Indian Society of Remote Sensing

Ahmedabad Chapter

NEWSLETTER

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Indian Society Of Remote Sensing
4, Kalidas Road, Dehra Dun - 240 001

MESSAGE

I am glad to know that Indian Society of Remote Sensing Ahmedabad Chapter is bringing out a special issue of News Letter. On the 17th March, 1988 the Indian Remote Sensing Satellite (IRS-1A) was launched successfully and it has been continuously operating since then. This is a major achievement. Benefits derived from the utilisation of the data, received from the IRS-1A, have indicated that use of Remote Sensing is currently playing a major role in providing a vital and necessary information regarding our natural resources. I am certain that in future, it will play a major part in our management of natural resources.

I am sure that a large number of contributions on Remote Sensing activities by various experts in the respective fields, would lead to advancement of knowledge and useful exchange of information. I wish this may go a long way for the overall development of Remote Sensing related activities.

I convey my best wishes for the success and growth of Ahmedabad Chapter activities.

1 - 3 - 1993

(Pramod Kale)
President

Editor : R K Goel

SPECIAL ANNUAL ISSUE

GEOLOGY

GEOLOGICAL APPLICATIONS OF SYNTHETIC APERTURE RADAR (SAR) DATA- SOME OBSERVATIONS & PROSPECTS

R K Sood, N S Mehta, S Mohan, A S Rajawat and I M Bahuguna, Space Applications Centre

Synthetic Aperture Radar (SAR) data collected by the Shuttle Imaging Radar (SIR) - A & B, airborne INTERA-SAR, and data collected by the recently launched first European Remote Sensing Satellite (ERS-1) over parts of the Indian landmass have been evaluated for geological applications.

The above mentioned four data sets covering different areas have been studied. SIR-A data (L-band) covers about 1700 km long and 50 km wide SE-NW linear strip starting from Chilka lake in Orissa to the Thar desert near Jaisalmer in Rajasthan. SIR-B data (L-band) covers 1000 km long and 50 km wide NNE-SSW linear strip over the Indo-Pak border in Punjab and Rajasthan. Airborne INTERA SAR data (X-band) covers around 2000 sq. km area over parts of Anantpur district in Andhra Pradesh. SIR-B and INTERA SAR data were also collected over some other parts of the Indian region. One frame of ERS-1 SAR data (C-band) covering 10,000 sq. km area over parts of Dhenkanal district of Orissa has also been studied. Comparative analysis of these data with optical sensor data like Landsat MSS and RBV, Salyut-7 space photographs, IRS-1A and panchromatic aerial photographs was also carried out.

The unique imaging geometry of SAR provides excellent delineation of structural features. It is observed that signature of lineaments with positive or negative topographic expression is far better on radar images. Bright linears correspond to structural ridges, dykes, quartz reefs etc. or features showing positive relief. Most of the darker linears correspond to fracture controlled valleys, fractures or features of negative relief. Comparison of rose diagrams prepared using different data sets show that the number of lineaments mapped using SAR data is more in all directions except the look direction of SAR. It has been observed that mapping of outcrop pattern is easier on SAR images and this facilitates the delineation of structures like folds and faults in the area around Kota and Jhalawar in Rajasthan and Dhenkanal in Orissa . Identification of small lineaments (macro linears i.e. 2-10 km) is observed better in SAR data.

It has been observed that SAR is sensitive to topographic relief and surface roughness variations which get manifested as different tonal and textural patterns. These tonal and textural patterns facilitate mapping of different geomorphic features. On SAR image, delineation of landforms with positive relief seems to be quite easy e.g., structural ridges, structural hills, denudational hills, residual hills etc. It is observed that low lying areas such as flood plains, river valleys, pediment, pediplain, aeolian plain, alluvial plain etc. are seen as comparatively darker areas on SAR data. Few drainage traces could be mapped using SAR data. The details within flood plains of even major rivers like the Ravi, the Sutlej, the Narmada and the Mahanadi are not distinct. However, on SIR-B images acquired over desert region, it has been obsereved that delineation of inter-dunal depressions and flats is easy as they are seen as dark tonal patches of different dimensions. The contrast with surrounding sand dunes has been observed to be more on SAR data as compared to Landsat MSS data.

Radar images do not reflect any unique signature for specific lithology. However, rock types which reflect definite geomorphic expression in terms of relief or specific dissection pattern of the relief can be easily delineated. SIR-A image over central India e.g., south of Saugor, Madhya Pradesh shows zig-zag scarp lines appeared as conspicuous white lines with alternate dark areas corresponding with horizontal Deccan Trap flows. The contrast is so high that it is possible to delineate flow boundaries as close as 1 km. In Anantapur area, Andhra Pradesh intrusive quartz reefs, dolerite/gabbro dykes etc. could be easily mapped due to target characteristics such as positive relief, linear shape and association with the country rock. In addition some of the litho contacts have been observed as lineaments.

Most of the land cover features that acted as rough surfaces at the imaging frequency could be mapped. It has been observed that SIR-A and SIR-B images provide relatively more information on cultural features like built up lands, roads, railways, bridges etc. SAR images show limitations for delineating smooth land cover surfaces and features.

The above studies suggest that geological potential of SAR data is quite substantial and it is emerging as an important complementary information source which can be used in addition to optical sensor data for planning regional exploration strategies and targeting localized areas for detailed field mapping and geophysical exploratory activities. It is envisaged that efforts for digital integration of SAR data with optical sensor images, thematic information, and geophysical data may result in better qualitative and quantitative analysis. The sensitivity of

SAR data to soil moisture may be effectively utilized to identify anomalous soil moisture pockets in unirrigated agricultural areas and non outcrop areas like aeolian plain, buried pediplain, alluvial plain etc. Such anomalous soil moisture pockets may be explored to target shallow aquifers.

PRELIMINARY ENGINEERING GEOLOGIC INVESTIGATIONS AROUND NANI-BARSAN WATER RESOURCES PROJECT SITE

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INTRODUCTION

The application of Remote Sensing has great potential in the engineering geological investigations for any dam site during the reconnaissance stage. This technology provides quick information on the various geological, geomorphological and structural features around the proposed project site. This helps apprise the design engineers and planners the implications of engineering geological problems, viz. seepage, sliding and settlement in the foundation of dam structure etc.

An attempt has been made for delineating quickly the terrain characteristics such as geology, landform, drainage pattern and structural set up for the proposed 34 m high Nani-Barsan dam located about 70 km ESE from Bharuch city. The study has revealed the presence of 2 sets of lineaments, i.e. dyke lineaments (set I) and fault lineaments (set II). The Karjan river on which the dam is proposed to be constructed flows along the fault lineament. This may pose the problem of foundation seepage and settlement. The dyke lineaments, which are almost perpendicular to the fault lineament may act as underground barriers to seepage through the foundation. The presence of buried pediments (shallow) in and around the proposed dam site is indicative of the cut off grade rock at a shallow depth.

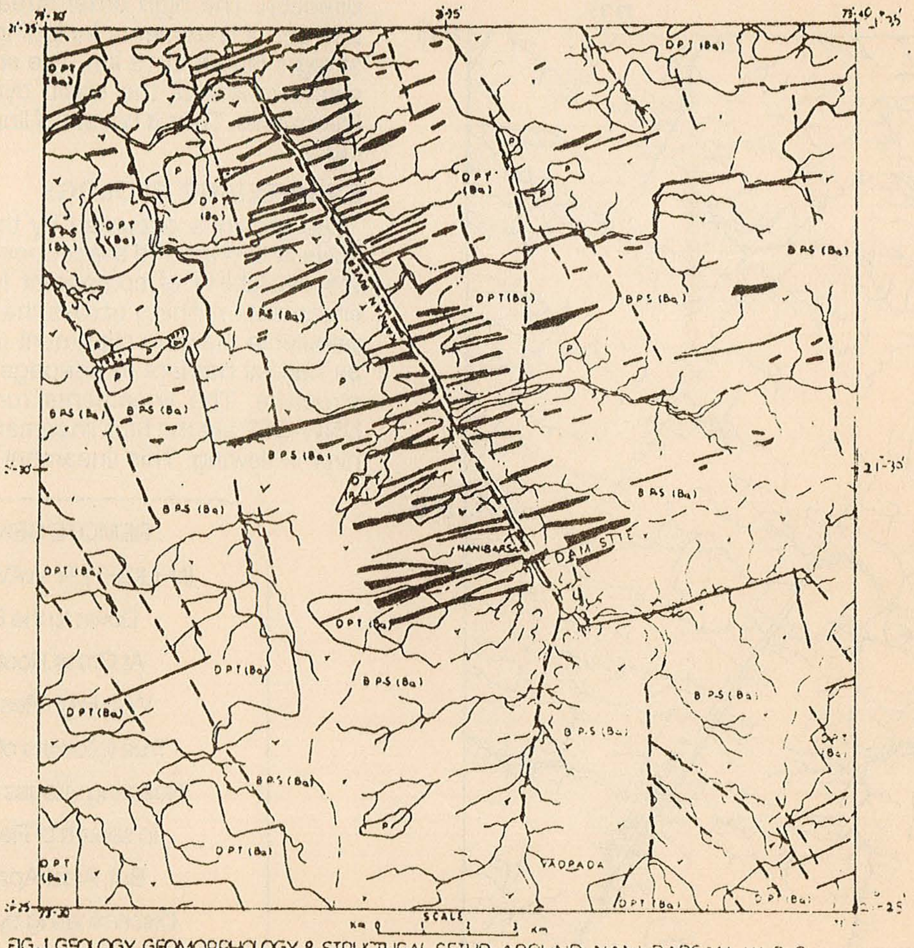

FIG. 1. GEOLOGY, GEOMORPHOLOGY & STRUCTURAL SETUP AROUND NANI BARSAN W. R. P.

LEGEND

1. GEOLOGY
   - ALLUVIUM
   - (Ba) DECCAN BASALT
2. GEOMORPHOLOGY
   - DPT (Ba) DISSECTED PLATEAU
   - P PEDIMENTS
   - BPS (Ba) BURIED PEDIMENTS SHALLOW
3. STRUCTURE
   - LINEAMENT (FAULT)
   - LINEAMENT (DIKE)
4. GENERAL
   - CATCHMENT AREA
   - COMMAND AREA
   - SUBMERGENCE AREA

METHODOLOGY

Topographical maps (1:50,000 scale) have been studied to have an idea of relief of the terrain, drainage pattern/system of Karjan river and its tributaries etc. The base map has been prepared using this map. Fifty numbers of black and white vertical aerial photographs were assembled and a loose uncontrolled mosaic was prepared to obtain the broad picture of geology, geomorphology, structural set-up and other terrain characteristics. These photographs were also studied under mirror stereoscope for more detailed work. IRS-1A/LISS-II geocoded satellite data were also used to supplement the information. A map showing the geology, geomorphology and structural set up around project site has been prepared (figure 1) and interpreted for evaluating engineering geological problems.

