Regional NPP and Carbon Stocks in Southwestern USA Rangelands: Land-Use Impacts on the Grassland-Woodland Balance

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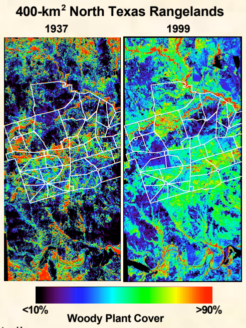
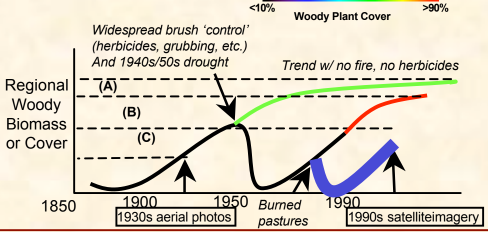
Woody Encroachment in Northern Texas

Our work to date in northern Texas, indicates a net increase in regional aboveground plant carbon pools of 32% between 1937 and 1999. In addition, there has been a homogenization of woody plant cover due to woody plant encroachment into open grasslands and brush management-induced reductions of woody biomass in areas once characterized by high woody cover.

Woody plant aboveground biomass accumulation (A) with no management intervention, (B) interrupted by intensive clearing in the 1950s but no follow-up, and (C) clearing in 1950s and again in early 1990. Comparisons of woody cover in 1937 versus 1999 thus represent net, rather than absolute changes.

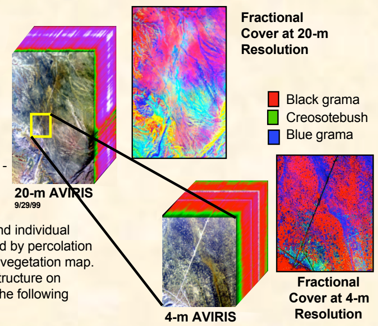




Woody Encroachment in New Mexico

At the Sevilleta LTER, climate/ topoedaphic variation and landuse history contribute to grassland-woodland transitions.

Our studies will be based on a fine resolution vegetation map derived by spectral mixture analysis. This map defines the patch configuration associated with the Chihuahuan Desert - Shortgrass Steppe interface.



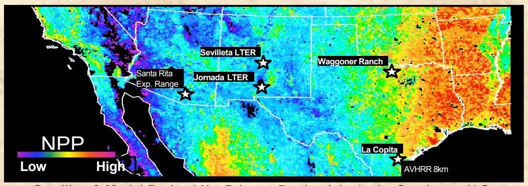
Fractal structure of the patch mosaic and individual patches and edges will be characterized by percolation and multifractal analyses based on the vegetation map. Studies of the influence of landscape structure on regional biogeochemistry will address the following questions:

1. Do localized increases in soil N below shrubs result in increased foliar concentrations in natural patches of creosotebush?
2. Does increased soil and foliar N result in increased shrub aboveground biomass as patch size increases?
3. Does the relationship between aboveground biomass and patch size amplify the influence of shrub encroachment on landscape biogeochemistry?

Background

Historical changes in grazing and fire regimes have resulted in an increase in woody plant abundance in the world's drylands. Rates and dynamics of these increases are poorly understood, but are known to vary with soils and topography. This change in land cover has been the impetus for brush management practices (chemical/ mechanical treatments, prescribed burning). As a result, ongoing increases in woody plant cover on some landscapes have been offset by decreases in woody plant cover on others. Regional tracking of plant carbon pools thus requires quantification of carbon losses associated with management-induced reductions in woody plant biomass and carbon gains associated with woody plant encroachment and regeneration

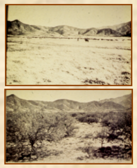
Approach: We are studying the dynamics of patch structure associated with major changes in shrub/grass due to grazing, fire, and management practices. Our sites capture the range in potential vegetation production and carbon storage throughout the region as constrained by the strong gradient in Southwestern precipitation.



Satellite- & Model-Derived Net Primary Productivity in the Southwest U.S.

