ISRS

SIGNATURES

Vol 9, No 1&2
August 1995

Newsletter of the Ahmedabad Chapter of the Indian Society of Remote Sensing

CONTENTS

Edited by : V. K. Dadhwal

Dear readers

We are happy to place in your hand the third issue of SIGNATURES by current editorial team which has the same pattern of coverage as was adopted in the previous two issues. Thus again a distinguished guest speaker at ISRS-AC function, Prof. S. D. Sabnis, Ex Pro-Vice Chancellor of MS University, Baroda has tried to communicate the essence of his lecture in his own words. Dr. S. M. Bhandari has drawn the attention of remote sensing community of great opportunity of observing TSE from space. The wonder world of vegetation indices, (new VI are being defined at frantic pace !), is presented in another article by Drs Ray & Dadhwal. The light touch is once again provided by Dr S. D. Naik through his cartoons.

Meanwhile, exciting things are in store for Indian RS community with three Indian-built satellites, INSAT 2C, IRS-1C & IRS-P3 will be placed in orbit by French, Russian and Indian launch vehicles, respectively. The IRS series of satellites will not only change the total scenario of data availability to Indian community but are global leaders as well. While all of you are aware of fast changes in technology, a prime example which can now be added is that 2-band WiFS onboard IRS-1C will be overtaken by 3-band WiFS onboard IRS-P3 before user community will become fully familiar with it. On drawing board, as part of IRS-P series, are a number of unique sensors. One such sensor package is planned on a satellite to be dedicated to ocean applications. The characteristics of sensors on this satellite - OCEANSAT, are described by Shri N. S. Pillai.

The Editorial Committee would welcome your feedback on what you would like to see in SIGNATURES. Our yardstick is to include material which would inform, educate and entertain.

- Editorial Committee.

BIODIVERSITY AND ITS IMPLICATIONS[1]

Prof. S. D. Sabnis
ex- Pro-Vice-Chancellor
The M.S. University of Baroda

Biodiversity now occupies scientific and political centrestage worldwide. It encompasses the variety of World's genes, species, ecosystems, landscapes and habitats.

Plants, animals and various kinds of micro-organisms occupy all conceivable habitats; from ocean depths to mountain tops, from tropical or temperate forests to hot or cold deserts; in rivers, wetlands and even hot springs. Not only that their genetic diversity cannot be correctly quantified, their species diversity varies from the presently known 1.4 million to now estimated 40 or even 100 million. This is due to our poor knowledge about diversity in micro-organisms and poor explorations of the tropical forest and marine ecosystems.

Various human activities have been responsible for adverse changes not only in the landscapes and habitats but also in the ecosystems and the various biotic-plants and animals-components therein. The destruction or shrinkage of these natural habitats has brought about a rapid erosion of the biological resources and their genetic variability. It is very likely that these life forms would disappear from the planet even before their role in the ecosystem or their utility to humans is properly evaluated.

The biodiversity has to be properly assessed not only from a strictly moral/ethical point of view but also from purely practical consideration of present and future human needs for a variety of purposes. It is also necessary to understand the role of biodiversity in the ecosystem structure and function in primary production governing the food chains and webs; and decomposition through micro-organisms for material/nutrient cycling.

Biodiversity losses have been the real crisis facing the humanity. Not only that a large number of species are already extinct or are threatened, there is an imminent danger to the genetic diversity so essential for breeding programmes for improvement of crops and domestic animals. This man-induced process is much faster than the natural process of extinction of species, which has taken place regularly during the past geological eras.

The biodiversity issue, thus touches all human activities. Besides being a scientific, biological issue, it revolves around biological resources and control over their exploitation, through which conmtrol over people and nations could be established and perpetuated. All these socio-economic and political issues like populational and consumptional imbalances, location of germplasm repositories, intellectual property rights, globalization of resources, etc., were also briefly discussed.

[1]Talk delivered under the auspices of ISRS-AC at Vikram Hall, SAC on May 4, 1995.

REMOTE SENSING DURING THE TOTAL SOLAR ECLIPSE OF OCTOBER 24,1995

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A Total Solar Eclipse is to occur on the morning of Oct. 24, 1995 (Diwali Day) over part of the Earth covering the Indian subcontinent.

A total eclipse of the Sun is an extremely unique and rare event. First of all, in the entire solar system, the sizes and orbits of planets and their satellites are not so optimally designed (!) for such an event to be visible from any planetary surface except of course, the Earth. The Earth-Moon system permits the occurrence of total and partial solar and lunar eclipses. Isn't it unique and astonishing that the great spectacle of a Total Solar Eclipse (TSE) occurs only for the planet which has inhabitants to watch and enjoy it !

The interplay of sizes and distances in the Sun-Earth-Moon system occurs in such a way as to cause a TSE about 2-3 times a year somewhere on the Earth. However, for any given place on Earth, a TSE is as rare as once in 360 years. The last TSE over India took place on Feb. 16, 1980, when the track of totality passed over the peninsular region. A large number of experiments were carried out by the Indian scientists.

The forthcoming TSE on Oct. 24,1995 is the second during this century with the totality path over India. During this event, the track of Moon's shadow would be passing over the highly populated regions of North India. Over India, the TSE would begin in the NW at 0830 IST and the shadow would travel towards E-SE, passing over many cities and would leave the country at around 0850 hrs IST. Fig. 1 shows the coverage of the umbral and penumbral regions of the Moon's shadow over the entire Indian region alongwith the beginning and ending hours, percentage of totality etc. as seen from different places.

During this TSE event, scientists from all over the world have planned a wide variety of experiments to investigate changes that are likely to take place in the state of the Earth's atmosphere and the ionosphere as a result of sudden blocking and unblocking of solar radiation. Astronomers and amateurs would be looking skywards to study the structure and dynamics of the tenuous solar corona, which otherwise is made difficult due to presence of extremely bright solar radiance.