GEOLOGY

The Deccan trap basalt flows, intruded by basic dykes of Cretaceo- Eocene age, have been mapped around the proposed project site.

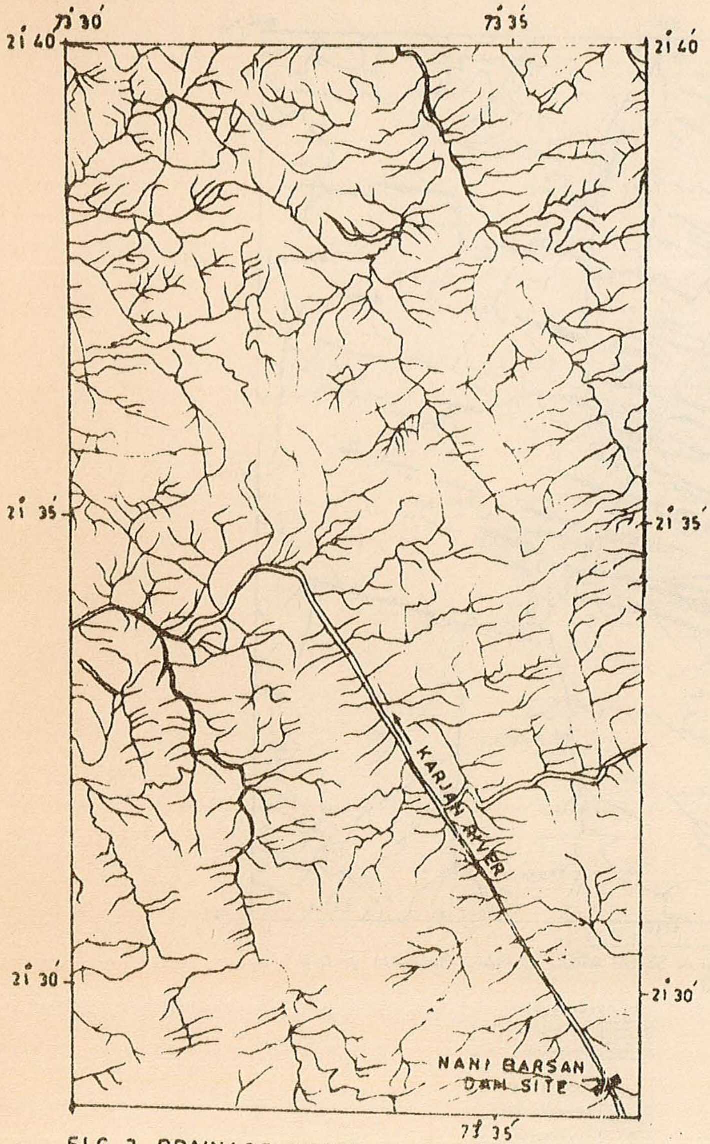

FIG. 2. DRAINAGE PATTERN OF STUDY AREA

GEOMORPHOLOGY

Geomorphologically, the area represents the landforms developed mainly due to the erosional processes. The various landforms, namely dissected plateaux of basalt in the southern portion and in North-East and North-West portion of the proposed dam site have been mapped. The intervening area is covered with thin veneer of soil and alluvial cover over the pediment of basalt (buried pediments-shallow). At a few places patches of pediments of basalt have also been noticed (figure 1). The drainage system in the study area (figure 2) is rectangular type representing its structural control. This also indirectly indicates the thin veneer of alluvium.

STRUCTURAL FRAMEWORK

The study of landform, drainage pattern as well as tone and texture in the aerial photographs, has revealed two sets of lineament patterns in the area. First set of lineaments is represented by basic dykes running in ENE-WSW direction having width of a few meters to as much as 30 m. They are closely spaced. The second set of lineaments is developed in the NW-SE to NNW-SSE direction. The high order streams are flowing along this set of lineaments including the Karjan river in a straight length of 13 km. The study has indicated the displacement of the basic dykes along this set of lineaments. Thus it is a set of lineaments controlled by faults.

ENGINEERING GEOLOGY

The terrain is occupied by the Deccan trap basalt flows at and around the proposed dam site indicating the availability of competent foundation rocks. The lineaments running across the Karjan river and subparallel to the dam alignment (ENE-WSW) would act as natural barriers to seepage underneath the dam structure. The lineaments running in NW-SE and NNW-SSE are the fault lineaments along which Karjan river is flowing. This lineament set is running almost

REMOTE SENSING
IN LIGHTER WAVELENGTH
Down to the Earth
At Grass Root Level
With High Resolution
True followers of Gandhi
Roaming villages and fields
In search of Real Truth
But, Alas! Apartheid
Discriminating by colours,
Never True, but False
Masking or Enhancing
That is Remote Sensing
......*P N Pathak, SAC*

perpendicular to the proposed dam alignment. This lineament (fault lineament) may pose the problem of seepage through the foundation of dam and occurrence of weak zone requiring foundation treatment against settlement. Moreover, this set of lineaments is important from seismic design consideration.

CONCLUSIONS

The remote sensing technology has proved its immense potential in evaluation of engineering geological problems at the reconnaissance stage itself for the Nani-Barsan Water Resources Project area and has brought out major geological features having tremendous impact in the design, planning and construction of the proposed structure.

UTILITY OF SMALL SCALE SATELLITE IMAGERY FOR REGIONAL GEOLOGICAL AND STRUCTURAL STUDIES - A CASE STUDY OF SAURASHTRA PENINSULA, GUJARAT

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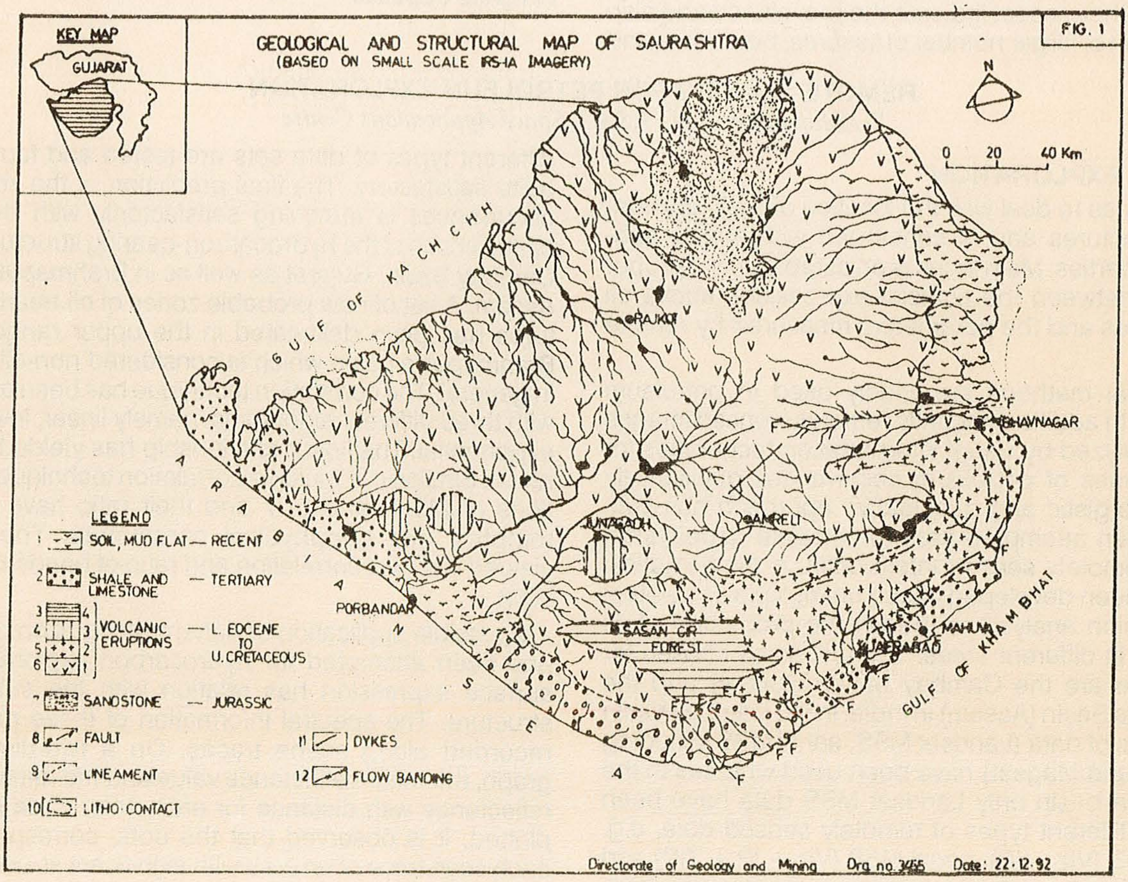
In view of the occurrence of huge lignite deposits in parts of Saurashtra and availability of wealth of lithological and petrological details for various rock types in the area, it was thought to take up this area for geological and structural studies by utilizing small scale (1:1.5 million scale) FCC imagery of IRS-1A to find out the possibilities of extension of lignite bearing horizons vis-a-vis regional geology and structure.

On the FCC mosaic, sandstone of Jurassic period (155 MY) stands out, apparently, in view of its light yellow tone and medium texture. The basaltic rock of U. Cretaceous (100 MY) to Eocene period (65 MY) occupying the entire area, except southern and south eastern coastal tract, is distinct in view of its typical joint controlled drainage pattern and greenish gray tone (pink tone wherever thick vegetation growth is observed) and medium texture. The sedimentary rocks comprising shale and limestone of Tertiary (65 MY) and quaternary period (1.5 MY) confining to southern and western coast can be deciphered based on pink tone, smooth texture and medium to poor drainage density.

Based on the photo characteristics, as stated above, four geomorphic landforms in the Deccan basaltic domain (trap), conforming to distinct episodes of eruption, could be distinguished (figure 1). The chronological order of episodes of eruption is as follows:

Episode - 1

Basaltic rock occurring as low to undulating terrain and occupying vast areas in parts of northern and central Saurashtra.



Episode -2

The alternating sequence of basic and acidic volcanic rocks forming two long trending semi-oval shaped hill ranges noticed from Sihor - Bhavnagar - Talaja - Rajula and Amreli.

Episode -3

The magmatically differentiated igneous complex comprising rocks of both acidic and basic variants having heterogeneous genetic history forming the semi-circular hills of Barda and Alech, (near Porbandar) Girnar (near Junagadh) and Chamardi hills (near Bhavnagar).

