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IEEE Gujarat Section Geoscience and Remote Sensing Society- Chapter Newsletter

Inside This Issue

*We, the passive & active remote sensing community, must consider ourselves to be therefore given the astute "Professional Status" with the innate responsibility of functioning as the "Pathologists and Radiologists of the Terrestrial and also Planetary Environments", and be entrusted to keep a watchful eye on the misuse of the "**Natural EM Spectrum (NES)**", which is indeed to be sanctified as one of the most "**sacred treasures and resources of Planet Earth**", our planetary system and the universe.*

-Prof. W. M. Boerner

Chapter Achievement!

IEEE-Gujarat Section-GRSS-Chapter **received international recognition by working as a technical sponser for International Conference on Aerospace, Electronics and Remote Sensing (ICARES) 2014, Yogyakarta. For further information, visit http://www.indoaessgrss.org/icares-2014/**

New Year Greetings - 2015

IEEE Gujarat Section GRSS Chapter wishes all Members & their Families A very Happy, Healthy and Prosperous New Year - 2015

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Editor's Column

IEEE-GRSS of Gujarat has made the first strides and so has its Newsletter. The Newsletter has helped not only in exchanging ideas and information on our activities; it has helped in fostering feeling of fraternity. All of us however realise that a marathon is much more difficult than a single sprint. It is therefore necessary that we select the right pace. It took almost a year to give shape to the present issue after we had the inaugural issue. It is hoped that Newsletter publication can be maintained as an annual activity. What will be of paramount importance to us should be its quality.

Several impressive activities were undertaken since we published the last issue. The activities included seminars, lectures, workshops and training programmes, many of them with participation of international experts. They have been appropriately mirrored in the present issue. So are the updates on achievements of members. It has been our endeavour to include the feedback of readers of the Newsletter.

Along with earth observations, planetary missions with remote sensing of other planets of the solar system as one of the prime objectives have been drawing attention in recent times. This is bound to open up new avenues of scientific research and technology. A large band of young researchers in the city are associated with several such programmes.

We look forward to interesting pieces from our members for publication in subsequent issues of the Newsletter.

Abhijit Sarkar
<sarkar.abhi@gmail.com>

IEEE- Gujarat Section GRSS Chapter Members' Meet at Aashray Restaurant, Ahmedabad on 19th July 2014 (Left) and 21st December 2014(Right)

The Cover Page Image is the picture of India and surroundings as captured by Mars Color Camera on-board India's Mangalyaan froma distance of 7500 Km.

Message from the Chairman's Desk

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Dear Readers,

As chair of IEEE Geoscience and Remote sensing Society (IEEE- GRSS) Gujarat Chapter, I am pleased to remind you that the Society was established by a group of renowned scientists and professionals of Gujarat region in the month of June 2013. The society represents members working in geoscience applications representing various institutes like Space Applications Centre (SAC/ISRO), Physical Research Laboratory,CEPT University, NIRMA University, Gujarat University, MS University, Corporate sector and freelancer providing science and educational services. During the current year, society has served the purpose of bringing out professionals from International and National institutes at a common platform by organizing the events like International and National Workshop, training course and lectures from specialists. In addition, chapter has established its own website and brought out its newsletter during first year of its operation. Chapter has also contributed towards working as a technical sponsor for International Conference. Thus, chapter has established its presence at National and International level which has built a confidence not only to our members but also brought up laurel from International and National professionals. All this was possible by team effort of our members who have worked hard as IEEE volunteers of the society. After overwhelming response from first newsletter, our editorial team has brought out second issue of the newsletter. At this moment, I congratulate IEEE GRSS members for their outstanding contribution in bringing out the second issue of the newsletter in a timely manner.

Dr. Shiv Mohan

Event Reports

REPORT ON THE LECTURE ON "CURRENT SCENARIO AND CHALLENGES IN THE ANALYSIS OF MULTI-TEMPORAL REMOTE SENSING IMAGES" (29th JANUARY 2014)

Release of the First IEEE- Gujarat Scetion GRSS Chapter Newsletter by Prof (Dr) Lorenzo Bruzzone

IEEE Geoscience and remote sensing (GRSS) - Gujarat, IEEE MTT/AP- Gujarat, Indian Society of Geomatics (ISG) - Ahmedabad Chapter and CEPT University organized an invited distinguished lecture on the topic "Current scenario and challenges in the analysis of multi-temporal remote sensing images" by Dr Lorenzo Bruzzone affiliated with Department of Information Engineering and Computer Science, University of Trento, Italy. On this occasion, Dr Bruzzone released the first issue of IEEE GRSS- Gujarat newsletter and launched the chapter website (www.ieee-grss-gujaratsection.org). Dr Bruzzone also presented in brief the activities of IEEE GRSS, on this occasion. His talk introduced the importance of the subject and overview on current problems associated with multi-temporal data analysis. Possible approaches towards data analysis were also demonstrated. With the relevant development in sensor technology like enhanced spatial, spectral and temporal resolution data, methodology and importance of appropriate research to handle such data set was highlighted by the speaker with illustrated examples. The Lecture addressed the problems by pointing out the state of the art and the most promising methodologies for change detection on images acquired by the last generation of satellite sensors. The Lecture generated considerable interest among the scientists, faculty and students as indicated by enthusiastic audience interaction with the speaker during question-answer session. There were about seventy participants representing various educational and research institutes like CEPT University, Space Applications centre (ISRO), Physical Research Laboratory, Gujarat University, Nirma University, CU Shah College, and Ahmedabad University etc. in the lecture. The lecture ended with the vote of thanks to the distinguished speaker and to IEEE GRSS for providing financial support for the lecture.

