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# PRELIMINARY EVALUATION OF AIS SPECTRA ALONG A TOPOGRAPHIC/MOISTURE GRADIENT IN THE NEBRASKA SANDHILLS

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## ABSTRACT

Six spectral plots, each summarizing single-pixel reflectance for 128 channels of AIS data, were examined. The six sample pixels were located along a topographic/moisture gradient from lake surface to dune top in the Nebraska Sandhills. AIS spectra for various moisture regimes/vegetative zones appear quite logical, with a general positive relationship between increasing elevation (i.e., decreasing access of plant roots to water) and increasing reflectance in the spectral regions diagnostic of leaf-water content (i.e., bands centered on 1.65 and 2.20 μm).

## INTRODUCTION

The importance of moisture content in plant leaves as a factor in spectral reflectance is well known and widely accepted in remote sensing. Close examination of one spectral region, the middle-infrared, underscores the water-content/reflectance relationship since reflectance measurements at 1.65 and 2.20 μm are significantly related to the total amount of water in the leaf and to the leaf-moisture deficit (Myers et al, 1970).

The intent of the present research activity was to provide a cursory evaluation of the utility of AIS spectral data for detecting variations in vegetative water status along a topographic/sub-surface moisture gradient in the Nebraska Sandhills. The availability of water is a primary determinant in the composition of plant communities that cover the sand dunes and inter-dunal valleys (IANR, 1983).

The study area for the research was the Crescent Lake National Wildlife Refuge, Garden County, Nebraska. This 46,000 acre unit is located in the western portion of the Nebraska Sandhills. The landscape consists of sand dunes stabilized, for the most part, by range grasses. Lakes and wetlands are numerous due to a large underground water reserve and minimal depth to that ground water. Many of the lakes in and around the Crescent Refuge are alkaline; summer temperatures exceed 100 degrees F and total annual rainfall is only about 16 inches.

The specific site selected for detailed examination is along a line extending from (and including) the northwestern portion of Gimlet Lake to a dune field beginning approximately one-fourth mile northwest of the lake. Relief from the lake to the dune tops is on the order of 100 feet.

The rationale for the analysis is based upon a simple inverse relationship between the elevation of selected locations along a Sandhills transect and the access of vegetation at those locations to moisture, whether at the surface or in sub-surface storage. In the Sandhills, the densest, most productive vegetation (by weight) occurs in the shallow lowland marshes and subirrigated meadows while the least productive is found on the dunes (IANR, 1983; Novacek, 1984).

Spectral data were acquired at the Crescent Refuge by the NASA Ames C-130 flight crew on August 6, 1984 for AIS grating positions 1-4. The flight corridor, five miles in length, began over Crescent Lake and terminated about two miles north and west of Gimlet Lake. Ground resolution elements are approximately ten meters on a side. Simultaneous 35mm black-and-white aerial photography, color-infrared aerial photography, and airborne Thematic Mapper digital data were obtained. A small subset of the Sandhills AIS dataset was analyzed for the present research. The dataset received the standard NASA JPL radiometric correction, but was neither calibrated for solar irradiance nor the atmosphere because of the short time span between data receipt and preparation of this preliminary report.

## ANALYSIS

Six pixels were selected for analysis along the transect described above. Each of these six AIS elements was located within the study site through comparison of the digital dataset with the concurrent aerial photography, 35mm oblique air photos of the area taken during previous projects, on-site ground-level photos, and the relevant USGS map quadrangle (Mumper, Nebraska, 15-minute). Unfortunately, a short lead time prior to the execution of the flight negated in-field vegetation sampling at the time of the mission. However, the on-site characteristics of each sample pixel (from wettest to driest position) can be summarized.