Episode -4

Pre-dominantly basic but subordinately acide volcanic rocks forming the semi oval shaped compact hill ranges noticed in Gir Forest range.

Whereas basaltic rock conforming to the fourth episode of eruption appears to be a part of regional volcanic eruption, noticed typically in parts of Maharashtra, MP, Gujarat and North Karnataka, the later episodes, being intrusives into the basaltic rock, are local in nature. The degree of weathering and erosion that these litho units belonging to different episodes of eruption have undergone, are distinctly reflected in the nature of their occurrence, i.e. the oldest have been eroded the most, while the younger ones standout as topographic highs. The confinement of younger intrusive episodes (No. 2, 3 and 4) to the southern coast indicate the prevalence and also concentration of larger number of fissures, both linear and curvilinear, in basalt of this area than in other parts. The occurrence of dyke swarms in this area, probably belonging to second episode of eruption, further corroborates this fact. The intrusion of basic magma of the first episode has disturbed the parallelism noticed in the flow pattern which is apparently seen south of Amreli.

Although the fact that the present configuration of Saurashtra is on account of a system of its bounding faults formed due to northernly movement of Indian plate during Eocene to Quaternary periods is well known, the occurrence of many long trending lineaments traversing the Peninsula, were unknown. The availability of small scale IRS-1A imagery have made it possible to delineate them (figure). The lineament pattern further reveals that in the area north- south trending lineaments are more pronounced and predominant in comparison to directions of other lineaments.

The analysis of the satellite imagery further reveals that the zig-zag alignment of coastal lines of north, south and east of peninsula are on account of the lineaments. The lineaments, being planes of weakness, have acted as loci for greater water movement and yielded to wave action than other portions, thus, causing zig-zag configuration. Since the tertiary sediments are observed to continue all along the coast, from south east to north west, systematic geological mapping, using large scale imagery and aerial photographs, is undertaken to delineate potential basins of lignite deposits.

REMOTE SENSING FOR PETROLEUM EXPLORATION

T J Majumdar, LRD, RSAG, Space Applications Centre

ON-SHORE EXPLORATION

The study has to deal with the location of hydrocarbon-bearing structures and is concerned with mostly sub-surficial properties. Main focus is on establishing a proper correlation between the surficial expressions above oil bearing zones and the parameters measured by remote sensing.

Geophysical methods are widely used in petroleum exploration. In addition, recently remotely sensed images are also analyzed by visual interpretation techniques for targeting zones of petroleum occurrences qualitatively only. A synergistic and quantitative approach has successfully been attempted here to correlate geophysical data with remotely sensed information. A mathematical model has been developed based on multiple correlation and regression analysis to predict the probability of oil occurrence in different areas. The test areas chosen for this purpose are the Cambay basin (Gujarat) and the Brahmaputra Basin (Assam) in India. In the Cambay basin different sets of data (Landsat MSS, aerial MSS including thermal IR, and Magsat) have been used whereas in the Brahmaputra basin only Landsat MSS data have been used. The different types of remotely sensed data, e.g. Landsat MSS (Viz + IR), aerial MSS (Viz + IR + TIR) and different types of geophysical data, e.g. gravity, magnetic, seismic, were integrated. In addition, topographic data have been used to differentiate the different neotectonic zones. The linear as well as multiple correlationships of different types of data sets are tested and found to be quite satisfactory. The final prediction of the zone of oil occurrences is matching satisfactorily with the actual occurrences of the hydrocarbon-bearing structures in the Cambay basin, Gujarat as well as in Brahmaputra basin, Assam. A set of new probable zones of oil-bearing structures has been delineated in the upper ranges of the Brahmaputra basin which is considered non-oil bearing, in general. The correlation technique has been attempted with three different algorithms, namely linear, inverse and exponential. The linear relationship has yielded the best result. Similarly, in multiple correlation technique, correlations of MSS band 5, 7 and their ratio have been attempted with geophysical parameters. The band 5 yielded the best correlation and ratio of bands 5 to 7, the least.

A possible application of pattern recognition technique has been attempted for hydrocarbon exploration. The surface expression has relation with the sub-surface structure. The spectral information of these patterns is recorded along scene traces. On a two-dimensional graph, the mean reflectance value and the relationship of reflectance with distance for each scan trace has been plotted. It is observed that the dots, corresponding to each scan trace of an area with significant structure, form a well- defined cluster.

In the next phase of study, thermal IR data have been utilized mainly for two purposes, namely, construction of subsurface structural isotherms and thermal inertia mapping. The calibrated thermal IR imagery of a part of the Cambay basin is utilized to determine the surface temperatures and to detect the heat-flow. Applying the conductive heat-flow continuation technique, the three-dimensional configuration of the hydrocarbon-bearing reservoir has been defined. The zone delineated by the present study coincides with the oil-bearing structures inferred by seismic survey. The results indicate the possibility of utilizing this technique as an effective tool for hydrocarbon exploration.

Generation of thermal inertia image and its possible geological application has been attempted over a part of the Cambay basin. Using the concepts of energy balance computation and also using the procedures involved in albedo computation and the digital registration of day time and predawn imagery, a thermal inertia map of a typical area of interest has been generated. An attempt has been made to correlate the thermal inertia anomalies with sub-surface structures. The analysis done here for a small area of interest shows the possibility of delineation of subsurface structures by thermal inertia mapping. In addition, Magsat vertical component (Z-component data over the Cambay basin have been used to generate the residual magnetic anomaly map. As it is well known that the major magnetic anomaly as obtained by satellite data have their origin lying in the lithospheric region and above, an attempt has been made to correlate them for prediction of basement depth in the area of interest. A strong correlation has been observed in the region of changing slope of the basin.

Some of the image processing techniques have been attempted for enhancing the typical geological features of interest, e.g. linear and anomalous patterns seen in the imagery. These include:

* Application of Haar transform for delineation of linear and anomalous patterns over a part of the Cambay basin.
* Extraction of shoreline and drainage patterns using edge detection and template matching techniques from aerial MSS thermal IR data over the Cambay basin with an attempt to automatize the threshold selection.
* Development of a digital filtering technique for extraction of directional components of linears in the Brahmaputra valley, Assam.
* The surface temperature modeling using INSAT-VHRR and MOS-1 VTIR data as well as generation of regional thermal inertia map over a hydrocarbon - bearing structure.
* Simulation of thermal inertia imagery using a model with day time HCMM data.

A mathematical model has been developed to determine the sedimentary thickness in a prograding deltaic system (West Bengal Delta). By applying the model, sediments accumulated during various geologic periods have been estimated. Since, petroleum occurring basins rarely show any signature on the surface, it is difficult to generate a set of optimal spectral bands with respect to petroleum exploration. However, an attempt has been made to generate a set of optimal bands using multispectral data over a known oil- bearing structure.

OFF-SHORE EXPLORATION

The basic concept behind off-shore hydrocarbon-bearing structure exploration relies on the fact that the shape of the sea surface reflects the distribution of the mass below and satellite altimeter can be used to infer this sea surface. However, corrections of the data required for the atmospheric effects as well as dynamic sea surface parameters, e.g. waves, tides etc.

Geosat/Seasat altimeter data have been preprocessed and suitably corrected to estimate the prospective geoid over western off-shore regions. The intensive test sites include Bombay-Ratnagiri and Kerala-Konkan basins. The prospective geoid information is being correlated with the existing sedimentary thickness over the area of interest. The other activities currently going on in this direction include gravity modeling using spherical harmonic expansion, high frequency and band-pass filtering of information related to crustal anomalies, regional profile plotting over Western off- shore using Geosat data, geophysical image generation, automatic stacking and cross-over corrections etc. Also, ERS-1 altimeter data analysis is being planned over the same region. The total effort is a part of a joint collaborative programme between ISRO and ONGC.

AGRICULTURE

CROP CONDITION ASSESSMENT : PAST, PRESENT AND FUTURE

Ajai & H P Bhatt, Space Applications Centre

Assessment of crop condition during its growth cycle is an important input in the production forecasting system. Crop production forecasts require accurate estimation of acreage for harvest, its geographic distribution and the associated crop yields as determined by local growing conditions. Both crop acreage and yield can vary from year to year and within year and therefore require periodic monitoring. An ideal forecast system is the one that can accurately assess current crop condition and can detect and rapidly respond to changes in the relevant conditions.

The term **crop condition** implies an evaluation of the degree of stress. The word **stress**, although difficult to define from physiological point of view, is commonly used to signify any effect on plant growth that is detrimental. The task of **crop condition assessment** requires *detection of stress, differentiation of stressed crop from the normal crop at a given time, quantification of extent and severity of stress and assessment of production loss.*

In order to develop a **crop condition assessment system** (CCAS) it was necessary to study the feasibility of using remote sensing technique for achieving each of the tasks mentioned above. Thus a large number of controlled field experiments were conducted during the last decade to understand the spectral signatures and to address the basic questions related to spectral manifestations of crop stress, growth and conditions. Some of the important questions to be addressed were:

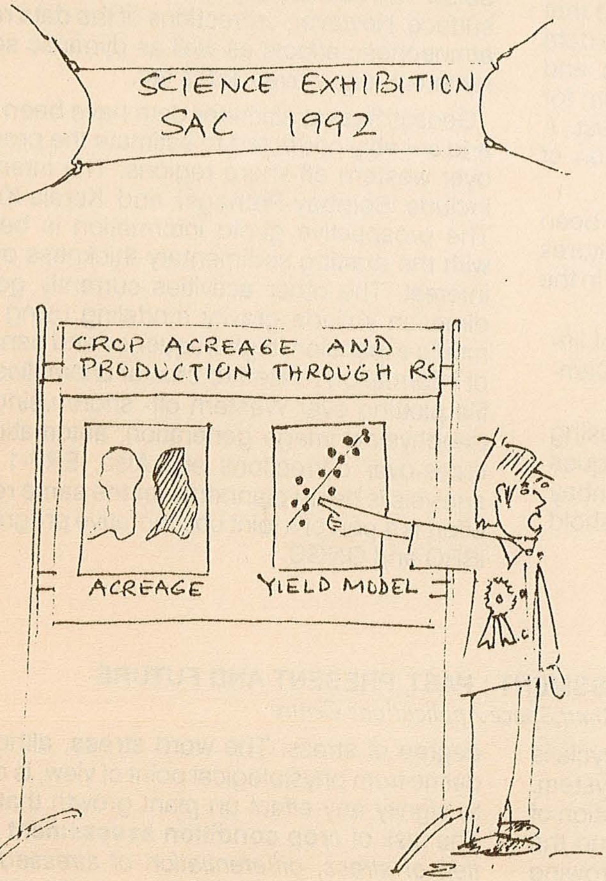
* Is there a significant change in the spectral reflectance/emittance characteristics of the plants undergoing different kinds of stress?
* Is it possible to quantify the degree of stress vis-a-vis spectral reflectance/emittance characteristics?
* what kind of relationship exists between the spectral response and growth variables?
* what are the spectral manifestations of the plants undergoing different kinds of stress

Concepts developed and inferences drawn from these experiments had led to the development of methodology for large area crop condition assessment using satellite data. The procedure developed was based on the condition assessment on grid cell basis. In this approach the area of interest is divided into geographically referenced grid cells of appropriate size and each grid is monitored individually. The index representing per cent of healthy pixels in the cell, called Green Index Number (GIN), is computed for each cell using the transformed multiband satellite data. Multidate data is used to generate GIN profiles for the cells. GIN data base is generated for 5-7 years. Current season's profile is compared with the **average normal profile** drawn from the data base for condition assessment. The procedure was tested for wheat crop in parts of Indore district of Madhya Pradesh. The procedure developed was further refined to give crop condition for a particular crop at district/tehsil level. This is being currently used for assessment of crop condition for cotton crop.

