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# Coordinates

Volume III, Issue 4, April 2007

A MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

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## CLEARING the smoke

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**Survey of India on Indian Geodetic Datums**

# **Extend Your Horizons Minimize Your Expense**

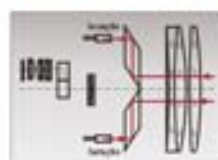


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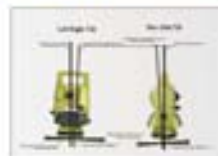
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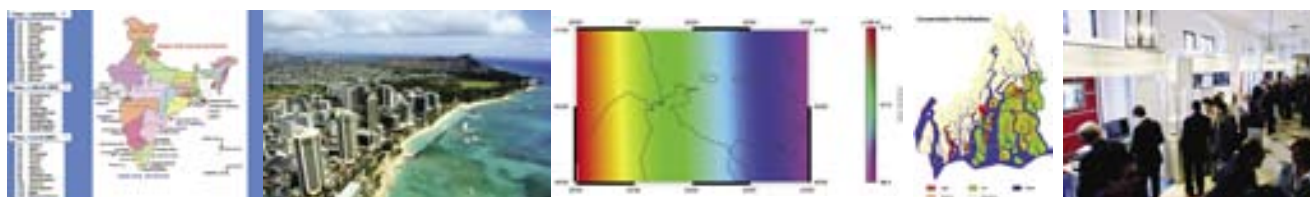
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This issue of Coordinates is of 40 pages, including cover.

## Tracking Galileo

The debate is intense.

So are interests, and the clash of interests.

Conflicts are visible.

Equally visible is the cynicism displayed by some.

We could see all these forces at play in the Munich  
Satellite Navigation Summit last month.

Still, there is a hope.

There is also a strong sense of conviction, commitment and confidence.

Galileo will happen.

It has to.

It is just a matter of time.

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# Coordinates

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

# Redefinition of Indian Geodetic datums - horizontal and vertical

This article aims at clearing the air of misunderstanding and myths that the Survey of India is using outdated, distorted datum and mapping system

**BRIG (DR) B NAGARAJAN AND R K SAWHNEY**

**D**uring the recent times it has been raised at many forums and written in magazines that the Survey of India is using outdated, distorted datum and mapping system. This article aims at clearing the air of misunderstanding and myths that have been generated in the minds of the common populace in general and the users from the scientific community in particular. By way of this article it is also attempted to explain some of the technical jargons which are used frequently, for the aid of common user.

## Horizontal Geodetic Datum

Survey of India has been preparing topographical maps on scale 1:50,000 and 1:25,000 both for defence and civilian use. The horizontal co-ordinates viz., Latitude and Longitude of the position are referred to Everest ellipsoid (best known as Everest 1830). It is locally best fitting ellipsoid particularly useful only to the Indian subcontinent.

With the advent of Satellite technology, worldwide mapping has switched

over to the co-ordinate system based on what is called “Geocentric Co-ordinate System” referred on globally best fitting ellipsoid like GRS80, WGS84 etc. So, the Survey of India took a conscious decision to switchover from Everest co-ordinate system to Geocentric co-ordinate system (ITRF).

Some of the reasons, as listed below, have also been considered while arriving at the decision for switchover. These are –

- To be in line with rest of the world.
- The use of Global Positioning System becomes easier as its co-ordinates are referred to in WGS-84, which is very close to ITRF.
- The updation of maps using Satellite imageries like that from IRS, IKONOS, Quick Bird etc. becomes easier as the Satellite parameters of these satellites are also described in geocentric reference frame.
- Full advantages of Satellite missions like Galileo, Glonass etc can be taken if our maps are also made on Geocentric Co-ordinate System.

As regards mapping of the resources of the country, a new mapping policy has

also been announced by the Survey of India for preparation of Open Series Map (OSM) and Defence Series Map (DSM). Under this new map policy, two series of maps are being brought out namely, Defence Series Maps (DSMs) and Open series Maps (OSMs).

**(a) Open series Maps (OSMs) - OSMs**

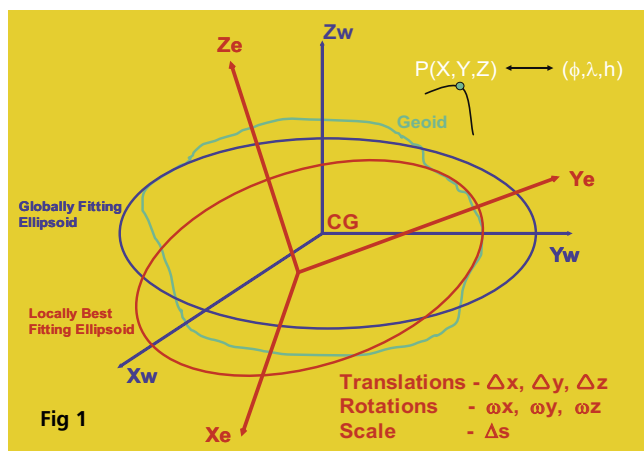
will be brought out by Survey of India, primarily for supporting developmental activities in the country. OSMs shall bear different map sheet numbers and will be in UTM Projection on WGS-84 Datum (Read ITRF). Each of these OSMs (in both hard copy and digital form) will become “Unrestricted” after obtaining a one-time clearance from the Ministry of Defence. Survey of India will ensure that no civil and military Vulnerable Areas and Vulnerable Points (VA’s / VP’s) are shown on OSMs.

## **(b) Defence Series Maps (DSMs)**

– Defence Series Maps will also be on ITRF geocentric Reference Frame but with Lambert Conformal Conical Projection. The topographical maps in this series will be brought out in different scales (with heights, contours and full content without dilution of accuracy). These will mainly cater to the needs of defence forces and national security requirements.

Steps needed for bringing out new map series have already been initiated by the department and some are already complete. However, for the knowledge of the common user, there are three different ways in which this transformation from one datum to another can be achieved –

- (1) By using the transformation Parameters for the conversion of co-ordinates from Everest to ITRF.
- (2) Transformation from ellipsoid to ellipsoid after re-adjusting the whole Indian datum (2D – Adjustment of the Horizontal Datum of India is already over).



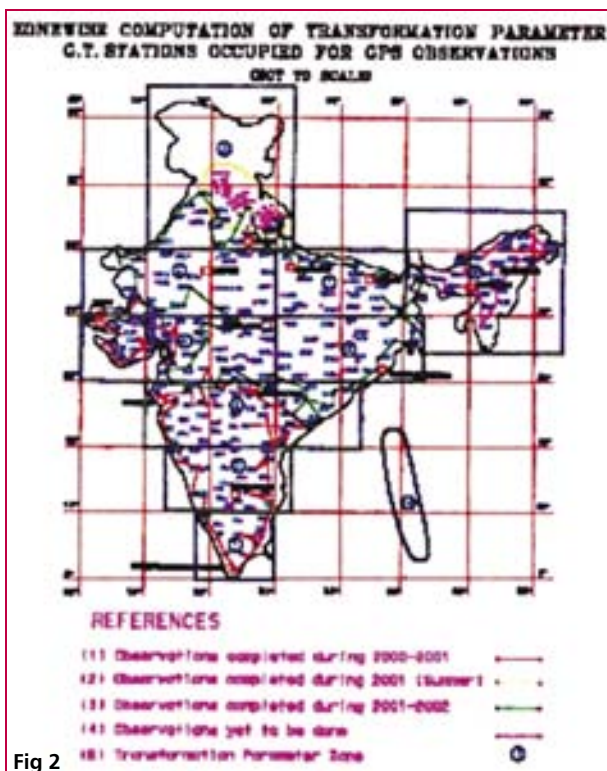


Fig 2

- (3) To come up with a newly observed co-ordinate System in Geocentric Reference Frame.

As regards **Method (1)**, we have already computed the transformation parameters. These transformation parameters have been computed for ten zones as shown in the figure below.

The zones have been selected keeping in mind the major and minor GT series adjustment available with the department. However, state-wise parameters also have been calculated and sent to various GDC's for any specific location-based application in various states. These transformation parameters are accurate up to 2 to 3 metres and hence suitable for transforming topographical maps on scale 1:25,000 and 1:50,000 from Everest co-ordinate system to ITRF co-ordinate system. These parameters are being used for transforming the existing topographical maps to Open Series Maps (OSM), from existing co-ordinates in Everest to Geocentric Reference Frame (ITRF). More than 4000 1:50,000 scale maps have already been prepared under OSM series and are ready to be made available to the user community.

Data in the department will be made use of. However, this has been kept in abeyance for want of manpower.

For **Method (3)**, Survey of India has taken-up the job of setting-up a GCP Library with 300 precise control points with monuments, fencing etc. at a spacing of approximately 250 to 300 km. for the first phase of observations. Observations at most of these points are already over and computations are being carried out simultaneously. Observations for Ground Control Points Library are at the advanced stages and are likely to be completed by March 2007.

In the second phase, 2200 GCPs at spacing of 30 km. have been planned for the purpose of densification of network.

These GCPs will serve as easy access for posterity by virtue of being on the ground as against hilltops as in the past, in contrast to the

For **Method (2)**, the adjustment of Indian Geodetic Network in Everest co-ordinates for the whole country has been completed for the first time. This adjustment is in 2-Dimension. We are planning to add more accurate GPS bases before transforming them to Geocentric Co-ordinate System. It is something similar to North American Datum-27 (NAD-27) to North American Datum-83 (NAD-83) Co-ordinates, as done in United States of America. If we adopt this method, already available voluminous Geodetic

Great Trigonometrical Stations. These Ground Control Points will have packets of geodetic information, such as, co-ordinates in ITRF, height above Mean Sea Level, Gravity Values in IGSN71 Datum, Total geomagnetic force, horizontal and vertical force of earth's magnetic field.

These stations may also be used for transmitting differential corrections to GPS users for obtaining positions within 1-2 metres in real time. In addition to this, these stations will also meet the requirements of cadastral and large-scale mapping.

A database giving the details of the GCPs state-wise, along with description, sketch etc. will be put up on the Survey of India website by 1st April, 2007 for user information.

It would not be out of place to mention here that in this case, advantage of availability of old data will not be made use of. However, this method will provide the best geocentric Reference Frame Co-ordinates that can also take care of new satellite missions like GALILEO, GLONASS etc.

## ITRF (International Terrestrial Reference Frame)

ITRF is the realization of International Terrestrial Reference System (ITRS). ITRS is a geocentric system. The origin of the system is the centre of the mass of the Earth. The unit of length is metre. The orientation of the axes

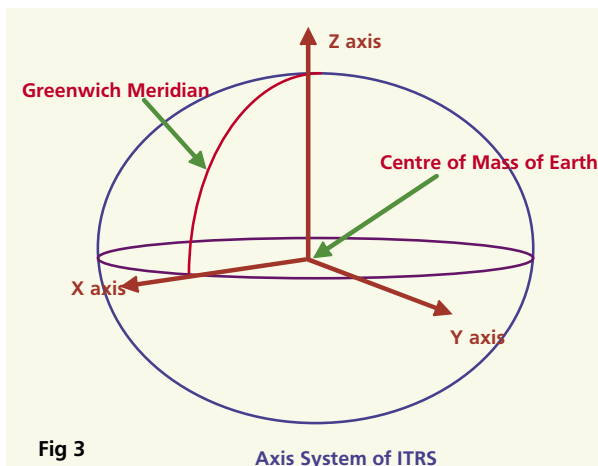


Fig 3

Axis System of ITRS



was established as consistent with that of IERS's predecessor, Bureau International de l'Heure, BIH, in 1984. The z-axis is the line from the center of Earth's mass through the Conventional International Origin (CIO). Between 1900 and 1905, the mean position of Earth's rotational pole was designated as the Conventional Terrestrial Pole (CTP). The x-axis is the line from the centre through the intersection of the zero meridian with the equator. The y-axis is the line from the centre to equator and perpendicular to x axis to make a right handed system.

The ITRF is an alternative realization of WGS84 that is produced by the International Earth Rotation Service (IERS) based in Paris, France. It includes more than 500 stations at 290 sites all over the world. Four different space positioning methods contribute to the ITRF: Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR), GPS and Doppler Ranging Integrated on Satellite (DORIS). Each of these techniques has strengths and weaknesses but their combination produces a strong multi-purpose Terrestrial Reference Frame (TRF). ITRF was created by the civil GPS community, quite independent of the US military organizations.

Each version of the ITRF is given a year code to identify it - the current version is ITRF2000. ITRF2000 is simply a list of coordinates (X, Y and Z in meters) and velocities (dX, dY and dZ in meters per year) of each station in the ITRF, together with the estimated level of error in those values. The coordinates relate to the epoch 2000.0 - to obtain the coordinates of a station at any other time. The station velocity is applied appropriately. This is to cope with the effects of tectonic plate motion.

ITRF is of higher quality than the military WGS84 Terrestrial Reference Frame. ITRF has proven to be the most accurate global Terrestrial Reference Frame ever constructed.

The ITRF is important to us for two reasons. Firstly, we can use ITRF

stations equipped with permanent GPS receivers as reference points of known coordinates to precisely coordinate our own GPS stations, using GPS data downloaded from the Internet. This procedure is known as 'fiducial GPS analysis'. Secondly we can obtain precise satellite positions (known as ephemerides) in the ITRF2000. Both these vital geodetic services are provided free on the Internet by the International GPS Service.

The WGS84 reference frame is consistent with the International Terrestrial Reference Frame (ITRF). The differences between WGS84 and ITRF are in the centimeter range worldwide.

## ii) Projection System to be used :

To get a 2-Dimensional map from a 3-Dimensional earth, we need to project the earth's surface to any plane surface. This process is called map projection. Presently Survey of India is using Polyconic Projection for preparing its topographical maps on scale 1:50,000 and 1:25,000 etc. This polyconic projection is neither conformal, equidistant, nor equal area projection. Each sheet is projected independently and there is a rolling fit in the adjacent sheets (E-W sheets). This projection is suitable only for a smaller area and hence it is not recommended to meet the present day requirements for generating seamless data. In order to meet the present day requirements, Survey of India has taken a decision to go to Lambert Conformal Conical Projection with two standard parallels (LCC) and Transverse Mercator Projection (TM) for Defence Series Maps and Open Series Maps respectively. Both

the projections are conformal projections in which the shape is maintained and the distortions at any point can be computed easily.

