Central Arizona - Phoenix Long-Term Ecological Research (CAP LTER)

First Annual Poster Symposium

January 22, 1999
Arizona Room, Memorial Union
Arizona State University

Sponsored by:
Center for Environmental Studies
Arizona State University

CAP LTER
Agenda
January 22, 1999
Arizona Room, Memorial Union

1:00-1:25 PM	Welcome and Introductions
1:25-1:45 PM	Keynote Address by Dr. John Magnuson, Project Director, North Temperate Lake LTER, Wisconsin
1:45-2:00 PM	BREAK
2:00-2:45 PM	Poster Session #1
2:45-3:00 PM	BREAK
3:00-3:45 PM	Poster Session #2
3:45-3:55 PM	BREAK
3:55-4:05 PM	Concluding Remarks
4:05-5:15 PM	Social with Refreshments

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Poster Session 1 (2-2:45 PM) A-K (17 posters)	Poster Session 2 (3-3:45 PM) L-Z (15 posters)
Baker, Xu, Lauver, McPherson, and Hope	Lauver and Baker
Becker, Ormiston, and Hogan	McDowell and Martin
Brazel and Heisler	McIntyre
Brazel	McIntyre, Rango, Faeth, and Fagan
Clark	Peterson, McDowell, and Martin
Damrel, Pinkava, and Landrum	Pyne, Schmieding, and Amerman
Edmonds and Hope	Robinson, Arrowsmith, Granger, and Phillips
Elser	Stefanov, Ramsey, and Christensen
Figueredo, Chuang, and Graf	Stiles and Scheiner
Gober, Burns, Knowles-Yánez, James, and Blevins	Stutz and Martin
Green, Oleksyszyn, and Farley	Swanson
Holloway	Vining, Gallaher, and Day
Hope, Chan, and Naegeli	Wu and Jenerette
Hostetler, Knowles-Yánez, Ohmart, and Pearson	Wu and Luck
Hostetler and McIntyre	Xu, Baker, and Wolfe
Knowles-Yánez, Moritz, Bucchin, Redman, Fry, McCartney, and Marruffo	Compton, Hunter, and Sommerfeld
Kuby, Matranga, and Conway	

LIST OF POSTERS

Baker, Larry, Ying Xu, Lisa Lauver, Nicole McPherson, and Diane Hope. ***Nitrogen mass balance for the Phoenix ecosystem.***

Becker, Todd, Mike Ormiston, and Tim Hogan. ***The economic value of living near open space.***

Brazel, A. J., and G. Heisler. ***Long-term climate of Baltimore and CAP LTER.***

Brazel, A. ***Simulations of urban climate in Scottsdale, AZ.***

Clark, Kevin. ***Vertebrate species responses to fragmenting habitat in an urban system.***

Compton, Mark, J. Hunter, and Milton Sommerfeld. ***Urban lakes – relationships between source water, lake age, and water quality and biota***.

Damrel, Dixie, Donald J. Pinkava, and Leslie R. Landrum. ***Phoenix flora data base.***

Edmonds, Jennifer, and Diane Hope. ***Spatial and temporal trends in surface waters moving through the Phoenix metropolitan area.***

Elser, Monica. ***CAP LTER K-12 education program.***

Figueredo, Patricio H., Frank C. Chuang, and William L. Graf. ***Analysis of temporal and spatial changes in the upper 48th Street reach of the Salt River using GIS (IDRISI).***

Gober, Patricia, Elizabeth K. Burns, Kim Knowles-Yánez, Jeffrey James, and Karen Blevins. ***Rural-to-urban land conversion in metropolitan Phoenix.***

Green, Douglas M., Michelle Oleksyszyn, and Chris M. Farley. ***CO_2 flux and enzyme activity under two patch type conversion scenarios.***

Holloway, Stephen D. ***Surficial mapping of the Union Hills, central Arizona, based on thematic mapper simulator remote sensing imagery.***

Hope, Diane, Andy H, Chan, and Markus W. Naegeli. ***Nutrient and metal loadings on asphalt parking surfaces of the Phoenix area determined using simulated summer rainfall experiments.***

Hostetler, Mark E., Kimberley Knowles-Yánez, Robert D. Ohmart, and David Pearson. ***Land use and bird distributions in the Phoenix metropolitan area.***

Hostetler, Mark E., and Nancy E. McIntyre. ***Effects of urban land use on pollinator-insect community structure.***

Knowles-Yánez, Kimberley, Cherie Moritz, Matt Bucchin, Charles L. Redman, Jana Fry, Peter McCartney, and Joaquin Marruffo. ***Historic land use team: generalized land use for CAP LTER study area.***

Kuby, Michael, Eric Matranga, and Sheila Conway. ***Sustainability in Scottsdale: geographic analysis of resource and waste flows.***

Lauver, Lisa, and Larry Baker. ***Nitrogen mass balance for wastewater in the Phoenix CAP LTER.***

McDowell, L. Brooke, and Chris A. Martin. ***Plant gas exchange in urban landscapes.***

McIntyre, Nancy E. ***Influences of urban land use on the frequency of scorpion stings in the Phoenix, Arizona, metropolitan area.***

McIntyre, Nancy E., Jessamy Rango, Stanley Faeth, and William Fagan. ***Effects of urban land-use type on ground-arthropod communities.***

Peterson, Kathleen A., L. Brooke McDowell, and Chris A. Martin. ***Frequency and diversity of plant life forms in residential urban landscapes.***

Pyne, Stephen, Sam Schmieding, and Stephen Amerman. ***The ecology of urban fire: a methodological meditation, a research reconnaissance.***

Robinson, Sarah, Ramon Arrowsmith, D. E. Granger, and F. M. Phillips. ***Using cosmogenic dating nuclides to determined the chronology and geometry of alluvial fan deposits.***

Stefanov, William L., Michael S. Ramsey, and Philip R. Christensen. ***Land cover classification of Maricopa County using Landsat thematic mapper data.***

Stiles, Arthur, and Samuel Scheiner. ***The effects of urbanization on plant species diversity of remnant desert patches within metropolitan Phoenix.***

Stutz, Jean C., and Chris A. Martin. ***Arbuscular mycorrhizal fungal diversity along a temporal gradient in Phoenix urban landscapes.***

Swanson, Steven J. ***Predicting biomass in the Phoenix Basin: integrating time series and spatial analysis of environmental data.***

Vining, Erin C., J. B. Gallaher, and T. A. Day. ***Effects of urban ground cover on microclimate and landscape plant performance.***

Wu, Jianguo, and Darrel G. Jenerette. ***Simulating the spatial and temporal dynamics of urban landscapes: model structure and preliminary results.***

Wu, Jianguo, and Matthew Luck. ***Structural characteristics of the CAP LTER landscape in relation to urbanization.***

Xu, Ying, Larry Baker, and Karol Wolfe. ***Temporal and spatial patterns in groundwater nitrogen in the Phoenix CAP LTER watershed.***

Baker, L.[1], Y. Xu[1], L. Lauver[1], N. McPherson[1], and D. Hope[2]. ***Nitrogen mass balance for the Phoenix ecosystem***. [1]Department of Civil and Environmental Engineering, Arizona State University, PO Box 875306, Tempe AZ 85287-5306 and [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

The objective of this study is to develop a preliminary N balance for the Phoenix ecosystem. Key questions are: (1) how much N is being retained, (2) what is the distribution of N loadings among patch types, (3) how does N accumulation change with time? Answers to these questions can provide the basis for a comparative framework for comparing various types of ecosystems.

