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Editor's Desk

Dear Members,

It is a great pleasure to bring the new-look ISG Newsletter to you. The newsletter hence forth will follow this pattern of fixed columns by eminent contributors. The interview shall remain a constant feature. This will make news more prominent and articles little less so. This of course will change when we bring out the ISG NL for special occasions. Nonetheless we intend to stick to this format. You may suggest any fixed columns along with possible contributors for expanding our range of news and events.

The interview column in this issue features wide variety of questions with Dr Shailesh Nayak, Secretaty MOES and outgoing President ISG. You can enjoy reading his thoughts and views on the subject of Geomatics and earth sciences.

The articles in this issue, as intended, do not conform to a specific theme, but are highly relevant to the contemporary issues challenging the field of Geomatics. So you can read articles on India's data and map policy by S. A. Sharma, and an overview of 3D measurements from satellite imagery by Ritesh Agarwal. A brief report on the ISG-ISRS National Symposium has also been presented. This issue also features a section on Geoinformatics education and career prospects, which we hope will interest the Student Members of ISG.

We apologize for delay in bringing out this issue - mostly because columns and columnists had to be finalized and goaded into action. Hopefully next one onwards it will be streamlined.

Happy reading! Keep in touch.

R. P. Dubey, Editor
rpdubey@hotmail.com

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Address for correspondence:

Secretary,
39, Basant Bahar-II, Bopal,
Ahmedabad – 380058

Email:
nsmehta55@gmail.com
secretary@isgindia.org

Editorial Board - ISG Newsletter

Editor:

Shri R. P. Dubey
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Interview with Dr. Shailesh Nayak

Dr. Shailesh Nayak, the Secretary - Ministry of Earth Sciences, and former President - ISG, has pioneered several applications related to coastal and marine sciences in India. In his candid interview with Shri R. P. Dubey, Dr. Nayak, presents a road map for Geomatics to take center-stage in decision making.

RD: You have been the President of ISG for last three years and have had association with this profession from the very beginning of your career. What according to you is the current scenario and future prospects of Geomatics in India?

SN: During last 30 years or so, GIS as a technology as well as an application tool has grown tremendously. We had many either data-centric or technology-centric programs or projects. Now, it has emerged as a tool for building a decision support system. The tsunami warning system is a very good example. Today, with the matured remote sensing, global navigation and geographic information systems and advances in computing and communication technologies, it is possible to build such decision support system and provide location and web-based services. The proposed program on National GIS envisions to develop such decision support systems in variety of fields such as health, education, agriculture, rural and urban development, etc. and is likely to be implemented soon. Many entrepreneurs have come up with very novel ideas and developed innovative applications. In my view, the prospects of Geomatics in India are extremely bright and in near future many citizen-centric systems will be built around GIS.

RD: Do you feel that there is need to re-orient the ISG in terms of enhancing its relevance both in Indian and abroad. Do you feel the need for better networking with other societies?

SN: I think so. ISG currently addresses issues mostly related to natural resources and environment using image data bases. ISG needs to focus issues related to content of data and their update, spatio-temporal data models, indexing image data bases, data mining techniques, object-based image analysis, automatic image interpretation especially of high resolution of data, analysis and archiving geo-sensor data, integration of heterogeneous data, data standards including meta-data, advancement in visualization, 3D and 4D modeling, decision support systems and capacity building.

There is an excellent cooperation with the Indian Society of Remote Sensing. We need to network with other societies, especially, INCA, CSI, etc.

RD: How would you sum up the achievements of ISG during your tenure? Are you satisfied with the progress. What would be your suggestions for future?

SN: I think ISG did quite well in dissemination of Geomatics knowledge at grass root level in the different parts of the country, encouraging participation of younger colleagues including students at post-graduate level in seminars and workshops, recognizing meritorious work in the field of Geomatics, bringing awareness of innovative applications of Geomatics in school children and society. However, we need to consider to participate at international level, interaction with industries and government and focusing on scientific and technical issues.

RD: You have been heading the Ministry of Earth Sciences as Secretary for

Dr. Shailesh Nayak

"GIS now has emerged as a tool for building a decision support system"

"ISG needs to consider participating at international level, interact with industries and government, and focus on scientific and technical issues."

more than six years. Could you please tell how the earth sciences activities have developed in these years and how you have brought the fruits of research, observations and modeling nearer to society?

SN: Our vision was to develop insight into the scientific understanding of the Earth System to improve prediction of weather, climate and natural hazards, explore polar and ocean sea bed and develop technology for sustainable use of resources. Thus the national agenda was to promote discovery of phenomena and/or new perspective on earth system and their components, better understanding of earth processes and their interaction with human and social systems, apply this knowledge for sustainability of the Earth and develop services for the societal benefits. The support these agenda, we had augmented our capacity to observe atmosphere, ocean, polar regions and solid earth. We initiated many projects to improve our weather, climate and ocean modeling, data assimilation capability, both for operational forecast and research in earth processes, building high performance computing capability, set up high-speed network to facilitate data accessibility and exchange of model outputs, etc. The project on Monsoon Mission and Severe Weather are two classic examples. We have strengthened our international collaborations, both bilateral and multilateral. We are funding many universities in US, UK, Japan and Australia to carry out specific research related to monsoon. Third, we have initiated projects to answer scientific questions related to cloud physics, air-sea interaction, ocean circulation, bio geochemistry of oceans, air-sea-ice interaction, teleconnection between polar regions and monsoons, earthquake processes by drilling deep borehole in Koyna, evolution of Himalaya and origin of monsoons, investigations for Geoid anomaly, etc. Large scale investigations of sea bed for exploration of gas hydrates, poly metallic nodules, hydro-thermal deposits as well as living resources and developing technology for harnessing these resources have been initiated. We had also started an Advanced Training School to train young recruits in earth system modeling. The knowledge gained by these studies has helped us to improve models and thus forecast of weather, climate and hazards. The forecasts has been converted into services for specific sectors like agriculture, fishery, aviation, water resources, disaster management, shore protection, tourism, etc.

The National Council of Applied Economic Research (NCAER) has carried out the survey of weather and marine services. According to this survey, economic benefits of weather and climate forecasts as well as fishery and ocean state services about Rs 100,000 crores per year. The benefit of accurate cyclone forecast is of utmost importance in saving lives as seen in the case of the Phailin cyclone. The services rendered in the Lakshdweep Islands such desalination plants, ornamental fishery, etc. has led about 12 per cent increase in the gross domestic product of the Lakshdweep Islands. These are few examples of services rendered by us.

RD: What is current emphasis in terms of agenda of earth sciences activities and what are your future plans?

SN: For the next few years, the major emphasis will be to enrich our knowledge base about the Earth System and the interactions within and across system for developing improved weather, climate and hazards related services for sustainable and inclusive development. The major goals for developing major services are:

i) Improving forecast for weather including monsoon.

ii) Providing an early warning of natural hazards.

iii) Providing ocean information for safe navigation and fisheries.

iv) Understanding of polar science and it's implication for climate change.

v) Exploration of ocean mineral resources and development of technology.

vi) Protection of shore and conservation of coastal ecosystem.

vii) Projection of climate change and developing climate services.

RD: You have pioneered many applications related to coastal and marine sciences. What are your views on the current state and how do you see the future of research and regulations in this directions.

SN: Marine and coastal ecosystems are most productive areas and hence continuous monitoring is vital. We need to to argument current observations on physical, geological, chemical, and biological to understand seasonal and inter annual variability, sensitivity to global change and model ecosystems in terms of productivity to assess their health. The gradual changes in sea level due to global warming or episodic changes due to storm surges, tsunamis, high waves, affect significantly ecosystems and ultimately the coastal communities. We have seen the extensive damage to mangroves and coral reefs during the 2004 Indian Ocean tsunami, and has lead to loss of livelihood for coastal communities. The inundation also affects settlements and infrastructure In coastal regions. Hence we need to build ecosystem models to study impact of climate change. Various Ocean Color products are being generated to answers questions such as how much phytoplankton the oceans contain, where they are located, how distribution is changing with time and how much photosynthesis they perform. They could be vital input for ecosystem modeling.

Vulnerability of the coast due to climate change and natural hazards can be a major criteria to develop regulation measures. The vulnerability maps to address these issues have been prepared for the Indian coast and they needs to be effectively utilized. Areas likely to be affected by inundation have been identified using high-resolution topographic base developed using Cartosat and other data. We need to build impact models to address issues related to vulnerability of economic and social sectors.

The loss of marine biodiversity is another major issue. Today, the loss has been estimated to be 100 to 1000 times more than what could be considered natural. Whether the Earth can sustain current rate of loss? The detailed records of marine life and changes needs to be meticulously recorded. The programs on Census of marine life and Ocean-Biogeographical System (OBIS) have been initiated. The impact of loss of marine biodiversity on other ocean processes needs to be understood. The focus should be on the understanding of the structure, function and vulnerability of ecosystems. We need to ensure healthy ocean environment for sustained benefit of our successive generations.

RD: Do you feel that the technologies developed by central research labs are being utilitised properly. Is there a gap in this area which you would like to plug?

SN: We have very clear roadmap and plans for translating knowledge into services. Of course, there is a time lag between creating new knowledge and improvement of services. The time lag depends on variety of factors such as needs of the society, technological, financial, human and managerial resources required to convert knowledge into

"Marine and coastal ecosystems are most productive areas and hence continuous monitoring is vital."

"The acquisition of knowledge, passion for scientific understanding, hard work and dedication will lead to success."

product or service and their acceptability by users. So each specific issue needs to addressed separately.

RD: Research in modern times overarches the boundaries of nations. What is your vision of collaboration and cooperation with other countries for research in general and that related to earth sciences in particular?

