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Volume XIII, Issue 02, February 2017

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

Key Role of GNSS in Space Weather

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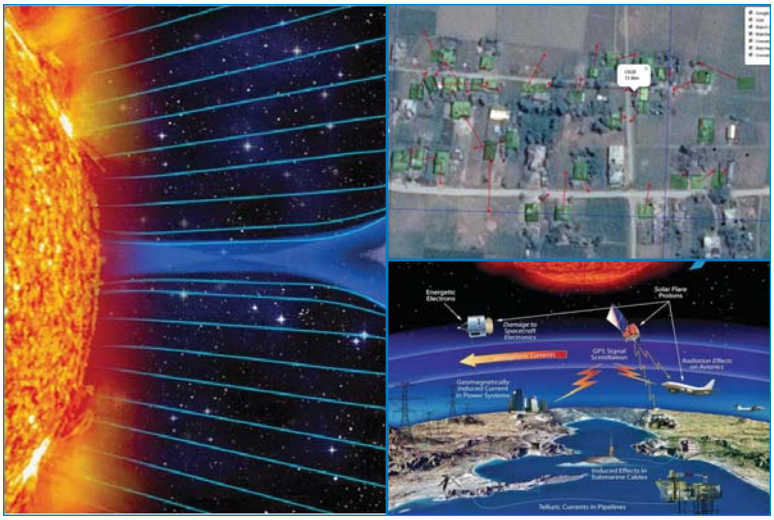

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Coordinates Volume 13, Issue 02, February 2017

Articles

Columns

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This issue of Coordinates is of 52 pages, including cover.

Space Weather

The sun and the earth,

The connections and the complicated relationship

Physics, Meteorology, …

Solar emissions, electromagnetic interactions

Solar flare, solar burst, solar wind, …

Ionosphere, ionospheric ionization, …

Scintillations.

A complex phenomenon.

Our lead paper decodes some such complexities.

And their impacts on GNSS signals (read on page 6).

Bal Krishna, Editor
bal@mycoordinates.org

Space Weather, from the Sun to the Earth, the key role of GNSS

The goal of this paper is to give a clear view of the Sun Earth relationships that are complex. The phenomena acting at large scales and essentially related to dynamic and electromagnetic physical processes have been addressed. Besides physics, the work done to develop the training in Space Weather by focusing on Global Navigation Satellite Systems has also been presented. We present this paper as a series in two parts. In this issue the focus is on physics of the relationships Sun, Earth and Meteorology of Space. In March issue, GNSS training and capacity building would be discussed

Dr Christine Amory-Mazaudier
Senior Scientist, University Pierre and Marie Curie and Staff Associate at ICTP. Recently awarded Marcel Nicolet Medal for her work in Space Weather

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Director, African Regional Centre for Space Science and Technology Education - in French Language (CRASTE-LF), Rabat, Morocco was Professor in University Mohammed V, Rabat, Morocco

This paper presents a study made for the Seminar on Space Weather and its effects on GNSS held in conjunction with United Nations/Nepal workshop on the applications of GNSS held in Kathmandu, 6 to 12 December 2016. . The Seminar focused on cross-cutting area, in particular resiliency, the ability to depend on space systems and the ability to respond to the impact of events such as adverse space weather.

The aim is to give an outline of the Space Weather and its effects on GNSS receivers, and this in relation to the international organizations in charge of the harmonization of the various GNSS systems.

This article is composed of 3 parts: Part I: Physics of the relationships Sun Earth and Meteorology of Space, Part II: GNSS teaching and parameters that can be deduced from GNSS receivers, Part III: Building capacity of developing countries in using GNSS technology for sustainable development

From the Sun to the Earth, Space Weather and its effects

Emissions from the Sun

The sun is our star and it influences the terrestrial environment according to different channels,

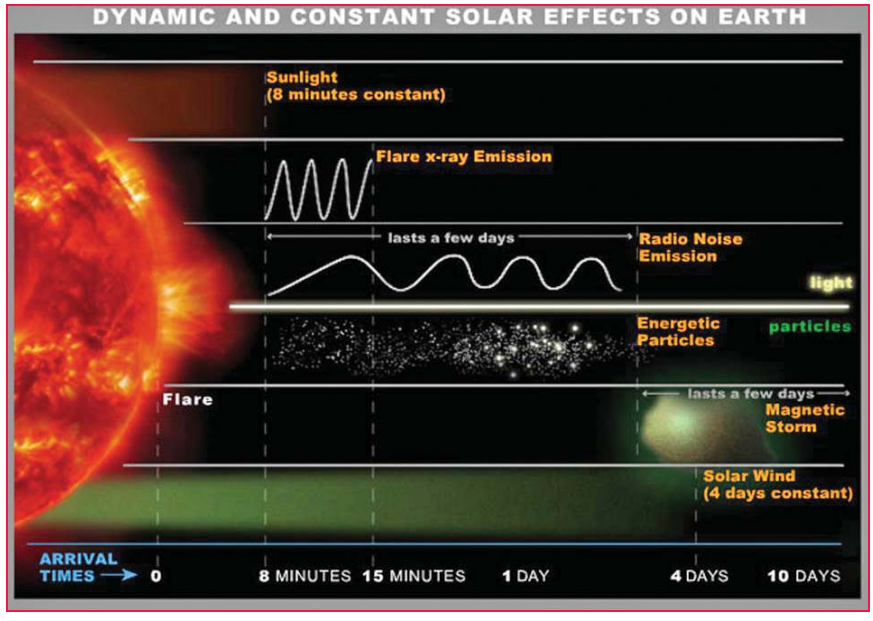

Figure I.1: https://www.nasa.gov/sites/default/files/thumbnails/image/faq26.jpg

the two main channels are:
1) The radiation channel
2) The particle channel.

Figure I.1 shows the different radiations and particles. From the top to the bottom, we have the light, the X-rays and the radio noise emissions. All these phenomena move at the speed of light (300000km / s) and reach the earth in 8 minutes.

After, there are the energetic particles, Magnetic storms and the regular solar wind. For these physical processes, the time to arrive to the Earth depends on their speed, from few 15 minutes for the energetic particles to several days for the regular solar wind.

What is Space Weather and why it is important? The role of ionosphere

Solar emissions affect the terrestrial electromagnetic environment. Figure I.2 presents some types of perturbations: energetic particles cause damage to satellites and solar radiation affects aviation.

As far as this presentation is concerned, we are more interested in the GNSS signal and thus in the effects of the ionosphere on the GNSS system. The ionosphere is an ionized layer located between 50 and more than 1000 km around the earth. It is the layer of the atmosphere that most disrupts the GNSS signal.

In this layer electric currents circulate (Richmond, 1995). These ionospheric electric currents induce telluric currents in pipeline or submarine cables and can also cause power failure of transformers.

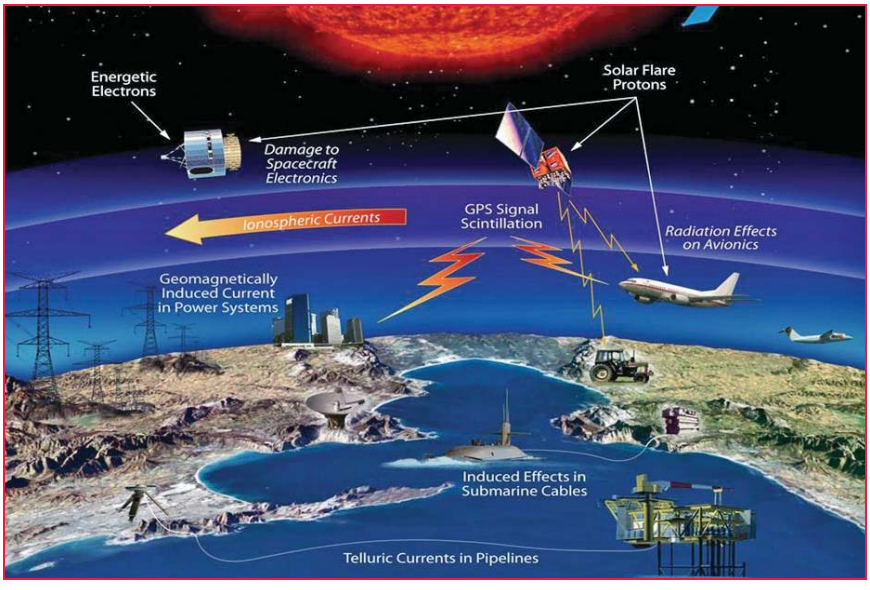

Figure I.2: https://www.nasa.gov/sites/default/files/thumbnails/image/faq13.jpg

Space weather consists to anticipate the action of solar phenomena and try to predict how these phenomena can disrupt all our new technologies (Lilensten and Blelly, 1999; Knipp, 2011)

The Sun and regular connections between the Sun and the Earth

The sun has been observed for several millennia. During the Middle Age, due to the use of the first telescopes by Galileo, the scientists began a study of the sunspots. They have recorded them since about 1611. Figure I.3a shows the motion of a sunspot drawn by Scheiner, Jesuit Father Mathematician working at the University of Ingolstadt (Near Augsburg in Germany). During the Middle Age, scientists did not know what these sunspots were.

It was only at the beginning of the 20th century that Hale discovered the existence of the poloidal solar magnetic field. At the top left of figure I.3b is presented the poloïdal solar magnetic field. In fact, the sun turns on itself at a different speed between the pole and the equator. About ~27 days at the equator and ~ 31 days at the poles. The differential velocity between the poles and the equator twists the lines of the poloïdal field and creates magnetic loops which are the sunspots. Figure I.3b shows the formation of a sunspot.

The amplitude of the poloidal field is 10 G and the amplitude of the toroidal field (sunspots) is 3-5 kG. The poloidal magnetic field reverses every 11 years (Li et al., 2011). The toroidal magnetic

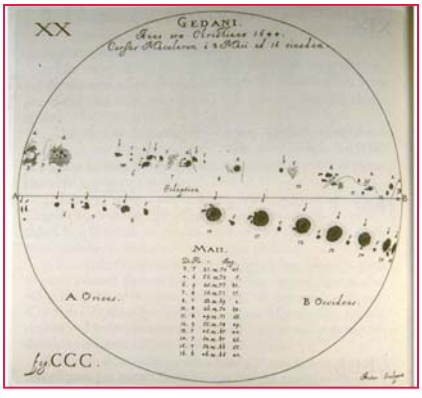

Figure I.3a: Sunspot drawn by Father Scheiner

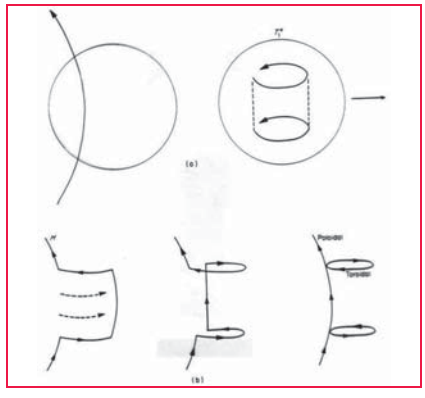

Figure I.3b: Formation of a sunspot from Friedman, 1987

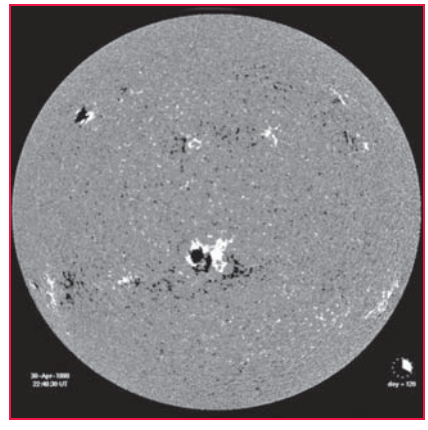

Figure I.3c: Magnetogram from the Sun: SOHO satellite data

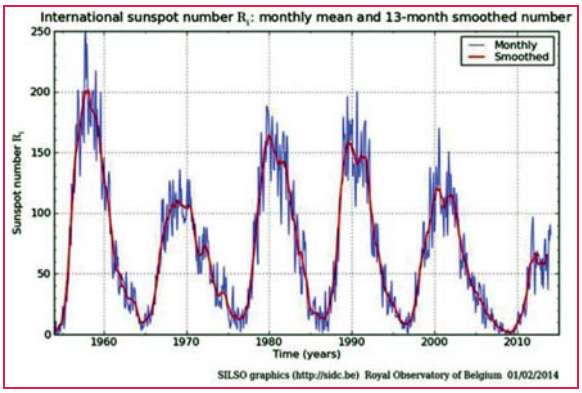

Figure I.3d: The sunspot cycle

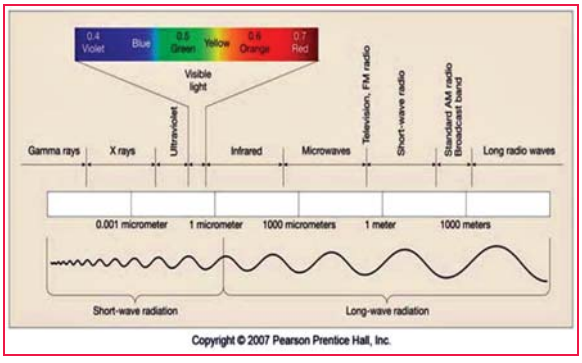

Figure I.3e: Regular solar radiations

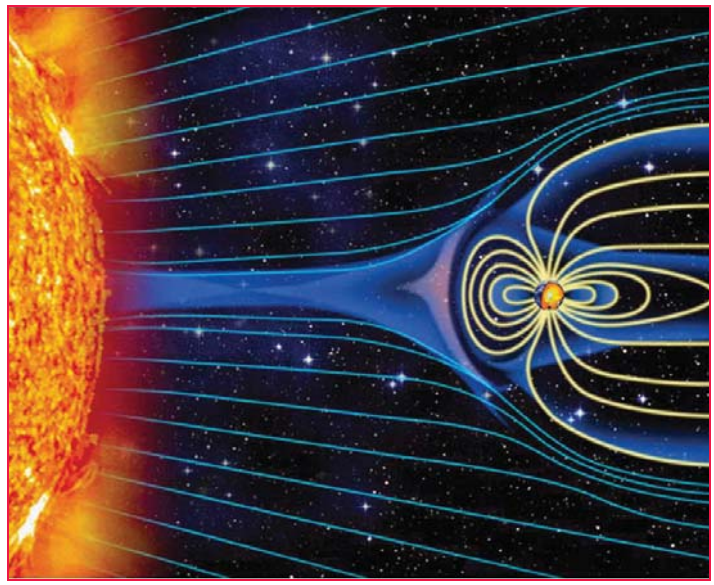

Figure I.3f: Regular solar wind
http://img.over-blog-kiwi.com/1/47/74/29/20160308/ob_86e793_la-magnetosphere-161-fre.jpg
For a complete presentation of the sun see the website: https://solarscience.msfc.nasa.gov/SunspotCycle.shtml

field, sunspot cycle has a period of about 11 years. The two components of the solar magnetic field are anti-correlated. The maximum of the poloidal field occurs at the minimum of the toroidal magnetic field (cycle of spots).

Figure I.3c shows a solar spot observed by the SOHO satellite. Figure I.3d shows the variation of the sunspot cycle over the last 6 decades.

These two components of the solar magnetic field influence the terrestrial environment differently as we shall see later.

The sun is a dynamo which converts motion in electricity.

Figure I.3e shows the complete spectrum of solar radiation from gamma rays to radio waves. In this figure the visible and infrared radiation reaching the ground are presented in color.

Figure I.3f shows the solar wind, which compresses the magnetosphere (cavity of the earth's magnetic field), at the front and stretches it at the rear.

The regular solar wind is a constant stream of coronal material that flows off the sun at a speed of ~300-400km/s. It consists of mostly electrons, protons and alpha particles with energies usually between 1.5 and 10 KeV. The Earth's magnetic field acts as a shield for solar wind. However, there are regions of the ionosphere that are directly connected with the interplanetary medium and this the solar wind flow.

The Earth

Earth as the sun is a moving magnetic body. Figure I.4a shows the Earth's magnetic field, which is approximately that of a dipole. Figure I.4b presents the two main movements of our planet which are the rotation on itself and the revolution around the sun. These two movements introduce diurnal and seasonal variability to all the terrestrial phenomena.

Around the earth, solar radiation, mainly Ultra, Extreme Ultra Violet and X-rays, ionize the atmosphere at altitudes ranging from about 50 km to more than 1000 km. Figure I.4c shows the process of photo ionization. The

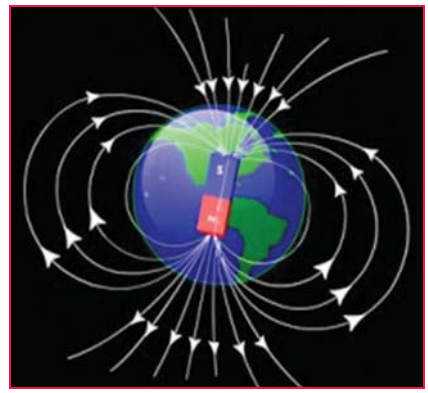

Figure I.4a: Earth's dipole

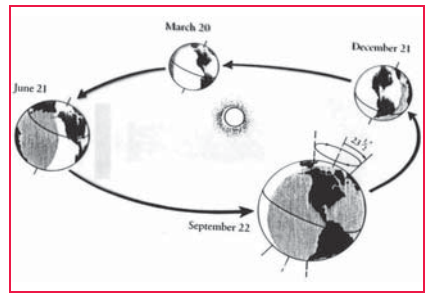

Figure I.4b: Main motions of the Earth

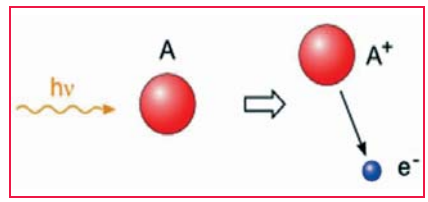

Figure I.4c: Photoionization

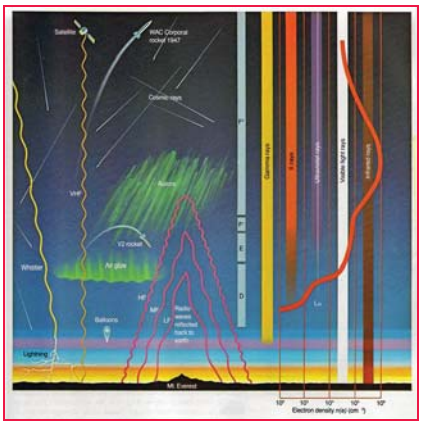

Figure I.4d: Lonizing radiations from Friedman, 1987

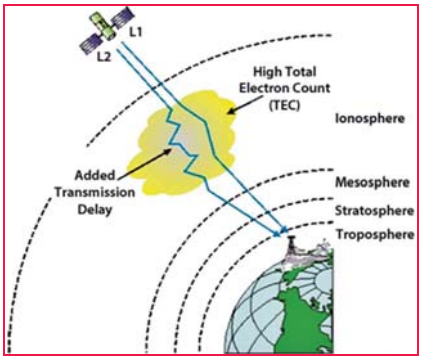

Figure I.5b: TEC and added transmission delay http://reflexions.ulg.ac.be

solar radiation tears an electron from an atom and thus forms an electron ion pair. There is only one ionized atom on 1 million atoms. Figure I.4d shows the radiations which ionize and which do not reach the ground. Only the visible and infrared radiations reach the ground.

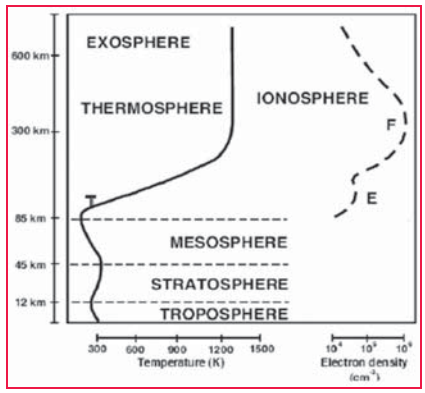

Figure I.4e: Layers of the atmosphere and ionosphere

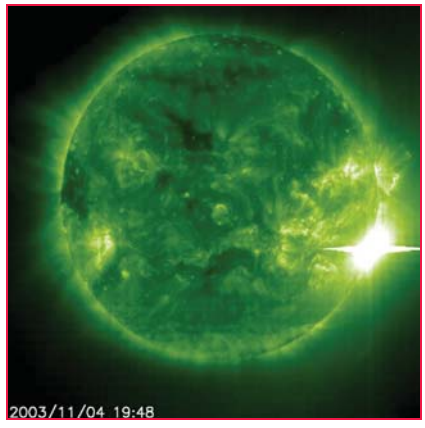

Figure I.5a: Solar Flare (SOHO satellite data) https://cnes.fr/sites/default/files/migration/wordpress/images/2014/10/Giant_solar_flare1.gif

Figure I.4e shows on the left the layers of the atmosphere presented on a scale of temperature (from 300 to 1000°K) and on the right the layers of the Ionosphere presented on a scale of the number of electrons per unit volume. The Ionosphere is located mainly at the level of the atmospheric layer called thermosphere, see books on ionosphere by Rishbeth and Gariott, 1969 and Davies, 1990.

In the section ***The Sun and regular connections between the Sun and the Earth,*** we have presented the regular phenomena that connect the sun and the earth, in following sections we will present the perturbations of the sun that can dramatically affect our environment.

Solar flare and solar burst

The Solar flare is a significant emission of X-radiation and the solar burst a significant emission of radio noise, see figure I.3e on the spectrum of solar radiation. Figure I.5a shows a solar flare observed by the SOHO satellite in 2003, on November 4. A solar flare creates important additional photo ionization in the ionosphere which affects the GNSS signal and added a transmission delay see figure I.5b.

The solar burst is a strong increase in the radio noise of the sun. If the radio frequency emitted by the sun is the same as airport radars, there is a serious incident as the radars can no longer follow the trajectories of the planes. They are saturated by the disturbed radio signal from the sun.

"The **2015 Nov. 4th** there is a radio burst **[15.30 to 16.30 LT]** exceeding everything before. It was so strong that neither GPS nor radar nor communication nor instrument landing system did work properly. All these receivers were completely saturated by the radio radiation, instruments went blind", figure I.5c, *communication from Christian Monstein*.

The disturbed solar wind

The solar wind is a flux of particles that regularly escape from the sun. Some events such as coronal mass ejections or fast winds associated with coronal solar holes can disrupt this solar wind

Figure I.5c: Web announcement of the problem in air plane traffice

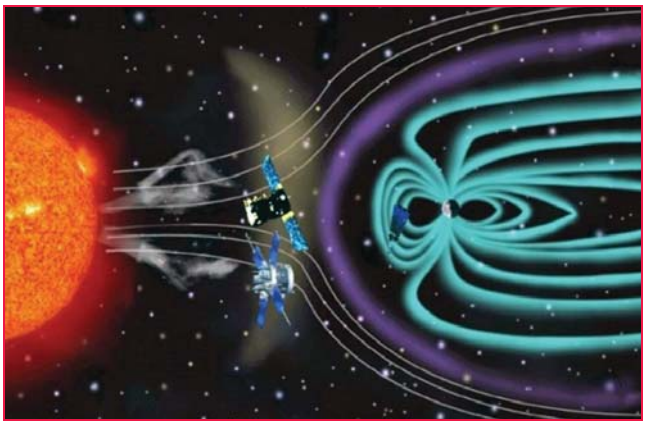

Figure I.6a: Satellite in front of the magnetosphere

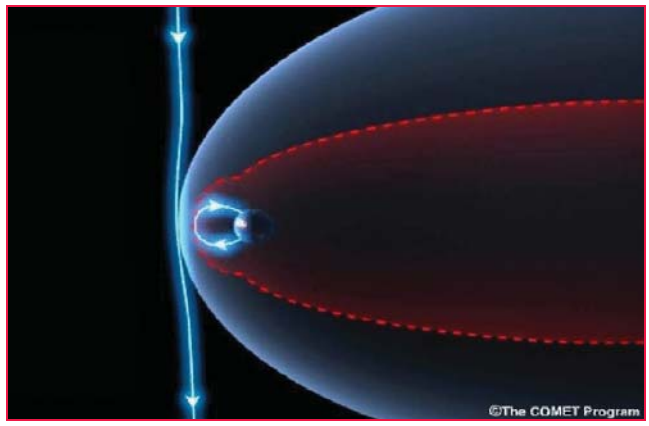

Figure I.6b: Reconnection process

and create near-earth disturbances called magnetic storms see figure I.1.