We are well along in the development a N mass balance for the region. Some tentative conclusions:

1. Areal N inputs vary tremendously in space. A plot of areal input rate (g/m^2-yr) versus % land use ranges over 4 log units along both axis. Points plotted to date fall almost precisely on a straight line. This mathematical nature of the loading-area relationship may eventually be useful as a tool in comparing ecosystems.
2. Deliberate imports (mainly fertilizer and food) are large compared with inputs from surface waters and precipitation.
3. N retention is apparently very high. This reflects the fact that N inputs are added in such a way as to prevent their loss through runoff.
4. The relative importance of N inputs may be changing as wastewater inputs become larger and irrigated agriculture declines.
5. We postulate that most of the N retention occurs in the vadose zone and groundwater. If so, this could be problematic, because N in the vadose zone may eventually reach the groundwater (or the groundwater may rise within the vadose zone).

Becker, T[1], M. Ormiston[1], and T. Hogan[2]. ***The economic value of living near open space.***
[1]Department of Economics, Arizona State University, PO Box 873806, Tempe AZ 85287-3806, and [2]Seidman Research Institute, Arizona State University, PO Box 874006, Tempe AZ 85287-4006.

The purpose of this project is to study the economic value that homeowners place on living near open space within a crowded urban environment.

The analysis employs price information for 1997 and 1998 sales of single-family homes in the area of Scottsdale adjacent to the McDowell Mountain Preserve. The study area borders the McDowell Mountain Regional Park on the west and south of the range. It is bounded by Jomax Road on the north, Pima Road on the west, the McDowell Mountain Regional Park and the City of Fountain Hills on the east and the Salt River Pima-Maricopa Indian Community on the south.

A GIS database is being constructed that combines the home sales data with information about the characteristics of the homes and characteristics of their locations. The information relating to sales price and characteristics of the home are derived from Maricopa County housing sales records. The geographic data has been compiled from a variety of sources including both the City of Scottsdale and the Maricopa Association of Governments GIS databases.

Multiple regression analysis will be used to develop hedonic price models for home prices in the study area. The results of the analysis will provide:

1. Insight into the relative importance to homeowners in the area of adjacency to the Mountain Preserve versus other locational characteristics – e.g., proximity to schools, shopping, freeway access, etc.
2. Statistical estimates of the incremental dollar value that homeowners place on living near the Mountain Preserve.

Brazel, A. J.[1], and G. Heisler[2]. ***Long-term climate of Baltimore and CAP LTER***.
[1]Department of Geography, Arizona State University, PO Box 870105, Tempe AZ 85287-0104 and [2]U.S. Forest Service, Northeast.

An analysis of the climate of the two urban LTER sites in the U.S. was conducted by using the Global Historical Climate Network data of NOAA and other local data sources and references describing and explaining urban climate conditions of the two cities. Rates of urban warming, for example, are considerably different in timing and magnitude, reflecting several factors, such as overall synoptic and regional climate forcings, population density, urban morphology, and land use mosaic patterns. The comparisons of the two cities highlight the integrated and holistic aspect of the urban system that must be understood in order to unravel trends and patterns of parts of the ecosystem – in this case the climate sub-system. A coordinated climate agenda for studies in the future is underway with the present author and the climate LTER representative from Baltimore.

Brazel, A. ***Simulations of urban climate in Scottsdale, AZ.*** Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104.

As part of a City of Scottsdale project, the author simulated urban, suburban, and desert climates and ran some scenarios of change that are typically occurring within the city and its surroundings. Four scenarios were created: (a) reducing percent green spaces, (b) increasing percent shading on heavily asphalted landscapes, (c) reducing the desert surface reflectance in new development areas through decreasing percent desert terrain, and, (d) increasing the surface aerodynamic roughness over typical surfaces as the surface continues to be built up. The results for (a) to (d) indicated significant warming, cooling, warming, and cooling respectively on surface temperatures, thus illustrating the complex nature of microclimatic alterations to be expected as development continues. These data, in concert with global change data, need to be further analyzed to produce a comprehensive understanding of the dynamics between urban ecology, city morphology and fabric, and surface climate.

Clark, K. B. ***Vertebrate species responses to fragmenting habitat in an urban system***. Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

The continued fragmentation of natural environments across the continent has raised concern about the ability of wildlife and ecological communities to persist into the future. Though this process has been studied by researchers in rural landscapes, it has been ignored in urban systems where the problem is often most acute. To address community responses to fragmentation in an urban setting, the vertebrate species present on habitat fragments of various sizes were analyzed in a rapidly growing urban area in the Sonoran Desert. Urban growth around Phoenix, Arizona, over the last 40 years has produced numerous isolated fragments of remnant habitat. Each of these fragments has its own unique vertebrate community, determined by such factors as the fauna present prior to isolation, area of remaining habitat, vegetation characteristics, time since isolation, and distance to other fragments or source populations. These factors can all be used as predictors of how future urban growth will affect desert communities. Diurnal avian, mammal and reptile abundance and diversity were recorded on each of eight fragments and three controls, from May 1998-January 1999. Fragment size ranged from 15 acres to over 500 acres. Factors such as the time since isolation of the fragment, distance to other fragments, and vegetation characteristics were analyzed as predictors of species diversity and abundance. Results will be discussed.

Compton, M., J. Hunter, and M. Sommerfeld. ***Urban lakes – relationships between source water, lake age, and water quality and biota***. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

More than 50 urban lake systems exist in the Phoenix metropolitan area. These systems serve as recreational and aesthetic respites for residential and commercial developments, and frequently as catchment basins for urban stormwater runoff. Lakes with three different types of source waters (canal, well, and reclaimed effluent) and ranging in age from newly constructed to over 30 years are being compared chemically with respect to specific conductance, nutrients (N, P, C), metals (Cu, Zn, Pb), organics (BTEX) and total petroleum hydrocarbons, and biologically for algal biomass and species diversity. The objectives of the research are to determine to what extent (1) source water and increasing urbanization in the watershed influences lake water and sediment quality, and algal biomass and species diversity, and (2) urban lakes are repositories for nutrients and other materials in the urban watershed. Preliminary data on several lakes will be presented.

Damrel, D., D. Pinkava, and L. Landrum. ***Phoenix flora data base***. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

We are preparing a checklist of plants growing within a 40-mile radius of Arizona's State Capitol Building in Phoenix. The boundaries roughly include the following perimeter sites in parts of Gila, Maricopa, Pinal and Yavapai counties: Hassayampa River Preserve, Lake Pleasant, Seven Springs, Tortilla Flat, western part of the Superstition Mountains, Sacaton, just north of Casa Grande, and Gila Bend. The vegetation here is predominantly Upper Sonoran Desert Grasslands and Pinyon-Juniper zones on its mountain "islands." Our checklist has been organized into two separate databases, one devoted to native/established alien plants and the other devoted to cultivated plants. There are also divisions within each database: four unequal sections for the native plants and two halves for the cultivated plants, which are used to determine the localities of the specimens in the study.

Goals. The goals of this study are:

1. To provide a baseline database of what native and cultivated vascular plants grow in this area and their locations within the various quadrants; and
2. For the study of changes that might occur during the 21st century, one of the goals of the Central Arizona - Phoenix Long-Term Ecological Research project (CAP LTER).

Although the project is currently incomplete, to date approximately 1,000+ native taxa and 770+ cultivated taxa have been documented and entered into the checklist database. Various fields describe each species and may include the following: *taxonomy*- family, genus name, species and infraspecific epithets, authors, common names; *geography*- presence/absence in certain county and city parks and other specific sites; *habit*- tree, small tree, shrub, subshrub, vine, perennial herb, annual herb, bulb. The database can be queried to compare and contrast taxa according to any one of the various fields described above.