## iii) Vertical Datum :

The levelling height information presently available is more than 100 years old. When these heights were computed, neither the concepts of fore and back leveling, use of invar staves were there nor the actual observed gravity values. Also, the vertical datum (MSL Datum) was based on constraining nine tide-gauges all along Indian coast as zero. This height information is sufficient for the needs of topographical mapping on scale 1:50,000 or 1:25,000 where contour interval is 5 m / 10 m in plane areas or 100 m / 200 m in hilly areas. Now with the demand of 50 cm to 1 m contouring, the available precise height information is not sufficient.

In the past 100 years, due to developmental activities like widening of roads and railways, construction of townships and industrial setups, most of the permanent benchmarks have got destroyed or are missing. The frequent seismic activities in various parts of the country and corresponding crustal movement



Fig 4



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activities etc. have also necessitated the introduction of new height system based on geopotential numbers and Helmert Orthometric heights.

In order to redefine and establish a new vertical datum, Geodetic & research Branch of the Survey of India has taken up a massive task of re-levelling 100,000 linear kilometers stretch of the country along with gravity observations with the following objectives.

- Provide dense network of precise benchmarks that will have their geopotential numbers, Helmert Orthometric heights and gravity values.
- Connect the benchmarks to National GPS Ground Control Point Library for the state governments to use in their irrigation, cadastral and utility mapping.
- Connect these benchmarks to all the tide-gauge benchmarks so that the sea level variation studies, inundation mapping and port management activities can be taken up more accurately.
- Establish standard benchmarks for further densification of vertical control and also to setup a reference frame for scientific studies like landslides, crustal movements and seismotectonics.

## Methodology

The entire project will be carried out in two phases. Phase – I will involve High Precision Levelling of 40,000 linear kilometres mainly along the national and state highways to form the backbone of the survey task (Refer figure 4)

In Phase – II densification by High Precision Levelling to cover the entire country will be taken up which will also involve approximately 60,000 linear kilometers of leveling and gravity observations.

Under this program, Reconnaissance and monumentation of 17,000 lin. km., High Precision Levelling of

15,000 lin. km. in the Fore direction etc. have already been completed.

High Precision Levelling in back direction along with gravity observations have commenced from the middle of December, 2006. Fieldwork for the Back Levelling is likely to be completed by April 2007. Levelling framework control will be further densified to meet the requirements of the various government/non-government agencies to cater to their needs for the developmental projects.

At the beginning of the details about the Vertical Datum, we had discussed about the Mean sea Level Datum (MSL Datum). Such datum can be accurate only if the data acquisition system and equipments are sophisticated enough. For this, geodetic & research Branch of the Survey of India has initiated a massive project for “Modernisation and Expansion of Indian Tide-Gauge Network”. Details of this project are as under.

## Modernisation and Expansion of Indian Tide-Gauge Network

Under the Modernisation and Expansion of Indian Tide-gauge Network Project, it has been decided to establish 36 state-of-the-art digital tide-gauges co-located with the dual frequency GPS receivers at strategic locations all along the Indian coastline and its islands.

GPS receivers are being deployed to segregate the sea level rise from that of possible subsidence or upheaval of land mass.

Both tidal and GPS data is being transmitted in real time from the remote locations and received through dedicated VSAT network at the central hub installed

at National Tidal Data Centre/ National GPS Data Centre located at the Geodetic & Research Branch, Survey of India, Dehra Dun. A typical network is shown in the figure 5.

Both GPS and Tidal data received in real time is being spliced before sending it to the National GPS Data Centre or National Tidal Data Centre respectively. GPS Data is being encrypted at remote locations (Tidal Observatories) and decrypted at the central hub.

This tidal and GPS Data is being analysed in real time to identify any possible signatures related to the tsunami and storm surge. In event of tidal heights crossing a preset threshold, the information will be passed on to the Tsunami Warning Centre being established at the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, for dissemination or issuance of alert.

Apart from various applications, this tidal data will also be analysed, after quality control, for the improvement of tidal constituents, used for tidal predictions thereby ensuring safe navigation.

Following 14 ports have already been equipped with such facilities:

- Kandla (Gujarat)
- Marmagao (Goa)
- Cochin (Kerala)
- Minicoy (Lakshadweep Islands)
- Kavaratti (Lakshadweep Islands)
- Haldia (Kolkata)
- Paradip (Orissa)
- Visakhapatnam (Andhra Pradesh)



- Machilipatnam (Andhra Pradesh)
- Ennore (Tamilnadu)
- Chennai (Tamilnadu)
- Tuticorin (Tamilnadu)
- Port Blair (Andaman & Nicobar Islands)
- Nancowry (Andaman & Nicobar Islands)

- Jaigarh (Maharashtra)
- Kanniyakumari (Tamilnadu)
- Rameshwaram (Tamilnadu)
- Bepore (Kerala)
- Androth (Lakshadweep Islands)
- Nizampatnam (Andhra Pradesh)

### Development of High Resolution Geoid Model

In the second phase, efforts are on at following ports for installation and upgradation. Construction/ modification of tide gauge cabins at these locations is in progress.

- Pondicherry (Pondicherry)
- Mumbai (Maharashtra)
- Karwar (Karnataka)
- Aerial Bay (Andaman & Nicobar Islands)
- Nagappattinam (Tamilnadu)
- Chandipur (Orissa)
- Campbell bay (Andaman & Nicobar Islands)
- New Mangalore (Karnataka)
- Garden Reach (Kolkata)

In the third and final phase, the following 13 tide gauge stations are proposed to be established by June 2007.

- Vadinar (Gujarat)
- Okha (Gujarat)
- Porbandar (Gujarat)
- Veraval (Gujarat)
- Hazira/ Dahej (Gujarat)
- Sagar (Kolkata)
- Diamond Harbour (Kolkata)

As it is a well known fact, Levelling is a laborious process and GPS observations cannot give the heights directly above Mean Sea Level (MSL), which is essential for depicting height information in the form of contours in our mapping. In order to make use of GPS to obtain heights above MSL, determination of geoid undulation is essential.

It would not be out of place to mention here that the globally available geopotential model(s) do not fit into the Indian subcontinent very well (inaccuracy in height may be  $\pm 5$  m or more).

In order to meet the requirement of 'GPS Levelling', a High Resolution Geoid Model 'INDGEIOD' Version 1.0 is being developed at Geodetic & Research Branch by combining available long wavelength Global Geopotential Model in combination with high frequency gravity data. The resultant High resolution Geoid

Model will help in obtaining heights within the accuracy of  $\pm 5$  cms. in combination with GPS measurements.

With the help of this developed geoid model, laborious levelling procedures can be completely avoided and better

heights can be obtained for disaster management and coastal inundation mapping etc. Version 1.0 of this Geoid Model is expected to be ready by March 31, 2007.

Efforts are also being taken to develop a 'Hybrid Model' combining gravimetric geoid undulation and geometric geoid undulation details. However, this will be taken-up only after the present gravimetric geoid undulation model 'INDGEIOD' goes through few more iterations and also sufficient GPS observations are available for providing gravimetric undulation data.

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2. Geoid, Vol III, Issue 1, January – March, 2007, A News Bulletin of Geodetic & Research Branch, Survey of India.



#### Brig (Dr) B Nagarajan

is presently the Director of Geodetic & Research Branch of the Survey of India. He has Masters and PhD degree in

Geodesy from Ohio State University, USA. He has more than 30 years of service in all facets of surveying. Various projects discussed in the article are being executed under his guidance.



#### Shri R K Sawhney,

Officer Surveyor is presently working as one of the Technical Staff Officer, monitoring the technical activities of the Geodetic &

Research Branch of Survey of India. He has a Masters degree in Mathematics and 20 years experience in the field of surveying.



Fig 6



# "Printed maps will continue to be in demand

although distribution mechanisms and types of products available may change"

**JOHN PAYNE, PRESIDENT, INTERNATIONAL MAP TRADE ASSOCIATION**

IMTA claims to be "the voice of the industry worldwide". Please comment.

The IMTA was established over 25 years ago with the aim of promoting the interests of all companies and businesses involved in the mapping industry, from retailers of atlas products and manufacturers of globes, right through to the developers and distributors of geographic information systems and spatial data. As you know, our industry has many aspects to it and there is no one organisation, except the IMTA, responsible for linking together all the many companies that are involved in producing a product and bringing it to market. By its structure into three specific regions, the IMTA is a truly global organisation. The IMTA has recently re-evaluated its strap line and believes that the one we have adopted for 2007 and beyond "Connecting the Business of Maps Worldwide" better reflects our roles and objectives.

## What is IMTA all about?

The International Map Trade Association (IMTA) represents the commercial interests of the global mapping and spatial information industry. It is organised into 3 regions, The Americas, Asia Pacific, Europe, Africa and the Middle East, and altogether represents over 500 companies and organisations from over 50 countries. We are committed to:

- Bringing together in one organisation, for mutual benefit, persons, firms and institutions engaged in the production and sale of maps, globes, spatial information, software and related products and materials;



**J K Payne (John)**  
International President,  
International Map Trade  
Association (IMTA)

John has over thirty years experience in the production, sales and distribution of maps and spatial information. He was one of the foundation members of the Asia Pacific Region of IMTA and has been a Board member since the establishment in 1989 in Australia of an industry organisation. In 2004 he was elected the International President of the Association.

John is a graduate of the Australian National University, spent 30 yrs working for the Australian Federal Government's mapping organisation (now called Geoscience Australia) and is currently Managing Director of, Earthinsite.com Pty Ltd, which specialises in the use of the Internet for the delivery of spatial information products.

- Providing services and educational programs, consistent with the needs of the membership;
- Promoting high standards of professional competence, conduct and ethics; and
- Fostering communication and cooperation within the global mapping and spatial information industry.

## Is it an association or does it make maps?

The IMTA is a business association providing mechanisms which its members can use to improve and grow their businesses. It does not produce maps of its own. Instead, it leaves this to its many members to undertake.

## Does IMTA carry out profit-making activities as well?

The aim of the IMTA is not to make profit but to undertake activities and services that provide a beneficial return to its members. This includes organising and managing trade shows and conferences and providing other communication mechanisms by which members can grow their businesses. In providing these services, there is understandably a need to ensure that they are provided value for money for all organisations participating, whether they be members or not.

## Could you highlight some of its main achievements?

The IMTA undertakes a global programme of activities each year. These include undertaking three trade



shows and conferences a year, one in each of the main continents of Europe, the Americas and the Asia Pacific area. These events include forums for government agencies, retailers and publishers that provide an opportunity for both members and non members to promote their services. They also include programs aimed at educating participants in emerging technologies and business practices. The IMTA also participates in other associated events such as book fairs in Frankfurt, Tokyo and New York and also in the ESRI Users Conference in San Diego. The IMTA was also a founding member in the establishment of the Joint Board of Geospatial Information Societies (JB GIS), which is a coalition of leading international geospatial societies that can speak on behalf of the geospatial profession at international level, especially to the United Nations and other global stakeholders (<http://www.fig.net/jbgis/>). We have also been a founding member of the UK Geoforum, a group comprising all spatial information societies in the UK with the aim of working together jointly to promote the spatial information industry and the related industry societies.

## How do you encourage use of emerging technologies?

New technologies, cartographic techniques and mapping products are emerging all the time – and keeping up-to-date with industry developments can be a real challenge. That is why the IMTA organises global conferences to facilitate the exchange of information between companies. At these conferences, not only are there displays of new products by participating companies, but educational and information forums are also held for the benefit of all members. In addition, we produce a regular journal for members called The Map Report. This journal contains a broad range of articles and features on new developments, trends and products in the industry. Our web site also provides a forum for new products and

services to be advertised and discussed.

## Do you lobby for conducive map policies?

The IMTA does not have any specific policies for governments of lobbying countries to ease the restriction on the production and distribution of spatial information. However, we find it best to work in conjunction with our members in those countries to assist in the growth of their business.

## How do you see the future of map making industry?

The map-making industry is a broad term. If you are talking about printed products, I believe that there will still be a demand for printed products for many more years to come. I can remember that over 10 yrs ago some were predicting the demise of the printed map but that has not stopped the production of many more maps than was available years ago, and the growth in speciality map shops. In some countries there has been a rationalisation of map outlets but in others there has been a significant growth. These outlets now offer a wider range of products, both in hardcopy and digital, and also a range of ancillary products such as GPS and software.

With the increasing ease of availability of maps and mapping products over such delivery mechanisms such as the web there has been a corresponding increase in map usage amongst the public and businesses. For example, many more businesses are now using maps in their day to day business and mostly in digital form. Individuals can now plan a trip via the web but many still buy a printed product before they leave.

Although distribution mechanisms and types of products available may change I am optimistic that our industry will continue to grow for many years to come.



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# Building sustainable cities using enterprise GIS

Honolulu, Hawaii recognized the enormous potential of enterprise GIS over 20 years ago and has developed an award winning system

## MAYOR JEREMY HARRIS RET

**T**he onset of the 21st century marked the beginning of the Asia-Pacific era. This is the region where most of the world's growth and economic development will occur over the next twenty years. The new millennium also signaled the birth of the urban era. Half of the world's population now lives in cities, and that number is growing rapidly. In fact, the rate of urbanization in the Asia/Pacific is alarming. The region currently has a population of 3.5 billion people; with that number expect to grow to 5 billion within the next 20 years. Most of that growth will occur in Asia's cities.

This rapid urbanization presents staggering challenges for the region's city governments. Up until now, most cities have not developed in a sustainable way. Economic development, land use planning, urban infrastructure, sewers, potable water systems, solid waste handling, and transportation systems are all inadequate to meet current needs let alone the rapid growth that lie ahead.

Most cities have very limited resources to provide for the growing demand for services that comes with rapid urbanization. To meet this challenge, cities have to be organized and managed as efficiently as possible.

City leaders need to restructure city operations and institute management reforms that increase productivity.

The most important tool that a city can deploy to meet this challenge is an enterprise-wide Geographic Information System. In order for cities

to achieve urban sustainability, government leaders need to organize and manage cities utilizing a systems approach. Such a systems approach cannot be achieved without employing enterprise GIS. GIS technology will enable city leaders to integrate and visualize enormous amounts of data for better decision making. Land use planning, infrastructure operations and maintenance, emergency services, tax assessments, public safety services, economic development, and virtually every other city function can be enhanced with the use of a city-wide GIS system.

