CHOICE OF SPECTRAL BANDS FOR SENSORS ONBOARD IRS-1C

In the last two issues of INTERFACE (Volume 5 No.1 and 2) we have dealt with the overview of IRS-1C mission and the referencing scheme. In this article we will discuss the spectral bands selected for each of the three sensors and their significance.

The choice of spectral bands of a sensor vis-a-vis, their bandwidth, central wavelength and number of bands is dictated by the applications envisaged for that sensor. Selection of spectral bands is also restricted to the spectral regions where the effect of atmosphere is minimum. Besides, there should be less correlation between data of different bands to avoid redundancy. Agricultural applications have been envisaged as one of the major application areas for IRS-1C satellite. The pattern of reflectance of vegetation along the electromagnetic spectrum is characterised by pronounced changes from band to band. The spectral response curve of vegetation shows absorption in the blue region, a first peak reflectance at 0.55 microns and a low at about 0.67 - 1.3 microns. In the middle infrared region (1.3 - 2.5 microns) there is a decrease in reflectance due to absorption by plant water. Since the Rayleigh scattering is more for shorter wavelengths, the blue region loses its specificity for remote sensing of vegetation. Consequently, the bands chosen for IRS-1C lie in the green, red, near infra-red and middle infra-red regions.

LINEAR IMAGING AND SELF SCANNING SENSOR (LISS-III)

Band 2 (0.52 - 0.59 microns)

This band is centered around the first peak of the vegetation reflectance curve and is useful for discrimination of vegetation. Some carotenoid and chlorophyll absorption occurs in the 0.50 - 0.52 microns region hence the lower limit of this band is kept at 0.52 microns in order to exploit the unhindered reflectance by vegetation in this region. Extending this band beyond 0.59 microns reduces the regression significance and hence not advisable. Reflectance in this band along with those in the red and near infrared regions forms the core data useful for discrimination of vegetation. Since this band is on the longer wavelength side of the broad attenuation minimum of water, it helps in the assessment of turbidity and evaluation of clear water bathymetry upto 20m depth. This region is also known to be useful for discrimination of rocks and soils on the basis of their iron content.

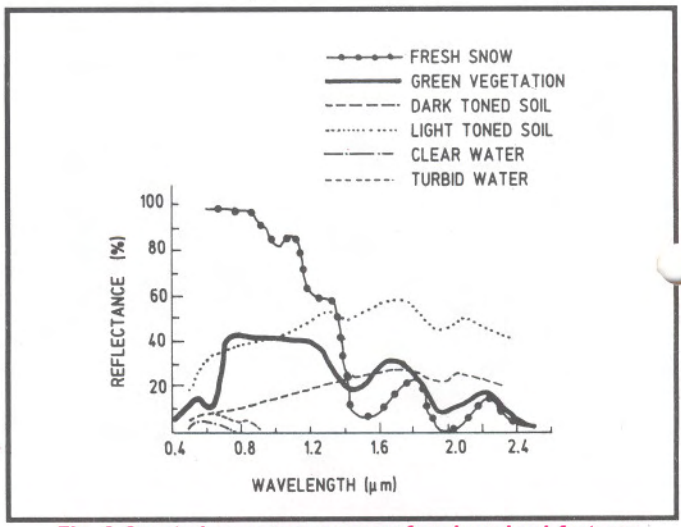

Fig. 2 Spectral response curves of various land features

Band 3 (0.62 - 0.68 microns)

This band is centered around the chrolophyll absorption region of vegetation. The 0.60-0.62 micron region shows lower absorption coefficient and inclusion of this region decreases the regression significance. On the upper side, this band is limited to 0.68 microns because atmospheric transmittance reduces to less than 90% around 0.69 microns. Strong correlation exists between spectral reflectance in this region and the chlorophyll content. A reduction in the amount of chlorophyll can occur when the plant is stressed. This results in less chlorophyll absorption and an increase in red reflectance. This band alongwith the near infra-red band is used widely for deriving spectral indices like Ratio and Normalised Difference Vegetation Index (NDVI) which have been found to be very good indicators of crop vigour and biomass.