Edmonds, J.[1], and D. Hope[2]. ***Spatial and temporal trends in surface waters moving through the Phoenix metropolitan area***. [1]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501 and [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

The surface water monitoring project assibilated with the CAP LTER has been in place since February 1998. Building on the previous USGS program that sampled surface waters flowing into Phoenix and waters exiting the city from 1995-1997 (essentially along a native desert to urban gradient), the LTER sites and sampling protocol are almost identical. This congruency allows researchers to combine the USGS data with the data collected by the LTER, extending the temporal record at each site. Water samples are analyzed for a variety of chemical constituents. The initial objective of the project is to initiate and develop a field sampling program designed to answer the following questions:

1. What are the concentrations and amounts of key nutrients, salts and trace metals being imported to and exported from the CAP LTER urban areas in surface water (river and canal)?
2. How do these terms change over time in response to increasing urbanization and variations in climate?

Data from the seven sites currently being sampled on a monthly basis are supplemented by six other sites that have been chosen for sampling during flood events only, because they only flow when there is significant overland transport of water. Fluxes at each site will be calculated by multiplying daily discharge (volume of water passing a point along the stream) data collected by USGS gauging stations by the concentration of the chemical constituent of interest.

Data analysis to this point indicates that waters entering the city are high in salts, have a pH around 8, are low in nutrients and metals, and have moderate concentrations of dissolved organic carbon (DOC). Water found exiting the 91st Avenue treatment plant, in the Buckeye Canal, and in the Hassayampa River (all three of which are urban, impacted sites) have an average pH of 7.0, 7.7, and 8.2, respectively. These mid waters (along the native desert to urban gradient) have even higher salt concentrations than the input waters, and are higher in nutrient (organic and inorganic) and DOC. Particulate organic carbon (POC) and nitrogen (PON) are low in the input waters, then jump an order of magnitude or more once they reach the Buckeye Canal. Concentrations in the Gila River water at Gillespie Dam (the output to the whole metro system) are higher than input concentrations or the mid-city concentrations for inorganic N, total N, PON, POC, sulfate, chloride, and magnesium. Gila River ammonium concentrations are low. Spatial trends suggest that engineered features are influencing water moving through the city, as is the spatial configuration of agriculture in relation to sampling sites. Temporal analyses suggest that rain events transport high amounts of some measure constituents (DOC, Cl, sulfate) into surface waters, supporting the idea that disturbance events control surface water chemistry.

Elser, M. ***CAP LTER K-12 education program***. Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

Ecology Explorers, the K-12 education outreach program has been working with teachers from several elementary, middle, and high schools across the Valley to incorporate long-term monitoring in their schoolyards. Several classes have collected population data on birds, ground arthropods and bruchid beetles. Some of this data, as well as other material created by the students and teachers will presented.

Figueredo[1], P. H., F. C. Chuang[1], and W. l. Graf[2]. ***Analysis of temporal and spatial changes in the upper 48th Street reach of the Salt River Using GIS (IDRISI)***.
[1]Department of Geology, Arizona State University, PO Box 871404, Tempe, AZ 85287-1404, and [2]Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104.

As part of a class project for Geographic Information Analysis, we have studied historical and temporal changes in a one-mile stretch of the Salt River using a combination of aerial photo interpretation, GIS (IDRISI), and field work. The study area covers the section of the river between 48th Street in Phoenix and Priest Drive in Tempe. Major changes in channel morphology which affect the natural evolution of the river occur naturally (during flood events) and from human activity.

From our analysis of aerial photos, it appears that the river expanded laterally during major floods such as those in 1978 and 1980. To control expansion, engineering work performed after the 1983 flood confined the active river channel to one-fourth of its normal size between two artificial levees. This activity caused: 1) severe constriction of the channel which increased both the energy and erosive power of subsequent flows and 2) homogenization of fluvial structures and sediment in the river bed. Human activity along this stretch of the Salt River has increased with the rise in urbanization. Several structures have been built over time which has accompanied urban development: 1) bridges which cross the Salt River at Hohokam Expressway and Priest Drive, 2) the 1890 Jointhead Dam, and 3) engineered barriers designed to divert flow and prevent channel widening during flood periods.

Using IDRISI GIS software, we have developed locational probability maps of the study area showing where the greatest potential for water flow will be in the future. In the process of developing these maps we have defined six major morphological units which include three classes of channels: high, middle, and low. Areas of high probability tend to follow the natural bend of the river towards the northwest. Lower probability areas occur along the southern margin on the east side of the reach. With the exception of a few low probability areas along the southern margin, little variation of the low flow channel has occurred. Although channelization has reduced the width of the river, low flow will continue to follow the northwest trend in the immediate future. We have also used IDRISI to calculate the area occupied by each major morphological unit in the active channel, as interpreted from aerial photos. From our area calculations, it appears that a relatively consistent proportion of the major morphological units had developed before channelization. This trend changed, however, when channelization reduced the active channel width and caused water to flow at a higher velocity across the entire river.

Gober, P.[1], E. K. Burns[1], K. Knowles-Yánez[2], J. James[1], and K. Blevins[1]. ***Rural-to-urban land conversion in metropolitan Phoenix***. [1]Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104 and [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

This paper focuses on the conversion of rural land into urban uses and explores this process, first, from the perspective of housing unit growth, and second, from the perspective of population growth between 1990 and 1997 for metropolitan Phoenix. We find that Phoenix behaves like a metropolitan donut with new home construction concentrated at the outskirts and housing loss in the center. Intense activity occurs along a fairly well-defined line of new development at the urban fringe. Farther out appears to be a zone of moderate development that has not yet been inundated by new home construction. Closer in is an area whose period of intense development is now past. The pattern of population change reveals that population gains and losses are interspersed throughout the urban fabric. From a population perspective, 1990 and 1995 land consumption rates and land absorption coefficients for 1990-1995 identify two types of local community, those that grew by turning over more land to urban uses and those that grew by infilling land that was already urban. Our long-term goal is to identify how communities affect development patterns by their policies. Our initial survey identifies community land use and development policies at the urban fringe, but does not establish a clear link with the character of urban fringe development. Our next steps involve identifying the extent of the invisible fringe beyond the line of new development by examining landownership records at three field sites.

Green, D. M.[1], M. M. Oleksyszyn[2], and C. M. Farley[3]. ***Soil CO_2 flux and enzyme activity in residential patch types of differing origins***. [1]School of Planning and Landscape Architecture, Arizona State University, PO Box 872005, Tempe AZ 85287-2005, [2]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601, and [3]School of Natural Resources, Colorado State University, Ft. Collins CO.

Soil CO_2 flux rates and enzyme activity vary with factors such as moisture regime, temperature, and soil type. We hypothesized that CO_2 flux rates and enzyme activity would differ between residential patch types of differing origin. Our study sites consisted of xeriscaped and mesiscaped yards in developments built on agricultural sites and xeriscaped and mesiscaped yards in developments built on desert remnant sites. Control sites were an alfalfa field and a desert remnant. Each site was replicated three times. Soil CO_2 flux rates were determined with an infrared gas analyzer at 10 sites within each site. The activity of three enzymes, cellulase, xylanase, and invertase was determined. All measurements were made on a monthly basis. CO_2 fluxes across all sites ranged from 0.03 to 1.71 g CO_2 $m^{-2}h^{-1}$. The lowest rates of CO_2 flux occurred on the desert remnant sites while highest rates occurred in the desert mesiscaped sites. Due to high within site variability no significant differences occurred between patch types of differing origin. This variability was probably due primarily to differences in water regime and fertilizer inputs coupled with relatively short response time of soil organisms to changes in the soil environment. Soil enzyme activities were significantly higher in mesiscaped sites of both agricultural and desert origin than other sites examined. This is probably due to homeowner inputs of water and fertilizer necessary to maintain grassed areas.