A view of audience in the lecture hall

IEEE- Gujarat Scetion GRSS Chapter Members greets Prof (Dr.) Lorenzo Bruzzone

REPORT ON THE LECTURE ON "ADVANCED NEURAL ADAPTIVE PROCESSING IN INTERFEROMETRIC AND POLARIMETRIC RADAR IMAGING" (4^{th} JUNE 2014)

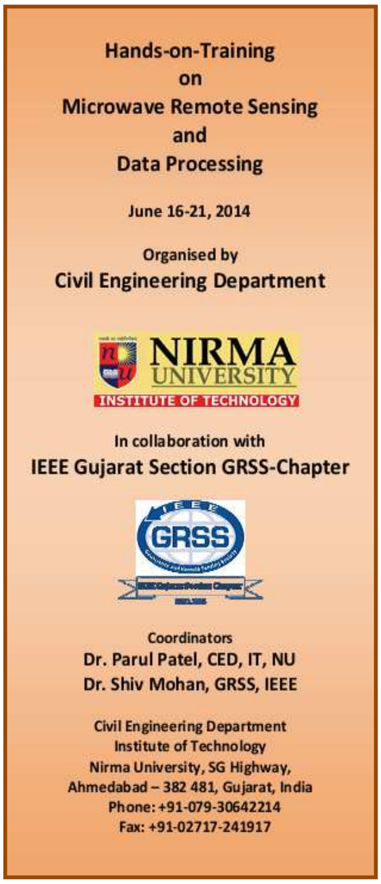
IEEE Geoscience and Remote Sensing Society (GRSS) - Gujarat, IEEE MTT/AP- Gujarat and Space Applications Centre (ISRO) organized an invited distinguished lecture on the topic "Advanced neural Adaptive Processing in Interferometric and polarimetric radar Imaging" by Prof (Dr) Akira Hirose, Department of Electrical Engineering and Information Systems, the University of Tokyo, Japan. With a brief introduction of IEEE GRSS, Dr Akira Hirose introduced the complex subject with simple introduction on basic ideas, overall framework and fundamental treatment in the complex valued neural networks (CVNNs). The presentation discussed the processing dynamics of Hebbian rule, back-propagation learning, and self organizing map in the complex domain. During the latter half he displayed some examples of CVNNs processing in the fields of geosciences and remote sensing, viz., distortion reduction in phase unwrapping to generate digital elevation model (DEM) from the data obtained by Interferometric Synthetic Aperture Radar (InSAR). In Polarimetric SAR (PolSAR), applications of quaternion networks for adaptive classification was presented. Another example is Ground Penetrating Radar (GPR) to visualize underground objects to distinguish specific targets in high-clutter situation. Prospect of the CVNNs in the GRSS fields were interesting to the audience. The Lecture also addressed the problems in critical areas of research and promising methodologies including commercialization of technologies during question-answer session. The Lecture generated a lot of interest among the scientists, faculty and students as evidenced by enthusiastic audience interacting with the speaker during question-answer session. There were about one hundred and fifty attendees representing various educational and research institutes like Space Applications Centre (ISRO), Physical Research Laboratory, Gujarat University, Nirma University, etc. in the lecture. The lecture ended with vote of thanks to the distinguished speaker and to IEEE GRSS for providing financial support and ISRO for providing infrastructure facility.

Prof (Dr) Akira Hirose delievering the lecture

Dr. Aishwarya Narain, Vice Chairman, IEEE-Gujarat Scetion GRSS Chapter felicitating Prof (Dr) Akira Hirose

Audience in the lecture hall patiently listiening to Prof. Hirose

REPORT ON HANDS-ON-TRAINING ON “MICROWAVE REMOTE SENSING AND DATA PROCESSING” (JUNE 16 - 21, 2014, NIRMA UNIVERSITY, AHMEDABAD)



Civil Engineering Department, Nirma University in collaboration with IEEE Geoscience and Remote Sensing Society (GRSS) - Gujarat jointly organized hands-on training on Microwave Remote Sensing and Data Processing at NIRMA University during June 16-21, 2014. The programme was inaugurated by Shri Tapan Misra, Deputy Director, Microwave Remote Sensors Area, Space Applications Centre (ISRO), Ahmedabad. Dr. R.P.

Inaugral Seesion

Dubey Chairman, Indian Society of Geomatics (ISG), Ahmedabad chapter was also invited to grace the function. Various dignitaries including head, civil engineering department Dr.P.V. Patel and senior faculty member Dr.P.R. Patel, civil engineering department, NIRMA University, Dr. Ajai and Dr. N.S. Mehta of SAC (ISRO) attended the inaugural function to motivate the participants. The inaugural function was

Lightening of the Lamp

started with Welcome address by Dr. P.V. Patel. Thereafter, Dr. R.P. Dubey gave his remarks about the programme. Followed by this, Dr. Shiv Mohan discussed about the objectives of the training programme. Shri Tapan Mishra delivered enlightening

Shri Tapan Misra inaugural speech to the participants

inaugural speech to the participants. Vote of thanks was given by Dr. P. R. Patel. There were total 18 participants representing various parts of India in the training program. There was a blend of academia, researches, students and professionals from various fields. Laboratory sessions were also arranged for hands-on practice for microwave data analysis. There were total 16 lectures covering various applications of microwave data and 08 sessions of hands-on practice in the training program. The program was concluded with a very positive feedback from the participants. Dr. Shiv Mohan, Dr. Aishwarya Narayan and Dr. P.R. Patel were present during concluding session. Participants provided their feedback about the course and appealed for more such training programs in future. Certificates were distributed to all participants. Programme was very well appreciated by participants. There was demand from participants to conduct advanced training programme on same topic and more hands on training practice. All lecture notes and freely available software were given to all the participants in Pendrives.

Participants undergoing hands-on training at the laboratory

Lecture sessions during the training programme

ARTICLE CORNER

SPACE TECHNOLOGY IN DISASTER MANAGEMENT

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Summary

A disaster management support program (DMSP) at ISRO has been undertaken at Space Applications Centre, ISRO under the 10th plan (2002-2007). The program addressed the various stages of disaster like pre-disaster planning, during and post disaster. The program is being continued into the subsequent plan periods including the present 12th Plan of the Government of India. Accordingly, an integrated approach of using Remote sensing and Communication systems like disaster warning Radar system and many other portable communications systems with satellite link developed at the Space Applications Centre of ISRO was found to be very suitable. This article provides an overview of the role of space technology in disaster management techniques.

1. Introduction:

The geographical location of our country is such that it is subjected to disasters with varying intensity and timescales in different parts of the seasons. Some of the frequent ones that occur almost every year in some or the other region of the country are floods or drought, the landslides in the hilly regions besides the less recurring like earthquakes. The other type occurring in some specific periods is the cyclone causing flooding in the coastal region on varying scales. On relatively small scales are the avalanche and forest fire frequently reported in the Himalayan region in northern India. It is reported that amongst the 36 states/union territories as much as 22 are disaster prone. Although the community has adapted to such disaster of regular occurrences, it is observed that almost every year the economic and social losses are on an increase year after year. River floods are the most frequent and devastating. Most of the floods (> 60 per cent) are expected taking place in the Ganga-Bhramputra-Meghna basins.

