CLASSIFICATION OF URBAN PARK ECOSYSTEM SERVICES IN A DESERT CITY

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Research Overview

Lack of sustentative, multi-dimensional research on city park systems, particularly in arid urban regions, has undermined the potential role of these valuable social and ecological amenities in advancing urban sustainability goals. Addressing this gap, this research spatially and statistically analyzes and classifies parks in a large desert city in the Southwest United States—Phoenix, Arizona—with the goal of understanding the park system holistically and multi-dimensionally, providing a baseline to inform public policy and planning aimed at enhancing urban sustainability, particularly by way of increased, equitable ecosystem services provisioning. Urban parks in Phoenix were classified using a multi-step quantitative approach and the results are discussed with regards to their implications for public policy and planning aimed at enhancing the social and ecological sustainability of the park system and the city as a whole.

Specifically this research asks:

- *What are the social, ecological, built, and spatial characteristics of Phoenix parks and how can the parks be classified according to these multiple dimensions to reveal distinct park types?*
- *How do these findings inform public policy aimed at enhancing the sustainability of the park system and the city overall?*

Approach

1. **Variable computations:** First 33 variables related to the social, physical, ecological, and urban morphological characteristics of park and park neighborhoods (defined as areas within ¼ mile) were calculated.
2. **Principal Component Analysis (PCA**) was run on to reduce the overlap and redundancy in data and reveal which factors explained the majority of the variance in park and park neighborhood characteristics.
3. **A two-step cluster analysis:** A Hierarchical Cluster Analysis was run on regression factor scores identified in the PCA to determine the appropriate number of clusters. Then, the k-means method was used to form the clusters, assigning each case a specific group based on their similarities with regards to the factors.

Variables Analyzed & Park Map

The data for this research represents physical, ecological, social, built, and spatial characteristics for urban parks in Phoenix and their surrounding neighborhoods

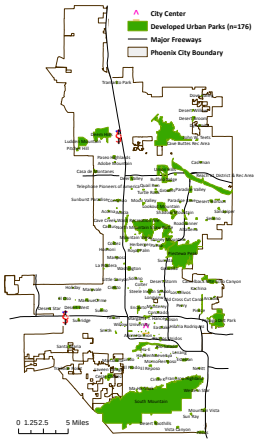


Table 1. Data and associated variables used in this study

	Description	Dataset	Source
Physical park characteristics	Location & area	Park Boundaries (2012)	City of Phoenix Parks & Recreation Department
	Amenities (n=10): community center, paths/trails, ball field/court, playground, pool, water body, shade area, drinking fountain, restroom, picnic area	Parks database (2010)	City of Phoenix Parks & Recreation Department website
	Distance to city center	City center shapefile	ASU GIS data repository
Ecological/ environmental park characteristics	% grass	Quickbird, classified	CAP-LTER, created by Soe Myint, Chris Galletti, Shai Kaplan, Won Kim, Chao Fan
	% trees		
	% green (grass + trees)		
	% soil		
	Average greenness based on Soil-adjusted Vegetation Index (SAVI) (range= -1.5 to 1.5)	SAVI index (2005)	CAP-LTER
Social characteristics of park nbhds	Average number of people per acre	Census block (2010)	U.S. Census Bureau
	Median household income within ¼-mile buffer of park in dollars	Census block group (2010)	
	% Hispanic		
	% white		
	% black		
	% other ethnicity		
Built environment of park nbhds	% impervious	Quickbird, classified	CAP-LTER, created by Soe Myint, et al.
	% buildings		
	% developed (impart.+ build.)		
	% single-family parcels in park neighborhood	Parcels (2010)	PURL
	% multi-family parcels in park neighborhood		
	% retail parcels in park neighborhood		
	% commercial/industrial parcels in park neighborhood		
	% C/I and retail parcels in park neighborhood		
	Mix of commercial/industrial (C/I), single-family (SF), and multi-family (MF) landuses		
	Distance from city center	Park Boundaries (2012)	City of Phoenix Parks & Recreation
Other	City boundary	Phoenix boundary (2010)	ASU GIS data repository

Park Types, Associated Ecosystem Services, and Policy Implications

The principal component analysis identified five key factors that typified the park system in Phoenix. Using these factors, the cluster analysis produced nine distinct park types, each with a unique mix of physical, ecological, social, built, and spatial characteristics—and therefore particular implications with respect to sustainability policy and ecosystem services provisioning.

Park Type #1 (n=10): ***Minimally-developed large desert parks in low-density affluent, white neighborhoods with paths/trails.***

Associated services→ Play a critical role in the overall ecological sustainability of Phoenix, protect the majority of the cities native biodiversity habitat and highly valued scenic features.

Policy Implications→ Because of their high ecological value, it is recommended areas around these parks remain of low urban intensity, but higher access by lower-income, minority communities should be pursued in other ways.