What does a TSE offer to the remote sensing scientists who look at the Earth from space? Certainly, there are many interesting possibilities. As is well known, quite a bit of remote sensing of the Earth even today is being undertaken by measuring and monitoring the reflected solar radiation in the visible band. During the process of a TSE, the incoming solar radiations is blocked by the appearance of dark Moon in the line of sight to the Sun. As a result of this, areas under the shadow would appear dark in any images from space taken during TSE. The response of different types of surfaces on Earth to disappearance and reappearance of the Sun during the TSE can be investigated by remote sensing in the visible and thermal bands.

High resolution imaging from space could thus be used to study the reflected and emitted radiation from various regions of the Earth's surface in the path of the eclipse. These can be supported by ground based monitoring of the incoming and reflected solar radiation, surface and sub-surface temperatures, humidity etc. Resource satellite images may also be useful in imaging any atmospheric gravity waves that the TSE may trigger by the relatively sudden removal and restoration of solar input to the atmosphere/ionosphere system.

While the forthcoming TSE is occurring during the most favorable conditions of weather in terms of cloudiness etc. and in terms of logistics of planning and execution of experiments due to its occurrence over highly populated areas, the time of its occurrence is not suitable in terms of passage of resource satellites over the region. For example, IRS would be collecting images at around 0945 hrs IST, about an hour after the end of TSE.

On the other hand, geostationary meteorological satellite INSAT with VHRR onboard, has the basic flexibility of imaging the entire Indian region at the desired time of the day. Additionally, as India

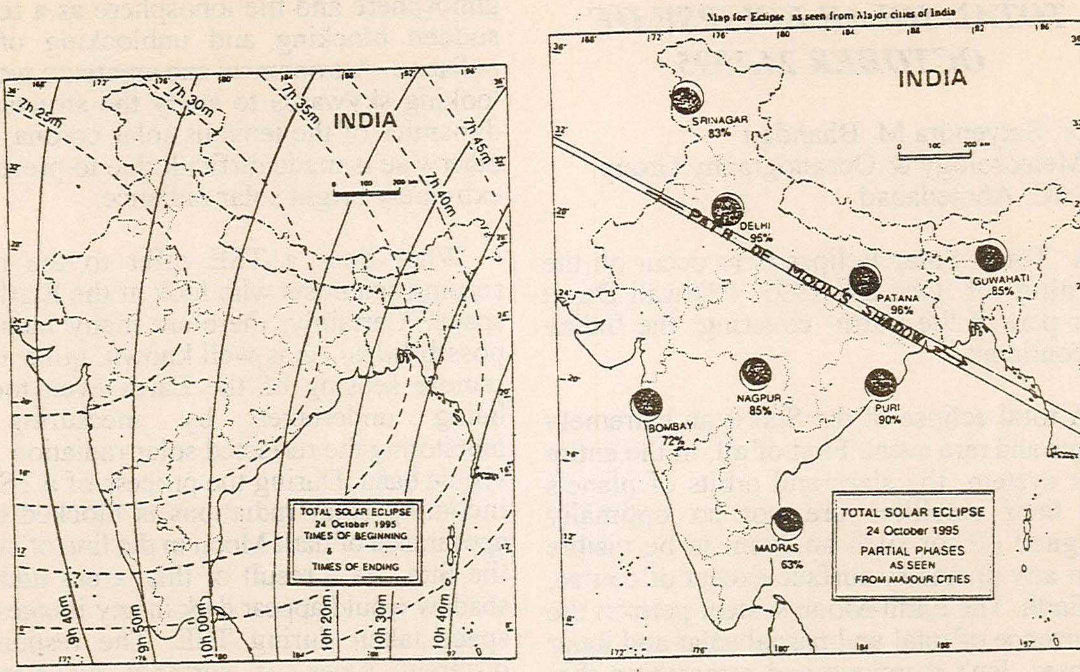

Figure 1. Times of beginning and end of TSE on 24 October 1995 and partial phases as seen from major cities.

simultaneously maintains at least two INSAT-VHRRs in space, these can be used with advantage to get a better coverage of the scan mode to image the shadow 3-4 times in a sequence at different places over the track of the eclipse. INSAT-VHRR images collected in both the visible and IR bands would be analysed to study the size, shape and the dynamics as well as the thermal state of the Moon's shadow during the TSE.

Ground based monitoring of various surface and atmospheric parameters is also planned in collaboration with other colleagues/ agencies to support the remote sensing measurements.

In addition, the occurrence of partial eclipse conditions over the Bay of Bengal would be utilised to study the region of specular reflection of the Sun, called Sunglint, in the INSAT-VHRR visible band images.

The images acquired by the resource satellites like RS, meteorological satellite e.g. NOAA and the oceanic satellites like ERS & TOPEX, which are crossing the region at various hours after the end of the eclipse, would serve to monitor any ong term changes in the behavior of the earth's atmosphere and oceans caused due to the TSE.

While a TSE is normally associated with astronomers undertaking ground based remote sensing of the Sun and its atmosphere, remote sensing of the Earth and its environment from space would add a new dimension to the TSE studies. An image of the Earth from the vantage point of space taken during the TSE, showing the regions actually under the shadow of the Moon, would also have tremendous educational value for the student community excited and eager to learn more about such events.

Remote Sensing community is therefore urged to design and undertake scientific experiments of different types to utilise the rare opportunity offered by the occurrence of a TSE over the Indian region, to gain better insights into the workings of Nature. It may be noted that the next and the last of the 20th century TSE over India is to occur on 11 Aug. 1999 at a time of the year when sky is likely to be overcast, hampering many an investigations. Hence the forthcoming TSE on Oct. 24,1995 should be viewed and utilised as once-in-a-lifetime opportunity.