As against floods, the other major disaster frequently occurring is drought in some states. It is estimated that about 16 per cent of country's geographical area is drought prone and affects more than 50 million people on an annual basis. As much as 8 per cent of the total sown area of the country is drought prone covering the arid, semi and sub-humid regions. The long coastline (mainland: ~ 5700 km.) of the country is subjected to cyclone originating in the Bay of Bengal and the Arabian Sea. The Indian Ocean is one of the six major cyclone prone regions of the mid-ocean. Cyclone activity is confined mainly during April-May and October-December. As much as 80 per cent of the total cyclones formed are on the east coast. The most infrequent and impossible to predict amongst the various disasters are the earthquakes. However there is a good understanding as regards the seismically active areas of the country, which is 50-60 per cent of the total area and much of it is confined to the Himalayan, Sub-Himalayan and in Andaman and Nicobar Islands. In recent years, SAC has developed a large number of communication systems which make use of the transponders on the Indian National Satellite (INSAT) and its utility has been demonstrated for establishing audio/ video communication in the disaster affected areas. The meteorological payload-Very High Resolution Radiometer (VHRR) on INSAT has been successfully used in tracking the movement of cyclones and forecasting the likely areas to be affected. This has led to mitigation of disasters by moving the people and livestock to safer places. Similarly, use of high-resolution remote sensing data from the constellation of Indian Remote Sensing Satellite (IRS) has been found useful in damage assessment.

2. Disaster and Management Issues:-

There are different types of disasters encountered in different parts of the country varying in magnitude and occurrence. The following are the types of disasters based on its frequency:

Frequent:	**Less frequent:**	**Infrequent:**	**Others:**
- Drought - Flood/cyclone	- Oil spill and volcanic eruption	- Earthquake	- Industrial, Disaster

✚ Forest fire ✚ Landslides			and Epidemics

It should be noted that this is only an indicative list of disasters and not necessarily an exhaustive list. The following are the three broad categories which typically are to be addressed for designing any disaster management system (DMS):

i) Pre-disaster planning (= warning)
ii) Response (= Assessment of damage caused)
iii) Post-disaster (= Recovery)

The above mentioned categories essentially represent different phases and it is observed that the most important activity spread over all these is the "mitigation" which refers to all actions taken prior to the occurrence of the disaster and that includes preparedness and long-term risk reduction measures so as to ultimately reduce the impact of disasters. Mitigation includes both planning and implementation of measures directed at reducing the possible risk associated with the disasters. In economic terms, it is fairly well demonstrated by different countries that the mitigation offers the best and cost-effective long-term method of dealing with disasters. This is achieved through optimal planning measures, which can be judiciously integrated to start with into the normal development schemes. The present status worldwide is that most of the disaster prone countries are spending huge amount of money on post-disaster relief, rescue and rehabilitation. It looks quite logical that it is better to invest on mitigation measures and finally reduce the impact of disaster losses.

i) Preparedness (= Pre-disaster)

This includes the design, development and installation of early-warning systems, drafting of response procedure, conducting regular exercises and operational emergency steps including training of personnel.

ii) Response (= during or just after disaster)

The response deals with strategies associated with search and rescue operations including evacuations, emergency medical care, food and alternate shelters.

iii) Recovery (= post-disaster)

This activity is directed at taking all actions after the disaster once the urgent needs are accomplished. In simple terms this refers to all post-disaster activity directed at restoration of infrastructure like repair of roads, bridges, embankments, other community services like power, water supply and shelter.

3. Disaster Management using Communication and Remote Sensing

In the area of disaster management, there are two major components viz., communication and remote sensing which can be very well addressed by using satellite system from different orbital platforms. The INSAT in geostationary orbit can provide a variety of solutions right from setting up communication links using the portable systems, which makes use of the transponder on-board the satellite to tracking the cyclones. Like-wise the remote sensing payload provides detailed spatial data (Imagery) for mapping the areas affected due to disaster leading to appropriate planning for relief rescue and rehabilitation. For example the meteorological payload-VHRR on INSAT system has amply demonstrated its use in tracking and movement of cyclones whereas the high resolution spatial data on IRS series satellites has been extensively used in assessing the extent of damage and can be used for creating a database on areas vulnerable to different types of disaster.

The activities on the disaster management support within ISRO started in a most concerted manner in the 10th plan period with an active collaboration with the Ministry of Home affairs (MHA).

3.1. Communication

A variety of communications hardware[2] has been developed in-house which make use of the onboard system on INSAT. Such systems can be easily transported to the affected areas for audio/video transmission including transmission of imageries. In addition, these systems can also be used for imparting developmental education to the agencies involved in handling disaster related activities. These portable systems allow the following:

- Establishing audio/ video communication
- Transmitting pictures of the affected area(s) for use in planning the relief and rescue measures.

- Imparting education and training to the personnel supervising the relief operations

The following are the satellite base communication systems which have been developed at SAC and their capabilities have been fairly well demonstrated in the field.

3.1.1 MSS Type – C Reporting Terminal

The MSS (Mobile Satellite Service) Type– C Terminal has capacity to transmit short messages (up to 40 characters). The INSAT reporting terminals are of the three types.

a) Portable terminal
b) Portable GPS integrated terminal
c) Fixed type data reporting terminal

Amongst the three types, the first one was developed as the prototype for demonstration but in due course of time GPS integrated and the fixed/ mobile type is being pursued and is being demonstrated for various user driven applications.

3.1.2 Digital Sound and Data Broadcast (DSDB)

The DSDB developed at SAC is a broadcast system for transmission of multiple digital channels from a central station with a provision for sending video and audio. It also has a provision for sending the images to distant places or user defined locations. Cyclone warning can be provided in the form of audio alarm also followed by a detailed digital message in the form of image for taking remedial measures in the affected areas.

3.1.3 WLL - VSAT Hybrid Network

A hybrid network of WLL (wireless local loop) and VSAT (Very Small Aperture Terminal) can provide all types of communication solutions like audio, data and fax in a radius of 8-10 km of the affected area. A portable vehicle mounted base station of WLL can help communication between the handsets and to the base station. The VSAT can forward / receive messages to user's terminal through the satellite linked to a hub station.