SN: Earth system science is a global as well as of national importance. You know that the Earth behaves as a single, interlinked and self-regulating system. Its components, viz. atmosphere, oceans, cryosphere, geosphere and biosphere, function together and their interactions are complex and significant. Hence we need global collaborations for observations, understanding of various earth processes, improve models to develop forecasting capabilities for weather, climate and hazards as well as sustainable use of energy and resources. Since, few countries are engaged in the generation of knowledge it is necessary to have multilateral /regional collaboration to address science questions, and develop cooperation in observing system and modeling. We have build very effective collaborations with USA, UK, Korea and informal collaborations with many countries. We also participating in many multilateral collaboration like Belmont Forum and UN organizations like IOC/ UNESCO, WMO, etc.

RD: What is your message to the youth and the young professionals?

SN: The acquisition of knowledge, passion for scientific understanding, hard work and dedication will lead to success.●

National Map Policy—2005

Shashikant A. Sharma, Scientist, Space Applications Centre (ISRO), Ahmedabad.
E-mail: sasharma@sac.isro.gov.in

Shri Shashikant A. Sharma

1. Preamble

All socio-economic developmental activities, conservation of natural resources, planning for disaster mitigation and infrastructure development require high quality spatial data. The advancements in digital technologies have now made it possible to use diverse spatial databases in an integrated manner. The responsibility for producing, maintaining and disseminating the topographic map database of the whole country, which is the foundation of all spatial data, vests with the Survey of India (SOI). Recently, SOI has been mandated to take a leadership role in liberalizing access of spatial data to user groups without jeopardizing national security. To perform this role, the policy on dissemination of maps and spatial data needs to be clearly stated.

2. Objectives

- To provide, maintain and allow access and make available the National Topographic Database (NTDB) of the SOI conforming to national standards.
- To promote the use of geospatial knowledge and intelligence through partnerships and other mechanisms by all sections of the society and work towards a knowledge- based society.

3. Two Series of Maps

To ensure that in the furtherance of this policy, national security objectives are fully safeguarded, it has been decided that there will be two series of maps namely

(a) ***Defense Series Maps***

(DSMs)- These will be the topographical maps (on Everest/ WGS-84 Datum and Polyconic/UTM Projection) on various scales (with heights, contours and full content without dilution of accuracy). These will mainly cater for defense and national security requirements. This series of maps (in analogue or digital forms) for the entire country will be classified, as appropriate, and the guidelines regarding their use will be formulated by the Ministry of Defense.

(b) ***Open Series Maps (OSMs)*** – OSMs will be brought out exclusively by SOI, primarily for supporting development activities in the country. OSMs shall bear different map sheet numbers and will be in UTM Projection on WGS-84 datum. Each of these OSMs (in both hard copy and digital form) will become "Unrestricted" after obtaining a one-time clearance of the Ministry of Defense. The content of the OSMs will be as given in Annexure 'B'. SOI will ensure that no civil and military Vulnerable Areas and Vulnerable Points (VA's/VP's) are shown on OSMs.

The SOI will issue from time to time detailed guidelines regarding all aspects of the OSMs like procedure for access by user agencies, further dissemination/ sharing of OSMs amongst user agencies with or without value additions, ways and means of protecting business and commercial interests of SOI in the data and other incidental matters. Users will be allowed to publish maps on hard copy and web with or without GIS database. However, if the international boundary is depicted on the map, certification by SOI will be necessary. In addition, the SOI is currently preparing City Maps. These City Maps will be on large scales in WGS-84 datum and in public domain. The contents of such maps will be decided by the SOI in consultation with Ministry of Defense.

4. National Topographical Database (NTDB)

SOI will continue to create, develop and maintain the National Topographical Data Base (NTDB) in analogue and digital forms consisting of following data sets:

(a) National Spatial Reference Frame;

(b) National Digital Elevation Model,

(c) National Topographical Template,

(d) Administrative Boundaries, and

(e) Toponomy (place names).

Both the DSMs and OSMs will be derived from NTDB.

5. Map Dissemination and Usage

Open Series Maps of scales larger than 1:1 million either in analogue or digital formats can be disseminated by SOI by sale or through an agreement to any agency for specific end use. This transaction will be registered in the Registration database with details of the receiving agency, end use etc.

Through the agreement, SOI will allow a user to add value to the maps obtained (either in analogue or digital formats) and prepare his own value-added maps. The user should be able to share these maps with others – the information of all such sharing will also require to be logged in the Map Transaction Registry.

6. Applicability of Previous Instructions

The Ministry of Defense has from time to time issued detailed guidelines on various aspects of map access and use. These instructions shall continue to hold good but for the modifications cited herein. ●

Note: More information is available on website of SOI.

SOI will continue to create, develop and maintain the National Topographical Data Base (NTDB) in analogue and digital forms .

OSM is primarily for supporting development activities in the country.

Annexure B: Contents of OSM

Sl. No.	Category \ Layer	Details	Sub Details
1	GENERAL		Latitude/Longitude Name of State/District/Administrative index Topo sheet Number/Year of Survey/Edition No./Index to topo sheets Magnetic variation from true North direction Map reference Bar scale/Representative Factor
2	ADMINISTRA-TIVE BOUNDA-RIES	Names Boundary Boundary Pillars	Administrative/Locality or tribal International to village, Forest, all boundary pillars, village tri-junctions
3	COMMUNICA-TIONS/ ROADS	Roads Tracks Railways Embankments Other Lines	All Roads All Tracks, pass, footpath All gauges with stations, tunnels Light railways or tramway, All embankments, Road/rail/tank
4	HYDROLOGY	Stream/Canals Dams Rivers / Banks Wells, Water Features	All streams/canals All earthwork dams All rivers with details, banks, islands All wells/tube wells/springs All Tanks (excluding overhead tanks), Lightship, buoys, anchorages
5	SETTLEMENT/ CULTURAL DETAILS	Towns or Villages Offices Settlements	Village inhabited, deserted and forts Huts, Tower, Antiquities Religious places, tombs/grave All post/telegraphic/Police stations hut All Bungalows
6	TRANSMIS-SION LINE		
7	RELIEF/ HYPSOGRA-PHY	Contours Sand Features Ice Forms Heights Benchmarks	Contours with sub features All sand features Ice forms (all features) Spot height, Approximate height Bench marks (Geodetic tertiary, canal)
8	VEGETATION	Plantations, Trees	All trees, Vine on trellis, grass, scrub.
9	FOREST		Reserved/Protected

** Contours & heights will not be available in restricted zones as per MOD's instructions.*

Overview of 3D Measurements from Satellite Imagery

Ritesh Agrawal[+@] and A. S. Rajawat[+]
+ Scientist, Space Applications Centre (ISRO), Ahmedabad
@ Corresponding Author E-mail: ritesh_agrawal@sac.isro.gov.in

Shri Ritesh Agrawal

Dr. A. S. Rajawat

The use of satellite images to produce Digital Elevation Model (DEM) is rapidly gaining prominence. In recent years, the number of satellites capable of generating DEM has rapidly increased. Moreover, in order to obtain the DEM, a plethora of options are available to remote sensing user community, offering different spatial, radiometric, spectral and temporal resolutions. The DEM produced from satellite images have considerable advantages in respect to time, money and effort. Several methods have evolved to generate DEM from space-based technologies, leading each time to new techniques with improved capabilities, overcoming few limitations of the earlier approaches.

This article presents an overview of techniques for extraction of 3D information from satellite data. The performance and limitations of three different methods, viz. satellite photogrammetry, SAR stereoscopy and SAR interferometry are explained. Additionally the available DEM products, namely ASTER GDEM, Carto DEM and SRTM have also been discussed.

Introduction

A digital elevation model (DEM) is a digital representation of ground surface topography or terrain. DEM are used to perform a lot of application such as the rectification of aerial photography or satellite imagery, modeling water flow or mass movement, rendering of 3D visualizations, creation of relief maps, creation of physical models, reduction (terrain correction) of gravity measurements, extracting terrain parameters and surface analysis. Elevation data are represented with different forms like contour lines, point elevation or DEM. Today, elevation data are represented as Digital Elevation Model (DEM), Digital Terrain Model (DTM) and Digital Surface Model (DSM).

Digital Elevation/ Terrain Model are acquired from several different sources. These sources are ground surveying, airborne data (e.g. aerial photo), existing cartographic data (e.g. Topographic maps), radar satellite (e.g. Radarsat, ALOS/ Palsar, ENVISAT/ASAR), optical satellite (e.g. Ikonos, Aster, Geoeye-1) and airborne laser scanning. The most accurate DEM within these methods are available with ground surveying. But this method is very expensive, time consuming and requires more effort. Accurate DEM can be obtained using laser scanning too but the equipment/processing is expensive in terms of flight cost and requirement of high -end processing. The DEM generated using satellite images are therefore rapidly gaining popularity due to their advantages in respect of time and cost.

Digital elevation models (DEMs) are currently one of the most important data used for geo-spatial analysis. Since the elevation extraction is an active R & D topic, there is need to understand different techniques for extraction of the elevation information using different satellite viewed from space. Three different techniques photogrammetry, radargrammetry and interferometry are explained for extraction of relative or absolute elevation along with their limitation and advantage over each other. The freely available global and Indian elevation datasets are also explained in this article.

RPCs provided along with the stereo data are essentially a form of generalized sensor model .

Satellite Photogrammetry

Satellite photogrammetry has slight variations compared to photogrammetric applications associated with aerial frame cameras. The coverage of satellite images is large and is thus suitable for large-scale survey or investigation having much coarser resolution than aerial photogrammetry. SPOT5 Earth observation satellite produces 2.5 meter panchromatic and 10 meter multispectral imagery. The first high-resolution satellite of the world, IKONOS launched by US in year 1999 with its coverage of 11km×11km and spatial resolution of 1 meter panchromatic and 4 meter multi -spectral imagery. QuickBird launched in 2001 satellite has provided the finest 61 centimeter class panchromatic imagery. Therefore, the difference between the spatial resolution of satellite image and that of aerial image is gradually reducing. The Cartosat-1 launched by ISRO in May 2005 is the first near-real time stereo mission giving stereo product having a temporal gap of 54 seconds. Its acquisition geometry is shown in Fig. 1.