The Crop Condition Assessment System (**CCAS**) uses transformed IRS data to give cotton crop condition during its growth cycle. Here, the output from cotton acreage estimation is used in generating a **cotton mask** and is fed into CCAS as an input. The procedure consists of registration and radiance normalization of multidate data, generation of vegetation index (VI), vegetation index number (VIN) and its time profiles for each cell. The VINs computed for each cell are aggregated over district and finally district VIN profile is generated and stored in the data base. This data base along with the weather data is used in crop condition assessment.

Use of canopy temperature based satellite derived indices in estimating evapotranspiration, crop stress detection and condition monitoring has been attempted in limited cases. Canopy temperature based indices are very sensitive to crop, water status and responds well to fast changing weather variables. These indices are thus useful in providing the crop conditions on a day to day basis whereas the spectral VI responds to integrated effects over a period of time. A lot of research is still needed in this direction.

The use of data from active microwave sensors in crop condition monitoring specially in kharif season s[illegible] requires a lot of R&D and therefore becomes a potential area for further research. Measurement of laser induced fluorescence from plants is another recent area of research in the field of crop condition assessment. Chlorophyll fluorescence, which is a signal related to the performance of plant photosynthetic apparatus, seems to be the most promising approach for detection of different kind of plant stresses including that of soil and air pollution.



"NO WORKING MODELS ?.... BUT THIS IS ALSO AN OPERATIONAL MODEL.

- T.T. Medhavy

HYDROLOGY

CHANNEL PATTERN CHANGES OF THE SUBANSIRI RIVER IN ASSAM DECIPHERED FROM THE SATELLITE DATA OF 1985-88

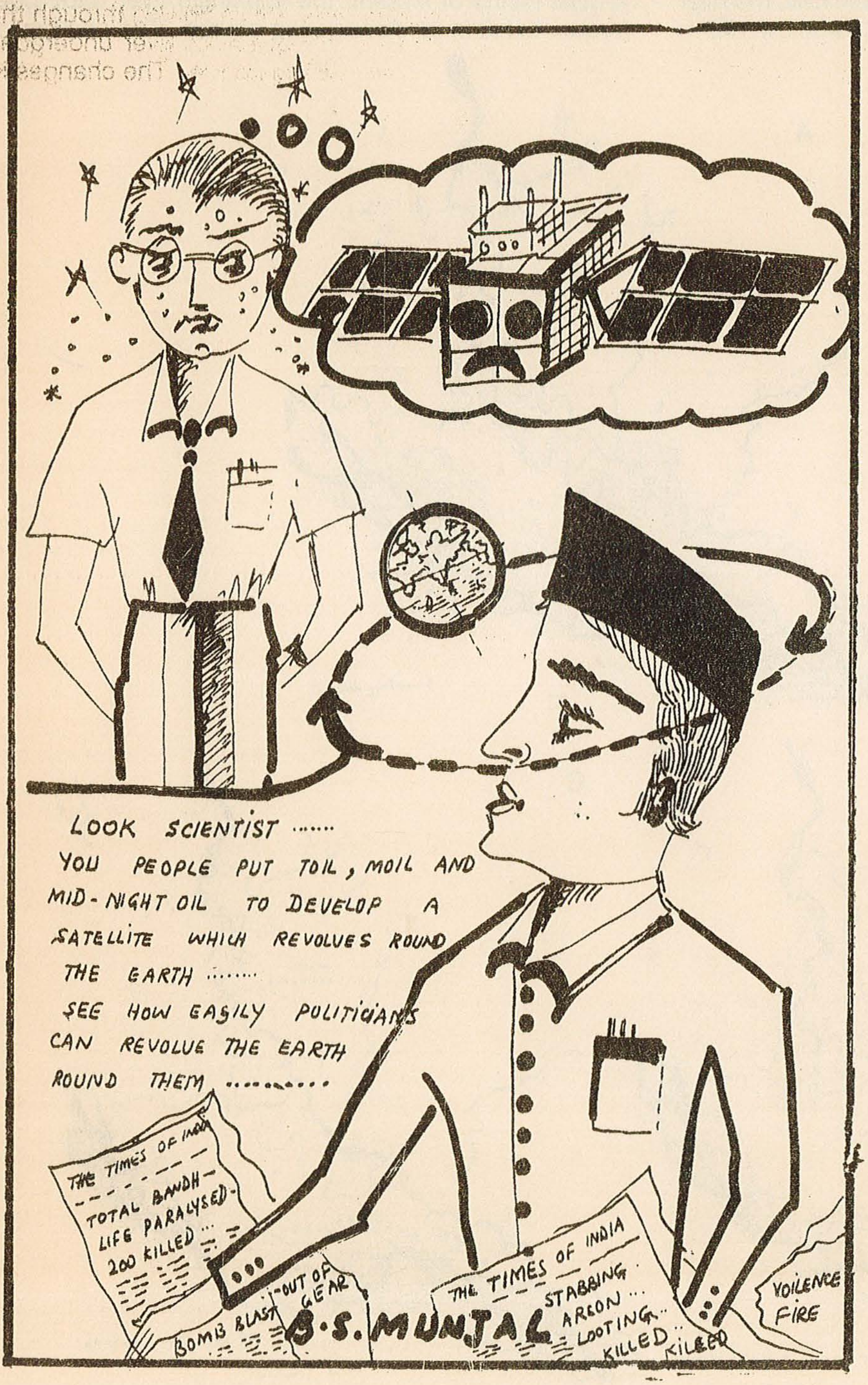
S D Naik, Space Applications Centre

The Subansiri river, one of the major tributaries of the Brahmaputra river in the north bank, rises in the snowy part of the Central Himalayas having an average height of 5182 m. After traversing through the Miri hills, the river enters into the plains near Dolongmukh to below 152 m in the foothill zone. It flows through the plains for about 72 km southwards and takes south-westerly course till it meets the Brahmaputra river. While flowing through the alluvial plains of Assam, the Subansiri river undergoes frequent shift in its meandering course . The changes in

Figure 1 : Channel pattern of the Subansiri river as seen on the topographical map (A) and deciphered from the Landsat imagery of 19-1-1985 and IRS-IA imagery of 20-11-1988 (C).

its channel pattern observed from the satellite imagery of the period 1985-88 are briefly outlined in this note.

The channel pattern of the Subansiri river flowing through the alluvial plain of Assam upto its confluence with the Brahmaputra river as presented by the Landsat MSS scene of 19.1.1985 and IRS-1A LISS-1 scene of 20.11.1988 is shown in figure. The data was interpreted at the scale of 1:250,000. Stream course of the Subansiri river as shown on the Survey of India topographical map is presented in figure A. The course of the Subansiri river deciphered from the Landsat MSS of 19.1.1985 and IRS-1A LISS-I of 20.11.1988 has been shown in figure B and C respectively. Comparison of the channel pattern as seen on the topographical map and as deciphered from the satellite images indicates that the river course has undergone considerable shifts in its course within the period under consideration.



After debauching into the plains, the Subansiri river flows towards south in the meandering pattern. A notable change in its course is seen near the confluence of its tributaries namely the Bagi and the Dirgha rivers (inset 1). The bifurcated stream course of the Subansiri shown in the topographical map has undergone significant changes as is evident from the satellite images covering this part of the Subansiri basin. Stream course of the Subansiri river has taken a sharp bend causing severe bank erosion during 1988 affecting the landmass measuring for about 2 sq. km in extent.

While flowing towards south the Subansiri river, during the period 1985-88, has adopted a shorter channel by flowing in the direction of southwest as shown in inset 2. This segment of the river has undergone major changes in its course during such a short period. The study of the IRS-1A imagery indicates that the tendency of this river is to shift towards west in this particular area.

In its southwesterly course near the confluence of the Ranga river with the Subansiri river, a gently meandering pattern has developed a sharp bend in its course as is evident from the IRS- 1A imagery of 1988, bringing additional area under bank erosion (inset 3). The Ranga river, one of the major tributaries of the Subansiri river, has indicated shift in the course of its lower reaches. This is in particular clear from its rectangular bend which has become nearly straight by shifting about 2 kms westwards.

OCEANOGRAPHY

OCEANOGRAPHIC APPLICATIONS OF VISIBLE BAND IMAGES FROM INDIAN OPERATIONAL REMOTE SENSING SATELLITES

Satyendra M Bhandari, Space Applications Centre

Ever since the birth of Satellite Oceanography, more than two decades ago, satellites have become a vital part of the oceanographers kit - much like the CTD or the Echosounder. Satellite based remote sensing has helped in extending the oceanographer's view to include basin and global scales. As a result, a variety of new oceanic processes and phenomena have been explored and understood.

Most of the satellite based ocean observations have come from sensors onboard satellites launched by the U.S. - for example the AVHRR onboard NOAA, CZCS & SMMR onboard NIMBUS etc. A number of satellites specifically designed to cater to the need of the oceanographers have also been launched by U.S. over the last two decades. These are GEOS-3, SEASAT, GEOSAT and TOPEX. Imaging radar sensors were also flown on SIR-A and SIR-B missions. Recently the European Space Agency (ESA) and Japan have launched satellites specially configured for ocean remote sensing (ERS-1 and JERS-1). India is also contemplating to launch its own dedicated met/ocean satellite sometime during the 90s.

While oceanographic community in India has shown interest in the analysis of data from different satellites whenever available, there is no systematic effort to investigate oceanic regions around India. This is so because there is no Indian satellite for oceanography with assured and continuous data availability.

