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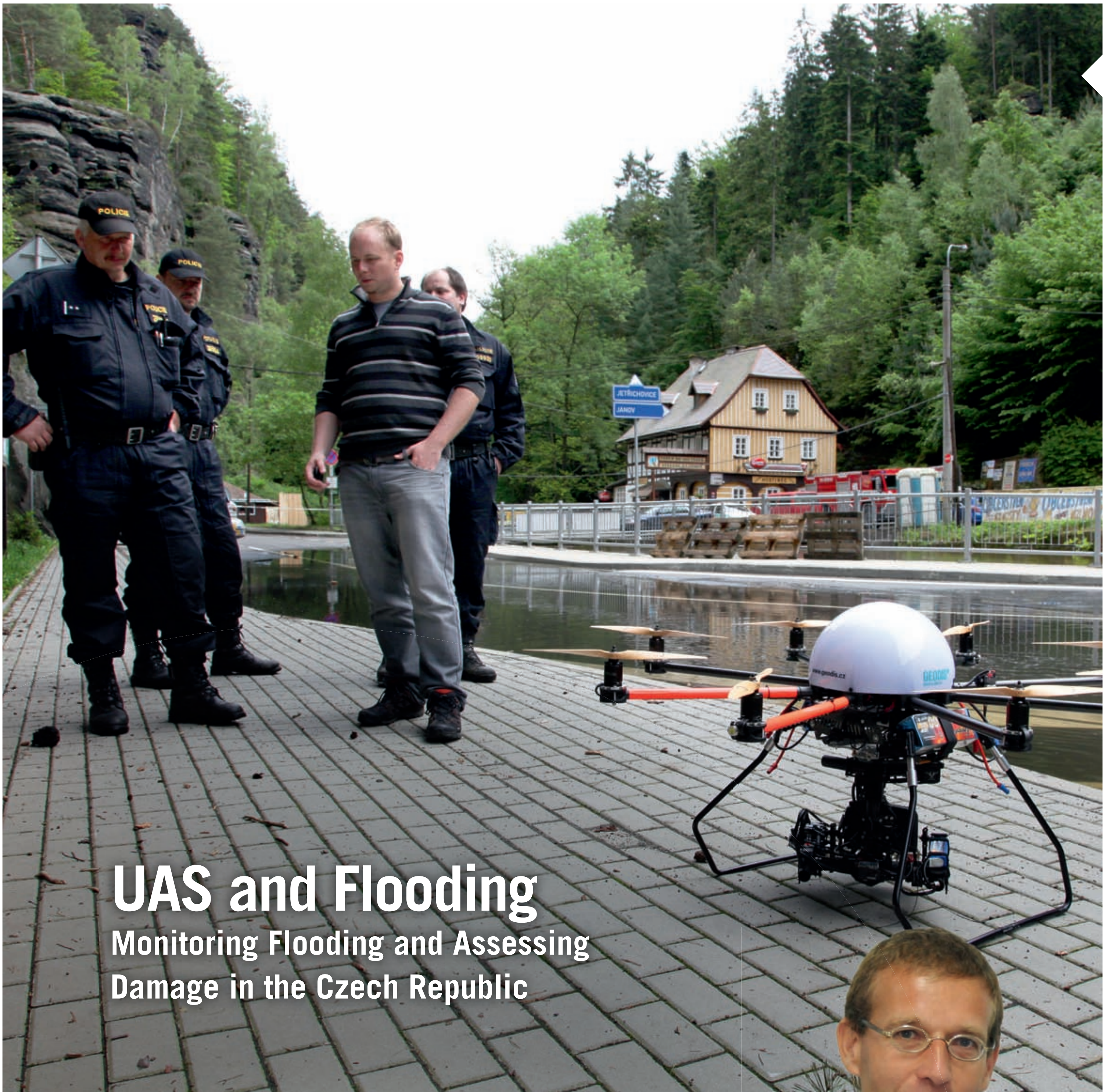

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GIM INTERNATIONAL

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Looking Forward as Well as Back

It's a common phenomenon: looking back – often with a hint of nostalgia – at what has been. In much of this issue of *GIM International*, we look back at the Intergeo, which took place last month in the German city of Essen. And we indeed do so with some nostalgia, because we had a great time in Essen meeting lots of our clients – readers and advertisers alike. We also saw plenty of new and interesting companies with amazing hardware and software solutions, and of course we enjoyed ourselves at the social events held in parallel with Intergeo.

Over 500 exhibitors and 16,000 visitors made for a lively event, and in this edition our editors Mark Pronk and Mathias Lemmens both share their experiences at the year's largest geomatics tradeshow for those of you unable to attend. Mark Pronk highlights the tremendous impact of Germany's decision to shift away from nuclear energy completely, which is leading the country along the path of renewable energy at a rapid pace. The construction of major solar, wind and biogas energy plants is creating more demand for a wide variety of geomatics solutions and hence boosting further developments in techniques such as photogrammetry, positioning and spatial planning.

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Photography: Arie Bruinsma

Mathias Lemmens visited Intergeo with a group of his international students – from as far afield as Lithuania, Greece and China as well as The Netherlands – who were able to see technology first-hand at the booths of Leica, Optech, Pix4D and many more. The UAS displays attracted plenty of attention, not only from the students but from all visitors to the show. Since the introduction of the first unmanned aerial system by Gatewing (now Trimble) a few years ago, their number has grown immensely and the systems have claimed their rightful position in the array of tools for surveyors.