Initial satellites such as Spot -5, IRS-1C/1D used physical sensor model based on the physical meaning of the imaging process. The concept of Rational Function Model (RFM) carrying the sensor-image-ground relationship in the form of coefficients has been introduced with the launch of IKONOS satellite. The RFM model was further used in other satellites such as Geoeye, Quickbird, Prism and Cartosat-1 etc. The Rational Function Model (RFM) coefficients, called RPCs, provided along with the stereo data are essentially a form of generalized sensor model i.e. the model parameters are sensor independent, having high fitting accuracy and are calculated in real time .

Rational Function Model

A sensor model relates 3D object point positions to their corresponding image positions through the collinearity condition. The RFM relates object space coordinates to the image space coordinates. The image pixel coordinates (x, y) are expressed as ratios of polynomials of ground coordinates (X, Y, Z). Generally they are represented as third order polynomials. Ratios have a forward form:

$$x = \frac{P1(X,Y,Z)}{P2(X,Y,Z)} \quad \ldots.(1)$$

$$y = \frac{P3(X,Y,Z)}{P4(X,Y,Z)} \quad \ldots..(2)$$

Where, Pi (i =1,2,3 and 4) are polynomial functions. This equation is called upward RF. Usually RF model

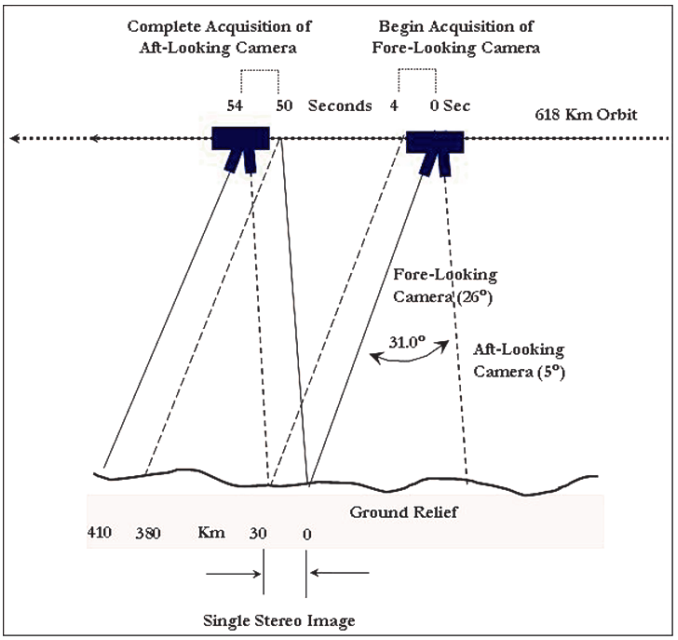

Figure 1: Acquisition geometry of the Cartosat-1 stereo mission

is generated based on a rigorous sensor model.

The order of the terms is trivial and may vary in different literature. The number of coefficients in the polynomial can be reduced gradually by applying different conditions (P2=P4) & (P2=P4=1). A minimum of 7, 19, and 39 GCPs are required to resolve the first, second and third-order RFM having 14, 38 and 78 number of RPCs respectively. Refinement with polynomials corrects the remaining error and refines the mathematical solution. The major steps involves in the generation of the digital elevation models are as:

- GCP and Tie points are identified on both the images used for the updating of RPCs in the stereo image to enhance the geometric and stereo model accuracy. The GCPs and tie points are further used to co-registering the image to minimize and remove Y - parallax to establish Epipolar geometry.
- Image matching techniques are used in order to find point correspondences i.e. conjugate points or match points. The image matching is performed based on image pyramids, where the results i.e. the disparities, are calculated on the smaller image pyramid level and are then projected to the next larger pyramid level for refinement.
- The generated conjugate points use space intersection to get its geo-location and elevation information by relating image object relationship defined by RFM model.
- The geo-located elevation information is interpolated for the creation of DEM at a regular posting.

This technique is used to produce ASTER Global Digital Elevation Map (GDEM) and CartoDEM national DEM (nDEM).

ASTER GDEM

The ASTER Images are acquired in 14 spectral bands using three separate telescopes and sensor systems. These include three visible and near-infrared (VNIR) bands with a spatial resolution of 15 m, six short-wave-infrared (SWIR) bands with a spatial resolution of 30 m, and five thermal infrared (TIR) bands that have a spatial resolution of 90 m. A separate telescope for acquiring image in VNIR Band3 with backward-looking orientation, thus providing along-track stereo coverage from which high-quality digital elevation models (DEMs) are generated as one of a suite of ASTER standard data products. ASTER GDEM is 30m elevation dataset created by stereo-correlating the 1.3 million scene ASTER VNIR archive, covering the Earth's land surface between 83N and 83S latitudes, formatted in 1 x 1 degree tiles as Geotiff file format. ASTER DEM standard data products are produced with 30m postings, and have Z accuracies generally between 10 m and 25 m root mean square error (RMSE). The ASTER GDEM is distributed by METI and NASA through the Earth Remote Sensing Data Analysis Center (ERSDAC) and the NASA Land Processes Distributed Active Archive Center (LP DAAC) at no charge to users worldwide as a contribution to the Global Earth Observing System of Systems (GEOSS). Along with the data, the quality assessment shows the number of scene-based DEMs contributing to the final DEM value at each pixel or the location of data anomalies that have been corrected (Figure 2). At the time of releasing of product it was also observed that the detail of topographic expression resolvable in the ASTER GDEM appears to be between 100m and 120m arising due to a variety of local effects and geometric shapes.

ASTER Images are acquired in 14 spectral bands using three separate telescopes and sensor systems

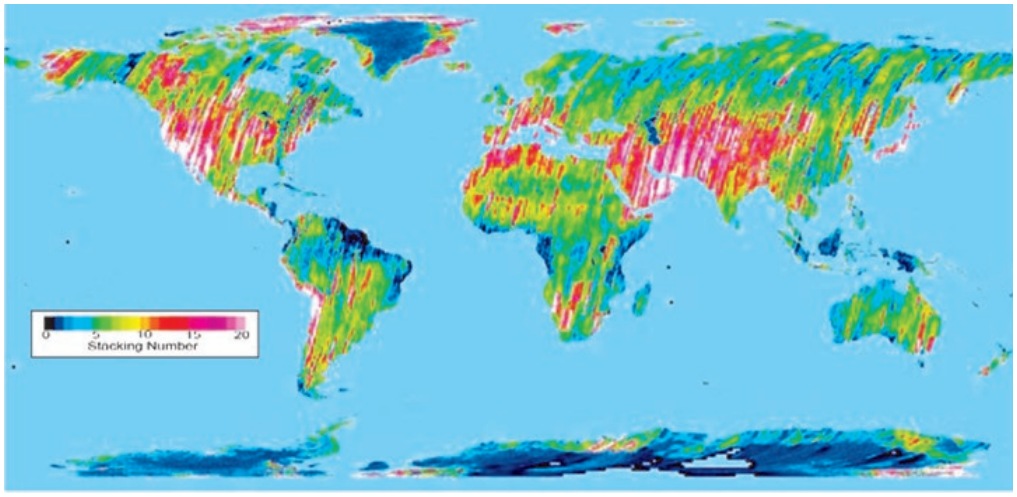

Figure 2: ASTER GDEM (1 Arc Second) global stacking number map showing numbers of ASTER DEMs contributing to the GDEM by location.

CartoDEM

Standard Planimetric accuracy and vertical accuracy of Carto DEM is 15m and 8 m respectively.

IRS-P5 (CartoSat-1) satellite, launched on May 05, 2005, is designed to deliver high resolution spatial data of better than 2.5m in stereo with covering a ground swath of 27 km. The twin cameras, with a fixed base-to-height ratio of 0.62, image the terrain through in-track stereo almost simultaneously with a time lag of approximately 52 sec. The pair of Panchromatic cameras having an along track stereoscopic capability to acquire two images simultaneously, one forward looking (Fore) at +26 ^{o} and another rear looking (Aft) -5^{o}. The primary mission goal of CartoSat-1 is to generate Digital Elevation Model (DEM) covering the entire country to facilitate the user communities of remote sensing and cartography. To fulfill the goal of Cartosat-1 Indian Space Research Organization (ISRO) provide Cartosat-1 Digital Elevation Model (CartoDEM) for entire country with a spatial resolution of 30m in public domain in 1^{o} by 1^{o} tile shown in figure 3. These tiled datasets can be downloaded from Bhuvan (www.bhuvan.nrsc.gov.in). The standard planimetric accuracy and vertical accuracy of CartoDEM is 15m and 8 m respectively.

Figure 3: CartoGDEM (1 Arc Second) in 1^{0} by 1^{0} tile available from Bhuvan

SAR Stereoscopy

SAR stereoscopy is the technology of extracting geometric object information from radar images. Radargrammetry particularly derives topographic map (DEM) from the disparity angles, which is the angle of parallax, of two overlapping stereo radar images. In radargrammetry, the rigorous extraction of three-dimensional geometric data is defined by a radar stereo intersection. Based on the knowledge of interior orientation (image pixel and line coordinates) as well as exterior orientation (satellite positions and velocities), the solution is represented as the intersection of a range sphere and Doppler cone. Since a pair of stereo images provides two sets of slant range and satellite ephemeris information, it is an over-determined solution of three unknowns from four range sphere intersection (RSI) equations also known as the radargrammetric orientation approach. Based on stereo geometry, the averaging solution takes the mean value of two vector solutions. The difference between two solutions can be treated as mis-closure, which is an evaluation parameter to quantify the accuracy of the solution. The stereo approach for elevation extraction, requires as input, overlapping image pairs created from airborne or satellite platform positions which, as viewed from a common 'target' within the images, are separated in incidence angle by several degrees (optimally 10-20°) in same side or opposite side stereo acquisition shown in figure 4.