The solar wind carries with it a part of the solar magnetic field which is called interplanetary magnetic field IMF. This magnetic field acts as a trigger for magnetic storms. If it is directed southward, in the opposite direction to the terrestrial magnetic field, there is reconnection of the interplanetary magnetic field and the terrestrial magnetic field (Dungey, 1961). The magnetosphere is open and is completely under the influence of the solar wind. **There is a magnetic storm**.

Figure I.6a shows a satellite which is located in front of the magnetosphere and which makes it possible to know the arrival of a solar wind that can generate strong magnetic storm. Figure I.6b shows the favorable conditions for the triggering of a magnetic storm, that is to say an interplanetary magnetic field directed towards the South.

The auroral zone

As mentioned earlier, the earth's magnetic field (magnetosphere) acts as a shield and protects the earth from particles from the solar wind. However, there exists near the poles a region where the solar particles can penetrate directly, it is the polar cusp. There is also a region around the pole where the particles precipitate and create an extra ionization which is not due to solar radiation but to particles of the solar wind.

Figure I.7a shows a light circle around the pole that corresponds to the auroral zone, where the particles precipitate. It is

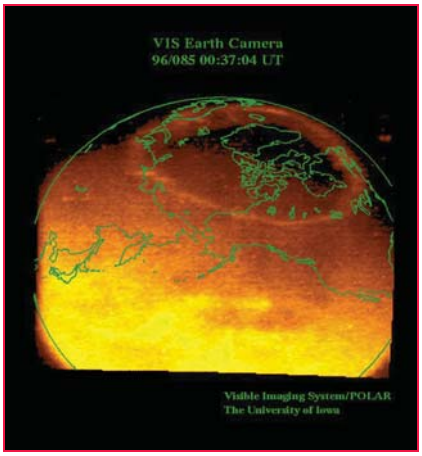

Figure I.7a: The auroral zone

Figure I.7b: An aurorae

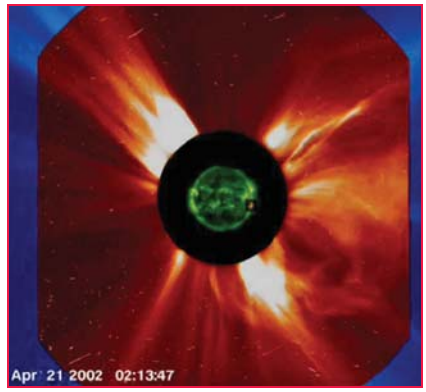

Figure I.8a: Coronal Mass Ejection near the Sun

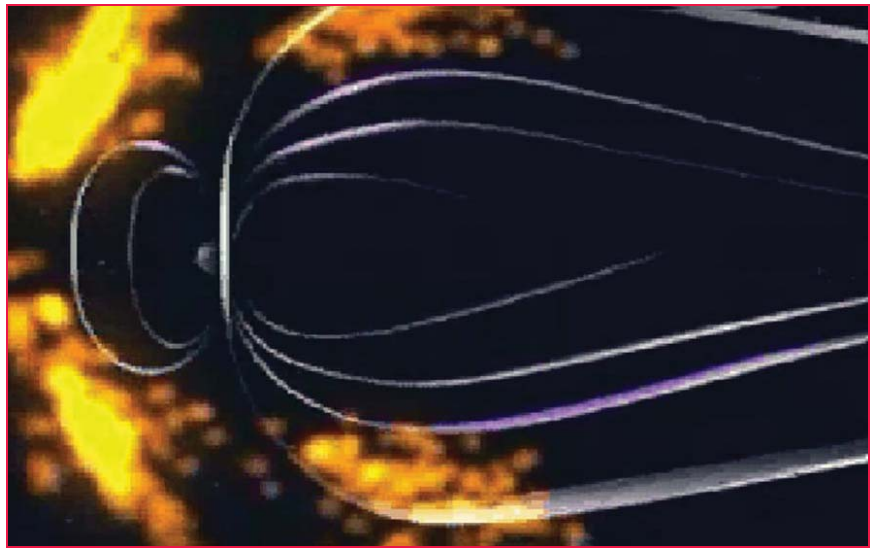

Figure I.8b: Coronal Mass Ejection arriving near the Earth

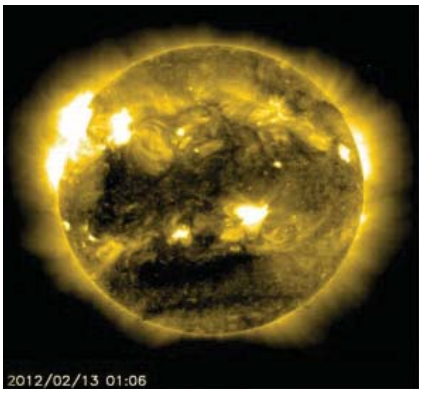

Figure I.9a: Coronal hole

in this region that one can observe auroras (borealis aurora for the northern and austral aurora for southern hemisphere). The particles excite the atoms that emit light and create aurorae (Figure I.b).

The Coronal Mass Ejection: CME

Billions of tons of coronal matter are ejected from the sun and head towards the earth. If the magnetic field transported by the CME is directed towards the south, there is a magnetic storm. In general, coronal mass ejections are preceded by solar flares and associated with interplanetary shock. The Solar Flare arrives in 8 minutes on Earth while Coronal Mass Ejection takes 1 or more days depending on its speed.

Figure I.8a shows a CME seen by the SOHO satellite. One distinguishes the coronal matter ejected from the sun. Figure I.8b shows the arrival of the CME near the earth, this figure is an artistic view. If the magnetic field carried by the CME is directed southward and therefore opposite to the earth's magnetic field, there is a magnetic storm. The occurrence of CME is related to the sunspot cycle. There is much more CME at the maximum of the sunspot cycle (toroïdal component of the solar magnetic field).

High Speed Solar Wind Stream

As we have seen previously, there is a component of the poloidal solar magnetic field which has open field lines on the interplanetary space allowing

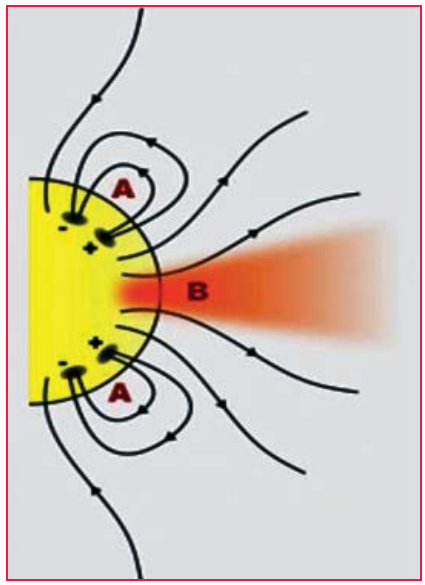

Figure I.9b Open field lines

rapid solar wind to escape from these structures called coronal holes

Figure I.9a shows a coronal hole observed by the SOHO satellite, this hole presents itself as a large black spot on the sun. Figure I.9b shows the lines of the poloïdal solar magnetic field open on the interplanetary medium. If the Earth is on the trajectory of a fast solar wind carrying an IMF interplanetary magnetic field directed towards the south, there is a magnetic storm (see figure I.9c). There is a maximum occurrence of fast winds during the decay and minimum phase of the sunspot cycle, so that the poloidal magnetic field grows to its maximum.

Telluric induced currents

The currents induced in the Earth by the electric currents circulating in the ionosphere strongly disturbed the Earth's environment. During strong magnetic storms, the auroral oval descends towards the mid-latitudes (see figure I.10a) and as a consequence the strong auroral electric currents will induce telluric currents at the middle latitudes or even the low latitudes (figure I.10b) and produce electrical failures in the transformers and cut down the electricity (figure I.10c). This was the case during the storm of 13 March 1989

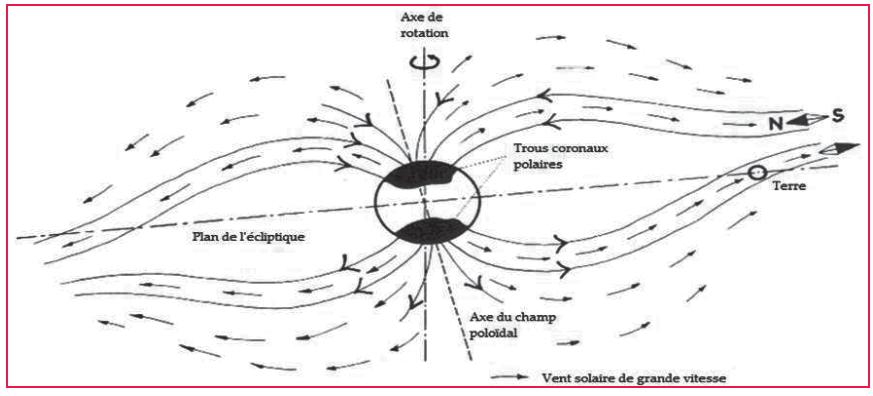

Figure I.9c: Fast wind trajectory from a coronal hole from Legrand 1984

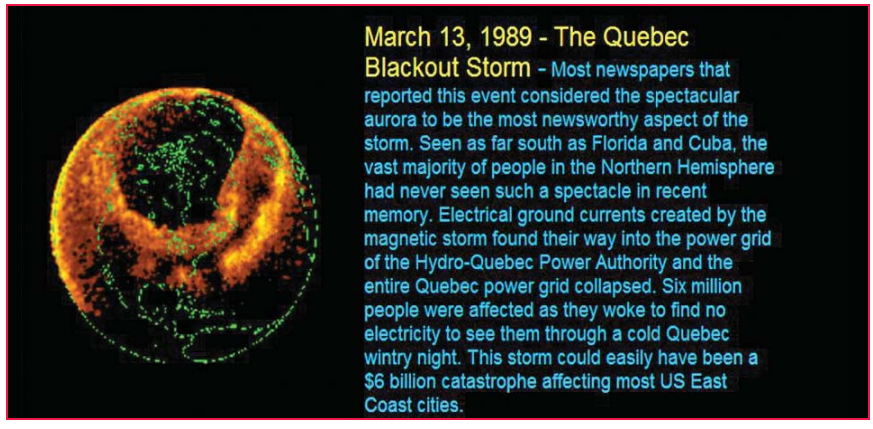

Figure I.10a: Black out storm

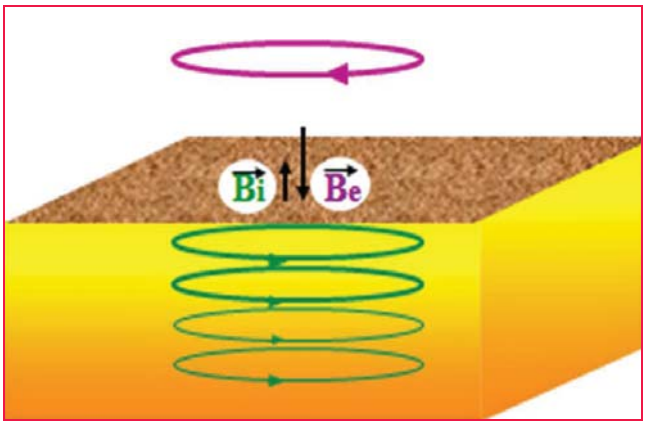

Figure I.10b: Induction of telluric currents (Luu, 2011)

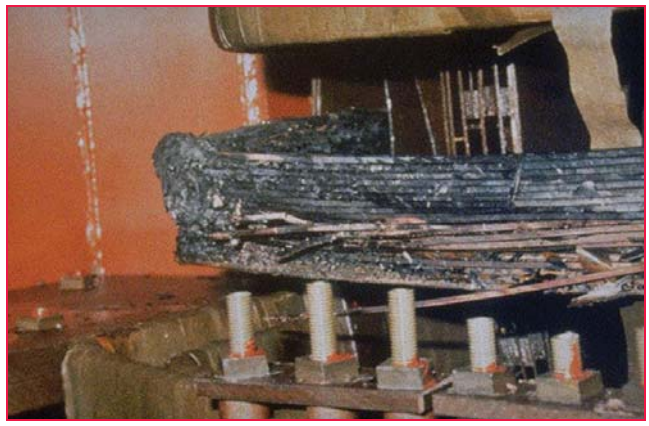

Figure I.10c: Destruction of a transformer

St Patrick's Day magnetic storm: impact on a CME on the ionospheric ionization

Figure I.11a illustrates the variations of different parameters during the magnetic storm of St Patrick's Day (March, 17, 2015). From the top to the bottom, there are the solar wind in km/s, the Bz component of the IMF (in nT) , the magnetic index Ae (in nT) which is related to the ionospheric currents in the auroral zone, the magnetic index SYM-H (in nT) related to the electric currents, in the magnetosphere (Mayaud, 1980; Menvielle and Berthelier, 1991; Amory-Mazaudier, 2010), the Global TEC and the solar index F10.7cm related to the solar radiation.

At the arrival of the CME on March 17, there is a large increase of the solar wind speed associated to a southward component Bz of the IMF; these two conditions are favorable for the development of a magnetic storm. (see section: the disturbed solar wind).

Figure I.11a shows two large increases of the Global Electron Content (GEC) occurring after increases of the Ae magnetic index (auroral currents) and large decreases of SYM-H (magnetospheric equatorial current). These large increases o the GEC are followed by large decreases of GEC.

Figure I.11b shows the TEC maps obtained from 200 GPS stations. We have presented these maps for the 3 sectors of longitude: Asian, African and American, for the period March 14 to April 1st 2015. The x-axis represents the magnetic latitudes with the magnetic equator at zero. The y-axis represents time. On March 17 at 04.45 UT, a CME hits the magnetosphere. This CME was emitted by the sun, 2 days earlier, on March 15. Before the arrival of the CME, on March 14, 15 and 16, we observe on

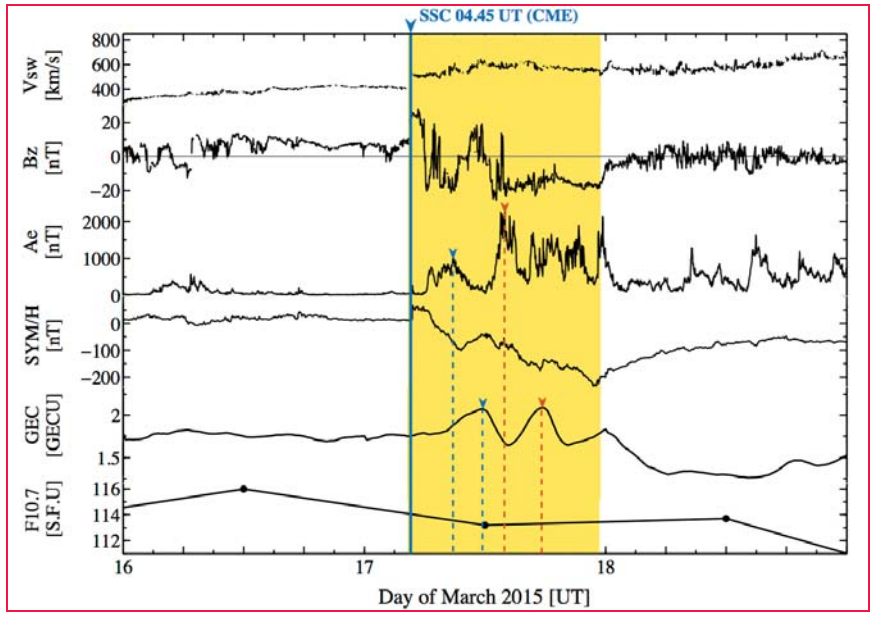

Figure I.11a: Solar wind parameters, magnetic indices, GEC and Solar F10.7 cm on St Patrick's Day storm (Nava et al., 2016)

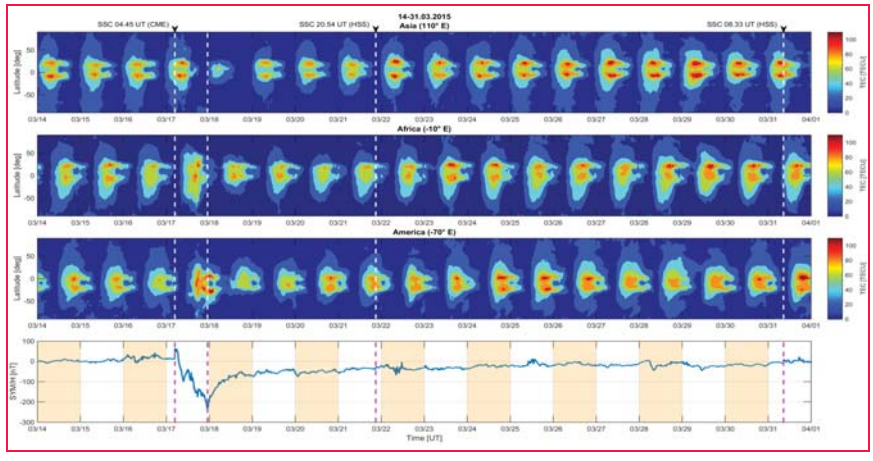

Figure I.11b: Maps of VTEC in the different longitude sectors (Nava et al., 2016)

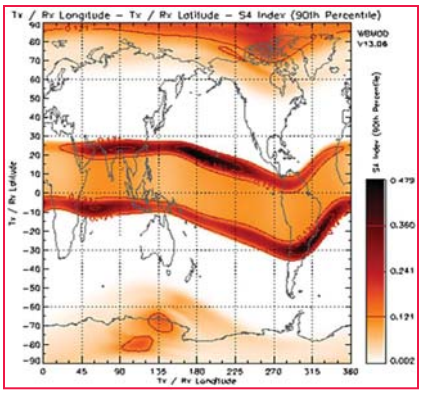

Figure I.12: Scintillation index at GPS L1 (1575.42 MHz) assuming constant local time 23.00 at all longitudes (from http://www.sws.bom.gov.au)

the VTEC maps the signature of the equatorial fountain consisting of 2 VTEC maximum at 15° North and 15° South of the magnetic equator. The impact of CME is very different depending on the sector of longitude considered. In the Asian longitude sector, there is a total disappearance of the ionosphere on 18 March. In the American longitude sector, there was a marked increase in ionization on 17 March. In the African sector, the impact is lower. At the bottom of the figure there is the H-SYM magnetic index which illustrates the variation of magnetospheric currents during the magnetic storm.

Scintillations

Ionospheric scintillation is the rapid modification of radio waves caused by small scale structures in the ionosphere.

Ionospheric scintillation is primarily an equatorial and high-latitude ionospheric phenomenon, although it can (and does) occur at lower intensity at all latitudes.

Ionospheric scintillation generally peaks in the sub-equatorial anomaly regions, located on average ~15° either side of the geomagnetic equator.

Ionospheric scintillations are one of the major problems of GNSS propagation in the equatorial zone. They are not due to solar events such as coronal mass ejections or fast winds associated with coronal solar holes, there are related to **Instabilities in the ionospheric Plasma,** see the book Kelley(1989) on equatorial ionosphere.

Concluding remarks

In this part we have presented the dominant physical processes of the space weather, without which there is no space weather. These dominant physical processes are:

- the magnetic fields and the motions of the Sun and the Earth,
- the magnetosphere, the Ionosphere, the auroral zone,
- the more common solar disturbances due to extra radiations: solar flare, solar burst,
- the coronal Mass Ejection and High speed solar wind related to coronal hole, at the origin of magnetic storms,
- The ionospheric scintillations, related to ionospheric plasma instabilities.

But, there are many other secondary physical processes that also influence the space weather.

In short the space weather is the science of the dynamic and electromagnetic interactions of two magnetic bodies in motion: the sun and the Earth.

This new science includes two aspects: 1) the physics of Sun Earth relations and 2) the effects of solar disturbances on new technologies. In this paper we will focus in the second part on the GNSS technology.

In order to make progress in space meteorology there is the need for international interdisciplinary cooperation. This is the mission of the International Space Weather Initiative (ISWI: http://www.iswi-secretariat.org).

This network promotes a synthetic training on Sun-Earth Relationships. This training is given in schools in the different countries over the world.

This network is based on different rules:
- Distribution of scientific instruments in countries where instruments are lacking,
- The training of students over the world and particularly in developing countries,
- The supervision of PhD, and capacity building in Space Weather, particularly in developing countries,
- Public conferences on Space Weather for public science.

Some students trained in this network defended PhD connecting the recent discoveries of the physics of the sun to the ionosphere (Ouattara, 1999; Zerbo, 2012)

The websites with the data concerning this part are:
ISGI http://isgi.unistra.fr/geomagnetic_indices.php
Institut Royal Météorologique de Belgique http://aeronmie.be
International Association of Geomagnetism and Aeronomy IAGA https://www.ngdc.noaa.gov/IAGA/vdat/
NASA SOLAR SCIENCE http://solarscience.msfc.nasa.gov/
NASA SOLAR DATA https://igscb.jpl.nasa.gov/igscb/data/format/rinex211.txt
NOAA ftp://ftp.swpc.noaa.gov/pub/weekly/Predict.txt
OMNIWEB : http://omniweb.gsfc.nasa.gov/
Satellite ACE http://www.swpc.noaa.gov/ace
Satellite SOHO http://sohowww.nascom.nasa.gov/
Site web Space Weather http://spaceweather.com/

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Watch out for March issue for GNSS training and capacity building.

Development of geospatial and space technologies for disaster management platform

This article presents a study project on collaborative schemes of geospatial and space technologies for disaster risk management (DRM) in the ASEAN region to establish a platform facilitating sustainable operations of the technologies and services

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Asian Institute of Technology
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Center for Spatial Information Science
The University of Tokyo

Resilience of social infrastructure has been considered important for economic growth of Asia as well as the ASEAN region. For example, the 2011 Great East Japan Earthquake and the 2011 Flood in Thailand left enormous damages of human resources, industry, and economics in the disaster affected regions. The Asia region has experienced 150 large-scale disasters (equivalent to 40% of largescale disasters in the world), 200 million of victims, and economic damages of 41.6 billion US dollars per year between 2000 and 2010 (Sawada and Zen 2014). Particularly, the area of the ASEAN Member States is the most affected by disasters in the world (Sawada and Oum 2011). Therefore, strengthening resilience to natural disasters is an urgent issue in the ASEAN region.

In aftermath of Sumatra Earthquake and Tsunami in 2004, the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) was ratified by all 10 member states and entered into force in December 2009. AADMER Work Program 2010-2015 was developed to cover all aspects of disaster management and outlined a detailed road map for four components of disasters: (i) risk assessment, early warning and monitoring, (ii) prevention and mitigation, (iii) preparedness and response, and (iv) recovery. The ASEAN Committee on Disaster Management (ACDM), which comprises national disaster management agencies of participating countries, is an implementing body of the AADMER in collaboration with ASEAN and other countries as well as international organizations.