3.1.4 Digital Cyclone Warning and Dissemination System (DCWDS)

The DCWDS has been developed for IMD for its use in issuing warning of an impending disaster likely to hit the coastal areas. Satellite aided search and rescue services have been demonstrated particularly through participation in international programmes (COSPAS–SARSAT) also involving a large number of users like shipping industry, airport authority of India, mountaineering expedition etc. Some of the recent examples of RS data are disaster response for the super cyclone of Orissa in 1999, devastating earthquake of Gujarat in 2001 besides regular monitoring and assessment of inundation due to Brahmputra river flood to the concerned authorities.

In addition to the large number of communication systems developed at SAC, there are many, which are commercially available today. One such example is the use of satellite phones type M and mini M from INMARSAT.

3.1.5 Training and Developmental Communication Channel (TDCC)

The Development and Education Communication Unit (DECU) of ISRO has in recent past made use of the TDCC[3] on board INSAT for the purpose of distance education and training. One such area is support to disaster management. An appropriate continuation of TDCC had served the purpose of imparting the much-needed education and training to various relief agencies and NGOs involve in Disaster Management. In the recent past, a pilot project named Jhabua Development and Communication Project (JDCP) was implemented by DECU in the Jhabua district of Madhya Pradesh.

The JDCP addressed the following area of distance education and disaster management in due course of time can form one of the components

- Watershed development
- Health
- Education
- Skill Development
- Panchayati Raj

In recent years with the increased capacity of TDCC Channels such concept of distance education has been extended to other states viz., Mysore in Karnataka, Bhopal (Mahdya Pradesh), Gandhinagar (Gujarat), Bhubaneswar (Odisha). The State Remote Sensing Centre have been identified as the nodal center i.e., the ORSAC at Bhubaneswar and RESECO (BISAG) at Gandhinagar, Gujarat.

3.2. Remote Sensing

Data from IRS series of satellite has been used in a variety of applications related to disaster management. The National Remote Sensing Centre (NRSC) has been regularly using the high-resolution data form IRS sensors in mapping and monitoring of floods in different parts of the country. In the case of super cyclone of Orissa, the INSAT was used to monitor the track of cyclone. Due to cloud cover conditions, data from RADARSAT was used for damage assessment. In the case of super cyclone of Odisha studies, IRS data could still be used to monitor the area inundated and assess the damage to Kharif Crop almost in real time. Multidate data of WiFS on IRS was used to study the changes caused similarly in the devastating earthquake of 2001 in Bhuj and its environment. Pre- and post-earthquake images clearly brought out that there was an activation of a number of channels in the great Rann of Kachchh around Kharda, Khadir, and Bela, which subsequently dried up and almost returned to the pre- earthquake situation. The extent of damage to the urban settlement in Bhachau was similarly estimated using high-resolution aerial data. Techniques have been developed at SAC to study frequently occurring landslides in the Himalayan region. Remote Sensing data was found useful in:

- Inventory
- Assessment
- Warning
- Risk zoning

3.2.1 Case Studies

The following are the three case studies, which have been discussed in respect of technique development/operational demonstration in the areas of:

i) Cyclone caused damage assessment
ii) Landslides in the Tehri Reservoir Rim Area
iii) Flood damage Assessment using Radarsat.

(i) Cyclone caused Damage Assessment of Krishna Delta

The study dates back as one of the earliest effort made of using the remote sensing data for damage assessment[4]. A 2-Step procedure was used viz. LANDSAT Image (Pre and Post event (**Fig. 1**) and large scale aerial photographs to assess the damage caused due to the devastating cyclone which hit the AP Coastal area on 19th November 1977. The storm sea-surge developed to about six meter affected an area of 80 km in length and 16 km in width of the Krishna delta region. It was observed that the extent of flooding lie almost within the high flood limit.and most of the hardest hit areas are adjacent to the coast with a small proportion of mangrove. A cost benefit analysis was also carried out to highlight the efficacy of remote sensing technique.

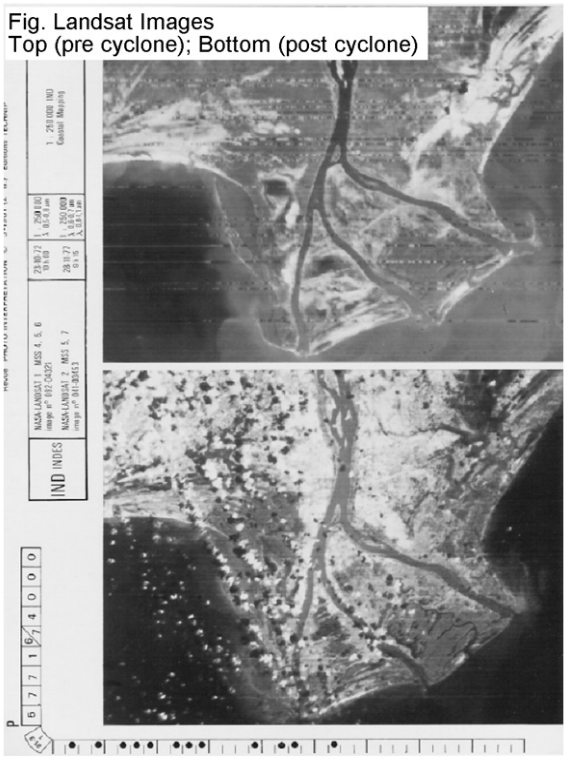

Figure 1 Landsat Images: Top (pre cyclone); Bottom (post cyclone)

(ii) Landslides Identification/zoning in the Tehri Reservoir Rim

Techniques were developed using IRS LISS II and SPOT MLA and 71 slides were mapped in Bhilangana and Bhagirathi reservoir rim area (36 during field visit and another 25 on image alone)[5]. Only four were found to be misinterpreted. Geo-environmental theme unit maps were prepared using IRS data like geomorphology, lineament, land use, slope and lithology (from published data). These were integrated in ARC/INFO GIS with appropriate weightage assignment and finally a hazard zonation map was generated.