XIV INCA CONGRESS

The XIV Indian National Cartographic Association (INCA) Congress will be held during 28th November to 1st December 1994 at Bangalore. The focal theme of the congress is "Mapping from Space-Cartographic challenges". For more details please contact :

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Band 4 (0.77 - 0.86 microns)

The high reflectance plateau region of the vegetation reflectance is in this band. There is an absorption band due to water vapour at 0.76 microns and has been avoided. A broad water absorption band exists in the 0.92 - 0.98 microns region. However, the upper end of this band has to be still lowered to 0.86 microns due to limitation of detector devices. Plant reflectance in this region is primarily governed by the internal structure of plant leaves. The internal air-cell interfaces cause infrared light to be scattered. With increasing number of interfaces, the amount of internal scattering increases. Changes in reflectance in this band are therefore related to internal cell structure of plant species or cell deformation caused by stress. This band shows high reflectance for healthy vegetation and is useful for green biomass estimation and crop vigour studies. Quite a few studies have shown that spectral measurements in this region in conjunction with those in red band are highly correlated to biometric parameters. As water is almost opaque in this band, land-water boundaries can be clearly demarcated.

Band 5 (1.55 - 1.70 microns)

The middle infra-red region from 1.3 - 2.5 microns is sensitive to leaf water content. It has been shown that 1.55-1.75 microns band was best suited in 0.7 - 2.5 micron region for monitoring plant canopy water status. However, due to sensor design considerations, the upper limit of this band has been kept at 1.70 micron. It has been observed that crop classification accuracies improve by 1-15 percent when the band combinations which included MIR band was used. Major applications of this band include discrimination of crop types, canopy water status, forest type separation and damage assessment. Due to absorption by snow and non-selective scattering by clouds, data collected in this band will be useful for snow-cloud discrimination. In geological studies, it will be useful for rock type discrimination.

WIDE FIELD SENSOR (WiFS)

(0.62 - 068 microns and 0.77 - 0.86 microns)

The two most important bands for vegetation studies viz., red and near infra-red bands have been chosen for this sensor. This sensor will provide a unique opportunity for viewing the terrain in the same spectral bands at two different spatial resolutions. With larger swath (770km), high repetivity (5 days) and operation in two vegetation specific bands, the data collected by this sensor will provide vegetation index information at regional level, thus helping in assessment of crop condition and drought monitoring. It will also enable monitoring of agricultural operations. Other applications of the data collected by this sensor will be snow and flood mapping and damage assessment.

PANCHROMATIC CAMERA (PAN)

(0.50 - 0.75 microns)

The data in the panchromatic region is useful in geological studies for mapping of geological and geomorphological features. Higher spatial resolution will be useful for urban planning studies, detecting urban fringe growth, updating the urban transportation infrastructure etc. As the spectral responses of the ground features are averaged out over the width of this band, it is of little importance for spectral signature studies. However, it has been demonstrated that in conjunction with multispectral data, this band is useful for mapping various features at larger scales. Also, it will have off-nadir viewing capability and the view angle can be varied between ± 26 degrees. The advantages of off-nadir viewing are : increased repetitive coverage and stereoscopy. Stereoscopic image pair obtainable by PAN can be used for topographic studies and generation of digital terrain models.

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See next page for sensor specifications

REGIONAL WORKSHOP HELD AT MANGALORE

The fifth in the series of regional workshops was jointly organised by NDC, Department of Marine Geology, Mangalore University and District Committee for Science and Technology, Dakshin Kannada on 30th May, 1994 at Mangalore University campus. Presentations by NRSA personnel included an overview of remote sensing and applications, IRS missions (present and future), types of data products, different user services from NDC and data ordering procedures.

A series of case studies using remote sensing data were presented by personnel from Mangalore university and other organisations. This was followed by discussions about data products and services. The participants felt that there was a need for carrying out application studies for the development of the region and monitoring of the environment.