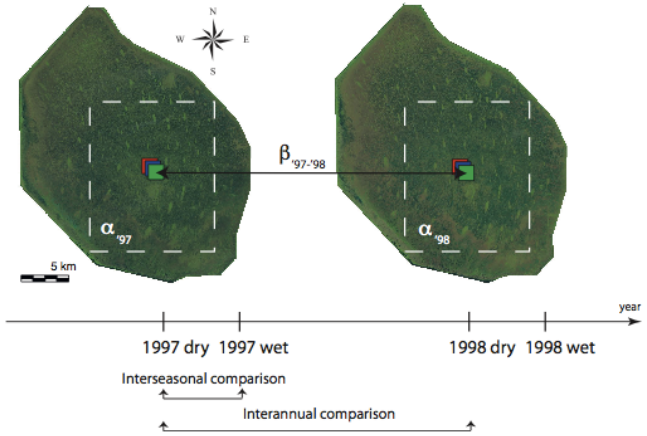
# Inferring Species-Richness and Species-turnover by Statistical Multiresolution Texture Analysis of Satellite Imagery

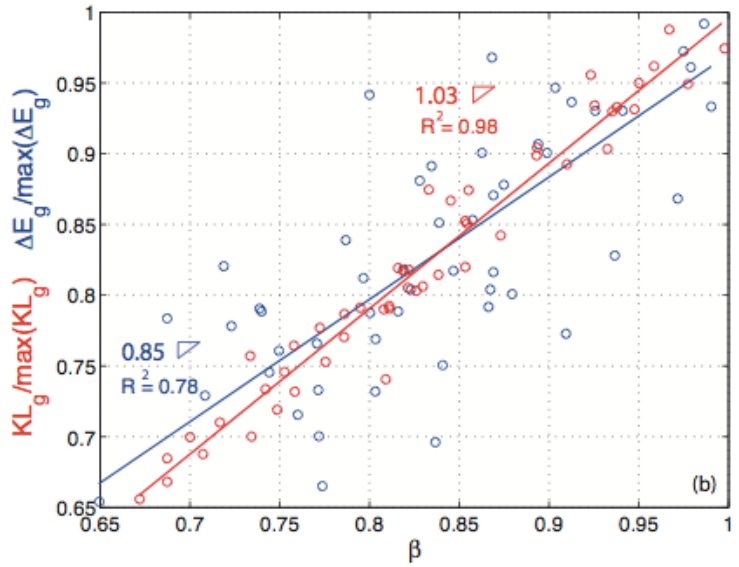
M Convertino, R Mangoubi, I Linkov, N Lowry, M Desai
*Brutsaert-Parlange Symposium – Cornell University*

The quantification of species-richness and species-turnover is one of the most important tasks in monitoring ecosystems. Wetland ecosystems are particularly sensitive to external changes, such as rainfall and water management that affect hydrology, soil, and species patterns. Thus, quantification enhances both ecosystem function, and helps environ- mental scientists understand the linkages between natural and human stressors. The effect of these changes at the species metacommunity level in space and time are still not well understood.




Here we analyze interseasonal and interannual plant species-richness and turnover of the Arthur R. Marshall Loxahatchee National Wildlife Refuge ("Water Conservation Area 1" in the Greater Everglades Ecosystem) in South Florida as a case-study for the application of a novel multispectral image analysis technique. We apply statistical multiresolution wavelet texture analysis to satellite images (Landsat) in order to detect texture changes of vegetation, soil, and water patterns. The joint density function from one textured image is compared to that of another textured image using the Kullback-Leibler (KL) divergence. The α- and β-diversity measures, which are observed to be independent, are estimated for the green-band of images by the Shannon entropy and by the KL divergence respectively.

Validation with 27-years observations of plant species shows that the method predicts 73 % and 100 % of species-richness and turnover within the study-area from 1984 to 2011. It is shown that the KL divergence correlates better with β diversity than the entropy, with an R2 = 0.98 vs. 0.78 respectively. This is because the KL divergence potentially accounts for the pairwise interactions between vegetation communities in time.




The Shannon entropy of the green- band can be considered as the spectral heterogeneity in water-dominated ecosystems and as a result, it is highly correlated with the average annual and seasonal rainfall. We find that changes in vegetation, soil and water are positively correlated, and the fluctuations of the Shannon entropy for each pattern in the wet-season are smaller than in the dry-season.