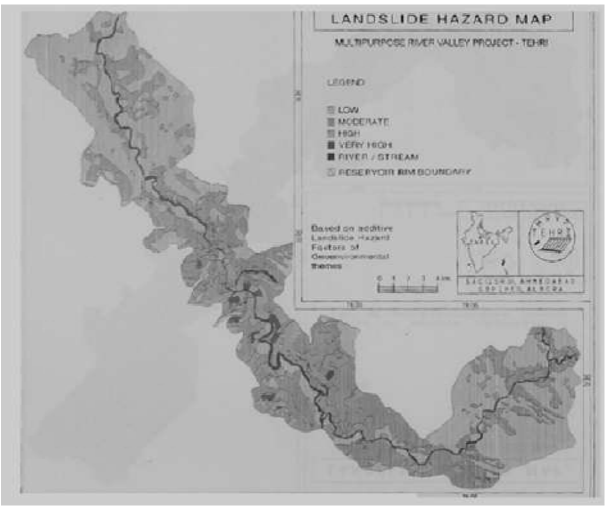

Figure 2 Landslide Hazard Zone Map

(iii) Use of RADARSAT Data in EAST UP Floods of 1998

RADARSAT data was used in absence of cloud free images from IRS to assess the extent of flood damage in the Eastern UP during 1998[6]. The floods were caused by the Rapti and Ghaghra rivers resulting from heavy rainfall breaking records of the past several years. More than 20 embankments were reported to be breached along the Rapti and a few along the Ghaghra river. The information generated was found useful for planning relief measure in view of the fact that even as late as second week of September many areas were reported inaccessible. The total analysis was completed with a fortnight from the reported occurrence of the flood. It was concluded that a database created in GIS could be useful for planning remedial measures in the future.

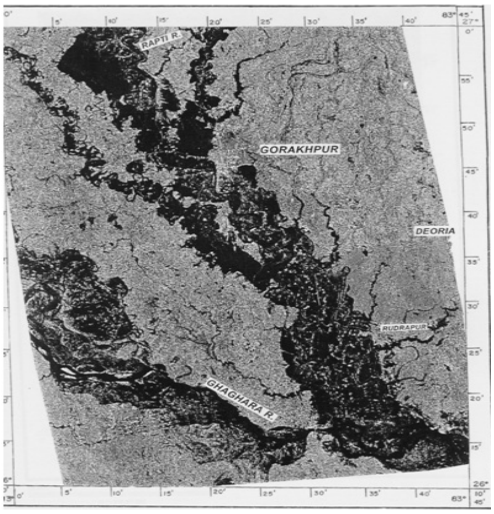

Figure 3 Radarsat image (September 1, 1998) covering parts of East UP districts showing inundated areas

3.2.2 Disaster Management

An elaborate program of disaster management with linkages with concerned Government departments in particular Ministry of Home Affairs (MHA) was initiated in the 10th Five year plan (2002-2007) and is being continued into the 11th plan and is currently being pursued in the current 12th Plan (2012-2017). An elaborate program with inter-center involvement of ISRO led to the following:

- An airborne C-band DMSAR (Disaster Management Synthetic Aperture Radar) was developed and extensively flown to collect flood signature data and also at times for use in correction and calibration of space-borne SAR system.
- Launch of RISAT (Radar Imaging Satellite) in 2012 provided the indigenous capability to have its own radar satellite system in orbit.
- Generation of close contour data of areas vulnerable to floods/ cyclones and landslides using the Airborne Laser Terrain Mapping (ALTM)
- Modelling techniques in flood forecasting besides techniques for damage assessment.
- Demonstrating the applicability of a GIS based decision support system for a disaster
- Landslide zonation at 1: 10000 or larger and a GIS based impact assessment scheme
- End-to-end pilot study for demonstrating the forest fire monitoring and damage assessment. Defining sensors for surveillance from geostationary orbit
- Cyclone tracking and movement including space inputs to weather model
- SAR interferometry and GPS for precise movement in seismically active areas
- Setting up of Decision Support Centre (DSC) at National Remote Sensing Centre (NRSC) under the DMS Program as a single window service provider for disaster service. It operates on 16X7 basis during normal time and 24X7 in the event of disaster.

3.2.3. Geoportal – Bhuvan

Under the National Natural Resources Management System of the Planning Commission, DOS is the nodal agency for its implementation. The main aim is the optimal utilization of natural resources by integrating conventional data with that derived from remote sensing satellites besides providing these information to users through web based services. This has led to the launch of Bhuvan, which is a geo-portal and is maintained by the NRSC. All this information is organized and available through Bhuvan to users for geospatial services.

4. Conclusions

An integrated approach using satellite communication including developmental education through TDCC channels and remote sensing has provided a viable input at various stages of a disaster. This ultimately has led to defining the various components of a disaster management system. A large number of activities to start with were proposed in ISRO's tenth plan to support the disaster management and significant progress was made in the subsequent plan periods. This activity continues in the ongoing 12th Plan. Today many of the disasters like flood, fire, landslides, and drought are being routinely monitored in active collaboration with the concerned Dept. of GOI and State Governments. The information thus extracted is shared over Bhuvan, the geoportal managed and hosted by National Remote Sensing Centre, Hyderabad. Launch of Radar Imaging Satellite (RISAT) has significantly enhanced the capability in monitoring and assessment of some disaster in near real time during cloud covered conditions.

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Interview with Prof Boerner (Continued from the Previous Issue...)

It was in December last year that we met Prof Boerner in Ahmedabad. Those were early days for the nascent chapter and Prof Boerner's presence acted like a catalyst for its steady progress. We could snatch very few moments with him during the Microwave Experts' Meet, which he compensated later with his emails loaded with valuable texts on Microwave Remote Sensing.

(His answers to the first three questions were reproduced in our earlier issue. The questions were Q: 1 Microwave Sensors are seen to be increasingly used in Remote Sensing in research mode. Please throw some light on new microwave sensors in this and the coming decade. Q: 2What are the research challenges which are expected to be addressed by the scientific-academic community? Please enlighten us with a few examples, in short. Q: 3 Many research sensors and concepts are likely to be promoted to the category of Operational civilian use. Which according to you are such potential sensors and concepts of this decade?)

We move on to our subsequent questions in this issue.

Q.4 Both Microwave spectrum and Remote Sensing Technology are becoming increasingly popular across the globe. Countries with strong infrastructure and human resources as well as those which are in different stages of development are actively practising Remote Sensing using microwaves. Which collaborative programmes and international forums would you like to strongly recommend to IEEE-GRSS Gujarat-Chapter through this column?

Prof WMB: International collaboration on advancing day/night global monitoring of the terrestrial covers was demonstrated with the launch of the three fully polarimetric multi-modal SAR Satellites at L-,C-, X-Band, and its tandem satellite-pair updates are forthcoming very swiftly. All of this will be topped by the near-future DESDynl/Tandem-L wide-swath, high-resolution fully polarimetric sensor implementation, which in due time will be enlarged to accommodate next to the L-, C/S-, X- also P-Band sensors using one and the same reflector.