Although a lot of studies indicated that geospatial technologies and space technologies have notable potentials to strengthen the resilience, sustainable mechanism for integrating the technologies in practice for disaster risk management (DRM) has not still been well established (Miyazaki et al. 2015). A study project conducted under Economic Research Institute for ASEAN and East Asia (ERIA) pointed necessities of (i) trans-border mechanism to deliver the geospatial and space-based information from data provider to end users in disaster-affected areas with support of international activities and (ii) financial schemes involving private sectors, or public-private partnerships (PPP), to operate collaborative integration of the technologies in sustainable and practical manners.

The University of Tokyo and Japan Space Forum started a study project on this issue under ERIA in June 2016 with a support of Cabinet Office, the Government of Japan. This article is to present scheme of the study project and perspectives of the outcomes.

An Envisaged Sustainable Scheme of DRM Information Service in ASEAN Region

In the study project, a trans-border DRM platform in the ASEAN region

was proposed to establish a trans-border mechanism with PPP scheme in a sustainable manner (Figure1). The platform comprises the following components.

(a) Data resource—Resources of necessary information for DRM, such as satellite data, geographic data, meteorological data, ground stations, socioeconomics data, and demographic data. The data resources shall be virtually connected by standardized protocols and infrastructure among data archives and real-time streams from several technology providers rather than a single provider. Because geospatial and space technologies have potentials in international expansion, we especially highlight data resources which are available and extensible in regional and global scale, such as GNSS and earth observation.

(b) Knowledge—Technology itself is a sort of knowledge. In addition, DRM needs knowledge on how to apply the technologies in practice, such as institutionalization, stakeholders' cooperation, local community participation, and local capacities and resources regarding the technologies. Good practices should be studied well so that following projects can apply the knowledge. DRM experts may contribute to the platform to produce and share knowledge products with the stakeholders. Also, the knowledge products will be used for capacity development of human resources that can create DRM solutions using geospatial and space technology in the ASEAN region.

(c) Human network—Practical DRM consists of collaborations among local and international experts of monitoring, data acquisition, data management, science, visualization, and DRM. In addition, it should need local stakeholders cooperation as end users of the DRM technologies and services, with which various kinds of stakeholders shall participate in implementations. For efficient coordination among experts and stakeholders, the platform shall provide directories of experts, government officers, and local community leaders participating in DRMs. Online/offline forums shall be considered to promote efficient coordination for development of DRM practices.

The platform shall work as DRM service infrastructure for public disaster management agencies and private companies, such as mobile phone operators, insurance companies, consulting firms, and information service companies. While the service providers develop businesses using the infrastructure, the platform collect operation fees from the service providers to ensure sustainable operations of the platform and data resources from the technology providers. This scheme will help to ensure sustainability in operations of the technology providers and service providers by the finances facilitated by the platform.

Steps to Design the Platform

The study project aims to (i) analyze feasibility of the proposed platform in terms of technology and finance and (ii) design and prototype the platform based the feasibility study. This study is structured by three steps: (a) collection and development of core examples; (b) design of the trans-border platform; and (c) design of the financial arrangements. Details of each step are described in the following.

(a) Collection, Design, and Development of Core Examples

The project will conduct exhaustive case studies of DRM activities and supporting data resources (e.g. GNSS and earth observation) and practical knowledge through literature reviews and interviews to stakeholders (e.g. operating body and end users) to identify essential requirements of the platform to be designed base on practices. Another approach is organizing existing technologies and know-hows into consistent DRM services as core examples of the platform. To collect such examples efficiently and quickly, the project will hold workshops with data providers, service providers, and end users to discuss DRM applications of global and regional data resources.

There shall be an assumption that the core examples are scalable to other cities, provinces, and countries by the trans-border feature of geospatial and space technologies. The analysis of the core examples will be by data resources, knowledge, and services to investigate how much the core examples are scalable by the trans-border basis.

(b) Design of the Platform

Through reviews of collected core examples, the platform will be designed with requirements which enable scaling up applications by the shared data resources and knowledge. The design shall include and not limited to: (i) technical interoperability of the data resources and technology, (ii) partnerships with data providers, and (iii) participation of local, national, and international stakeholders who has interests in the core examples.

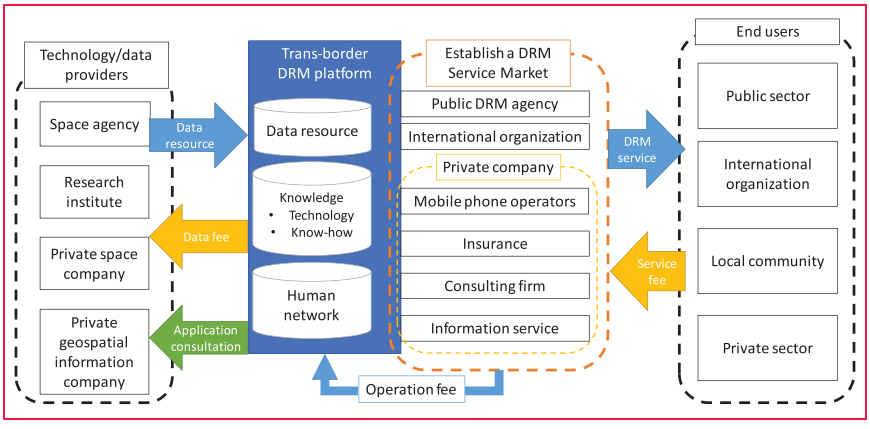

Figure 1: An Envisaged Sustainable Scheme of DRM Information Service in the ASEAN Region

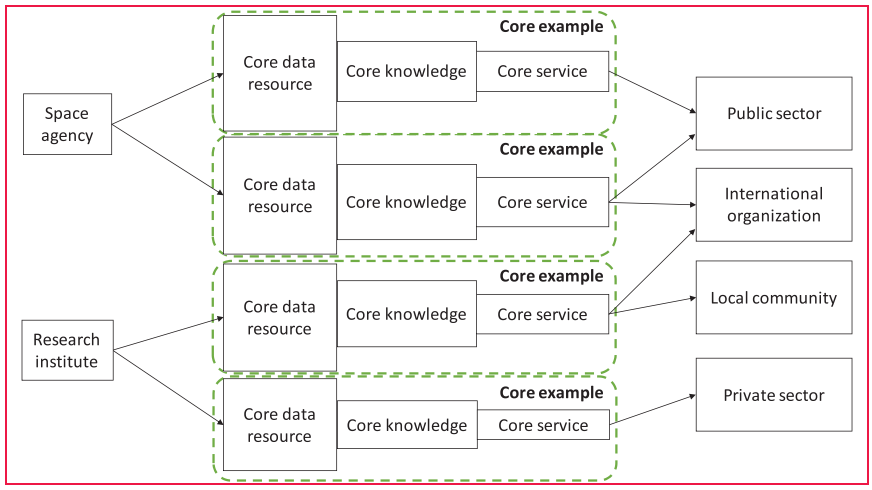

Figure 2: Phase 1—Collection of core examples

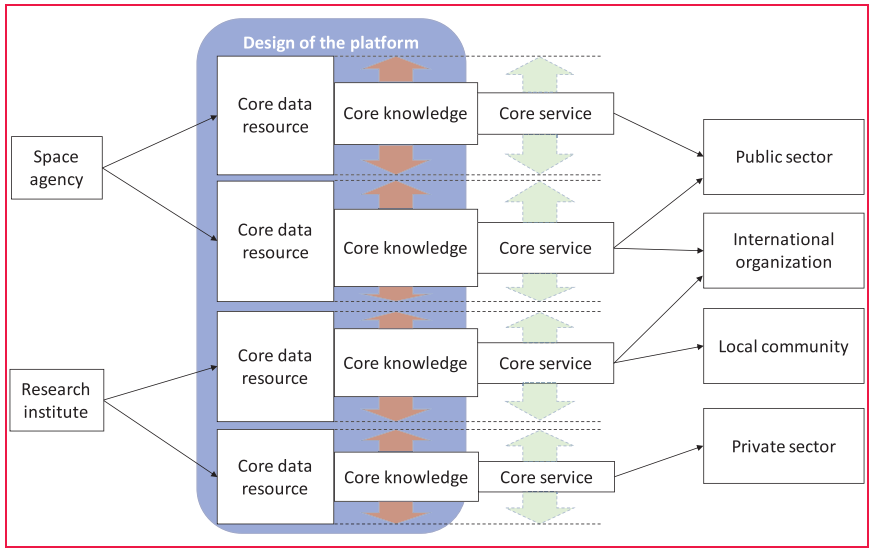

Figure 3: Phase 2—Design of the platform for scaling up applications

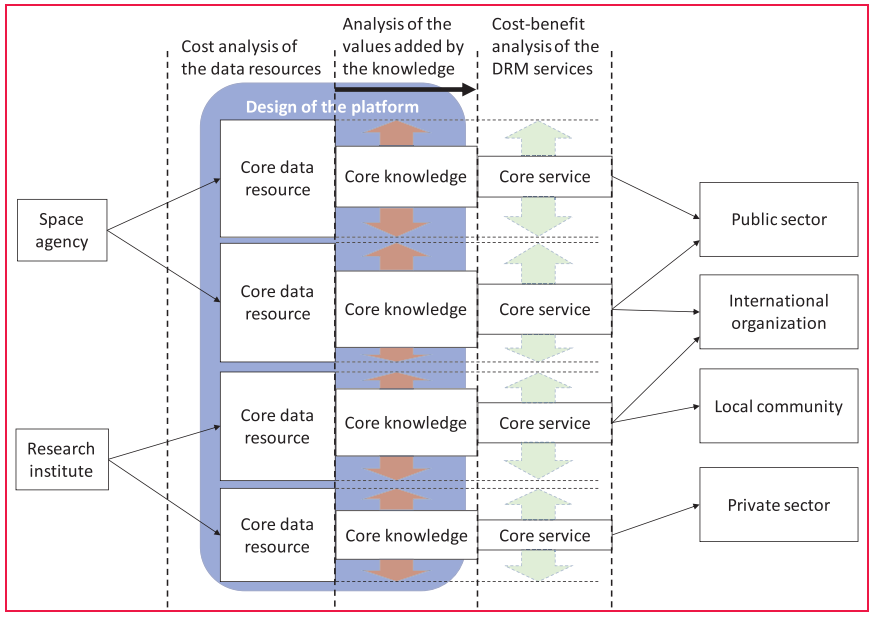

Figure 4: Phase 3 — Financial analysis of the platform

(c) Design of the Financial Arrangements

A financial analysis of the designed platform will be conducted to assess feasibility and sustainability, such as operational cost of data resources, cost-benefit of the services, and analysis of added values by scaling up applications (Figure 4). The analysis will help to draw short- and long-term strategy of operating the platform in sustainable manners. The analysis results are expected to be basis of the financial arrangements among the stakeholders, such as corporation between data provider and the platform and another one between service provider and the platform.

Expected Outcomes and Perspectives

(a) Core examples collected, designed, and developed

This study project will involve some groups who are working for DRM applications of geospatial and space technologies as core examples. The core examples will be classified and shared as data resources, knowledge, and services. The study project also will attempt to combine the components to create new core examples applicable to DRM in the ASEAN region.

(b) Technical design of the platform

The platform shall be designed with technical specifications which are identified by the analysis of the core example comprising data resources, knowledge, and services. The design shall include technical requirements to promote collaborations among core examples, such as inclusion of standardized protocols and infrastructure. Also, the design shall include technical perspectives to scale up the core knowledge and services as broad as a geographical extent that the core data resources supports.

(c) Financial design of the platform

Financial arrangements needed for establishment of the platform will be designed based on results of the analysis on costs and benefits between the data

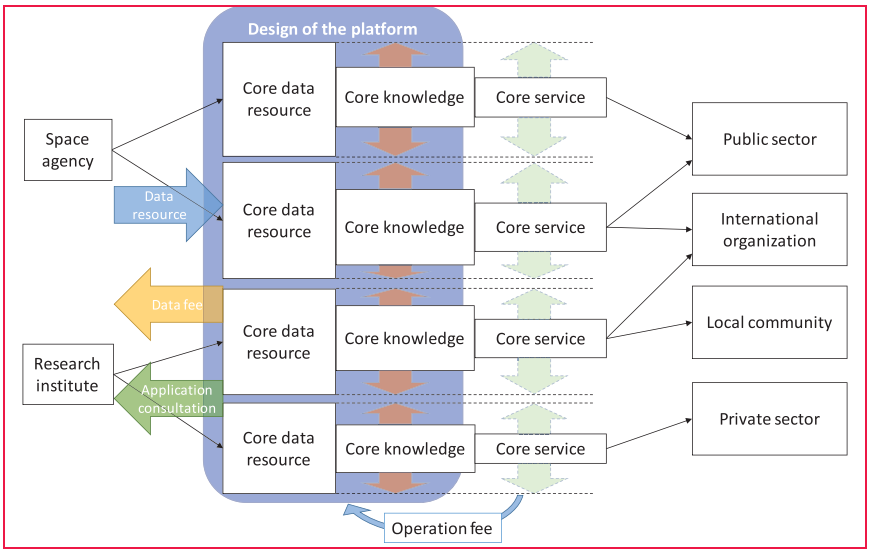

Figure 5: Phase 3 — Design of financial arrangement

resources and services, and added values by the knowledge. The design will support to develop strategies of collaborations with development agencies who would have interests in DRM technologies and its applications, such as the World Bank and the Asian Development Bank, the main players of promoting mainstreaming DRM in development projects. The design also will help to facilitate dialogues within the ASEAN member states to finance for sustainable operation of the platform.

(d) Strategy for development and operation of the platform

The project will draw short- and long-term strategies of development and operation of the platform based on the technological and financial design. The strategy shall include collaborations with partners, such as the core example participants comprising the ASEAN member states, technology providers, stakeholders, and financial partners, such as international development agencies and bilateral assistance schemes. Therefore, the strategy shall be consistent with partners' resources and strategies. The strategy also shall include measurable goals in disaster reduction which can be achieved by establishment of the platform.

Conclusion

This article presented a study project on collaborative schemes of geospatial and space technologies for DRM in the ASEAN region to establish a platform facilitating sustainable operations of the technologies and services. The study project is ongoing to seek core examples through literature reviews and consultations with DRM stakeholders (as of February, 2017). The collected core examples will be complied into a design of the platform to share the good practices for strengthening resilience of the ASEAN region.

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SNIPPETS

At a Glance

- CalAmp's GovOutlook Integrates with Cityworks to Streamline City of Ann Arbor Public Works Operations
- FARO® Opens New Office in Australia
- WorldStores Maps Optimised Routes with Maxoptra
- 3D Repo BIM App Helps Crossrail Digitally Manage Assets
- Supergeo's New Reseller in Pakistan – Chaudhery Brothers
- TerraGo partners with CompassTools on advanced GIS and GPS data collection
- Topcon releases new ES series total station with data transfer functionality
- Simularity, Taqnia join hands for analyzing satellite imagery
- TerraGo partners with CompassTools to deliver advanced GIS, GPS data collection
- UrtheCast signs $180 million contract to operate two OptiSAR satellites
- Aeris, MapmyIndia form business partnership to tap IoT market in India
- Alphabet likely to sell Skybox Imaging to rival Planet
- Koito, Quanergy join hands to design compact solid state LiDAR sensors
- TriLumina collaborates with Analog Devices on illuminator module automotive LiDARs
- Intel announces it will buy 15% stakes of HERE

In Coordinates

10 years before...

mycoordinates.org/vol-3-issue-02-February-07/

NAVIGATION

Satellite Navigation – Truths & Myths

It is a myth that Galileo will give Europe independence of the US in satellite navigation

PROFESSOR DAVID LAST

I believe it is a myth that Galileo will give Europe independence of the US in satellite navigation. It is equally a myth that it will necessarily bring to Europe a vigorous new industry. The country that has benefited most industrially from GPS is not the US, but Japan. Operating a satellite system is of little commercial value; you get your vigorous new industry from selling users the equipment they want. And yet, Galileo will achieve so much more than those dreams of independence that have convinced European politicians to fund it. This is the future of Global Navigation. With a reinvigorated GLONASS, new satellites from Japan and China, and global financial and technical collaboration, the impact of Galileo-plus-GPS will exceed the sum of its parts. Backed up with carefully-chosen terrestrial systems such as eLoran will create robust navigation for all modes of transport - a goal of immense value that is almost within our grasp!

GEODESY

Determination of local gravimetric geoid

A case study of Delhi area

SK SINGH, BRIG (DR) B NAGARAJAN, PK GARG

The study has firmly shown that EGM96 can be effectively used for gravimetric geoidal modeling in India notwithstanding its own shortcomings provided that the other aspects of the methodology are explicitly designed and followed carefully. The procedure of analytical solution of Stokes integrations with spherical cap of radius of o.5° using dense gravity data has worked well and achieved an accuracy, in absolute sense, of the order of 20 cm as determined from comparison with GPS/leveling differences making it an alternative to conventional method of leveling, suitable for most of the mapping applications.

NAVIGATION

A new approach for SINS stationary self-alignment

A new self-alignment approach based on the measurement of IMU is proposed for SINS on a stationary base.

JIANGBIN ZHOU, JIANPING YUAN, XIAOKUI YUE, JIANJUN LUO

Because of the poor observability of the system, it is hard to give attention to the accuracy and speed of alignment by the traditional initial alignment technology. In order to solve this problem, through analyzing the characteristic of the SINS stationary alignment seriously, a bran-new SINS stationary alignment approach is proposed by means of establishing new system model and measurement model. The new approach could complete the SINS stationary alignment process through the outputs of IMU without any external information.

DEBATE

The datum debate continues

Readers may recall the vision and mission outlined by the Dr APJ Abdul Kalam, the President of India (Coordinates, December 2006). Alongside we printed an open letter from Dr Muneendra Kumar addressed to the President where he emphasized the need to modernize the datum. Some experts respond:

We need Everest 2007 soon

Prof M N Kulkarni
IIT Bombay

Redefinition of Indian datum is necessary

N K Agrawal, Former Director, Survey Training Institute, Survey of India

Not advisable to stick to weak datum

Lt Gen Surindar P Mehta (Retired), Former Surveyor General of India

Use of GPS in survey data error control and management

Building Code Implementation program, a project of National Society for Earthquake Technologies, uses Global Positioning System (GPS) data to control error of its surveys

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National Society for Earthquake Technology - Nepal (NSET), Nepal

Kapil Bhattarai
National Society for Earthquake Technology - Nepal (NSET), Nepal

Deepak Saud
National Society for Earthquake Technology - Nepal (NSET), Nepal

Suman Pradhan
National Society for Earthquake Technology - Nepal (NSET), Nepal

Building Inventory Data Survey (BIDS) is a survey carried out by NSET to develop the earthquake scenario of cities. It collects structural data, occupant number and spatial information of all buildings within city. This survey is planned to be conducted in 8 municipalities of Nepal that BCIPN has been working on. So far, the BIDS survey has been successfully completed on Bharatpur, Vyas, Birendranagar and Birtamode municipalities. The main purpose of the survey is to develop an earthquake scenario for these municipalities. This earthquake scenario estimates the loss of the infrastructure, economy and social disruption [1]. This crafted scenario provides a powerful tool to draft mitigation policies and action plan. It will also help the community to set priorities that will significantly reduce the impact of likely future events.

The survey consists of two aspects, geography (the georeferenced building footprints) and attribute (building and occupant data). They navigate on field with the help of the map that they are provided with. However, while navigating, there are often problems as there are many areas that seem similar on map. As seen in the satellite image below in Figure 1, the two buildings marked by squares below are very similar in geographical configuration. Also, the satellite image is not recent which means that there could be some considerable changes such as extraction of new buildings as well as demolition of buildings. In these situations surveyors may get confused while locating the correct building on the map. This often leads in a chain effect and the buildings around it being incorrect surveyed as well. In order to tackle this GNSS (Global Navigation Satellite System) technologies have been put to use. Modern smart phones that are available in market have built in GPS receiver [2]. GPS is a navigation system that uses satellites that are constantly orbiting the Earth to provide location of the receiver. This location can be compared with the location of the footprint of the surveyed building. This can tell whether the survey is spatially correct or not.

Methodology

The area to be surveyed is broken down into grids and a map is prepared for each grid of 200 by 200 meters. Then, surveyors are provided with a map and asked to go to the corresponding location and survey all buildings in the region within the grid.

Figure 1: Buildings with similar geographic configuration

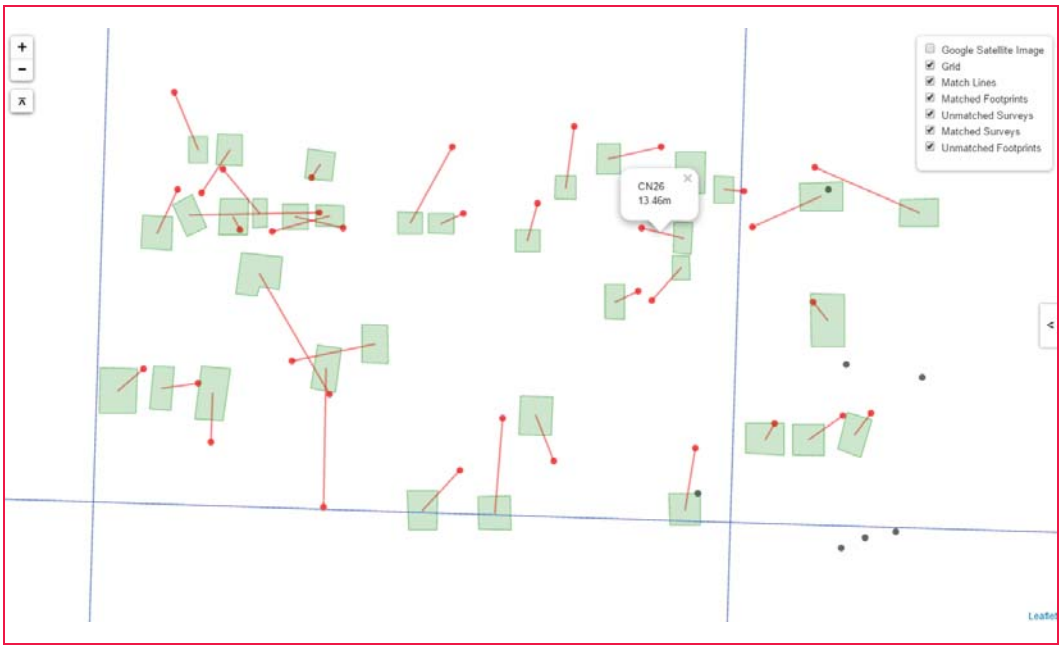

Figure 2: Web application developed for error control

Survey data is collected on a smart phone and uploaded to the ODK based platform KOBOTOOLBOX [3] while the footprint of the building is drawn on the map. The drawn footprint is then digitized using google earth or a web tool developed by NSET after the completion of survey by surveyor in their assigned grid.

The first step in finding the error is to check the distance between the locations recorded by devices during survey and their corresponding digitized building footprints. To find the distance, first the centroid of a building is computed. After that, the distance between centroids and their corresponding survey locations are computed. These distances are used to determine whether the surveyed building was indeed the building marked on map. In order to make the process efficient and easier, a web map application was developed. The web application automatically fetches GPS coordinates and identifier of survey data from the database where it was uploaded. In the web application, after the digitized footprints that is saved as kml file is selected, it is parsed and matched it against the surveys that it fetched earlier. The matched survey and footprint are connected with a line that, when clicked, pops up with the identifier and distance between building centroid and survey GPS location which is computed by the application. A screenshot of the web application can be seen in Figure 2.

Satellite image can also be added as base on this map to get a better idea as it can be seen below in Figure 3.