The first element ("lake surface") was comprised of open surficial water, for the most part, although some floating vegetation was present at the time of the AIS data collection and is discernible on the color-infrared photos taken during the mission. The location of the second element ("lake margin") was also offshore, although it was in close proximity to the shoreline. The vegetative mat was relatively thick, as evidenced on the aerial photography, with some emergents associated with floating types. Such a Sandhills location is typified by Cattails (Typha), Bulrushes (Scirpus), and Reeds (Phragmites) (U.S. Department of Agriculture, 1975). The third sample pixel ("shoreline") was located on shore, but very close to the lake proper. Thick emergent vegetation characterizes such a site with Cattails and Bulrushes being colocated with vegetation such as Arrowhead (Sagittaria), Smartweed (Polygonum), and some Sedges (Carex) (U.S. Department of Agriculture, 1975). The location of the fourth element ("lowland meadow") is in a Sandhills subirrigated meadow consisting typically of Sedges plus Prairie Cordgrass (Spartina), Reedgrass (Calamagrostis), Reed Canarygrass (Phalaris), Switchgrass (Panicum), some Big Bluestem (Andropogon), and various shrubby plants (U.S. Department of Agriculture, 1975; Nichols, 1984). The fifth element ("dune slope") is located on a southeast-facing slope just above the meadow/dune transition. Such a Sandhills range site contains mostly warm-season grasses including Blue Grama (Bouteloua), Porcupinegrass (Stipa), and Little Bluestem (Schizachyrium) (U.S. Fish and Wildlife Service, 1969; Nichols, 1984).

The last element in the transect ("dune top") is located high on a dune and consists of warm-season grasses such as Sand Bluestem (Andropogon), Hairy Grama (Bouteloua), Prairie Sandreed (Calamovilfa), and Soapweed (Yucca) (U.S. Fish and Wildlife Service, 1969; Nichols, 1984).

Three spectral plots along the topographic/moisture gradient are shown as Figures 1-3. As expected, the variations in the curves tend to occur in the three portions of the AIS spectrum separated by the atmospheric water-absorption bands centered on 1.45 µm (Channel 33) and 1.93 µm (Channel 85). Even though some variation in the spectra is apparent in the range from Channel 1 (1150.68 nm) to approximately Channel 20 (1334.9 nm), this area of the spectral plot is not important with regard to the present analysis since spectral response in this region is due primarily to cell structure rather than water content (Hoffer, 1978). However, the spectra centering on 1.65 µm (Channel 54) and 2.20 µm (Channel 113) are significant to the purpose of this research since, as noted earlier, these spectra are diagnostic of water content in the leaf.

Reference to the spectra illustrated as Figures 1-3 allows for some preliminary inferences. The "flat" curve associated with the "lake-surface" element (not shown) is as expected, although some minor amounts of reflectance from the floating vegetation were seen. A noticeable increase in reflectance at all wavelengths is apparent in the "lake-margin" element (Figure 1), but the curve remains relatively flat due to the influence of standing water beneath the canopy of emergent and floating vegetation. The spectra for the "shoreline" pixel (not shown) was noticeably different from the first two examples. Presumably, the effect of greater canopy development and little or no standing water caused increased reflectance in the three spectral "zones" adjacent to the two water-absorption regions. The slope of the curve from approximately Channel 40 to Channel 60 (1513.2 - 1707.6 nm) may be of diagnostic value, but the cause of that slope is as yet unknown to the writer. The most interesting spectral plot of those presented may well be that for the "lowland-meadow" pixel (Figure 2) where both a pronounced increase in reflectance and a very steep slope can be seen for the peak vegetative-reflectance bands centering on 1.65 µm (Channel 54). Again, I am uncertain about the cause for the change in slope, but the increased reflectance appears to be diagnostic of a decrease in leaf-water content relative to the previous pixel ("shoreline"). The spectral plot labelled "dune slope" (not shown) not only exhibits reduced reflectance in the "cell-structure" region (Channels 1-20), presumably because of reduced density of vegetation as compared to the wetland locations of pixels 1-4, but also exhibits a noticeable flattening of the curve in the area centering on 1.65 µm (Channel 54). Interestingly enough, the plot for the pixel located at the highest elevation ("dune top") also displays a "flattish" characteristic for the spectral zone centering on 1.65 µm with what appears to be a slight tendency toward a "negative" slope (Figure 3). Some exposed sand may contribute to reflectance from the "dune-slope" and "dune-top" pixels, but further research is needed to evaluate that phenomenon.