Of course, it's not all looking back in this issue of *GIM International*. Senior editor Mathias Lemmens has interviewed professor Peter van Oosterom from the Technical University of Delft and currently on sabbatical at the University of Technology Malaysia (see page 14). Van Oosterom sheds light on the future of geomatics and talks about synergies between universities in different parts of the world, educating young researchers in geomatics in joint projects, working together with manufacturers in putting research into practice, and the future of LADM. He looks back a little too, identifying mobile computing, positioning and augmented reality as techniques that have developed with surprising speed in recent years.

But with articles by Patrick Adda, David Coleman and Peter Dare, University of New Brunswick, Canada, on 'Challenges in Validating Large Spatial Datasets, Experiences Using Airborne Lidar Data' (see page 22), and by Jakub Karas, Geodis, Czech Republic, on 'UAS and Flooding – Monitoring Flooding and Assessing Damage in the Czech Republic' (see page 18), the main focus this month is on looking forward into the future – and not looking back.

The photo on this month's front cover shows the village of Hřensko, Czech Republic, situated at the confluence of the River Kamenice with the Elbe. Severe floods hit the country in late May and early June 2013. The Czech company Geodis helped to monitor the situation with its octocopter, which captured video and oblique images for use by the rescue crews and TV broadcasters.

(PHOTO COURTESY: GEODIS)

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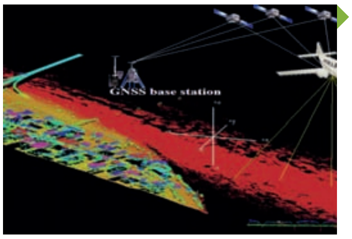

How to Stop Land Grabbing in Africa

The International Land Coalition estimates that about 83 million hectares of rural land have been acquired by investors in large-scale agriculture. There is evidence that the true owners of these land parcels have been neglected and unlawfully evicted. The High Level Panel of Experts of the FAO urges for better recording of those land rights. In urban areas, the Centre of Housing Rights and Eviction calculates that more than 4 million people have been evicted from their homes or are living in fear of eviction. The Centre urges for better recording of housing rights. Providing secure land and housing tenure should be at the top of the political agenda, but it is not. The responsible political elites appear to be occupied by other interests. Land professionals can create mechanisms to identify and record ownership and use, but they cannot make such systems meaningful unless politicians shoulder their responsibilities to create the necessary legal and social fabric. And, even then, it will take time to roll the systems out. Meanwhile, land grabbing and eviction continues. Is there no alternative which provides vulnerable people with a tool to make their governments accountable? Yes, there is: the African Charter of Human and People's Rights. This Charter, adopted in 1981, states in article 14 that "the rights to property should be guaranteed". Although the Charter was developed at a time when African States were far from eager to guarantee the property rights of their former colonisers, this article opens up a way for calling governments to account on land grabbing and eviction. Two things have to be changed to make this possible. Individuals do not have easy access to the African Court of Human and People's Rights. Under article 5.3 of the Court's protocol, individuals can only apply when their home States make a declaration accepting the competence of the Court in the case. That is the first thing to be changed. Secondly, in the terminology of the Charter, indigenous land rights are – wrongly – not considered to be a 'property right'. By allowing individuals and groups to lodge an Art. 14 appeal, the Court can follow what the European Court of Human Rights does. Since its inception in 1959, this Court has ruled on more than 2,200 cases regarding property rights. Case law indicates that four questions are at stake: does the plaintiff indeed exercise a property right, is the interference of the State lawful, is it proportionate, and does the interference comply with principles of legal certainty (compensation)? In the African situation, vulnerable people might then have an opportunity to get their property rights recognised by the African Court, regardless of the absence of a land register, and the Court can prevent States from evicting them and grabbing their land.

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Photogrammetry and Laser Scanning on Single Aircraft

Diamond Aircraft, Austria, has introduced its new DA42 GEOSTAR that enables laser scanning and photogrammetry data to be collected during a single flight. The team from Diamond Airborne Sensing (a subsidiary of Diamond Aircraft) has succeeded in perfect sensor integration on the DA42 MPP, the most economic remote-sensing platform worldwide. Both systems are integrated with sufficient resources for fuel and flight crew. ◂

▸ http://tw.gs/RYS8dw

The specially designed pod on the nose of the aircraft for the photogrammetric camera and the gyro stabilisation mount.

