AVIRIS DATA AND NEURAL NETWORKS APPLIED TO AN URBAN ECOSYSTEM

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1.0   INTRODUCTION

Urbanization is expanding on every continent. Although urban/industrial areas occupy a small percentage of the total landscape of the earth, their influence extends far beyond their borders, affecting terrestrial, aquatic, and atmospheric systems globally. Yet little has been done to characterize urban ecosystems or their linkages to other systems horizontally or vertically. With remote sensing we now have the tools to characterize, monitor, and model urban landscapes world-wide. However, the remote sensing performed on cities so far has concentrated on land-use patterns as distinct from land-cover or composition. The popular Anderson system (Anderson et. al. 1976) is entirely land-use oriented in urban areas.

This paper begins with the premise that characterizing the biophysical composition of urban environments is fundamental to understanding urban/industrial ecosystems, and, in turn, supports the modeling of other systems interfacing with urban systems. Further, it is contended that remote sensing is a tool poised to provide the biophysical composition data to characterize urban landscapes.

2.0   A V-I-S MODEL

A Vegetation-Impervious Surface-Soil (V-I-S) model has been proposed (Ridd, in press) to characterize urban environments. These three components represent a basic distinction of urban biophysical variables, which exhibit highly contrasting influences on energy and moisture flux. They provide a basis for many science and engineering models, such as runoff, transpiration, heat island, etc. Figure 1 shows the V-I-S model. Figure 2 suggests the V-I-S composition for some familiar urban and near-urban environments. If remote sensing can distinguish these compositional variables with accuracy, from the pixel on up to landscape aggregations, urban ecosystem modeling will be advanced substantially.

TM and SPOT data have been inadequate in this effort. Neither system has been shown to distinguish soil and impervious surface adequately. This paper explores the use of AVIRIS data, coupled with a neural network classifier toward a better distinction and mapping of V-I-S composition of urban places.

3.0   AVIRIS and NEURAL NETWORKS

In an effort better to distinguish soil from impervious surfaces both the spectral resolution and the classification procedure are explored. Using

WTJ GenIsis software, characteristic spectral bands were selected from an AVIRIS data set collected over Pasadena on 20 September 1989. By examining the spectral reflectance curves from sample sites, signatures were generated to represent eight categories of cover composition in the urban and nearby environments: Vts (trees and shrubs), Vgg (green grass), Vgd (dry grass), Id (dark impervious), Il (light impervious), Ib (building roofs), S (soil), and W (water). The spectral bands deemed most diagnostic were selected, namely: AVIRIS 12-13 (508-518 nm), AV 29-31 (675-695 nm), AV 50-52 (844-863 nm), AV 99-100 (1263-1273 nm), AV 128-130 (1550-1569 nm), AV 145-147 (1718-1728 nm), AV 180-182 (2020-2040 nm), AV 200-202 (2219-2238 nm). To keep processing time within reason, these were combined and entered into the classifier as follows: channel 1 AV 12-13; channel 2, AV 29-31; channel 3, AV 50-52; channel 4, AV 99-100; channel 5, ratio of AV 145-147/AV 128-130; channel 6, ratio of AV 200-202/AV 180-182.

4.0   RESULTS

Preliminary results are promising. To begin with, merely displaying the Pasadena AVRIS data in a three-channel composite image, using combinations of the above bands, and some others, draws a distinction between soil and impervious surfaces. Clearly the narrow-band sensor is able to distinguish these common urban substances more effectively than broad-band TM and SPOT sensors.

Neural network classification is more than a clustering procedure. It involves a sophisticated internal reiterative process on the basis of spectral signatures per pixel, plus a textural evaluation of pixel groups to derive the final classes. The paper summarizes and displays the results.

5.0   REFERENCES

Anderson, J.R., E. Hardy, J. Roach, R. Whitmer, A land use and land cover classification system for use with remote sensor data, U.S.G.S. Professional Paper 964, 1976.