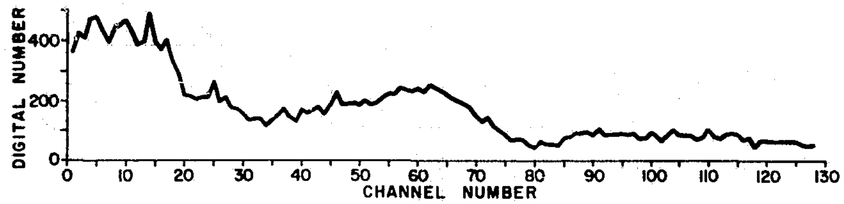


Fig. 1. Raw AIS data for lake-margin location

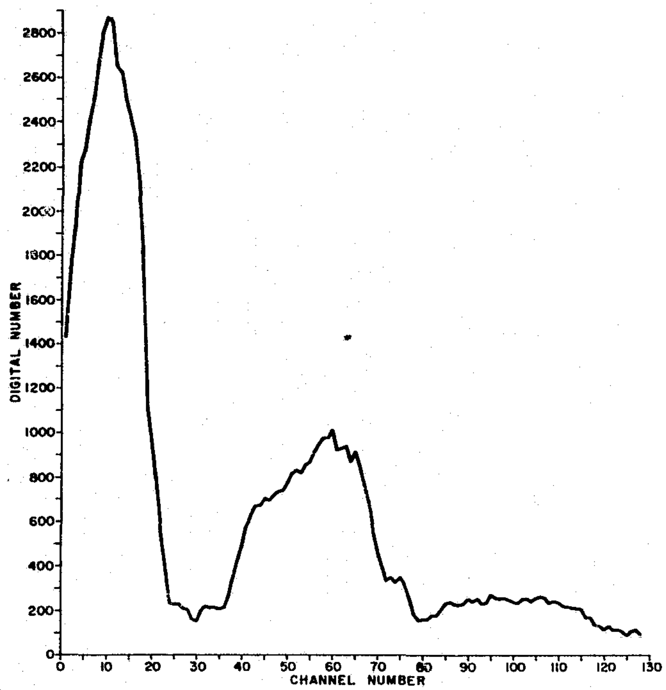


Fig. 2. Raw AIS data for lowland-meadow location

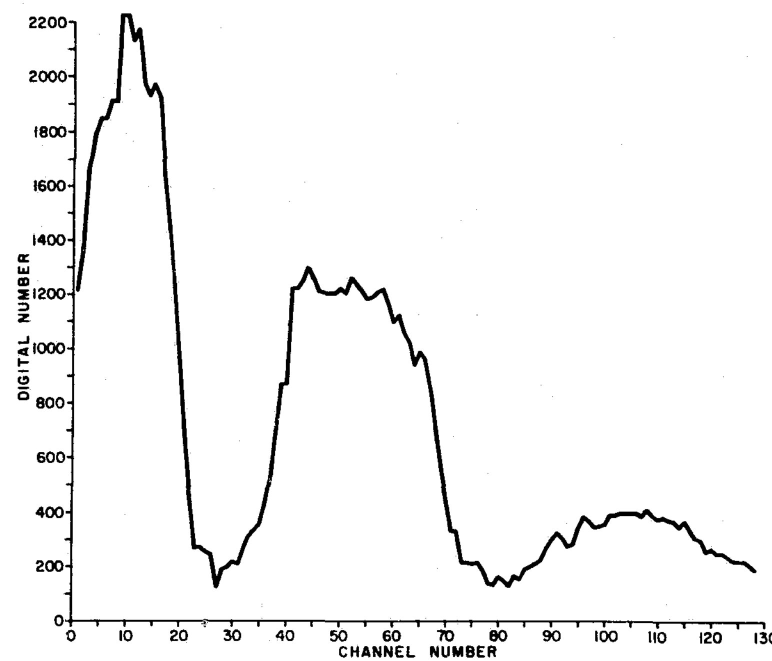


Fig. 3. Raw AIS data for dune-top location

## CONCLUSION

Despite use of essentially uncorrected AIS data, the plotted raw spectra are deemed useful for comparing and analyzing vegetative sites in the Sandhills. Examination of data for the peak vegetative-reflectance region centering on 1.65 μm (Channel 54) produced the expected result: a positive relationship between increasing elevation (i.e., decreasing access of plant roots to water) and a general increase in reflectance. It seems certain that variations in the slope of the curve in this spectral region are diagnostic of some condition related to the plants themselves or materials within their root zone, but the exact cause of slope variability is unknown at present. Some variation is evident in the spectral region centering on 2.20 μm (Channel 113), a secondary vegetative reflectance peak in the middle-infrared, but the overall visual impact of variability is not as pronounced as that for the 1.65 μm peak.

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