Hexagon to Acquire Devex

Hexagon, Sweden, has signed an agreement to acquire Devex, a supplier of automation solutions for mining operations. This Brazilian company has grown significantly in size and scope in recent years, taking solutions from Devex beyond fleet management deep into mine process automation. The portfolio has grown from SmartMine into a comprehensive automation platform for optimising mine performance through real-time control and remote monitoring of all mine activities – in 3D and from a single platform. ◂

▸ http://tw.gs/RYS8ex

Most Shared

Most shared during the last month from www.gim-international.com

1. UAS Captures 20cm-resolution Data for 3D Model of Matterhorn
   - http://tw.gs/RYS8fy
2. Photogrammetry and Laser Scanning on Single Aircraft
   - http://tw.gs/RYS8dw
3. Astrium Grants a Look Behind the Scenes of SPOT 7
   - http://tw.gs/RYS8fa
4. Intergeo Focuses on the Energy Transition
   - http://tw.gs/RZRdfx
5. Topcon Announces New Portable Laser Scanner
   - http://tw.gs/RYS8e4

Geo-matching.com Adds Unmanned Aerial Systems Category

Geo-matching.com, the product comparison website for devices used in geomatics, hydrography and related industries, has announced the addition of a new category for Unmanned Aerial Systems. The types of Unmanned Aerial Systems (UAS) that qualify for inclusion in this new category are all UAVs equipped with cameras, Lidar or other sensors capable of surveying Earth and/or sea surfaces, including relevant processing software. ◂

▸ http://tw.gs/RYS8A3


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UAS Captures 20cm-resolution Data for 3D Model of Matterhorn

Engineers from senseFly have marked a new milestone in the history of surveying techniques by demonstrating that minidrone mapping technology is capable of producing a digital 3D model of the Matterhorn, one of the iconic peaks of the Swiss Alps, in 20cm resolution. The data was acquired during a total of 11 flights by several eBee minidrones flying concurrently and collecting over 2,200 images within just a few hours.

http://tw.gs/RYS8fy

An eBee minidrone mapping the Matterhorn.

Topcon Announces New Portable Laser Scanner

Topcon Positioning Group has announced the GLS-2000 laser scanner. An expanded field of view, high speed and compact size make it a versatile laser scanner suitable for any job site. With its 350m (1,150ft) eye-safe long-range scanning technology, the GLS-2000 features survey-grade accuracy that reduces the amount of scan set-ups required on site. The integrated twin cameras help to ensure that the images recorded provide photography with the best possible definition for all levels of scan detail.

http://tw.gs/RYS8e4

GLS-2000 laser scanner.

EuroGeographics Now Covers Whole of Geographical Europe

Two new authorities have joined EuroGeographics which means the association's membership now covers the whole of geographical Europe. Applications for full membership from the State Authority for Geospatial Information, Albania, and the State Committee on Property, Belarus, were approved at the General Assembly held in Warsaw, Poland. EuroGeographics now represents 59 organisations from 46 countries.

http://tw.gs/RYS80Y

EuroGeographics General Assembly family photo.

OF MATTERHORN ++ ASTRIUM GRANTS A LOOK BEHIND THE SCENES OF SPOT 7 ++ ALTUS IN

INTERGEO 2013 ++ THIRD-GENERATION ULTRACAM HAWK UNVEILED ++ DRONEMETREX ACC

Astrium Grants a Look Behind the Scenes of SPOT 7

On Friday 4 October, *GIM International* was invited to the Astrium Services facilities in Toulouse, France, to receive an update on the SPOT satellite project. Just a month after the first anniversary of the SPOT 6 launch, and with the SPOT 7 set to be launched in the first quarter of 2014, Astrium organised a full-day programme for the press including demonstrations, a Q&A lunch with Bernhard Brenner, executive director of the GEO-Information Division, and a tour round the company including a visit to the clean room to see the SPOT 7 satellite itself. ◂

▸ **http://tw.gs/RYS8fa**

SPOT 7 satellite in development (photo taken in December 2012).

University of Leicester Honours Bluesky Technical Director

James Eddy, technical director of aerial survey specialist Bluesky, has been conferred the honorary title and status of Industrial Associate by the University of Leicester, UK. As Bluesky's technical innovator, James has been working in partnership with the University of Leicester on a number of projects including research into the development of a new system for Nightsky mapping and the use of specialist sensors for air-quality monitoring. Designed to provide recognition of the significant and regular contribution to the work of the Department of Geography made by James, the title runs for a period of five years. ◂

▸ **http://tw.gs/RYS80w**

James Eddy.

Intergeo Eurasia and Seismic Safety Present Exhibtion Concept

With a concept that has been developed especially for the region, the trade show duo Seismic Safety and Intergeo Eurasia will be held in Istanbul, Turkey, for the first time on 28-29 April 2014. The central approach of the event is a solution-oriented range of information and products that covers the entire process chain in the sectors of earthquake resistance and fire protection. It will include all of the necessary tasks in planning, design and construction as well as urban development and urban renewal in general. ◂

▸ **http://tw.gs/RYS8eX**

Intergeo Eurasia website.

