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Semi-Annual Status Report #1

IRRIGATION MANAGEMENT WITH REMOTE SENSING

To

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

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BACKGROUND

A grant was established 4/1/80 with the long term objective to test the utility of thermal and reflective data for predicting crop coefficients and soil moisture as inputs into the U.S. Water and Power Resource Service (formerly U.S. Bureau of Reclamation) irrigation scheduling program. The grant proposal was in response to RTOP 677-22-23 entitled Irrigation Scheduling.

A ground study utilizing hand-held radiometers was to be conducted at the Navajo Indian Irrigation project near Farmington, New Mexico in conjunction with ongoing USW&PRS measurements including lysimetric measurements of evapotranspiration. The Remote Sensing Institute was to collect visible, near IR and thermal IR measurements to be analyzed and evaluated in terms of the ground measurements which included percent crop canopy cover obtained by RSI. Results were to be used to recommend future action regarding use of satellite data in irrigation management.

PROGRESS TO DATE

Introduction

RSI conducted a field measurement program during the summer of 1980. Measurements were made with two visible/near IR hand-held radiometers and a hand-held thermal radiometer. Soil moisture and lysimetric measurements were collected by USW&PRS personnel and forwarded to RSI along with meteorological data. All the data are described in detail in the next section of the report.

Analysis has been completed on the visible/near IR radiometer measurements in conjunction with the moisture and canopy cover data. Analysis is presently underway on the thermal IR data.

Field Measurements

The study was conducted on the Navajo Indian Irrigation Project near Farmington, New Mexico, in conjunction with a Water and Power Resource Service water use study. The test site consisted of four alfalfa plots with lysimeters that were irrigated with a line source sprinkler. The line source linearly decreases the amount of water applied as the distance from the source increases. With the configuration of the system, plot 1 was over-irrigated, plot 2 received optimum applications, and plots 3 and 4 were under-irrigated.

Radiances from each plot were measured with Mark II three-band and EXOTECH four-band radiometers in the mid-morning (1000-1100 MDT) and early afternoon (1300-1400 MDT). Radiances were converted to reflectances using radiance measurements of reference panels coated with 3-M white Nextel paint and $BaSo_4$. Panel radiances were measured before and after each plot measurement. Radiometric temperatures of the plots were measured with a PRT-5 within the same time frame. Radiances of bare soil were also measured.

Surface soil water contents (0-4 cm) were determined gravimetrically on samples collected at the same time as the spectral measurements. Percent canopy cover was determined using 35mm color slides (photographed from a vertical position) projected on a random dot grid. All measurements began after the second cutting of alfalfa in early July 1980 and continued to maximum canopy cover.

Water and Power (USW&PRS) personnel collected profile soil moisture (neutron attenuation method) and lysimetric measurements of actual evapotranspiration. Meteorological data they collected included maximum and minimum air and dew point temperatures, solar radiation, wind speed, and pan evaporation. USW&PRS calculated potential ET using the Penman equation which was calibrated for the climatic conditions at Farmington.

Preliminary Results

The scheduling procedure used by Irrigation Management Service (IMS) of USW&PRS requires estimates of the crop coefficient which is the ratio of actual to potential ET. We evaluated the relationship between Mark II spectral measurements and the crop coefficient.

Best relationships were obtained with the perpendicular vegetation index (PVI) of Richardson and Wiegand (1977) using channels 1 (0.63-0.69μm) and 2 (0.76-0.90μm). The soil background line was

$$\text{channel 1} = 1.03 \text{ channel 2} - 0.05$$

with an r^2 of 0.89.

Figure 1 shows the relationship between PVI and the crop coefficient for the morning measurements. The relationship for the afternoon measurements was not significantly different. A PVI based on channel 2 and 3 (1.55-1.75μm) did not improve the results.

Ratios of channels 2 and 1, and 2 and 3 were compared with the crop coefficient and respective r^2 of 0.791 and 0.793 were obtained. The lower correlation was probably due to soil background variations.