Holloway, S.D. ***Surficial mapping of the Union Hills, central Arizona, based on thematic mapper simulator remote sensing imagery.*** Active Tectonics and Quantitative Structural Geology and Geomorphology Group, Department of Geology, Arizona State University, PO Box 871404, Tempe AZ 85287-1404.

This study uses remote sensing and field mapping to aid in the understanding of the extent and development of river and piedmont deposits and potential geologic hazards of the Union Hills, central Arizona. Traditional surface mapping is based on air photo analysis and field studies. This study incorporates Thematic Mapper Simulator (TMS) remote sensing imagery with 3-m resolution to enhance the detail and accuracy of the final map. In addition to aerial photos, this study uses TMS data, which has 12 bands that cover the visible, near-infrared, and thermal wavelengths (0.42-14.0 mm). Band combinations and ratios enhance differences in iron content, varnish development, clay content, and vegetation, based upon free silica, type of silicate bond, and carbonate and clay content. Thus, the data can be used to effectively discriminate among surficial units in methods unavailable to traditional air photo analysis. Surface units are separated into river and piedmont deposits and are characterized by their clast composition, soil development, rock varnish development, desert pavement development, vegetation, surface roughness, drainage development, and relative elevation. River deposits of the Union Hills include active channels and adjacent river terraces and are related to the development of the nearby Cave Creek drainage. Piedmont deposits are shed onto gently sloping, broad plains that extend down from the mountain front to the basin floor. Relatively young alluvial surfaces become increasingly extensive downslope on the piedmonts of the Union Hills. The oldest surfaces are found along the mountain front while the youngest surfaces are dominant adjacent to the main drainages. This distribution suggests a general tendency toward erosion punctuated by periods of equilibrium or aggradation. Potential geologic hazards consist of flooding and erosion along Cave Creek, Skunk Creek, and their larger tributaries, and flash flooding associated with the smaller tributary streams that flow across the piedmonts of the area. Cave Creek is capable of generating large floods, and its principal tributaries can generate smaller, but still significant, 100-year floods. These floods involve deep, high-velocity flow in the channels, inundation of overbank areas, and may cause substantial bank erosion along the channels. Flood hazards associated with smaller tributaries are subdivided into: 1) localized flooding along well-defined drainages, where there is substantial topographic confinement of the wash, and 2) widespread inundation in areas of minimal topographic confinement (e.g., active alluvial fans). The extent of young piedmont deposits is an accurate indicator of areas that have been flooded in the past few thousand years. These are areas that are most likely to affect the encroaching development of the Union Hills.

Hope[1], D., A. H. Chan[2], and M. W. Naegeli[3]. ***Nutrient and metal loadings on asphalt parking surfaces of the Phoenix area determined using simulated summer rainfall experiments***. [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211, [2]ECOREU-Program, University of California, Berkeley CA, and [3]Department of Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

The chemistry of urban runoff from impervious asphalt parking lot surfaces embedded within different land uses (desert, industrial, commercial, residential) was characterized to determine if these surfaces are likely to be significant contributors of urban pollution to received waters. A rainfall simulator was used to produce 5-minute rainfall events (intensity equivalent to 6.2 inches hr^{-1}) from which runoff was collected in a 'mini-watershed' (surface collection area of 0.29 m^2). The runoff was collected using a Geopump and analyzed for major nutrients (C, N, P) and selected trace metals (Cu, Pb, Zn). The variability in surface loadings was examined with respect to land use, traffic type and density, surface slope, pavement condition and distance to the nearest curb. The nutrient loading data were also compared with results obtained for a similar experiment carried out on an undisturbed natural desert soil surface. Results showed that both nutrient and trace metal loadings on asphalt parking lot surfaces vary considerably within sites, with NH_4-N and NO_3-N, particulate C and Zn loadings also showing significant differences between site types. Dissolved nutrients, Zn and particulate C showed a significant correlated with pavement condition; NO_3-N and Zn also differed significantly with traffic type. Dissolved nitrogen loadings measured in asphalt runoff were dramatically higher than for desert soil (approx. 200x for NO_3-N and 30x for NH_4-N), while soluble reactive phosphorus showed no such difference. A repeated wash-off simulation was conducted to determine the proportion of the total 'rain transportable' load sample during the 5 minute rainfall experiments. The results of this further experiment will be discussed and suggestions for future work will be presented.

Hostetler[1], M., K. Knowles-Yánez[1], R. D. Ohmart[2], and D. Pearson[2]. ***Land use and bird distributions in the Phoenix metropolitan area***. [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211 and [2]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501.

No long-term study exists about the effects of landscape structure on bird distributions in urban areas. The goals of this project are (1) to document the changes in avian richness and abundance over time and space, and (2) to determine the biotic/abiotic and socio-economic factors that cause these changes to occur. Using a stratified random sampling strategy, we have established thirty, 1-km transects in four key habitats within the Phoenix metro area. These habitats are desert remnants, new residential neighborhoods, old residential neighborhoods, and golf courses. In addition, approximately 35 volunteers have established transects and are censusing residential areas from Sun City to Apache Junction. Since 1 May 1998, each transect has been censused 3-4 times per month and we plan to continue censusing until 1 May 1999 (and continue for a number of years thereafter). Data is being stored in the LTER database and we are currently analyzing the data to address a number of different ecological variables that could affect the distribution of birds. We are also placing the results of the surveys on the web so that people can access it and view LTER census results.

Hostetler, M. E., and N. E. McIntyre. ***Effects of urban land use on pollinator-insect community structure.*** Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

We are comparing the diversity of pollinator insects in four different types of urban land use in the Phoenix metropolitan area: xeriscaped residential yards, mesic residential yards, urban desert-remnant parks, and desert areas on the fringe of the city. This study, a work in progress, will hopefully answer the following questions: (1) How does the ratio of native species to the exotic honeybee differ among natural desert, urban desert remnants, and residential areas that also have flowering plants? (2) How does insect pollinator community structure (richness and abundance) differ among natural desert, urban desert remnants, and residential areas? (3) How does insect pollinator community structure differ with different residential horticultural practices (xeriscaping with native plants vs. watered lawns with exotic species)?

Knowles-Yánez, K.[1], C. Moritz[2], M. Bucchin[3], C. Redman[1], J. Fry[4], P. McCartney[5], and J. Marruffo[3]. ***Historic land use team: generalized land use for CAP LTER study area.***
[1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211, [2]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601, [3]School of Planning and Landscape Architecture, Arizona State University, PO Box 872005, Tempe AZ 85287-2005, [4]Information Technology, Arizona State University, PO Box 870101, Tempe AZ 85287-0101, and [5]Archaeological Research Institute, Arizona State University, PO Box 872402, Tempe AZ 85287-2402.

The Historic Land Use team of the Central Arizona - Phoenix Long-Term Ecological Research (CAP LTER) project at Arizona State University used GIS software and diverse data sources to produce maps showing generalized desert, agriculture, and urban land uses for the Salt River Valley/Phoenix metropolitan area for the following approximate time periods: 1912, 1934, 1955, 1975, 1995. In addition to other data sources, each map utilizes a topographic relief image as its background and shows streams and lakes taken from the Arizona Land Resource Information System (ALRIS) database, provided by the Arizona State Land Department. Maps and data tables created are available for use by other CAP LTER researchers.

Kuby, M., E. Matranga, and S. Conway. ***Sustainability in Scottsdale: geographic analysis of resource and waste flows.*** Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104.