Altus Introduces GIS-1 at Intergeo

Altus Positioning Systems is expanding its line of GNSS surveying products with the introduction of the GIS-1, a versatile Personal Digital Assistant (PDA) for data collection and geolocation. It can be used as a data collection device with Altus's APS-series GNSS survey instruments, providing up to eight hours of operation time in the field between charges. In addition, the unit's built-in L-1 GPS receiver and 3.2 Mpix camera can be used for navigation and GIS applications. It can even be used as a smartphone. ◂

▸ **http://tw.gs/RYS8g1**

PHOTOGRAMMETRIC MAPPING PROJECT ++ RAPIDLASSO ADDS LASTOOLS LIDAR PROCESSING TOOLBOX TO QGIS ++ UNIVERSITY OF LEICESTER HONOURS ... L DIRECTO

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No 2433

GEO Business 2014: a Major New Geospatial Event

Diversified Business Communications, UK, has announced the launch of GEO Business, a major new geospatial event incorporating an international trade exhibition, a conference and a hands-on workshop and demonstration programme. GEO Business 2014 is scheduled to take place at the Business Design Centre in London on 28 and 29 May 2014.

http://tw.gs/RYS8B2

Rapidlasso Adds LAStools Lidar Processing Toolbox to QGIS

At the code sprint following the FOSS4G 2013 conference, rapidlasso completed a toolbox that exposes the extensive Lidar processing capabilities of the LAStools software suite within QGIS. QGIS (previously known as 'Quantum GIS') is a comprehensive desktop geographic information system that is free and open source software (FOSS). QGIS has seen rapid growth in acceptance as a viable and cost-effective alternative to the commercial ArcGIS products from Esri.

http://tw.gs/RYS805

Intergeo, Students and the Geoinformation Chain

Intergeo 2013 – held 8-10 October in Essen, Germany – attracted over 500 exhibitors and 16,000 visitors. The sizes of the booths from China were notable, as were their number. The Chinese mainly focus on levels, total stations, GNSS receivers and mobile GIS software, but more recent developments such as laser scanners are increasingly joining these. Many visitors looked skywards, since there were multicopters in the air everywhere, both outdoors and in. Flight demos were given by over 30 UAS firms – a tenfold increase on a few years back, when many sniggered at these 'toys for boys'. Today, however, UAS have evolved into high-potential surveying devices. Outdoors Ascending Technologies allowed bystanders to remotely pilot its octocopter, designed in a cut V shape. Stability is ensured by software allowing rapid feedback from sensors to rotors. This was the first time I had attended Intergeo since resigning as editor in chief of this magazine in 2008. This year, my main aim was to guide my students from the Delft University of Technology, The Netherlands, around the exhibition. Having all gained a BSc in a geomatics-related field, either from The Netherlands or from as far afield as Lithuania, Greece and China, these students started in September 2013. Thanks to courses on geodata acquisition and the principles of GIS and having studied the book *Geo-information: technologies, applications and the environment* (Springer, 2011), they were sufficiently equipped to absorb the technology. Klaus Neumann (Leica), Donald Carswell (president of Optech), Christoph Strecha (CEO and founder of Pix4D) and others explained the nitty gritty of digital cameras, airborne Lidar, photogrammetric and point cloud software and more. Delft's 2012 redesign to create the MSc in Geomatics for the Built Environment preserved the entire geoinformation chain. The starting point is that geoinfo is needed to support proper management of the Earth and good governance. In order to do so, geodata must first be acquired and subsequently stored in DBMS after georeferencing and other pre-processing. The data is then ready for analysis which includes merging a diversity of datasets, performing GIS operations and loading data in hydrological or other specialised computer models. At the end of the chain, the results – tables, maps, 3D models, animations, etc. – are sent over the web to serve planners, constructors and others. Data without indicating quality is no data, so its assessment and control are key. Boards of educational institutions are often impressed by glossy 3D city models or flood animations and may overlook the fact that the results entirely depend on high-quality geo datasets. They are crucial, as are the piles of concrete for upholding buildings and bridges, but they are hidden from view and hence are not sexy. These early stages in the chain might become seriously endangered when university boards confuse invisibility with irrelevance. Intergeo was a great chance to catch the entire chain in a nutshell, and to be reassured of the value of every link within it.

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CATEGORY ++ 'EARTH FROM SPACE - THE MOST EFFECTIVE SOLUTIONS' ATTRACTS OVER 400 DELEGATES ++ GEO BUSINESS 2014: A MAJOR NEW GEOSPATI ... REMOTE SENSING LAB ESTABLISHED AT KUWAIT UNIVERSITY ++ PHOTOGRAMMETRY AND LASER SCANNING ON SINGLE AIRCRAFT ++ HEXAGON TO ACQUIRE DEVEX ... ESSING

GIM INTERNATIONAL INTERVIEWS PROFESSOR PETER VAN OOSTEROM

In-depth Research to Serve Practice

Peter van Oosterom joined Delft University of Technology (TU Delft) in The Netherlands as a full professor in 2000. The main thrust propelling his efforts is a keenness to see how his research serves practice. That is why he co-operates extensively with industry and governmental agencies, and also why the University of Technology Malaysia (UTM), where he is presently on sabbatical, is so appealing to him.

Which developments in the geo-ICT field have most surprised you?
Mobile computing, positioning and augmented reality (AR) have all developed surprisingly rapidly. In 2000, my group was involved in an AR project and we carried the devices we needed in a backpack. Today, you have Google glasses, projections on windshields and Layar apps. Impressive progress has also been made based on combining positioning and orientation, 3D geo datasets and user interfaces. The huge interest in geoinformation from giants such as Google and Microsoft along with other major ICT players has surprised me as well.

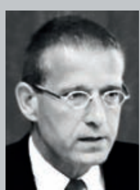
And what about the other way around?
Reactive data structures to store vario-scale map data – the topic of my PhD research 25 years ago – developed slower than I expected, as did advanced geometry support to integrate CAD and GIS including 3D topology, curved primitives and point clouds. The solutions are still ad hoc and they have not yet gone mainstream.