Preliminary results demonstrate the potential for using spectral measurements to estimate the crop coefficient. Inclusion of

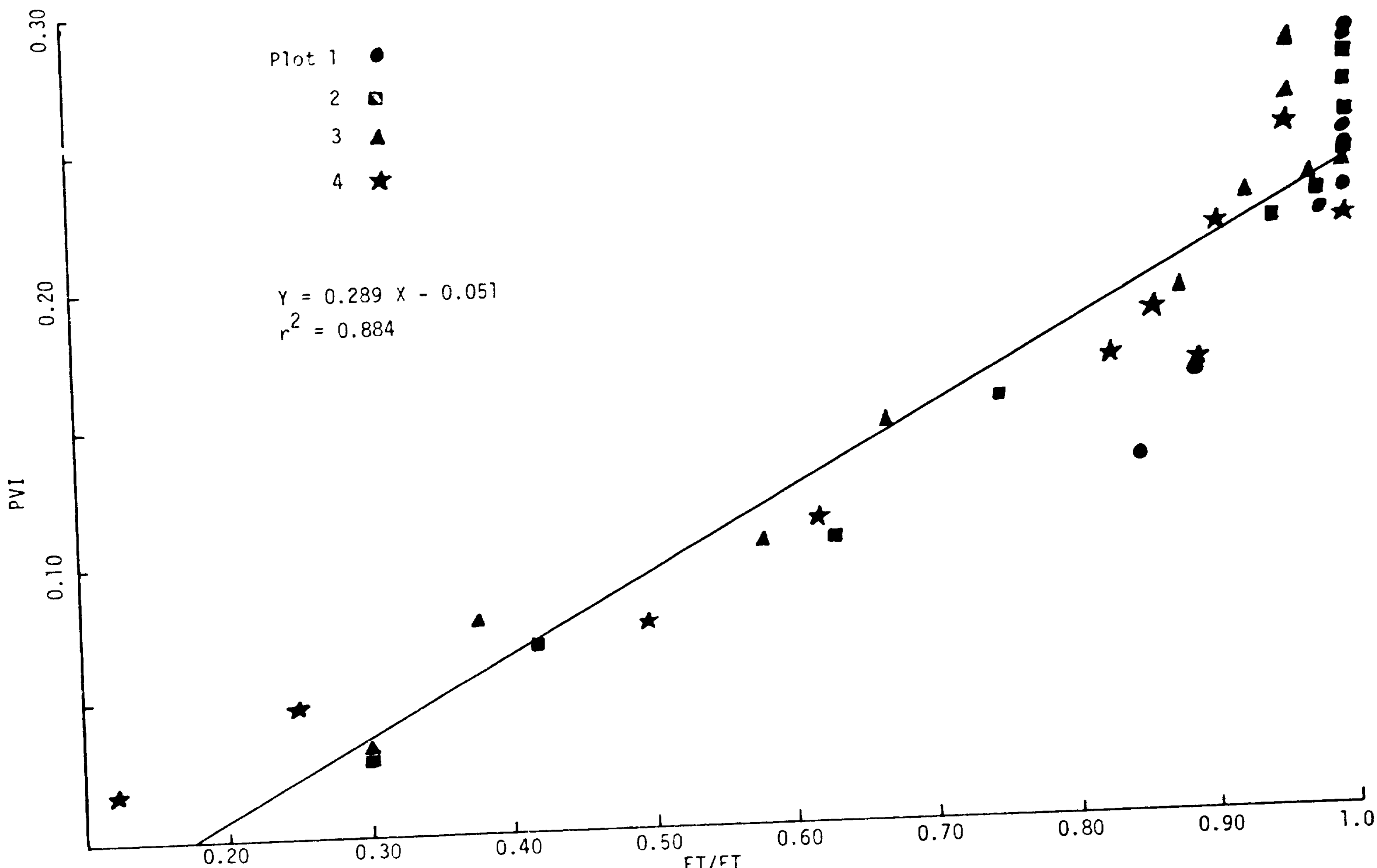

Figure 1. Mark II channel 1 and 2 PVI values vs. ET/ET_p for morning measurement periods. (ET/ET_p is the ratio of actual to potential ET, which is the definition of the crop coefficient.)

a liquid water absorption channel does not appear to offer a significant benefit.

References

Richardson, A. J. and C. L. Weigand. 1977. Distinguishing vegetation from soil background information. Photo. Engr. & Remote Sensing 12: 1541-1552.

ACTIVITIES PROJECTED THROUGH MARCH 1981

The first year activity remaining will include analysis of the thermal IR data in relation to the crop coefficient. EXOTECH four-band radiometer data will be evaluated for analysis, but it is not expected that they will be analyzed due to problems with the data caused by individual channel readings being saturated (off scale on the high end) much of the time. The cause for these off-scale readings is not known.