This report analyzes current geographic patterns of water and energy use and hazardous waste generation in Scottsdale, Arizona. Using GIS and multiple regression, we compared areas of recent construction with older areas and found that energy consumption per dwelling increases significantly from older to newer areas, mainly because the newer homes are larger. Factoring out the size of the homes, no reduction of energy use per square foot can be detected in the newer homes, despite advances in technology. Water use, on the other hand, neither increases nor decreases significantly from older to newer areas. For hazardous waste, there are conflicting trends. The toxic releases by large quantity generators in Scottsdale have plummeted in response to Federal regulation, but the number of poorly regulated small quantity generators has mushroomed. Toxic releases by these smaller companies are unknown. The report concludes that technological improvement in energy and water use is being offset by increasing affluence, and that any move towards sustainability will require either much greater economic incentives to producers and consumers, or stricter regulation. Completion of this spatial database opens up numerous opportunities for future research work, including analysis of the economic effects of the urban heat island. This research was funded by NASA's Mission to Planet Earth/Science Applications Program, and was conducted in collaboration with the City of Scottsdale's Advanced Technology Group.

Lauver, L., and L. Baker. ***Nitrogen mass balance for wastewater in the Phoenix CAP LTER.*** Department of Civil and Environmental Engineering, Arizona State University, PO Box 875306, Tempe AZ 85287-5306.

This project was supported in part by the Women in Science and Engineering Program. The purpose of this study is to investigate the possible accumulation of nitrogen in the watershed surrounding the Phoenix metropolitan area due to recharge and reuse of treated effluent. Traditionally, wastewater treatment plants discharged their effluent into rivers or streams. Any nitrogen in the effluent was then transported out of the local area. Now, increasing amounts of treated wastewater are being reused in the communities that produced them. In the Phoenix area, treated effluent is used as irrigation water for landscaping, golf courses, or agricultural crops. Effluent is also used as cooling water for industrial plants. Sometimes the effluent is directly recharged into underground aquifers via percolation ponds or injection wells. Any nitrogen that is in the reused/recharged water does not leave the local ecosystem, as it traditionally would have. An accumulation of nitrogen in the watershed is potentially hazardous. Nitrates in drinking water are known to be a health hazard to infants.

This study focused on effluent produced during the year 1997. Flow and nitrogen data was collected for 18 municipal wastewater treatment plants in the Phoenix metropolitan area. Together, these facilities handled 98% of the organic wastewater flow in 1997 in the Valley. Each site was surveyed to find out what treatment methods were being used and how effluent and biosolids were disposed of. Data on amounts of flow and nitrogen levels in the effluent were obtained from either Arizona Department of Environmental Quality records or plant records.

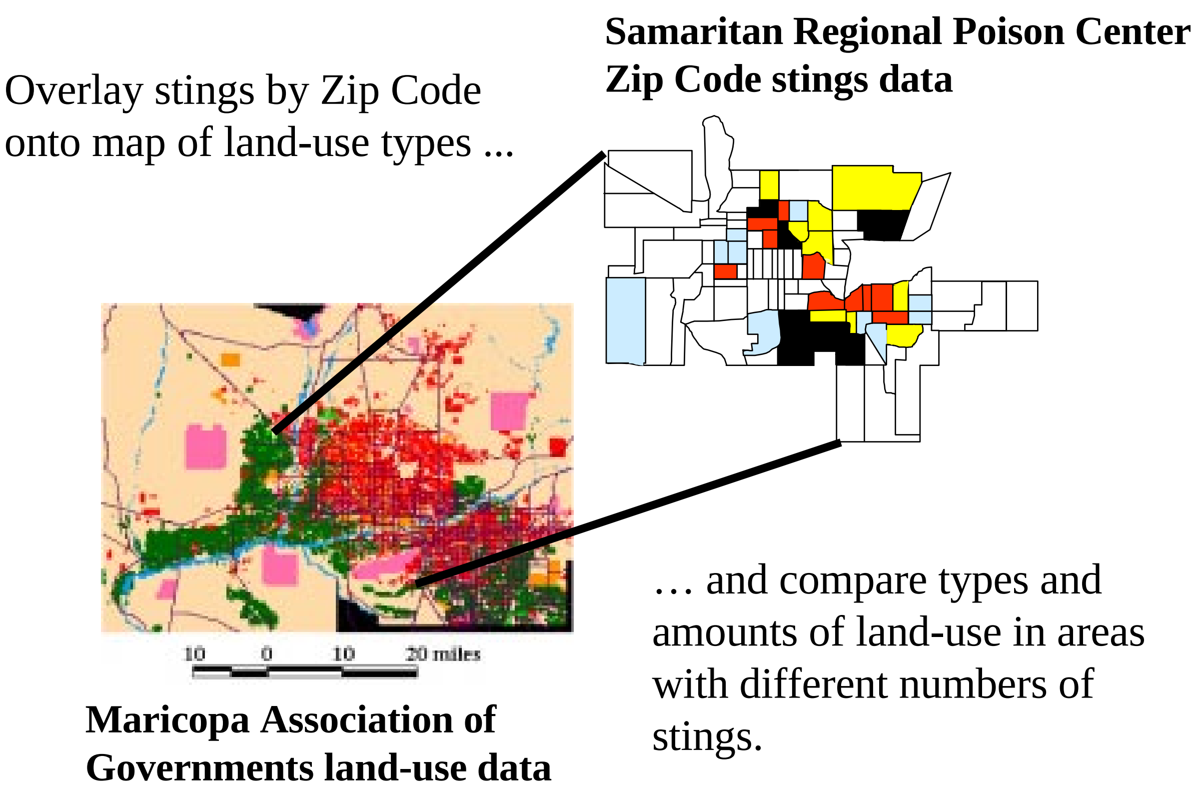
The study results show that 29% of the treated effluent was reused or recharged. Another 24% was used for cooling by the Palo Verde Nuclear Power Plant. The remainder, 47%, was discharged into a river. In terms of nitrogen, 37% of the total nitrogen in the effluent was retained in the Phoenix area ecosystem, and 36% was in effluent discharged to a river. The remaining 27% of total nitrogen went to the Palo Verde plant, where it is effectively taken out of the system because no cooling water is permitted to leach into the soil.

McDowell, L B., and C.A. Martin. ***Plant gas exchange in urban landscapes***. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

Comparisons of maximum gas exchange fluxes were made from July to December, 1998, for landscape plants in a factorial patch matrix of formerly desert or agricultural land uses and xeric or mesic residential landscapes. Remnant desert sites adjacent to residential communities and an alfalfa agricultural field were patch controls. Residential landscape and alfalfa plants were irrigated regularly. Monthly instantaneous measurements of leaf and stem carbon assimilation (A), conductance (gs), and transpiration (E) were made with a portable infrared gas analyzer on plants within three site replicates of each patch type. The time-of-day for maximum photosynthesis was estimated based on preliminary measurements of diel gas exchange patterns. Gas exchange parameters changed seasonally. In general, A fluxes were lowest in December and highest in October. Additionally, E fluxes and gs were highest in July and declined each month thereafter. Gas exchange parameters were also affected by patch type. Assimilation fluxes were not related to former land use, but were higher for plants in mesic compared with those in xeric landscapes. Transpiration fluxes were higher for plants in formerly agricultural sites compared with those in formerly desert sites, and higher for plants in mesic than for those in xeric landscape designs. Compared with plants in residential landscapes, fluxes of A and E were lower for plants in remnant desert sites and higher for alfalfa plants. Instantaneous transpiration efficiency (ITE) increased seasonally during the study period and was negatively correlated with shoot temperature ($r = -0.65$). ITE was greater in formerly agricultural sites than in formerly desert sites but was not affected by landscape design. Concomitant seasonal increases in A and decreases in gs suggest that maximum landscape plant carbon assimilation under well-watered conditions was not limited by shoot conductance, but was more responsive to seasonal cooling. Monthly maximum gas exchange, residential irrigation volumes and continuous micrometeorological data will be collected at these and additional sites for a minimum of three years to evaluate carbon assimilation and water use efficiency in various urban landscape patch types.