You are co-designer of the Land Administration Domain Model (LADM). Why should authorities implement or upgrade land administration systems (LAS) based on LADM?
It took the FIG/ISO team led by Christiaan Lemmen over a decade to reach the consensus necessary to bring LADM to a standard adopted by ISO and CEN, but the benefit is that it is based on the collective experiences of experts from right around the globe. It allows meaningful exchange of data within and between countries and it is a cornerstone of SDI. The LADM covers surveying, cadastral maps, RRR (rights, restrictions, responsibilities), mortgages and persons, whether individuals or groups – in all, the complete LA spectrum. It supports formal and informal RRRs, allows integrated 2D and 3D representation of spatial units, and links registration data to source documents, both spatial (survey) and legal (title, deed). Being LADM compliant will seldom be the reason behind building a new LAS. However, all systems need upgrading and maintenance eventually, which would be a good point to switch to LADM compliance. In countries where LAS still has to be pioneered it is possible to start simply, with texts, sketches and point parcels, and to later move towards full topology and 3D support, as Rod Thompson pointed out at the 5th LADM workshop. This is why UN-HABITAT and FAO use the standard.

Tenure security increasingly requires registration of real estate in full 3D. Can you tell us about the progress in establishing 3D cadastres in practice since 2000?
In 2000 some jurisdictions such as Queensland, Australia, had legislation in place supporting the creation of 3D parcels, but no country stored 3D parcels in a database, which is the characteristic of a true 3D cadastre. Queensland, for example, stored source documents in a register, which impeded checks on overlaps in 3D space and other geometrical inconsistencies. Since 2000, several countries have carried out studies to assess the need and usefulness of 3D cadastre and have developed prototypes. The first 3D cadastre workshop was held in 2001, and the PhD thesis (2003) by Jantien Stoter from TU Delft raised international awareness. At the third workshop, which was held in 2012, an operational 3D cadastre was presented by Shenzhen from China. 3D may sound more complicated than 2D but the reverse is true as the latter does not cope well with describing ownership in urban areas, where spaces on which many parties may have settled different rights are built on top of each other.

Your research also focuses on automatic generation of maps starting from one complete and detailed source map. What is the gravity of this research?
Automatic generalisation allows data collection, interpretation and processing to be done just once, while time-consuming and semi-manual workflows can be eliminated, thus reducing costs. The consistency between the various map scales improves as they are all derived from the same source. Thanks to automated production, all required map scales can be produced more rapidly resulting in more up-to-date maps. Automation turned out to be unexpectedly tough. A lot of (PhD) research has been done resulting in partial solutions. Since 2012, The Netherlands has been deriving the 1:25,000 maps from scale 1:10,000 maps fully automatically – as the world's first country to do so – and is now working on the smaller scales, all in co-operation with TU Delft.

Peter van Oosterom



Peter van Oosterom (1963) has been a full professor and head of the section GIS Technology at Delft University of Technology, The Netherlands, since 2000, where he presently teaches Geo Database Management Systems within the recently redesigned MSc in Geomatics for the Built Environment. In 1990 he gained a PhD from Leiden University with his thesis on Reactive Data Structures for GIS, which was published in revised form by Oxford University Press in 1994. In 1985 Peter started his career with TNO Physics and Electronics Laboratory, The Netherlands. In 1995 he joined the Dutch Cadastre. He has gained various scientific awards and a patent on vario-scale maps and has been chairman and (co)organiser of multiple conferences and (FIG) workshops. Peter is co-designer of the Land Administration Domain Model (LADM), has been guest editor of special issues of scientific journals on such subjects as 3D cadastres and map generalisation (in CEUS). He is presently associate editor of CAGEO. He has supervised nearly ten PhD theses and is (co)author of over 100 publications.

✉ p.j.m.vanoosterom@tudelft.nl

The next step is truly vario-scale maps. The PhD research by Martijn Meijers revealed that scale should be considered an additional dimension and thus represented by 3D structures. The benefits of our patented approach include absence of redundancy, smooth zoom, progressive transfer, guaranteed consistency between scales and mixed-scale (perspective) views.

There is increasing co-operation between universities and research institutes from Asia, particularly China, and the West – and that goes for TU Delft too. What do you consider to be the main mutual benefits?

In parallel with the economic emergence of Asia, the research capabilities of those countries are increasing both quantitatively and qualitatively. Governments and enterprises are quite innovation-driven and willing to invest. Research results are swiftly put into practice, thus inspiring and encouraging further research. Many Asian researchers have gained MSc or PhD degrees from Western universities or stayed on as postdocs – providing a solid basis for joint research, exchange of staff, double-degree education and much more. The decade-long collaboration between Wuhan University, China, and TU Delft was consolidated in the Joint Research Centre on Spatial Information (JRC-SI) in 2012, headed by prof Jianya Gong and myself. In addition to GIS, the collaboration also covers geoinformation governance, remote sensing, GNSS and physical and satellite geodesy.

How do you co-operate with manufacturers of geomatics hardware, software and geodata?