For several years , however, India has successfully operated IRS and INSAT series of operational remote sensing satellites for natural resources and weather monitoring, respectively. The sensors onboard these satellites are not optimized for oceanographic applications. Nevertheless, the long term database of high resolution high quality state-of-the-art images generated by these satellites provide tremendous opportunity to systematically explore and study a variety of oceanographic phenomena over the oceanic regions surrounding India. The LISS-I and II, onboard IRS, provides multispectral images in the visible (0.4-0.7 μ) and VHRR onboard INSAT operates in the visible (0.55-0.75 μ) and the thermal IR (10.5-12.5 μ) window regions of the atmosphere. IRS and INSAT images therefore contain significant amount of *Oceanographic* signal to be extracted and utilized for oceanographic applications.

The INSAT-VHRR thermal IR band images have been used in a few applications to locate some ocean surface thermographic features e.g. eddies and fronts. The strong thermal gradients in VHRR images over the shelf-slope region have been used in fisheries application. On the other hand, the visible band images have largely been ignored as far as oceanographic applications are concerned.

Here we intend to highlight the potential utility of high resolution IRS and INSAT visible band images for oceanographic studies.

LISS-I & II onboard IRS produce high resolution (~70 and 35 m) wide swath (140 and 70 km) images in four spectral bands in the visible region once every 22 days. With the simultaneous availability of IRS-1A and 1B in suitably staggered orbit, the frequency of imaging a given place reduces to once every 11 days. With these imaging characteristics IRS images permit exploration of mesoscale and submesoscale oceanographic phenomena. Of course, ocean imaging in the visible band would be restricted to cloud free regions.

Using IRS images we have successfully studied the characteristics of large internal waves occurring in the Andaman sea region. In spite of the fact that Andaman sea region is frequently cloud infested, a careful search through the large LISS-I browse database has revealed a number of cases of clear surface signatures of subsurface internal wave activity. Finer resolution LISS-II images under suitable conditions show presence of swell propagating over the ocean surface. Study of evolution of wavelength and direction of these large gravity waves can be used to infer the ocean bottom topography. A number of IRS images also reveal a variety of surface features which help in visualization of surface flow field. Also present are signatures of naturally occurring oil slicks which are good indicators of surface current patterns in the region.

VHRR onboard INSAT series of satellites, on the other hand, provide frequent (say 3 hourly) simultaneous visible and thermal IR band images covering the entire oceanic region of interest. Cloud free IR images provide valuable source of information to study the surface thermographic features and their time evolution. These find applications in studies of boundary currents, fronts and eddies etc. Again the vast amount of visible band images have not found favor with the oceanographic community.

We have explored the phenomenon of **Sunglint** which regularly occurs in all daylight visible band VHRR images. Sunglint is the specular reflection of sun imaged by the sensor. The detailed characteristics of the observed sunglint signatures are a function of the sea-state (i.e. state of roughness of the sea surface) and the observation geometry. We have analyzed the sunglint signatures in INSAT visible band images to estimate surface wind speed over the glinted area. Sunglint signatures provide a valuable and complementary source of wind information over the oceanic regions.

These and many other oceanographic phenomena and processes can be explored with the storehouse of already available IRS and INSAT images. Both IRS and INSAT are operational satellites with assured availability in the years to come. At present, data collection from IRS is primarily dictated by requirements of land resources studies.

Therefore the ocean coverage of IRS extends only upto the continental shelf regions of the country. For meaningful oceanographic studies it would be worth extending the IRS coverage to open ocean areas over the Arabian sea and Bay of Bengal. It would also be desirable to operate LISS cameras with high gain settings over low radiance ocean scenes. Whenever appropriate and necessary, these data can be supplemented with other concurrently available high resolution images from LANDSAT,SPOT, NOAA, ERS-1 etc. to gain a deeper understanding.

In future, India is planning to upgrade the IRS system with sensors providing improved resolution, wider swath , spectral coverage extending to middle and thermal bands as well as sensor tilt capability allowing more frequent revisits of a given area. These developments would increase the ocean information content of IRS images further.

The importance of satellite images in oceanographic studies lies in the opportunity it offers to visualize surface flow fields and their modifications by subsurface processes on scales impossible to obtain with in-situ localized ship based measurements. Sometimes it is difficult to quantify such a contribution, but often the insight gained by examining these images may give rise to new discoveries. It is with this hope the attention of scientists interested in oceanographic studies is drawn to the long multiyear data base of high quality images over the oceanic regions surrounding India produced by indigenous operational IRS and INSAT series of satellites.

SPATIAL INFORMATION SYSTEMS

SOME THOUGHTS ON REALIZATION OF A SOIL INFORMATION SYSTEM (SIS)

B S Lole and R K Goel, Space Applications Centre

SYSTEM REQUIREMENTS

A Soil Information System (SIS) can be visualized as a computerized mechanism which manages spatial and non-spatial data in support of soil survey and which can facilitate generation of interpretative maps and tabular outputs showing potentials and problems of soils for various development planning tasks such as

* watershed management (soil and water conservation and integrated watershed development)
* wasteland development
* forest and pasture development
* agriculture development and
* urban development etc.

Soil Information System (SIS) should be able to

* accept and manage a variety of input data sets available in tabular as well as map form at different scales
* validate and update the data base contents
* inter-relate various data sets in spatial as well as tabular context
* manipulate the spatial as well as tabular data and provide interface to other systems
* provide a user friendly interface in order to retrieve the information in desired form
* provide appropriate tools to assemble the data sets for publication.

Primary input data on soils is collected in the form of hand written notes, formatted data with text and abbreviations, in a particular form with codes, user related forms, hand held data sheets, grid maps, final maps and analytical data related to typical pedon. The data could be collected in various stages on different aspects like

* meteorology (climate from IMD)
* crop data on regional and/or area basis from agriculture departments, statistical offices or universities
* landuse from village records, Directorate of Economics or Remote Sensing
* Geology from GSI or Department of Geology and Mining
* Analytical data based on laboratory analysis
* soil morphology from field
* soil maps from field or remote sensing

GIS - CORE OF THE SYSTEM

Such an SIS would require to handle a large amount of input data sets in various forms. A Geographical Information System (GIS) which provides a mechanism for managing georeferenced data sets in an integrated manner, would have to be the core of SIS. Furthermore, the input data sets will have to be integrated and analyzed in order to generate the interpretative maps as mentioned above. A GIS providing tools for manipulation and analysis of geo-referenced data sets would be very essential for realization of SIS. Capability of a GIS to be able to treat the geographic coordinates and attributes of spatial features separately and at the same time in a related manner would be very much essential. Various other GIS tools would be required for integration of different spatial data sets on topography, landuse and water resources via. overlay analysis, proximity analysis for interpretation of relationships amongst the soil areas and for non-spatial data modeling of soil units and spatial depiction of the results.

DATA BASE DESIGN AND CREATION

Design and creation of an integrated data base is of utmost importance for realizing an effective SIS. The first task would be the identification of complete set of input data elements considering the needs of generating outputs, non-redundancy and multiple usage of single data element. Spatial inputs in map form could be on map sheet basis at different scales. Non-spatial inputs may be based on a variety of units. On the other hand the outputs may have to be generated on the basis of hydrologic units, forest units or administrative units for different functions. It is therefore desirable to organise the data base in a manner it facilitates three different views.

User's view (functional schema) which provides an illusion of functionality to the organization of data base as per the end uses like watershed management etc. At the same time another user view could be the logical schema which facilitates retrieval of spatial information on different types of spatial units like watershed, forest range, taluk etc. Internal storage (physical schema) will have to be decided based on the spatial units of input data availability. Such an organization will have to be supported with data base dictionaries providing means of across view translations.

The data entry into the system would be via map digitisation and direct entry through alpha-numeric terminal. Prior to the input of individual maps into the system, a spatio-tabular framework has to be laid down.

USE OF GIS FOR BRACKISH WATER AQUACULTURE SITE SELECTION IN WEST BENGAL

M C Gupta, Space Applications Centre

Fisheries in India is an established sector so far as marine fisheries of coastal waters is concerned. However, much remains to be done in offshore waters. There is ample scope for development of brackish and inland fisheries. Government of India (GOI) and Food and Agriculture Organization (FAO) have identified a Brackish Water and Inland fisheries project covering the development of brackish water shrimp culture and culture-based fisheries. This project has selected 14 sites from three states viz West Bengal, Orissa and Andhra Pradesh.

This note presents the work done for brackish water aquaculture site selection viz data collection, data base creation and development of a menu based user friendly software using Simple Macro Language (SML) around Geographic Information System (GIS) for two selected sites of West Bengal namely Digha and Dadanpatra. Figure shows an integrated map of Digha and Dadanpatra sites of West Bengal. It includes landuse, road network, habitation, population and village codes.

Aquaculture is one of the source of export earning to India. It also creates employment opportunities to the skilled and unskilled rural poor. However, production levels are low due to scarcity of seed during the year and the lack of compound shrimp feeds. Thus there is a need to exploit aquaculture resources and to use newer methods to enhance the production as well as the export earning.

An attempt has been made to develop a model for prioritisation of sites by integrating various parameters such as engineering, ecological, infrastructure, demographic and meteorology using weightage factors to help planners/decision makers in selecting aquaculture sites. In the model, the weightages are assigned to the parameters in two steps.

The percentage weightages are assigned among the parameters depending upon their importance in selecting aquaculture sites. Parameters like water salinity, soil texture, seeds availability, feeds availability and population around site are given higher weightages. Certain other parameters like air temperature, water temperature and training are given lower weightages. In the second step, weightages are assigned to the parameters individually depending upon their suitability for aquaculture.

Thus a cumulative weight is calculated for various sites by taking into accounts all the parameters for ranking the sites for their suitability for aquaculture development.