McIntyre, N. E. ***Influences of urban land use on the frequency of scorpion stings in the Phoenix, Arizona, metropolitan area.*** Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

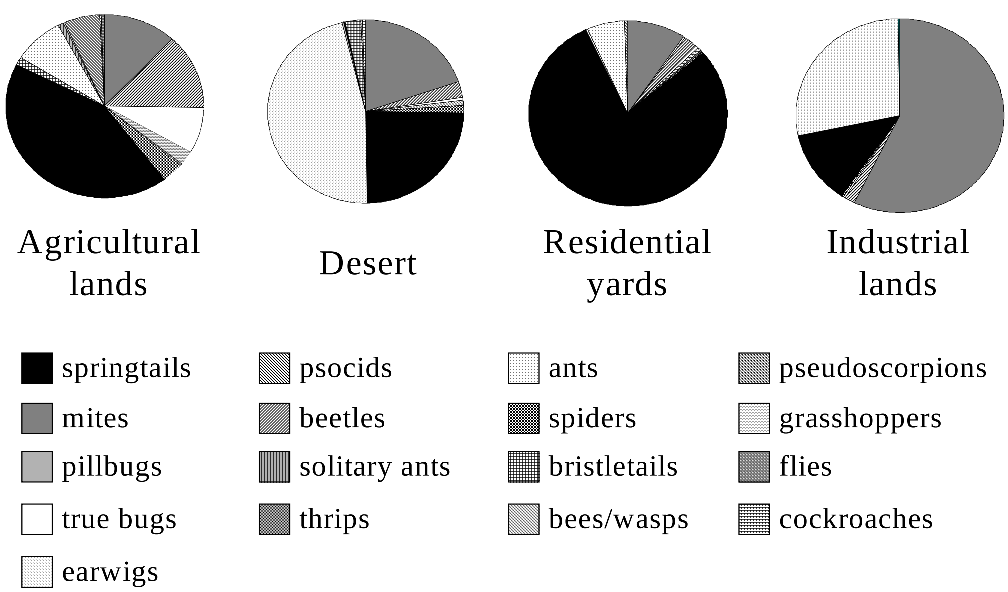
Between 3,000-4,000 people report being stung by scorpions each year in the Phoenix, Arizona, metropolitan area, but the frequency of stings is not distributed evenly across the metro area: certain portions of the city consistently report higher numbers of scorpion stings. I overlaid data from the Phoenix Samaritan Regional Poison Center about the number of scorpion stings per Zip Code onto a Geographic Information System coverage of land use in the Phoenix metro area. I then compared the types and amounts of land use among Zip Codes that differed in the number of scorpion stings. The number and geographic location of scorpion stings in the Phoenix metro area was reflected in the presence and abundance of some forms of urban land use. Density of single-family homes and proximity to undeveloped open space were good predictors of the frequency of scorpion stings; other forms of land use were unrelated to the number of scorpion stings in an area. These results suggest that undeveloped areas may act as sources for urban scorpions. It is hoped that these results may shape future urban development in Phoenix so as to minimize human-scorpion contacts.



McIntyre[1], N. E., J. Rango[2], S. Faeth[2], and W. Fagan[2]. ***Effects of urban land-use type on ground-arthropod communities.*** [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211, and [2]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501.

The richness and abundance of ground arthropods are being systematically monitored at 16 sites in the Phoenix metropolitan area. Using pitfall traps, arthropods are being collected over a 72-hr period once a month from four different types of urban land use: residential, industrial, agricultural, and desert remnant. Currently in its pilot phase, this long-term monitoring is providing fundamental information about how various facets of urbanization affect the diversity and distribution of ground arthropods, which may have important ramifications on ecosystem-level trophic dynamics, nutrient cycling, and other functions from the diverse roles that arthropods play in ecosystems. Relationships among site, habitat type, location within the metro area, average body size, and trophic position are among the topics under current investigation. Preliminary results from data collected in June 1998 show that the most abundant arthropods are <2mm in total body length. Agricultural sites had the greatest number of taxa, followed by desert-remnant, industrial, and residential sites; however, there were no significant differences in richness among land-use types when captures were standardized by trapping area. Predators and herbivores were most abundant in the agricultural sites, whereas scavengers were most abundant in desert-remnant and industrial sites, and detritivores were found primarily in residential areas. The greatest abundance of ground arthropods was collected at industrial sites, followed by residential, agricultural, and desert-remnant sites, but the numbers of individuals collected per taxon were the most evenly distributed in the desert-remnant sites. There were no differences in the average number of taxa captured in different portions of the metropolitan area. Sampling has revealed a diverse arthropod fauna that is characteristic of each of the four types of urban land use, which may be useful in indicating latent effects of urbanization.

relative abundances of ground arthropods by land use (Phoenix, AZ, June 1998):



Peterson, K. A., L. B. McDowell, and C. A. Martin. ***Frequency and diversity of plant life forms in residential urban landscapes.*** Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

Residential urban landscapes provide an ecological community structure governed by human influence. Plant preference is often more anthropocentric than ecological and this is seen in the prevalence of green residential landscapes, even in desert climates. Landscape schemes containing desert-adapted species are termed “xeriscape.” while those containing “high water use” species and turf are termed “mesoscape.” Tree, shrub, and ground cover frequency, species diversity, canopy cover, and monthly irrigation application data were collected from six xeriscape and six mesoscape residential landscapes of similar age in south Tempe and Phoenix suburbs. Mesoscapes had significantly more trees and shrubs and a higher percentage of canopy cover per landscaped area than xeriscapes, but species diversity was similar for both landscape types. Monthly irrigation application volumes per landscaped area were higher for xeriscapes than mesoscapes, even though mesoscaped sites contained more plants. Human landscape preference may be ecological in principle, but in practice, it appears that using desert-adapted species in residential settings does not conserve water. In the future, we plan to expand our monitoring of residential landscape watering practices, and study the effects of socio-economic factors and time since development on landscape vegetation patterns.

Figure. A representative Phoenix xeriscape and mesoscape.

Pyne, S., S. Schmieding, and S. Amerman. ***The ecology of urban fire: a methodological meditation, a research reconnaissance.*** Department of History, Arizona State University, PO Box 872501, Tempe AZ 85287-2501.

Urban fire today involves two ecologies: that of cities and that of industrialization. It is clear that, until modern transport drove them outward, cities had a fire ecology, that they burned in roughly the same rhythms as the surrounding countryside that supplied building materials. A formal analogy is possible with agricultural burning regimes.

Industrialization has radically reconstructed urban fire, as it has virtually every other fire habitat. For fire studies the definition of industrialization is simple: it means the substitution of fossil biomass for living biomass. Accordingly, open burning is receding from urban landscapes, although combustion persists as an ecological driver and open fire remains a kind of strange attractor, affecting the design of every building by its threat.

Phoenix offers the opportunity to study a city built almost from its origins along the principles of industrial fire. Our research has evolved in two directions: one, a conceptual exploration of what urban fire ecology might mean, and two, a reconnaissance of data and archival sources for pursuing that inquiry with more detail.

Robinson, S. E.[1], J. R. Arrowsmith[1], D. E. Granger[2], and F. M. Phillips[3]. ***Using cosmogenic nuclides and remote sensing to determine the chronology and geometry of alluvial fan deposits*.*** [1]Geology Department, Arizona State University, PO Box 871404, Tempe, AZ 85287-1404, [2]Earth and Atm. Sciences Department, Purdue University, West Lafayette IN 47907, and [3]Hydrology Department, New Mexico Institute of Mining and Technology, Socorro NM 87801.

The piedmont of the White Tank Mountains, Arizona, provides an ideal site to study piedmont development, timing of Quaternary incision and aggradation, and magnitudes of sediment flux. This piedmont consists of sediment packages deposited by debris flows and braided streams to form coalescing alluvial fans during the Quaternary. The current focus of this study is the application of cosmogenic dating to produce numerical dates for the deposits that will help constrain age ranges determined with relative dating techniques.