(Interested ISRS-AC members are encouraged to contact the author for all the necessary details of the circumstances of the Oct. 24, 1995 total solar eclipse for planning and undertaking any interesting experiment.)

******Watching the Spectacle of Total Solar Eclipse Safely******

The National Council of Science & Technology Communication (NCSTC) has developed a kit with a handy device with proper filetrs to protect the eyes while viewing the eclipse during all its phases. The kits are available for Rs. 25/- + postage from : Director, NCSTC, Technology Bhawan, New Mehrauli Road, NEW DELHI - 110 016.

ISRS-AC plans to coordinate requirements of these kits from ISRS-AC members for placing the consolidated order. Interested members may give their requirements to the Secretary, ISRS-AC latest by September 30, 1995 so that kits could be obtained in time. A sample kit is available with Dr S. M. Bhandari (Room No 4372, SAC) for the members to examine.

SPECTRAL VEGETATION INDICES: RECENT ADVANCES

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The typical reflectance pattern for vegetation shows high absorption due to chlorophyll, at 0.65 µm (red region) and high reflection, due to leaf internal structure, at 0.75 µm (near infra red, NIR, region). This differential vegetation responses at different spectral regions have been used to develop various arithmetic formulae, commonly known as Vegetation Indices (VI). The VIs reduce the multispectral remote sensing data to single numbers for assessing vegetation characteristics, such as, species, leaf area index, biomass, stress etc. VIs are also related to fractions of absorbed total solar and photosynthetically active radiation, canopy photosynthesis, stomatal conductance and land surface albedo. This information is needed in all surface energy balance and climate studies (Sellers et al., 1986), productivity analysis (Prince, 1991) and ecosystem models (Peterson and Running, 1989). Also as result of different arithmetic combinations VIs reduce the additive and multiplicative errors associated with atmospheric effect and sensor characteristics.

This article discusses the modern (post 1980) developments in spectral vegetation indices (VI). As a background the earlier developed and commonly used indices have been summarized in table 1. Most of these VIs suffer from soil brightness and atmospheric influences. So the VIs developed after these are mostly meant to be free from these effects.

1. Broadband Indices

Clevers (1986) proposed a weighted difference VI (WDVI) to correct the IR reflectance for soil background. It is given by,

$$WDVI = R_{nir} - \tau . R_r \qquad ... 1.1$$

where τ is the slope of the soil line.

Huete(1988) developed a transformed VI, called Soil Adjusted VI (SAVI), to minimize soil brightness influences. Graphically, this transformation involves a shifting of the origin of reflectance spectra plotted in nir-red wavelength feature space to account for first order soil-vegetation interactions and differential red and nir flux extinction through vegetated canopies. Mathematically SAVI is given by,

Table 1. *A summary of the major vegetation indices developed before 1980.*

Name	Formula	References
Ratio		
	R_r/R_{nir}	Birth & McVey, 1968
Normalized Difference VI		
	$(R_r+R_{nir})/(R_r-R_{nir})$	Rouse et al.,1973
Transformed VI		
	$(NDVI+0.5)^{1/2}$	-do-
Orthogonal VI [Greenness(GVI)/Brightness(SBI)]		
	$a.R_{bl}+b.R_{gr}+c.R_r+d.R_{nir}$	Kauth & Thomas,1976
Perpendicular VI		
	$[(R_r^s-R_r^p)^2+(R_{nir}^s-R_{nir}^p)^2]^{1/2}$	Richardson & Weigand, 1977
Ashburn VI	$2.0*R_{nir}-R_r$	Ashburn, 1978
GRABS	$GVI - a.SBI + b$	Hay et al., 1979

$R_{bl}, R_{gr}, R_r, R_{nir}$ are, respectively, the radiance values at blue, green, red and near infra-red wavelength regions. the superscripts s and p stand for soil and plant respectively.

$$SAVI = [(R_{nir}-R_r)/(R_{nir}+R_r+L)](1+L) \quad .... 1.2$$

where, L is a soil adjustment factor. Although Huete found the optimal adjustment factor to vary with vegetation density, he used a constant L.

Baret et al. (1989) proposed a transformed a transformed SAVI (TSAVI) by taking into account the soil line slope (τ) and intercept (i):

$$TSAVI=[\tau(R_{nir}-R_r-i)]/[\tau R_{nir}+R_r-\tau i+X(1+\tau^2)]]3$$

where X is a factor (0.08 in their case)adjusted so as to minimize the soil background effect.

Qi et al.(1994) developed a modified SAVI (MSAVI) that utilized an iterative, continuous L function to optimize the soil adjustment and increase the dynamic range of the SAVI. The L function may be derived by induction or by using the product of the NDVI and WDVI (i.e. L= 1- 2τ NDVI.WDVI). For inductive L function MSAVI is given by,

$$MSAVI=\{2.R_{nir}+1-[(2.R_{nir}+1)^2-8(R_{nir}-R_r)]^{0.5}\}/2 \quad ... 1.4$$

In addition to minimizing the effect of soil background, top-of-the atmosphere spectral radiance values should be corrected for atmospheric effects to recover the vegetation signal. One such index, the Atmospherically Resistant VI (ARVI) was proposed by Kaufman and Tanre (1992), that incorporated a self correction process for the atmospheric effect at red wavelength by utilizing the radiance difference between blue and red wavelengths. Mathematically it is denoted by,

$$ARVI = (R_{nir} - R_{rb})/(R_{nir} + R_{rb}) \quad .... 1.5$$

$$\text{where } R_{rb} = R_r - \tau(R_b - R_r) \quad .... 1.6$$

This index requires prior corrections for molecular scattering and ozone absorption.

