Ecosystem Services and Smart Growth Planning: Integrating Public Service Costs Into Conservation Planning at the Urban Fringe

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Goal of Research

Develop a methodology that minimizes the costs of urban expansion while meeting targets for the protection of ecosystem services.

In application, how can Tucson grow while “saving” money in public services and protecting key ecosystem services at the same time?
Road Map

Problems and Assumptions
- Land conservation and urban growth
- Study System in S. Arizona

Process and Methodology
- Ecosystem Services
- Public Services
- Spatial Optimization

Results and Take Aways
- Conservation Lands System
- Implications for Future Efforts
Urban and Ex-Urban Growth in the Southwest United States

- In Arizona, population has increased >500% since 1950
- Lowering population densities, greater proportion of land absorption
- Cheaper, larger tracts of land at urban fringe drive development
- Ecological, municipal, and social costs/demands intensify
Growth and Land-use Conflict

- Concentrated at urban fringe
- Municipal tax base matters
- Sprawl is growth, growth is not sprawl
- Growth patterns and land absorption have large implications for ecosystem and public service costs

Population Growth in Pima County, Arizona
The Study System

Eastern Pima County

- Greater Tucson
- > 1 million humans
- ~2.3 million acres
- 32% private land
- Topographically and ecologically diverse
Quick Definitions

Ecosystem Services: Ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being (Boyd & Banzhaf 2006).

Public Services: the commodities (e.g. water, electric) or service (transportation) provided to a community.
Conservation Targets - Ecosystem Services

**Drinking Water**
Proxy: aquifer recharge zones

Dataset: EPA’s DRASTIC Groundwater model (Aller et. al. 1987)

Limitations: Does not account for inter-basin transfers
Conservation Targets - Ecosystem Services

Outdoor Recreation (non-motorized)
Proxy Generalized linear model
Explanatory variables:
- elevation
- distance to major wash
- distance to spring
- distance to major road
- canopy cover
- landscape roughness

Response Variable: Trail locations
The Ecosystem Services

**Food Production**
Proxy: Prime farmland

Dataset: NRCS SSURGO

Limitations: Does not consider drylands agriculture
Conservation Targets - Ecosystem Services

**Biodiversity**
Proxy: Habitat ranges for 38 priority vulnerable species representing the four major vertebrate taxa

**Dataset:** Pima County Science Technical Advisory Team’s habitat models

**Limitations:** Poor indicator for spatial relationships of species richness
Modeling Public Services

Relative Costs of Extending Public Services

Linear Weighted Model

Weights derived from AHP with municipal experts

Roads and water lines are most significant factors

Limitations: Does not consider a density-dependant variable.
Method of Designing Conservation Lands System

The study uses a spatial optimization algorithm called Marxan (Possingham et. al. 2000)

Marxan considers multiple features simultaneously and outputs a mathematically “near optimal” conservation lands system that meets specified targets while minimizing “costs” applied across the landscape

www.uq.edu.au/marxan/
Results

Analysis Highlights

- Existing protected areas capture 11% of important groundwater recharge areas
- 62% of recreation
- Food production absent from committed protected areas
Results

Growth Implications

- 315,164 acres of private or state land excluded from conservation lands
- Growth areas concentrated near urban fringe, with exceptions
Results

Conservation Lands System for Ecosystem Services with Existing Protected Areas

Existing Conservation Lands System with Existing Protected Areas
Implications for Future Efforts

Take Aways

Protected areas are an anchor, but . .

Zoned conservation lands (restricted development via P&Z, Comp. Plan) are essential

Spatial optimization techniques = efficient tool for evaluating and identifying areas for ES conservation

Urban growth considerations (i.e. cost of extending public services) may be integrated into planning
Appreciation for Support and Funding

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