Field studies and analysis of remote sensing data resulted in a Quaternary map of the geometries and relative ages of the deposits. This study used NS001 data (7 bands, 0.458 to 2.38 mm) and TIMS data (6 bands, 8.2 to 12.2 mm). The most discerning algorithms for the Quaternary units were NS001 (742) and NS001 (6*3/4*4, 7*6/5*5,1). They appear to rely heavily on information contained in the near infrared such as iron-oxide absorptions and absorption bands of hydroxyl-ions in minerals.

The Quaternary map produced was used to assign approximate ages using relative dating techniques. The three major Quaternary units are Old (O) which is greater than 1000ka, Middle (M) which is 10-1000ka, and Young (Y) which is less than 10ka. In order to determine numerical ages we have sampled for cosmogenic nuclides in two depth profiles: one, 8.8 meters deep in the O deposit and a second 5.4 meters deep in the oldest M deposit. A total of 36 AMS isotopic nuclide measurements were made for 10Be, 26Al, and 36Cl on 26 samples.

Using three nuclides and both surface and depth samples allows us to attack the question of deposit age from several directions. First, these results will be used to test the applicability of Be/Al burial dating in shallow, alluvial fan sediments. Second, the multiple samples per deposit, both at the surface and at several depths, allows multiple age calculations to be made for each deposit. Lastly, by measuring three isotopes for an individual sample or depth we can attempt to determine not only a numerical age, but also erosion rate and inheritance. These three variables should aide in developing a better understanding of both the timing of aggradation and incision and the processes by which alluvial fans form and degrade. We expect to determine the applicability of this general approach on piedmont deposits, specific information about the White Tank piedmont, and eventually compare the chronology of this piedmont to others.

*Originally published as: Robinson, S. E., J R. Arrowsmith, D. E., Granger, and F. M. Phillips, 1998, Using Cosmogenic Nuclides and Remote Sensing to Determine the Chronology and Geometry of Alluvial Fan Deposits, *EOS Transactions AGU*, v. 79, no. 45, p. F967.

Stefanov, W. L., M. S. Ramsey, and P. R. Christensen. ***Land cover classification of Maricopa County using Landsat Thematic Mapper data***. Geological Remote Sensing Laboratory, Department of Geology, Arizona State University, PO Box 871404, Tempe AZ 85287-1404.

The Central Arizona - Phoenix Long-Term Ecological Research (CAP LTER) Project is modeling urban centers as discrete ecosystems. The large areal extent of the CAP LTER site presents a challenge for collection of ecological, geological, and physiographic data necessary for the variety of investigations that comprise the project. Remote sensing offers a viable alternative to costly and time-consuming field collection of these data, and will allow for temporal monitoring of surficial changes in the study area.

The primary focus of the remote sensing pilot study is to generate land cover and land use maps for the Maricopa County portion of the CAP LTER study area. Landsat Thematic Mapper (TM) data collected from 5/10/93 to 6/20/93 form the base dataset used in the pilot study. The TM data consist of 28.5 m/pixel resolution reflected radiance collected in six wavelength regions ranging from visible to near-infrared. Selected bands of the TM data were ratioed to highlight variations in surficial material composition such as presence of hydroxide, opaque materials, and iron-bearing materials. These ratios were chosen as they are sensitive to variations in both natural and man-made materials. A land cover classification scheme was devised in collaboration with CAP LTER researchers based on the input data needs for various ecological models.

A ratio image of the east-central Phoenix and Tempe area was used to examine the classification methodology. A variety of classification rules were tested including unsupervised ISODATA, supervised minimum distance, and supervised maximum likelihood. Accuracy of the classified ratio image was assessed using the 1995 Maricopa Association of Governments (MAG) Land Use GIS data coverage as the reference dataset (augmented with field verification). Comparison of land cover based classification maps to a land use based reference dataset necessitated the generation of a correlation matrix for use in accuracy assessment. The maximum likelihood classification rule was found to obtain the highest accuracy (71%) for this region. The correlation matrix indicated that significant overlap exists between several land use classes and land cover types that contributes to classification inaccuracy, along with temporal variations between the 1993 TM data and the 1995 reference data.

The second (and current) phase of the pilot project consists of more rigorous application of the developed techniques to the entire Maricopa County region (and ultimately the entire CAP LTER site). A mosaic of portions of three TM scenes covering Maricopa County has been constructed, corrected for atmospheric scattering, and converted to calibrated reflectance. Land cover classification maps have been generated using both the ratio technique described above and the calibrated reflectance data to assess the accuracy of both base datasets. These land cover maps are currently undergoing accuracy assessment using the MAG database and field verification.

Stiles, A.[1], and S. Scheiner[2]. ***The effects of urbanization on the plant species diversity of remnant desert patches within metropolitan Phoenix.*** [1]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

The vascular plant species within undeveloped remnant patches were sampled in order to assess the impact of habitat fragmentation on relict desert community species diversity within the urban matrix of the CAP LTER study area. Metropolitan Phoenix provides a unique opportunity for studying the ecological consequences of urban sprawl upon Sonoran Desert plant communities. The large spatial dimensions occupied by the city and its settlement patterns have allowed an abundant collection of parks and preserved areas, in a wide assortment of sizes, to remain intact. This relatively high number of remnant patches will allow us to test for correlations of species diversity with a range of landscape level parameters, including spatial characteristics of the patch (e.g., surface area, fractal dimension), connectivity of patch clusters, time since patch formation, and disturbance. For each study area, we will create a patch level estimation of species diversity through field sampling of representative habitats found in each patch. A transect of five 100 m^2 quadrats, spaced 20 meters apart, is established within a single habitat type. Within each 100 m^2 quadrat, four 1 m^2 quadrats are established, allowing us to investigate the effect of grain size on the results. All woody species are counted and all herbaceous species are listed within the quadrat. Estimation of patch species diversity is obtained from the asymptotic value of species-area curves. Preliminary results presented here are extracted from data collected in spring 1998. Although too few patches have been sampled at this point to test for correlations with the parameters, general comparisons can be made between the four patches sampled. Cluster analysis has also been performed to study the character of species associations.

Stutz, J. C., and C. A. Martin. ***Arbuscular mycorrhizal fungal diversity along a temporal gradient in Phoenix urban landscapes***. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

Although arbuscular mycorrhizal (AM) fungi form symbiotic relationships with about 90% of land plant families and are considered a key species group in ecological processes, little is know about their functioning in urban ecosystems. In this study, five residential landscapes ranging from 3 to 45 years since the time of landscape establishment were selected for sampling along a temporal (time since development) gradient starting in urban core of Tempe, AZ and extending south to the urban fringe of the Phoenix metropolitan area. Rhizosphere soil was collected from ash trees (*Fraxinus* sp.) at each sampling site in June, 1997. Pot cultures using sudangrass [*Sorghum sudanese* (Piper) Staph.] as a host were established and grown in a greenhouse for 4 months. Spores of AM fungi were extracted from each pot culture by wet-sieving followed by sucrose density gradient centrifugation. Using a stereomicroscope, spores were examined, and each morphotype was mounted for taxonomic identification using light microscopy. Species richness and composition were determined for each sampling site. Species richness of AM fungi ranged from 3 to12 AM fungal species at each sampling sites and was positively related to time since development. The species richness at the sampling site in the urban core (45 years since landscape establishment) matched or surpassed that previously reported for sampling sites in the adjacent Sonoran Desert. The mean number of species detected per soil sample was also positively related to time since development. A total of 12 AM fungal species were detected with 11 of the species in the genera *Glomus.* A progression of AM fungal species occurred in urban landscapes over time. *Glomus eburneum, Glomus intraradices, Glomus macrocarpum* and *Glomus microaggregatum* were detected at all five sampling sites. *Glomus spurcum* and *Acaulospora trappei* were detected at all sites after ten years of establishment. *Glomus occultum* and *Glomus* AZ112 occurred at all sites established after 20 years. *Glomus versiforme* was only detected at sites established 30 or more years. Three AM fungal species were unique to the sample site that was established over 45 years ago.