ARVI can be coupled with SAVI or MSAVI, the resulting index (SARVI or MSARVI) is expected to correct for both atmospheric and background effects.

$$SARVI = (1+L)[(R_{nir} - R_{rb})/(R_{nir} + R_{rb} + L)1.7$$

$$MSARVI= \{2.R_{nir}+1-[(2.R_{nir}+1)^2-8(R_{nir}-R_{rb})]^{0.5}\}/2 \quad ..1.8$$

Xia (1994) found that the VIs based on soil line concept could only reduce soil moisture effect on RS data parallel to the axis, the direction of the soil line, failing when different soil types appeared (in the direction perpendicular to the soil line). Hence he proposed a Two-axis Adjusted Vegetation Index (TWVI) to diminish most soil influences. It is shown to be more suitable as global monitoring VI than other indices.

Many VIs have been computed using thematic mapper data (Thenakbail et al., 1994) One of these is a cubed ratio VI $(TM4/TM5)^3$ which was found to be particularly useful for modelling corn characteristics.

A Global Environmental Monitoring Index

(GEMI) was developed to specifically correct for atmospheric effects in AVHRR data by employing a non-linear combination of red and nir radiances (Pinty and Verstraete, 1992). GEMI exhibits a high atmospheric transmissivity, insensitivity to soil reflectance, with the exception of very bright soils and is empirically representative of vegetation properties in a manner similar to other indices.

$$GEMI = \eta(1-0.25\eta)-(R_r-0.125)/(1-R_r) \quad ....1.9$$

where

$$\eta = \{2(R_{nir}^2-R_r^2)+1.5\,R_{nir}+0.5R_r\}/(R_{nir}+R_r+0.5)$$

Rondeaux and Vanderbilt (1993) proposed modifications in NDVI and SR (simple ratio) by excluding effects of specular light which contains no cellular pigment information. The modified minus specular (ms) indices are given by,

$$SR_{ms} = (R_r-R_s)/(R_{nir}-R_s) \quad .... 1.10$$

$$NDVI_{ms} = (R_r-R_{nir})/(R_r+R_{nir}-2R_s) \quad .... 1.11$$

R_s is the magnitude of the specularly reflected light which can be estimated using Fresnel equations.

2. Narrowband Indices

Spectral VIs in narrow bands can produce better information about the structure and physiology of leaves than NDVI. Hence these indices are also known as physiological indices. Penuelas et al. (1994) have described three such indices. These are, Physiological Reflectance Index (PRI), Normalized Pigment Chlorophyll ratio Index (NPCI) and Water Band Index (WBI).

$$PRI = (R_{550}-R_{530})/(R_{550}+R_{530}) \quad .... 2.1$$

$$NCPI = (R_{680}-R_{430})/(R_{680}+R_{430}) \quad ... 2.2$$

$$WBI = R_{970}/R_{902} \quad ... 2.3$$

PRI shows the changes in the xanthophyll pigments and the photosynthetic rates of leaves. NPCI varies with the total pigments per chlorophyll. The WBI indicates the water status of the leaves.

3. Indices for Temporal Changes

The temporal changes in vegetation can be studied using a Vegetation Change Index (VCI) based on non-corrected radiometric data (Abednego and Collet, 1992).

$$VCI = NPVI_{t1} - NPVI_{t2} \quad .... 3.1$$

where NPVI is Normalized Perpendicular Vegetation Index based on non-corrected radiometric data.

$$NPVI = PVI/\sigma(PVI(bls)) \quad .... 3.2$$

where $\sigma(PVI(bls))$ is the standard deviation of PVI base line (soil line) samples. It has been found that NPVI was not influenced by multiplicative and additive factors due to sensor charateristics, atmospheric and illumination conditions.

To characterize the temporal trends in vegetation indices three derived indices/ parameters have been used. The area-under-the-curve integral index produces a single number that is associated with total dry matter accumulation (Tucker et al., 1981). The skew index (Samson, 1993) reflects the time in the seasonal profile when the highest NDVI values occur. This accomplished by bisecting the time domain of the observations and determining the proportion of the area under the curve in the first half of the season to the total area under the curve. The range index (Samson, 1993) is associated with the range of NDVI values observed over the temporal sequences. This index reflects the relative change in NDVI values observed over the growing season.

4. Thermal Indices

McVicar et al. (1993) developed a temperature based index, called NDTI (Normalized Difference Temperature Index) from AVHRR derived and atmospherically corrected composite surface temperatures T_s.

$$NDTI = (T_\infty - T_s)/(T_\infty - T_0) \quad ... 4.1$$

where T_0 and T_∞ are the energy balance based composite surface temperatures the same area would have at the time of overpass assuming (respectively) fully available moisture (or zero surface resistance) and no available moisture (or infinite surface resistance). NDTI has been found to be very closely related with moisture availability of surface.

Becker and Li (1991) have observed that, as the reflectance contrast between optical bands is very low for soils, indices based on optical bands do not properly characterize soil properties. So a combination of optical data with thermal data will be suitable for this purpose. However, the thermal ir data is a combined effect of surface emissivity(which represents soil properties) and surface temperature. In order to solve this problem they have defined Temperature Independent thermal ir Spectral Indices (TISI). In general, TISI is defined as:

$$TISI = \prod_{k=1}^{N} \epsilon \qquad ...4.1$$

if atmospheric reflected radiance is neglected,

$$TISI = C.\prod_{k=1}^{N} \epsilon \qquad ...4.2$$

if it is not neglected ,with $C \approx 1$, N is the number of channels and ϵ is the emissivity.