Honolulu, Hawaii recognized the

enormous potential of enterprise GIS over 20 years ago and has developed an award winning system that improves city services, saves taxpayer dollars, and advances urban sustainability.

## Economic development

Without a strong sustainable economy, no city, state, or local government can offer the opportunity for a high quality of life to its citizens. All of the challenges that a city faces are related in some way to its economic base. Land use planning will be profoundly affected by the type of economy a city develops. Land use will then dictate infrastructure investment. Sewers, water, utilities and transportation systems will be driven by the land use plan.

Developing a sustainable city with true economic opportunity requires a comprehensive city master plan that understands and takes into account these complex interrelationships. An enterprise-wide GIS system is an invaluable tool in developing such plans.

The first step of the master planning process is to conduct a resource assessment of the city and then to analyze these resources from an economic development perspective. Resources may take many forms. Natural resources such as forests or water resources are easily understood, but other resources, such as the workforce, a good infrastructure, a transparent taxation system, and recreational and cultural resources may be even more important.

An enterprise GIS system allows a city to assess resources and guide the development of its master plan to optimize the use of these resources in a sustainable way.

GIS can help a city determine which target industries have the greatest potential for expanding the region's economy and can help to develop the detailed economic development plans the city needs

to realize its economic potential.

In Honolulu, all aspects of the city's resources and infrastructure are in its GIS system. Topography, sewers, historic buildings, transportation systems, police beats, wind energy resources, emergency response times, demographics, traffic markings, these are just a few of the databases that can be accessed and integrated in the city's planning process through GIS. By being able to integrate information from all of these sources and a hundred more, the city can make better decisions to advance its economy.

The City of Honolulu utilizes its enterprise GIS system and its award-winning city website to market Honolulu around the world over the internet. By logging on to Honolulu's Economic Development website, potential investors can access every piece of commercial property that is for sale on the island. By entering their selection criteria they can determine which properties meet their needs. Investors can call up complete demographic information for any radius around a property they may be interested in, as well as all information relating to such things as infrastructure, zoning, taxes, traffic volumes, and land use plans. The potential investor can even use the GIS system to view the traffic in the area in real time by accessing the city's transportation video camera system that is integrated into the enterprise GIS.

## Land use

Building livable and sustainable cities starts with good land use policy. If land use is not planned and managed correctly then all other city functions fail. Land use decisions drive infrastructure, determine transportation systems, frame energy policy, affect economic development, and impact the quality of life in a city in immeasurable ways. Here again, enterprise GIS is invaluable to a city facing these challenges.

Many cities are now paying the price

for flawed land use planning decades ago. Urban sprawl destroys valuable open space and agricultural land and has required the development of costly and inefficient freeway and highway systems. This has resulted in poor mobility, automobile generated air pollution and high "opportunity costs" with people and goods tied up in traffic jams for hours each day.

Another result of these previous land use planning mistakes was the death of downtowns. With people moving to the suburbs, downtown stores and shops closed their doors and relocated to suburban shopping centers, leaving many downtowns plagued with crime and decay.

In Honolulu, enterprise GIS is central to the land use planning process. All of the attributes of all of the land on the island is included in the GIS system. Property ownership, population distribution, topography, soil types, water lines, drainage systems, building plans, development patterns, land use regulations, are only a few of the types of information databases that city planners have access to through the city's GIS system to make better land use policy decisions.

Most cities have tremendous potential to expand their tourism industry. In many cases, however, tourism is being developed in an unsustainable way. In other words, as tourism grows it diminishes the very things that the visitors are coming to see and experience. If this continues, visitors will ultimately stop coming and the industry will fail.

GIS can be used to help grow tourism so that the industry fosters the enhancement of the natural, scenic and cultural resources that are the foundation of the tourism economy and to expand tourism into new niche areas not previously developed.

When Honolulu was planning for the revitalization of its tourist center in Waikiki, planners used GIS to identify all of the building structures that were over 30 years

old and had the greatest potential for redevelopment. Open space, floor area ratios, tsunami inundation zones, infrastructure capacity, and view planes were all analyzed using enterprise GIS, before planning decisions were made. When the City was planning its development of a sports tourism industry, GIS was again instrumental in identifying appropriate properties for sports facilities and for maintenance planning for park lands.

Urban design is also extremely important for sustainable urban planning and economic development. In the past, cities competed to attract business and industry to their communities. Once established, these businesses attracted talented workers in the city and its prosperity grew.

Now this model is being reversed. In the more mobile new world, the competition between cities is for talented workers. This means that making your city a great place to live is no longer simply “nice to do”, it is essential for economic survival. Much of what makes a city an attractive place to live centers on good urban design. Streetscape design, urban landscaping and architectural design can all be improved utilizing an enterprise GIS system in order to enhance the livability in a city and make it more competitive for the skilled workforce.

In Honolulu, the City has made extensive use of enterprise GIS in urban design in the revitalization of its communities. Utilizing its GIS system, Honolulu planners, as well as its citizens, can “fly thru” a digital Honolulu evaluating planning and urban design options from every perspective. Viewers can stop at any building and instantly call up the floor plans and construction plans of the structure, its utilities, view planes, and street trees. By utilizing companion Sketch-Up software, planners and citizens can use GIS to jointly design and illustrate an infinite number of urban design scenarios for the subject urban area. Enterprise GIS provides the City of Honolulu with the ability to integrate

a wide array of architectural, technical, infrastructural, and aesthetic variables into its urban design decision making, and to educate and involve the general public in the design process as well.

## Transportation

Perhaps nothing is as important to a city’s economic vitality as a good transportation system. Cities that have been developed around automobile transportation invariably face enormous losses in productivity with workers, goods, and commerce delayed in unproductive traffic congestion. A truly sustainable city with a vibrant economy needs efficient and convenient mobility.

To achieve this goal, cities need to take a systems approach to transportation. Only an integrated approach utilizing a variety of technologies and advanced traffic management techniques can provide for the transportation needs of a modern city. Here again, an enterprise GIS system is a valuable tool.

In Honolulu, the City utilizes GIS in transit planning, trip generation, and travel time analysis. Bus routes and stops are better planned, managed and maintained as a result of GIS, bike routes are inventoried, and street and lane markings are efficiently inventoried, catalogued and evaluated utilizing the GIS aerial inventory of photography.

Highway planning in Honolulu also relies on GIS with its extensive databases of land use, soil types, and aerial photography. Even the demographic data available in its GIS is utilized in the island’s transportation planning. To avoid negative transportation projects from always being located in low income communities, the city has established an Environmental Justice program which uses GIS to evaluate the socio-economic aspects of affected communities before any transportation infrastructure is planned.

## Urban infrastructure

The quality of life in a city is greatly affected by the efficacy of its urban infrastructure. Storm-water drainage systems, wastewater treatment, and solid waste recycling programs directly impact environmental quality in an urban area. An enterprise GIS system allows city governments to plan, operate and maintain its urban infrastructure more effectively.

Refuse can quickly overwhelm a city if it is not handled in an efficient and sustainable way. GIS can help cities better plan their solid waste collection operations. In Honolulu, GIS is used to plan automated and manual solid waste pick-up routes, increasing system efficiency.

Clean drinking water is vital for a city’s economy and for the health and well being of its citizens and visitors. The lack of pure drinking water is perhaps the largest obstacle to the growth of tourism in some cities, and contaminated water supplies represent the largest threat to public health.

In Honolulu, the entire potable water system is GIS based. All of the City’s watersheds, wells, reservoirs, pump stations, fire hydrants, and transmission lines are on the enterprise GIS. Utilizing GIS, water managers are able to track water consumption using a wide array of variables.

The maintenance and repair of the island’s entire water infrastructure is also GIS based. Field workers, carrying hand-held computers can call up the construction details of a damaged water main while in the field, make the necessary repairs, and update the GIS database on the repaired utility while still at the site. By providing the utility with as-built drawings in the field and up to the minute maintenance records, the efficiency of this vital public service is greatly enhanced.

Storm-drain and wastewater systems are similarly operated and managed. Every storm-drain manhole cover in Honolulu has an attached



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bar code. Work crews carrying handheld computers simply swipe the manhole cover and have instant access to the maintenance records of that catch-basin. Once their maintenance duties are performed, workers enter the information into their hand-held computers and that information instantly updates the citywide GIS data base. In this way, the efficiency of the storm-water system is dramatically improved, and emergency response personnel evaluating the potential flooding impact of an oncoming storm will be able to evaluate flooding risks on a street by street basis.

Natural disaster planning and response, police and fire operations, renewable energy resource inventories, park planning and maintenance, real property tax assessment; in case after case, the institution of an enterprise-wide GIS system has improved city operations and reduced operating costs in Honolulu. Cities throughout the world are realizing that the application of enterprise GIS is essential if local government is going to improve the livability and sustainability of their communities.

The Sustainable Cities Institute (a Honolulu based NGO) and its partners, has established a number of services and training programs to help cities in meeting these challenges.

## The Mayors' Asia/Pacific environmental summit

The Mayors' Asia/Pacific Environmental Summit (MAPES) is a unique forum for mayors and other local government officials in the Asia/Pacific region to assist cities in becoming more sustainable utilizing enterprise-wide geographic information systems (GIS). The program helps city leaders advance the protection of their urban environments, promote sustainable development, and share information and best practices about sustainable urban technology and management between cities.

This biennial summit focuses on leadership building, training, and capacity building for city leaders and managers. Since its founding, over 120 cities from 30 countries have participated in the MAPES program.

In addition to providing Summit activities, MAPES also provides targeted support for city leaders in the form of Executive Seminars, City Leaders' Training Programs, and Technical Advisory services. In conjunction with the Royal Institute of Technology, Stockholm, Sweden, a two day Certificate in Sustainable Urban Development training program for selected Mayors and city managers is also offered.

MAPES is a unique partnership of city leaders, municipal associations, world renowned experts, donor organizations, and NGO's that leverage support for cities that are committed to sustainable development.

In addition to The Sustainable Cities Institute, other MAPES collaborating partners include the Asian Development Bank (ABD), the International Council for Local Environmental Initiatives (ICLEI), US-Asia Environmental Partnership (US-AEP), the United Nations Environment Program (UNEP), the Stockholm based Royal Institute of Technology (KTH) and the Global Environment & Technology Foundation (GETF), as well as others.

## City Leader training program

This program is an exclusive, state-of-the-art training and mentoring program for sustainable, urban development directed at city leaders and executives.

Under this program, The Sustainable Cities Institute in partnership with the Royal Institute of Technology in Stockholm, Sweden will send the Royal Institute professors to the participating city to provide a two to three day training program for city personnel in sustainable urban infrastructure utilizing enterprise GIS.

The coursework includes training in land use planning, municipal solid waste handling and recycling, wastewater treatment and recycling, green building design, municipal energy efficiency, renewable energy, urban transportation, and urban design, utilizing enterprise GIS. Upon successful completion of this course, participating city staffs earn a Certificate in Urban Sustainability from Stockholm's prestigious Royal Institute of Technology.

## Advisory services

The Institute provides advisory services to cities in the areas of city master planning and resource assessment, economic development (specializing in sustainable tourism), land use planning and urban design, solid waste handling and recycling, water system development, wastewater treatment and recycling, transportation, parks and recreation, energy, and city management and technology. Once again, the application of an enterprise GIS system is central to the advisory services provided.

An Institute team is available to travel to a requesting city to provide either a comprehensive review of city operations or to focus on a particular problem area. The team will make presentations to city staff and recommendations to city leaders once its review is complete.



**Jeremy Harris** served for more than ten years as the Mayor of the City and County of Honolulu, Hawaii. He retired from politics in January 2005.

Prior to becoming Mayor, Harris was Honolulu's longest serving Managing Director, a position he held for nine years. [Jeremy@JeremyHarris.net](mailto:Jeremy@JeremyHarris.net)

# Munich satellite navigation summit ... goes global

A review on one of the most famous european satnav symposia

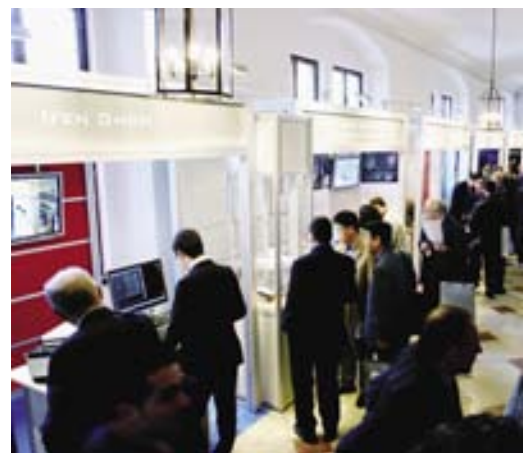
HEIKE HAAS

The Munich Satellite Navigation Summit (MSNS) 2007 closed on March, 8th – about 400 guests from 28 nations left Munich after three days conferencing. In the run-up of the MSNS the conference advertised with the words: High quality, high rank, high tech, high interaction which was already fulfilled in the Opening Plenary Panel at the “Allerheiligenhofkirche” of the “Residenz München”.

Prof. Dr. Guenter W. Hein, director of the Institute of Geodesy and Navigation of the University FAF Munich and organiser of the MSNS welcomed everybody to the conference titled “Munich Satellite Navigation Summit... Goes Global”. Matthias Ruete (European Commission, Brussels), Ralph Braibanti (US State Department, USA), Pedro Pedreira (GSA, Brussels), Guiseppe Viriglio

(ESA, France) and Erwin Huber (Bavarian Department of Transport and Technology) were the panellists of the Opening Plenary Panel. Ruete said that “Munich has become a very particular rendezvous in the world of satellite navigation.” He pointed out that “Galileo has already seen crisis in the past and the way forward has already been found. We need this crisis to find the way to move forward.”

During the following days experts from science, industry and politics discussed the advantages and challenges of GNSS and especially of Galileo. After getting updated in the first session, the auditorium could listen to sessions like “Galileo at the crossroads – a debate between the Galileo responsables”, “Starting, waiting or no interests in Galileo/GNSS applications” or “Do we know more about the Galileo Public Regulated Service (PRS) now?”