This procedure can be carried out in two approaches depending when it is carried out

1. Post-Survey Approach
2. During-Survey Approach

Post-Survey Approach

In this approach, the check is performed after the whole survey is complete. The advantage of this approach is that it is performed only once i.e. at the end and is not dependent on availability of internet connection. Since Microsoft Excel is a widely used application, so once the data is exported to spreadsheet, the level of expertise required is relatively low. Since the error management is done after survey ends, the survey period can be kept short. The general workflow for this approach can be seen below in Figure 4. However, there are some disadvantages as well. One of the major disadvantages is that since the check is done at the end, any error occurred will be solved only at the end. This results in accumulation and propagation of error. Since the corrections are made after survey ends, most of the corrections are based on conclusions derived from the available data such as satellite image which is not always reliable as the images are generally old. Visiting the place itself could prove to be impractical if the activity has a predefined time limit.

During-Survey Approach

In this approach, the check is performed after survey in each grid is complete before

Figure 3: Error control web-application with satellite image enabled

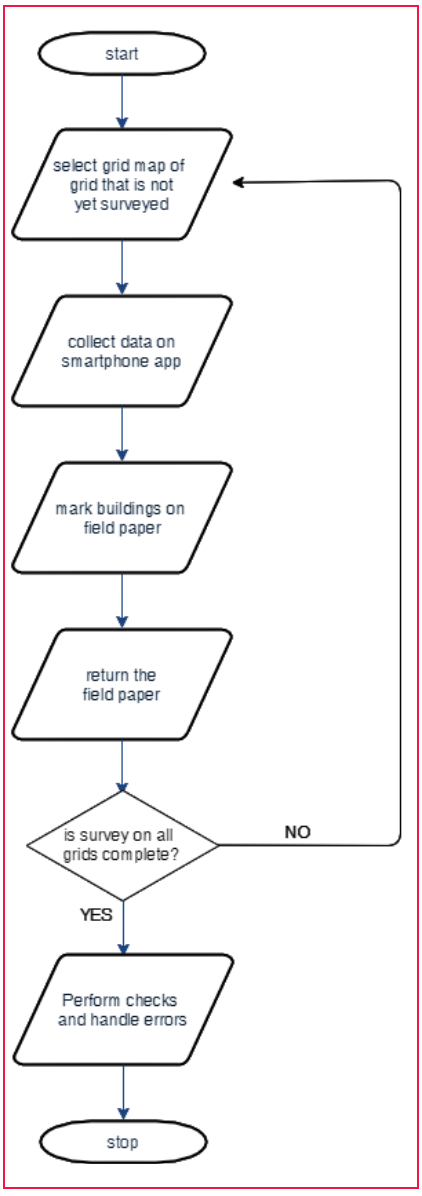

Figure 4: Post-survey approach

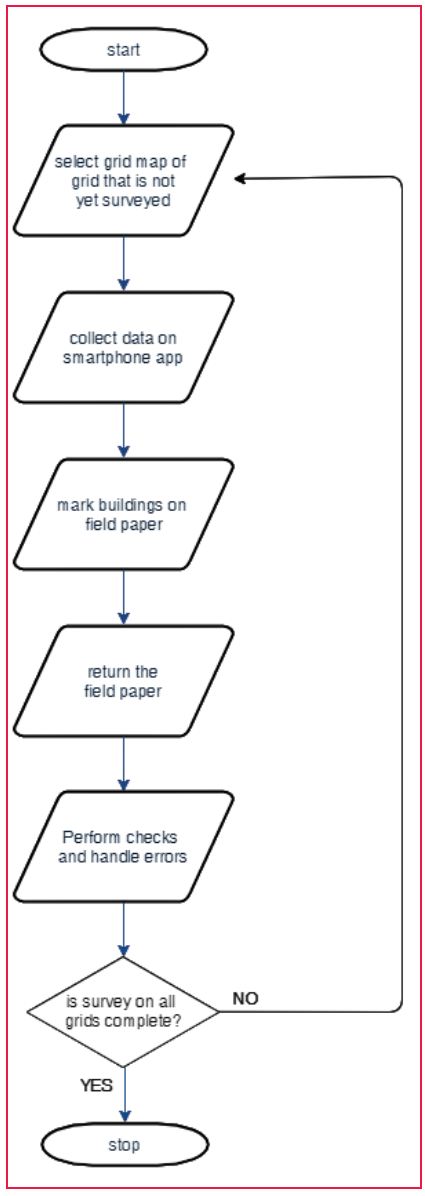

Figure 5: During-survey approach

the overall survey ends. Using this approach, errors that occur in survey can be handled during survey which stops the accumulation and propagation of error. Since the survey is ongoing when checks are performed, the corrections can be made more accurately as it's more practical to visit field if any confusion arises. Most corrections will be done by the time the survey ends and errors will also be smaller in number because of the quality control. So, the data management process after survey becomes a lot faster and easier. The general workflow for this approach can be seen below in Figure 5.

One downside to this approach is that since checks and corrections are carried out during survey period, the survey period is generally longer. Since the data is checked in parts, the whole state of survey can't be seen while it is being checked. For example, surveys towards the outer extents of region completed till now could appear to be spatially correct when they are not.

Conclusion

GNSS has made collection of geolocation very easy. Collecting location obtained from GNSS services such as GPS has multiple advantages. While checking spatial correctness of geographic data, the ability to collect location information with such ease makes a huge difference. Even while conducting BIDS survey, GPS data has been implemented as core element of the survey. While it has been used and evaluated using two different approaches, it can be concluded that the approaches are suited for different scenarios. In scenarios where the on-site survey duration is limited and have limited on-field personnel, even though post-survey check would take longer time, the post-survey check approach is better suited. However, in order to minimize possible errors, it is best to have experienced surveyors when using this approach. Conversely, if there is no time constraint, then during-survey check approach is best. Surveyors with less experience can also work in this approach as the data they bring is constantly monitored.

Acknowledgements

The authors would like to acknowledge all people directly and indirectly involved with the program. The financial support provided by United States Agency for International Development, Office of U.S. Foreign Disaster Assistance (USAID/OFDA) to NSET for BCIPN program is also greatly appreciated. The authors would also like to thank the involved municipalities for their assistance for the program. The encouragement and review provided by NSET management and colleagues, especially Er. Sumit Maskey, is highly acknowledged.

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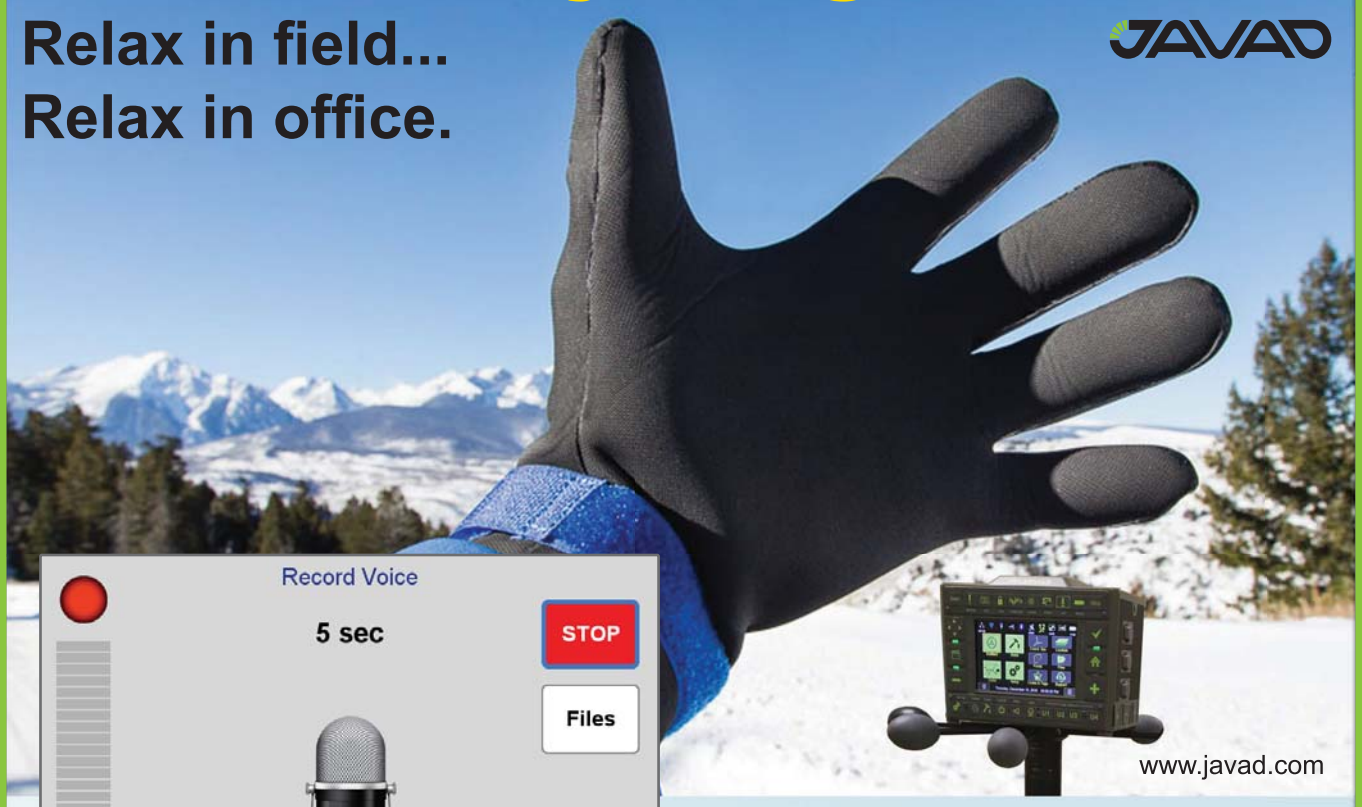
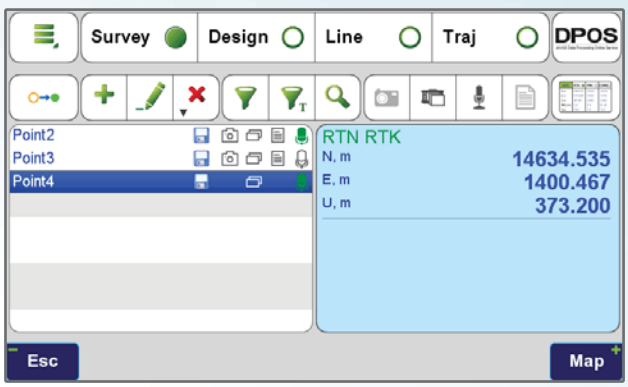
[2] "GPS.gov: GPS Overview," [Online]. Available: http://www.gps.gov/systems/gps/ [Accessed 26 December 2015].

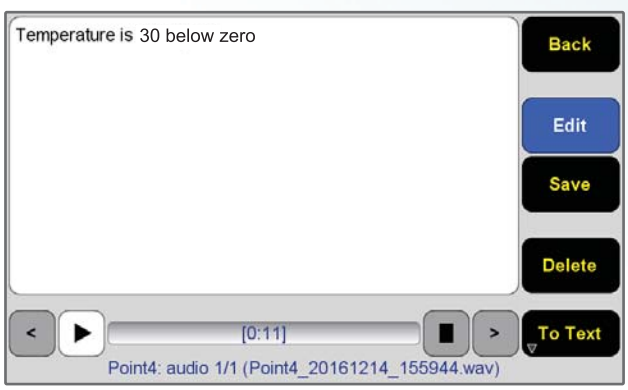
[3] "KoBoToolbox | Data Collection tools for challenging environment," KoBoToolbox, [Online]. Available: http://www.kobotoolbox.org/. [Accessed 26 December 2015]

Don’t take your gloves off!

Relax in field...
Relax in office.







1. Start by proximity sensor – stops automatically when all OK
2. Talk all info in microphone.
3. Takes photos and screen shots automatically or manually
4. TRIUMPH-LS converts to text automatically and created HTML and PDF reports.

Icons description:

Raw GNSS data
Photo
Screenshots
Notes
Audio file
Audio file converted to text

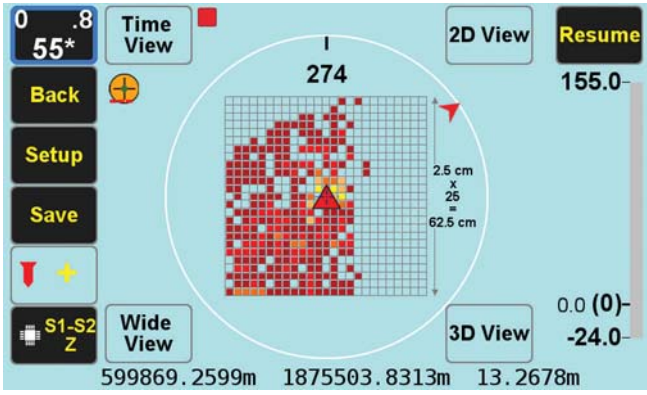
to Text – converts voice to text. Long push converts all voice files attached to this point

Edit – edit text after conversion and Save. Long push on these icons goes directly to screens to attach more.

Front

J-Tip

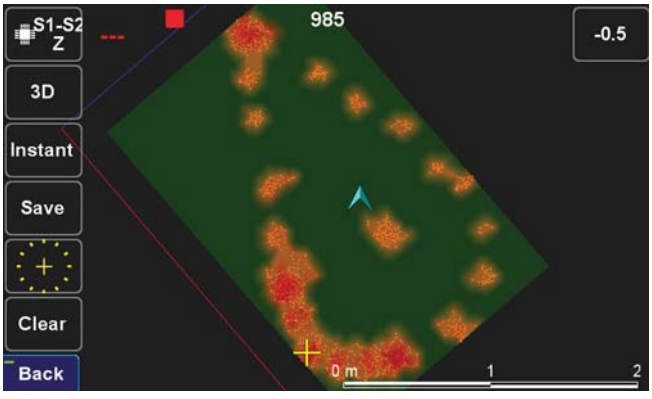
TRIUMPH-LS tags coordinates with magnetic values, It also guides you to top of the item to survey it.

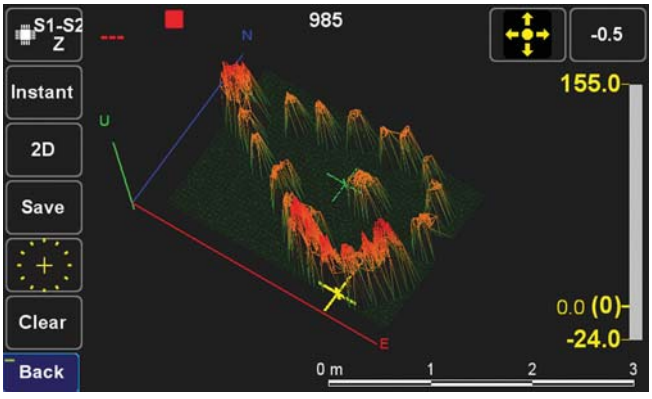


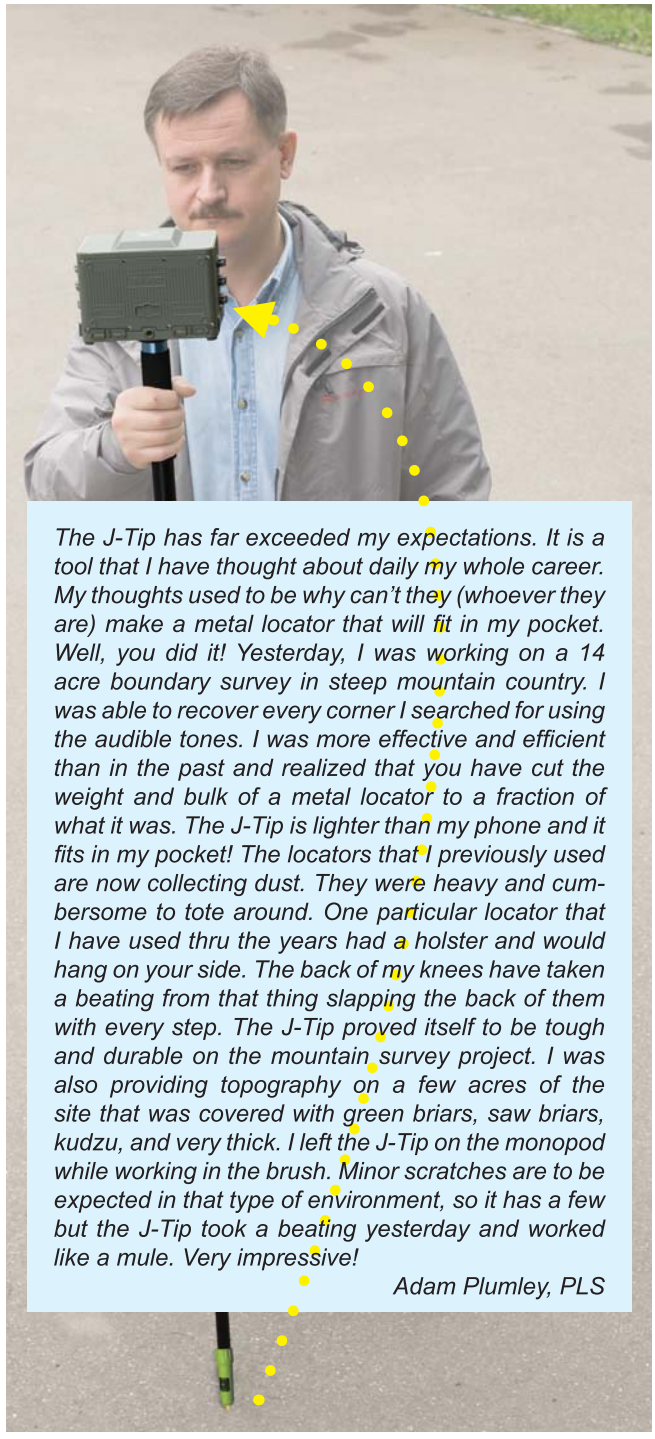
The Mag View focuses only on the mag object with the highest mag value.

The audio and graphical bar on the right side show the magnitude of the magnetic object.

In “Setup” you can select the cell size and the size of the field you want to scan.







The J-Tip has far exceeded my expectations. It is a tool that I have thought about daily my whole career. My thoughts used to be why can’t they (whoever they are) make a metal locator that will fit in my pocket. Well, you did it! Yesterday, I was working on a 14 acre boundary survey in steep mountain country. I was able to recover every corner I searched for using the audible tones. I was more effective and efficient than in the past and realized that you have cut the weight and bulk of a metal locator to a fraction of what it was. The J-Tip is lighter than my phone and it fits in my pocket! The locators that I previously used are now collecting dust. They were heavy and cumbersome to tote around. One particular locator that I have used thru the years had a holster and would hang on your side. The back of my knees have taken a beating from that thing slapping the back of them with every step. The J-Tip proved itself to be tough and durable on the mountain survey project. I was also providing topography on a few acres of the site that was covered with green briars, saw briars, kudzu, and very thick. I left the J-Tip on the monopod while working in the brush. Minor scratches are to be expected in that type of environment, so it has a few but the J-Tip took a beating yesterday and worked like a mule. Very impressive!

Adam Plumley, PLS

2D and 3D views of the field show the magnetic objects that have been scanned.

Zooming the 2D and 3D screens can show the shape of the magnetic objects under the ground.

For many sophisticated features of the J-Tip see its Users Manual in www.javad.com

Concepts Behind RTK Verification

Fundamental in the determination of GNSS solutions is calculating the correct number of full wavelengths (so-called ***fixing ambiguities***) in order to figure out the distances from the satellites to the receiver. In doing Real Time Kinematic (RTK) surveying, we need it fast and we need it to be correct.

Multipath, the reflections of GNSS signals from ground and nearby objects and structures create their own indirect measurements from the satellites to the GNSS receiver. It's as if your measuring tape is bent around an obstacle such as a tree instead of a free and clear line of sight between two points. No calculator is going to improve this result.

TRIUMPH-LS has sophisticated hardware to distinguish between the direct and indirect signals and remove most of the indirect signals. It also reports the amount of indirect signal that has been removed. The worst case is when the receiver doesn't see the direct signal at all; e.g., the satellite is behind a building, but it's still receiving the signal reflected off of the nearby structure. It is the task of the RTK engines to isolate such indirect signals and then exclude them from the calculations.

If too many of the signals are affected by severe multipath or indirect signals, no solution may be found. Remember, indirect signals are analogous to the bent measuring tape! When you're preforming RTK surveying, observe your environment and come to recognize that the structures around you are like mirrors for GNSS signals.

The other aspect impacting the veracity of a fixed solution is when there are weak GNSS signals. Frequently, weak signals are due to their penetration directly through tree canopy.

While the **TRIUMPH-LS** can't move the obstacles that are creating multipath out of the way, its sophisticated hardware has advanced multipath reduction sub-system, its tracking software is designed to handle even the weakest signals, and its **J-Field** software provides reliable RTK solutions like no other system with its **Automatic RTK Verification System** (patent pending). J-Filed also has ample tools to demonstrate the reliability of the solution or warn against questionable results. You can readily see that without such tools other systems can provide you wrong and misleading solutions.

J-Field uses six RTK engines (Figure 1) running in parallel plus a support engine to monitor and aid the six engines. Each engine uses a different criteria and mathematical method tailored to resolve ambiguities in different conditions. These six parallel engines not only verify robust solutions but also maximize the possibility of providing solutions in all conditions.

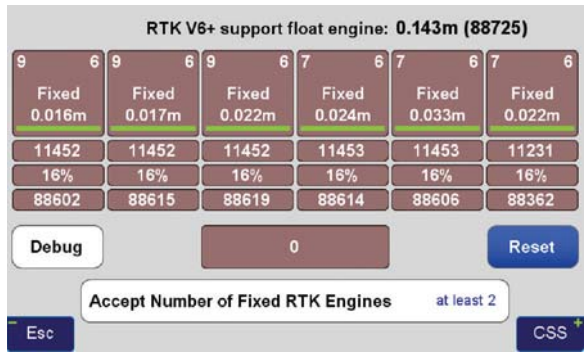


Figure 1 *V6+ six RTK Engines*

User Defined Verification Tools

J-Field provides the option for you to specify the **Minimum Number of Fixed RTK Engines** in verifying solutions **N** times before a position is automatically accepted where **N** is a user defined value.

J-Field employs two metrics to evaluate the performance of its RTK system of six engines: **1) Confidence Counter, and 2) Consistency Counter.** (Figure 2)

Confidence Counter

Figure 2 *Verify Settings*

This metric is incremented each time an engine is reset, ambiguities are recalculated, and the solution is in agreement with the previous ones (as defined by the **Confidence Guard (CG)**, default value 5 cm) is achieved. The Confidence Counter increments by 1, 1.25, 1.5, 1.75, 2.0, and 2.5 depending on the number of reset engines that fix in that epoch.

Consistency Counter

The Consistency Counter is incremented each time a solution is in agreement with the previous ones (as defined by the Confidence Guard) irrespective of engines being reset or not. The Consistency Counter is incremented by 0.0, 0.1, 0.25, 0.5, 1.0 and 1.5 depending on the number of fixed engines used in that epoch. Note that one fixed engine gets no credit and 6 fixed engines gets a **Consistency Credit** of 1.5.

Using these Confidence and Consistency verification tools, J-Field has two options to achieve reliable RTK solutions: **1) Verify With Automatic RTK Engines Resets** and **2) Verify Without Automatic RTK Engines Resets.**

Verify with Automatic RTK Engines Resets

This method has two steps: **1) Confidence Building** and **2) Smoothing and verifying**.