5. Microwave Indices

VIs have also been defined in microwave region, which are used for crop discrimination. Paloscia and Pampaloni (1992) a microwave VI, called Normalized Temperature Difference, which is the difference between the normalized temperature T_r at 36 GHz and 10 GHz, where T_r is the ratio between the microwave 'brightness' and infrared 'radiance' temperatures. This index was foun to depend upon plant biomass and could be related to some crop parameters such as plant water content and leaf area index.

The Microwave Polarization Difference Index (MPDI), developed by Becker and Choudhury (1992) is the normalized difference of brightness temperatures in horizontal and vertical polarization measured at 37 GHz.

$$MPDI = (\quad T')/(T_H + T_V) \qquad ....5.1$$

where $$T' = (1\text{-}C)\, T_s + C.\, T \qquad ....5.2$$

T - brightness temperature difference, C - fraction cover and T_H and T_V are brightness temperature in horizontal and vertical polarization. The subscript s is for soil. MPDI has been found sensitive to water content of plant.

Conclusions

Because of the large amount of information provided by the VIs, these form the core of an evolving branch of remote sensing technology with a significant role in the forthcoming Earth Observation System (EOS) era. However it must not be forgotten that the information content of a VI depend only on the constituent radiances (or reflectances) and that an empirical relationship does not necessarily imply a causal relationship. Though the recently developed broadband VIs try to correct for soil and atmospheric influences, still they are not able to completely be free of those influences. For example, ARVI corrects well for atmospheric effects resulting from sun angle changes and moderate variations in aerosol optical depth. However it does not correct for net negative atmospheric effect at near infra red wavelength, which is large under turbid atmosphere. For critical discussions on different VIs, readers are referred to Hall et al. (1992) and Myneni and Asrar (1994).

REFERENCES

Abednego BSP, Collet C (1992) A theoretical approach for vegetation change index based on non-corrected radiometric data. *IJRS*. **13**:699.

Ashburn P (1978) The vegetation index number and crop identification. *Proc. LACIE Symp.* Johnson Space Centre, Houston, USA. pp. 843.

Baret, F. Guyot, G. and Major, D. (1989) TSAVI: a VI which minimizes soil brightness effects on LAI or APAR estimation. *12th Canadian Symp. on Rem. Sens. and IGARSS'90*, Vancouver, Canada, 10-14 July.

Becker F, Choudhury BJ (1988) Relative sensitivity of NDVI and MPDI for vegetation and desertification monitoring. *RSE* **24**:297.

Becker F, Li ZL (1991) Complementarity of temperature independent thermal ir spectral indices (TISI) and NDVI : Compared properties and combined use for soil and vegetation discrimination. *Proc 5th Int. Collquium - Physical Measurements and Signatures in Rem. Sens.*, Courchevel, France. pp. 475-480.

Birth GS, McVey G (1968) Measuring the colour of growing turf with a reflectance spectrophotometer. *Agron J* **60**:640.

Clevers JGPW (1986) The application of a VI in correcting the IR reflectance for soil background. *Proc. Symp. on RS for Res. Dev. & Environ. Mgt.*, Enschede, 25-29 Aug, 1986.

Hall FG et al. (1992) Satellite Remote Sensing of surface energy balance: successes, failures, and unresolved issues. *J. Geophy. Res.* **97**, D17:19,061

Hay L et al. (1979) Development of AI procedures for dealing with the effect of episodal events on crop temporal response. Agristars Rep. SR-B9-00434. Johnson Space Centre, Houston, USA.

Huete, A.R. (1988) A soil adjusted vegetation index (SAVI). *RSE* **25**: 295

Kaufman YJ, Tanre D (1992) Atmospherically resistant vegetation index for EOS_MODIS. *IEEE Trans. Geosci. Rem. Sens.* **30**: 261-270.

Kauth, R.J. and Thomas, G.S. (1976) The Tasseled Cap - a graphic description of the spectral-temporal development of agrl. crops as seen by Landsat. *Proc. Symp. Machine Processing of RS data*. Purdue University. pp. 44-51.

McVicar TR et al. (1993) Soil moisture and drought monitoring using remote sensing. *Proc 14th ACRS*. Tehran.

Myneni, R.B. and Asrar, G. (1994) Atmospheric effects and spectral vegetation indices. *RSE*. **47**:390-402.

Paloscia S, Pampaloni P (1992) Microwave vegetation indexes for detecting biomass and water conditions of agricultural crops. *RSE* **40**:15

Penuelas, J et al. (1994) Reflectance indices associated with physiological changes in nitrogen and water limited sunflower leaves. *RSE* **48**:135-146.

Pinty, B. and Verstraete, M.M. (1992) GEMI : a non-linear index to monitor global vegetation from satellites. *Vegetatio*, **101**:15-20.

Peterson, D.L. and Running, S.T. (1989) Application in forest science and management, in 'Theory and Application of Optical Remote Sensing' (G. Asrar, Ed.) Wiley, New York, pp. 429-473.

Prince, S.D. (1991) A model of regional primary production for use with coarse resolution data. *IJRS* **12**:1313.

Qi J et al. (1994) A modified soil adjusted vegetation index. *RSE* . **48**: 119.

Richardson, A.J. and Weigand, C.L. (1977) Distinguishing vegetation from soil background information. *PERS* **43** : 1541

Rondeaux G, Vanderbilt VC (1993) Specularly modified VIs to estimate photosynthetic activity. *IJRS* **14**: 1815.

Rouse, J.W et al. (1974) Monitoring earth vegetation system in great plains with ERTS. Proc. 3rd ERTS-1 Symp., GSFC, NASA, SP-351. pp. 309-317.

Samson, S.A. (1993) Two indices to characterize temporal patterns in the spectral response of vegetation.*PERS* **59** : 511

Sellers, P.J., Mintz, Y., Sud, Y.C. and Dalcher, A. (1986) A simple biosphere model (SiB) for use with general circulation models. *J. Atmos. Sci*. **43**:505-531.

