N87-17122

MONITORING VEGETATION RECOVERY PATTERNS ON MOUNT ST. HELENS USING THERMAL INFRARED MULTISPECTRAL DATA

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INTRODUCTION

The Mount St. Helens 1980 eruption offers a unique opportunity to study vegetation recovery rates and patterns in a perturbed ecosystem. The eruptions of Mount St. Helens created new surfaces by stripping and implacing large volumes of eroded material and depositing tephra in the blast area and on the flanks of the mountain. Areas of major disturbance are those in the blast zone that were subject to debris avalanche, pyroclastic flows, mudflows, and blowdown and scorched timber; and those outside the blast zone that received extensive tephra deposits.

It has been observed that during maximum daytime solar heating, surface temperatures of vegetated areas are cooler than surrounding nonvegetated areas, and that surface temperature varies with percent vegetation cover. This study investigates a method of measuring the relationship between effective radiant temperature (ERT) and percent vegetation cover in the thermal IR (8-12 micron) region of the electromagnetic spectrum.

TEST SITES AND DATA SELECTION

Two test sites were selected as training areas for this study. Test Site A is in the Tephra Deposition Zone approximately 4 miles from the crater and on the south flank of the mountain. This area received extensive tephra deposition from four eruptions subsequent to the initial May 18th eruption. The vegetation in the area of Test Site A is comprised of old growth silver fir stands (Abies amabilis) and clearcuts at varying stages of regrowth. Test Site B is an extended area approximately 7 miles north of the crater in the Tree Blowdown Zone between Cold Water Creek and St. Helens Lake. This area received the full effect of the May 18th eruption.

Vegetation regrowth in the blowdown zone has not been uniform, but controlled by biological and physiographic factors. These include: presence of survivors, moisture availability, deposition level, topographic features, and surface stability. This study and others have observed that vegetation regrowth is highest in pre-eruption clearcuts and alpine meadows, and uniformly low in the blowdown forest (Adams, 1982; Means, 1982). Blowdown areas with snowpack had significantly higher vegetation cover than blowdown areas without snowpack. Regrowth in clearcut areas includes a variety of grasses and herbaceous plants dominated by fireweed (Epilobium augustifolium), Canada thistle (Cirsium arvense), blackberry (Rubus spp.), and other species.

TIMS data was acquired over Mount St. Helens on July 29, 1983 between 1210-1230 hours P.S.T. at an average ground resolution of 12 meters. Color infrared aerial photography was collected concurrently with the scanner data. As a result of excellent atmospheric conditions and minimum air turbulence, the photographic and scanner imagery are of high quality. The data, however, were collected as a functional test of the TIMS and not as part of an ongoing research project; therefore, no concurrent ground verification was conducted during the overflight.

In lieu of collecting field data during the overflight, conventional retrospective ground coverage was substituted. At Test Site A, vegetation type and percent vegetation cover was obtained from the U.S.D.A. Forest Management Data Base System.

The data base, updated annually, identifies information about vegetation and land management activities for each site. Discrete vegetation areas in Test Site B were identified using 1:24,000 pre-eruption orthophotoquads. The extent of pre-eruption clearcut regrowth was obtained from the Forest Management Data Base. Vegetation cover estimates for non-clearcut areas were based on interpretation of color IR photography obtained during the TIMS overflight.

TIMS data processing used ELAS software modules to compute ERT and to georeference the scanner data to the Universal Transverse Mercator (UTM) grid system. Once gridded, sensor and photographic data are registered to topographic maps of the test sites. The LOWTRAN-6 program (developed by the U.S. Air Force Geophysics Laboratory) was run on TIMS data to determine the effects of atmospheric attenuation and meteorological factors on areas scanned by the sensor.

ANALYTICAL PROCEDURES

Forty-three sample plots were selected and gridded in the Tephra Deposition Zone (Test Site A). Average plot size was 30.2 acres. To reduce the effect of slope aspect in measuring effective radiant energy levels, only plots with southeast, south, and southwest facing slopes were used in the study. USDA Forest Service personnel estimated the mean percent vegetation cover for each plot, which ranged from 20 to 100 percent. Using TIMS Band 6 data (11.2-12.2 microns), the mean digital value count was calculated and converted to ERT values. The coefficient of determination (r^2) was calculated for pair values of ERT and percent vegetation cover. The results (r^2 = .9321, Y = .16 x + 19.6, sig. at 0.05 level) show a strong linear relationship between surface ERT and percent vegetation cover.

In the Tree Blowdown Zone, thirty sample plots were selected and gridded. Average plot size was 10.6 acres and post-eruption vegetation cover ranged from 30 to 90 percent. One third of the plots were clearcut prior to the initial eruption; the remaining plots were alpine meadows with less than 70 percent tree cover. Similar to Test Site A, in the Tree Blowdown Zone, ERT and percent vegetation cover showed a relatively strong linear relationship (r^2 = .8276, Y = .12 x + 19.1, sig. at the 0.05 level).

CONCLUSIONS

A method has been described for using the TIMS sensor to monitor vegetation regrowth in primary and secondary disturbance zones on Mount St. Helens. The results of this study demonstrate that the sensor is highly sensitive to vegetation changes. Potentially, TIMS data could be useful in monitoring vegetation patterns over large areas, providing topographic data (e.g., aspect and gradient) are available to be registered with the sensor data.

REFERENCES

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