Scientific publications are one type of research output, but the transfer into applied software is even more viable. This can be realised by teaming up with industry, for which I launched the Geo-Database Management Center (GDMC) in 2000. To date, our partners include Oracle, Bentley and Safe Software. We are proud that many fruits of our research have been implemented in their products. Together with Bentley we have filed a patent on indoor positioning, for instance. We have other partnerships with industry including Fugro, Oracle, Esri, 1Spatial, Bentley and Snowflake, and with governmental agencies including Rijkswaterstaat, Geonovum and Kadaster. These connections help us to apply our research practically and to gain first-hand feedback, and thus act as a spur for further research.

Which major development(s) do you foresee in geoinformation technology in the next five years?

Predicting the future is precarious as my past predictions have proven, but I'm happy to make a guess: various LADM software systems will be available and increasingly used in many countries. At least 15 jurisdictions will have a true 3D cadastre while the greater part of 3D city models will be generated fully automatically from laser and optical sensors. Indoor navigation will become as common as outdoor GNSS navigation is today. Within the next 3 years, the leading mapping authorities will be producing day-fresh maps, resulting in real-time authentic maps some years later and finally a paradigm shift from fixed scales towards true vario-scales.

You are currently on sabbatical at the University of Technology Malaysia (UTM). What are your general impressions?

At UTM, professor Rahman's 3D GIS group is researching 3D city models, generalisation, LADM and integrating 3D space, time and scale just as we are doing, and they are also co-operating with industry in practice. Working together with this group is great. About 1,000 students enrol annually onto UTM's BSc geoinformation programmes, plus there are a further 600 MSc students. So many talented students – it's enough to make me jealous. While our campus in Delft certainly has international allure, the facilities and tropical setting of UTM in Johor Bahru are very special and particularly inspiring.

▲ *At the University of Technology Malaysia together with MSc student Nur Amalina Zulkifli discussing LADM.*

Attracting new students is an issue in Europe. How is Delft doing in this respect, and do you have any suggestions for ways to increase the influx?

In Delft, the struggle for students has been going on for two decades. After a decade of an influx of just 10 students per year, I uttered the wish in my inaugural address for a tenfold increase; that's not yet reality but we are making progress. It is no longer possible to study for a BSc in Geomatics in The Netherlands. If the viability of a BSc erodes, a minor – a half-year geomatics programme embedded within a broader BSc – is a suitable alternative. So we are now involved in the national minor in geoinformation, which started in 2012 and attracted an influx of 31 students in 2013. Ten years ago, we started the MSc in GIMA jointly with Utrecht University, Wageningen University and the University of Twente (ITC). In 2013 the influx was 27 students. In 2012 TU Delft started a geo track within a broader MSc with an influx of 15 students in 2013. Also in 2012 our MSc in Geomatics was redesigned with a focus on the built environment, and it attracted 18 new students this year. So altogether, my wish has partly come true. Vitally, one should team up with strong national and/or international partners, and the focus should be lucid for potential students. ◀

MONITORING FLOODING AND ASSESSING DAMAGE IN THE CZECH REPUBLIC

UAS and Flooding

Heavy rainfall in late May and early June 2013 caused the Elbe, Vltava and Kamenice rivers to burst their banks in the Czech Republic. Among other areas, the Troja area of Prague and the villages of Hřensko and Nové Kopisty were severely flooded. Here, the author describes the experiences gained by the Czech company Geodis while using UAS technology to monitor and assess the impact of floods for the first time. Having proved that it can provide geodata quickly, cheaply and efficiently, UAS is now attracting significant interest from authorities.

Geodis is the producer of the countrywide orthoimagery, resolution 12.5cm, and the Digital Elevation Model (DEM), with grid spacing of 10m, of the entire Czech Republic. The revision cycle of both products is three years. The company has monitored large-scale floods in the Czech Republic since 1997 – mainly by traditional airborne photogrammetry, up until 2013. Products derived from overlapping aerial imagery such as georeferenced orthomosaics, DEMs, flood levels and maps of waterways support water boards, municipalities and other authorities in taking flood prevention measures and in decision-making when flooding has occurred.

Jakub Karas (32) is specialised in photogrammetry and has been working in this field in the Czech Republic for 11 years. He started with Eurosense, spent nine years as head of photogrammetry at Gefos, and has been UAS manager at Geodis for the past year.

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IN-HOUSE SYSTEMS

Since 2012, Geodis is the owner of two types of UAS: the quadrocopter MD4-1000 (Figure 1) from the company microdrones and an octocopter developed in-house (Figure 2). Both systems are equipped with GNSS, gyroscopes, accelerometers and compasses. They are used in a variety of projects which are often carried out in co-operation with research institutions and universities. The MD4-1000, equipped with a Canon EOS 5D Mark III, has a maximum speed of 12m/s, can stay airborne for 25 minutes, weighs 6.2kg with sensor on board and can carry a load of up to 1.5kg. The 22MP Canon camera contains a high-quality chip and is able to capture HD video. The octocopter developed in-house has a maximum speed of 15m/s, can stay airborne for 15 minutes with the above-mentioned Canon EOS 5D Mark III on board, weighs 9.5kg and can carry a load of up to 6kg. The ability to carry a relatively large and heavy payload of 6kg is advantageous for capturing inaccessible areas with a pallet of sensors, including thermal infrared sensors and multispectral and professional cameras. Other features include retractable legs and a remote-controlled camera which is wirelessly connected to a monitor, thus allowing the operator to follow the flight in real time. The rotation of the camera around three axes can be steered by the operator and allows dynamic shots which can be directly transmitted to authorities for decision-making purposes. The flight path of the octocopter can be either steered by remote control or pre-specified in a flight plan.