Future Directions

- Work at the Santa Rita Experimental Range. The historical documentation available at the SRER makes it an ideal location to extend our work on management impacts on C and N sequestration due to woody plant encroachment of rangelands.
- Comparative studies among sites of patch structure and dynamics to understand response to management practices across a precipitation gradient and as constrained by topoedaphic settings.
- Our remote sensing results will be used to constrain an ecosystem process model (TerraFlux) in order assess to the combined effect of management and climate on productivity and carbon storage in vegetation and soil.

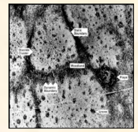


SRER (a continuously operating range experiment station since 1903) photographed in 1903 (top) and again in 1941 (bottom), showing conversion from grassland to mesquite shrubland. Martin 1975

References:
Asner, G.P., S. Archer, R.F. Hughes, R.J. Ansley, C.A. Wessman. Net changes in regional woody vegetation cover and carbon storage in Texas drylands, 1937-1999. *Global Change Biology* In Press.
Wu, X.B. and S.R. Archer. Scale-dependent influence of topogra[hy-based hydrologic features on vegetation patterns in savanna landscapes. In Prep.

Response to Herbicide Management in La Copita, Texas

Herbicide impact on woody encroachment has been assessed in northern Texas(Asner et al. In press). At the La Copita Research Area in southern Texas, increased landscape complexity, particularly the existence of a lush understory beneath a *Prosopis glandulosa* canopy, has made the assessment more problematic with remote sensing methods. Moreover, although runoff-runon relationships mediate patterns of woody plant cover and change at the catena scale, response to disturbance (e.g. management) is likely to be constrained by topoedaphic settings (Wu & Archer In press)



Aerial herbicide treatments applied in May of '86, '87 and '90 to select areas (Fig. 1) destroyed only the overstory in some areas and in others only the understory.

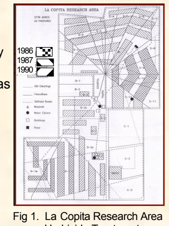


Fig 1. La Copita Research Area Herbicide Treatments

Spectral mixture analysis was applied to Thematic Mapper (TM) imagery acquired in 10/5/85 (baseline) and 9/25/87 and shade and green vegetation cover fractions were interpreted as surrogates scaling with tree canopy and understory respectively (Fig. 2) for a mandatory finer discrimination of herbicide effects (Fig. 3).

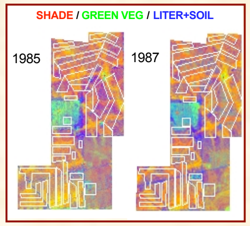


Fig 2. Fractional Cover Composites

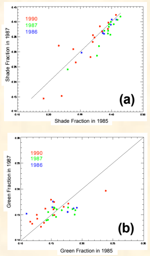


Fig 3. Changes in (a) Shade and (b) Green Fractions between 1985 and 1987.

Spatial distribution of changes in understory and overstory coverage (Fig. 4) prompted an examination of the factors determining herbicidal effects across the landscape, since potentially, these factors could be extrapolated to the entire region from southern to northern Texas.

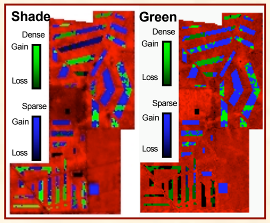


Fig 4. %Cover Differences between 1985 and 1987

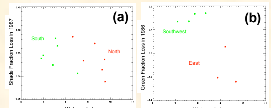


Fig 5. Regression plots of topographic wetness versus (a) 1987 shade and (b) 1986 green in dense treatment areas.

Hypothesis: Soil moisture related to topography is a factor influencing response to herbicide treatment.

Experiment: The La Copita '85 TM imagery was classified into areas of dense and sparse tree cover. Mean percent changes between '85 and '87 images in shade and green vegetation fractions were computed per treatment area and tree class, These means were regressed against a topographic wetness index (Wu & Archer In press).

Conclusion: Regressions such as in Fig. 5 show a persistent relationship between herbicide effects and spatial location that is not significantly explained by moisture. That is, there are other unknown factors, potentially soil type or herbicide dispersal, influencing response to herbicide treatment.

Future Work: Analyze more recent images of La Copita to assess recovery rate of woody vegetation and compare to north Texas results. It is anticipated that recovery will be accelerated in moister conditions.