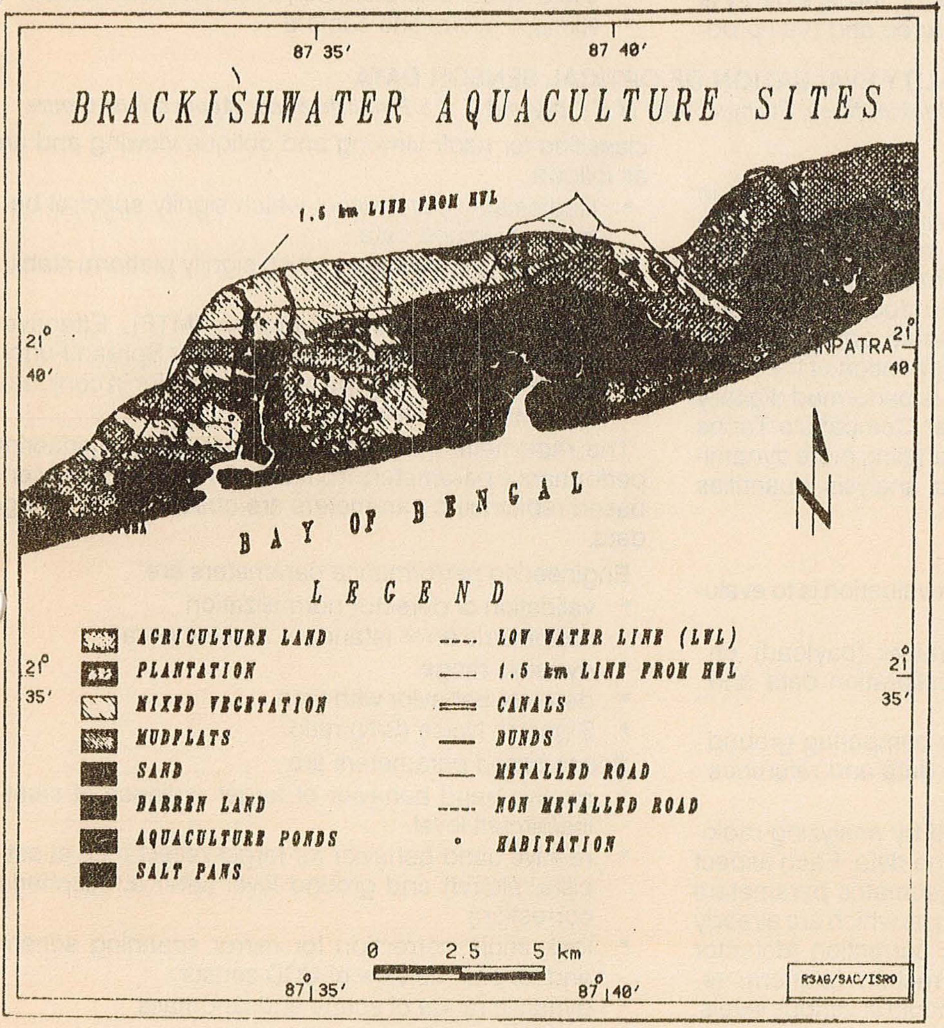


Figure 1 : Integrated Map of Digha and Dadanpatra sites in West Bengal.

IMAGE PROCESSING AND DATA PRODUCTS GENERATION

PHOTOGRAPHIC DATA PRODUCT GENERATION ACTIVITY AT SAC

A K Shukla, Space Applications Centre

Generation of photographic data product has been a very important activity in the overall data product generation system and was started at SAC since Bhaskara-I time frame. Bhaskara-I and II data product generation gave us valuable experiences to design and establish operational procedures for photo product generation in the country. During initial stages of IRS-1A project, well defined procedures were laid down after extensive experimentation conducted jointly by SAC and NRSA. A new set of photographic data product specifications were evolved for IRS-1A. Strict quality control criteria were established to supply better quality data products to user community. At SAC, a large number of IRS-1A precision and special data products were generated for dissemination to users. The R&D activities for the testing of IRS-1B and ERS-1 data product generation software and to operationalise at NRSA needed several checks at photo product level at SAC. Today, with the existing capability, the laboratory is involved in the generation of R&D Stereo and PAN product for IRS-1C, INSAT VIS/IR data product, ASAR data product and apart from other remote sensing user requests, special data products such as Gujarat Mosaic and India Mosaic FCC. Following facilities are currently available at the centre:

* Colour FIRE 240 film recorder
* Joyce Loebl photowrite system
* Kreonite E-6 and C-41 Colour film processors
* Colenta R-3 and One shot colour paper processor
* Luth B/W film processor
* Logeline B/W paper processor
* Durst 1840 and 2000 Colour enlarger
* Klimsch contact printer
* ESECO process monitoring system
* Klimsch linear measuring instrument
* Joyce Loebl Micro densitometer
* SICO Spectro photometer, PH motor and Titrator
* Klimsch microfiche camera

QUALITY EVALUATION OF OPTICAL SENSOR DATA

S S Palsule, H S Bhatt, Mritunjay, Bankim Shah, Pushpa Shah, H K Garg and C V S Prakash, Space Applications Centre

INTRODUCTION

The underlying concept of data quality evaluation in remote sensing satellite mission is the analysis of satellite imagery given a landscape of the object imaged. The comparative analysis could be performed visually in qualitative manner on photographic product (media) and measurement can quantify radiometric and geometric aspect of data with reference to specification of the product. The other comparative analysis is performed digitally in quantitative manner on Computer Compatible Tapes (CCTs) and this media allows data handling more dynamically and efficiently. The harmonic analysis quantifies frequency content of the image.

OBJECTIVES

The basic objective of data quality evaluation is to evaluate

* functional performance of sensors (payload) on ground and on board using calibration data and scene data.
* stability analysis of platform by comparing ground control points on image scene data and reference map data.

The evaluation could be quantified by analyzing radiometric and geometric aspect of scene data. Each aspect is translated into radiometric and geometric parameters and derived from user defined products which are already generated by applying radiometric correction (detector normalization) and geometric correction (platform related) on photographic and digital media at various levels.

PARAMETERS OF EVALUATION

The parameters of data quality evaluation are broadly classified for nadir viewing and oblique viewing and are as follows..

* Radiometric parameters which signify spectral behavior of image data.
* Geometric parameters which signify platform stability
* Modulation Transfer Function (MTF), Effective Resolution Element (ERE) and Point Spread Function (PSF) signifying the spatial behavior in conjunction with spectral fidelity.

The radiometric parameters are basically engineering performance parameters from calibration data and scene based radiometric parameters are observed from image data.

Engineering performance parameters are

* validation of detector normalization
* radiometric error (standard and temporal)
* dynamic range
* detector behavior with time
* Signal to Noise (S/N) ratio

Scene based parameters are

* relative band behavior of target radiance at satellite/aircraft level.
* relative band behavior for target reflectance at satellite/ aircraft and ground level (after atmospheric correction)
* look angle correction for mirror scanning sensor and for oblique view of CCD sensor
* dynamic range of scene and landmass
* saturation radiance
* effect of sun angle on normal and oblique viewed images

The geometric parameters are based on viewing geometry of payload from satellite platforms and they can be classified as:

* The parameters which affect dynamically the image scene due to attitude rate, velocity , height variation of the platform and modelling error.
* Geometric parameters which do not change rapidly but changes its viewing geometry with reference to ground measured references. The change may occur due to displacements induced by vibration generated during launch or misalignment due to thermal conditions. These parameters are basic viewing angle of satellite axis which has to be computed after launch and could be verified seasonally at six months interval. The dynamically affected parameters are:
* scale and scale variation
* location accuracy
* internal distortion

These parameters are functions of attitude values, height and velocity variation. They are also analyzed from ancillary computer compatible tapes (ACCT).

All parameters mentioned for satellite sensor are valid for airborne sensors. In the absence of Inertial Navigation System (I N S) data for aircraft platform, polynomial fitting method is used for comparing image and map data.

The other parameters which are static in nature can be called as bias matrix and classified as:

* Sensor alignment with spacecraft axis
* Inter sensor alignment angle
* Band to band registration
* Sidelap and overlap of sensor frames

Evaluation of all geometric parameters is based on Ground Control Points (GCPs) and Relative Control PointS (RCPs).

Parameters like MTF, ERE and PSF are evaluated both from natural test sites and on artificial test sites. Anisomorphism is yet another parameter which is a measure of variation in spatial resolution due to integration time variation and jitter in platform. It is computed from GCP's which are distributed over a circular shape on ground and normally seen as ellipse on image data. Sidelap and overlap of scene data quantifies orbital drift during mission.

At present following packages are operational at NRSA, Hyderabad.

* CALANL- Engineering performance of sensor from calibration data
* SCNEVAL- Scene based radiometric parameters
* GEOEVAL- Geometric parameters
* ACCT- Platform behavior from ACCT (Ancillary computer compatible tapes)
* MTF and ERE- from contrast of natural target

Accuracies obtained for IRS-1A/1B

Parameters	Accuracies	
	IRS-1A	IRS-1B
List of abnormal detectors(from onboard calibration data and scene data)	23-detectors (1088:1120) of LISS-1	58 detectors (153:185, 1531:1555) of LISS-2B
Standard Error (from onboard calibration data)	2 to 3%	1%
Dark current	1 count	0 count
Dynamic Range	0-127	0-127
S/N Ratio	255	255
Inter sensor calibration	10%	3%
Detector Normalisation	±1 count	±.5 count
Location Accuracy	±2.5 km (RMS)	±1.2 km (RMS)
Scale	.5%	.5%
Internal Distribution	±5 pixels	±5 pixel
BBR	± .8 pixel	±.3 pixel
Side lap of two cameras	32 pixel	74 pixels
Overlap of two frames of LISS-1	352 scan lines	347 scan lines

S/N ratio is defined as ratio of mean to standard deviation and standard deviation is half count.

CALIBRATION ANALYSIS OF OPTICAL SENSORS

H S Bhatt, R N Acharya, S S Palsule and CVS Prakash, Space Application Centre

The CALIBRATION is the determination of the quantitative relation of detectors response to uniform input value it is intended to measure. The calibration under consideration is the amplitude calibration of LISS camera. Amplitude calibration involves measurement of the proportionality factor between a change in radiant (radiance) input and the corresponding change in output units of the system as digital numbers. This factor is called gain. Also the relation must be known between some fixed lowest reference point on the input scale and a corresponding point on the output scale, a relation called offset.

LISS camera of IRS 1A/1B records radiance reflected from earth surface in four bands. Each band contains a 2048 element linear array of charge coupled devices. The scanned earth's surface energy in push broom mode is converted into electrical signal and this signal is converted to digital number in the range 0 to 127. The photo response of each detector from the detector array is different for uniform input intensity due to responsitivity of each detector. Establishing a relation between input and output of each detector of an array is a GROUND CALIBRATION exercise during prelaunch period. The ground calibration set up consists of an integrating sphere of 10" aperture as the light source which uniformly illuminates the payload. The different intensity (radiance) level is obtained by changing lamp current combination. This intensity (radiance) is measured by hand held indigenously developed ground truth radiometer. The camera is interfaced to satellite interface simulator and a VAX 11/750 computer. The output of camera is recorded on magnetic tape (CCT). Each file of CCT corresponds to 128 lines (records) of 2048 detectors array (Record length) for one intensity level and six such files are recorded for six intensity levels. The calibration data is recorded for all cameras (3), all bands (4) and all gain settings (4) of each camera, , 3 temperature values (15°C, 20°C, 25°C) and two power supply options as normal and standby.

The processing and analysis of recorded data involves

* Generation of curve for mean count vs detector number which provides the spread of response to input intensity over the whole array
* Line fitting between six input intensities (radiance) and corresponding counts (digital number) as outputs using least square fit.
* Generation of detector normalized curve as count vs detector number
* Statistical table for first, second and third minimum /maximum count, standard deviation and radiance with respect to detector number
* List of abnormal detectors or detectors deviating from normal behavior.