▲ *Figure 1, MD4-1000 from microdrones.*

▼ *Figure 2, Geodis Geocopter G8.*

FLOOD MONITORING

Floods have a significant impact on the local environment and the people living there. In the case of a flood, authorities need information on the extent of the flooding, its rate of expansion or contraction, the number of people in the endangered areas, their ages and their addresses. Is anyone injured or dead, do they need medical care, should basic necessities be distributed? Important decisions to be taken include whether to evacuate people, their livestock and possessions to higher ground, or whether to inundate sparsely populated lowlands upstream in order to bring relief to densely populated areas. The process of collecting information may be severely hindered by inaccessibility of the area. Meanwhile, citizens may want to be kept informed about the situation by television channels and the internet. For some rescue tasks, information gained through human observations alone may suffice. Other tasks require calculations and the newly collected data to be combined with existing maps and DEMs; in other words, the imagery should have a high spatial resolution and be rectified and georeferenced. Fortunately, today's photogrammetric software allows automatic generation of orthomosaics and DEMs to become available soon after the imagery has been recorded.

TAKING ACTION

When flooding was threatening the river areas in the north western ▶

▲ *Figure 3, Prague: flooded zoo (left) and Troja Castle.*

part of the country in late spring 2013, mobile mapping systems, manned aircrafts and UAS were deployed to collect geodata both from the ground and from the air. The use of UAS for monitoring such floods was new for the Czech Republic and proved to be very valuable. The extent of the flooded areas was relatively small, making them easy to cover using a UAS. For example, the area that had to be monitored along the River Vltava in Prague measured just 1km² (Figure 3). The video facility allowed instantaneous visual inspection by experts located near the flooded site or in crisis centres. The video images were also recorded and edited for broadcast by the national television network to inform the general public. For the creation of orthomosaics, DEMs and stereo views, overlapping images were taken at a height of 60m resulting in a ground sampling distance (GSD) of 1cm. The overlaps were 80% along track and 60% across track. For accurate georeferencing purposes, ground control points were measured or adapted from existing geodatabases. The resulting orthomosaics had a GSD of 3cm, while the GSD of the DEMs was 10cm.

A UAS can capture sites in the presence of continuous rain or cloud cover

INACCESSIBLE

Since a UAS can fly at low altitudes, it can capture flooded sites in the presence of continuous rain and cloud cover. In the same conditions, traditional aerial surveys carried out by manned helicopters or aeroplanes are impossible. The systems are easily portable, allowing them to be transported to flood sites simply and cheaply. Add to this their cost-effective operation and the fact that they can be quickly prepared for operation once on site, and it should come as no surprise that the Czech authorities are showing great interest in using UAS technology in crisis situations.

Figure 4, The village of Hřensko at the confluence of the River Kamenice with the Elbe.

Hřensko, a village located close to Germany at the confluence of the River Kamenice with the Elbe, was completed surrounded by water and almost the entire population was evacuated, although a dozen or so people refused to leave their homes (Figure 4). Regular UAS recording of this completely isolated village was the only way to monitor the extent of the flooding and to assess the steadily increasing damage.

Another inaccessible village was Nové Kopisty which lies on a plane where the River Eger flows into the Elbe. A dam failure created a large lake around the entire village, cutting it off from its surroundings. Flooded parts of the village had to be evacuated. Here, too, UAS proved to be an excellent tool for monitoring inaccessible terrain and for providing emergency services and electronic media with aerial images, videos and orthoimagery very rapidly.

PERMITS

All UAS surveys have to be registered at the Civil Aviation Authority (CAA). The various types of UAS are categorised according to their weight and usage. The weight categories are: up to 0.91kg, 0.91-7kg, 7-20kg, and above 20kg. The two types of use are recreational/sport and commercial/research. Registration is compulsory for both. The UAS should always be in line of sight of the pilot who should be licensed.

CONCLUDING REMARKS

UAS technology not only enables the collection of accurate and timely geodata but may also help to find missing persons and to protect shops, businesses and homeowners from illegal appropriation of goods.

EXPERIENCES USING AIRBORNE LIDAR DATA

Challenges in Validating Large Spatial Datasets

This article discusses the challenges involved in determining the accuracy of large spatial datasets, using airborne Lidar data as an example. Vendor and end-user blunders resulted in errors as high as two metres and as low as 1cm at different locations from the same dataset. To prevent such blunders, the 'checkpatching' method is proposed. Checkpatching detects errors in large spatial datasets using a sampling method employing randomly selected patches. Checkpatching also accounts for varying topography and ground cover. These potential error sources are overlooked by methods that simply use point elevations from ground surveys to check interpolated elevations at the same location.