• **Step One.** In Step One, fixed engines are reset and solutions are collected into groups. Each group contains all the epochs located within a specified radius (the CG value) from its center and new groups are created as necessary so that all epochs fall into at least one group. Each group has its own Epoch Counter, Confidence Level and Elapsed Time. A point may fall into more than one group. The groups are sorted from best to last by the sum of their Time and Confidence with the current best group being shown within [ ] and others within ( ). Step One continues until a group reaches the Confidence Level. (Figure 3)

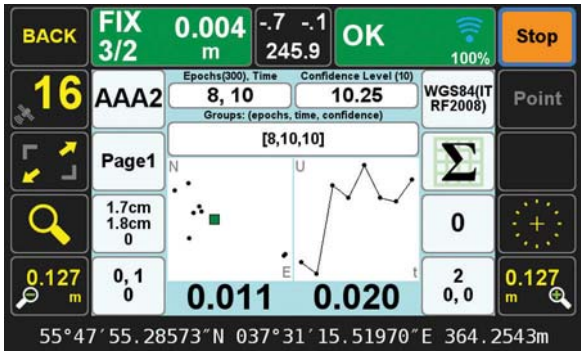


Figure 3 *End of Step one*

• **Step Two.** During Step Two the engines are not reset and solutions which are located inside the CG of the selected Group are added to that Group for the remaining number of epochs that user has requested (Epoch Number, EN) in the How to Stop screen. Epochs which are outside the CG of the selected Group will be stored in a new (or previously created) group; the RTK engines are reset if the epoch falls outside a sphere with a radius twice that of the CG and the process will then revert back to Step One and the Confidence Level of the current group will be reset to 0.

If the number of epochs falling outside of the current group (but less than 2X outside it) reaches 33% of epochs collected so far, the process will revert back to Step One. Previously created groups will remain intact and once an existing or previously created group meets the Step One criteria, it will pass to Step Two. (Figure 4)

In both steps the Consistency Counter is also incremented as mentioned earlier.

You can manually reset all RTK engines via the V6-RTK engines screen (Figure 1), or assign this

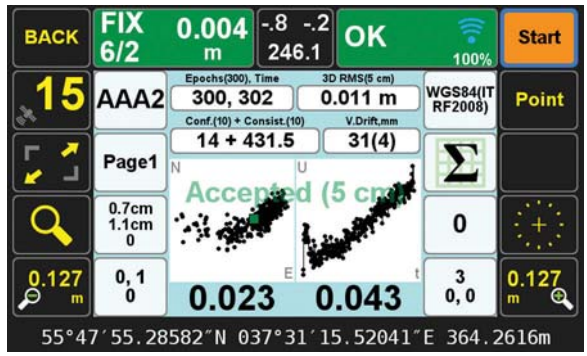


Figure 4 *End of Step 2*

reset function to any one of the U1 to U4 hardware buttons in front of the TRIUMPH-LS for easy access.

Verify without Automatic RTK Engines Resets:

In this method we don't force the RTK engines to reset but rely mostly on the Consistency Counter. There will be only one group as selected by the first epoch. Solutions that are not within the Guard band of the current average will be thrown out. If more than 30% of solutions are thrown out, the process will restart.

The horizontal and vertical graphs presented in both approaches also help the surveyor to evaluate the final solution. The linear drift of the vertical solution and its drift RMS are also shown above the vertical graph. A high linear drift (more than few centimeters) reveals severe multipath or, in rare cases, a wrong ambiguity fix. Pay close attention to the vertical drift and the horizontal and vertical scatter plots of epochs. Consider the scatter plots as doctors examine X-rays to determine anomalies.

The desired **Confidence Level** and **Consistency Level** are user selectable. Default values are 10. These parameters along with the desired number of epochs must be reached before a solution is provided.

In either case there is also a **Validate** option which, when selected, will reset all engines at the end of the collection and continues with 10 more epochs to validate if the solution is within the desired boundary of the Confidence Guard. (Figure 2) Minimum number of engines for the Validation Phase is user selectable.

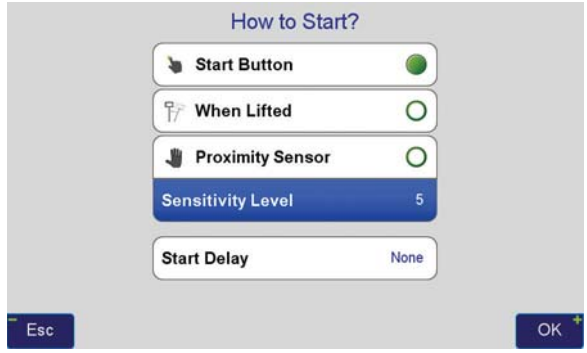


Figure 5 *How to Start*

Figure 6 *How to Stop*

In either case, if Auto-Accept is activated, the position will be automatically accepted if the RMS of the final solution is less than what user has selected in the Auto-Accept screen. (Figure 6)

You can also use **Auto-Restart** if you want to monitor structures or test the RTK system unattended. (Figure 6)

Screen Shots of Action Screen

Action Screen shows detailed information about each point collected. Screen shots can automatically be attached to each point and saved at the end of each collection (Figure 7). In **Verify with Automatic RTK Engines Resets** screen shots at the end of both Step One and Step Two are saved (Figures 3 and 4). In Action screen there are 8 white boxes that selected items can be viewed on them.

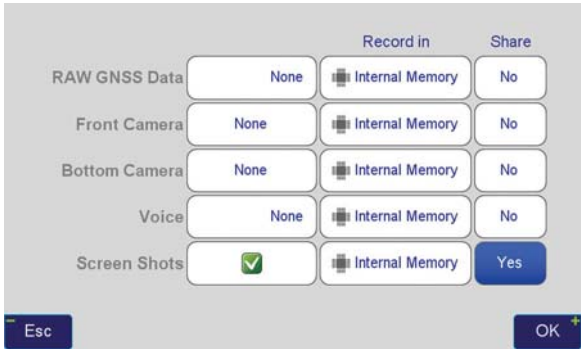


Figure 7 *What to record screen*

Review Screen

View cluster of all points. Select the desired point to see its point cluster (Figure 8). Click the icons to see additional details about that point (Figure 9) including the distance and direction to the current point (Figure 10).

The effects of multipath, ionosphere, orbit, and other sources of problems somewhat exponentially increase as the baseline length increases. In a VRS/RTN scheme your **actual** baseline length is the actual distance to the nearest base station. The **virtual** base station that is mathematically created is not the actual length. We strongly recommend using your own base station near your job site in a Verified-Base RTK (VB-RTK) scheme.

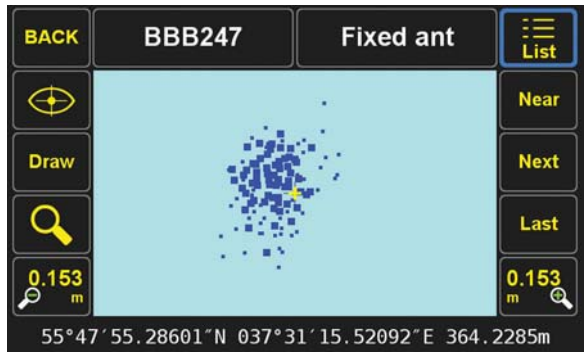


Figure 8 *Review screen shows cluster of 386 points*

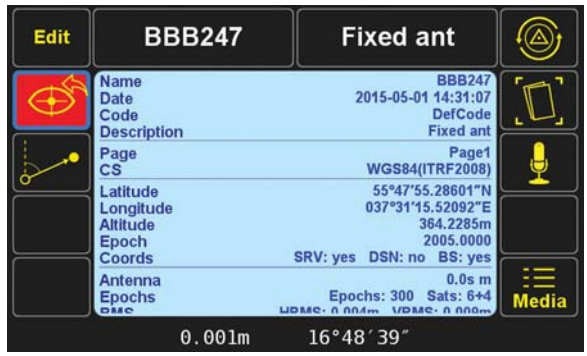


Figure 9 *Detailed information on selected point (scroll to see all information)*

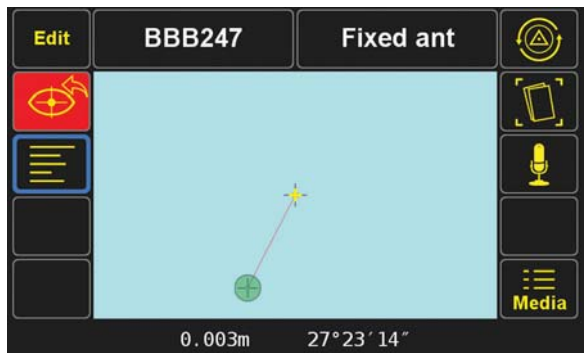


Figure 10 *Distance and direction from the current point to the selected point*

In addition to providing you with the most reliable RTK solutions (especially true in remote areas where cell coverage is hit or miss), using your own base receiver allows you to easily tie your solutions to well-established IGS/NGS spatial reference systems through Javad's exclusive Data Processing Online Service (DPOS) and J-Field's user-friendly Base/Rover Setup. Note that post-processed results returned to the TRIUMPH-LS using DPOS are dependent on the availability of orbital data from NGS and may require several hours. For further reading about DPOS, its integration into J-Field and the streamlined approach developed by Javad for setting up the base and rover, please check out Shawn Billings' excellent article on VB-RTK on our

website. Point your browser to: *http://www.javad.com/jgnss/javad/news/pr20150219.html*

Alternatively, if you don't have access to IGS-type stations to use DPOS, you can select an open area near your job site and use TRIUMPH-LS to obtain its position via RTN networks for about 5 minutes. You may repeat a couple of times for assurance. Then transfer this position to the TRIUMPH-1 or TRIUMPH-2 to use as the base station near your job site. The Base-Rover setup screen in the TRIUMPH-LS makes this job very easy.

Instantaneous Multipath charts

TRIUMPH-LS removes most of the multipath instantly on every epoch. Click on the Satellite icon to see the Signal Strength of satellites and then click the "+" key to see the multipath charts.

Figure 11 shows the amount of code phase multipath that TRIUMPH-LS has removed; relative to a fixed level. That is why negative numbers are in this figure. Units are in centimeter. Noting the signs in this figure, the amount of multipath in some satellites is in excess of 5.6 meters.

Figure 12 shows the amount of carrier phase multipath that TRIUMPH-LS has removed relative to a fixed level. Units are in millimeter. Noting the signs in this figure, the amount of multipath in some satellites is in excess of 4 centimeters.

SAT	EL	L1	P1	P2	L2C	L5	SAT	EL	L1	P1	P2	L2C	L5
GPS2	29↑	273	281	-76	--	--	BDU11	75↑	362	--	--	--	305
GPS6	44↑	55	201	-60	-5	189	BDU12	36↓	288	--	--	--	200
GPS12	70↑	183	190	-90	-94	--	GPS3	10	--	--	--	--	--
GPS14	25˜	281	317	-97	--	--	GPS29	3	--	--	--	--	--
GPS17	23↓	332	364	-74	6	--	GPS32	3	--	--	--	--	--
GPS24	53↓	117	566	67	-64	124	GLN7	3	--	--	--	--	--
GPS25	30↑	243	218	-42	-50	-34	GLN19	12	--	--	--	--	--
GLN1	10↑	305	229	-126	-404	--							
GLN8	16↓	26	87	-484	-617	--							
GLN9	32↑	359	301	-246	55	--							
GLN15	31↓	276	203	-93	-2	--							
GLN16	84↑	235	309	-133	-109	--							
GLN17	39↓	52	-84	-156	-52	--							
GLN18	69↑	190	168	-177	-184	--							
GAL12	68˜	680	-121	246	--	32							
SB127	25˜	469	--	--	--	319							
SB128	15˜	206	--	--	--	322							
QZ193	13↑	550	513	--	56	55							
BDU2	16˜	299	--	--	--	275							
BDU5	25˜	269	--	--	--	230							
BDU8	25↓	145	--	--	--	143							

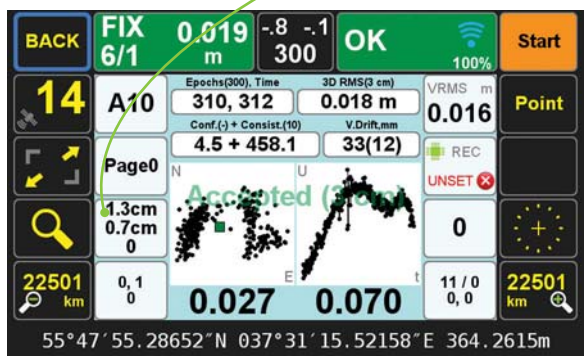
Figure 11 *Code Phase multipath removed (cm)*

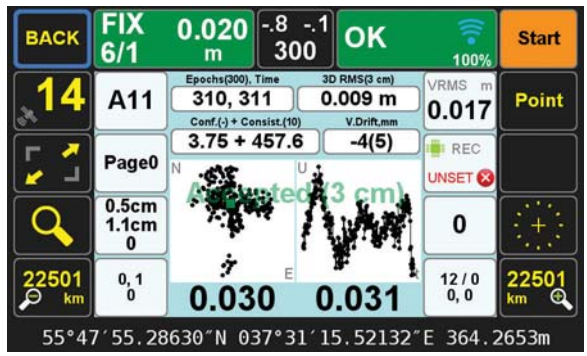
SAT	EL	AZ	L1	P1	P2	L2C	L5	SAT	EL	AZ	L1	P1	P2	L2C	L5
GPS2	29↑	154	7	7	2	--	--	BDU11	75↑	158	-6	--	--	--	-5
GPS6	44↑	98	11	9	2	2	-13	BDU12	36↓	60	-6	--	--	--	-14
GPS12	70↑	282	7	8	-2	-2	--	GPS3	10	26	--	--	--	--	--
GPS14	25˜	302	5	8	-4	--	--	GPS29	3	229	--	--	--	--	--
GPS17	23↓	58	6	9	-6	-2	--	GPS32	3	346	--	--	--	--	--
GPS24	53↓	196	1	4	13	1	-12	GLN7	3	297	--	--	--	--	--
GPS25	30↑	282	4	8	7	1	-32	GLN19	12	210	--	--	--	--	--
GLN1	10↑	34	1	4	-15	-23	--								
GLN8	16↓	344	12	15	17	25	--								
GLN9	32↑	316	0	2	-3	-6	--								
GLN15	31↓	142	5	5	0	1	--								
GLN16	84↑	266	2	2	-11	-18	--								
GLN17	39↓	44	-1	-4	-12	-10	--								
GLN18	69↑	188	-1	3	-1	-6	--								
GAL12	68˜	108	0	-26	0	--	-14								
SB127	25˜	160	7	--	--	--	-4								
SB128	15˜	130	9	--	--	--	-11								
QZ193	13↑	68	-3	-1	--	1	-19								
BDU2	16˜	132	-7	--	--	--	-17								
BDU5	25˜	154	-4	--	--	--	-7								
BDU8	25↓	54	-10	--	--	--	-20								

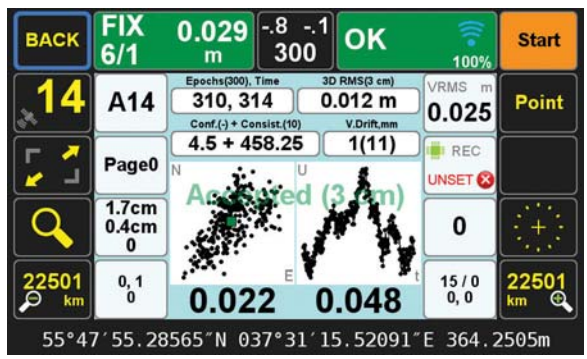
Figure 12 *Carrier Phase multipath remove (mm)*

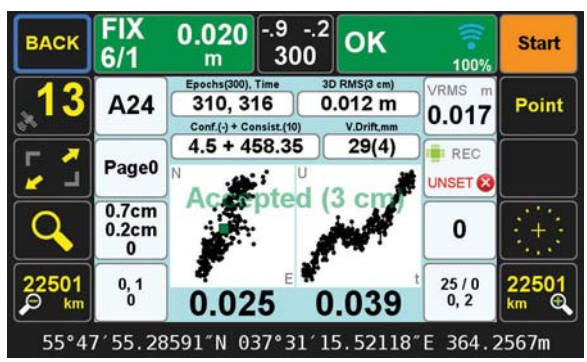
Multipath Showcase

Graphs in the following examples show multipath effects in a 13.8 km baseline where about 1/3 of the rover sky was blocked by a tall building. This box shows horizontal (top) and vertical (bottom) offsets from the actual coordinates of the point (earlier surveyed for test).









Javad Ashjaee, Ph.D.

TRIUMPH-LS
Rugged, Tough, Versatile

Built on a tough magnesium alloy chassis, all connectors, SIM cards, Micro-SD cards are protected against the harshest environment.

You can collapse the pole and take the unit next to you in your car seat.

9 buttons provide **direct access to all functions**. Six keys are user programmable.

The **built in GNSS full tracking antenna** has a large ground plane and the best centering and rotational performance on the market.

High resolution 800x480 pixels sunlight readable color display

Built in UHF, FH Spread Spectrum, WiFi, Bluetooth, Ethernet, GSM/GPRS.

Built in Microphone and two cameras for audio visual documentation.

20 hour battery life in RTK rover mode with full screen brightness and UHF/GSM. Hot Swappable" and "removable batteries" are concepts of the past.

The internal batteries are field serviceable and can be easily replaced by the user when needed.

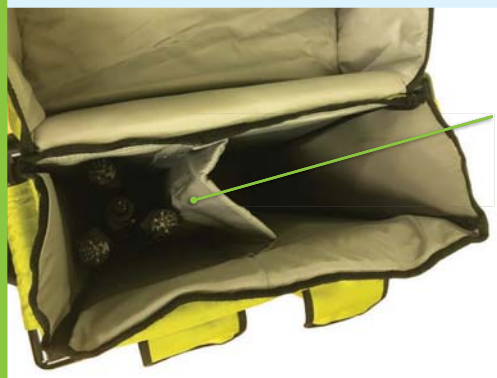
The TRIUMPH-LS, including batteries and pole is the lightest complete GNSS RTK receiver in its class. The total weight of the TRIUMPH-LS RTK system, including radio, controller, pole and 20 hours of internal battery is **2.5 Kg**.

For comparison, the Trimble R10, TSC3 data collector and pole, with about 5 hours of battery life is 3.57 Kg (7.86 lb).

Built in Spectrum analyzer for GNSS and UHF bands and protection against interference.

The J-Pack

It was not our job... You asked for it - we did it!



Javad.....Bravo!!!!

The J-Pack is nicest bag I have ever seen for surveying. I especially like the pocket in the back and all of the places to tie down equipment and stuff.

Adam Plumley, PLS

Ship date - January 2017

See full video “J-Pack & J-Tip in Use” at www.javad.com

Recovery from Disaster - The Canterbury Earthquake Sequence

How professionals have helped to prevent recovery in Canterbury and have caused a separate disaster for property owners

Adrian Cowie
Topografo Limited,
Christchurch,
New Zealand

The city of Christchurch, New Zealand, has suffered over 10,000 earthquakes since the M7.1 earthquake which occurred on 4th September 2010.

It has been stated that New Zealand has one of the highest rates of insurance for natural disaster damage in the world, however, 5 years after the first earthquake in September 2010, many Christchurch homeowners are no further forward with the settlement of their earthquake claims. Many are unhappy with the professional assessments carried out on their homes, questioning both the assessment of earthquake damage and the proposed repair strategy.

Professionals carrying out damage assessments have routinely used the incorrect standard for both assessment and the repair of the earthquake damage.

This paper provides a review of the last five years in Christchurch and suggests that Professionals have caused a new disaster for homeowners - a "Professionally Induced Disaster" with this disaster having a more detrimental effect on homeowners than the effects of the actual earthquakes.

Introduction

Christchurch, New Zealand.

A city that for many of its residents, the phrase 'Recovery from Disaster' is simply not a reality. A city where many of it's homeowners are in the midst of a new disaster caused by the incorrect assessment of earthquake damage. Where professionals are assessing and scoping repairs to damaged homes without considering the standards stated in the legal insurance contracts.

The terms 'Recovery from Disaster', 'The Rebuild', and 'Resilience' abound in Christchurch. However, for many homeowners these words have no meaning to either their homes or their lives.

At the time of writing this paper (February 2016) it is over 5 years on from the terrifying M7.1 earthquake which struck at 4:35am on 4th September 2010. It is one week from the fifth anniversary of the M6.3 earthquakes that struck at 12:51pm on 22nd February 2011 with the resulting loss of 185 lives. An earthquake that had measured vertical acceleration of 2.2g, one of the highest ever recorded earthquake accelerations.

98% of residential homes in Canterbury had insurance cover for earthquake damage, with the majority of homes having the standard of reinstatement for damage being full replacement, new for old, with no upper limit to the sum insured.

The EQC Act[1] and the various private insurance contracts that homeowners had in place at the time of the earthquake defined both the loss and damage that was insured and the standard of reinstatement of that damage.

Why is it, that after 5 years, professionals (including surveyors, structural engineers and geotechnical engineers) are using the incorrect standard for the determination of damage, and the incorrect standard for the repair of this damage?

This paper explores what has actually occurred in Christchurch; the disaster that has occurred for many homeowners due to professionals not understanding both their professional duties, but also the legal requirements in assessing earthquake damage when private insurance policies exist.

A 'professionally induced disaster'

This is a story about a new disaster in Christchurch. A 'Professionally Induced Disaster' that has affected tens of thousands of Christchurch homeowners, and has prevented these homeowners from participating in any recovery.

The FIG2016 conference theme is "Recovery from Disaster." The FIG website states:

"In spite of the disastrous swarm of quakes, Christchurch remains fully functional and repairs to essential service infrastructure have largely been completed… Suburbs, particularly those to the north, south and west, are experiencing a boom and visitor attractions out of the city centre are unaffected."[2]

It also states:

"Surveying and spatial professionals are key actors in making an important contribution to improve, simplify and shorten the disaster mitigation, rehabilitation and reconstruction phase."[3]

The evidence in Christchurch shows that the various 'actors' have not improved, simplified or shortened the disaster rehabilitation for many homeowners. To the contrary, their assessments have caused significant delays in the settlement of earthquake claims, with many homes being left with significant damage totally un-repaired. This has resulted in homeowners living in significantly damaged homes while they spend what funds they have to obtain their own expert reports.

While Christchurch cannot be held as a model for 'Recovery from Disaster', it can be used to show the moral, ethical and professional deficit that is prevalent throughout professions in New Zealand.

A candid appraisal of what has occurred in Christchurch to date will hopefully help prevent a similar 'Professionally Induced Disaster" from occurring elsewhere in the future.

The media's headlines

The New Zealand media paints a rather disturbing picture about the 'Recovery from Disaster' in Christchurch, with headlines such as:

"Damage specialist warns of 'catastrophe' for homeowners."[4]

"'Questionable Methods' used by EQC, says surveyor."[5]

"EQC floor test 'unreliable, non-expert.'"[6]

"Study backs homeowners on floor flaws."[7]

"More than 6500 homes need fix after faulty EQC repairs."[8]

"Engineers leaving reports 'unsigned'.[9]

"Government's 'dogged determination' to deny mental health problem in Canterbury."[10] 29 December 2015.

"Earthquake stress triggers mental health issues."[11] 25 May 2015.

"Attempted suicides highest in Canterbury, twice as much as Auckland."[12] 20 January 2016.

Natural disaster insurance in New Zealand

The Earthquake Commission (EQC) and Private Insurance

EQC is a Crown entity which administers insurance against natural disaster damage provided under the EQC Act.[13] The cover provided by the Act is akin to that offered by private insurers.[14]

Section 18 of the EQC Act outlines the insurance provided by EQC for natural disaster damage, which states that if a person enters into a contract of fire insurance with an insurance company for a residential building, then EQC is liable for up to the $100,000 (excluding GST) in respect of each earthquake event. This amount is commonly called the 'cap'.