The straight line curve of each detector is called a **light transfer characteristic** curve which gives gain and offset coefficient for (2048 X 288) detectors. If this curve could not be fitted within a count for more than two intensity level and if normalized curve for any intensity is not within a count, the ground calibration exercise is repeated for those specific conditions. The saturation radiance of detector corresponds to maximum count of127 and minimum saturation radiance of an array is used for normalizing the curve to avoid striping near high counts. The detailed analysis is carried out to quantify dependent/independent parameters like combination of gain number, temperature range and power supply. The normalized look up tables (LUTs) are generated for each detector, band and camera. This LUT is the basic input for applying radiometric corrections (detector normalization) for scenes acquired from satellite. LUTGEN software package is an operational package for generating LUT of any camera.

The gain and offset factor of each detector changes (degrades) with time and this is monitored using onboard calibration data. The onboard calibration system is based on light emitting diode (LED), the illumination of the two LEDS's are powered on ground command. The two LEDs generate 12 intensity levels by changing current values and exposure duration. This data is obtained as reference data during thermovac testing of payload for various engineering conditions. On board calibration data is acquired once in every cycle. CALANL software package at data reception station computes (near real time) a list of abnormal detectors. Detail analysis of each detector is performed using CALDQE software package at Balanagar, Hyderabad, in an hours time.

Operational software package GNDCAL and LUTCAL has been developed to analyze onboard calibration data during thermovac test and ground calibration data for detector characterization during prelaunch period respectively. Both the packages give detailed analysis of each detector in a few hours after data being recorded. This analysis gives input to payload engineers for i) accuracy of calibration set up ii) detector performance for various camera set up conditions.

To summarize results of on board calibration data for IRS 1A in 3 years time, it is found that standard error is within 2% and dark current value increase by 1 count for some bands, while for IRS 1B we find in one year standard error is within 0.5% and dark current is at zero range. Ground calibration data exercise of IRS 1B for all camera provides normalization within 1 count. IRS 1E LISS-E camera provided normalization within 2 count for band 1 and band 2 and the other bands it is within 1.5 count for the three input intensity levels provided to us. The same package has been used to analyze ground calibration data recorded for MEOSS payload at DLR Germany and with three intensity values. normalized curve is within one count.

SENSORS

Minimum Saturation Radiance and Count to Radiance conversion factors for various bands of IRS - IB LISS

	Minimum Saturation Radiance (mw/ Cm -Sr -u)			Conversion Factor K : (mw/ Cm - Sr - u) * 100		
	LISS - I	LISS- IIA	LISS- IIB	LISS - I	LISS- IIA	LISS- IIB
Band 1	16.69	15.74	15.18	13.30	12.39	11.95
Band 2	17.84	24.60	24.49	14.05	19.02	19.28
Band 3	16.85	15.85	15.22	13.27	12.48	11.98
Band 4	17.06	15.83	15.12	13.43	12.46	11.91

Source : A S Kiran Kumar and K Mathew, in NNRMS Bulletin - 16 (Nov, 1992)

INSAT-2 VERY HIGH RESOLUTION RADIOMETER

VERY HIGH RESOLUTION RADIOMETER (VHRR) is one of the major payloads onboard INSAT-2 series of spacecrafts to carry out Meteorological observations in the visible (0.55-0.75 microns) and thermal infrared (10.5-12.5 microns) bands. The ground resolution at the sub-satellite point is nominally 2km x 2km in the visible and 8 km x 8 km in the IR band. The incoming radiation is reflected onto an 8-inch aperture R-C telescope by a Beryllium scan mirror mounted at 45 deg. to the optical axis. The optical system includes a gold film dichroic beamsplitter which transmits visible light energy and reflects IR energy so that the radiation from earth is channeled to the visible and IR focal planes simultaneously. The detector configuration consists of two staggered arrays of four silicon photodiodes each sensing in the visible band and two Mercury-cadmium Telluride detectors operating nominally at 105 deg. K sensing in the Thermal - IR Region. The Scan mirror is mounted on a two-axis gimballed scan mechanism system to generate a two dimensional image by sweeping the detector instantaneous field of view across the earth's surface in East to West (fast scan) and North to South (slow scan) directions. Four contiguous visible lines alongwith a registered IR line are generated during the fast scan at the end of which the scan mechanism steps in N-S direction by one IR IFOV. Scan direction in fast scan is reversed at the end of every line to improve scan efficiency. Three modes of operation are provided.

* Full frame mode scans 20 deg x20 deg minimum in about 33 minutes covering the entire earth disc and some space around.
* Normal mode covering 14deg N-S x 20 deg. min E-W in about 23 min.
* Sector mode in which the sector can be positioned anywhere in steps of 0.5 deg. in N-S direction to cover 4.5 deg N-S X 20 deg minimum E-W is particularly suited for rapid, repetitive coverage during severe weather conditions like cyclone.

The 20 deg coverage in E-W direction ensures cold space view at both the ends of the scan line. This is used for DC restoration and as a calibration point for IR and visible channels. In orbit IR channel calibration is realised by viewing an internal black body at the end of full frame and normal frame modes as well as when commanded in sector scan mode. The temperature of the blackbody is accurately monitored at five locations and transmitted in VHRR data stream.

The visible and IR detector outputs are individually amplified, band limited and digitized by ten bit A/D converters. The digitized data of all the channels, house keeping information, calibration data etc. are formatted, randomized and transmitted serially in the extended C band.

The INSAT-2 VHRR differs from INSAT-1 VHRR in several significant ways in the design approach as well as in system realization to provide functional improvements and operational flexibilities. The salient features include:

* Better resolution : 2 km in visible and 8 km in IR band.
* The optics design employs R.C. telescope with a novel concept of a Dichroic with a wedge angle and curvature.
* No auxiliary optics requirement for Visible channel.
* Patch control possible at 8 different control points in the range of 105 - 115 deg. K.
* Full redundancy for Path control and monitoring
* Visible detector staggering for better SNR, lower cross talk and contiguous scan line generation.

A very important aspect of INSAT-2 VHRR development is the high level of indigenisation achieved. Apart from overall design, design analysis, integration and evaluation at the payload level several critical components and processes have been developed and qualified for flight use inspite of the tight time schedule and stringent demands put forward by the state-of-the art performance requirements of the VHRR payload. Various ISRO centers as well as Indian industry have been involved in the development of VHRR.

The first flight model of VHRR was integrated with INSAT-2A spacecraft and launched on 11 July 1992 from KOUROU by ARIANE rocket. It was operationalised on August 6,1992 after detailed on-orbit performance evaluation. The India Meteorology Department is operationally using INSAT-2A VHRR data since then. The second flight model currently under Test and Evaluation at SAC will be integrated with INSAT-2B spacecraft for launch by ARIANE later this year.

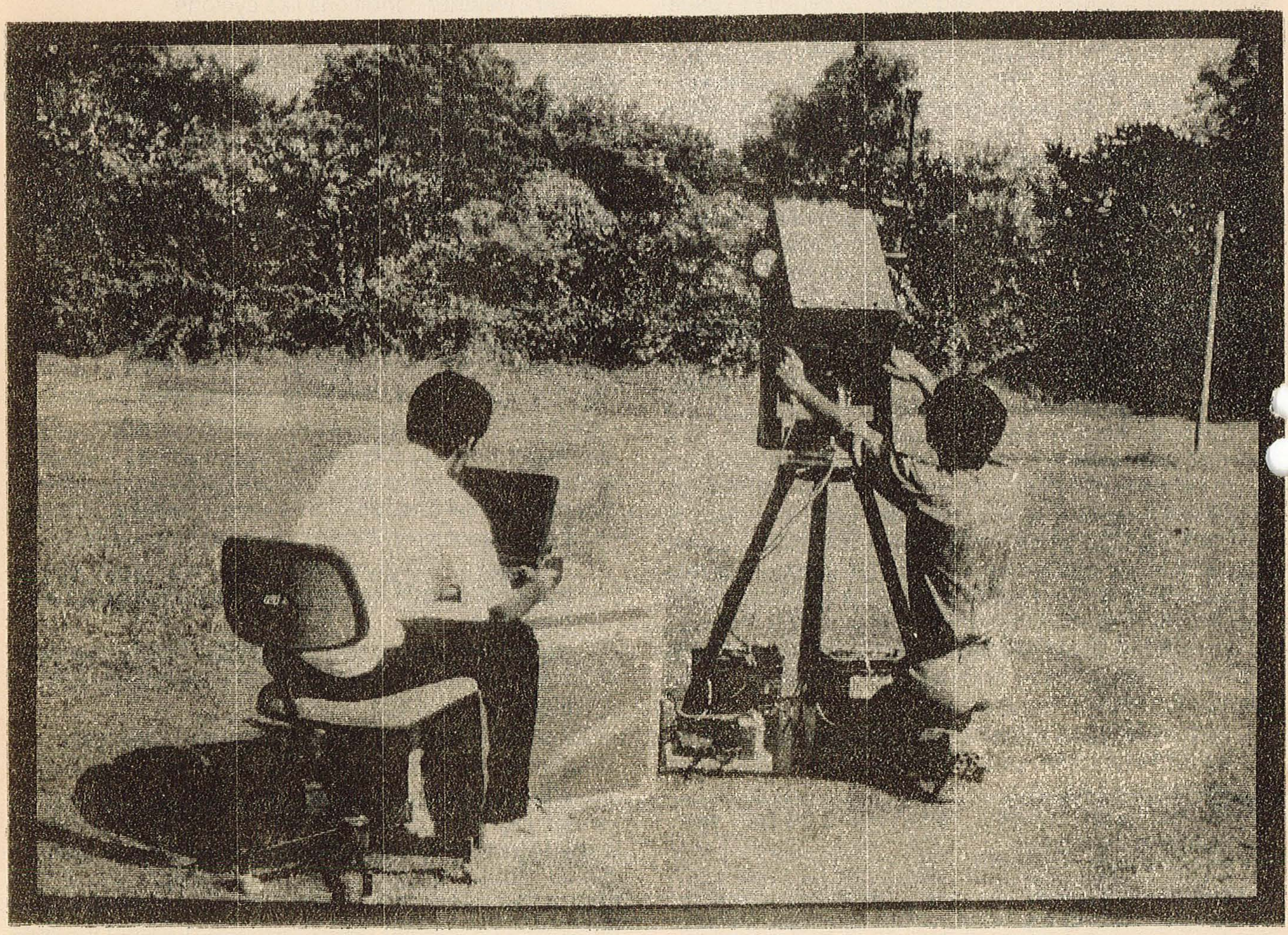
Source : Electro-Optical Sensors Group, Space Applications Centre

OPERATIONALIZATION OF PROBAR - A NEW TOOL FOR AEROSOL MONITORING AND SPECTRAL SIGNATURE STUDY

A.K. Shukla, Y P Desai, A Garg and K S Pandya, Space Applications Centre

PROBAR is a **programmable band radiometer** meant for the recording of simultaneous spectral radiance and irradiance in the visible and NIR region. The equipment was obtained from M/s. Moniteq, Canada and was received in damaged condition without any further technical support from the company which has been closed now. Recently, the equipment was brought to working condition with in-house efforts and satisfactory performance was obtained.