Radargrammetric Orientation Approach: Range-Doppler model

Range Doppler Model primarily considers the precise relationship between image coordinates of (line, sample) and object-space coordinates (Latitude, Longitude, Height) of the target with respect to the geometry of the SAR image. This approach, utilizing two Doppler equations and two range equations to obtain the position of an unknown ground point in space intersection, has been the mainstream solution for SAR stereo restitution.

Range equation

$$(Px- Sx)^2 + (Py- Sy)^2 + (Pz - Sz)^2 = R^2$$

.....(3)

and,

Doppler Equation

$$(V_s)(P-S) = 0$$

.....(4)

Where, P = Position of the Ground feature; S = Corresponding satellite location; and R= Range between satellite & ground feature.

Major ways in which satellite stereo SAR differs from the airborne cases:

For space-borne applications most commonly used radargrammetric mode is same-side stereo instead of opposite-side stereo

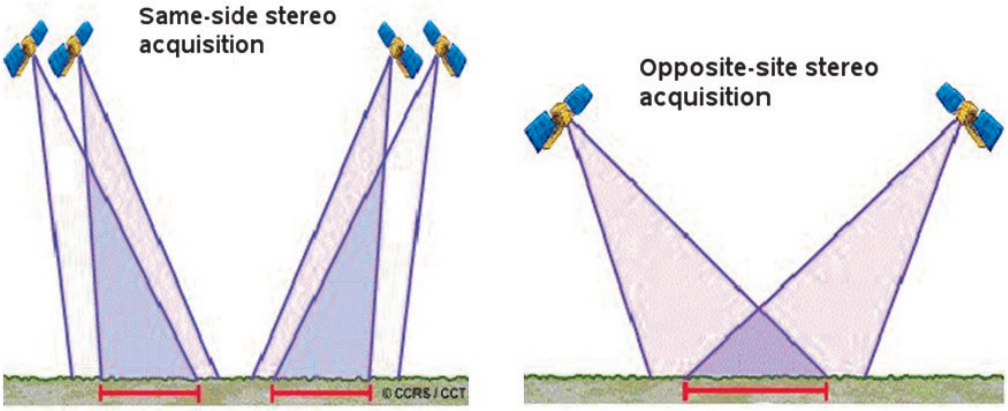

Figure 4: Stereo acquisition geometry of SAR a) Same side b) opposite side

- Better stereo geometry
- Motion compensation not required
- Poorer resolution
- Cost effective
- Wider area coverage

Since the procedures and the resulting products lead directly to photogrammetry, radargrammetry faces some issues arising from the microwave nature of radar images and the side-looking geometry of SAR: foreshortening, layover, and shadow. Due to these phenomena two radar images of the same area may present many differences and variability. The combination of non-optical measurements and side-geometry makes the microwave image difficult to assess by the human eye although microwave imagery much resemble optical photos at first glance. Stereoscopic processing by a human interpreter is still possible. For space-borne applications, mostly same-side stereo radargrammetric mode is used instead of opposite side stereo shown in Figure 4.

SAR Interferometry

Interferometric SAR is a technique which allows to extract information on the terrain topography from phase of SAR signal. The principle is based upon measurement of phase difference between the backscattered wave fronts from a common target pixel, arriving at two spatially separated antennas. Figure 5a shows transmitting at one antenna and receiving on two separated antennas separated by a fixed distance known as single pass interferometry. These separated antennas may also be configured by single satellite passing over same location after some time termed as repeat pass interferometry shown in figure 5b. The importance of InSAR is related to its high spatial resolution, the good potential precision and the highly automated DEM generation capabilities. The complete InSAR procedure to generate DEMs using spaceborne data either in repeat pass or single pass interferometry consists of following stages:

- Image registration;
- Interferrogram generation;
- Interferrogram filtering;
- Coherence calculation;
- Phase unwrapping;
- Geometric calibration;
- Generation of irregular grid of 3D points;
- Interpolation of the regular grid.

Satellite interferometry is currently implemented by computation of an interferogram from two passes of a satellite with time separation of at least 1 day to 24 days as in case of RADARSAT. The orbit of the second pass must be within several hundred meters of the first in

Interferometric SAR is a technique which allows to extract information on the terrain topography from the phase of the SAR signal

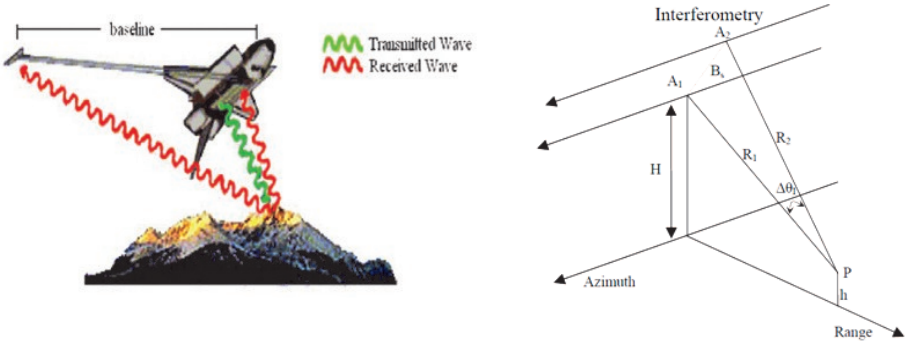

Figure 5: Sensor geometry of a) Single pass, and b) Repeat pass Interferometry

order to preserve phase coherence between the two views of the target. The critical baseline, beyond which phase coherence is lost, is dependent upon altitude, wavelength and spatial resolution of the system. Another serious problem is possible 'temporal decorrelation' which is the potential loss of coherence caused by the time delay between passes. Thus the quality of DTM derived by repeat-pass interferometry will be dependent on the terrain, vegetation cover, local climate and other factors in the target area. To reduce the problem of temporal de-correlation, earlier ERS-1 and ERS-2 operatesd in tandem mode whereby the satellite orbits were separated by one day only and in present system Terrasar-X satellite operating in tandem mode known as Tandom-X having a temporal separation of 1 day. This techniques is used to produce first global SRTM DEM at high resolution by mounting C-band Space borne Imaging RADAR (SIR-C) and X-band Synthetic Aperture RADAR (X-SAR) on space shuttle flown with mission of 11 days in February 2000.

SRTM

NASA Shuttle Radar Topography Mission (SRTM) is a joint project of NASA and the U.S. National Imagery and Mapping Agency (NIMA). Using C-band Space borne Imaging RADAR (SIR-C) and X-band Synthetic Aperture RADAR (X-SAR), SRTM collected data during a shuttle flight in February 2000. The SIR-C/X-SAR is a multi-frequency and multi-polarization imaging RADAR system, complemented by additional antennas located at the end of a 60 m long mast which deployed from the shuttle after reaching orbit. This configuration produced single-pass interferometry and during the mission SRTM imaged all of the Earth's land surface between 60 degrees north and 50 degrees south.

In 2003, NASA released the SRTM dataset for same regions, with 3 arc-second resolution for the globe, and 1 arc-second for the United States. The vertical units represent elevation in meters above mean sea level. The SRTM obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of Earth. SRTM consisted of a specially modified radar system that flew onboard the Space Shuttle Endeavour during an 11-day mission in February of 2000. All elevations are in meters referenced to the WGS84 EGM96 Geoid and the horizontally georeferenced to the WGS84 ellipsoid using a geographic projection.

Conclusions

Remote sensing imagery can be processed by different methods Satellite photogrammetry, SAR stereoscopy, and SAR interferometry taking advantage of the different sensor and image characteristics in terms of geometric, radiometric and phase measurement. In photogrammetry and remote sensing communities, photogrammetry is most preferred and used method due to the heritage of the well-developed aerial photogrammetry technology.

Since every method has its own advantages and disadvantages, the satellite photogrammetry is a well-established method and works well but in cloudy weather conditions this techniques fails to generate DEM. Since obtaining SAR image have 'all-weather'' capability have a good advantage over optical data. InSAR DEMs have high spatial resolution and good precision over hilly/flat terrain. Their precision is quite degraded in mountain areas and can be affected by atmospheric artifacts. The InSAR data also suffer with inadequate baseline specially in the case of the repeat pass interferometry. The another issue of the temporal decorrelation of the SAR data in the vegetated areas such as forest and agricultural land due to

SRTM obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of Earth.

loss in the coherence due to change in backscattered value.

SAR stereoscopy generated in a fully automatic way DEMs with a quite good global accuracy. However an important degradation of DEM quality in mountain areas occurred. Compared with InSAR and photogrammetry, Radargrammetry DEMs have poorer resolution, are less precise but the quality is independent of atmospheric conditions during image acquisitions. Whereas on comparing photogrammetric DEMs with InSAR DEMs, the InSAR DEMs are more accurate and precise but obtaining proper InSAR pair is always a major concern particularly with regards to good baseline and good temporal coherence between data pairs.●

Remote Sensing Data Policy

Shri Shashikant A. Sharma

Shashikant A. Sharma
Scientist, Space Applications Centre (ISRO), Ahmedabad
E-mail: sasharma@sac.isro.gov.in

Recognizing that Remote Sensing data provides much essential and critical natural resources information – which is an input for developmental activities at different levels and is also of benefit to society;

Noting that a large number of users – both within and outside government use Remote Sensing data from Indian and foreign remote sensing satellites for various developmental applications;

Taking into consideration the recent availability of very high-resolution images from foreign and commercial remote sensing satellites and noting the need for proper and better management of the data acquisition distribution from these satellites in India;

Recognizing that national interest is paramount and that security consideration of the country needs to be given utmost importance;

The Government of India adopts the Remote Sensing Data Policy (RSDP) – containing modalities for managing and/or permitting the acquisition/ dissemination of remote sensing data in support of developmental activities.