Optimal Utilization and Protection of the EM Spectrum in Remote Sensing

The demands on additional frequency bands for radar and SAR remote sensing is steadily increasing, resulting in various collisions of the remote sensing with other user communities of the EM spectrum. Because safeguarding against such collisions is absolutely pertinent to the development of POL-IN/TOMO-SAR technology, these aspects need to be addressed.

Need for EWB (Hyper-Band) POL-IN-SAR Imaging in Environmental Monitoring: Depending on the dispersive material and structural properties of the scattering surface, the vegetative over-burden and/or geological under-burden, a careful choice of the appropriate frequency bands - *matched to each specific environmental scenario* - must be made. This is strictly required in order to recover - *next to material bio-mass parameters* - canopy versus sub-canopy versus understory, ground-surface versus sub-surface DEM + STRUCTURE information. With increasing complexity of the environmental multi-layered scattering scenario, the implementation of increasing numbers of scenario-matched frequency bands - *in the limit* - contiguous *EWB (HYPER-BAND and ULTRA-WIDE-BAND) POL-IN-SAR* across 10 (100) MHz to 100 (10) GHz becomes all the more necessary and essential. For example, in order to assess - as accurately as ever possible - the bio-mass of specific types of forested regions - such as *boreal tundra shrubbery, vs boreal taiga, vs temperate-zone rain-forests, vs sparsely vegetated savannahs, vs dense sub-tropical to equatorial jungle-forests* - requires in each case a different choice of multiple-to-wide-band POL-IN-SAR imaging platforms, not necessarily operated at one and the same band and at one fixed altitude, for optimal performance within the HF/VHF{(10)100 MHz} to EHF (100 GHz) regime. Similarly, for more accurate and verifiable estimation of soil moisture and roughness such multi-band and multi-altitudinal POL-IN/TOMO-SAR implementations become essential. Here, we emphasize the need for the rapid advancement of these integrated POL-IN-SAR Imaging techniques in order for advancing the still overall poorly performing bio-mass estimation algorithms, which still lack such vital capabilities.

Indeed, the ideal operational altitudes also differ from one scenario to the other. For most semi-dense to dense forests of the temperate zones, the EWB VHF/UHF/SHF (600 - 5000 MHz) regime may be optimal whereas, for a dense virgin equatorial rain forest with huge trees of highly conductive hard-wood, the UWB (10 - 1000 MHz) regime is required, etc. Thus, the current choice of frequency bands for bio-mass determination is indeed very limited and insufficient in that the L/S/C/X-Bands all lie well above the upper

saturation curve; and, the nominal P-Band (420 MHz) well below the lower saturation curve of the bio-mass hysteresis - for most types of forested regions within the temperate climatic zones.
Similarly, in order to recover the three-dimensional sub-surface image information of dry to wet soils including its soil moisture properties, the optimal EWB HF/VHF-regime lies below the nominal P-Band (420 MHz) to well below 10 MHz. Thus, adaptive EWB-POL-IN/TOMO-SAR modes of operation become a stringent requirement for 3-dimensional environmental background validation, stress assessment, and stress-change monitoring. In addition, next to the UHF/SHF (300 MHz - 30 GHz) regime, the EHF (30 - 300 GHz) spectral regime becomes important for the detection of man-made structures - such as telephone and electric power-lines - embedded in forests, shrubbery, thickets, grasslands; and in addition - for vegetative canopy plus rugged terrain as well as for atmospheric scatter analyses.
Therefore, every possible effort must be made to expand and to extend but not to give up the existing, highly insufficient availability of free scientific '*remote sensing spectral windows*', which must absolutely be spread *with 'deca-logarithmic periodicity'* throughout the pertinent frequency bands of about 1 (10) MHz to 300 (100) GHz, and beyond. In addition, for a reliable and more accurate estimation of biomass parameters, it is definitely necessary to add and include polarimetric hyper-spectral EO wideband FIR-VIS-FUV imagery].
Joint Radio Frequency & Optical Repeat-Pass SAR Operations: Furthermore, whereas most '*Hyper-spectral Optical Radiometers*' and "*Microwave Multi-band Radio-altimeters*" operate in a down-look Nadir mode, and the '*UWB-POL-IN/TOMO-SAR Imaging Sensors*' in left/right-side-looking operation, inducing shadowing and '*front-parching (fore-shortening or overlay)*', the simultaneous implementation and operation of three laterally displaced imaging platforms - flying side-by-side, and being fully equipped with Microwave Multi-band (polarimetric) *Radio-altimeters* and Hyper-spectral Optical plus UWB-POL-IN/TOMO-SAR systems - is strictly required, for example, for the environmental stress-change monitoring within the *Baikal Lake Basin, Siberia* or of the multitude of pertinent Pacific Rim (PACRIM) regions, monitored by the SIR-C/X-SAR Mission-2 as well as the PACRIM-AIRSAR-1/2 measurement campaigns, such simultaneous triple platform imaging modes of operation are warranted. By implementing *Differential GPS*, the three platforms could be flown side-by-side with perfectly overlapping foot prints, and by executing contiguously spaced, parallel repeat-pass flight operations, so that the complete wide-band microwave *radio-altimeters* plus hyper-spectral optical down-look image information can properly be overlaid on top of the strip images produced by 2 left/right side-looking UWB-POL-IN/TOMO-SAR platforms.
In addition, it is most desirable and necessary for testing newly to be developed '*EWB-POL-D (RP) -IN-SAR Image Processing Algorithms*' to execute with highest possible precision, '*Square-Loop - parallel (0˚), orthogonal (90˚), anti-parallel (180˚), and cross-orthogonal (270˚) Flight-Line Repeat-Pass Operations*' over carefully selected, most diverse geo-environmental calibration test and ground-truth validation sites. The execution of such demanding flight operations has - *in principle* - been realized, is no longer a distant dream, and can be implemented now and immediately thanks to the accelerated advancement of Differential High Precision GPS electronic real-time navigation. In addition, due to the rapidly developing "*Terra Digitalis*" - - which is to preserve detailed environmental mapping information even of the most distant, hidden, corners of our terrestrial and also planetary covers for posterity - - we should be able to collect a long-lasting complete geo-environmental data base which can be updated continuously.
The frequency-dependence of the averaged spectral characteristics over a wide frequency band of natural electromagnetic emissions within the Earth's covers and its surface are not well known – especially not toward the lower end of the spectrum. Its determination becomes ever more hopeless with an increasing civilization unless isolated **"electromagnetic quiet zones (sites)"** are being identified and are being sanctioned as such to becoming permanent ***'World Natural Heritage Electromagnetic Ground-truthing Quiet Sites'*** by the United Nations. Aeronomists have sought for and identified a few isolated "*electromagnetically quiet sites*" such as the" *Arrival-Heights of Hut-Point-Peninsula on Ross Island, Antarctica*", and other similar sites for establishing the 'Average Amplitude/Power-Spectra', especially for the ULF/ELF/VLF spectral bands. Similarly, one of radio astronomy's prime goals is to determine the '*virgin radio signatures*' before modern civilization was perturbing it. For technological applications it is essential to know as precisely as ever possible the average characteristics together with reproducible lower and upper (peak-power) bounds within which man-made systems must operate; and within which we need to discover the passive and active environmental remote sensing signatures.
Allocation of Additional SAR Imaging Frequency Bands: In order to secure the required frequency windows within ELF (**HF/VHF**) to (**UHF-SHF**) EHF regime for environmental remote sensing, we must place our requests, at once, to the '*World Radio Frequency Conference (WHO-WRC'03, Sept./Oct., Geneva, Switzerland*)' via