PROBAR has the concept of a spectrometer and the spectrum falls on 128 element CCD array and the Pbs detector. The 400 µm to 1100 µm spectral range are detected by CCD whereas 1.5 um to 1.75µm and 2.08µm to 2.35 µm are detected by Pbs detector. The spectral bands have been programmed in PROBAR for IRS, Landsat-TM, SPOT and thirteen 5 nm narrow bands. However, it is possible to program any spectral band of interest. A

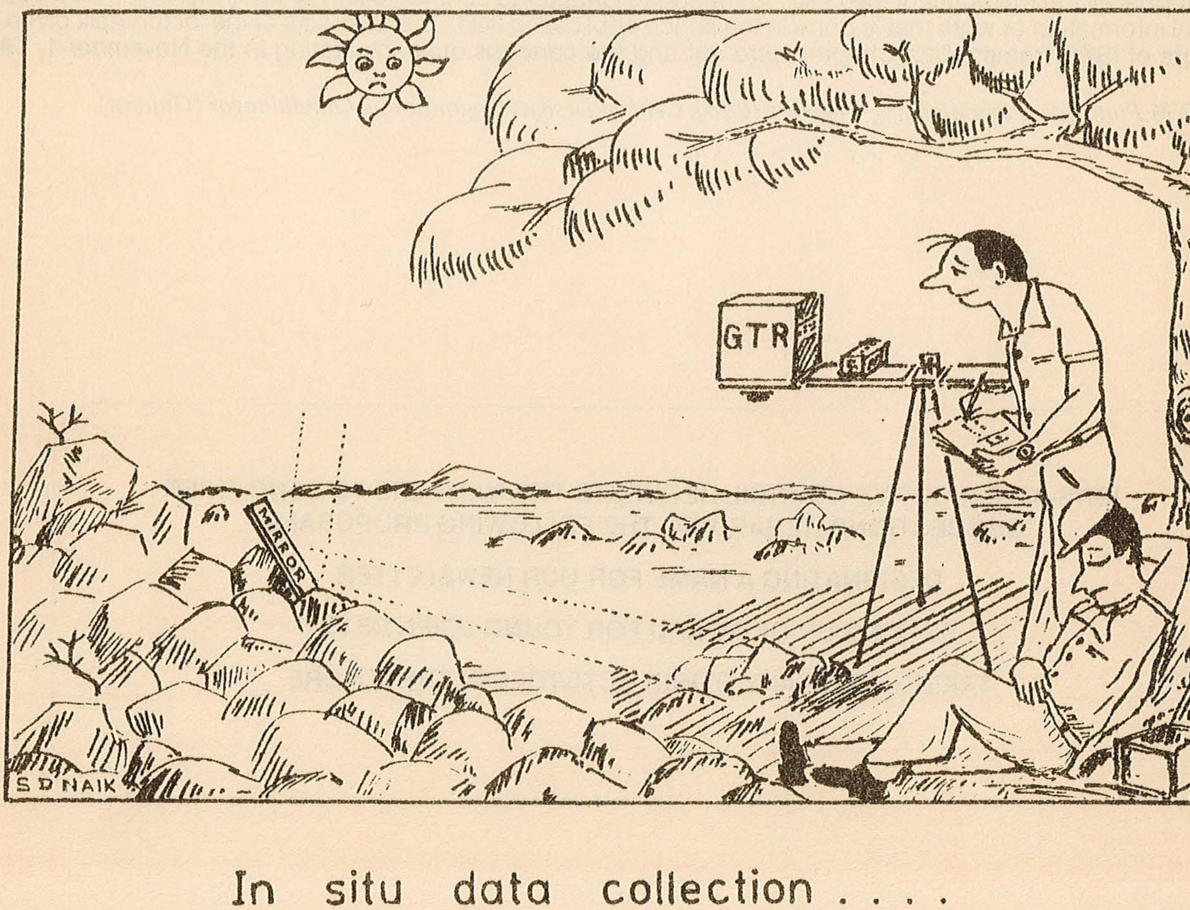


PROBAR in operation

maximum of three bandsets of sixteen each can be programmed in PROBAR.

The wavelength calibration of 128 element CCD array has been performed using mercury source upto the accuracy of 2 pixels. The spectral calibration of PROBAR has been done using 1000W calibrated tungsten light source for 1° FOV and 15° FOV. The radiometric correction software has been developed to process raw data obtained on Lap top PC using calibration coefficients. The pointing accuracy of PROBAR has been achieved better than +/- 0.50 degree. Repeated measurements has confirmed the equipment measurement repeatability of +/- 0.5%.

PROBAR has been used operationally at KANIJ test site selected for data product calibration. Using 15° FOV, PROBAR was used to measure reflectance of sand in satellite bands while 1° FOV was used to record direct solar irradiance in thirteen narrow spectral bands. The experiments were conducted synchronous with IRS and Landsat passes. The radiometrically corrected PROBAR data was used to construct Langley plot for the determination of total optical depth of atmosphere and aerosol optical depth. The realistic particle size distribution derived from the inversion of spectral optical depth measurements taken by PROBAR has been used to compute path radiance. Based on the total optical depth and path radiance, IRS data over KANIJ test site has been corrected for atmospheric effects. It is planned to use this technique for the absolute calibration of IRS data after conducting few more synchronous data collection. Another important application of PROBAR planned is on the study of spectral signature of various features using high resolution capability of PROBAR varying from 1.5 nm at 400 nm to 15 nm at 1100 nm.



In situ data collection . . . .

CHAPTER ACTIVITIES

We provide herewith a report on activities of ISRS Ahmedabad chapter during April to December 1992.

MEMBERSHIP DRIVE

As a result of untiring effort by the current executive council and enthusiastic support of the remote sensing community, the membership of our chapter has increased from **185 to 241**.

LECTURES

Following lectures were organised.

* Popular lecture, **Environment and Man**, by Dr. S K Nigam on **World Environment Day** ,June 5, 1992 at SAC.
* Popular lecture, **Regional Planning through Remote Sensing** , by Shri D G Pandya, on July 9, 1992 at SAC.
* Lecture, **Remote Sensing : A broad perspective,** by Dr. R R Navalgund for students and lecturers on Sept 18, 1992 at M G Science Institute.

PUBLICATIONS

Frequency of the Newsletter has been increased to once in two months. Three issues were released as follows:

Vol. 5, No. 4 and Vol. 6 No. 1, 2 and 3, July 1, 1992

Vol. 6 No. 4, Sept 1, 1992

Vol. 6 No. 5, Nov. 1, 1992

OTHER ACTIVITIES

* Van Mahotsav was organised during July 1992 wherein 350 saplings of different varieties were distributed to the members.
* Excursion tour is planned for January 1993 in order to provide an informal forum for interaction amongst the members/families

MEMBER'S VIEWS ON THE NEWSLETTER

The Newsletter of ISRS Ahmedabad Chapter is perfecting itself with the passage of time. However, perfection has the sky as its limit. The contents of the Newsletter are of varied interests and provide information and educative reading. I appeal all the members of the ISRS, Ahmedabad Chapter to contribute for the up- keep of the Newsletter, the personal information or work that is done in the space application field. The abstracts of the lecture/talk given by the members of ISRS Ahmedabad Chapter were apt and the cartoons quite interesting in the November 1, 1992 issue.

D M Pancholi, Superintending Engineer (Geo), Central Designs Organization, Gandhinagar (Gujarat)

ISRS-AC EXECUTIVE COUNCIL REQUESTS THE MEMBERS TO SEND THIER SUGGESTIONS REGARDING THE FOLLOWING PROPOSALS:

DESIGNATING A NAME FOR OUR NEWSLETTER

SETTING UP OF AWARD FOR YOUNG SCIENTISTS

TAKING UP OF ANY OTHER ACTIVITIES IN THE FUTURE

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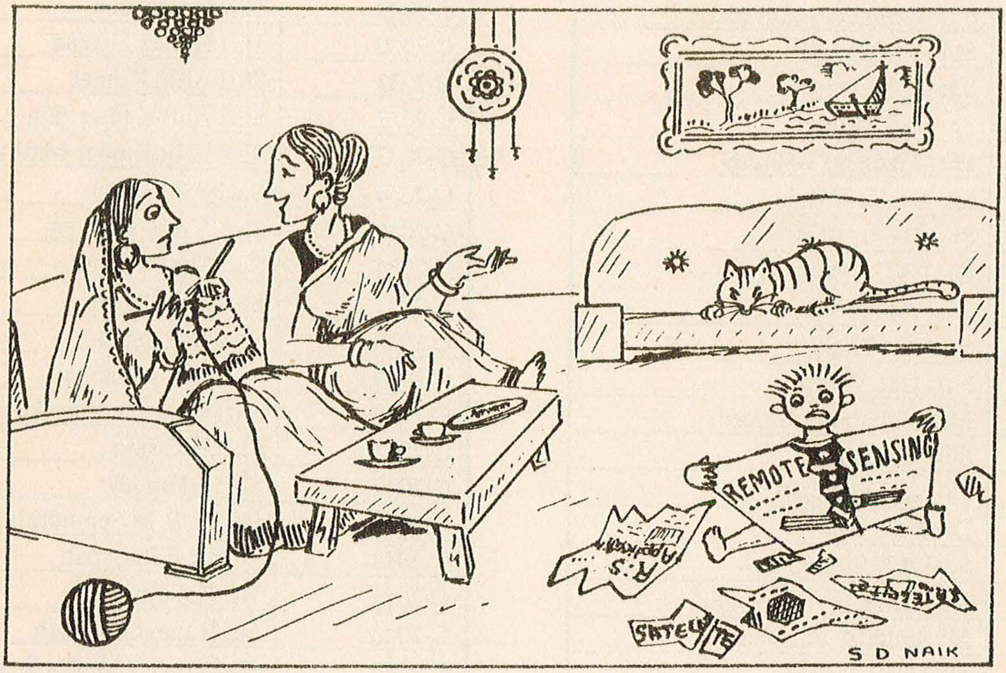

I am afraid if my son also makes career in remote sensing like his father

BOOK POST

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