Tucker, C.J., Brent,N.H., James, H.E.Jr. and James, E.M. (1981) Remote sensing of total dry-matter accumulation in winter wheat. *RSE* **11**:171-189.

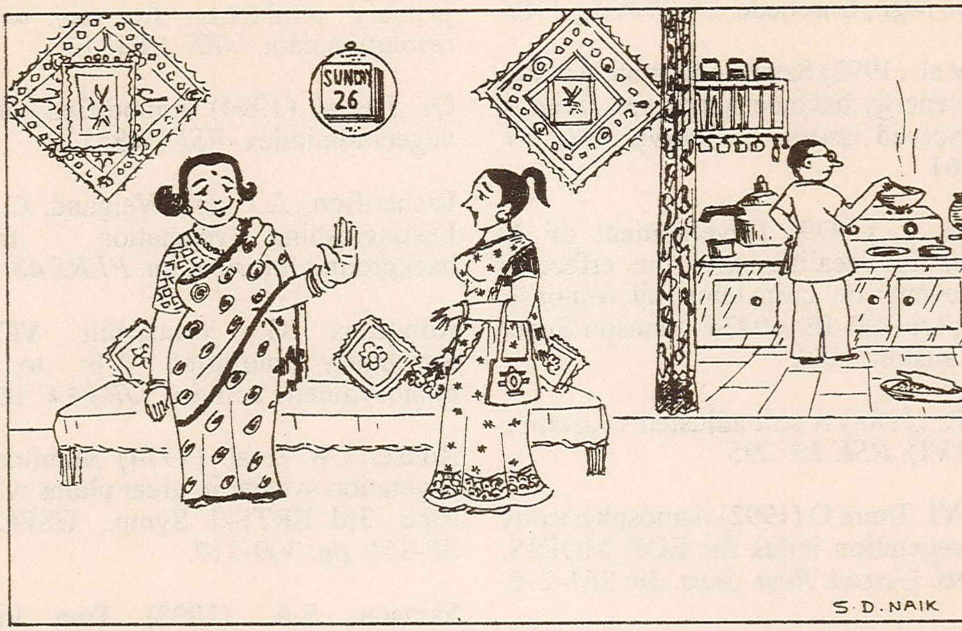
Thenkabail, P.S., Ward, A.D., Lyon J.G. and Merry, C.J. (1994) Thematic mapper VIs for determining soybean and corn growth parameters. *PERS* **60**: 437-442.

Xia, Li (1994) A two-axis adjusted vegetation index (TWVI). *IJRS* **15**:1447-1458.

(IJRS : Internat. J. Remote Sensing;
PERS : Photogramm. Engg. & Remote Sens.,
RSE : Remote Sensing of Environment)

Obituary Notice

Indian born Astrophysicist and Nobel Laureate S. Chandrashekar passed away in USA in August 1995.



ESPECIALLY ON HOLIDAYS , WHAT I DO IS , I PROFUSELY PRAISE HIS REMOTE SENSING WORK AT THE TIME OF MORNING TEA AND RELAX REST OF THE DAY

OCEANSAT

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Following the successful development and operationalisation of IRS 1A and 1B satellites and the planned launch of IRS 1C and 1D to cater largely to the needs of land related applications, it has now been proposed to develop and launch OCEANSAT, catering largely to oceanographic applications. The data from this satellite will also provide valuable inputs for the meteorological and climatological studies.

OCEANSAT is expected to carry a Ku-band scaterrometer, a Ku-band altimeter, a three frequency radiometer and a ocean colour monitor. Scatterometer will provide data on ocean surface wind speed and direction, altimeter will provide data on significant wave height, ocean surface topography and wind speed and the ocean colour monitor would provide data related to ocean biological parameters. The microwave radiometer data will be primarily used for computing the atmospheric parameters for correcting the altimeter data. The major specifications of these sensors are given below:

Sensor 1. Ku-band scatterometer

Frequency	13.995 GHz
Polarisation	vertical
Antenna	3 fan beam antennas (45, 115 & 135 deg wrt flight vector)
Swath	500 Km
Resolution	50 x 50 Km
Wind Direction *(a) Range* *(b) Accuracy*	 0 - 360 deg 20 deg

Wind Speed *(a) Range* *(b) Accuracy*	 4-24 m/s 2 m/3 or 10%

Sensor 2. Ku-band Altimeter

Frequency	13.6 GHz
Antenna	1.2 m dia parabola
Altitude measurement accuracy	10 cm
Significant Wave Height Measurement *(a) Range* *(b) Accuracy*	 1-20 m 0.5m or 10 %
Scattering Coeff. Measurement *(a) Dynamic Range* *(b) Accuracy*	 48 dB 1 dB

Sensor 3. Radiometers

Frequency	18, 21 & 37 GHz
Antenna	800 mm dia. parabola
Resolution	54x58 km, 44x29 km & 28x18 km
Temp. Measurement Accuracy	1 deg K

Sensor 4. Ocean Colour Monitor

No. of Channels	9 (402 - 1700 nm)
IFOV (a) VNIR *(b) SWIR*	250 m 500 m
Swath	1500 km

The altitude of the spacecraft will be around 743 km in the polar sun synchronous orbit. The repetivity will be 2 days for the 500 km swath. The data will be downlinked in both S and X bands during the visibility period and there will be provision for on board data recording and storage also.

RS-NEWS : INTERNATIONAL

Landsat 7 program is making progress and current plans indicate a launch in 1997/98.

High Resolution Eyeglass (see Signature 8(1/2)p13) is being considered as a two satellite configuration to increase viewing frequency.