SWANSON, S. ***Predicting biomass in the Phoenix Basin: Integrating time series and spatial analysis of environmental data.*** Department of Anthropology, Arizona State University, PO Box 872402, Tempe AZ 85287-2402.

This poster presents the results of a pilot study that integrates several sets of environmental data. These include geographic information system (GIS) data on elevation, soils, and vegetation, precipitation data collected at various points in Maricopa County during the last century, and remotely sensed satellite data collected between 1973 and 1993. The data on topography, soils, vegetation, and precipitation provide independent variables affecting vegetation productivity, or biomass. A series of normalized difference vegetation indices (NDVI) are derived from the remotely sensed satellite data, and provide a time series of dependent variables. Using techniques of time series analysis and spatial analysis, accurate weightings can be assigned to each of the relevant independent variables, so that for a given amount of precipitation, predictive biomass probability maps can be created for the study area. This is quite useful for retrodiction purposes, since prehistoric precipitation data exist in the form of tree rings, allowing a series of these maps to be created for the last 1,400 years. This type of prehistoric, spatially varying prehistoric data provides archaeologists with richer ecological contexts for understanding human interaction with and impact on their environment. In turn, these richer contexts allow archaeologists to conduct research that is increasingly relevant to the resolution of modern environmental problems.

Vining, E. C., J. B. Gallaher, and T. A. Day. ***Effects of urban ground cover on microclimate and landscape plant performance.*** Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

In order to better understand the relationship between urban ground cover, microclimate, and landscape plant performance, four plots of varying ground cover types have been constructed: (1) mesoscape (well-irrigated turf), (2) xeriscape (crushed rock), (3) concrete, and (4) asphalt. The microclimate in each of these plots has been characterized by monitoring air, soil, and surface temperatures, relative humidity, and net solar radiation. Potted oleander (*Nerium oleander* L.) plants have been submerged in the center of each plot, and monthly measurements of growth, net photosynthesis, and dark respiration have been made. Preliminary results indicate air, soil, and surface temperatures and vapor pressure deficit tend to be lowest in the mesoscape and highest in the asphalt. Microclimate differences among the plots are greatest at night, and are diminishing with seasonal decreases in air temperature. Early in the season, midday to afternoon net photosynthesis rates were highest in the mesoscape, suggesting lower temperatures may minimize effects of heat stress on photosynthesis. Later in the season, net photosynthesis rates were higher in asphalt, suggesting higher temperatures may have beneficial effects as overall air temperature decreases. Few differences have been noted in growth rates among treatments, however, plants in the mesoscape tend to be shorter with more attached leaves and branches than the other treatments. We expect to see more pronounced differences with seasonal increases in temperature from winter to spring.

Wu, J., and D. G. Jenerette. ***Simulating the spatial and temporal dynamics of urban landscapes: Model structure and preliminary results.*** Department of Life Sciences, Arizona State University West, 4701 W. Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-7100.

Understanding the reciprocal relationship between urbanization and ecosystem processes is central to urban ecology. To achieve this understanding, we must be able to quantify and project land use/cover pattern and link it to ecosystem processes explicitly. As the main focus of the CAP LTER modeling project, we have begun to develop a multiple-scale, Markov-cellular automaton-ecosystem process model for urban landscape dynamics in the Phoenix metropolitan area, Hierarchical Patch Dynamics Model for CAP LTER (HPDM-CAP). This model is based on the conceptual framework of hierarchical patch dynamics and simulates land transformation, as driven by natural and human factors, with three distinct scales: the Phoenix metro-region, the local landscape, and the land-use/cover patch. Explicit recognition of these scales permits consideration of unique scale-dependent patterns and processes, and thus facilitates ecological understanding, linkages between natural and socioeconomic factors, and model building processes. We will present the general model structure and simulation scheme of HPDM-CAP. In addition, some progresses in this modeling work will be presented. For example, using the recently acquired historical land-use data, a prototype region-level model has been developed. A model of human population dynamics in Phoenix we have developed is being examined as a possible driving force of land-use/cover change.

Wu, J.[1], and M. Luck[2]. ***Structural characteristics of the CAP LTER landscape in relation to urbanization***. [1] Department of Life Sciences, Arizona State University West, 4701 W. Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-7100 and [2]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501.

Quantifying landscape pattern and its change is essential for monitoring and assessment of urbanization. Recent studies have suggested that measures of landscape pattern, when used appropriately, may help understand underlying ecological processes operating at different scales, and thus may be used as indicators for monitoring ecosystem changes. We have conducted a series of spatial analysis for the Phoenix metropolitan area based on land use and land cover data, using a variety of methods frequently used in landscape ecology. The questions to be addressed by these analyses include: How to quantify the urban - rural - wilderness gradient? What are indicator variables of the degree of urbanization in the Phoenix metropolitan area? How do landscape structural variables respond to the urbanization gradient? How does landscape pattern differ with increase in distance from the urban center? How does orientation of the transect affect the results of such gradient analysis (directionality of urban development)? Do they respond to the urbanization gradient differently? Do land use/cover types have their own “spatial signatures”?

Xu, Y.[1], L. Baker[1], and K. Wolfe[2]. ***Temporal and spatial patterns in groundwater nitrogen in the Central Arizona - Phoenix LTER watershed.*** Department of Civil and Environmental Engineering, Arizona State University, PO Box 875306, Tempe AZ 85287-5306 and [2]Salt River Project, Phoenix AZ.

The development of nitrogen and salt balances is a part of CAP LTER study. Accumulation in the groundwater and vadose zone is an important part of these mass balances in arid agro-urban ecosystems.

A groundwater data base is being constructed from several sources: SRP, USGS, and ADWR. The master data file includes information on chemical composition, well construction (well depth; screened interval) and annual pumping rates. Cumulative fertilizer N inputs are being computed from data on irrigated acreage (1912, 1934; 1955; 1975; 1995) and per-acre fertilizer rates typical for each time period.

As these data are obtained, we are examining spatial and temporal patterns of nitrate concentration. These patterns will be compared with historical patterns of land use, particularly change in irrigated agriculture. Some key questions are: (a) what is the natural background nitrate concentration in the region? (b) how has nitrate and salt concentrations varied over time?, (c) how do these concentrations vary in space, in relation to land use?, and (d) what is the relationship between land use and groundwater nitrate concentration? Preliminary data show that nitrate concentrations have risen dramatically in some wells and that there is a rough correlation between agricultural areas and nitrate concentration, particularly for the upper aquifer (to 300 ft).

The next step will be to develop an estimate of nitrogen export from the aquifer by pumping. This will be done two ways: (a) by computing the product of nitrate x flow for each production well, and (b) on an aquifer-by-aquifer basis, as the product of nitrogen pumping from each aquifer (estimated from MODFLOW) times the location-interpolated nitrate concentration (estimated from our GIS nitrate map). Theoretically methods (a) and (b) should yield the same result.

The long-term goal is to develop a nitrogen balance for the groundwater system. The model will include surface N inputs, N losses in the root zone (removal of crop N, denitrification), movement through the vadose zone and into the aquifer, and pumping from the aquifer. A parallel model will be constructed for salts. This model will be used to simulate changes in groundwater N and salt concentrations over time in response to changing human activities.