Remote Sensing and Landscape Metrics for Global Urban Ecological Monitoring

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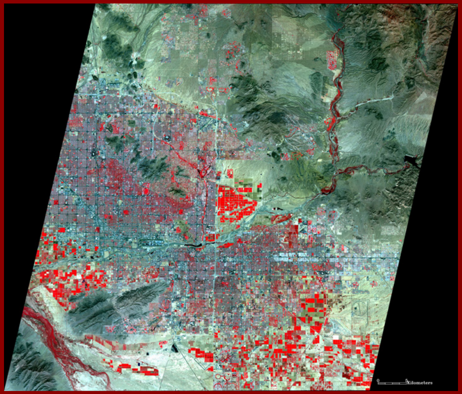
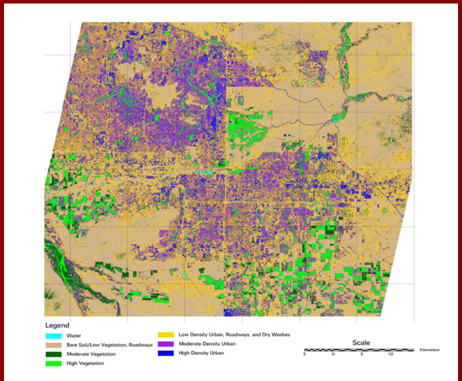


Central Arizona Phoenix Region
ASTER - Visible and Near Infrared



Central Arizona Phoenix Region
ASTER – Land Cover Classification

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A research program that provides the opportunity to apply CAP LTER research results on a global scale is the Advanced Space-borne Thermal Emission and Reflection Radiometer Urban Environmental Monitoring (ASTER UEM) program. The primary goal of the UEM program is to monitor land cover and land use change over a six-year period for approximately 100 global urban centers (Stefanov et al. 2001a). Land cover classification techniques developed for the CAP LTER project are being applied to ASTER UEM data (Stefanov et al. 2001b; Stefanov, 2002).

The primary application of remote sensing data in this study is to provide a means for extrapolating detailed measurements at local sites to a regional context. Specifically, multi-spectral image classification and texture analysis are used to identify land cover types, such as different forms of vegetation, soils, man-made materials and water. Because modifications of the urban environment are coupled frequently with modifications of the spatial structure, the investigation of texture and shape parameters, or neighbourhood relations, out of remote sensing data apart from the spectral investigation applied so far represents an additional analysis potential (Netzband & Kirstein, 2001).

Within the last ten years *landscape metrics* have been implemented on remote sensing image data for different mapping scales (Frohn, 1998). A methodological approach is presented, initially applied to the land cover classifications of Phoenix and Mexico City. We demonstrate that monitoring and evaluation of landscape diversity in suburban landscapes is feasible on the basis of medium to high resolution satellite data. Thus a 10*10 km grid is used to calculate the metrics on a regular and comparable basis.

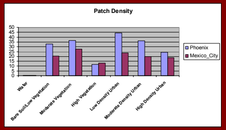


Fig. 1

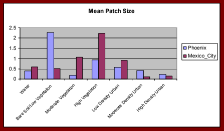


Fig. 2

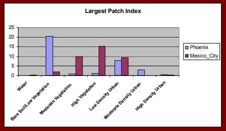


Fig. 3

The 'Patch density' (fig. 1) equals the number of patches of the corresponding patch type (NP) divided by total landscape area, multiplied by 10,000 and 100 (to convert to 100 hectares). It is an index for the fragmentation of a landscape and facilitates the comparison of landscapes with different sizes. This metric shows higher values for all classes in the Phoenix area except for the 'High Vegetation'.

'Mean patch size' (fig. 2) indicates the medium patch size in hectares and is a function of the total area of the landscape and the patch number. Smaller values point to a higher fragmentation of the landscape. The 'Largest Patch Index' (fig. 3) is the average 'perimeter-to-area-ratio' for a certain class. A low value indicates a very compact form with small edge lengths, whereas higher values express more complex forms. Both indices show a similar distribution for the compared urban areas: there is a peak in the Mexico City area for the vegetation classes ('moderate' and 'high') as well as for the 'Low Density Urban' class. While peaks for this class and the 'High Vegetation' class are also present for Phoenix, a more significant peak is present for the 'Bare Soil/Low Vegetation' class.

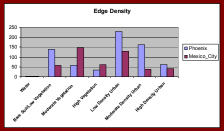


Fig. 4

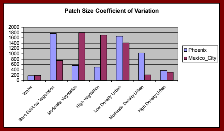


Fig. 5

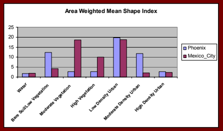
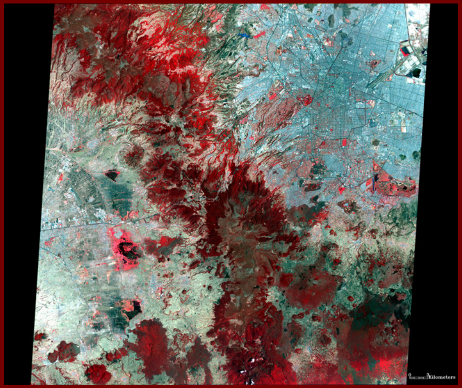


Fig. 6

'Edge density' (fig. 4) equals the sum of the lengths of all edge segments involving the corresponding patch type, divided by the total landscape area, converted to hectares. Here the urban classes show higher values in Phoenix compared to Mexico City, whereas the vegetation classes are distributed vice versa.

The value of 'Patch size coefficient of variation' (fig. 5) becomes 0, if the investigated landscape consists of one (or equally large) patches. A high value displays a strong variation in the landscape sample. The variation is higher again within the urban classes of the Phoenix area, although the highest values of this index can be found in the vegetation classes of the Mexico City area.

The 'Area-weighted mean shape index' (fig. 6) calculates the complexity of the patches in the landscape and these are weighted according to their size. Larger patches enter more strongly in the calculation than smaller ones do. The most significant differences between the two compared urban agglomerations can be observed in the 'Moderate Density Urban' class (higher in Phoenix), as well as in the Moderate and High Vegetation classes which show higher values in Mexico City. This can be identified as general pattern for most of the analysed metrics. The 'Bare Soil/Low Vegetation' class is always higher in the Phoenix area.



Mexico City Metropolitan Area
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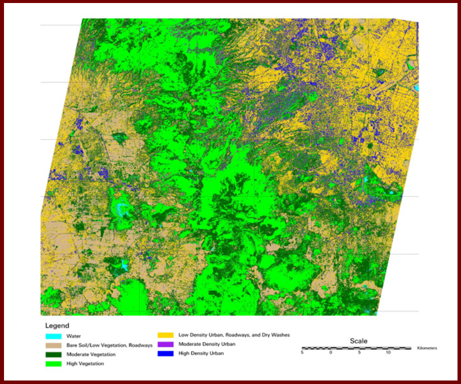

Mexico City Metropolitan Area
ASTER – Land Cover Classification

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