the pertinent *National Research Councils (NRC), Committees on Radio Frequencies (CoRF).* The pertinent frequency bands between HF to EHF are already over-crowded; but with the rapidly accelerating conversion to digital communications and worldwide digital video transfer, etc.; we had better wake up! The "R*emote Sensing Community*" must relentlessly request that the rights to operate in periodically spaced "*deca-logarithmic (octave) windows*", extending from below HF to beyond EHF bands, be granted because very little revenue can be collected from remote sensing allocated frequency bands (which are however of utmost priority for securing successful environmental stress change monitoring), the proposal of "*levying a user's tax for commercial and profit utilization*" of EM spectrum needs to be supported strongly. User's tax so collected need to be applied directly to supporting basic remote sensing needs across the entire EM spectrum; and for sustaining natural EM quiet sites for monitoring unperturbed natural planetary and galactic background noise against which the user needs to provide natural radio frequency interference reduction methods.

This trend of reducing the available EM frequency bands for surveillance and remote sensing indeed represents a very serious, major problem for all of military surveillance and environmental stress-change monitoring. It is one of the most pressing issues that could reach catastrophic proportions within the near future unless we act immediately. The commercial '*Mobile Radio Communications, Telephone and Video Transmission'* industry has already initiated a fierce battle for acquiring various frequency bands hitherto allocated exclusively for military radar, and for radar sensing and imaging. The "*natural resource of the electromagnetic spectrum*" is 'densely over-packing' the *"commercially appropriated frequency windows*" plus '*encroaching into neighbouring scientific bands'*.

We must follow the successful example of the '*International Radio Astronomic Research Community*' , who had to address a similar problem a few decades ago - - in the early Fifties - - in order to ensure that far-distant Radio-Stars could be detected without interference by radio communications clutter - - for then a still relatively "*sparsely occupied*" VHF, UHF, SHF frequency region. Now, with the imminent threat of the ever accelerating *"Digital Communications Frequency Band Cluttering , Mobile Communications Pollution, and 'www' Propagation Space Contamination",* we - - '*the International Remote Sensing Research Community'* - - are called to duty; and, we must take the helm - once held by the *'Radio Astronomic Research Community'* - in forcing a visionary solution on behalf of future generations to ensure that environmental background validation, stress assessment and stress-change monitoring of the terrestrial and planetary covers - - under the relentless onslaught of an un-abating population explosion and with it the quest for higher standards of living and quality of life - - can be carried out also in the future.

User Collision of the "Natural Electromagnetic Spectrum (NES)": The user community of the EM frequency bands within the ULF-band to the FUV-band is rapidly increasing; and the *natural EM spectrum (NES)* – **one of the most fundamental Resources** - is being overtaxed in providing the required frequency band allocations. This has lead to direct confrontations between the active and the passive user groups. The active user group includes the entire terrestrial-space & mobile tele/video-communications industry, tele-navigation including the US GPS (Global Positioning System), the RF GLONASS (GLObal NAvigation Satellite System), and the EU GNSS (Global Navigation Satellite System), the defense, in future the homeland security and other active remote sensing communities, whose interests among themselves are colliding with increasing frequency because the available spectral bands are not sufficient for satisfying all needs. The passive user group consisting of aeronomy, radio-astronomy and of passive near-field sounding & far-field remote sensing are also colliding because radio-astronomy and in great parts aeronomy are directed outward toward the planetary and galactic space, whereas airborne and shuttle/satellite multi-modal passive and active remote sensing is looking down close-to-nadir on the terrestrial covers, which tends to add to the interference by the active user groups. Furthermore, the rapid increase of expanding narrow-band to ultra-wide-band mobile communication is creating havoc and an unavoidable impasse. Therefore, the entire issue of frequency allocation and radio spectral-band sharing coupled with modern advanced digital techniques, such as digital antenna beam forming, digital coding and correlation plus digital radio frequency interference reduction must be re-addressed.

Although hitherto remote sensing utilization of the EM spectrum was absolutely not an economically viable and may remain a less profitable venture for a long time to come, we request that an entirely new approach to revenue sharing be adopted. This could mean to levy a surcharge for the use of "*NES*" from the commercial users for maintaining and operating the passive and active remote sensing and monitoring bands, which must be considered a justified measure in order to be able to monitor on a permanent un-interrupted time-scale the health of planet Earth; and even the *"Modern Telecommunications Complex"* cannot deny that it relies on the availability of a clean and clear "*NES*".

We, the passive & active remote sensing community, we must consider ourselves to be therefore given the astute "*Professional Status*" with the innate responsibility of functioning as the *"Pathologists and Radiologists of the Terrestrial and also Planetary Environments",* and be entrusted to keep a watchful eye on the misuse of the "**Natural EM Spectrum (*NES*)"**, which is indeed to be sanctified as one of the most "**sacred treasures and resources of Planet Earth**", our planetary system and the universe. However, propagation space pollution of ***"NES"*** is not irreversible; and still today measures can be taken to reverse the trend by implementing more efficient spectrum utilization based on advances in digital communications and novel RF interference reduction techniques.

