attitudes toward the desert. Heat vulnerability and opportunities for recreation in the desert were also significant factors, whereas social legacy was less important than originally hypothesized.

Our study indicates that attitudes about the desert vary based on the social characteristics and geography of an individual and that different approaches to improve people's relationship with the desert are necessary for groups that are inequitably influenced by their regional environment. For example, park managers and local groups can work to create more accessible open space and experiences for disenfranchised or disadvantaged people in desert cities. Increasing the outreach about and accessibility to desert parks could increase the number of positive attitudes and reduce the environmental inequities (in terms of access and use of recreational open space) throughout a city. Overall, attitudes toward the desert are important to understand because they can help strengthen the connection between the regional environment and the local community, ultimately encouraging land preservation and sustainability efforts in arid cities (Bonaiuto et al. 2002; Brody, Highfield, and Alston 2004).

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ORCID

Riley Andrade http://orcid.org/0000-0003-3640-6013
Kelli L. Larson http://orcid.org/0000-0001-6558-2687
David M. Hondula http://orcid.org/0000-0003-2465-2671
Janet Franklin http://orcid.org/0000-0003-0314-4598

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RILEY ANDRADE is a PhD candidate in the School of Geographical Sciences and Urban Planning at Arizona State University, Tempe, AZ 85287. E-mail: rileyandrade@asu.edu. Her social–ecological systems research examines human–environment geography, biodiversity, and urban green space.

KELLI L. LARSON is a Professor of Geography and Sustainability at Arizona State University, Tempe, AZ 85287-5302. E-mail: kelli.larson@asu.edu. Her research focuses on how risk perceptions and environmental attitudes affect decision making for water governance, landscape management, and urban sustainability.

DAVID M. HONDULA is an Assistant Professor in the School of Geographical Sciences and Urban Planning at Arizona State University, Tempe, AZ 85287. E-mail: david.hondula@asu.edu. His research addresses the health and social effects of environmental heat exposure in urban areas.

JANET FRANKLIN is a Distinguished Professor in the Department of Botany and Plant Sciences at University of California, Riverside, CA 92521. E-mail: jfrankl@ucr.edu. Her research interests include landscape ecology, biogeography, and geographic information science.