The private insurance contract is, in effect, top-up insurance cover for loss or damage not covered by EQC. If the cost of reinstatement of the earthquake damage is less than the $100,000 cap, then the private insurer is not involved with the claim, and EQC either repair the damage or cash settle the claim with the homeowner. It is only if the reinstatement cost is above the EQC cap, that EQC would pay the cap amount, and the claim would be forwarded onto the private insurer.

This statutory scheme of insurance can be seen as providing a first layer of natural disaster damage (which includes earthquake damage), with a second (or excess) layer being the private insurance policy taken out by the homeowner. A homeowner is therefore able to insure a property for full replacement value, noting that the private insurance policy need not contain the same terms or provide the same protection

In Christchurch approximately 15% of all earthquake damage claims have been over the EQC cap of $100,000 and have been passed onto the private insurer. That is, 85% of the residential earthquake claims have remained undercap and with EQC.

Standard of Reinstatement – The Terms of the Legal Contract

Both the EQC Act and the private legal contract between the Insured (the homeowner) and the Insurer define both the damage covered by the insurance, and the standard of reinstatement of that damage.

As Tim Grafton, Chief Executive of the Insurance Council of New Zealand outlined in a presentation delivered 19 February 2015[15]:

"Insurance 101

*Insurance exists to **protect your possessions** against unforeseen loss or damage*

***Risk transfer** – you pay an annual premium to transfer risk to insurer, the money is pooled from which insurers pay for losses suffered."*

EQC Reinstatement Standard

EQC through the Earthquake Commission Act, provides cover for both residential homes and land.

In simple terms, the Act provides replacement cover to *"a condition substantially the same as but not better or more extensive that its condition when new.."*[16]

This is also complimented by the requirement that EQC *"shall not be bound to replace or reinstate exactly or completely, but only as circumstances permit and in a reasonably sufficient manner.."*[17]

The Act defines both what natural disaster loss and damage is covered, and the standard of replacement of that damage.

The wording *"substantially the same as but not better or more extensive than its condition when new"* is critical in understanding the standard to which the repairs or replacement should be carried out to.

Private Insurers Reinstatement Standards

It has been commonly stated that there were around 100 different insurance policies in place at the time of the Canterbury earthquake sequence. Each of these insurance policies had different terms and conditions with the reinstatement standard varying greatly. Some policies were based on indemnity (e.g. the market value of the property at the time of the loss), while others provided for full 'new for old' replacement with no upper limit as to the cost to achieve this.

The vast majority of the insurance claims that the writer has been involved with are the full replacement, new for old type reinstatement standards.

Some examples of the wording in these contracts are:

- "We will pay to repair or rebuild your house to an 'as new' condition."
- "We pay the costs actually incurred to repair or rebuild it [the house] to substantially the same condition and extent as when it was new, or at *our* option the cash equivalent."
- "We will pay the cost of restoring [the home] to a condition as nearly as possible equal to its condition when new using current materials and methods..."

In these examples, the reinstatement standard is to 'as new' or 'when new' type standard, rather than a depreciated standard.

The assessment and reinstatement strategy disaster

What has occurred in Christchurch, and what has been replicated in thousands of homes throughout the region, is people carrying out damage assessments and reinstatement strategies in which they were either not properly qualified to carry out, or they did not know what standard they were both assessing to and reinstating to.

Homes that have suffered severe settlement that have rendered them with critical flooding issues have been assessed by people who have simply not understood, and not measured the building settlement and the impact that this has on the structure. There are thousands of homes in Christchurch (probably tens of thousands) that have had critical building settlement (over 500mm in height in some cases) that has simply been ignored. Repair strategies have been prepared that have ignored raising the building to either it's height "when new" or "as new" and have left the building in a floodprone state with the prospect of losing future flood insurance. This has occurred in many instances where there was a legal contract requiring the house to be reinstated to a condition of "as new".

Many homes have been assessed for structural damage by people with absolutely no expertise in structural engineering. Severe foundation damage and superstructure damage has, in many cases, been totally overlooked due to the person carrying out the assessment not having the correct expertise to identify the actual damage.

Where there is a legal contract of insurance, the persons involved with assessing earthquake damage and determining the appropriate reinstatement strategy should carry out two important things:

1. Determine all of the loss and damage that has occurred due to the earthquake which is covered by the legal contract of insurance, and
2. Determine a reinstatement strategy that meets the standard set out in the legal contract of insurance.

Critical to these two steps is having a clear understanding of what loss or damage is covered by the EQC Act and private insurance contract, and also a clear understanding of the standard of reinstatement required.

It seems ludicrous that a person, without the required expertise, could visit a house to both determine the loss and determine a reinstatement without knowing, or understanding what the actual required legal standards are.

These two steps require a multitude of professionals and experts, including (but not limited to):

Measurement experts (Surveyors) to accurately map the buildings and land. This would include measuring floor tilt and superstructure leans, lateral spreading and stretching, building and land settlement;

- Geotechnical Engineers to determine the ground conditions on and around the site;
- Structural Engineers to determine the structural damage to the building,

and to determine what structural reinstatement is required;
- Builders and other trade professionals (drainlayers, electricians, plumbers, etc.) to determine the damage to the building 'fabric';
- Weather-tight specialists to determine whether the earthquakes have caused the building weather-tightness to be compromised.

All of these experts and professionals have expertise and specialties in certain areas. It is most unlikely that one particular expert will have expertise in all of these areas.

For instance, the builder or plumber would not have the required expertise to assess and scope the structural elements. The structural engineer is unlikely to have the expertise to assess damage to the electrical wiring. The electrician is unlikely to have the expertise to carry out the swathe of complicated and accurate survey measurements of the land and buildings required to determine the various parameters of the damage.

Whose Responsibility is it to 'Prove the Loss'?

Various High Court Judgments have clearly indicated that it is the job of the Insured (that is, the homeowner) to 'prove the loss'.

In order to correctly 'prove the loss', the homeowner would require probably around at least $50,000.00 of expert reports, ranging from geo-technical engineers, surveyors, structural engineers, weather-tight experts, lawyers, builders, quantity surveyors, to name but a few.

The average insurance excess for a claim in 2010 would have been less than $1,000, however, in reality, a further $50,000 may be required to obtain the necessary information to 'prove the loss.'

Typically, the first assessments have been carried out by both EQC and the private insurers with the homeowner then obtaining their own professional assessments if they find they do not agree with these assessments.

The vast majority of assessments that have been carried out by persons acting for EQC, the private insurers and the homeowner have used the incorrect standards for their assessments and reinstatement strategies. These assessments and reinstatement strategies have typically been carried out to no defined standard, or to the 'standard' setout in the 'MBIE Guidelines'.

It is noted that the writer is aware of a small minority of assessments carried out by EQC and various insurers where the standard in the legal contract or Act was used by the professionals. This has resulted in the earthquake damage being correctly determined, a reinstatement strategy being correctly calculated, and the earthquake claim quickly settled.

The 'MBIE guidelines'

Shortly after the 4th September 2010 the Government's Department of Building and Housing (the DBH, which is now the Ministry for Business, Innovation and Employment (MBIE)) issued Guidelines titled *"Repairing and rebuilding houses affected by the Canterbury Earthquakes."*

The MBIE Guidance was issued under Section 175 of the Building Act 2004. Guidance issued under Section 175 is for the sole purpose of assisting persons to comply with the Building Act. It was not issued to assist persons to comply with the EQC Act or private legal contracts of insurance.

The paradox with the MBIE Guidance is that the Building Act does not outline, or mandate any assessment standards or repair standards for earthquake damage, yet, the MBIE Guidance (which was issued solely to assist persons to comply with the Building Act) outlines indicator criteria for floor dislevelment, wall leans, cracks widths, and many other areas of damage. It also outlines suggested repair strategies for this earthquake damage.

In essence, the MBIE Guidance suggests standards and procedures that are not contained within the Building Act, which indicates that the Guidance may not have been solely issued to assist persons to comply with the Building Act.

This MBIE Guidance was issued to address three areas of earthquake damage:
1. Assessment criteria, or assessment indicators for earthquake damage;
2. Suggested repair standards, or repair strategies for earthquake damage; and
3. Suggested foundation design for new foundations in both areas of liquefied ground, and on the slopes of the Port Hills. (The foundation rebuild strategies outlined in the Guidance are generally considered robust and are therefore not addressed in this paper).

Section 112 (and 42a for building consent exemptions) of the Building Act outlines the required standard for repair work, with this standard being that the area of repair work needs to comply with the Building Act and Building Code, however, as long as the rest of the building does not comply to any lesser extent than it did immediately before the repair work commenced (note: not before the earthquake damage occurred), then the repair work would meet the requirements of Section 112, and therefore the Building Act.

For assessments and repair of earthquake damage under both the EQC Act and the private insurance contract, the standard of reinstatement is significantly higher than what is required in the Building Act and MBIE Guidance. That is, the MBIE Guidance is by definition, created to a lesser standard than the EQC Act and most private insurance contracts require.

Therefore, using the MBIE Guidance for the purpose of assessing earthquake damage and for a repair strategy will most likely result in the building not being returned to an 'as new' or 'when new' condition.

The MBIE Guidance has been used almost universally as the 'standard' for assessment in earthquake claims

involving both EQC and private insurance contracts, even though legally, it is not the correct standard.

There is an argument that the MBIE Guidance could be used as the correct standard if the expert (e.g. structural engineer) provided proof, calculations and rational analysis that it did meet the reinstatement standard in the insurance contract, however, to date no such proof has been seen.

Example: Table 2.2 of the MBIE Guidance – Criteria for 'No Foundation Damage'

Table 2.2 of the MBIE Guidance is commonly used a the 'standard' for determining whether there has been any structural foundation damage to a house.

These indicator criteria for a concrete slab on grade house states that if the total floor height difference is less than 50mm in height, with all floor slopes less than a grade of 1 in 200, with lateral stretch of the slab less than 20mm, and any slab cracks less than 5mm in width, that no structural repair is required or indicated.

In many cases, Table 2.2 has been used as a justification that a house is not structurally damaged. However, it has been shown repeatedly that by carrying out a detailed and accurate survey assessment, followed by a structural engineering assessment, that critical structural damage has occurred to the house.

For instance, a very common area of damage in the flat areas of Christchurch prone to liquefaction[18] is for the building to suffer from Localised Settlement, that is, settlement of the house into the ground on it's own footprint. This damage may not be readily seen, however, there are many instances where the floor dislevelment in a house has been less than 50mm in height, with no slab cracking, yet, it has suffered around 100-200mm of Localised Settlement.

This in most cases is critical damage, as it results in the house sitting in a localised depression, with underground services flowing uphill, and with surface water flowing towards the house rather than away from the house. In almost every case where this has occurred, the only suitable method of reinstatement to 'as new' is to lift the house up to at least it's original height. Yet, this area of damage has been overlooked in thousands of Christchurch homes by the use of the MBIE Guidance and Table 2.2.

Survey assessments of earthquake damaged homes

Arguably the most useful (and mis-used) survey instrument in the whole Canterbury Earthquake saga has been the hydrostatic altimeter. This instrument was extremely useful for floor level surveys immediately after the 22nd February 2011 earthquake when the Central Business District of Christchurch was cordoned off as a 'Red Zone'.

The hydrostatic altimeter allowed for the surveying of floor levels in buildings which conventional surveying would be almost impossible. Many of the CBD Red Zone buildings were critically damaged, with collapsed walls, partitions, ceilings, stairs and roofs. Furthermore, the lack of electricity required many surveys to be carried out in the dark, and for basement surveys – waist or chest deep in water. The altimeter was an ideal instrument to use in these adverse conditions.

As the use of these altimeters became common-place, it opened the door for a new breed of surveyor: those with no knowledge of actual surveying, no knowledge of the concepts of error mitigation, error propagation, independent checks, and so forth. It allowed for anyone to simply turn the instrument on and read a number on the screen.

The surveying of residential houses (and multi-storey multi-unit apartment blocks) was regularly carried out by people with absolutely no knowledge of surveying.

Errors were made. Large errors. Buildings with significant floor tilt due to earthquake damage were not surveyed correctly, and shown to be 'level'. It was commonplace for these 'surveyors' to miss measuring in the critical areas of the floor, for instance, the highest and lowest floor levels.

The plans that these 'surveyors' prepared were by and large rough hand drawn sketches showing an array numbers on a floor layout plan that was not to scale. In many cases, measurements were not even recorded, with the only evidence being the note "the floor is level".

Table 2.2: Indicator criteria for foundation damage not requiring structural repair (all technical categories)

Dwelling Foundation Type		Settlement Status		Lateral stretch status		Crack widths[1]/Other
Type A		Vertical differentrial settlement <50 mm and floor slope less than 1 in 200 between any two points >2 m apart	and	<20 mm [2]	and	Pile tilt <15 mm per 1 m height and no floor framing damage
Type B						<5 mm cracks in perimeter foundation
Type C						<5 mm cracks in the floor slab

(1) Crack widths are those principally related to earthquake actions
(2) A maximum lateral stretch of 20 mm is based on a resulting potential out of plumb of house end walls of 10 mm.

The art, or profession of the Surveyor in New Zealand, with the ability to measure accurately, and then to show the measurements clearly on an accurately scaled plan, with contours, colours, slopes, gradients was mostly forgotten.

Unfortunately, the New Zealand Institute of Surveyors even implemented a one hour 'training' session for these new 'surveyors' in order to teach them how to use these altimeters.

The 9-10 years' university training and post-graduate work, exams and assessments to become a Registered Professional Surveyor, became redundant when a two-hour training session provided the same expertise.

The surveying of earthquake damaged homes is not easy. It requires expertise and an understanding of construction and building to be able to know where to measure, and what to measure. There are many cases of even the best survey firms in Christchurch making gross errors in their precise level surveys of residential homes. If the most experienced surveyors can mange to make mistakes, it is clear that the person with two hours of training will not fare well.

The result of the 'easy-to-use' technology, and a survey profession reluctant to educate society on the expertise that only a surveyor possesses, has resulted in many damaged homes being accepted as not damaged, merely due to the insufficient survey work being carried out.

It is the writer's belief that we, as professional surveyors, as measurements scientists, are the most well trained to undertake measurement in the real world and to represent these measurements in a way that the general public can understand.

This unique skill set that surveyors have should not be ignored. We have the ability to accurately measure real-life three-dimensional elements (for example, buildings) and represent the building as a series of plans and measurements in an easy to understand format.

This skill, expertise and accuracy has been sadly lacking as part of the damage assessments in Christchurch.

Christchurch 5 years on

Christchurch for many of its residents is a difficult place to live. The stresses of daily living, of working, family, finances, health, have been complicated by having to become experts in their own earthquake damage. Many homeowners have become insurance and engineering experts in their own right.

Many residents are still living in homes that are in their original damaged state from the 4th September 2010 earthquake. Many live in non-weather-tight conditions, with mould and rot invading their homes. Elderly people are having to walk around homes that have a 200mm height difference on their floors. Many have settled their earthquake claims in the belief that their home was not damaged, or had only superficial 'cosmetic' damage.

Thousands of Christchurch home-owners are still waiting in limbo for their insurance claims to be settled.

Thousands more Christchurch home-owners are now having to have EQC re-repair their homes due to the first round of repairs being incorrectly carried out.

Hundreds of home-owners have filed proceedings in the High Court and District Court in order to have what they believe their true legal entitlement realised. The High Court has become clogged with earthquake cases, with the simple task of going to trial requiring around a two year wait.

Many home-owners have become ill, either physically or mentally due to the stress of dealing with their insurance claims.

The publics perception of professionals (this would include structural engineers, geotechnical engineers, and unfortunately surveyors) has been significantly damaged over the last 5 years in Christchurch.

Christchurch is slowly rebuilding its inner city commercial and retail buildings, but for many homeowners, the prospect of a new, undamaged house is a distant dream.

Recommendations for the next earthquake

Professionals (including surveyors) involved in earthquake damage assessments, and reinstatement strategies need to make themselves aware of the legal contracts of insurance associated with a particular building.

If the legal contract of insurance defines the standard of reinstatement to be "as new", then they need to assess and scope to "as new", and not to a lesser standard.

Professionals (including surveyors) need to replace the mantra of "We work to the brief given to us by the client", to that of working to standards of honesty, integrity, and objectivity.

If the brief given by the client is different to that in the legal contract, the Professional needs to query and not blindly follow the instructions given.

Professionals (including surveyors) need to be acutely aware of the people affected by their work. In the area of earthquake damage assessments, this includes:

- The Insurers (who are paying the cost of the repair or rebuild);
- The banks and financial institutions with mortgages over the property (they want their equity in the property retained);
- The homeowner (they also want their equity in the property retained).

Sadly, for tens of thousands of homeowners, possibly hundreds of thousands, the experience they have had over the last 5 years would not be what they would call "Recovery from Disaster".

For many, their experiences with the substandard assessments and reporting by professionals has left them with their own "Professionally Induced Disaster."

Conclusion

The effects of incorrect and inadequate professional earthquake assessments will have a detrimental impact on many Christchurch residents for years to come.

It may well be that some people in Christchurch simply do not recover.

The "Professionally Induced Disaster" caused by the incorrect damage assessments and reinstatement strategies will affect homeowners in Christchurch for many years.

As professionals, we are required to act professionally, above and beyond the 'brief' of the client. We are required to act honestly, impartially, and objectively. To be aware of the people affected by our work, and to act accordingly.

The Christchurch lesson is a good lesson to learn. It is hoped that in future earthquake events, that Surveyors and other professionals will remember their professional and ethical duties.

Endnotes

[1] Earthquake Commission Act 1993
[2] http://www.fig.net/fig2016/theme.htm
[3] http://www.fig.net/fig2016/
[4] http://www.stuff.co.nz/business/71112274/Damage-specialist-warns-of-catastrophe-for-homeowners
[5] http://www.stuff.co.nz/the-press/news/9017710/Questionable-methods-used-by-EQC-says-surveyor
[6] http://www.stuff.co.nz/the-press/news/christchurch-earthquake-2011/10570525/EQC-floor-test-unreliable-non-expert
[7] http://www.stuff.co.nz/the-press/news/10246566/Study-backs-homeowners-on-floor-flaws
[8] http://www.stuff.co.nz/the-press/business/the-rebuild/73205717/More-than-6500-homes-need-fix-after-faulty-EQC-repairs
[9] http://www.stuff.co.nz/business/10578566/Engineers-leaving-reports-unsigned
[10] http://www.stuff.co.nz/the-press/news/75161125/Governments-dogged-determination-to-deny-mental-health-problem-in-Canterbury
[11] http://www.stuff.co.nz/the-press/opinion/68769392/Earthquake-stress-triggers-mental-health-issues
[12] http://www.stuff.co.nz/national/health/76060300/Attempted-suicides-highest-in-Canterbury-twice-as-much-as-Auckland
[13] Earthquake Commission Act 1993, ss 4A and 5(1)(a).
[14] Paragraph [21] Earthquake Commission v Insurance Council and Ors CIV 2014-485-5698
[15] Presentation to the NZ Society of Local Government Managers, 19 February 2015
[16] See definition of 'replacement value', EQC Act 1993
[17] s9(1)(a) Schedule 3, EQC Act 1993
[18] Liquefaction is the process in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.

The paper was presented at FIG Working Week 2016, Christchurch, New Zealand, May 2 - 6, 2016

Fit for Purpose Parcel Mapping Methodologies for a Seamless Cadastre Database

Parcel mapping that ensures secure land tenure for a large percentage of a nation's citizens can be produced at an acceptable and Fit-for-purpose level of accuracy using general boundary survey techniques that are a small fraction of the cost of parcel mapping created using fixed boundary survey techniques. We present here first part of the paper

Jack McKenna
Director, Business Development in Africa and the Caribbean, Trimble Land, Administration Solutions

The joint FIG/World Bank Publication states that Fit-for-purpose means that the land administration systems – and especially the underlying spatial framework of large scale mapping – should be designed for the purpose of managing current land issues within a specific country or region – rather than simply following more advanced technical standards. The Fit-for-purpose approach is participatory and inclusive – it is fundamentally a human rights approach. Benefits relate to the opportunity of building appropriate land administration systems within a relatively short time and for relatively low and affordable costs.

Land Administration Visionaries

Few would dispute (though some surely do) that Torrens and De Soto are two pioneering visionaries in the land administration field. Torrens was responsible for the establishment of the Land Registry of England and Wales in 1862 and de Soto, in large part through the publication of his ground breaking book, *The Mystery of Capital*, alerted us to the mountain of dead capital that exists within the developing countries of the world.

Sir Robert Richard Torrens

Born in 1814 in Cork, Ireland, Torrens travelled to South Australia with his wife in 1840. He became collector of customs and quickly gained a reputation for unorthodox practices: in his first year he was censured for reducing wharfage rates without authority, carelessness with pay lists, unauthorised absences and not supporting some of Governor Sir George Grey's policies. Despite his cavalier political and business practices during his appointment as colonial treasurer and registrar-general, he was a nominated member of the Legislative Council between 1851 and 1857 and member of the Executive Council in 1855.

In 1856, the *South Australian Register* published the first report and outline of a Torrens bill. Although he claimed authorship of the system, it's clear that it had been an evolutionary process and was not his achievement alone. He stood for the seat of Adelaide in the 1857 House of Assembly election and won, purely for his land titles reform policies. He continued work on the bill while treasurer between October 1856 and August 1857, but no action was taken on the bill while he was Premier in September 1857. Despite strong opposition to the bill, it passed through both houses on 27 January 1858.

Torrens became Registrar-General in 1858 and, until his return to England in 1862 to enter politics, he helped turn the Act into a workable system, influencing public opinion and organising petitions to parliament. In England he served in the House of Commons and continued to

lobby for adoption of his title system in England and Wales. (Victoria State, 2012)

Hernando de Soto

Peruvian economist Hernando de Soto's message to the developing countries of the world and their donors is a simple one: Enable poor people to register their property so that they can borrow against it to build businesses, buy farming equipment, seed and fertilizer and for other purposes. Millions of citizens of developing countries do not have formal title to their land and De Soto believes that this is a key source of rural and urban poverty. According to de Soto, the value of un-registered land in developing countries totals over US$9 trillion. As a result of not registering their land, their most under-utilized and prized possession, they cannot convert their asset into collateral for loans.

De Soto and the importance of Secure Land Tenure

Between half and three quarters of a country's wealth can be comprised of land and buildings. Securing land tenure through creation of a property title can significantly increase property values and subsequent investments. de Soto's book *The Mystery of Capital* attempts to explain why capitalism has triumphed in the west and failed everywhere else. The following extracts from that book offer powerful arguments to support his theories.

"The major stumbling block that keeps the rest of the world from benefiting from capitalism is its inability to produce capital. Capital is the force that raises the productivity of labor and creates the wealth of nations and it is the one thing that the poor countries of the world cannot produce for themselves.

Even in the poorest countries, people save and accumulate wealth. In Egypt, for instance, the wealth that the poor have accumulated is worth fifty-five times as much as the sum of all direct foreign investment ever recorded there, including the Suez Canal and the Aswan Dam. But the poor hold their resources in defective forms: houses built on land whose ownership rights are not adequately recorded, unincorporated businesses with undefined liability and industries located where financiers and investors cannot see them. Because the rights of these possessions are not adequately documented, these assets cannot readily be turned into capital, traded or used as collateral for a loan.

The formal property system is where capital is born. Once the focus is on the title to a house and not on the house itself, it is possible to go beyond viewing the house as mere shelter (a dead asset) and to see it as live capital.

In the West, by contrast, every parcel of land, every building, every piece of equipment or store of inventories is represented in a property document that is the visible sign of a vast hidden process that connects all these assets to the rest of the economy. These assets can be used as collateral for credit. The single most important source of funds for new business in the United States is a mortgage on the entrepreneur's house. These assets also provide a link to the owner's credit history, an accountable address (universally available from what3words.com, 2015) for the collection of debts and taxes, the basis for the creation of reliable and universal public utilities and a foundation for the creation of securities (like mortgage backed bonds) that can then be rediscounted and sold in secondary markets. By this process the West injects life into assets and makes them generate capital. Americans and Europeans established widespread formal property law and invented the conversion process in that law that allowed them to create capital.