Ridd, M.K., Exploring a V-I-S (Vegetation-Impervious-Surface-Soil) model for urban ecosystem analysis through remote sensing, International Journal of Remote Sensing, out for peer review.
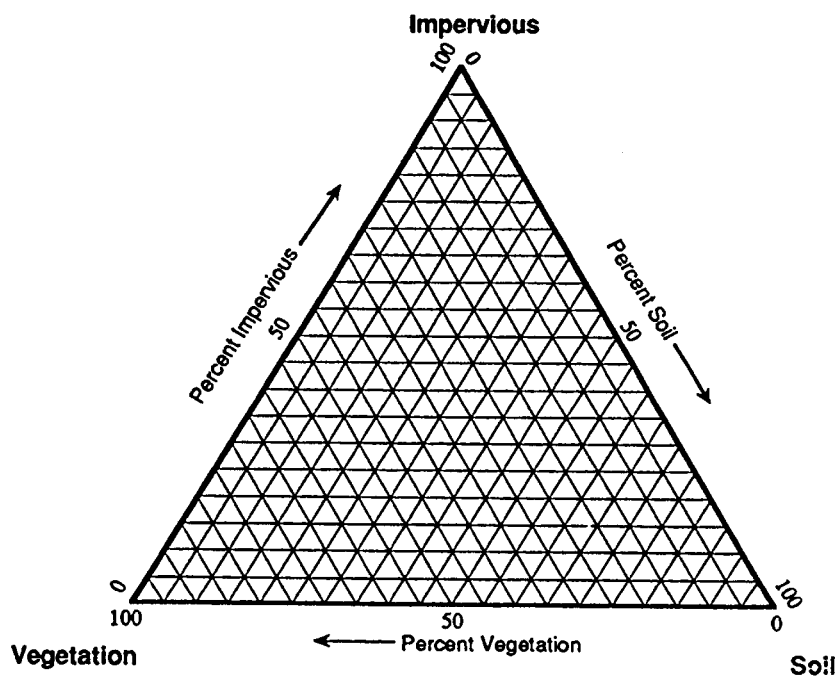
Impervious

100 0

Percent Impervious

50

Percent Soil

50

0

100

Vegetation

100 50 0

← Percent Vegetation

Soil

Figure 1. The V-I-S model.

Impervious

100 0

CBD

Percent Impervious

High
density
residential

Light
industry

Percent Soil

50

Medium-
density
residential

50

Heavy
industry

Low-density
residential

0

Park   Cover   Forest   Row   Desert   Idle   Bare   100
        crops   crops   land   soil

Vegetation

100 50 0

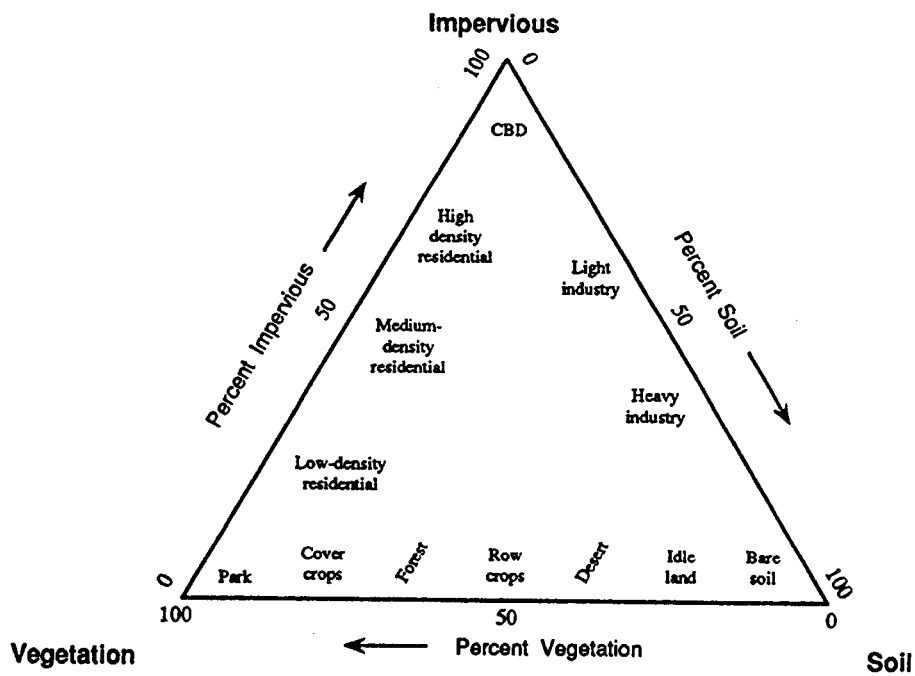← Percent Vegetation

Soil

Figure 2. Some familiar urban and near-urban environments placed in
the ternary V-I-S model.

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