Department of Space (DOS) of the Government of India will be the nodal agency for all actions under this policy, unless otherwise stated.

I. For operating a remote sensing satellite from India, license and/or permission of the Government, through the nodal agency, will be necessary.

a. As a national commitment and as a "public good", Government assures a continuous/ improving observing/ imaging capability from its own Indian Remote Sensing Satellites (IRS) program.

b. The Government of India, through the nodal agency, will be the sole and exclusive owner of all data collected/ received from IRS. All users will be provided with only a license to use the said data and add value to the satellite data.

c. Government reserves right to impose control over imaging tasks and distribution of data from IRS or any other Indian remote sensing satellite when it is of the opinion that national security and/or international

obligations and/or foreign policies of the Government so require.

II. For acquisition/ distribution of remote sensing data within India, license/ permission from the Government of India, through the nodal agency, will be necessary.

a. Government reserves the right to select and permit agencies to acquire/distribute satellite remote sensing data in India. DOS shall be competent to decide about the procedure for granting license/ permission for dissemination of such data and for the levy of necessary fees.

b. To cater to the developmental needs of the country, the National Remote Sensing Agency (NRSA) of the DOS is vested with the authority to acquire and disseminate all satellite remote sensing data in India – both from Indian and foreign satellites.

i. NRSA will enter into appropriate arrangements with DOS for acquiring/ distributing data from IRS within visibility circle of the NRSA receiving station (s).

ii. NRSA will be competent to enter into agreements with foreign satellite operator (s) for acquisition/distribution of foreign satellite data in India. However, so far as the acquisition/ distribution of IKONOS data in India is concerned, Antrix Corporation Limited (of DOS) will conclude agreements with Space Imaging, USA on such terms and conditions as may be considered appropriate by it and NRSA will distribute the data as per terms agreed to with Antrix.

c. NRSA will maintain a systematic National Remote Sensing Data Archive and a log of all acquisitions/sales of data for all satellites.

III. For acquisition/ distribution of IRS data for use in countries other than India, the Government of India, through the nodal agency, would grant license to such bodies/ agencies of those countries as are interested in the acquisition distribution of IRS data, as per specific procedures.

a. The Antrix Corporation Limited (of DOS) is vested with the authority for receiving the applications for grant of license for acquisition/ distribution of IRS data outside of India; to consider and decide about the grant of license within the policy considerations of the Government and to enter into licensing agreements with the prospective users on behalf of the Government. It shall be competent to levy such fees for granting licenses as may be considered appropriate by it. It shall also be responsible, where necessary, for rendering any further help/guidance needed by the license.

b. The Government reserves right to impose restrictions over imaging tasks and distribution of IRS data in any country when it is of the opinion that national security and/or international obligations and/or foreign policies of the Government so require.

IV. Government prescribes the following guidelines to be adopted for dissemination of satellite remote sensing data in India:

a. All data of resolutions up to 5.8 m shall be distributed on a non-discriminatory basis and on “as requested basis”.

b. With a view to protect national security inter-

Remote Sensing Data Policy contains modalities for managing and/ or permitting the acquisition/ dissemination of remote sensing data in support of developmental activities.

all data of 5.8 m and better resolution will be screened by the appropriate agency before distribution so that images of sensitive areas are excluded.

ests, all data of 5.8 m and better than 5.8 m resolution images will be screened by the appropriate agency before distribution so that images of sensitive areas are excluded.

i. Data of 5.8m and up to 1m resolution can be distributed to users after screening and ensuring the sensitive areas are excluded.

ii. Data of 1m resolution and better will also be screened as above and the following procedure will be followed for its distribution.

1. Government users can obtain the data without any further clearance.

2. Private sector agencies, recommended by at least one Government agency for use of 1 m and better resolution data for supporting development activities, can obtain it without any further clearance.

3. Other Private, Foreign and other users can obtain the data after further clearance from an inter-agency High Resolution Image Clearance Committee (HRC).

4. Specific requests for data of sensitive areas, by any user, can be distributed only after obtaining clearance from HRC.

5. Specific sale/non-disclosure agreements to be concluded between NRSA and users for data of 1 m resolution and better.

V. This policy comes into effect immediately and may be reviewed from time-to- time-by Government.

Reference

ISRO (2001), Remote Sensing Data Policy (RSDP), ISRO:EOS: POLICY-01:2001, Indian Space Research Organization, Bangalore.

Spatial Data Sources in India

www.bhuvan.nrsc.gov.in

Bhuvan portal provides an Open Data Archive, rich thematic data as OGC Web Services, Disaster Management Information Support and Crowd sourcing. The portal is a one stop versatile visualization system showcasing the Indian Earth Observation capabilities in 2D and 3D mode. It also provides a collaborative applications platform to share user data and create governance applications.

www.nsdiindia.gov.in

National Spatial Data Infrastructure (NSDI) provides National Infrastructure for the availability and access to organized spatial data. It enables search of spatial metadata created and hosted by several Government departments / organizations.

NSDI envisages the use of the spatial infrastructure at Community, Local, State, Regional and National Levels for sustained economic growth in India.

www.nnrms.gov.in

National Natural Resources Management System (NNRMS) portal enables search of spatial data & metadata through interactive web GIS interface. Web Map Services (WMS) has been implemented to enable access to large volume of spatial datasets such as land use \ land cover, geomorphology, litho-logy, soil, wastelands, wetlands, snow cover, desertification status etc in India.

ISG - ISRS National Symposium – 2013, A Brief Report

N. S. Mehta, Secretary, ISG (Email: nsmehta55@gmail.com)

Indian Society of Geomatics (ISG) and Indian Society of Remote Sensing (ISRS) jointly organized a National Symposium on "Remote Sensing and GIS for Environment with Special Emphasis on Marine and Coastal Dynamics", at Visakhapatnam during December 04 – 06, 2013 as part of their Annual Conventions. The Symposium was jointly organised and hosted by the Department of Geo-Engineering & Centre for Remote Sensing, College of Engineering (A), Andhra University, Visakhapatnam and Indian Society of Geomatics - Visakhapatnam Chapter.

The inaugural session began with traditional invocation and lighting of the lamp by the dignitaries. Dr. T. Ramasami, Chief Guest and Secretary, Dept. of Science & Technology (DST), Govt. of India, inaugurated the symposium. He also delivered prestigious millennium lecture on "National Geographic Information System of India: A Developmental Approach". In his lecture, Dr. Ramasami stressed upon the need for National GIS incorporating all physical and cultural features, resources and environmental issues related to all parts of the country into one database system. He has also explained tools and techniques required for this purpose and the methods of how to go about to build such a comprehensive system. Prof. G.S.N. Raju, Honourable Vice - Chancellor, Andhra University welcomed all the distinguished guest and delegates. He also briefed the delegates about the Symposium and appreciated the efforts made by the Organinsing Committee under the Chairmanship of Prof. Ch. V. Ramachandra Murthy, Principal AUCE (A), to ensure the success of the programme. He welcomed all the delegates and appreciated the overwhelming response received for the Symposium.

Dr. Shailesh Nayak, President, ISG and Secretary, Ministry of Earth Sciences (MoES) and Dr. V.K. Dadhwal, President, ISRS & Director, National Remote Sensing Centre (NRSC), delivered Presidential addresses. Dr. Shailesh Nayak, President ISG and Secretary, MoES, in his address welcomed all the delegates and gave an account of the activities of the Society and reiterated that the ISG Visakhapatnam Chapter is

Shri N. S. Mehta

National Symposium on "Remote Sensing and GIS for Environment with Special Emphasis on Marine and Coastal Dynamics" was organized at Visakhapatnam during December 04 – 06, 2013

Prof. P. K. Verma
National Geomatics Award - Applications

Shri Shashikant A. Sharma
ISG Award Technology

Dr. Alpana Shukla
President's Appreciation Medal for Contribution to the ISG

Dr. Sandhya Kiran
receiving *The Best Chapter Award* for
Vadodara Chapter

privileged to organize the Annual Convention of ISG & ISRS and National Symposium – 2013 during its formative year. He mentioned about the initiatives made by the Society to popularize the GIS technology especially by publishing ISG Journal & Newsletter. Dr. Dadhwal, President ISRS and Director, NRSC briefed about ISRS activities at national and International platforms and provided a roadmap for future activities. Dr. Swarna Subba Rao, Guest of Honour and Surveyor General of India, stressed the need of GIS technology in the process of making open series maps besides stressing the ongoing national efforts towards integrated coastal zone management through making use of the geospatial technologies.

Several ISG and ISRS individual and organizational achievement awards were presented during the inaugural function. Awards conferred by ISG include National Geomatics Award for Applications to Prof. P.K. Verma, DG, MPCST and Advisor, Government of Madhya Pradesh, Bhopal, National Geomatics Award for Technology to Shri Sashikant A. Sharma, Scientist, Space Applications Centre, ISRO, Ahmedabad, Best Chapter award to the Vadodara Chapter, President's Appreciation Medal to Dr. Alpana Shukla, Head, Botany Department, M.G. Science Institute, Ahmedabad and Prof. K. Nageswara Rao Endowment Young Achiever Award jointly to Mrs. Shweta Sharma, Scientist, Space Applications Centre (ISRO), Ahmedabad and Dr. Arabinda Sharma, Assistant Professor & HOD, Civil Engineering Department, BRCM College of Engineering and Technology, Bahal, Bhiwani, Haryana.