Every effort must be made to guarantee that mankind is protecting the **"Natural *unperturbed-by-man* EM Spectrum"** as a ***"Natural Treasure***", which must be safeguarded against the greedy misuse of the "***International Communication Complex***" In order to fulfil this request, a finite set of isolated "***World Heritage Natural Electromagnetic Quiet Sites***" needs to be identified, so designated, licensed by UNESCO and protected by the UNITED NATIONS. ***Passive & Active Remote Sensing must be given MUCH HIGHER PRIORITY***; anything not requiring the open propagation space must be removed, and should be subjected to the existing well developed but highly underused EO fibre communication links. The Telecommunications Complex must be forced to work hard in reducing their reliance on the increase of designated spectral bands for their commercial use, in fact must be enticed/forced to reduce their electromagnetic spectral real-estate by many factors with the focused implementation of efficient digital techniques of spectral bandwidth reduction.

The passive & active Remote Sensing community must adopt ***the high professional stature of being the pathologists and radiologists of the terrestrial and also the planetary environment, and nothing less***. Much improved RFI reduction and mitigation methods must rapidly be advanced because of the increasing needs of an expanding civilization. This implies introduction of standardized signal coding techniques and time-sharing for the use of identical spectral bands. In every respect, the general public ought to be educated about the serious state of pollution of the natural EM spectrum, and especially our educational systems K12 to Post-Doctoral levels – *all inclusive* – about reducing the undesirable propagation litter! The "*International Remote Sensing Community*" ought to request that the commercial users be levied with a - *say 10% to 15% or even higher surcharge* – solely to be applied to safeguarding the purity – *as far as is physically required* - of the "*Natural EM Spectrum*" by providing funds for developing the pertinent "*Remote Sensing & Monitoring Ground-based, Air/Space-borne Sensor Systems*", including the establishment of "*World Natural EM Quiet Sites*". In other words there has to be a fair distribution of the revenues gained from using *"NES",* similar to levying toll-charges and gasoline tax for designing, building and maintaining clean motorways, etc.; there should be charges introduced for utilizing the "*National and International Information Highways*". In fact, any misuse of the sacred ***"NES"*** ought to be punished by stiff fines; and the intentional and/or careless generation of propagation litter along the *"International Information Highway"* ought to be dealt with similar to fining the ruthless production of refuse litter along our National, State and Local Highways in the US, and elsewhere.

Radio Frequency Interference Reduction and RFI Security Threat Mitigation: Next to the *"User Collision of NES",* another equally serious radio interference and jamming problem is threatening not only military plus homeland security surveillance and environmental monitoring from ground, in air and space, but also environmental stress change monitoring from air and space. The RF sensors affected include polarimetric, interferometric and polarimetric-interferometric antenna arrays, multi-arm spiral and Butler matrix antennas, wideband polarimetric receivers as well as adaptive processing, and so on. Current mitigation techniques for determining the temporal and spatial plus differential temporal and spatial geo-location of one or more - including sparsely and densely distributed clusters of emitting sources – at ground, in air and space – is known as *"Vector Position Finding*". A large body of methods were developed in Electronic Signal Warfare – such as the *"Angle-of-Arrival (AOA)"* or the *"Line of Bearing/Position (LOB/LOP)"* of the incoming interfering signal relative to *"true astronomical north*", and *"magnetic north*" (in case of Faraday rotation correction requirements at radio frequencies at the order of 3MHz and below). In general, this requires several optimally spaced and separated vector receiver locations for computing the exact time and space varying emitter locations via *"Time of Arrival (TOA)", "Differential Time of Arrival (TDOA)", and "Frequency of Arrival (FOA)"* or *"Differential Doppler (DF)"* methods as reviewed most recently in Poisel. Of specific interest is the "***Mu****ltiple* ***Si****gnal* ***C****lassification (MUSIC)"* technique introduced by R O Schmid, which is based on an eigenvector/eigenvalue decomposition technique applied to the complex geo-location system transfer matrix, which can also be formulated and computed for the polarimetric, the interferometric and the polarimetric-interferometric radar and SAR cases. This MUSIC algorithm was applied successfully in telecommunications satellite technology for TOA, TDOA, FDOA and several other algorithms derived from DF methods including the formulation of error bounds and cross-ambiguity functions, etc. as reviewed most comprehensively in Poisel.

Of specific interest are airborne and space borne RF emitter detection, recognition, identification and differential temporal and spatial geo-location algorithms for stationary and moving RFI and jammer sources. In these cases, the baselines of the distributed receivers are extremely small and they require adaptive optimization algorithms – over a rather wide frequency band, which in turn requires the development of compact minimum-weight packaging technology. Of interest are hybrid EO-RF conversion, as well as, EO laser sensor array techniques, which make possible such compact denser packaging. Similar observations also hold for EO-Laser imaging and telecommunication techniques, for which the recently developed *"Optical real time Phase Registration Devices"* will enable to cover the wideband RF and EO wavelength regime while maintaining the desired sensitivity and false alarm rejection requirements for implementing the optimal geolocation algorithms.

Therefore, the entire issues of frequency allocation and radio spectral-band sharing, coupled with modern advanced digital techniques, such as digital antenna beam forming, digital coding and correlation - plus digital radio frequency interference reduction as well as RFI threat mitigation must be re-addressed totally and immediately – especially as regards the unavoidable implementation of POL-IN/TOMO-SAR surveillance and remote sensing technology.

To be continued............in next issue

Chapter and Members Achievements

Dr. Anup Das (Member, 2013) – Treasurer, IEEE-GRSS-Gujarat Section

He is a Scientist/Engineer in Space Applications Centre (ISRO), Ahmedabad. He was promoted from Scientist/Engineer 'SE' to 'SF' grade in july'14 in his organization.

Dr. Dipanwita Haldar (Member, 2013)

She is scientist/Engineer in Space Applications centre. She was promoted from Scientist/Engineer 'SD' to 'SE' grade in January'14 in her organization.

Dr. Maneesha Gupta (Member, 2013)-Associate Editor IEEE-GRSS-Gujarat Section

She is scientist/Engineer in Space Applications centre. She has earned her Doctor of Philosophy (Synthesis and characterixation of doped nano manganites for biomedical applications) in the month of february '14 from Aligarh Muslim University, Aligarh and also got promoted from Scientist/Engineer 'SC' to 'SD' grade in July'14 in her organization.

Mr. Sriram saran (Member, 2014)

He has Joined Space Applications Centre as "Research Associate" from A and elevated to Member" grade from "Student member" from July'14.

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