Without formal property representation or law, the assets to be found in Third World and former communist nations are dead capital. The inhabitants of these nations have houses, but not titles; crops but not deeds; businesses but not statutes of incorporation and they have not been able to produce sufficient capital to make their domestic capitalism work.

The laws and the institutional frameworks of the West do not work in Third World and former communist countries where the rules that govern property can vary from neighborhood to neighborhood or even from street to street." (de Soto, 2000)

Before the Torrens System

Before the Torrens system was introduced in 1862, a General Law title system operated that consisted of a chain of title deeds all of which had to be in place to enable a property to be transferred. Title deeds are documents that show ownership, as well as rights, obligations, or mortgages on a property. A General Law title could have many deeds, many of which were handwritten, not always legibly.

In colonial times, there was often confusion with the General Law title system, particularly if one or more deeds were misplaced. Because all deeds had to be made available when a property changed ownership there would be serious problems if a deed was missing. The General Law title system depended on proof of an unbroken chain of deeds back to the original grant. This chain was made up of all the documents involved in every sale, resale or mortgage of the property.

Torrens created a central registry where all transfers of land are recorded in the register, thereby producing a single title with a unique number (or folio) that also records easements, mortgages and discharges of mortgage.

What is the Torrens Title System?

The Torrens title system is a secure and reliable method of recording and registering land ownership and interests. Established in South Australia in 1858, the then revolutionary and efficient land titling system was adopted throughout Australia and New Zealand, and subsequently spread across the world. Countries now using the system include,

among others, England and Wales, Ireland, Trinidad and Tobago, Malaysia, Singapore, Iran, Canada and Madagascar.

The Torrens title system works on three principles:

1. The land titles Register accurately and completely reflects the current ownership and interests about a person's land.
2. Because the land titles Register contains all the information about the person's land, it means that ownership and other interests do not have to be proved by long complicated documents, such as title deeds.
3. Government guarantee provides for compensation to a person who suffers loss of land or a registered interest. (Victoria State, 2012)

UK Land Register Rules (LTR 1898) – Maps and Verbal Descriptions of Land (Fixed Boundary and General Boundary Surveying)

It appears that in 1898 the UK Land Registry was not about to become entangled in a discussion of the pros and cons of general boundary versus fixed boundary surveying methodologies. Rather, their focus seemed to be squarely on getting properties into the revenue-generating register as quickly and affordably as possible by either method. As might be expected, revenue was the driving force in the establishment of the Land Registry.

Rule 209. The ordnance map, on the largest scale published, shall be the basis of all registered descriptions of land.

Author note: The UK Ordnance Survey national coverage map series consists of 1:1,250 (urban), 1:2,500 peri-urban) and 1:10,000 mapping (rural). In the past, 1:10,560 (6 inches to I mile) scale mapping was also used.

Rule 210. The notes on the plan, if sufficiently exhaustive, will in many cases render a verbal description of the land on the register unnecessary, but a schedule in the case of large estates should at any rate be added.

Rule 211. If it is desired to indicate on the filed plan, or otherwise to define in the register, the precise position of the boundaries of the land or any parts thereof notice shall be given to the owners and occupiers of the adjoining lands, in each instance, of the intention to ascertain and fix the boundary, with such plan, or tracing, or extract from the proposed verbal description of the land as may be necessary, to show clearly the fixed boundary proposed to be registered; and any question of doubt or dispute arising therefrom shall be dealt with as provided by these Rules.

Rule 212. When the position and description of the boundaries of the land have been thus ascertained and determined, the necessary particulars shall be added to the filed plan, which shall be the Property Register.

Rule 213. Except in cases in which the fixed boundary of the land has been thus ascertained the map shall be deemed to indicate the general boundaries only. In such cases the exact line of the boundary will be left undetermined (as for instance whether it runs along the centre of a wall or fence, or its inner or outer or how far it runs within or beyond it; or whether or not the land registered extends to the centre of an adjoining road or stream). When a general boundary only is desired to be entered in the register, notice to the owners of the adjoining lands need not be given. The result of this Rule is that, where the boundary is left undetermined, no indemnity will be given if the dispute is confined to the general boundary line.

Rule 214. Where, and so far as, physical boundaries or boundary marks do not exist, the fullest available particulars of the boundaries shall be added to the plan. This Rule appears to be applicable whether a precise boundary is fixed or not. (Benjamin, Marigold, 1899)

Author note: The UK Land Registry system, and its exclusive use of 1:1,250, 1:2,500 and 1:10,000 national map coverage for creation of the cadastre, is worthy of consideration of adoption by developing countries as a Fit-for-purpose parcel mapping model for creation of a seamless cadastre database. It was obvious to the pioneering UK Land Registry, even in 1862, that accurate topographic mapping in conjunction with a hybrid of general boundary and fixed boundary surveying methodologies, was eminently Fit-for-purpose.

Converting Dirt to Gold: How to Create Capital for Millions of People in Developing Countries

Millions of the world's poor have assets in the form of houses, crops and businesses, yet they cannot create capital from them. One reason they are not able to leverage their assets is due to the lack of a formal property system. Or, on the other hand, there is a formal property system that operates under corruption-ridden, complex, expensive and pro-wealthy rules. Too much land is in the hands of too few people in developing countries and by some estimates, putting land measuring as little as one tenth of an urban acre, or one or two rural acres, in the hands of the poor in developing countries is sufficient to break the cycle of poverty.

Citizens of developing countries can begin to generate wealth in the form of land that they own or occupy. The first step in converting their land from an asset to capital is providing a solution to the problem of achieving secure land tenure. Debates have been taking place regarding the lack of secure land tenure in developing countries for many decades. If nothing is done to implement a workable program for establishing secure, pro-poor and pro-women land tenure in the very near future it is safe to assume that the same debates will continue for many more decades. A global approach to helping people secure land tenure must be implemented as soon as possible.

The real estate market is the proven catalyst for generating capital movement in markets worldwide. The power of

the real estate market is the asset (land and structures). Knowing "**where**" this property is located, and "**who**" owns it is the basic foundation for real estate transactions. The ability to access the "where" and "who" information is critical for the rapid exchange of properties in the marketplace. If a comprehensive, accurate and transparent land records system is in place, the speed with which such property transactions can transpire is significantly increased. The faster property contracts move, the more capital there is in motion in the marketplace. The more capital that is available in the marketplace, the greater the investment and development that results.

Many developing countries deny women the right to own property. A report by ActionAid International, *Cultivating Women's Rights for Access to Land 2005*, states that, although it has been proven that empowering women socially and economically leads to positive effects on household food security levels, women experience unacceptable statutory and customary discrimination. Women's rights to land are often secondary and derived from the rights of others. They have limited knowledge of their citizenship rights and they are susceptible to instrumentalization by men. However, it is one thing to acquire the right to own property: it is quite another to secure tenure to that property, and create capital from it in a corruption-free, affordable and timely manner.

Geospatial mapping and GIS foundations are the means by which the door to the property title insurance market is opened. Once the issue of who owns what property is settled, this provides the assurance needed for financial institutions to provide primary and secondary mortgage financing. The concept revolves around the reality in developing countries that the citizens, when they acquire title to the property they own (or occupy) can obtain secured loans, backed by the property title, for the purpose of improving their property or for buying new property. (de Soto, 2000)

The US model is the basis for establishment of the primary and secondary mortgage markets in developing countries. The effect on the economies of those countries is substantial. This is not surprising when it is realized that 12% or more of the US economy is driven by the primary and secondary mortgage and real estate markets. When people buy a home they start to take better care of it. They buy paint, lumber and plumbing supplies. They employ builders to construct additions to their property. They buy a second home. They employ landscapers, plumbers, electricians, and painters. The economic conditions within countries that enable their citizens to own property improves dramatically.

The happy citizens are then persuaded that paying property taxes and getting permits to build or improve a home are necessary functions of society and of benefit to everyone. Taxes pay for improvements in city infrastructure, construction of schools, hospitals and parks. They learn that capitalism can be a good thing. So they register their property and pay taxes on

equitably assessed property values. A modern land records management system is created and all the property ownership and mapping information is used to feed a GIS, in addition to a variety of land records management software modules for land registry records keeping, cadastral mapping and tax revenue calculation. The databases are kept current and the information becomes available for use by both the public and private sectors. As a result, a reliable and transparent revenue stream is established to enable local and national governments to provide greatly improved services to the citizens, attract investment and provide funding mechanisms for property and industrial development. (McKenna, 2006, 2016)

Who Owns the World

A recently published book, *Who Owns the World* by author Kevin Cahill is a compilation of landowners and landownership structures in every single one of the world's 197 states and 66 territories.

The following extracts from that book offer powerful arguments to support his theories.

This book asserts that the main cause of most remaining poverty in the world is an excess of land ownership in too few hands. What the book also asserts is that private ownership of a very small amount of land – one tenth of an urban acre or an acre or two of rural land, granted to every person on the planet has the potential to, and Cahill believes will, begin the ending of poverty on a global basis.

In some countries people have obtained the land they need, the acreage for a private dwelling, and obtained a form of ownership for that acreage. In many cases, what they have is not ownership but feudal tenure, sometimes called 'freehold'.

The very touchstone of what freedom really is, though, in the here and now, is clear. It is the right and ability of individuals, men and women, to actually own land. With ownership comes security of shelter, and a vital means to the right to life. But, as the 15% of the planet who have obtained relative ownership of their homes show, ownership is also the first step to prosperity and the solvent that destroys poverty.

More than 50% of the world's 197 countries and 66 territories have either no land registry at all, or one that covers less than 10% of the land of the country. Ask why so few proper land registries exist anywhere in the world. Then look at those who scream the loudest about the sanctity of private land ownership rights, those not named in any land registry, but who really do own most of the land of the earth.

Of the earth's 6,500 million inhabitants, few, perhaps just 15%, own anything at all, and most are pitifully poor. The distinguishing feature of universal poverty is landlessness. Yet, there is no great movement to get land to the impoverished masses. Aid, yes. Land, no." (Cahill, 2006)

Bono and the 'One" Campaign

Bono created the '*One*' campaign and the following quotes from the utopian pop superstar offer powerful arguments to support his theories:

- "Aid money does not reach the poor."
- "Global aid pledges have doubled from $25 billion to $50 billion and still 1 million people die from malaria every year."
- "Money does not translate into help on the ground; it disappears into the money sink of bureaucracies."
- "Aid agencies responsible for distribution of money must be held accountable and should not, as they currently do, grade themselves."
- "Only projects that make sense should be funded, under the scrutiny of independent auditors and accountants, just as in the corporate world."
- "The recipients of aid must be asked if they are satisfied with the results. Currently this does not happen."

According to Bono, Africans are traders and they prefer commerce to aid (*Give a man a fish, he'll eat for a day, teach him how to fish he'll eat forever*). (Bono, 2005)

To be concluded in next issue.

Indonesian mall integrates tech in the shopping experience

Supermal Karawaci, one of the largest mall entertainment center in Western Jakarta, has launched an interactive mobile application that would allow retailers to offer personalized content and engage with customers better. The app, which was built on the shopper engagement platform of Singaporean technology firm Sprooki, is integrated with Supermal Karawaci's touchpoints and mobile apps. Using location and contextual data, retailers would be able to offer individualized content such as vouchers, special offers, event alerts and store information. *www.enterpriseinnovation.net*

"Mobiking Experience" by MapmyIndia

MapmyIndia has announced the launch of its Rover Bike – a state-of-the-art connected IoT device for motorbikes. It is a comprehensive solution that offers a connected biking experience. It is inconspicuous and easy to install and is powered by MapmyIndia's maps and location technologies and comes equipped with built-in GPS and Internet connectivity. Users get a free accompanying mobile app (iOS, Android, Windows) that keeps them connected with the bike. Rover Bike is a GPS tracker for bike, once fitted onto your motorcycle, it lets you see where it is, through a secure portal 24×7. You get LIVE locations of your motorbike on a map, down to building-level detail, with direction as well as speed.

Playo mulls international expansion

Playo, a location-based mobile app that brings together sports enthusiasts, facilities, trainers and organisers on a single platform, is planning to expand its presence in another four cities and two countries in 2017. "Currently, we are operating in Bengaluru and Hyderabad. We are targeting Chennai, NCR and Pune in the near term, as the cities constitute a large working young immigrant population which is where most of our early adopters are from (25-34 year age bracket)," according to the Playo founder Gauravjeet Singh. http://www.deccanherald.com

Galileo update

FCC seeks public comments on receivers using Galileo signals in US

The Federal Communications Commission (FCC) is inviting public comments on the European Commission's request for a waiver of licensing requirements applicable to Galileo receivers in the U.S.

If the waiver is approved, Galileo-capable receivers won't need to be licensed in the U.S. Right now, FCC rules require that receivers operating with non-U.S. licensed space stations obtain a license.

In a letter dated Jan. 30, 2015, the National Telecommunications and Information Administration submitted a request by the European Commission for a waiver of the FCC licensing requirements to permit non-federal receive-only Earth stations — receivers — within the U.S. to operate with Galileo signals.

ESA wants to know why Galileo satellites' clocks stopped working

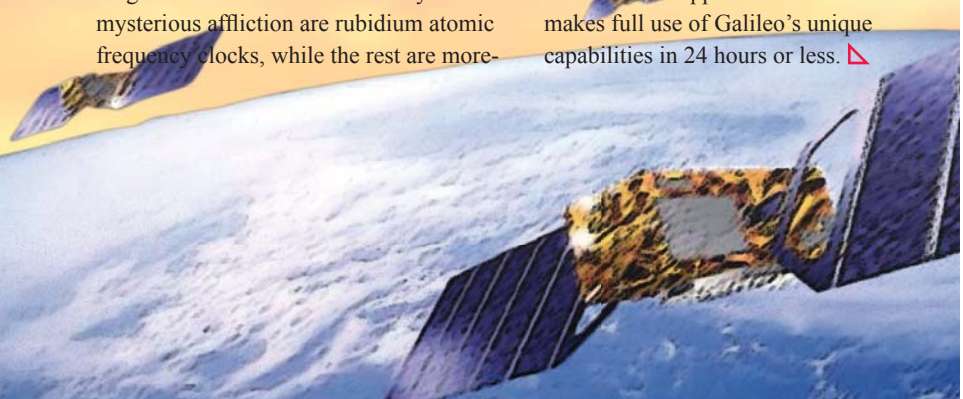
Something strange is going on with the Galileo satellites, and the European Space Agency wants to find out what's causing it. Apparently, ten atomic clocks on board five of the 18 navigation probes already in orbit have malfunctioned, and it could force the agency to delay the scheduled launch of four more satellites in August. Sat Nav systems like Galileo need highly precise atomic clocks to work properly, since they have to broadcast their signals at the same time. Broken clocks will hinder its ability to "deliver real-time positioning accuracy down to the meter range". Three of the devices hit by the mysterious affliction are rubidium atomic frequency clocks, while the rest are more-precise passive hydrogen maser variants. One of the hydrogen devices has been restarted, bringing the total number down to nine. Since each satellite carries four clocks and none of them have more than two broken devices, Galileo still works. According to *Space*, the agency thinks the clocks short-circuited and failed because they're switched off for long periods. However, it still needs to investigate the event further to make sure the rest of the clocks won't get affected. *https://www.engadget.com*

Second Galileo Hackathon expects to produce new innovative applications

After a successful first GSA Galileo Hackathon, the European GNSS Agency (GSA) is busy making plans for its next adventure in app building, scheduled to coincide with infoShare 2017, May 17-19 in Gdańsk, Poland.

Last year teams of passionate coders and geo-enthusiasts from around the world gathered to compete during the first event, which served as an opportunity to showcase coding skills, connect with the Geo-IoT (Internet of Things) app development community, and gain a competitive insight on what Galileo location-based services (LBS) can bring to your mobile device.

The idea and the challenge behind the first GSA Galileo Hackathon was to come up with an innovative application that makes full use of Galileo's unique capabilities in 24 hours or less.



Haryana will identify Najafgarh lake as wetland

After claiming that there was no lake called Najafgarh Jheel in their records, Haryana government told National Green Tribunal of India that it will be included and identified as a wetland in a survey by the government.

"Haryana government had first claimed there is no jheel, then they said the lake was not demarcated in their revenue records and it was just a natural depression. Today, they said Najafgarh Jheel will be identified after a survey and notified," said Jayant Tripathi, lawyer representing Indian National Trust for Art and Cultural Heritage (Intach).

Intach had proposed a plan to revive the lake to Delhi Development Authority (DDA) and Haryana Urban Development Authority (HUDA) but none acted. In its application, Intach says "the jheel, if revived, would not only be a huge reservoir catering to the needs of the residents of Delhi and Gurgaon, it would also be a very important source for recharge of the groundwater aquifers. It is submitted that by the acts of omission and commission on part of the various respondents (Delhi, Haryana governments and Centre) the jheel is nearly extinct."Najafgarh Jheel is marked in Delhi government's master plan 2021 but the government has not taken any steps to either revive it or prevent encroachments. *http://timesofindia.indiatimes.com*

Prof Vidal Ashkenazi has been awarded an OBE

Nottingham Scientific Ltd (NSL) has announced that Prof Vidal Ashkenazi, Founder and CEO of NSL, has been awarded an OBE in the 2017 New Year's Honours List for Services to Science.

Vidal has been involved with the geodetic aspects of positioning by using satellites from the earliest days. In 1976 he was invited by the US National Geodetic Survey (NGS) to assist with the development of geodetic coordinate systems, the framework that is still used today by satellite navigation (satnav) and mapping systems.

Galileo satellites experiencing multiple clock failures

The onboard atomic clocks that drive the satellite-navigation signals on Europe's Galileo network have been failing at an alarming rate. Across the 18 satellites now in orbit, nine clocks have stopped operating. Three are traditional rubidium devices; six are the more precise hydrogen maser instruments. Galileo was declared up and running in December.

Prof Jan Woerner, the director general of the European Space Agency (Esa), told a meeting with reporters: "Everybody is raising this question: should we postpone the next launch until we find the root cause, or should we launch?

Each Galileo satellite carries two rubidium and two hydrogen maser clocks. The multiple installation enables a satellite to keep working after an initial failure.All 18 spacecraft currently in space continue to operate, but one of them is now down to just two clocks. Most of the maser failures (5) have occurred on the satellites that were originally sent into orbit to validate the system, whereas all three rubidium stoppages are on the spacecraft that were subsequently launched to fill out the network. Esa staff at its technical centre, ESTEC, in the Netherlands are trying to isolate the cause the of failures - with the assistance of the clock (Spectratime of Switzerland) and satellite manufacturers (Airbus and Thales Alenia Space; OHB and SSTL). It is understood engineers have managed to restart another hydrogen clock that had stopped. *http://www.bbc.com*

3 atomic clocks fail on 1 Indian satellite, replacement prepped

Three atomic clocks onboard a single satellite of the NAVIC Indian regional navigation satellite system have failed.

According to Indian Space Research Organization (ISRO) Chairman A.S. Kiran Kumar, the agency is trying to restart the clocks. Kumar said the affected satellite, IRNSS-1A, is otherwise healthy, and the rest of the constellation is performing its core function ofproviding accurate position, navigation and time. Sometime back, European Space Agency discussed clock failures on board Galileo satellites. Rubidium atomic clocks onboard both constellations were manufactured by Spectratime of Switzerland, but the cause of the failures has not been identified and could involve factors other than clock design.

The ISRO is readying one of the two back-up navigation satellites — IRNSS-1H — to replace it in space in the second half of this year. IRNSS-1A was launched in July 2013 and has an expected lifespan of 10 years.

Boost for sat nav positioning accuracy anywhere in world

A project exploiting Global Navigation Satellite Systems (GNSS) to establish the blueprint for the world's most accurate real-time positioning service is to run at the University of Nottingham.

The service, to be developed at prototype level, will benefit safety-critical industries like aviation and maritime navigation, as well as high accuracy dependent applications such as offshore drilling and production operations, dredging, construction, agriculture and driverless cars and drones, just to name a few. The EU-funded TREASURE project, will integrate signals from satellite navigation systems such as GPS, launched by the US, alongside Russia's GLONASS, China's BeiDou and Europe's new Galileo system.

Combining these different satellite systems to operate together is a new development known as multi-GNSS, which is key to provide instantaneous, high accuracy positioning anywhere in the world. The four-year project will focus on a service that will take the current use of GNSS - normally based on just one or two systems - to the next level, to provide accuracy of a few centimetres in real time, opening up a multitude of new possibilities. *https://phys.org*

Russia, China Work on Joint High-Precision SATNAV System

Russia and China are in the process of setting up a joint Differential Corrections and Monitoring (SDCM) high-precision satellite navigation system, China National Space Administration (CNSA) chief representative in Russia Zhang Yuan said.

Plans for the system were first mentioned in 2015. In September, the Russian Space Systems (RSS) company said talks were ongoing. RSS deputy head engineer Grigory Stupak said that high precision would be achieved by expanding the two countries' network of SDCM system stations working with the Russian Glonass and Chinese BeiDou satellite navigation systems.

Esri India launches GIS Academia Council, GIS Innovation Hub

Esri India has launched GIS Academia Council of India. The council will serve as a platform for GIS knowledge sharing aimed at encouraging GIS adoption and promoting teaching excellence in spatial data management and analysis in higher education across India.

Universities like IIT Delhi, JNU, SP Pune University, Symbiosis institute of Geoinformatics, UPES, CEPT, BITS Pilani, IIT Kharagpur, IIT Bombay, IIEST, PEC, Manipal University-Jaipur, Sarsuna college and MG Kashi Vidyapeeth have become the members of the council.

T-Hub, India's growing start-up engine launched the 'GIS Innovation Hub' (GIH) for the start-ups. The GIH is powered by Esri India. The facility was inaugurated by Jack Dangermond, Co-founder, President and CEO of Esri Inc. The GIH will be a platform for start-ups within T-Hub ecosystem, to leverage the power of GIS through Esri India. As a part of the partnership, Esri India will be inducting the start-ups into a three-year program where they would get free access to Esri's ArcGIS, a cloud-based mapping platform, software development tools and ready-to-use content. It will provide training and technical support as well.

The system, intended for use by the BRICS group of countries and the Shanghai Cooperation Organization, is planned to have a positioning accuracy of around 1 meter (3.3 feet) and will start with the creation of three Russian stations in China and three Chinese stations in Russia. Further 46 SDCM ground stations are planned to be constructed in Russia and eight more on its neighboring countries' territories. *https://sputniknews.com*

Glonass Satellite Navigation Station in Nicaragua

Experts from the Russian Central Research Institute of Machine Building (TsNIIMash) will construct a ground Glonass satellite navigation tracking station in Nicaragua.

The implementation of the project started in November 2014 and the contract on construction of the station was signed in August 2015. Glonass is the Russian version of the GPS, a global navigation satellite system meant to fix the location and speed of surface, sea and air objects to within an accuracy of one meter. *https://sputniknews.com*

Netherlands employs GNSS monitoring for rail

The Dutch state-owned rail company NS Groep N.V. is deploying a real-time remote diagnostics monitoring system. As a core component of NS' overall real-time monitoring architecture, the system allows railway operators to streamline maintenance costs and provide efficiencies across their fleet by automating manual tasks.

NS in the Netherlands will join a growing number of large rail operators that have implemented GNSS solutions, in this case the Trimble R2M system. Others using R2M include South West Trains in the United Kingdom, Irish Rail, SNCF France, SBB Switzerland and VR Finland.