Exhibition Area

Beside the conference 15 organisations and institutions had the opportunity to present themselves or their products on the Summit Exhibition. The exhibition as well as the two evening receptions and many side-meetings made a successful networking possible. Nevertheless the MSNS 2007 was characterised by many honest appreciations especially concerning the delay on Galileo. One of the highlights at MSNS 2007 was the last session with Thomas Reiter, the German crew member of the ISS. He referred about the 166 days in space and explained the importance of the research work during his time in the shuttle.

The Munich Satellite Navigation Summit 2008 will be held from February 19th to 21st. The run on the tickets 2007 should call everybody's attention on a well timed registration.

The complete summary of the Summit documentation is available on: <http://www.munich-satellite-navigation-summit.org/DocumentationIndex.htm>



Hein, Pedreira, Huber, Ruete, Braibanti, Viriglio (left to right)

**Heike Haas**

Institute of Geodesy and Navigation,  
University FAF Munich, Germany



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# TEC values estimation over a permanent GPS station

A rapid method of monitoring the ionospheric disturbance using dual frequency GPS data of the Aristotle University Thessaloniki (AUT1) permanent station is presented

CHRISTOS PIKRIDAS AND MILTIADIS CHATZINIKOS

The ionosphere represents one of the most important error sources that affecting GPS positioning. It is strongly related to solar activity and geomagnetic field. The GPS satellites and dual frequency receivers can be used to measure the Total Electron Content (TEC) of the Earth's ionosphere. Global electron content maps have been produced by various research centers using the world-wide permanent network of GPS receivers. In this study a rapid method of monitoring the ionospheric disturbance using dual frequency GPS data of the Aristotle University Thessaloniki (AUT1) permanent station is presented. The Total Electron Content can be determined using the so called Single Layer Model (SLM) of the ionosphere. The SLM is based on the assumption that all free electrons are concentrated in a spherical layer of infinitesimal thickness (single layer) at height  $H$  above the earth's surface. The Total Electron Content is modeled as a truncated Taylor series with the geographical latitude and the hour angle of the sun as independent variables, using the L4 – geometry free linear combination. The results are confirmed using global information for Sun spot and geomagnetic activity from NOAA and Kyoto University respectively.

## TEC estimation from GPS data

The change in satellite to receiver signal propagation time due to the ionosphere is directly proportional to the integrated free-electron density in a column of one meter-squared cross-section along the signal path. Ionosphere consists of a shell of

ionized gas plasma surrounding the Earth between altitudes of about 80 and 1000 Km. In order to model the TEC parameter over the test area GPS data from our permanent station named AUT1 was used. The ionospheric model is a single-layer model at 350 km from the earth's surface. The model makes the assumption that all the electrons are concentrated in a spherical layer at height  $H$  above the earth's surface. The observable is the plain difference of the L1 and L2 phases (L1-L2, both expressed in meters), the parameters are the coefficients of a two dimensional Taylor series development as given in equation 1 (the independent arguments are geocentric latitude and hour angle  $S$  of the sun) of the electron density of a single layer model of the ionosphere. Therefore for each session data an electron density containing five parameters is written as follows:

$$E(\varphi, S) = E_{00} + E_{01}(S-S_0) + E_{02}(S-S_0)^2 + E_{10}(\varphi-\varphi_0) + E_{11}(\varphi-\varphi_0)(S-S_0) \quad (\text{Eq. 1})$$

where:  $S$  is the hour angle of the sun which defined as the angle between the sun and the local meridian. The local solar time  $t$  is related to the hour angle of the sun as:  $t = S + 12^h$ .  $\varphi$  is the latitude  $\varphi_0, S_0$  are the suitably chosen origins of the development.

In October 2003 the GPS rinex data, with 30-sec sampling rate cut-off angle of  $15^\circ$  along with precise satellite orbits and clock corrections, was selected in order to generate ionospheric TEC data. The GPS data was processed with Bernese software and the parameters of equation 1 were estimated using a least squares algorithm (for more details see Wild, 1994).

## Global information for Solar and Geomagnetic activity

Due to the dependence of the ionosphere on the solar radiation and

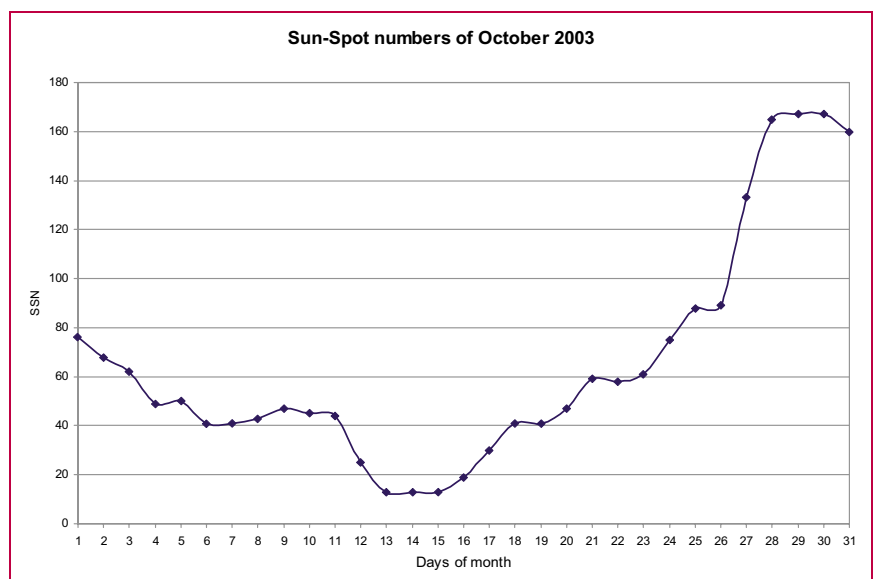


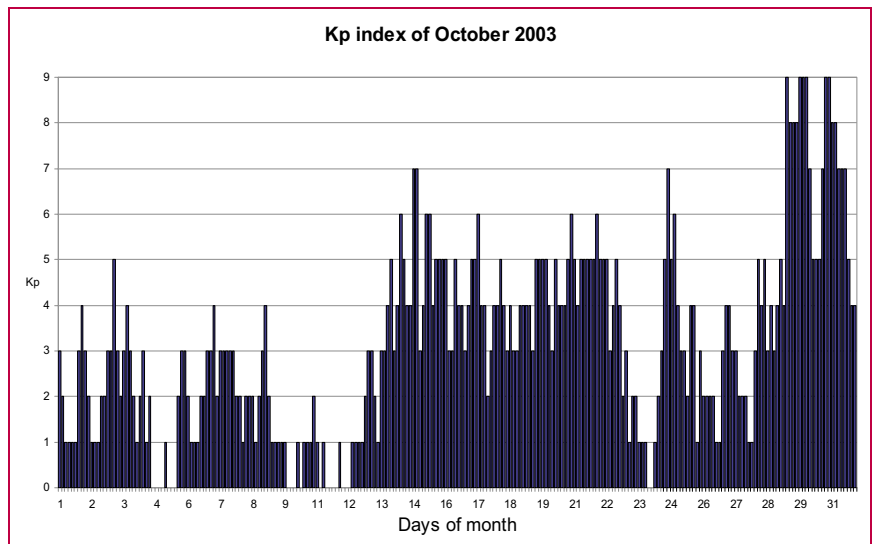
Figure 1: The Sun-Spot numbers during October 2003

the geomagnetic field, first the sun spot activity was examined using the relevant information of NOAA National Geophysical Data Center, which provides scientific products and services for geophysical studies. It is known that the solar cycle varies over a period of typically 11 years from trough to peak and then back to another low point. The conventional index of the cycle is known as the sunspot number (SSN) which is defined from observations of the sun by optical telescopes and can be used as a predictor of ionospheric disturbance. The increment in sunspots induces a series of solar flares and coronal mass ejections. Solar flares are explosions on the surface of the sun that produce a quick directed high-speed blast of charged particles and electromagnetic energy. The SSN numbers of October 2003 are presented in Figure 1. As it is clearly shown the days from 14 to 16 are characterized as quiet with SSN less than 20, while for 27 to 31 the SSN is over 160, which means storm event.

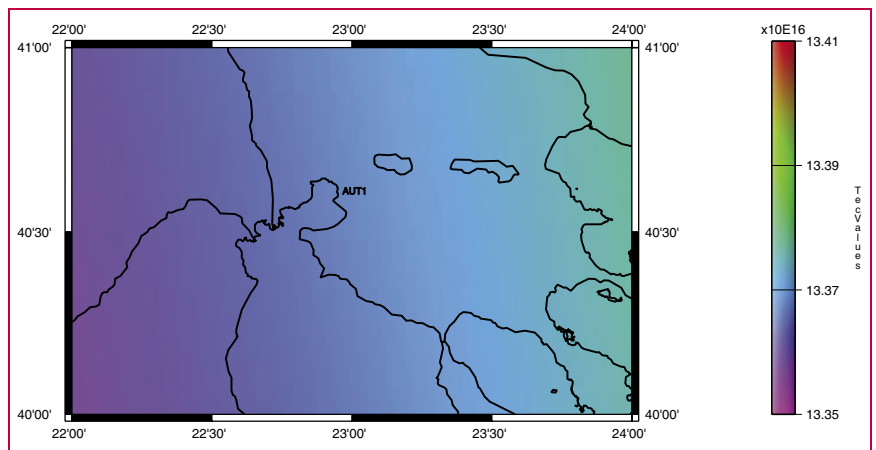
In order to have the best possible global information about the ionospheric activity we have also investigated the magnetic conditions using the available information from the Data Analysis Center for Geomagnetism and Space Magnetism of Kyoto University in Japan.

Variations in Earth's magnetic field are measured by magnetometers. There are two measurements readily available from magnetometer data, the daily A index and the three-hour K index. The A is an average of the eight 3-hour K indices, and uses a linear scale and going from 0 (quiet) to 400 (severe storm). The K index uses a quasi-logarithmic scale (which essentially is a compressed version of the A index) and goes from 0 to 9 with 0 being quiet and 9 being severe storm. Generally an A index at or below 15 or a K index at or below 3 is best for propagation. As the K values increase, the severity of the storm increases. Figure 2 illustrates the state of geomagnetic conditions (Kp index, p stands for planetary) for the days of October 2003.

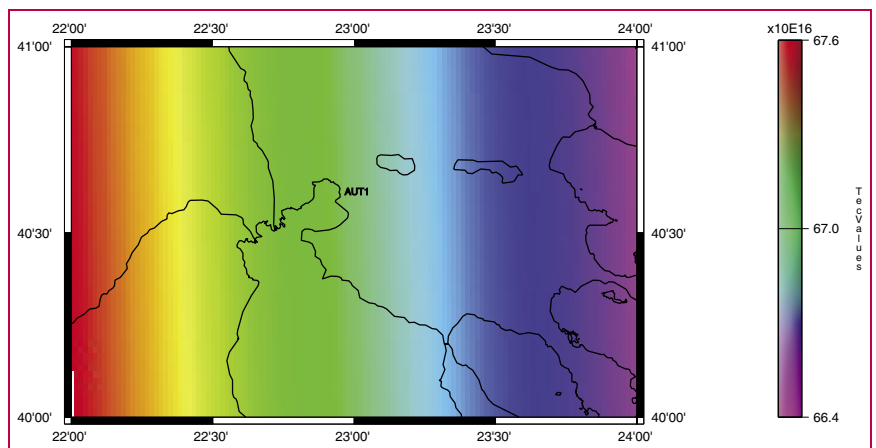
Same results with figure 1 are shown



**Figure 2: Planetary Kp indices for the period of October 2003**



**Figure 3: The total electron content (TEC) in the broader area of the GPS permanent station on 16/10/2003 at 10:00 UT.**



**Figure 4: The total electron content (TEC) in the broader area of the GPS permanent station on 29/10/2003 at 10:00 UT.**

especially for days between 28 to early of 31 where the geomagnetic activity was very high and reached at its maximum value of 9. From many researchers these days have been

characterized as one of the most exciting space weather events in recent history. For comparison purposes and in order to better understand the event and its impact on GPS positioning we



produced two ionospheric maps for the broader area of Thessaloniki where the permanent GPS station is located. All the maps were generated using the Generic Mapping Tools. The first map is for the 16th day of October on 10 UT time which in general is under quiet geomagnetic and solar activity with SSN number almost 20 and Kp index less than 4. We processed every one hour the GPS data and the produced results are illustrated on figure 3. It is clearly shown that the ionospheric conditions are at very low order of magnitude with TEC values (at 10 UT) between 13.35 to 13.39 TECU (TEC Units). On the contrary, during intense storm conditions with SSN 170 and Kp equal to 9 as it was expected, TEC values for the 29th day of October at 10 UT are over 5 times bigger and reached 67.6 TECU. For these geographic latitudes (40-42N), TEC values greater than 50 TECU reflect the enhanced storm phenomena associated with large gradients and high ion flux values. Figure 4 illustrates the TEC values in the broader area of the permanent station where also a different spatial variability- plume is sparsely shown.

## Conclusions

In this study a rapid method for monitoring ionospheric variations using data from only one permanent GPS station is presented. TEC data are estimated using the iono-model of single layer where dual frequency GPS data are used in a least squares procedure. The model was found to be adequate during quiet and storm conditions, which indicates that, for surveying applications in the vicinity (up to 100 Km) of permanent GPS tracking stations, the ionosphere models distributed by the permanent station are sufficient for use. TEC maps are produced with time resolution of one hour, which is a rapid scheme of knowing space weather conditions. Therefore a user can be quickly informed whether a day is characterized by a high ionospheric activity for GPS signals, in order for him to better handle the

corresponding errors. Also, knowing space weather conditions in a short time interval can be found useful for telecommunication systems, as well as navigation systems. Furthermore, more reliable ionospheric results using more sophisticated models for bigger areas or countries can be produced, if data from several GPS receivers, being part of permanent networks, combine.

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# Mangrove habitat dynamics

This study reports on a mangrove monitoring task using LandsatTM and IRS-LISS-III data to assess mangrove ecosystem dynamics in Sunderban, India

S K SINGH



Sunderban, one of the largest mangrove forests in the world, is located in the deltaic region of Ganga and Bramhaputra rivers in India and Bangladesh. The impact of biotic and abiotic factors on Sunderban is enormous (Rao, 1959), due to which the area has got reduced to nearly half during the past few centuries (Blasco, 1975; Naskar and Guha Bakshi, 1982; Naskar, 1985). The mangrove-forested area of Sunderban (including portions in Bangladesh) was recorded to be 20,000 km<sup>2</sup> by Clark (Annon., 1895), and 17,500 km<sup>2</sup> by Prain in 1903. Griffith (1982) reported that mangrove forests in the Sunderban covered over 4264 km<sup>2</sup> and 4109 km<sup>2</sup> respectively in India and Bangladesh during early eighties. The present area of Sunderban is 2081 km<sup>2</sup> (Anon., 2001).