RADARSAT, the Canadian microwave satellite is expected to be launcehed in September, 1995 from USA. The launch services are being provided at no cost by USA for having access to data over USA.

RS-NEWS : NATIONAL

IRS-1A was retired from service on March 17, 1995.

INSAT-2C is scheduled for launch on Nov 30, 1995 by Arianne. It does not carry the AVHRR as already 3 AVHRR are currently deployed in space.

IRS-P3 is scheduled for launch in January, 1995 by PSLV from Sriharikota. The sensor package onboard IRS-P3 includes DLR payload of MOS-A, MOS-B and MOS-C and SAC-built 3-band WiFS.

Antrix Corporation has signed an agreement with EOSAT that provides latter with exclusive world rights for data generated by IRS series of satellites. EOSAT is already acquiring and distributing data from IRS-1B and IRS-P2 satellites.

ARTICLE UPDATE

The contributions of ISRS-AC members in the ISRS 25 Silver Jubilee Symposium on Remote Sensing for Environmental Monitoring and Management with Special Emphasis on Hill Regions, held at Dehradun (22-24 Feb, 1995) are given here for the benefit of those who did not participate in the symposium.

Oral Presentations

Palria S, TS Singh, M Chakraborty, V Tamilrasan, MA Kawosa, Mapping of turbidity levels and aquatic vegetation in Wular Lake using IRS-1A data. pp 1-9.

B Sahai, MM Kimothi, Resources survey of Nanda Devi biosphere reserve. pp 26-33.

TT Medhavy, C Patnaik, NK Patel, An evaluation of speckle removal filters for ERS-1 SAR data. pp 91-97

N Padmanabhan, KP Rao, KL Majumdar, A method for correcting terrain related distortions in remote sensing data. pp 98-105.

HS Bhatt, IC Matieda, CVS Prakash, Light transfer analysis and radiometric normalization of IRS-1B payloads. pp 121-131.

HS Bhatt, PB Shah, CVS Prakash, Near real time monitoring of IRS LISS payload performance. pp 132-138.

G Arun, S Kothari, TP Singh, Application of remote sensing in mapping and management of land degradation : A case study of Sagwada Tehsil, Dungarpur, Rajasthan. pp 203-209.

R Krishnamoorthy, R Ramesh, S Ramachandran, S Sundarmoorthy, B Sahai, SR Nayak, P Chauhan, Study on sediment concentration in coastal waters of Tamil Nadu. pp 222-229.

MM Kimothi, RN Jadhav, AK Kandya, MB Mankare, PB Bhalekar, SC Chavan, Catchment area treatment plan for directly draining subwatersheds of Sardar Sarovar catchment (Maharashtra) using remotely sensed data. pp 273-281.

PH Vaidya, KF Patel, UD Datir, TP Singh, V Tamilarasan, RR Navalgund, Application of remote sensing in monitoring of water logging - A case study of Dharoi command area, Gujarat. pp 295-303.

MP Oza, VK Srivastava, PK Devaiah, Predicting mean crown diameter in tropical dry deciduous forest from characteristics. pp 312-317.

RN Jadhav, PS Thakker, MM Kimothi, YS Vanikar, JP Aggarwal, A GIS-based approach for forest working plan revision : A case study in Santrampur Taluka, Panchmahals District, Gujarat. pp 318-326.

IM Bahuguna, AS Rajawat, NS Mehta, DS Mehta, P Bhatnagar, AK Srimal, Synergistic use of ERS-1 SAR and IRS LISS-II data for mineral exploration : A case study covering Pur-Banera region (Bhilwara district, Rajasthan). pp 375-381.

Posters & Abstracts

RM Gairola, S Basu, PC Pandey, Rainfall estimation using integrated satellite visible, infrared and microwave observations. p 393.

HS Bhatt, RN Acharya, SS Palsule, CVS Prakash, Light transfer characteristics analysis and radiometric normalization of MEOSS payload. p 396.

S Mohan, NS Mehta, RL Mehta, P Patel, DR Rajak, HS Srivstava, ERS-1 SAR for the identification of forest cover - A case study covering parts of Agra. p 397.

B Kartikeyan, PS Dhinwa, M Jethakumar, KL Majumdar, Development of an expert system for land cover classification using spectral knowledge and ancillary information. p 401.

Shri Lakshmi Narayan Calla Memorial Lecture Series Revived

With delivery of sixth lecture by Prof. V. K. Gaur, the above series, which was started in 1987 has been revived. The funds for this series are provided by Shri O.P.N. Calla, Deputy Director, SAC and first Chairman of ISRS-AC. The distinguished list of past speaker is provided below :

I. **Prof. P. R. Pisharoty** : Remote sensing of ocean floor topography (Dec 30, 1987).

II. **Shri P. A. Raj** : Sardar Sarovar Project - A lifeline of Gujarat (Dec 30, 1988).

III. **Prof. S. S. Merh** : Sea-level changes along Gujarat coast (Dec 11, 1989).

IV. **Prof. B. L. Deekshatulu** : Remote Sensing for national development (Jan 11, 1991).

V. **Dr. K. Kasturirangan** :Bio-Astronomy - A test for anthropomorphic principle (Jan 9, 1992).

FORTHCOMING SYMPOSIA

National Symposium on Remote Sensing of Environment with special emphasis on green revolution and Annual Convention of Indian Society of Remote Sensing. - Ludhiana, Nov. 22-24, 1995

- Dr. P. K. Sharma, Organising Secretary, ISRS Symposium-1995, Punjab Remote Sensing Centre, PAU Campus, Ludhiana - 141004.

Workshop on Application of Remote Sensing and Geographical Information System in Urban and Regional Planning. October 17-20, 1995 at Dehra Dun.

