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SATELLITE IMAGERY FOR ASSESSING RANGE FIRE DAMAGE IN THE SANDHILLS OF NEBRASKA[1]

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HIGHLIGHT

Initial imagery from the first Earth Resources Technology Satellite indicates that satellite-acquired data is of value in determining the location and extent of range fire in the Sand Hills region of Nebraska. Preliminary results suggest that it can also provide a tool for monitoring soil erosion by wind and evaluating the recovery of vegetation in burned areas.

Fire has a major ecological and economic impact within the 19,250 square miles of rangeland composing the Sand Hills region of Nebraska. Analysis of initial imagery from the first Earth Resources Technology Satellite (ERTS-1) indicates that satellite-acquired data can be of immediate value to those who must act to restore the range following a severe fire.

With the exception of local areas of subirrigated meadows, precipitation is the only source of soil moisture over about 89 percent of the Sand Hills region, and the water holding capacity of the coarse textured soils is relatively low (Keech and Bentall, 1971). Thus, there is considerable potential for fire when range conditions are dry. In view of the susceptibility of the sandy soils to erosion by wind, range management practices necessary to insure the rapid recovery of grass cover after a fire are essential to stabilize the soil and prevent blowouts.

On March 6, 1972, a range fire began about two miles south of Mullen, Nebraska (Jensen, 1972). Before it was controlled, the fire consumed an irregular swath of rangeland about 30 miles long and 10 miles wide. Estimated damage totaled one million dollars in destroyed grazing vegetation, cattle and calves, hay, bridges, fences and equipment. Once the fire was controlled, an assessment of its extent and damage was initiated to provide a basis for programs to restore plant cover and control wind erosion.

The first ERTS-1 imagery of the burned area was obtained on August 17, 1972. Of immediate interest was the clear delineation of the burned area on near-infrared imagery (0.8 to 1.1 micrometer wavelength band) obtained by the multispectral scanner aboard the spacecraft (Fig. 1). In contrast, imagery obtained simultaneously in the visible wavelength bands (0.5 to 0.6 and 0.6 to 0.7 micrometer) did not clearly define the burned area.

The light gray, irregular pattern across the center of Figure 1 is an area of relatively strong near-infrared reflectance corresponding to rangeland burned in the March fire. Westerly winds up to 40 miles per hour swept the fire in fan-like patterns toward the east from its starting point in the left portion of the picture. Attempts to control the fire along north-south fire breaks are clearly visible, as are points where strong winds swept the fire across the fire breaks. Before the fire was controlled, a shift in wind to a northerly direction burned additional areas to the south of the main swath. The destruction of plant cover enhanced wind erosion locally within the burned area (Fig. 2).

Since portions of the burned rangeland are not readily accessible on the ground, an obvious use of the satellite imagery was to locate the extent of the fire and to estimate the acreage involved. The burned area was located readily using a transparent overlay of a standard U. S. Geological Survey map of Nebraska (1: 1,000,000 scale) showing geographic features and township and range boundaries. Using major geographic features for positioning, the overlay was placed over a system corrected image (Goddard Space Flight Center, 1972) of the burned area prepared as a positive transparency with a scale of 1: 1,000,000.

Measurement of acreage affected by the fire was accomplished by the dot-grid method (Bryan, 1943). Using grids of 64 and 256 dots per square inch, an average of four determinations (two with each grid) gave a measurement of 76,480 acres within the burned area. Previous estimates of the burned area made in the field immediately after the fire ranged from 75,000 acres to 120,000 acres.

Thus, satellite imagery of Sand Hills rangeland could facilitate measurements of the location and extent of range fires, information needed to implement disaster relief such as deferred grazing payments.

By October, 1972, the only difference in the appearance of the burned v.s. the unburned areas in the field was the lack of plant residues from previous years in the area that had been burned. Nevertheless, reflectance patterns from the burned area obtained from ERTS-1 imagery in the 0.8 to 1.1 micrometer wavelangth band during September and October, 1972, showed the same appearance and outline as the pattern obtained in August. Apparently the relatively strong near-infrared reflectance from the burned area resulted from new vegetative growth and the absence of older plant residues to interfere with reflectance.

It is anticipated that ERTS-1 imagery will provide a synoptic view for monitoring the recovery of Sand Hills rangeland damaged by fire. Because of the total spectral response of sand, bare surfaces of sandy soils within the Sand Hills may be distinguished using remote sensing techniques (Cihacek and Drew, 1970). Consequently, detection of severe wind erosion and blowouts can identify areas requiring immediate application of erosion control measures. Preliminary interpretations of ERTS-1 imagery of the Sand Hills region suggest that multispectral data may provide a partial substitute for observations on the ground in measuring damage caused by range fire and in monitoring the density of forage as the rangeland recovers from fire.

FIGURES

Figure 1. A portion of an ERTS-1 scene showing the burned area as detected by the 0.8 to 1.1 micrometer wavelength band of the multispectral scanner on August 17, 1972. The diagram outlines the burned area interpreted from the ERTS-1 imagery.

Figure 2. A ground photo taken April 5, 1972, showing the extent of wind erosion which occurred prior to regrowth of vegetation after the fire.