Baseline information on mangrove resources is still lacking and improper utilization has lead to their threatened status. Present study gives the type and extent of vegetation cover available and the kind of changes it has experienced. The trends of changes have been utilized for predicting the future extent and distribution. The above

information was then used for conservation prioritization.

Haliday Wildlife Sanctuary (6 km<sup>2</sup>).

## Study area

Sunderban is located in eastern India in the state of West Bengal along sea coast. The total geographical area of the Indian part of Sunderban is 9630 km<sup>2</sup> between the (21° 31'N and 22° 30'N and 88° 10' E and 89° 51' E), in north and south 24-Pargana districts. The limit of the Sunderban has been demarcated by the Dampier and hodes Line in 1831. Six principal estuarine rivers viz; Bartala, Saptamukhi, Thakuran, Malta, Gosaba and Herobhanga drain via Sunderban into the Bay of Bengal in the southern extremities. The area falls under the inter-tidal zone and has tropical humid climate.

Sunderban has also been declared as Biosphere reserve (BR) under Man and Biosphere (MAB) of UNESCO and as World Heritage Site (1987). About 40 percent of the reserved forest area of SBR under protected area, which includes Sunderban Tiger Reserve (2585 km<sup>2</sup>), Sunderban National Park (1330 km<sup>2</sup>), Sajnakhali Wildlife Sanctuary (362 km<sup>2</sup>), Lothian wildlife Sanctuary (38 km<sup>2</sup>) and

## Data and Methods

Landsat-TM and IRS-1D/1C, LISS-III digital data were used for the present study. The details of the data are given in Table 1.

Survey of India (SOI) topographic maps of the study area on the 1:50,000 scale were used for geo-referencing. Village locations, roads, ferry network and drainage information was also taken from SOI maps. A field survey from Canning to Baghmara was carried out for four days to recognize and relate vegetation types to respective tonal variations on Satellite image. Various observations were noted in vegetation types and species composition. Major vegetation types together with locality details were recorded. All possible estuaries and creeks were visited using a jetty. Geometric and radiometric corrections were applied to the satellite data. The dark pixel subtraction technique (Lillesand and Kiefer; 1987) was used for radiometric correction. Different band combinations were used to extract more information from imagery. In general, the Landsat-TM (5,6,1) and LISS-III (3,4,1) were found to be good for delineation of Phoenix paludosa and Avicennia sp. dominated mangroves.

Table 1: Satellite data used in the present study

| Satellite | Sensor     | Path | Row  | Dated                              |
|-----------|------------|------|------|------------------------------------|
| Landsat   | Landsat-TM | 138  | 44   | 06.11.1987                         |
|           |            | -do- | -do- | 24.12.1987                         |
| IRS-1D    | LISS-III   | 108  | 56   | 16.12.2000, 01.12.2002, 12.12.1998 |
|           |            | -do- | 57   | -do-                               |
|           |            | 109  | 56   | 03.12.2000, 28.11.2002             |
| IRS-1C    | -do-       | -do- | 57   | -do-                               |
|           |            | -do- | 57   | 01.01.1998                         |
|           |            | 109  | 56   | 30.01.1998                         |
| -do-      | -do-       | -do- | 57   | -do-                               |

**Table 2: Area under different mangrove/ non -mangrove categories**

| S.No. | Land use Categories              | Area in km <sup>2</sup> |             |             |             |
|-------|----------------------------------|-------------------------|-------------|-------------|-------------|
|       |                                  | 1987                    | 1998        | 2000        | 2002        |
| 1.    | Agriculture                      | 3494                    | 3270        | 3171        | 3172        |
| 2.    | Avicennia sp.                    | 109                     | 153         | 153         | 153         |
| 3.    | Fallow land                      | —                       | —           | 3           | 2           |
| 4.    | Fish pond/water/logged area      | 161                     | 229         | 235         | 214         |
| 5.    | Forest blank                     | 49                      | 50          | 39          | 40          |
| 6.    | Dense mixed mangrove             | 2170                    | 2128        | 2050        | 2045        |
| 7.    | Mudflat                          | 57                      | 74          | 82          | 77          |
| 8.    | Open mixed mangrove              | 63                      | 61          | 99          | 99          |
| 9.    | Phoenix paludosa + Avicennia sp. | 190                     | 90          | 246         | 251         |
| 10.   | Sand                             | 13                      | 15          | 43          | 77          |
| 11.   | Tree farmland                    | 207                     | 352         | 426         | 446         |
| 12.   | Waterbody                        | 3113                    | 3107        | 3083        | 3054        |
| 13.   | Young Avicennia                  | 4                       | 1           | 00          | 00          |
|       | <b>Total</b>                     | <b>9630</b>             | <b>9630</b> | <b>9630</b> | <b>9630</b> |

On-screen visual interpretation technique was employed for mapping of mangroves and other land cover categories. Tone, texture, pattern, size, shape, shadow, coupled with site/ location and associated features were considered for delineation of land cover features. The classification scheme adopted in the present study was kept open- ended to facilitate the further augmentation of scheme by future workers. The simplified mangrove/non-mangrove maps for the period 1987, 1998, 2000 and 2002 were subjected to change matrix analysis to generate change/no-change maps pertaining to 1987-98, 1998-2000, 2000-2002 and 1987-2002. The vegetation type map showing mangrove/non-mangrove cover was imported into the GIS from the

image-processing platform for landscape analysis. Bio\_CAP software (IIRS,1998) was used for this purpose (IIRS, 1998, Behra, 2001). The landscape indices so derived was further operated over a complex linear model to obtain disturbance index (DI) map (Li and Reynolds,1994). For the landscape analysis, different mask sizes were used to assess the fragmentation starting from mask size of 75m × 75 m to the mask size of 350m × 350m at an interval of 25 m. On plotting the fragmentation level in different size, sigmoid stability was observed with 250 × 250 m. The 250 × 250 m mask size, therefore, was used for fragmentation assessment. The area for conservation was measured by calculating the amount of forest patches occurring in a landscape with respect to

non-forest patches and fragmentation was carried out using Bio\_CAP program. The vegetation cover map was reclassified into two categories namely, forest and non-forest. The fragmentation image was recoded to three levels of fragmentation excluding non-forest and snow/cloud classes and the area was calculated. A raster-based analysis was carried out on the forest and non-forest map. The fragmentation weightage was used to find out the maximum disturbed or the possibly disturbed areas. The weights were assigned to various levels of landscape indices for deriving conservation index viz; (change map 4, Soil 0.25, drainage density 1, disturbance index 2, land use/land cover 0.5, geomorphology 0.25). The high values require more attention for conservation strategies. The critical area for conservation in SBR was obtained by change analysis technique. The three period (1987-1998, 1998-2000, 2000-2002) time series analysis was carried out to find the dynamism of the pixel on temporal domain. The dataset was rescaled on the basis of dynamism. The highly dynamic pixel was named as critical areas. The areas are attributed to maximum changes in spatial extent due to both natural and anthropogenic agents. The mangrove dominated areas were stratified in three levels viz; high medium, medium and low. The ground knowledge and socio-economic drivers were used to validate the results.

**Table 3: Changes in the land cover between 1987 and 2002 through 1998 and 2002.**

| S.No. | Categories                      | Change period (km <sup>2</sup> ) |             |             |             |
|-------|---------------------------------|----------------------------------|-------------|-------------|-------------|
|       |                                 | 1987-1998                        | 1998-2000   | 2000-2002   | 1987-2002   |
| 1.    | Agriculture to dense mangrove   | 23                               | 17          | 6           | 35          |
| 2.    | Agriculture to water            | 103                              | 16          | 47          | 132         |
| 3.    | Dense mangrove to agriculture   | 11                               | 13          | 5           | 24          |
| 4.    | No change in mangrove           | 2464                             | 2448        | 2533        | 2379        |
| 5.    | Agriculture to open forest      | 9                                | 39          | 2           | 47          |
| 6.    | Dense mangrove to forest blank  | 4                                | 8           | 2           | 13          |
| 7.    | Dense mangrove to water         | 37                               | 16          | 5           | 55          |
| 8.    | Open mangrove to agriculture    | 6                                | 00          | 00          | 7           |
| 9.    | Open mangrove to dense mangrove | 5                                | 10          | 2           | 12          |
| 10.   | Forest blank to agriculture     | 5                                | 17          | 1           | 20          |
| 11.   | Water to agriculture            | 48                               | 32          | 99          | 136         |
| 12.   | Water to forest                 | 32                               | 20          | 4           | 60          |
| 13.   | No change in water              | 3193                             | 3283        | 3215        | 3078        |
| 14.   | No change in agriculture        | 3690                             | 3713        | 3709        | 3632        |
|       | <b>Total</b>                    | <b>9630</b>                      | <b>9630</b> | <b>9630</b> | <b>9630</b> |

## Results and Discussion

Fourteen land use/land cover classes viz., agriculture, Avicennia forest, fallow land, fish pond/water-logged area, forest blank, dense mixed mangrove, mud flat, open mixed mangrove, Phoenix paludosa forest, sand, tree farmland, water body, young Avicennia were mapped. The area under various categories is shown in Table 2. Maximum area is occupied by agriculture (32.93% of the total study area), followed by waterbodies (31.71%) and Pheoenix paludosa, Avicennia sp. (2.60%). Open mixed mangrove occupies

**Table 4: Area under different fragmentation categories in SBR**

| S.No. | Level of fragmentation | Area in km <sup>2</sup> | Area in %     |
|-------|------------------------|-------------------------|---------------|
| 1.    | High                   | 44                      | 0.45          |
| 2.    | Medium                 | 56                      | 5.84          |
| 3.    | Low                    | 2488                    | 25.83         |
| 4.    | Non-forest             | 6537                    | 67.88         |
|       | <b>Total</b>           | <b>9630</b>             | <b>100.00</b> |

0.65% whereas *Avicennia* sp. occupies 1.58%. Tree farm land occupies 4.63% and sand occupies 0.79%.

From the Table 2 it is clear that maximum area under agriculture was 3270 km<sup>2</sup> during the period of 1998 and fish pond/water logged area occupies 235 km<sup>2</sup> during the year 2000 and it is maximum in-between 1987-2002. Dense mangrove is estimated maximum during 2170 km<sup>2</sup> (1987) and goes on decreasing in the subsequent years 2128 km<sup>2</sup> (1998), 2050 km<sup>2</sup> (2000) and 2045 km<sup>2</sup> (2002). *Phoenix paludosa* and its associates spp has shown increasing trends 190 km<sup>2</sup> (1987) to 251 (2002), it is also indicating that lot of opening is coming is up because *Phoenix paludosa*

to 77 km<sup>2</sup> (2002). Change detection was carried in the image processing software in the GIS analysis through matrix for the period of 1987-1998, 1998-2000, 2000-2002 and 1987-2002. Table 3 shows the results.

Maximum area converted from agriculture to mangrove 82 km<sup>2</sup> from 1987 to 2002, dense mangrove changed to forest blank 13 km<sup>2</sup> in between 1987-2002 and dense mangrove to water 55 km<sup>2</sup> from 1987-2002. The fragmentation image obtained was categorised into three levels of fragmentation: low, medium and high. The area statistics shows 25.83 per cent area to be intact. Low, medium and high fragmentation areas together constituted 6.29 per cent

is light demanding. In SBR, lot of accretion is taking place and this is validated by the area of sand which shows a constant increase from 13 km<sup>2</sup> (1987)

of the area. The area in the western side of SBR (Ajmalmari and Dulbhashani) shows high level of fragmentation. These areas are close to settlements, roads and ferry points. Table 4 shows the fragmentation map of SBR. The SBR was found to be under low level of fragmentation. The area showing medium level of fragmentation all over Sunderban Biosphere Reserve is mainly on the fringes of creeks and channels.

Disturbance index image obtained was reclassified in to three levels of disturbance: low, medium and high. 10.73 per cent of the area falls under low level of disturbance. 14.21 per cent had medium and 1.58 per cent had high level of disturbance. Low disturbance areas were characterized by low level of porosity, fragmentation, patchiness, interspersed and high level of juxtaposition. The undisturbed and homogenous nature of mangrove forests was observed in porosity image. The image showed high levels of disturbance in western part of SBR (Saptamukhi, Thakuran and Ajmalmari). These areas

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**Table 5: Area under different disturbance index categories in SBR**

| S.No. | Level of fragmentation | Area in km <sup>2</sup> | Area in %     |
|-------|------------------------|-------------------------|---------------|
| 1.    | High                   | 153.                    | 1.58          |
| 2.    | Medium                 | 1368.                   | 14.21         |
| 3.    | Low                    | 1033.                   | 10.73         |
| 4.    | Non-forest             | 7076.                   | 73.48         |
|       | <b>Total</b>           | <b>9630.</b>            | <b>100.00</b> |

**Table 6: Area under different conservation priority categories in SBR**

| S.No. | Level of fragmentation | Area in km <sup>2</sup> | Area in %     |
|-------|------------------------|-------------------------|---------------|
| 1.    | High                   | 345                     | 3.58          |
| 2.    | Medium                 | 593                     | 6.16          |
| 3.    | Low                    | 1615                    | 16.77         |
| 4.    | Non-forest             | 7077                    | 73.49         |
|       | <b>Total</b>           | <b>9630</b>             | <b>100.00</b> |

**Table 7: Area under different critical zone categories in SBR**

| S.No. | Level of Critical zone | Area in km <sup>2</sup> | Area in %     |
|-------|------------------------|-------------------------|---------------|
| 1.    | High                   | 23                      | 0.24          |
| 2.    | Medium                 | 260                     | 2.70          |
| 3.    | Low                    | 2306                    | 23.95         |
| 4.    | Non-forest             | 7041                    | 73.11         |
|       | <b>Total</b>           | <b>9630</b>             | <b>100.00</b> |

are close to human habitation, roads and ferry points. Inaccessibility, risk to life from tiger and restrictions imposed by forest department are reasons for low disturbance in SBR. Conservation priority of the area was determined based on the information on forest cover, change, soil, drainage density, disturbance regime and geomorphology. The result shows that Lothian, Dia, Jameson, Prentice, Thakuran, Burge, Ajmalmari, central area of Herobhanga, eastern part of Sajanakhali WLS, Jhilla, northern side of Baghmara, central region of Gosaba and eastern side of Mayadwip need immediate attention. 3.58 per cent of the area falls under high priority zone. Medium and low together contribute 23.93 per cent of the total area. Middle level of conservation priority area is spread all over the Tiger Reserve and that too confined to creeks and channels. Most of the low conservation Priority areas are in the Tiger Reserve area except Dulbhasani and Chulkati area which comes under south 24 pargana division. The critical area map shows that the area near habitation and the loss in mangrove forest due to natural ebb erosion are to be considered for conservation on

priority basis. These areas come under Jambudwip, Sagar Island, Lothian Island and Ajmalmari. In the year 2020, the SBR will have 873 km<sup>2</sup> area under dense forest with more than 70 per cent probability, and 1311 km<sup>2</sup> dense forest with more than 50 per cent and less than 70 per cent probability. In the year 2050, it will have 104 km<sup>2</sup> dense forest with more than 70 per cent probability and 2097 km<sup>2</sup> dense forest with more than 50 per cent and less than 70 per cent probability.