R2M processes diagnostic data from rail vehicles in real time. It provides a comprehensive view of the overall fleet's status including specific vehicle faults. The system also identifies potential faults that may arise while analyzing and detecting anomalies in on-vehicle component behavior to identify component issues and the possible impact this behavior may have on the vehicle and overall fleet.

China to launch Beidou-3 navigation satellite in July

Chinese navigation satellite Beidou-3 is scheduled to be launched in July 2017, according to its developer, China Aerospace Science and Technology Corporation (CASC). The company claimed that six to eight satellites will be deployed within the year.

Five experimental Beidou global navigation satellites have been launched since 2015, according to Guo Shuren, assistant to the chief engineer of the Beidou-2. Based on experimental verification, a basic plan for the Beidou-3 satellite system has already been confirmed, Guo added.

Satellite imagery aids in prediction and prevention of food crises

One of NASA's goals for 2017 includes the purchase of Earth Science data from small and medium satellite agencies. It aims to support the development and use of commercial small satellites and intends to use the data for disaster management, food security, weather forecasting and more.

According to the World Bank, the world is about to lose 25% of its crop yields to climate change. But what if we could predict shortages around the world with enough lead time to manage a life-saving response?

One such initiative is being undertaken by Descartes Labs; the company is intent on helping to solve the looming food security crisis. The startup, which works extensively with image recognition technology, claims to produce food supply forecasts that surpass even government and commercial sources. It captures satellite images and, with the help of deep machine learning, makes accurate predictions of food production and availability that are more granular, frequent and precise than those of the U.S. Department of Agriculture.

First-ever global survey of Earth's surface waters

The Canadian Space Agency (CSA) awarded a $3.8M contract to Communications & Power Industries Canada (CPI) to build components for the Surface Water and Ocean Topography (SWOT) mission.

SWOT will survey 90 percent of the Earth's surface water, observe the fine details of the ocean's surface topography, and measure how lakes, rivers, reservoirs and oceans are changing over time. The scientific data will contribute to improving ocean circulation models, weather and climate predictions, and the management of water as a strategic resource.

The Canadian contribution to this international mission is a set of extended interaction klystrons (EIKs) built by CPI, the company involved in building and flying this sophisticated device. The high-power EIKs will be used to generate microwave pulses to collect precise water measurements. In exchange, Canadian scientists will have early access to SWOT data and scientific expertise. *http://asc-csa.gc.ca*

Satellite-based solar irradiance mapping service launched

Brussels-headquartered consultancy and software service company 3E Data Services has launched a satellite-based solar irradiance mapping service which can be used to assess the likely profitability and performance of planned solar PV projects.

It is a web-based service that uses the Cloud Physical Properties algorithm validated at over 200 meteorological sites in Western Europe. Data comes from Meteosat 9, one of five currently operating weather satellites launched by the intergovernmental European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The service is also embedded in SynaptiQ, 3E Data Services' software suite for solar installation performance monitoring and optimisation. *http://www.pv-tech.org*

PCI Geomatics marks milestone in cloud-based image processing

PCI Geomatics has announced that it is six years since it began providing clients with cloud-based processing. It has deployed many public and private cloud-based GXL processing systems for other customers, including Vancouver-based Urthecast. GXL is a key component of the processing chain for Iris and Theia, Earth-observing sensors that collect imagery daily from the International Space Station (ISS). Providing timely access to processed imagery by the Urthecast API is a key enabling technology that can help developers to implement new, innovative applications. *www.pcigeomatics.com*

Belarus' Academy of Sciences to start making BKA-2 satellite in 2017

The National Academy of Sciences of Belarus (NASB) will start making the second satellite for the remote sensing of the Earth BKA-2 in 2017, according to NASB Chief of Staff Piotr Vityaz. "A new branch of science — space research — emerged in Belarus in the last two years. We have created a system for the remote sensing of the Earth for this kind of research. We also have a satellite of our own. We are now working to create a new remote sensing satellite with the 0.5 meter resolution. Our job this year is to start making it. We have already worked out the engineering specifications and have signed the necessary contracts." said Piotr Vityaz.

FARO launches FocusM 70 Laser Scanner

FARO has announced a new entry price-performance standard for its entire FARO Focus laser scanner portfolio. The FARO FocusM 70 solution provides an ideal entry point for all professional users considering laser scanning in the construction BIM/CIM and public safety forensics markets.

Key features of FARO FocusM 70 include an Ingress Protection (IP) Rating of 54 for use in high particulate and wet weather conditions, HDR imaging, and an acquisition speed of almost 500,000 points per second and extended temperature range.

It is specifically designed for both indoor and outdoor applications that require scanning up to 70 meters and at an accuracy of +/- 3 mm. *http://www.faro.com*

Hungary joins ESA's space technology network

Hungary has joined ESA's network of finding down-to Earth uses for space technologies. Under ESA's leadership, European space industry develops top-notch space technologies, many of which offer valuable attributes to terrestrial industries as well, solving production problems or forming the basis of new products or services.

The Agency's long-running Technology Transfer Programme supports this spin-off process, working with local industry and national technology institutes. The Programme oversees an expert network of technology transfer brokers across 16 European countries – now including Hungary – to find new terrestrial homes for space technologies.

Terra Drone chooses Queensland for home

A major Japanese start-up has chosen Queensland for its regional office after being inspired by the Palaszczuk Government's drive to advance innovation and entrepreneurship across the state. Deputy Premier and Minister for Trade and Investment Jackie Trad said Terra Drone, Japan's leading unmanned aerial vehicle (UAV) provider, made the decision to come to Brisbane as a result of the Premier's trade mission to Japan in November 2016. *http://statements.qld.gov.au*

Unifly is the winner of the 'Best Emerging Drone Company'

On January 24th, 2017 the first EU Drone Awards were presented at the European Parliament in Brussels. The EU Drone Awards are an organisation of the European Young Innovators Forum (EYIF) and are meant to boost the European drone industry. Unifly was presented with the award of Best Emerging Drone Company. This category awards the most attractive European emerging company taking into account market potential, impact of the solution, team, European dimension and technological innovation.

Aerial photography company hit with large fine for FAA violations

After seeking a record sum of US$1.9 million from aerial photography company SkyPan International, the Federal Aviation Administration (FAA) has accepted $200,000 as part of a settlement. SkyPan International was charged with orchestrating 65 unauthorized flights in congested airspaces, lacking proper certification and registration for flights and not flying with the proper signaling equipment on-board to alert other aircraft to the presence of the SkyPan drones.

The alleged violations took place during 2012-2014 in New York City and Chicago and the FAA opened an investigation in 2015. SkyPan has been in the aerial photography business for 28 years and has regularly utilized full-size helicopters and remote control helicopters during its tenure. The violations took place during a period when the FAA was still developing drone regulations, but nonetheless, it appears that SkyPan got off much easier than it otherwise could have. *www.imaging-resource.com*

SurvTech selects NEXUS 800 for aerial mapping

A NEXUS 800 UAS powered by HYPACK has been provided to the US southeastern geospatial solutions company SurvTech. The company will use the device to acquire upland data simultaneous with subaqueous data and make a seamless point cloud of upland and submerged data. The integration with the company's heading RTK GPS, IMU, sonar and HYPACK was experienced as straightforward. When planning to equip a UAV copter with the Puck sensor, heading RTK GPS, IMU and computer processing board, SurvTech aimed for a commercial grade copter that would be extremely robust and have built in redundancy.

IDRA to provide Insurance service to its members

The International Drone Racing Association (IDRA) has come up with some reliefs for drone pilots. IRDA is going to launch the first primary UAV Aircraft Liability Insurance policy to cover drone pilots worldwide. The insurance policy will include the IDRA's membership where every IDRA member will be provided with a maximum of US$1,000,000 UAV liability coverage. It will cover different mode of operations like UAS training and racing competitions, recreational use of drones all around the world. According to the Founder and CEO of IDRA, Justin Haggerty, "it was a tough time to find the right insurance provider and underwriter to support the organization's goal. Now IDRA is ready to provide this service to its member all around the globe. The IDRA as a drone community is excited to provide an extra layer of protection to its members." *http://www.dronemirai.com*

Major Improvements on the Ellipse Series Inertial Sensors from SBG Systems

SBG Systems releases a new version of the Ellipse Series, its popular product line of miniature inertial sensors. The Ellipse has been greatly improved, showing unmatched performance in attitude measurement while adding Galileo constellation to its GNSS receiver.

After thousands of Ellipse miniature inertial sensors operational on the field, SBG Systems proves again its capability of continuous innovation. With major improvements, the Ellipse line of miniature inertial sensors strengthens its position as "best combination of innovation, performance, and reliability" while keeping the same form factor and price level.

Few notable features are

- Amazing Performance: Attitude Accuracy Improved by a Factor of Two
- GNSS Navigation: Ellipse-N Operational with Galileo Satellites
- 2-Year Warranty: The Most Reliable Industrial-grade Sensors
- An Entry-level Solution for Surveying Applications
- Compatibility and Availability

Siemens and Bentley Systems Agree to Jointly Offer Planning and Design Solutions for Utilities

Building on the strategic alliance between Siemens and Bentley Systems that was made public in November 2016, Siemens' Energy Management Division and Bentley Systems have announced an agreement to jointly develop solutions to accelerate digitalization of planning, design, and operations for power utilities and industrial power customers.

The first of the new offerings will integrate Bentley Systems' utility design and GIS capabilities with Siemens' Power System Simulation (PSS) Suite, with specific solutions for

power transmission, power distribution, and industrial facilities. Combining these two platforms provides customers with Bentley's expertise in 3D infrastructure asset modeling and GIS with Siemens' knowledge and renowned experience in energy system planning and simulation.

Caltrans takes delivery of Riegl INS/GNSS mapper

Caltrans — the California state agency responsible for highway, bridge and rail transportation planning, construction and maintenance — has taken delivery of the new Riegl VMX-1HA mobile mapping system.

The Riegl VMX-1HA is a high-speed, high-performance dual-scanner mobile mapping system. It provides high performance and dense, accurate and feature-rich data at highway speeds. With two million measurements and five hundred scan lines per second, the turnkey solution is suited for survey-grade mobile mapping applications to meet the standards of departments of transportation nationwide.

The technology of the system comprises two Riegl VUX-1HA high-accuracy waveform lidar sensors and a high-performance INS/GNSS unit, housed in an aerodynamically shaped protective cover.

Ultra-small multi-GNSS module by u-blox

u-blox has announced the launch of ZOE-M8G, an ultra-compact GNSS receiver module, especially designed for markets where small size, minimal weight and high location precision are essential. ZOE-M8G offers exceptionally high location accuracy by concurrently connecting to GPS, Galileo and either GLONASS or BeiDou. *http://www.u-blox.com*

Spirent unveils PT TestBench software

Spirent Communications has announced the availability of PT TestBench – software to help technology, system and application developers build more accurate positioning functions more quickly. The testing, analysis and reporting package automates testing of GPS and other GNSS receivers, so higher quality systems are brought to market faster and more reliably.

Until now, there have been no standards for GNSS receiver performance assessment, leaving developers to create test plans themselves from scratch.

Apple adds QZSS support to iPhone 7/7 Plus

Apple has updated its website for the iPhone 7 and 7 Plus in Japan to add support for Quasi Zenith Satellite System (QZSS), a Japanese satellite positioning system that could improve location features for users in the region versus traditional GPS.

While it's unclear if users are already benefiting from the support for the positioning system, the website for QZSS is also now listing iPhone 7 and 7 Plus as a supported device alongside Apple Watch Series 2. It does note, however, that support is limited specifically to the iPhones sold in Japan. *https://9to5mac.com*

Satellite Interference Geolocation Service launched

Austria-based Siemens Convergence Creators has announced its new Satellite Geolocation Service, designed to enable satellite and service operators to localize satellite signal interference worldwide. For satellite operators and users, including the GNSS community, the ability to rapidly identify and mitigate interference — intentional or not — is crucial to protecting the core functionality of their assets and service operations.

According to a statement by the European Space Agency (ESA), which supported the development of the geolocation system, SIECAMS ILS ONE works by analyzing the signal distortions primarily caused by satellite movement, atmospheric, or weather influences and other environmental factors. By comparing such signal distortions of the interference signal with known signals, ILS ONE is able to identify the precise location of the interference source.

Raytheon's GPS OCX completes factory qualification

Raytheon's GPS Next-Generation Operational Control System, or GPS OCX, completed its factory qualification test.

The GPS OCX is a project under development for the U.S. Air Force with the aim of enhancing navigation capabilities for military and civilian users. Raytheon officials say reaching factory qualification puts the project closer to meeting Air Force requirements.The GPS OCX's factory qualification follows a number of other milestones for the program in 2016, including successful Critical Design Review for hardware development, LCS component-level qualification testing, and risk-reduction testing for ground system software. *http://www.upi.com*

ODOT Deploys DT Research Purpose-built GNSS Rugged Tablets

California-based DT Research announced on January 9 the successful deployment of the DT391GS Rugged GNSS Tablets for the Oregon Department of Transportation (ODOT).

The DT391GS tablets with Intel Celeron Dual Core Processors are used as Inspector Positioning Tablets with the critical hardware and software needed for line and grade determination on stakeless highway construction projects.

The tablet comes with four GNSS module options including two from Hemisphere GNSS and two from Trimble. The GNSS options are:

- Hemisphere single frequency GNSS module (P103) with embedded antenna.
- Hemisphere dual frequency GNSS module (P303) with embedded antenna.
- Trimble single frequency GNSS module (BD910) with embedded antenna
- Trimble triple frequency GNSS module (BD930) with embedded antenna:

ODOT wanted to embrace the growing trend in highway construction sites to go "stakeless" and forego physical stakes by using modern Automated Machine Guidance (AMG) applications on jobsites to determine line and grade when building or fixing stretches of road.

Hexagon Safety & Infrastructure launches new police analytics software

Hexagon Safety & Infrastructure has launched its web-based crime mapping and analysis application, Intergraph InSight Explorer, which will empower the agencies to discover, analyze and visualize complete crime, incident and operational data.

With richer insight and clearer presentation of complex information, agencies can uncover trends and patterns that assist investigations and improve the allocation of resources. Intergraph InSight Explorer allows analysts to search through and interpret large volumes of unstructured and structured data to make more informed decisions.

The application displays data in map and tabular format with interactive widgets, charts and filters for in-depth analysis. It also speeds up the investigative process by allowing detectives and investigators to perform simple analysis, freeing analysts to concentrate on the most demanding tasks.

Trimble introduces new water add meters and drum rotation sensor

Trimble recently introduced its new Water Add Meters (WAM) and an upgraded Drum Rotation Sensor for ready mix construction fleets. "These solutions will enable fleets to not only improve how they monitor the quality and consistency of their ready mix product but will also help them to streamline equipment troubleshooting and maintenance," said Jeff Van Grootel, director of product management for Trimble Construction Logistics. The new WAM300 and WAM350 are designed to accurately measure and control the amount of water added to specific concrete mixes.

Hexagon, RapidSOS partner to provide accurate location from smartphone users

Hexagon Safety & Infrastructure and RapidSOS have partnered to provide public safety agencies that use Hexagon's Intergraph Computer-Aided Dispatch (I/CAD) with accurate location and additional data from the RapidSOS NG911 Clearinghouse. With this partnership, the Public Safety Answering Points (PSAPs) working with Hexagon will be able to harness data from the RapidSOS Clearinghouse — including accurate handset location from all smartphone location sensors.

Millions of smartphones and other connected devices transmit precise device-based hybrid location and additional data to the RapidSOS Clearinghouse when a 9-1-1 call or other request for emergency is made. Through the RapidSOS integration, I/CAD users will be able to query the RapidSOS Clearinghouse when a wireless call is received to retrieve supplementary location and additional data through NG9-1-1 delivery mechanisms.

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ASPRS Imaging & Geospatial Technology Forum (IGTF) 2017
March 12-16, 2017
Marriott Waterfront, Baltimore, Maryland
http://conferences.asprs.org/

Munich Satellite Navigation Summit 2017
14 – 16 March
Munich, Germany
www.munich-satellite-navigation-summit.org

International Forum GEOSTROY
16-17 March 2017
Novosibirsk, Russia
http://www.geostroy-sib.ru/en/

April 2017

SPAR 3D Expo and Conference
3 - 5 April
Houston, USA
SPAR3D.com

ISDE10 & Locate17
3 - 6 April
Sydney, Australia
www.digitalearthsymposium.com

UNMANNED WORLD
5 - 7 April
Doha, Qatar
www.unmanned-world.com

GIS-Forum 2017
19-21 April
Moscow
www.gisforum.ru/en

International Navigation Forum / Navitech'2017
25 - 28 April
Moscow, Russia
www.navitech-expo.ru/en/

GISTAM 2017
27 - 28 April
Porto, Portugal
http://gistam.org

May 2017

MMT 2017: The 10th International Symposium on Mobile Mapping Technology
6 - 8 May
Cairo, Egypt
http://mmt2017.aast.edu/index.php

XPONENTIAL
8 - 11 May
Dallas, USA
http://xponential.org

11th Annual Baska GNSS Conference
7 - 9 May
Baska, Croatia
www.rin.org.uk

The European Navigation Conference 2017
9 – 12 May
Lausanne, Switzerland
http://enc2017.eu

GeoBusiness 2017
23 - 24 May
London, UK
http://geobusinessshow.com

FIG Working Week 2017
29 May - 2 June
Helsinki, Finland
www.fig.net

June 2017

10th International ESA Conference on Guidance, Navigation & Control Systems (GNC)
29 May - 2 June
Salzburg, Austria
http://esaconferencebureau.com

TransNav 2017
21 - 23 June
Gdynia, Poland
www.transnav.eu

July 2017

IGS 2017: International GNSS Service Workshop
3 - 7 July
Paris, France
www.igs.org

IEEE Frequency Control Symposium and European Frequency and Time Forum
9 - 13 July
Besançon, France
www.eftf-ifcs2017.org

Esri User Conference
10 – 14 July
San Diego, USA
http://www.esri.com/events/user-conference/papers

September 2017

Interdrone 2017
6 - 8 September
Las Vegas, USA
www.interdrone.com

ION GNSS+ 2017
25 - 29 September
Portland, USA
www.ion.org

Intergeo 2017
26 - 28 September
Berlin, Germany
www.intergeo.de

October 2017

ACRS 2017
23 - 27 October
New Delhi, India
www.acrs2017.org

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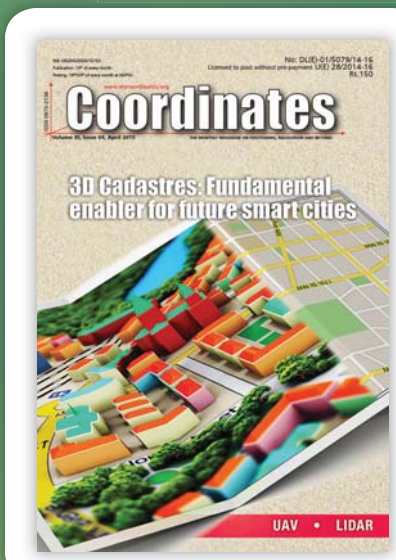

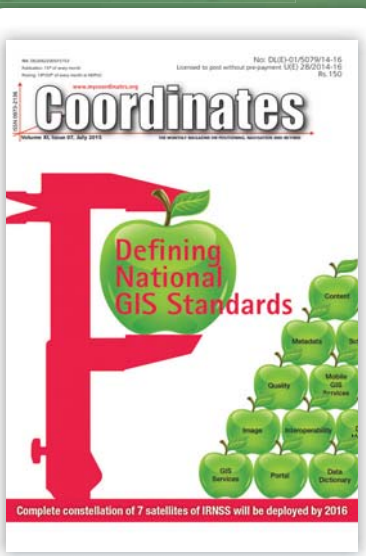

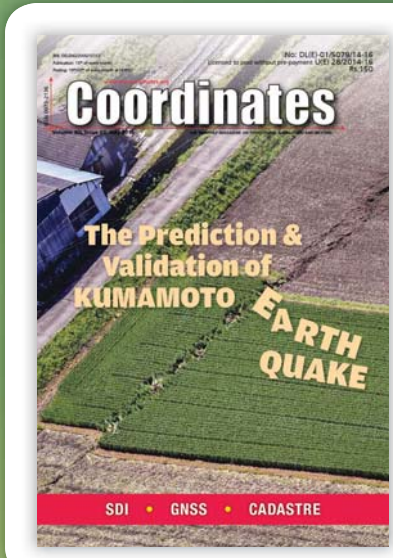

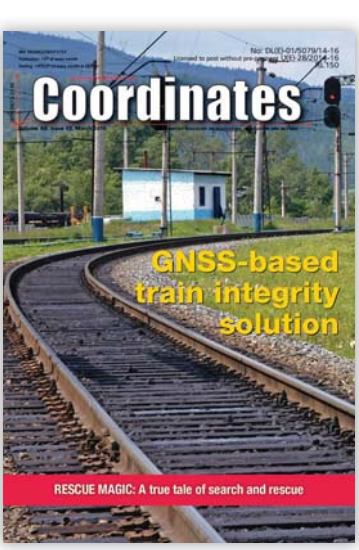

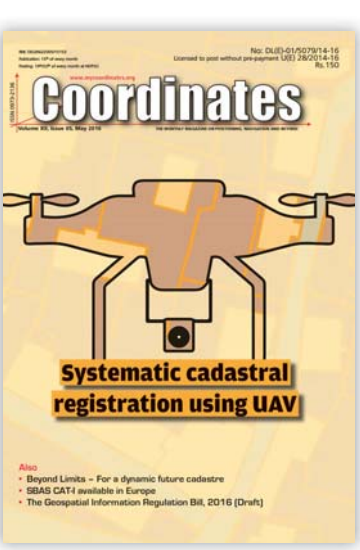

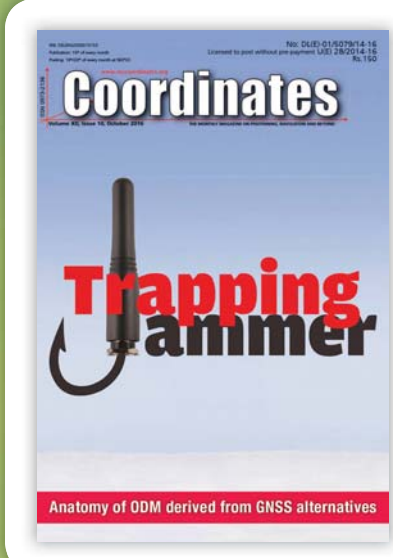

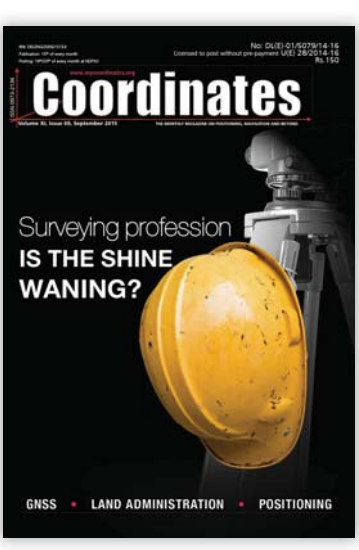

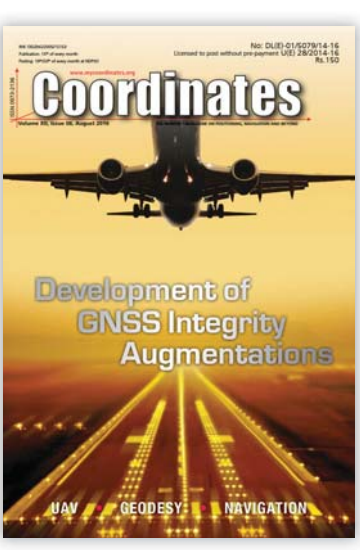

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