Awards conferred by ISRS include Satish Dhawan Award to Dr. M. Baba, former Executive Director, Advanced Training Centre for Earth System Sciences & Climate, IITM, Pune, National Geo-spatial Award for Excellence to Dr. B.K. Mohan, CSRE, IIT- Bombay and Dr. Bharat Lohani, IIT-Kanpur, P. R. Pisharoty Memorial Award to Dr. Mehul R Pandya, SAC, Ahmedabad, Indian National Geospatial Award to Dr. K.S. Rajan, IIIT, Hyderabad, President's Appreciation Award to Shri H. N. Madhusudhan, Associate Scientific Secretary, ISRO, Bangalore, ISRS Best Chapter Award to Dehradun Chapter, Best paper published in JISRS to Dr. P.K. Singh, GSI, Lucknow and Dr. V Sivakumar, C-DAC, Pune. Besides this ISRS Fellowship were conferred to eminent personalities which include Dr. R Krishnan former Director, ADRIN, Hyderabad, Dr. S. M. Ramasamy, former Vice-Chancellor, Gandhigram Rural Institute, Dindigul, Prof. P.K. Verma, DG, MPCST and Advisor, M.P. Government, Bhopal, Dr. Prithvish Nag former Director, NATMO, Kolkata, and Prof. Ramesh P Singh, IIT-Kanpur.

The inaugural function concluded with vote of thanks

by Prof (Emeritus). Kakani Nagerwara Rao, Organising Secretary, ISG - ISRS National Symposium – 2013. The inaugural programme was followed by presentations from awardees and technical parallel sessions.

An industrial exhibition was arranged during the Symposium with various governmental and private organizations such as National Remote Sensing Centre (NRSC), Indian Institute of Remote Sensing (IIRS), Survey of India (SOI), National Atlas and Thematic Mapping Organization (NATMO), Madhya Pradesh Council of Science & Technology (MPCOST), Indian National Centre for Ocean Information Services (INCOIS), IC Technologies, e2v Technologies, Geospatial Media & Communications and Lawrence & Mayo showcasing their products and services for the benefit of the participants and visitors. The industry and space exhibition was inaugurated by Dr. T. Ramasami just before lunch.

During three days five invited talks were delivered by eminent personalities which include Dr. Ajai, Brahmaprakash Professor, ISRO, Space Applications Centre, Ahmedabad, Dr. Raghava Murthy, Director, EOS, ISRO HQ, Bangalore, Dr. Prakash Chauhan, Group Head, Biology and Planetary Sciences and Applications Group, Space Applications Centre, ISRO, Ahmedabad Dr. Parul Patel, Senior Scientist, Space Applications Centre, ISRO, Ahmedabad, Dr. Tapas Ranjan Martha, Senior Scientist, National Remote Sensing Centre, Hyderabad on topics "Coastal Ecosystem Monitoring: Issues and Challenges", "Small Satellites", "Remote Sensing of the Oceans: an Indian Perspective", "SAR Applications over India with special reference to RISAT-1", "EO based information support for the recent Uttarakhand disaster", respectively. Twenty one Technical parallel sessions covering different areas related to the focal theme of the conference as well as various aspects of geoinformatics, natural resources and environmental inventory, and management were organized. Lead talk in each Technical Session was given by eminent scientists/academician having significant expertise and experience in respective field. The technical sessions are as follows:

- Coastal Ecosystem
- Geoinformatics tools and techniques
- Marine Biology
- Trends in Image Processing
- Advances in Sensor Technology
- Microwave Applications
- Coastal Processes and Hazards
- Photogrammetry and LIDAR for terrain analysis
- Planetary Science and Exploration
- Geomatics in Groundwater Conser-

Dr. Arabinda Sharma
Prof. K. Nageswara Rao Endowment Young Achiever Award 2013.

Mrs. Shweta Sharma
Prof. K. Nageswara Rao Endowment Young Achiever Award 2013.

vation and Exploration

- Agriculture and Soils
- Geosciences and Spatial Data Infrastructure
- Disaster Management
- Monsoon Dynamics and Climate Change
- Web and Location based Services
- Geomatics applications in Environmental Monitoring
- Hyperspectral Imaging and Applications
- Geomatics in Urban & Regional Planning
- Geomatics in Water Resources
- Geomatics in Agricultural Applications
- Land use/Land cover and Forestry

Around 160 oral presentations were made by scientists representing more than 70 Organisations / Universities in the country. In addition to above twenty one parallel technical sessions, one session on industry presentation and a Special Session where Dr. Shailesh Nayak, Secretary, MoES, New Delhi delivered Vikram Sarabhai Memorial Lecture entitled, "Towards Stewardship of Oceans", were also organised. In all 350 registered participants took part in the deliberations of the three day Symposium. A cultural program was organised at Kailash Giri, Visakhapatnam prior to welcome dinner on 1st day of the Symposium.

As a part of the endeavors of ISG and ISRS towards promoting the latest trends in RS & GIS, two parallel pre-Symposium Tutorials were also scheduled for December 2-3, 2013 on Geomatics in Marine and Coastal Environments (GMCE) and Planetary Exploration (PE) aimed at young scientists/ teachers/researchers/ students. As many as 89 candidates registered with 40 for GMCE and 49 for PE. The respective course coordinators, Dr. A.S. Rajawat (GMCE) and Dr. Prakash Chauhan (PE) from Space Applications Centre (SAC), Ahmedabad have meticulously planned the Tutorial topics, schedules and resource persons from SAC, PRL, NIO, NRSC, Mangalore University, Bharathidasan University, etc., to deliver expert lectures and conduct hands-on training in the laboratory.

At the end of the two days of successful running of the Tutorials, a valedictory function was held on December 3, 2013 with Prof. Ch. V. Ramachandra Murthy, Principal of College of Engineering (Autonomous), Andhra University as the Chief Guest who distributed participation certificates to all the 89 participants. All the participants of the Tutorials expressed immense satisfaction on the knowledge they gained on the latest developments of the respective topics and for the opportunity they had to interact with reputed resource persons.

The Conference was Co-sponsored by Ministry of Earth Sciences (MoES), Survey of India (SOI), Dept. of Science & Technology (DST), Indian Space Research Organization (ISRO), College of Engineering (A), Andhra University and Defense Research & Development Organization (DRDO). ●

Space News

K. P. Bharucha, Scientist, Space Applications Centre (ISRO), Ahmedabad

Shri K. P. Bharucha

Scientists Detect Direct Evidence of Big Bang's Gravitational Waves

In the most anticipated announcement in physics since the discovery of the Higgs Boson, the first detection of a gravitational wave has been reported. If verified, the find will dispel any lingering doubts about Relativity theory, transform our understanding of the universe's beginning and provide astrophysicists with a new tool to probe the universe. The importance of the detection is hard to overstate. The discovery came from the Background Imaging of Cosmic Extragalactic Polarization (BICEP) detector located at the South Pole, where the cold dry air makes microwave astronomy possible. The discovery of the Cosmic Microwave Background (CMB) polarization by gravitational waves, should it stand the test of time, settles one question on its own, the debate over whether the early universe was inflationary. The signal BICEP has found is so strong it makes many of the inflationary models of the early universe untenable, and leaves non-inflationary versions completely on the outer, suggesting the energy in the universe at that moment was well very much at the upper end of what was previously thought possible.

According to Stephen Hawking, black holes as we currently understand them do not exist

In a paper posted online Professor Stephen Hawking claimed that black holes do not exist - at least, not as we currently understand them. He claims that the traditional notion of a black hole's "event horizon" from which nothing can escape, even light, is incompatible with quantum physics. If so, physicists will have to redefine black holes entirely. According to his new paper, rather than an event horizon, black holes have an "apparent horizon". This apparent horizon only holds matter and energy temporarily, and it is eventually released. This idea would reconcile quantum theory and general relativity's predictions for black holes, and solve the "black hole firewall paradox" that has been plaguing physics for the last two years.

Massive Neutrinos Help Correct the Standard Model of Cosmology

The mass of neutrinos has been precisely calculated for the first time. The study was completed by Richard Battye and Adam Moss and was published in Physical Review Letters. Previous estimates had put the sum of the masses of the neutrino at about 0.06 eV, though these new calculations show that the sum is much higher, at 0.320 +/- 0.081 eV. For a comparison, a single proton is right about 938000000 eV. These new calculations for the mass of a neutrino will extend our knowledge into the world of particle physics as well as expand upon the standard model of cosmology. With a better model, physicists will be able to make better predictions when carrying out experiments to further explore our Universe.

NASA's Kepler Mission Announced 715 New Exoplanets

NASA has announced the discovery of 715 new planets found with the Kepler Space Telescope. This is the largest number of planets reported in a single go, bringing the running total to 1690. The findings confirm the belief that multiplanetary systems are the norm, and provide a feast of opportunities for analysis of patterns in planetary formation. From

the traditional notion of a black hole's "event horizon" from which nothing can escape, even light, is incompatible with quantum physics.

1988, when the first planet outside the solar system was discovered, new announcements came in ones and twos. However, Kepler's 2009 launch changed the game. Where early planetary discoveries were made by observing the wobble of stars caused by the gravity of their planets over long periods of time, Kepler detects the tiny blip as a planet passes in front of its parent star.

New Stars Born at Milky Way's Edge

Gas from two satellite galaxies have collided with the Milky Way's own gaseous features, triggering the birth of bright new stars at the edge of our own galaxy. The newborn stars paint a portrait of what happens when small, gas-rich galaxies smash together to give rise to giant ones.