## Conclusions

- Areas near habitation and facing creeks and channels are highly disturbed.
- The study has developed a comprehensive database and maps for conservation and planning of SBR and it could be further utilized for geo-spatial modeling.
- Mayadwip on its southern part has shrunk remarkably due to ebb erosion.
- In SBR, signs of degradation were observed viz; Pirkhali, Panchmukhani, eastern side of Baghmara bordering Bangladesh.

## Conservation Prioritization



- Areas identified for immediate management strategies are Ajmalmari, Dulbhasani, Thakuran, Saptmukhi.
- Jambudwip island has been found to be the most disturbed because of active human interventions and require immediate attention.
- There are certain areas of positive changes i.e. accretion due to upland formation. These new islands should be regularly monitored.

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Dehradun, India

*The complete paper  
with references can be  
seen at [www.mycordinates.org](http://www.mycordinates.org)*

## China cracks down on illegal surveying, mapping

China continues cracking down on illegal surveying and mapping and investigate and punish leaks of state secrets, said an official from the State Bureau of Survey and Mapping (SBSM). Seven government departments including SBSM, Ministry of Information Industry and National Administration for Protection of State Secrets have pledged to strengthen control of the geographical information market. A total of 759 cases of illegal surveying and mapping were found in 2006, and many of the cases involved foreign organizations and individuals. Last year, two Japanese scholars were fined a total of 80,000 yuan and deported for mapping the coordinates of an airport and water facilities in Xinjiang Uygur Autonomous Region. It was feared their results could be used for military purposes.

## Singapore police gets vehicle tracking system

Astrata Group Inc. has supplied a Vehicle Tracking and Immobilization System for Singapore's Police Force. The Police were able to monitor a fleet of cement mixers that had been fitted with tracking solution and had been granted access to a restricted area (where most vehicles were denied during the conference). <http://houston.dbusinessnews.com>

## In Iran, cheetahs collared with GPS devices

An international team of scientists led by the Wildlife Conservation Society working in Iran has successfully fitted two Asiatic cheetahs with GPS collars. This would help track highly endangered population of big cats. <http://caribjournal.com>

## South Korea aims to develop GPS-guided missiles

According to the Defense Acquisition Program Administration, South Korea would spend 43 billion won to develop GPS-guided missiles by

2012. The project is aimed at equipping currently-used missiles on fighter jets with the advanced navigational and surveying system. <http://english.yonhapnews.co.kr>

## Research leads to more efficient in-car GPS

Researchers at the University of New South Wales (UNSW), Australia, have developed the first receiver that can pick up both the L1 and L2C GPS frequencies, as well as the signal from the first prototype Galileo satellite. [www.sciencedaily.com](http://www.sciencedaily.com)

## GLONASS should be cheaper and better

The global navigation system GLONASS should be cheaper and of better quality than the GPS system. A total sum of 9.88 billion rubles (USD 380 million) has been earmarked for GLONASS program in 2007. In 2006, the figures were 23 billion rubles, respectively. According to Russia's Deputy Prime Minister Sergey Ivanov, Russian global navigation satellite system will be put into operation by the end of the year orbiting 18 space aircrafts of the GLONASS system by the end of 2007. [www.kommersant.com](http://www.kommersant.com), <http://en.rian.ru>

## Poland deploys nationwide GNSS infrastructure network

Trimble has been chosen by the Polish National Office of Geodesy and Cartography, GUGiK, to supply 78 Continuous Operating Reference Station (CORS) receivers and Trimble VRS (Virtual Reference Station) technology to establish a nationwide GNSS infrastructure network. The VRS network will provide a geospatial infrastructure for surveying, engineering and GIS professionals that enable high accuracy real-time kinematic (RTK) GNSS positioning without the need of separate base stations or software. [www.trimble.com](http://www.trimble.com)

## GPS breakthrough set to revolutionise undersea navigation

Engineers working for the US Office of Naval Research have found a simple way to let submarines and divers get an accurate GPS fix. It may lead to a revolution in navigation, as GPS would not work underwater due to the inability of radio signals to pass through water. According to New Scientist, a base station is tethered to the seabed at known depth and known GPS location. A submersible anywhere in the area sends out a sonar request pulse to which the base station replies with a signal that gives its GPS position and depth, as well as the bearing angle from which such request arrived. The submersible then uses its own depth, the round trip pulse time, and the bearing angle sent by the base to calculate its own position. [www.dailyindia.com](http://www.dailyindia.com)

## GPS to be used for identifying unauthorised hoardings

GPS shall be used to reduce visual pollution caused by illegal hoardings across New Delhi, India, which will help in keeping illegal hoarding at bay. A private agency will identify unauthorised hoardings, prepare an exhaustive data about them and constantly update officials on their status. All authorised hoarding shall have a computer chip that will carry its unique identification number that can be traced. [www.hindu.com](http://www.hindu.com)

## GPS navigation plan to help blind

Il Village, a firm in Turin in northern Italy has been developing a service called Easy Walk aimed at giving blind people greater independence and mobility. It uses a mobile phone that runs the Symbian operating system, a small Bluetooth GPS receiver, text to speech software called Talks (though rival products are also compatible) and a call centre that will operate around the clock seven days a week. <http://news.bbc.co.uk>

## GIS ILWIS migrates to open source

The Integrated Land and Water Information System (ILWIS, <http://www.itc.nl/ilwis>) is a PC-based GIS & Remote Sensing software, developed by ITC. The ITC directorate has recently decided to make current ILWIS software free of charge and to migrate it as such to open source software under the 52° North initiative. Leading research organizations in the field of geoinformatics (ifgi, conterra, ITC, ESRI) participate in 52° North's innovative development for establishing open spatial data infrastructures (SDI) and transformation of these into practical technological solutions.

## Vietnam to develop computerised land management system

VietNamNet Bridge The World Bank (WB) has helped Vietnam train land surveying and technical mapping managerial staff in preparation for a project to build a Land Information System. Capital for the project will be allocated from the WB's Official Assistance Development. Under the VLAP, a computerised and easily accessible land information service system will be set up with equitable services for people from all walks of life.

## Web GIS launched for Rural Roads of Rajasthan and HP

The largest ever Rural Road development project (expected cost around \$26 billion) in India, Pradhan Mantri Gram Sadak Yojna (PMGSY) has hosted web GIS for Rajasthan and Himachal Pradesh to provide transparency in implementation of



this project and providing interactive spatial information to citizens as well as officials for monitoring and management of works. Web GIS software GRIMMS-Web is designed to run various spatial queries related with rural road, habitations, work progress etc and also provides various GIS functionality. It can be accessed at <http://www.omms.nic.in/grimms>

## Southern Water to prepare detailed geographic data

The upgrade to a full corporate GIS using a single repository of spatial data has allowed Southern Water to take maximum advantage of Ordnance Survey's range of flagship mapping data. The company undertook a major exercise to improve the quality and accuracy of its own geographical data based on the Ordnance Survey Positional accuracy improvement (PAI) programme. It has given Southern Water, which provides water and sewage services to 4 million people, enhanced and more consistent accuracy in the mapping of rural areas while improving the relationship between Ordnance Survey 1:2500 scale map data and Southern Water's own GPS-positioned information.

## CenterPoint Energy Selects ArcGIS Image Server

Using ESRI's ArcGIS Image Server, CenterPoint Energy now benefits from high-performance, on-the-fly image processing that helps decision making and boosts productivity. ArcGIS Image Server provides for rapid deployment of imagery for multiple simultaneous users. The application is initially being used by clients in Minnesota, but will soon be made available to all CenterPoint Energy employees in the seven states it serves. [www.esri.com](http://www.esri.com)

## Mumbai Police Implement Command and Control System

Mumbai Police, has implemented the Intergraph Corporation's Incident Command and Control System. The shall serve as the foundational technology for the

security systems of high-value assets and critical infrastructure in the public safety, government and transportation industries. It will help identify the location of a fixed line to Dial 100 emergency call, on a map of Mumbai city. The system also provides detailed information of any emergency event. While the emergency call details are being registered, operators can also quickly locate the nearest police patrol vehicle to the reported incident site with help of this location-aware technology. <http://www.intergraph.com/press/>

## 5 year plan for precise level of the geoid development plan of Korea

Korean National Geographic Information Institute (NGII) announced the 5 years plan for precise (cm) level Geoid Development for which the Institute have established physical yearly plan as below to build it through 2007 to 2011. FY 2007 Land gravity survey (1200 points on Bench Mark Lacoste & Romberg and Scintrex relative gravimeter) [www.moct.go.kr](http://www.moct.go.kr)

## Europe and China collaborate on monitoring the Earth's vegetation

European and Chinese scientists recently met to discuss issues relating to monitoring the Earth's vegetation by means of multi-angular hyperspectral remote sensing, in combination with measurements of emission of radiation by soil and vegetation. The proposed technique makes use of solar-reflected sunlight, its spectral change due to various constituents present in plants in combination with its directional dependence on canopy structure. [http://www.esa.int/esaLP/SEMNONO2UXE\\_index\\_0.html](http://www.esa.int/esaLP/SEMNONO2UXE_index_0.html)

## ICIMOD inaugurated its country office in Afghanistan

ICIMOD has inaugurated its country office in Afghanistan, located at the Ministry of Agriculture and Irrigation, Department of Forest, Kabul. [www.icimod.org](http://www.icimod.org)



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### New Magellan ProMark™3 RTK alters the RTK Landscape



Magellan has announced the introduction of its ProMark3 RTK, designed to provide surveyors with centimeter accuracy in a real-time solution and complete post-processing and

mapping capabilities. It operates in two modes; base + rover and rover only. The rover can be connected to a real-time network through a GPRS-enabled cell phone using NTRIP and direct IP. The base + rover, employs plug-and-play spread-spectrum radio solution that does not require a license or separate configuration integrated with ProMark3 RTK. [cgeffroy@magellangps.com](mailto:cgeffroy@magellangps.com)

### Longcheer pick high sensitivity LEA-4S module

u-blox AG has announced the inclusion of its LEA-4S GPS module in the G300 GPS phone made by Longcheer, China.

It combines a high performance GPS engine, GSM phone, WAP Internet browser etc. weighing only 102 grams. u-blox has also announced a deal that sees this module included in smartphone by Tranzda Technologies Co. Ltd. The PM328 is a NEWPLUS Linux-Core smartphone that integrates phone, PDA, GPS and other multimedia entertainment functions in a product that is 16 mm thin. [www.u-blox.com](http://www.u-blox.com).



### Raytheon-IBM chip targets GPS jamming

Raytheon Co has developed a chip that may help prevent the jamming of handheld GPS devices used by the U.S. military. It is

a "system on a chip" powerful enough to replace the circuit boards previously needed for anti-jamming applications. [www.azstarnet.com](http://www.azstarnet.com)

### ASUS India introduces the R2H Ultra-Mobile PC

ASUS Technology Pvt. Ltd has launched the latest R2H Ultra-Mobile PC. It has built-in high-resolution webcam, incorporated GPS and biometric fingerprint authentication. <http://in.asus.com>

### Copernicus GPS receiver with WAAS and EGNOS capability

Trimble introduced a new firmware for its Copernicus GPS receiver – WAAS and EGNOS capability giving users advantage of satellite-based augmentation systems for improved positioning accuracy. It is a thumbnail-sized, surface-mount, low power GPS module for mobile devices.

Trimble has also introduced the Mini-T GPS, a miniature GPS disciplined clock. In order to optimize its assigned spectrum across very large geographical areas, wireless systems must be carefully timed and synchronized. It provides a simple, cost effective and high performance solution in Trimble's smallest form factor to date. [www.trimble.com](http://www.trimble.com)

### Leica GNSS QC Quality Control Software

Leica Geosystems introduces version 1.3 of Leica GNSS QC, that can run alongside Leica GPS Spider or other reference station software to perform automatic quality checking and reporting of the logged RINEX data. [www.leica-geosystems.com](http://www.leica-geosystems.com)

Leica GPS Spider, in V2.3.0 been further improved with exciting new functionality that significantly enhances the software usability and performance. Amongst software optimizations, GPS Spider now supports fully redundant site set-up to satisfy the highest demands of reliability. [www.leica-geosystems.com](http://www.leica-geosystems.com)

### Garmin nuvi 200 GPS

Garmin recently announced the release of the nuvi 200 series GPS devices. It works similar to most GPS devices like ability to find destinations by address, business name or even by category, voice-prompted turn by turn directions etc. [www.garmin.com](http://www.garmin.com)

### TomTom 715 GO portable GPS

The TomTom GO 715 portable navigation device is integrated with GPRS modem and SIM card. It will come equipped with a whole bunch of routing software and include features like; handsfree connectivity, 3D map view and spoken instructions. [www.mobilewhack.com](http://www.mobilewhack.com)

### NovAtel Inc. authorized to sell Galileo receivers

NovAtel Inc. has been granted temporary authorization by the European Space Agency (ESA) to sell Galileo/Giove-A receivers to a limited number of specified companies. It has had a production standard receiver and antenna available since early 2006, however ESA has restricted external sales up to now. [www.novatel.com](http://www.novatel.com)

NovAtel released version 7.80 of its GrafNav/GrafNet, GrafNav/GrafNet Static, GrafNav Lite, and GrafMov postprocessing software. It includes precise point positioning (PPP), enhanced GLONASS processing, and other features. The PPP processor permits dual-frequency carrier phase processing without a base station.