Park Type #2 (n=43): ***Small, less developed, green parks in dense neighborhoods***

Associated services→ Providing social benefit through the provisioning of public space, and are increasing human health and comfort by providing relief from the urban heat island

Planning concerns→ These civic spaces could be further improved by increasing active uses in the surrounding neighborhoods.

Park Type #3 (n=12): ***Low-amenity, urban parks in minority neighborhoods close to city center***

Associated services→ Seem to have low social, recreational value, or ecological value.

Planning concerns→ As the surrounding neighborhoods of these parks represent high-need populations, these areas should be targeted for improvements such as increased vegetation and the development of facilities such as picnic areas, playgrounds, and shade structures.

Park Type #4 (n=21): ***Parks in affluent white neighborhoods outside center***

Associated services→ Basic recreational benefit, possible ecological benefit, varies by park.

Planning concerns→ The abundance of these parks in neighborhoods where residents are likely to have their own private outside spaces suggests questionable equity standards and future efforts should strive to remedy this inequity. Field assessments should assess ecological integrity.

Park Type #5 (n=6): ***Community center parks with pools***

Associated services→ Recreation and cooling benefits for local populations.

Planning concerns→ Future community center parks should be prioritized in high density neighborhoods and should be more evenly distributed around the city.

Park Type #6 (n=16): ***Small, green park in affluent, white neighborhoods outside city center***

Associated services→ Provides recreational and/or public space benefits to local populations. May have ecological value through enhanced open space connectivity.

Planning concerns→ As these are low-need neighborhoods future parks should be prioritized in lower income areas.

Park Type #7 (n=16): ***Parks in low-income highly 'urban', minority neighborhoods***

Associated services→ Provide critical social benefits (i.e. access to public space) in these high need neighborhoods.

Planning concerns→ Field assessments should determine quality of individual sites and suitability to resident needs and preferences.

Park Type #8 (n=27): ***Highly-developed, high amenity parks***

Associated services→ These parks are not highly clustered in a single area of the city, therefore it can be said that they are providing necessary recreational benefits to a large portion of the city

Planning concerns→ Encouraging higher density development around these parks is recommended. Future planning and redesign efforts in these two park types should focus on enhancing the social benefits of these civic spaces as their ecological value may be limited.

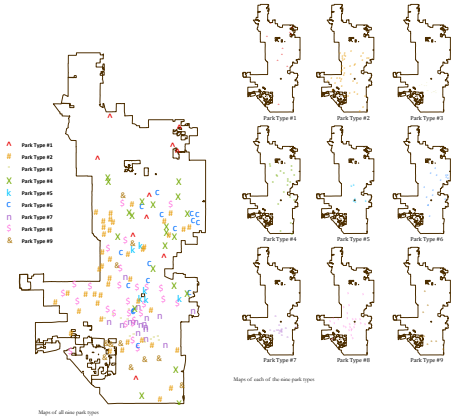
Park Type #9 (n=11): ***Large, high amenity desert parks in low-density neighborhoods***

Associated services→ Provide both social recreational value and native biodiversity and habitat protection.

Planning concerns→ More detailed field work in these parks should be conducted to determine how the ecological value of these larger, desert parks can be increased.

Principal Component Analysis Factors

- **Factor 1:** Neighborhood landuse (parks located in neighborhoods of high urban intensity/diverse landuse mix. Fewer single-family parcels correlated with more multi-family, commercial/industrial, and retail parcels)
- **Factor 2:** Ethnicity & urban location (parks located in affluent, white-dominated neighborhoods with few Hispanic or black residents correlated with large distances from the city center and fewer buildings).
- **Factor 3:** Amenities (parks with a high diversity of amenities overall and likely to contain restrooms, picnic areas, shade areas, playgrounds, and ball courts)
- **Factor 4:** Size, land cover, neighborhood density (smaller parks dominated by trees and grass, in densely populated neighborhoods correlated with less soil cover and fewer paths/trails).
- **Factor 5:** Level of development (highly developed parks dominated by impervious surfaces and buildings, with community centers and pools)



Conclusion

Towards the goal of enhancing the sustainability of cities through urban park planning and design, the specific contributions of this research were three-fold. First, this study applied a nuanced, multi-dimensional analysis of urban parks in Phoenix that moved beyond current simplistic classification schemes to enhance understanding of the physical, ecological, social, built, and spatial characteristics of the individual parks and the park system as a whole. Second, this research provided a place-specific means of quantitatively analyzing urban parks in an arid region that can be adapted for use in any other city based on their specific social, economic, environmental, and climatic conditions, urban form, and public policy goals. And, finally, this study provided a point of departure for the development, realization, and evaluation of public policy and initiatives focused on urban sustainability in Phoenix. Over time, targeted improvements to the Phoenix park system—sensitive to the social, ecological, built, and geographic context of the city—will serve to continually advance the contribution of these critical urban amenities to the sustainability of this unique desert city, making it a model for other large arid urban regions worldwide.

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