Discovered in the 1970s, the Magellanic Stream is a long ribbon of gas that stretches nearly halfway around our galaxy. At the head of the stream are two dwarf galaxies that orbit the Milky Way, the Large and Small Magellanic Clouds. Specifically, there is also a gaseous bridge between the two galaxies, as well as the Leading Arm, the shorter gaseous feature that leads the galaxies in orbit. And now, for the first time ever, researchers have spotted stars in the Leading Arm of the Magellanic Stream. The young, luminous stars must have formed recently when Magellanic gas collided with the gaseous hot halo and disk of the Milky Way. At least five of the newborn stars share the velocity of gas in the Leading Arm, suggesting they formed when its gas crashed into the Milky Way's outer disk; this compressed the Magellanic gas, triggering star formation. The sixth and farther star is extremely hot (about 44,000 Kelvins) and could have been born in the vast outer halo, beyond the galaxy's stellar disk. ●

Navigation News

Shashikant A. Sharma, Scientist, Space Applications Centre (ISRO), Ahmedabad

On April 4, 2014, ISRO successfully launched its second navigation satellite IRNSS-1B

IRNSS – India

Indian Regional Navigation Satellite System (IRNSS) is an independent regional navigation satellite system being developed by India. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area. The Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East.

IRNSS will provide two types of services, namely, Standard Positioning Service (SPS) which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorized users. The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.

The Indian government approved the project in May 2006, with the intention of the system to be completed and implemented by 2015.

The first satellite of the proposed constellation was successfully launched on the 1st of July 2013. It is IRNSS-1A one of the three Geosynchronous satellites that will is compose the entire constellation. The satellite successfully reached its defined inclined geosynchronous orbit and that the verification tests were conducted.

On April 4, 2014, ISRO successfully launched its second navigation satellite

IRNSS-1B aboard a Polar Satellite Launch Vehicle (PSLV) rocket and on April 23 the satellite reached its intended orbital location and is operating normally.

BeiDou (Compass) – China

While the Global Navigation Satellite System and Location-based Service Association of China estimates the Beidou will help create a domestic market worth 400 billion yuan (US$64.4 billion) by 2020, it is believed that a huge potential market exists outside the country.

With the deployment of operational reference stations built in Pakistan, BeiDou Navigation Satellite System will offer better location accuracy to Pakistani users. BeiDou offers positioning accuracy to within 25 meters, but the precision will improve to 10 meters as more satellites and reference stations are launched.After Thailand, Laos and Brunei, Pakistan will be the fourth country in the region to get navigation services from BeiDou.

Galileo -ESA

Galileo is Europe's own global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. It is interoperable with GPS and Glonass, the US and Russian global satellite navigation systems

Europe's first four Galileo satellites are already in orbit, the minimum number needed for achieving a position fix. This initial quartet has demonstrated the overall system works as planned, while also serving as the operational nucleus of the coming full constellation.

Europe's latest Galileo navigation satellite has arrived at the Agency's technical centre in the Netherlands for testing, as the previous two satellites are prepared for shipping to French Guiana for launch this summer.

Meanwhile, the previous two Galileo satellites have completed their long test campaign and are being readied for shipping to Europe's Spaceport in French Guiana, for launch together by Soyuz.

GLONASS – Russia

Russia is planning to launch another Glonass-M navigation satellite into orbit in March 2014.

Glonass is Russia's answer to the US Global Positioning System, or GPS, and is designed for both military and civilian uses.

The satellite will be launched from the Plesetsk space center in northern Russia on board the Soyuz-2.1b carrier rocket. The new Glonass-M will augment a group of 28 Glonass satellites already in orbit. Twenty-four satellites are currently in operation, while three are spares and one is in test-flight phase.

The Glonass system requires at least 18 operational satellites for continuous navigation services across the whole of Russia and 24 satellites to provide navigation services worldwide.

By 2020, Russia plans to have 30 Glonass-M and new-generation Glonass-K satellites in orbit, including six in reserve, space officials have said. ●

By 2020, Russia plans to have 30 Glonass-M and new-generation Glonass-K satellites in orbit.

Interesting Web-resources Related to Geoinformatics

Mrs. Pushpalata B. Shah

Mrs. Pushpalata B. Shah, Scientist, Space Applications Centre (ISRO), Ahmedabad
Email: pushpa@sac.isro.gov.in

http://www.geoinformatics.in/resources
Geo-informatics consortium at GBPUAT, Pantnagar is committed to bring new dimensions in the field of geo informatics to help farmers by providing latest information by the means of Remote Sensing, GIS, web technology and other means of IT. Consortium is working round the clock for providing all information related to farming at on click, right at farmer's doorstep.

http://g-i-blog.blogspot.in/2007/02/aboutgeo-inforamtics.html
Blog related to Open Source technologies to develop and host web-enabled Spatial Technology Applications and provide training in both the development and use of such applications.

http://blog.ipractice.in/geo-informatics-scope-in-india-course-details/Geoinformatics
This blog provides information on Geo Informatics scope in India and course details.

http://www.geoinformatics.com/event-calendar
Events Calendar for Geo Informatics

http://agisac.gov.in/Applications.html
Geo-information for the benefit of people and sustainable development.

http://www.csre.iitb.ac.in/csrewebsite/minor-course/38-minor-course/106-gnr-403-geoinformatics-lab
AMCSRE Announces GEO-MATRIX-14, a two day National Conference on Geo-informatics in Rural, Urban and Climatic Studies to be held on 6th & 7th June 2014.

http://www.agro-geoinformatics2014.org/news.html
The Third International Conference on Agro-Geo informatics, 11-14 August 2014, Beijing, China ●

Geoinformatics Education & Career

Dr. P. M. Udani

Dr P. M. Udani, EC Member, ISG
Email: prafuludani@yahoo.co.in

Geoinformatics is the synergy of multiple disciplines. Major subjects taught in Geoinformatics include GIS, Remote Sensing, Information Technology, Photogrammetry and GPS.

Geoinformatics provides career opportunities in the field of land resource management, utilities planning and management, water recourses management, disaster management, risk assessment, transportation, urban planning, environmental modeling and analysis, public health, forestry, agriculture, military, mining, business location and service centre planning, defense, space research, meteorology and climate change and academics. The IT industry is rapidly adopting Geospatial technologies for efficient delivery of products and services. Reliance Industries, L&T, Suzlon etc. are using geospatial technology for infrastructure project management. GIS Analysts, GIS Managers, Business Development Executives, GIS Software Developers etc. are in much demand and offer good salary package. ●

Institutes / Universities in Gujarat, Maharashtra , Madhya Pradesh and Rajasthan offering Geoinformatics courses

Institute / University	Geo-informatics Course
CEPT University, Ahmedabad	M. Tech. and M.Sc. in Geomatics.
Institute of Science & Technology For Advanced Studies & Research (ISTAR), Vallabh Vidyanagar	PG Diploma in Geo-informatics
MDS University, Ajmer	M.Sc. in RS and Geo-informatics
Barakatullah University, Bhopal	M.Sc. (Tech.) in Remote Sensing and M.Sc. in Geoinformatics
Jiwaji University, Gwalior	M.Sc. in Remote Sensing and GIS
Mehul Institute of Technology (DAVV), Indore	M.Sc. in Geoinformatics
School of Electronics, Devi Ahilya University, Indore	M. Tech. in Spatial Information Technology
Maulana Azad National Institute of Technology, Bhopal	M. Tech. in R S and Geoinformatics
IIRMR, Jaipur	Diploma and Certificate Course in Geoinformatics
Institute of Geology & Remote Sensing, Bundelkhand University, Jhansi	M.Sc. (R S and G I S)
Government College,Kota	Certificate Course in R S and G I S
University of Kota	PG Diploma in R S and G I S
CSRE,IIT, Bombay.	M. Tech. (NR Engineering)
Shridhar University, Pilani	M.Sc. & M. Tech. Geoinformatics
Advanced Computing Training School (ACTS), Pune	Diploma in Geoinformatics
Institute of Environment Education and Research, Bharati Vidyapeeth, Pune	M.Sc. in Geoinformatics
Pune University, Pune	M.Sc. in Geoinformatics
Sinhgad College of Science, Pune	M.Sc. in Geoinformatics
Symbiosis Institute of Geoinformatics, Pune	M.Sc. in Geoinformatics
Mahatma Gandhi Chitrakoot Gramodaya Viswavidyalaya,Satna, M.P.	M.Sc. and PG Diploma in RS & GIS
Solapur University,Solapur	M.Sc. in Geoinformatics

Note: List is Not Exhaustive.

Geoinformatics is the synergy of multiple disciplines. Major subjects taught are GIS, Remote Sensing, Information Technology, Photogrammetry and GPS.

Recent GIS Job Postings (Jan-April, 2014)

GIS Software Engineer
SECON, 3rd Floor, Satyam Complex, Chhani, Vadodara – 02 (Gujarat), Phone: 0265 – 6630700 / 2761790, Email: feedback@secon.in

GIS Specialist
Solapur Municipal Corporation

GIS Project Survey
GeoVista GIS Company, Thaltej and Bodakhdev, Ahmedabad

GIS Associate
The Wings , Block-CD115, Sector-1, Bidhan Nagar (Salt Lake), Kolkata- 700064 West Bengal, wings.gis@outlook.com, Phone: 033-23342975/76

GIS Technician
Ahmedabad – Gujarat, Ref No.: 68-7241608-a9a

GIS Surveyor and GIS Senior Assistant
Groundwater Survey and Development Agency (GSDA), Nashik Division, Nashik.