### Combined GPS/Galileo simulation system

Spirent Communications, UK, announces the availability of its GSS7900 GPS/Galileo Simulation System which allows the testing of advanced multi-system GNSS receivers. It simulates the RF environment to characterise, optimise and validate these receivers under accurate, controlled



and repeatable conditions in the laboratory. [www.spirentcom.com](http://www.spirentcom.com)

#### Topcon and SOKKIA announces agreement



Topcon Corporation recently approved to enter into a basic agreement on management integration with

Sokkia Company. The management integration will be implemented through an acquisition of SOKKIA's shares by the Company. The management integration will be implemented only when the Company and SOKKIA obtain clearance from the Fair Trade Commission of Japan from the viewpoint of the Antimonopoly Law of Japan. [www.topconpositioning.com](http://www.topconpositioning.com)

#### Hi-tech tracking system sold to Royal Navy

Applied Acoustic Engineering, UK has won a contract to supply its

underwater tracking system to the Royal Navy's fleet of minesweepers. The system is being incorporated into the Seafox mine disposal system, which is a remotely operated vehicle with an explosive warhead used to neutralise mines. <http://business.edp24.co.uk>

#### CSI Wireless reports 40% growth in GPS business

CSI Wireless Inc., Canada, reported financial results for the fourth quarter and year ended December 31, 2006. Its GPS business operates under the Hemisphere GPS brand which owns the Outback, Satloc and Del Norte product names. CSI will change to "Hemisphere GPS" soon <http://micro.newswire.ca>

#### Lockheed Martin completes work on modernized GPS satellites

Lockheed Martin announced the delivery of the eighth and final satellite in the modernized Global Positioning System Block IIR (GPS

IIR-M) production program to the Air Force. [www.lockheedmartin.com](http://www.lockheedmartin.com)

#### Autodesk signs MoU with IIT-Madras

Autodesk has signed an MoU with the Indian Institute of Technology-Madras, for establishing a 'Centre of Excellence', for promoting innovative design and research. Autodesk has invested Rs one crore to set up a COE and a 'Design Finishing School' at IIT-M for engineering students.

#### Contex releases new flatbed color scanner COPYmate 18 iJET

Contex, announced the release of its new COPYmate 18 iJET Flatbed Color Scanner. It rises to the challenge of handling any documents, even delicate, oversized, and valuable materials that require special treatment. It offers the outstanding color reproduction and reliability that is synonymous with the Contex brand. [www.contex.com](http://www.contex.com)

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- Integrated antenna and receiver in one compact enclosure
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#### Crescent R100 Series Receiver

- Same as A100 features but in a versatile, multipurpose receiver design
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- RTK and L-Dif™ capability for centimeter positioning



Powered by **Crescent**

The latest Hemisphere GPS products are powered by Crescent Receiver Technology, the future of precision GPS.



#### Custom navigation system for VE Commodore from Siemens

Siemens VDO's has been used to develop a custom navigation system for the recently released Holden VE Commodore vehicles which feature the premium colour screens. Using a good algorithm, the software developers have produced a high speed unit which allows the screen to be activated in seconds with the receiver for the GPS satellites more sensitive. [www.ferret.com.au](http://www.ferret.com.au)

#### MapInfo launches its Research and Development Center in India

MapInfo Corporation opens a research and development (R&D) and technical support center in Noida, India. "The launch of MapInfo India underscores our expanding global presence and establishes a new R&D office in one of the worlds leading technology centers" said Mark Cattini, President and CEO of MapInfo. Manish Choudhary will be the Managing Director of Operations.

#### Enterprise GIS project to Navayuga

The Ras Al-Khaimah e-Government Authority (EGA) and Navayuga Group, India have recently concluded an agreement for the development and implementation of an Enterprise Geographic Information System turnkey solution for the emirate. Navayuga is expected to GIS-wire the entire emirate of Ras Al Khaimah in the next 18 months. The agreement was signed by Dr Hashem Ar-Refaei, Director-General, EGA and IT Adviser, Government of Ras Al Khaimah, and Dr Mukund Rao, CEO of Navayuga Spatial Technologies, Bangalore, and Director, Navayuga Middle East FZC. [www.khaleejtimes.com](http://www.khaleejtimes.com)

#### Kuwait GIS launches spatial Digital Video Recorder

Kuwait GIS, has announced the availability of Spatial Digital Video Recorder (sDVR) for the Middle East. Its a complete, real-time geospatial MPEG2 video encoding

system. It helps collecting time and location data along with the video, resulting in an information rich data set all on a removable hard drive. [www.kuwaitgis.com](http://www.kuwaitgis.com)

#### PCI Geomatics completes Web Coverage Service testing

PCI Geomatics has announced that it has successfully completed the Web Coverage Service test suite from the Open Geospatial Consortium, Inc. (OGC) for their product Geomatica WebServer Suite – Web Coverage Server (WCS), Version 10.0.3. [www.pcigeomatics.com](http://www.pcigeomatics.com)

#### Ballhaus to lead network systems business

BAE Systems has named Dr. William L. Ballhaus president of its Network Systems business. Network Systems employs 5,000 people at more than 10 major U.S. sites that include Reston; San Diego; Burlington, Massachusetts, and Wayne, New Jersey. [keith.p.lewis@baesystems.com](mailto:keith.p.lewis@baesystems.com)



## Spatial Data Quality 2007

### 5th International Symposium

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Hosted by the International Institute for Geo-Information Science and Earth Observation (ITC), "Spatial Data Quality" is the premier international symposium of ISPRS working group II-7 -Quality of Spatio-Temporal Data and Models- for international leading scientists and young researchers to share experiences in this field.

The symposium will bring together experts from around the world to present the latest developments in quantitative and qualitative approaches and information theory towards spatial data quality.

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Mrs. Saskia Tempelman, Secretariat  
E-mail: [issdq2007@itc.nl](mailto:issdq2007@itc.nl)



[www.itc.nl/issdq2007](http://www.itc.nl/issdq2007)



## China outlines space program till 2010

China's space program scientists have published outlines of plans to begin development of a space laboratory and spacewalking by Chinese astronauts by 2010. The plans are among the goals published by the Commission of Science Technology and Industry for National Defence in its 11th five-year (2006-2010) plan for space science development. The blueprint states that China will continue to conduct manned space flight and lunar exploration. [www.spacedaily.com](http://www.spacedaily.com)

## Pakistan seeks Chinese help to boost space programme

Pakistan hopes for Chinese assistance in achieving expertise in rocket science and space technology and has already chalked out an elaborate space programme, official sources said. "To achieve the goals of making the economic progress and defence of the country impregnable, Pakistan is endeavouring to get space technology from China. Foreign Minister Khurshid Kasuri recently visited some sensitive installations of China, the country which has challenged the whole world in rocket science and space technology," said an official requesting anonymity. The official said the government was implementing a strategic programme for launching the country's own satellite to replace Paksat, which has already completed its designed life but might benefit the country for another one or two years. He said that new Pakistani satellite would orbit the earth at a height of 200-300 kilometres having a revolution period of 70 minutes.

## Abu Dhabi plans 2009 satellite launch

Abu Dhabi plans to launch its first satellite in 2009 and will choose one of two companies from Europe and the United States for the \$1 billion (about Dh3.6 billion) project, state-owned Mubadala Development Co said. The hybrid military and communications satellite will be

launched in second quarter of 2009, Mubadala's chief operating officer, Waleed Al Mokarrab Al Muhairi, told the Reuters Middle East Investment Summit in Dubai. "The project cost is about \$1 billion," he said, adding that the satellite footprint would extend to Africa and Central Asia. Al Muhairi said there were two companies vying for the project, European and US bidders, but declined to name them.

## RazakSat to be launched this year



RazakSat, earth observation satellite, which is to monitor floods, landslides, open burning, river pollution and some other disasters, will be launched this year in conjunction with Malaysia's 50th Independence Day celebration. Science, Technology and Innovation Minister Datuk Seri Dr Jamaludin Jarjis said the Government had chosen the launcher manufactured by an American-based company, Space X.

## Google yet to decide on blurring key Indian sites

Even as the high-resolution images of vital Indian installations on Google Earth have irked security agencies, Google Inc has said it has not yet taken a decision on blurring aerial images of sensitive Indian installations available on Google Earth. "We take security concerns seriously but obscuring images will not help. We have never degraded image quality. The images available on Google Earth are also available for purchase from various satellite companies in market. The government needs to deal with this issue at the level of satellite companies because they are selling images to us, mapping services are available commercially, sometimes

free of cost and sometimes for a price. If images damage security then they need to talk to satellite companies. Blurring needs to be done by satellite companies. Targeting Google Earth will not fix the problem," Andrew McLaughlin, head of Global Public Policy of Google, told ET. <http://economictimes.indiatimes.com>

## Space scientist Goel bags Aryabhata award

India's space scientist P.S. Goel, who is also a secretary in the union ministry of earth sciences, has been



selected for the Aryabhata award by the Astronautical Society of India (ASI). Prior to his current posting, Goel was director of the satellite centre of the Indian Space Research Organisation (ISRO) in Bangalore.

## Satellite imagery to help Indonesian asset management

DigitalGlobe announced a customer agreement with PT Telkomsel, the leading operator of cellular telecommunications services in Indonesia. Telkomsel is using satellite imagery from DigitalGlobe's QuickBird to plan, build and manage its next generation 3G infrastructure, including a new base station. QuickBird is currently the world's highest resolution commercial imaging system. <http://sev.prnewswire.com>

## McDonald Bradley selects ESRI toolset

McDonald Bradley, Inc. has recently won an \$11.2 million prime contract with the National Oceanic and Atmospheric Agency (NOAA) to develop the Nautical Charting System II -- an enterprise solution for managing chart data. The Company has selected ESRI as a subcontractor on the project. In addition, the team will utilize a software toolset from ESRI as part of the solution.

### Nokia N95 smartphone with GPS capabilities starts shipping

Nokia N95 has started shipping in key European, Asian and Middle Eastern markets. The phone is an all-in-one multimedia computer with a unique 2-way slide design, integrated GPS functionality and many other features. [www.nokia.com](http://www.nokia.com)

### Google and LG Electronics collaborate on mobile phones

L.G. Electronics and Google have announced a global collaboration to pre-install Google's services on LG mobile phones. The new feature would allow users to easily search for information, find locations, update blogs and manage e-mail while on the move.

### Now, a Mobile Phone for your Pets

On4 Communications has launched PetsCell which has A-GPS tracking module contained in it and is certified by many tier one and tier two telecoms worldwide. This device will provide pet owners with the world's first accurate GPS tracking and voice communication tracking solution. It is a waterproof, 2-way communication device with GPS Capabilities that provides the pet's location in real time through a desk top PC or hand held device complete with email notification services. It will allow pet owners to set a geo-fence boundary that will alert them when their pet steps outside the pre-set boundary.



### Motorola unveils framework to support location-enabled services

Motorola, USA has announced its new Location Services Framework, a flexible platform designed to support location-enabled applications and services on Motorola devices. It will accelerate innovation, reduce application time-to-

market, and improve usability and uptake for location-enabled services. [www.motorola.com](http://www.motorola.com)

### RIM launches BlackBerry 8800 in India

Research In Motion (RIM) launched BlackBerry 8800 smart phone in India. At 14mm, it's the thinnest Blackberry handset yet. It is equipped with a highly tactile, full Qwerty keyboard; multimedia features; a microSD expandable memory; and trackball navigation system and is the first smart phone from the company to feature built-in GPS [www.techtree.com](http://www.techtree.com)

### AAA, NIM announce GPS-enabled navigation system

AAA and Networks In Motion (NIM) have announced mobile phone-based GPS navigation and travel assistance. [www.telephonyworld.com](http://www.telephonyworld.com)

### HI-601VT GPS GSM real-time tracker

Taiwanese firm Haicom has announced HI-601VT GPS/GSM tracker. It helps track, remote control, tapping any object globally in real time by using any regular SIM card (with one phone number), any regular phone (home phone, mobile phone, smart phone, etc.) and any local mapping software or Google Earth. [www.gpsdaily.com](http://www.gpsdaily.com)

### Symbian OS v9.5 brings more features for smartphones

Symbian Ltd. launched its OS v9.5, the evolution of the operating system for smartphones at mass market costs. It brings high performance features designed for richer consumers and enterprise experiences as well as significant savings to phone build costs and time-to-market. [www.symbian.com](http://www.symbian.com)

### New GPS camera module launched

The Taiwanese company Tekom demonstrated a GPS module for cameras on CeBIT 2007. It records the location and movements of the

user on a 32MB internal memory, and when connected to a PC, it calibrates the GPS data with the time each photo was taken in. [www.tfot.info](http://www.tfot.info)

### TCS next-gen WIG supports messaging and LBS

TeleCommunication Systems, Inc. (TCS), USA, a provider of wireless data communications, launched Wireless Intelligent Gateway (WIG) application server. The WIG platform is a standards-based solution that fully integrates subscriber privacy and profiling across two-way messaging and LBS. It has over 25 million registered subscribers. [www.telecomsys.com](http://www.telecomsys.com)

### TruePosition announces SUPL server for A-GPS

TruePosition, Inc., USA has announced the availability of the TruePosition Secure User Plane for Location (SUPL) Server for A-GPS. The Server allows carriers to provide high-performance LBS without making significant changes to their infrastructure. It is also fully OMA-compliant location solution (OMA SUPL V1.0). [www.trueposition.com](http://www.trueposition.com)

### TI single-chip solution for GPS in mobile phones

Texas Instruments Incorporated (TI), USA, announced a single-chip device that is expected to drive GPS applications into mainstream mobile phones. The NaviLink 5.0 solution has a footprint of 25mm<sup>2</sup>, delivering high performance with the industry's smallest solution size and lowest bill of materials. It provides fast "time to first fix" (TTFF) in weak signal in metropolitan areas and deep indoor environments. <http://focus.ti.com>

