Mausam, (1987), **38**, 2, 239-240

551.501 : 63 : 551.576.38

Normalized difference vegetation index for drought monitoring*

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(*Received 24 September 1985*)

सार – इस अध्ययन में फसल की बढ़वार के समय वनस्पति आवरण में परिवर्तन का पता लगाने तथा सूखे की दशा का मूल्यांकन करने के लिए सुदूर संवेदी तकनीक का प्रयोग किया गया है। सूखे के कारण, फसल तथा वनस्पति आवरण (हरित आवरण) में परिवर्तन ज्ञात करने के लिए अवरक्त बैंड (NIR) (0.8–1.1 μm) तथा रक्त बैंड (0.6–0.7 μm) के निकट भूउपग्रह बहुवर्णक्रमीय अवलोकनकार (लैंडसैट मल्टीस्पैक्ट्रल स्कैनर) के सामान्यीकृत अन्तर के वर्णक्रमीय आंकड़े उपयोगी सिद्ध हुए हैं। इस तकनीक का प्रयोग 1982 में कर्नाटक राज्य के विभिन्न क्षेत्रों में उत्पन्न सूखे के लिए किया गया। अध्ययन के अन्तर्गत लिए गए क्षेत्रों में, सूखे के कारण हरित आवरण में, 54 प्रतिशत की कमी पाई गई।

ABSTRACT. In this study remote sensing technique has been adopted to monitor changes in vegetation cover during the crop growing season and assess the drought conditions. Normalized difference of Landsat Multispectral Scanner (MSS) near infrared (NIR) band (0.8-1.1 μm) and red band (0.6-0.7 μm) spectral data has been found useful to monitor the change in crop and vegetation cover (green cover) due to drought. The technique was tried for 1982 drought in parts of Karnataka State. 54 per cent reduction in green cover occurred due to drought in the study areas.

1. Introduction

The terminology defining drought is highly complicated. In very general terms, it is a rainless situation for an extended period of time leading to decrease in surface and sub-surface water levels and causing a severe shortage of moisture availability to local vegetation and crops. Plants are good integraters of many weather parameters and their response provide a reliable tool for monitoring drought (Wilhite and Neild 1982). A well established method of agricultural drought monitoring based on aridity index exists under the auspices of India Met. Dep. (George 1972; Chowdhury *et al.* 1977, Appa Rao *et al.* 1979). However, when unbiased information on drought occurrence is required for taking quick relief measures, the modern technology of satellite remote sensing has additional advantages.

A general agreement between the Landsat-MSS derived greenness index number (GIN) developed by Kauth and Thomas (1976) and ground based assessment of drought stress was reported by Thompson and Wehmanen (1979). The basic idea behind greenness index is that a weighted difference of the near infrared (NIR) and visible channels of Landsat MSS data represents the health of vegetation. The GIN is an estimate of the percentage of picture elements (pixels) in a Landsat scene having digital values high enough (decided a *priori*) to indicate the full cover of green vegetation. In order to minimize the error component due to location, time of data acquisition and atmospheric deviations several radiance normalization techiques are applied to the data. One of them is the difference of the radiance values of NIR and red bands normalized over the sum of radiance values of NIR and red. This normalized difference, (NIR—red)/(NIR+red), is used as a measure of greenness and called the vegetation index. The sensitivity of the normalised difference index (NVI) to changes in green cover (crops and natural vegetation) is due to the strong absorption of lincident radiation by the plant chlorophyll pigments in the red region and high reflectivity of plant canopies in the NIR region of the electromagnetic spectrum. More details on the relationships between various linear combinations of these two spectral bands and plant canopy variables are given by Tucker (1979) and Ayyangar *et al.* (1980). NVI was found to be a sensitive parameter to distinguish normal plants from soil moisture stressed plants (Tucker *et al.* 1980, Patel *et al.* 1982).

Recently, Negeswara Rao and Rao (1984) proposed an approach for agricultural drought monitoring wherein

*Paper presented at the symposium on Remote Sensing in Agriculture, 27-28, Feb. 1985, Ahmedabad.

TABLE 1

Normalized difference (difference/sum) values of 0.8-1.1 μm and 0.6-0.7 μm for different land cover types and percentage area occupied by each cover type

Landcover	Normalized difference vegetation index	Percent area covered by each cover type	
		1982 (Drought year)	1979
Bare soil	—0.16 to —0.06	87.06	32.85
Crops	0.12 to 0.36	9.36	58 68
Forest (sparse)	0.31 to 0.46		
Forest (dense)	0.56 to 0.72	2.39	7.52

the advantage of combined use of NOAA/AVHRR data for knowing rainfall occurrence during critical crop stages and Landsat/MSS imagery for delineating areas affected by drought was highlighted. In the present study an attempt has been made to quantify the severity of drought based on NVI which is sensitive to change in vegetation/crop cover.

2. Methodology

Landasat-2 MSS scene of path-row 155-051 on 16 October 1979 and Landsat-4 MSS Scene of path-row 145-051 on 30 September 1982 (drought year) both covering the same area, *i.e.*, 'parts of Tiptur taluk of Tumkur district and Arsikere and parts of Channarayapatna taluks of Hassan district of Karnataka State were selected for this study. The difference over sum value (normalized difference) of 0.8-1.1 μm (MSS 7 or 4) and 0.6-0.7 μm (MSS 5 or 2) spectral bands was calculated on IMAGE—100 system taking the digital data of these two bands. A "training gate" of equal size was chosen positioned at the same ground control points in both the scenes of 1979 and 1982. The coordinates of the four corners of the training gate are : 12° 47′N, 76° 1′E, 13° 40′N, 76° 9′E, 13° 38′N, 76° 31′E, 12° 43′N, 76° 24′E,. Within this training gate area general land over types were identified with the help of ground reference data. The percentage of bare soil and green cover having distinct NVI was calculated with reference to the gate area.

3. Results and discussion

Normalized difference vegetation index (NVI) values of general land covers and their percentage cover in 1979 (normal year for the area under study) and 1982 (drought year) are shown in Table 1. It can be observed from Table-1 that the land cover types having NVI values greater than 0.12 (crops and forest together called "green cover") covered about 12 per cent of the training gate area in 1982 and about 66 per cent in 1979. The decrease in green cover by 54 per cent in 1982 indicate that the area under study was affected by drought during that year. In fact, subsequent consultations with local farmers and district authorities confirmed the above observations.

4. Conclusions

The study offers scope for quantifying drought affect on vegetation and crop cover and thus help in monitoring drought using remote sensing techniques. Observations made in this study confirm the conclusions drawn from visual interpretation of Landsat false colour composites in the previous study of Nageswara Rao and Rao (1984). It is suggested that similar indices may be tried with NOAA/AVHRR band 1(0.55-0.68μm) and 2 (0.71—0.98 μm) data for nation-wide drought monitoring. More studies are required to relate the remotely sensed change in green cover to the severity of drought.

Acknowledgement

The authors thank the Director, Remote Sensing Technology Centre of Japan for extending the computer facility during JICA Training Programme. Senior author wishes to express his thanks to Shri Y.S. Rajan, Scientific Secretary, ISRO, for his encouragement and Dr. V.R. Rao, Scientist, ISRO for guidance.

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