GIS Engineer
Multimind Creations - Bhopal, Madhya Pradesh (Ref. Monster)

GIS Application Programmer
India Urban Space (IUSP) Janaagraha - Bangalore, (www.janaagraha.org)

GIS Project Associate
Department of Civil Engineering , National Institute of Technology (NIT Warangal) - Warangal, Andhra Pradesh, Email: mahesh@nitw.ac.in; Phone: +91 870 246 2112; +919849730834

GIS Developers & Surveyor
Geokno India Private Ltd., SY 20/1, 20/2, & 20/3, GMR BPL, 11th km, Arekere Bannerghatta Road ,Bangalore -560076 (www.geokno.com)

GIS Engineer
E I Technologies, Bangalore, gs.raghunath@eitech.in

GIS Engineer & LiDAR Engineer
Global Coordinates, D-19, II Floor, Okhla Industrial Area, Phase-I, New Delhi-110020,Phone:011-26371591,26371593, Email:siva.geoinfo11@gmail.com

GIS Application Developer
IBM, Sector 30, National Highway 8, Gurgaon.

GIS Developer
IDC Technologies, Pune

GIS Engineer
Stesalit Limited, Stesalit Towers, 1st Floor, E-2/3, Block EP & GP, Salt Lake, Sector - V, Kolkata 700091

GIS Faculty
Khagolam Institute of Geoinformatics, A-214, Sidhivinayak Sankul, Oakbag Station Road, Kalyan (West),Thane, Mumbai-421301, Vijay: hr@khagolam.com

GIS Analyst
Sagisol Technology Services Pvt Ltd, Level-7, Maximus Towers, Building:2A,Mindspace Complex,Hitech City, Hyderabad, 500081 www.sagisol.com; Mr. Rohit: rohit@sagisol.com

Marketing, (Female)
Trans Global Geomatics, 10/161 Srinivasa Nagar Colony, West Ameerpet, Hyderabad. Email: ggswamy@transglobalgeomatics.com, Mobile: Guruswamy 9866479962

GIS Engineer, Lidar Engineer, Photogrammetrist
Magnasoft Consulting India Pvt Ltd, 2nd Floor, 201 B, SEZ, Global Village, Mylasandra, Pattanageri Village, Bengaluru –60059, www.magnasoft.com, Prasad.p@magnasoft.com Mobile: 09845318452

GIS Developer
L&T Infotech, Chennai

GIS Analyst
Tech Mahindra, Hyderabad

GIS Field Surveyors
Dale Technologies, Darisi e clave, H.No.7-1-282/C/46, Aravindanagar Society, Balkampet, Hyderabad – 500038, Phone : 040 655500, www.dale-technologies.com

Asst. Manager (GIS App Design & Development)
Genesys International Corp Ltd, 73-A SDF III, SEEPZ, Andheri(E), Mumbai - 400096

GIS Engineer
Geodesy Centre for Science and Technology , 2nd Floor, Mudavathil Building, Edathala P.O., Pukkattupady, Ernakulam, Kerala 683 561.

Note:

- List is not exhaustive.
- Any other job related information may be submitted to Dr P. M. Udani for inclusion in the next issue.

New Members of ISG

L1581
Dr. Kuldeep Singh
HN-132, Akshardham Colony, Roorkee Rd., Nr. Potato Research Institute, Modipuram,
Meerut - 251001
Uttar Pradesh

L1582
Shri Janak P. Joshi
B-27, Siddhi Vinayak Society, New VIP Road, Opp. Ganesh Estate,
Vadodara - 390019
Gujarat

L1583
Shri M. Palaniyandi
S/o. Late Shri V. Masimalai Mooppar, Vector Control Research Centre (ICMR), Indira Nagar,
Pondicherry - 605006
Pondicherry

L1584
Miss Suneeta Jatwa
CWPRS, RSA Division
Khadakwasla R.S.,
Pune - 411024
Maharashtra

L1585
Shri Suryakant Ashok Sawant,
Ph.D. Research Scholar,
Indian Institute of Technology - Bombay, Centre of Studies in Resources Engineering (CSRE), Agro-Informatics Lab.,
Mumbai - 400076,
Maharashtra

L1586
Shri Madhurendra Nath Sinha
304, Indralok Apartment,
G.D. Mishra Path,
Patna - 800013
Bihar

L1587
Dr. Rabindra Kumar,
Associate Professor, Patna University, Patna Science College, Dept. of Geology,
Patna - 800005
Bihar

L1589
Shri Pradeep Soni
Scientist/Engineer, Space Applications Centre (ISRO), SCPD/SEG/SEDA (Room no. : 3868), Jodhpur Tekra, Satellite Road,
Ahmedabad - 380015
Gujarat

L1590
Shri Ishfaq Rasool Gujree,
Zadi Masjid Safa Kadal, ,
Srinagar - 190002
Jammu & Kashmir

L1591
Shri Tariq Abdullah
Khandipora Awantipora,
P.O. Panzgam via Bijbehara,
Pulwama - 192124
Jammu & Kashmir

L1592
Shri Fairan Jalal
Baghiomer Colony, Lal Nagar Chanapora,
Srinagar-190015
Jammu & Kashmir

L1593
Shri Asif Aziz Marazi
Research Student,
University of Kashmir
Dept. of Earth Sciences,
Srinagar
Jammu & Kashmir

L1594
Shri Shabir Ahmmed. Khanday, Zafran Colony,
Achanambal,
Srinagar - 192121
Jammu & Kashmir

L1595
Ms. Meenakshi Chaudhary
377, Chaudhary wara,
Sikandrabad,
Bulandshahr - 203205
Uttar Pradesh

L1596
Ms. Priyanka Sharma
Professor, Inst. Of Sci. & Tech. for Adv. Studies & Res. (ISTAR), Nr. UP Science College, Mota Bazar,
Vallabh Vidyanagar-388120
Gujarat

L1597
Dr. Aparna Shukla
Assistant Professor, University of Kashmir, Dept. of Earth Sciences, Hazratbal, Srinagar - 190006,
Jammu and Kashmir

L1598
Prof. (Ms.) Pratima Singh
F-304, Sahjanand Residency, Nr. Helmet Char Rasta, Memnagar,
Ahmedabad - 380052,
Gujarat

L1599
Dr. D.C. Jhariya
Assistant Professor,
National Institute of Technology, Dept. of Applied Geology, G.E. Road, In-front of Science College,
Raipur - 492010
Chhattisgarh

L1600
Shri Sandipan Kalyan Das
Opp. Golak Cold Storage,
Rony House, P.O. Memari,
Bardhamaan - 713146
West Bengal

L1601
Dr. M. Stalin
Director, Survey of India
Reena Complex, Pachpedi Nakka, Dhamtari Road,
Raipur - 492001
Chhatisgarh

L1602
Smt. S. Indhira Gandhi
Sr. Section Engineer, East Central Railway, Office of CAO, GELF / Madhepura, 6th Floor, Biscomaun Tower, Patna - 800001
Bihar

L1603
Shri Abhijit Mohanrao Zende, Asstt. Professor,
Pune Institute of Computer Technology (PICT)
Dhankawadi,
Pune - 411043
Maharashtra

L1604
Dr. Samratvivekanand Omprakas Khanna, 50/B/2, Maitreya Bunglows, Gandhigram Society, Ta. Bakrol, Anand - 388315
Gujarat. ●

Indian Society of Geomatics

C/o. Secretary
Indian Society of Geomatics
Room No. 4022,
Space Applications Centre,
ISRO, Jodhpur Tekra,
Ahmedabad - 380015,
Gujarat.

Phone:
+91-79-26914022
Email
secretary@isgindia.org

www.isgindia.org

Send your contributions/ comments to the Editor - ISG Newsletter at rpdubey@hotmail.com

News from Chapters

Science Day Celebration by ISG Ajmer Chapter

ISG Ajmer Chapter and Department of Remote Sensing and Geoinformatics, M.D.S. University, Ajmer, celebrated the Science Day on 28th February to 1st March 2014. A Workshop on "Basics of Remote Sensing, GPS and GIS" was organized along with an exhibition. Shri Ram Khiladi, Divisional Commissioner and Honorable Vice Chancellor presided the inaugural function of the workshop. Shri R. P. Dubey, Scientist (Ex-ISRO) was the Chief Guest and Dr. D. N. Pant was the Guest of Honor at the function. A lecture on Bhuwan was delivered by Dr Vinod Bothale, Group Director, NRSC, Hyderabad through Video conferencing.

Shri Ram Khiladi inaugurating the workshop and exhibition at M.D.S. University, Ajmer

AGM of ISG Ahmedabad Chapter Held

Annual General Body Meeting of ISG Ahmedabad Chapter was held on 16th May, 2014 at Space Applications Center (ISRO), Ahmedabad. The Chapter re-elected Shri R. P. Dubey as Chairman, while Shri Shashikant A. Sharma and Shri R. J. Bhanderi were elected as Secretary and Treasurer, respectively for two years (2014-16). The report on audited accounts of ISG Ahmedabad Chapter was also presented and discussed. ●

Forthcoming Events of Other Societies

Regional Conference at Shillong (Sep. 18-19, 2014)

Indian Society of Geomatics Shillong Chapter, North Eastern Space Applications Centre (NESAC - Meghalaya), and North-Eastern Hill University (Shillong) are jointly organizing "**Regional Conference on Geoinformatics for Early Warning of Disasters with Special Emphasis on NE Region**" during September 18-19, 2014. A pre-conference tutorial on Early Warning System for Floods has been arranged on 17 September, 2014. For further details, visit www.nesac.gov.in and www.isgindia.org

ISPRS TC VIII Symposium at Hyderabad (Dec. 09-12, 2014)

ISPRS Technical Commission VIII, Indian Society of Remote Sensing, and Indian Society of Geomatics are jointly organizing ISPRS TC VIII Symposium on "**Operational Remote Sensing Applications: Opportunities, Progress and Challenges**". The Symposium is being hosted by National Remote Sensing Centre (NRSC) at Hyderabad during December 09-12, 2014. For further details, visit: www.nrsc.gov.in/technicalcommission8.html. ●