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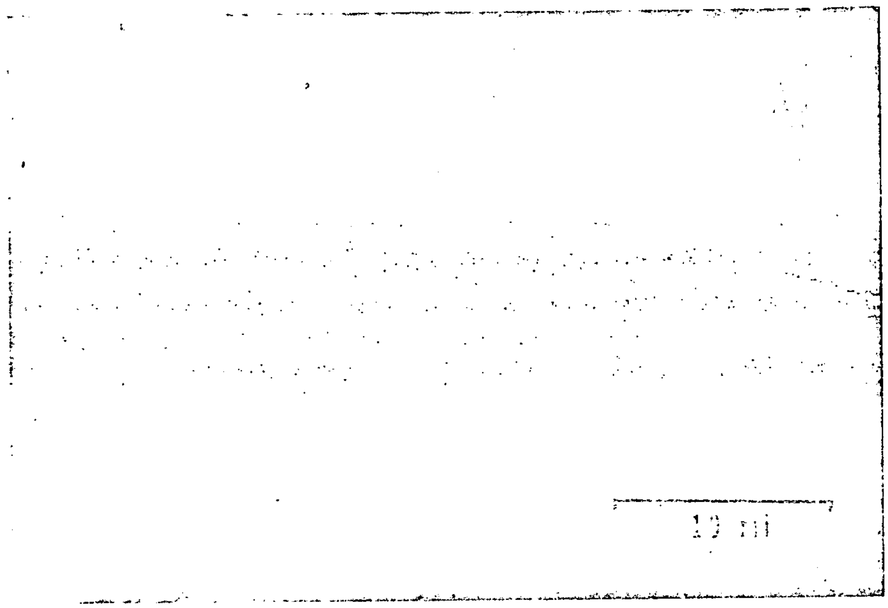

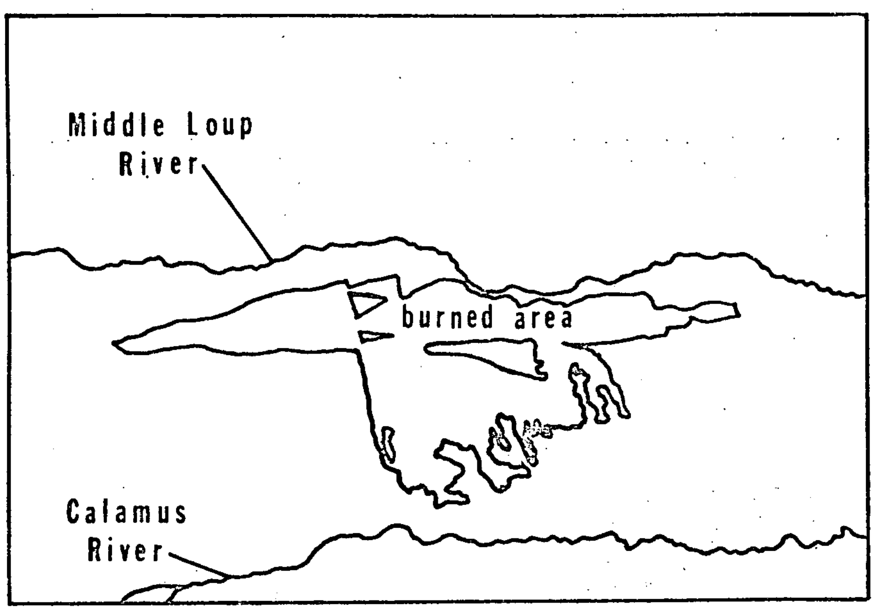

Figure 1.

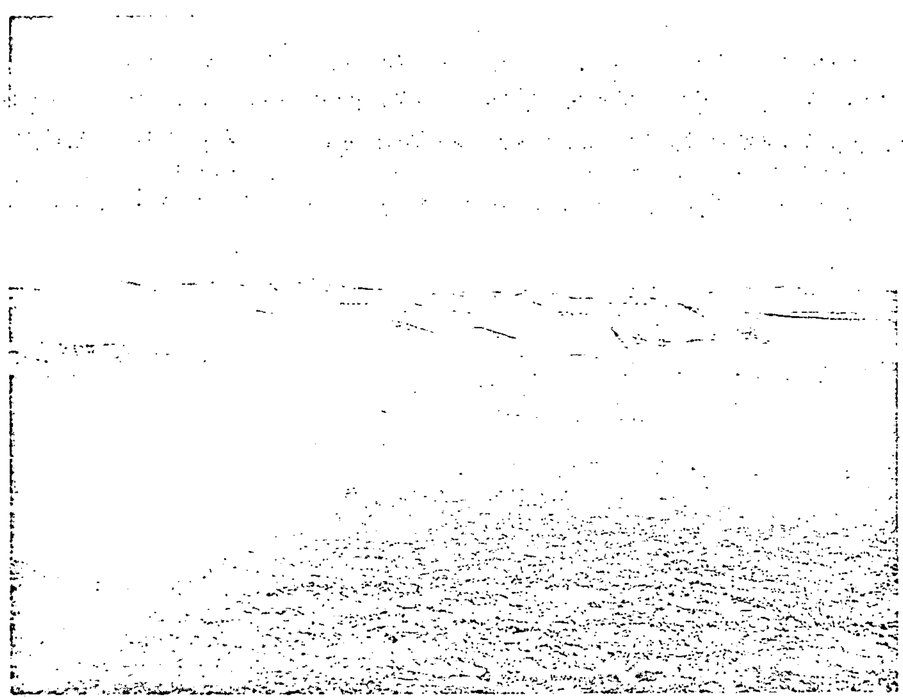

Figure 2