### AT&T launches suite of sensor-based network solutions

AT&T Inc. announced three new sensor-based networking solutions that enable businesses to track a wide array of valuable resources in real time, including AT&T Mobile Resource



Management, AT&T RFID Asset Visibility and AT&T-managed passive RFID solution. [www.prnewswire.com](http://www.prnewswire.com)

Railroads benefit from wireless web-based asset tracking solution

RFTrax, USA, announces the launch of its Asset Management Platform (AMP), an integrated asset tracking solution for Locomotives. The solution combines a rugged, onboard Asset Command Unit (ACU) with multiple sensors, a powerful backend database application and a Web portal for customer information and interaction. [www.jobwerx.com](http://www.jobwerx.com)

Autodesk recognised for LBS Middleware platform

Frost & Sullivan selected Autodesk, Inc. as the recipient of the 2007 North American Mobility Award for its LBS platform. The Autodesk LocationLogic platform provides the infrastructure, application services, content provisioning, and integration services for deploying and maintaining location-based services. [www.prnewswire.com](http://www.prnewswire.com)

Mobile Satellite ventures unveils MSAT-G2 Tracking

Mobile Satellite Ventures (MSV), USA, announces MSAT-G2 Tracking. It is a powerful event-driven service that operates exclusively with the popular push-to-talk mobile satellite radio launched last year. The radio's antenna system contains a GPS receiver enabling transmission of GPS location information over the MSAT Network when a user presses the PTT button or initiates a telephone call. [www.msvlp.com](http://www.msvlp.com)

Dual-mode cellular and satellite telematics solution

WebTech Wireless Inc., Canada, and Iridium Satellite have announced the introduction of a new dual-mode cellular and satellite asset tracking and management solution for the transportation industry called WT1900system. [www.webtechwireless.com](http://www.webtechwireless.com)

# Galileo update

**Galileo – the European Programme for Global Navigation Services for civil purposes is an initiative led by European Union. We provide regular updates to our readers on the Galileo programme.**

## European Commission sets Galileo satellite navigation deadline

The European Commission has given the eight companies picked to build and run the Galileo satellite navigation system until 10 May to create a single company and choose a chief executive. The commission is concerned about slipping deadlines and a lack of coordination for Galileo. "If there's no reaction in time then we'll have to look for alternative solutions," said commission spokesman Michele Cercone. "We'll talk about the alternatives after 10 May if the deadline is missed," he added. [www.computerworlduk.com](http://www.computerworlduk.com)

## ESA awards contract for GIOVE-A2

The European Space Agency awarded a contract to a British firm for technology to be used in constructing a second Galileo satellite navigation system. The new satellite, to be named GIOVE-A2 with an estimated total value of \$40 billion, will be based on Surrey Satellite Technology's GIOVE-A technology. GIOVE stands for Galileo In-Orbit Validation Element. The GIOVE-A2 satellite will be ready for launch during the second half of 2008. [www.sciencedaily.com](http://www.sciencedaily.com)

## GIOVE-A Signal-in-Space Interface Control Document released

The GIOVE-A Signal-in-Space Interface Control Document, the document that gives the technical details of the signals transmitted by the GIOVE-A satellite, has been released. This will allow receiver manufacturers and research institutions to use a real signal for their research and development. The GIOVE-A signal validation has been accomplished through a network of 13 Galileo Experimental Sensor Stations (GESS), deployed world

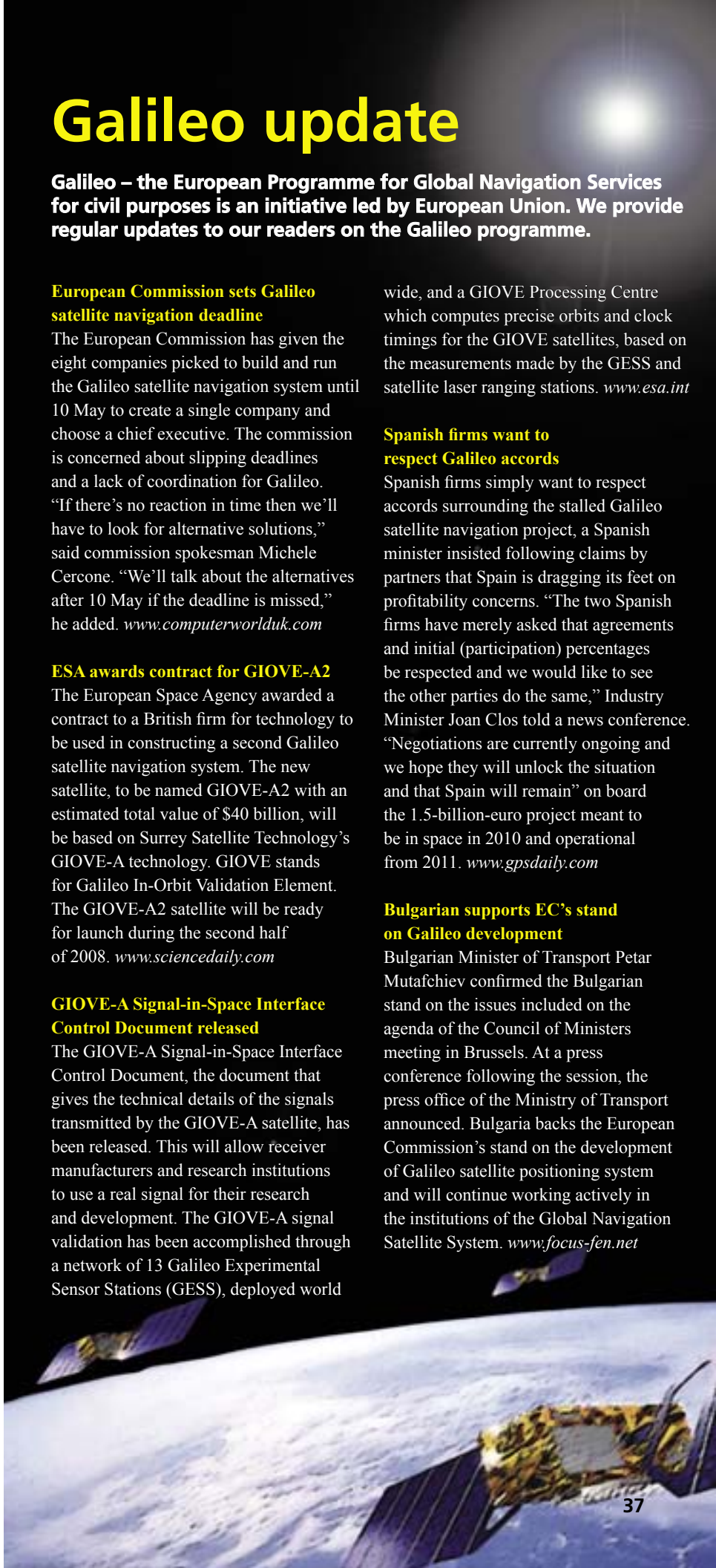
wide, and a GIOVE Processing Centre which computes precise orbits and clock timings for the GIOVE satellites, based on the measurements made by the GESS and satellite laser ranging stations. [www.esa.int](http://www.esa.int)

## Spanish firms want to respect Galileo accords

Spanish firms simply want to respect accords surrounding the stalled Galileo satellite navigation project, a Spanish minister insisted following claims by partners that Spain is dragging its feet on profitability concerns. "The two Spanish firms have merely asked that agreements and initial (participation) percentages be respected and we would like to see the other parties do the same," Industry Minister Joan Clos told a news conference. "Negotiations are currently ongoing and we hope they will unlock the situation and that Spain will remain" on board the 1.5-billion-euro project meant to be in space in 2010 and operational from 2011. [www.gpsdaily.com](http://www.gpsdaily.com)

## Bulgarian supports EC's stand on Galileo development

Bulgarian Minister of Transport Petar Mutafchiev confirmed the Bulgarian stand on the issues included on the agenda of the Council of Ministers meeting in Brussels. At a press conference following the session, the press office of the Ministry of Transport announced. Bulgaria backs the European Commission's stand on the development of Galileo satellite positioning system and will continue working actively in the institutions of the Global Navigation Satellite System. [www.focus-fen.net](http://www.focus-fen.net)



## SLA conducts first public e-consultation

The Singapore Land Authority (SLA) is conducting its first public e-consultation on a five-year master plan (2007 – 2011) which maps out a strategic plan that covers an integrated survey network, differential GPS positioning network (also known as SiReNT), a precise leveling benchmark network and the Geoid Model.

The desired outcome is that SLA will be able to provide better survey and mapping reference services through its network infrastructure which can be used in cadastral, engineering, topographical survey, aerial mapping and GIS applications, as well as new types of day-to-day positioning applications like LBS, structural monitoring, marine applications & hydrographical surveys, land transportation in road management, real-time fleet tracking and monitoring, in-vehicle navigation, vehicle theft protection etc.

The strategy map lists strategies to achieve goals, which includes reviewing existing data policies and to carry out market-demand and feasibility studies. In terms of technology, SLA intends to move into SiReNT and use new technology such as SMS for the dissemination of information on control markers and 3G wireless technology for the collection and dissemination of information on geospatial information. There will also be more training, collaborations and knowledge-sharing with the private sector.

SLA has invited MPA, HDB, JTC, LTA, Mindef, DSTA, Land Surveyors Board (LSB), Singapore Institute of Surveyors and Valuers (SISV), NTU and NUS to participate in the survey.

Public who has feedback on the proposed goals and strategies outlined in the paper can go to the REACH public e-consultation website <http://app.reach.gov.sg/olcp/asp/ocp/ocp01d1.asp?id=3843> or visit [www.sla.gov.sg](http://www.sla.gov.sg) main website.

## MARK YOUR CALENDAR

### May 2007

#### FIG Working Week 2007

13-17 May, Hong Kong, China  
<http://www.fig.net/fig2007/>

#### Spatial Sciences Institute Biennial International Conference

14-18 May, Hobart, Tasmania, Australia  
[www.ssc2007.com](http://www.ssc2007.com)

#### TIDES 2007 - 5th Taipei International Digital Earth Symposium

15-18 May, Taipei, Taiwan  
[derc@mail.pccu.edu.tw](mailto:derc@mail.pccu.edu.tw)

#### Intergraph 2007

21-24 May, Nashville, Tennessee, USA  
<http://www.intergraph2007.com>

#### International Conference on Integrated Navigation System

28-30 May, Saint Petersburg, Russia  
[elprib-onti@telros.net](mailto:elprib-onti@telros.net)

#### Geoinformation for Disaster Management

23-25 May, Toronto, Canada  
[junli@ryerson.ca](mailto:junli@ryerson.ca)

#### 5th International Symposium on Mobile Mapping Technology

28-31 May, Padova, Italy  
[naser@geomatics.ucalgary.ca](mailto:naser@geomatics.ucalgary.ca)

### June 2007

#### Rivers 2007

6-8 June, Kuching, Sarawak, Malaysia  
[rivers2007@gmail.com](mailto:rivers2007@gmail.com)

#### 13th PCGIAP Annual Meeting

12-15 June, Seoul, Korea  
[sec@pcgiap.org](mailto:sec@pcgiap.org)

#### 21st Pacific Science Congress

12-16 June, Okinawa, Japan  
[pssc21@to.jim.u-ryukyu.ac.jp](mailto:pssc21@to.jim.u-ryukyu.ac.jp)

#### Spatial Data Quality 2007 5th International Symposium

13 -15 June, ITC, Enschede, The Netherlands  
[issdq2007@itc.nl](mailto:issdq2007@itc.nl)

#### 27th ESRI International User Conference

18-22 June San Diego, California USA  
[www.esri.com](http://www.esri.com)

#### Geoinformation Forum Japan

20-22 June, Pacifico Yokohama, Japan  
[geoforum@survey.jp](mailto:geoforum@survey.jp)

### July 2007

#### Cambridge Conference 2007

15-20 July Cambridge, UK  
[www.ordnancesurvey.co.uk/](http://www.ordnancesurvey.co.uk/)

#### Transport 2007

25 July Christchurch, New Zealand  
[www.transport07.co.nz](http://www.transport07.co.nz)

#### Asia Oceania Geosciences Society,

#### 4th Annual Meeting

30 July – 3 August, Bangkok, Thailand

### August 2007

#### 7th International Workshop of Geographical Information System

1-3 August Beijing, China  
[iwgis@lreis.ac.cn](mailto:iwgis@lreis.ac.cn)

#### XXIII ICA International Cartographic Conference

4-10 August, Moscow, Russia  
[info@icc2007.com](mailto:info@icc2007.com)  
<http://www.icc2007.com/>

#### ISPRS Workshop on Updating Geospatial Databases with Imagery

28-29 August, Urumchi, Xinjiang, China  
[jjie@nsdi.gov.cn](mailto:jjie@nsdi.gov.cn), [jiangjie\\_263@263.net](mailto:jiangjie_263@263.net)

#### 2nd Indonesian Geospatial Technology Exhibition

29 August - 1 September Bakosurtanal; Jakarta  
<http://www.geospatial-exh.com/>

### September 2007

#### ION GNSS 2007

September 25-28, 2007, Ft. Worth, TX  
[www.ion.org](http://www.ion.org)

### October 2007

#### Nav 07 - The Navigation Conference and Exhibition

30 Oct 2007 -01 Nov 2007  
[www.rin.org.uk](http://www.rin.org.uk)  
[conference@rin.org.uk](mailto:conference@rin.org.uk)

### November 2007

#### ISG/GNSS 2007

6-8 November, Kuala Lumpur, Malaysia  
[md.nor@fksg.utm.my](mailto:md.nor@fksg.utm.my)

#### WG I/6 Workshop on Remote Sensing Applications

13-16 November, Kuala Lumpur, Malaysia  
[mazlan@fksg.utm.my](mailto:mazlan@fksg.utm.my)

## Institution of Surveyors, India announces:

#### Training Course on Modern Trend in Land Management

6-10 March, New Delhi  
15-19 May, Andaman & Nicobar Islands  
10-14 July, Shillong  
21-25 August, Jammu  
[colbhat@yahoo.com](mailto:colbhat@yahoo.com)

#### Spatial Data for Effective Land Management

10-12 October, Mumbai, India  
[colbhat@yahoo.com](mailto:colbhat@yahoo.com)

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