Human versus computer based classification of parcel landscape for outdoor water use analysis

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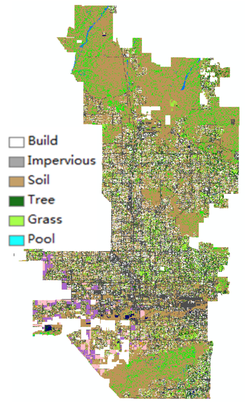
Introduction



1 m land cover map of the city of Phoenix

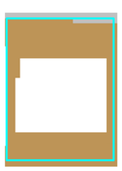
Over the past twenty years, the City of Phoenix has experienced a transition of residential landscapes from green 'mesic' lawns to 'xeric' yards with gravel groundcover. Such landscape transitions can lead to reduced municipal water use. To track these transitions and understand their impacts on water demands, accurate classification of landscape types is critical. One challenge, however, is systematically classifying a large number of parcels into distinct classes that have different water demand profiles in a cost effective way. Cooperating with the City of Phoenix Water Services Department, we compared two classification schemes based on human interpretation of fine-scale aerial photograph and computer-based object-oriented land-cover classification.

Human vs. Computer Based Parcel Classifications

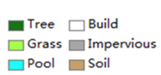
Human-Based Classification (HBC)
Using historical sub-meter 3-bands aerial photograph, staff at the Phoenix Water Services Department have classified the landscape of single-family residential parcels into 6 types based on the percentage of turf cover, total plant cover, and plant types. These classes are: Turf, Extensive plant cover, Moderate plant cover, Sparse plant cover, Arid, and Transition.*

Computer-Based Classification (CBC)
Using 1-meter aerial imagery with 4 bands from 2010, the ASU Environmental Remote Sensing and Informatics Lab created a land-cover map of the Phoenix area using an object-oriented classification method (Li X., et al. 2014). This method automatically assigns image objects into land-cover classes based on spectral, shape, and contextual information. In the residential area, the map contains 6 land cover classes with an overall accuracy of 91%.

Reference
Li, X., Myint, S. W., Zhang, Y., Galletti, C., Zhang, X., & Turner, B. L. (2014). Object-based land-cover classification for metropolitan Phoenix, Arizona, using aerial photography. International Journal of Applied Earth Observation and Geoinformation, 33, 321-330.

The landscape Five Types	HBC	CBC
Turf : turf > 35%		
Extensive : overall plant > 50% turf < 35% tropical plant		
Moderate : overall plant > 50% turf < 35% desert plant		
Sparse : overall plant cover less than the Moderate class		
Arid : The least amount of plant cover		

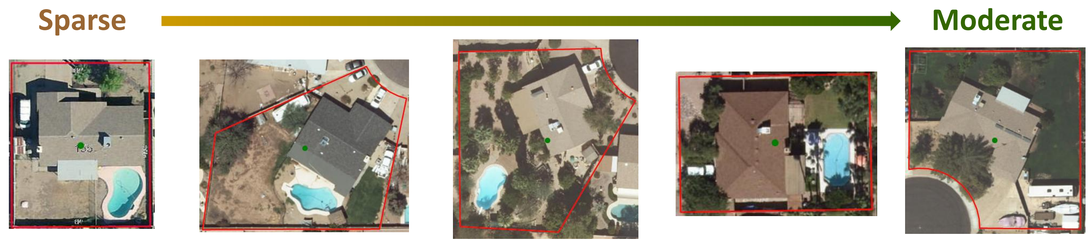
*The Transition category was excluded from the analysis because it is incompatible with the computer-based classification.



Comparative Findings

1 The Highly Varied "Moderate" and "Sparse" HBC Parcels

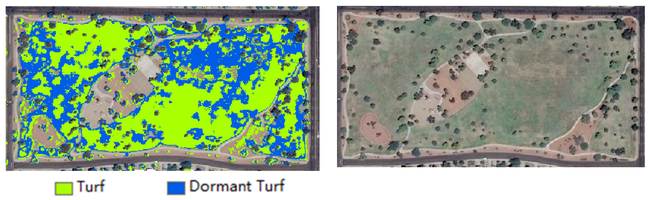
The HBC Moderate and Sparse types have the lowest level of agreement compared to the CBC data. These classes exhibit the largest variations in turf and tree coverage among the 5 types.



Percent Turf	0%	10%	<5%	15%	>25%
Percent Tree	<5%	<5%	35%	20%	>15%

2 Distinguish Dormant Turf from Bare Soil in the CBC Map

The HBC parcels helped distinguish between dormant turf versus bare soil in the CBC map. Previously, the majority of the dormant turf was misclassified as soil in the CBC map due to poor growing condition.



3 Discrepancies between the HBC and CBC Datasets

Classification Attributes		Human Based	Computer Based
Image Attributes	Resolution	0.3 m	1 m
	Year	multiple (2009, 2010)	2010
	Season	multiple	summer
Detectable Landscape Attributes	Land cover %	human judgment	systematic computation
	Tree vs. shrubs vs. turf	discernible	for some conditions, hard to distinguish
	Artificial turf	indiscernible	discernible using near-infrared band
	Plant species	quasi-discernible	indiscernible
	Area under tree canopy	visible in some cases	invisible
Classification Accuracy		accuracy varies by coder; hard to evaluate	accuracy evaluated systematically (91%)
Process Speed		slow	fast

Conclusions

The HBC approach is very labor intensive and slow, but captures more qualitative attributes of the parcel landscape, for example, variations in vegetation types, growing condition, and seasonality. In contrast, the CBC approach is faster and more accurate in estimating the quantitative variation of land covers, but unable to distinguish plant species due to resolution limitation.

Comparing the discrepancies between two landscape classification systems improved both. As detected by the CBC, the huge landscape variations within the HBC Moderate and Sparse types suggest that those classes might be subdivided into more discernable categories to better represent differences in water use. On the other hand, the HBC dataset helped to improve the classification accuracies for turf and soil in the CBC map by detecting dormant turf. This collaborative study lays a solid foundation for further examination of outdoor water use in Phoenix, where landscape designs can substantially affect municipal demands.

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