- Prof. N. D. Sharma, Head, Human Settlement Analysis Group, IIRS, 4 Kalidas Road, P.B. No. 135, Dehra Dun 248 001.

Fifteenth INCA International Congress : Cartography - Emerging Technologies and Alliances; 5 - 8 december 1995, Indore

- Prof. H.S. Mehta, Organising Secretary, Deptt of Civil Engineering, GSITS, Indore - 452 003 (MP).

National Workshop on Soil Resource Inventory for Perspective land Use Planning (SRILUP 95), September 26 - 29, 1995, Nagpur.

- Dr. J. P. Sharma, Organising Secretary SRILUP95, National Bureau of Soil Survey and land Use Planning, amravati Road, Shankar Nagar P.O., Nagpur - 440 010

TROPMET-96 : National Symposium on Meteorology and Natural Disasters, Feb 14-17, 1996, Andhra University, Visakhapatnam.

-Prof. J. K. Patnaik, Chairman LOC-TROPMET-96, Dept. of Meteorology & Oceanography, ANdhra University, Visakhapatnam - 530 003 (A.P.).

ISRS-AC ACTIVITIES

The Annual General Body Meeting of ISRS-AC was held on April 28, 1995 at Vikram Hall, SAC. About 100 members participated in deliberations which were rounded off with a high tea.

A lecture on biodiversity was delivered by Prof. S. D. Sabnis, ex Pro-Vice Chancellor, MS University, Baroda, on May 4, 1995 at Vikram Hall, SAC.

Sixth Shri Lakshmi Narayan Calla Memorial lecture was delivered by Prof. V. K. Gaur, Distinguished Scientist, CMMACS, Bangalore on May 24, 1995 at Vikram Hall, SAC who spoke on ' International decade of natural disaster reduction : An Indian Experience' before an appreciative audience.

Van Mahotsav was celebrated on August 5, 1995 by distributing about 600 saplings to the ISRS-AC members. We hope the members will take good care of their new 'wards'.

Members may get ready for the following activities, planned for near future :

* A painting competition for the children of ISRS-AC Members is planned for October, 1995
* A quiz program for college students will be held in November 1995.
* Seventh Shri Lakshmi Narayan Calla Memorial Lecture is tentatively scheduled for Nov/dec 1995.
* One day seminar on remote sensing for development of Gujarat state is planned in March 1996.

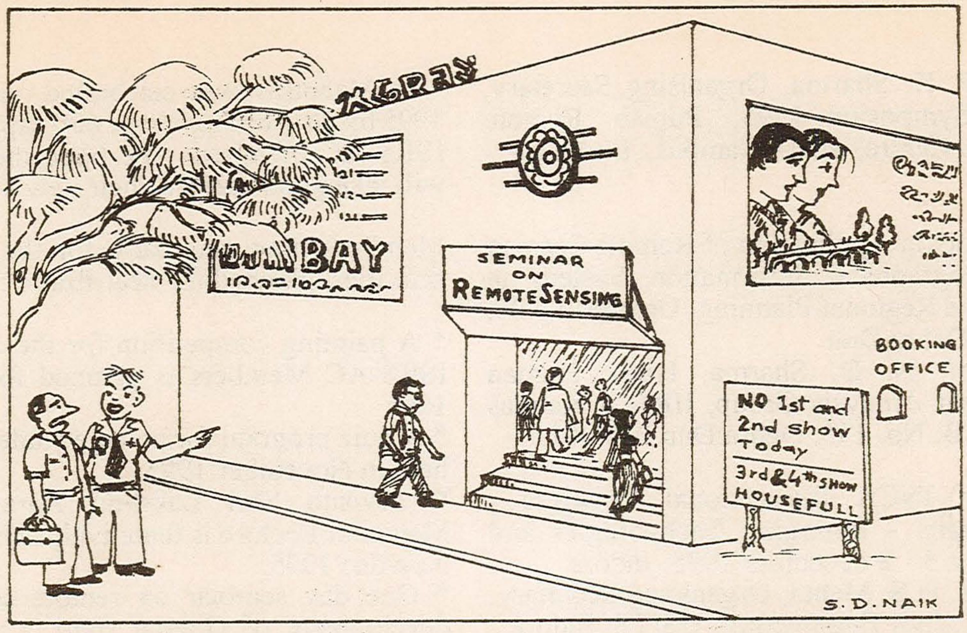
ABOUT ISRS-AC MEMBERS

The **Indian National Remote Sensing Award** for the year 1994 was conferred jointly on Dr. Shailesh Nayak and Shri A.S. Kiran Kumar for their contribtions in 'application and operationalisation of remote sensing technology in coastal mapping and management', and ' design, development and fructification of remote sensor technology'. This marks hat trick for ISRS-AC in winning this award, with previous winners being Dr R. R. Navalgund (1992) and Dr. R. N. Jadhav (1993).

Shri R. C. Garg, past Chairman. ISRS-AC, joined as director ADRIN, Hyderabad.

Indian Meteorological Society (IMS) has awarded **J. Das Gupta Award** to Shri S. Ilanthiryan, Shri A. K. Mathur and Dr. V. K. Agarwal for their article 'Cloud height determination using satellite stereoscopy from along track scanning radiometer on board ERS satellite', published in Photonirvachak - J. Indian Society of Remote Sensing, Vol 20, 1992. (*We would like to compliment them for publishing a valuable contribution in field of meteorology in the ISRS journal.*)

IMS has awarded **Dr. B. N. Desai Award** to Dr. P. K. Pal for his article on 'Cyclone track prediction over the North Indian Ocean' published in Monthly Weather Review, Vol 119, 1991.



Almost every delegate requested for best projection system and total darkness during presentation. This is the only hall in our town which has both.

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