Historically, when employing conventional surveys, end users of surveyed data have confirmed the accuracy of a dataset by randomly checking the delivered final coordinates. Today, however, complex technology captures billions of points to provide instant spatial information. A good example is Lidar, which employs and integrates a laser range detection system, an inertial navigation system (INS) and GPS to capture spatial data as shown in Figure 1.

Error is a deviation of a measurement from the true value due to one or more causes. In this context, the term 'true value' refers to a measurement that is at least three times more precise than the subject measurement to be validated. After the design of user specifications and the subsequent data delivery, two major possibilities of error

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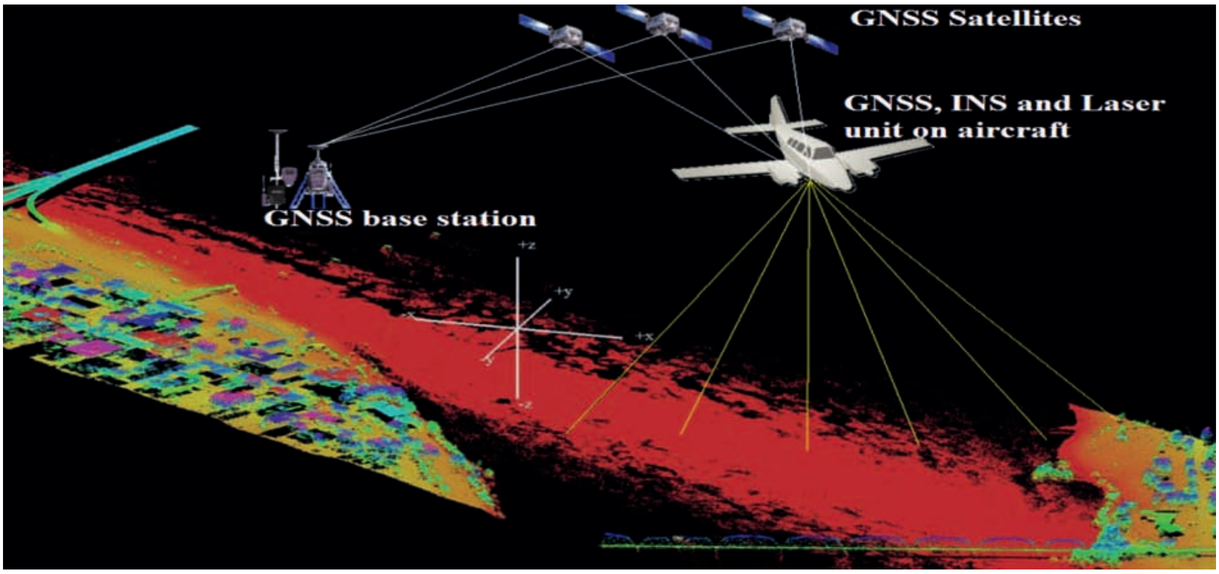

Figure 1, System integration in airborne Lidar surveys.

in determining data quality were encountered: namely, problems with some parts of the acquired data (errors from the Lidar survey vendor who has the primary task of planning and performing the survey according to specifications) and problems with the field validation process (error from the client or end user who has the mandate to determine whether or not the data was delivered according to specifications). However, the total propagated error will usually include a combination of both the Lidar survey errors and the field validation survey errors. Encountering these problems led to questions concerning the implications of the errors in the creation of accurate spatial data products.

THE CHECKPATCHING TECHNIQUE

Like any large dataset, it is practically impossible to validate each Lidar point in a project area by comparing it with a surveyed checkpoint. Therefore, sampling is necessary when validating large datasets produced from ALS surveys. With respect to empirical validation of the accuracy of large point clouds, a modification of the 'patch validation process' (used over the years by Merrett Survey Partnership UK) was employed. The patch validation method uses conventional land surveys in a defined test area to validate Lidar coordinates. When the test area is randomly chosen to cover varying terrain morphologies and ground cover, this article refers to it as a 'patch'. Five separate patches were chosen (see Figure 2) to cover the main variations in topography within the test area. This intentionally deviates from the patch validation method employed by Merrett Surveys where only one patch is employed. This modified procedure is referred to as 'checkpatching'.

An example of a checkpatching process adopted for this study area is as follows:

i. Choose five random checkpatches (i.e. test areas with varying terrain morphologies and obstructions to ground cover).
ii. Each checkpatch contains a set of checkpoints whose coordinates are determined. The accuracies of the checkpoints should be at least three times the accuracy of the data to be validated.
iii. A TIN is created for each of the checkpatches from clipped Lidar ground points.
iv. The checkpoints are used to derive their corresponding Lidar elevations from the TIN.
v. Finally, the difference between the checkpoint elevations and their corresponding Lidar elevations are determined for each checkpatch.

IDENTIFYING BLUNDERS

Lidar elevation accuracy is not only influenced by the accuracy of the Lidar data. Error validation can also be influenced by a user's methodology. Two different field validation surveys were undertaken to check the accuracy of a Lidar survey in Fredericton, Canada, as part of research into user-determined error budgeting. The first field validation survey method employed the GNSS Post Processing Kinematic method (PPK) for all areas of the survey without regard to changes in terrain morphology or ground cover. Applying PPK for all topographies was obviously an incorrect procedure. Nevertheless, the method was used as a possible alternative to observing


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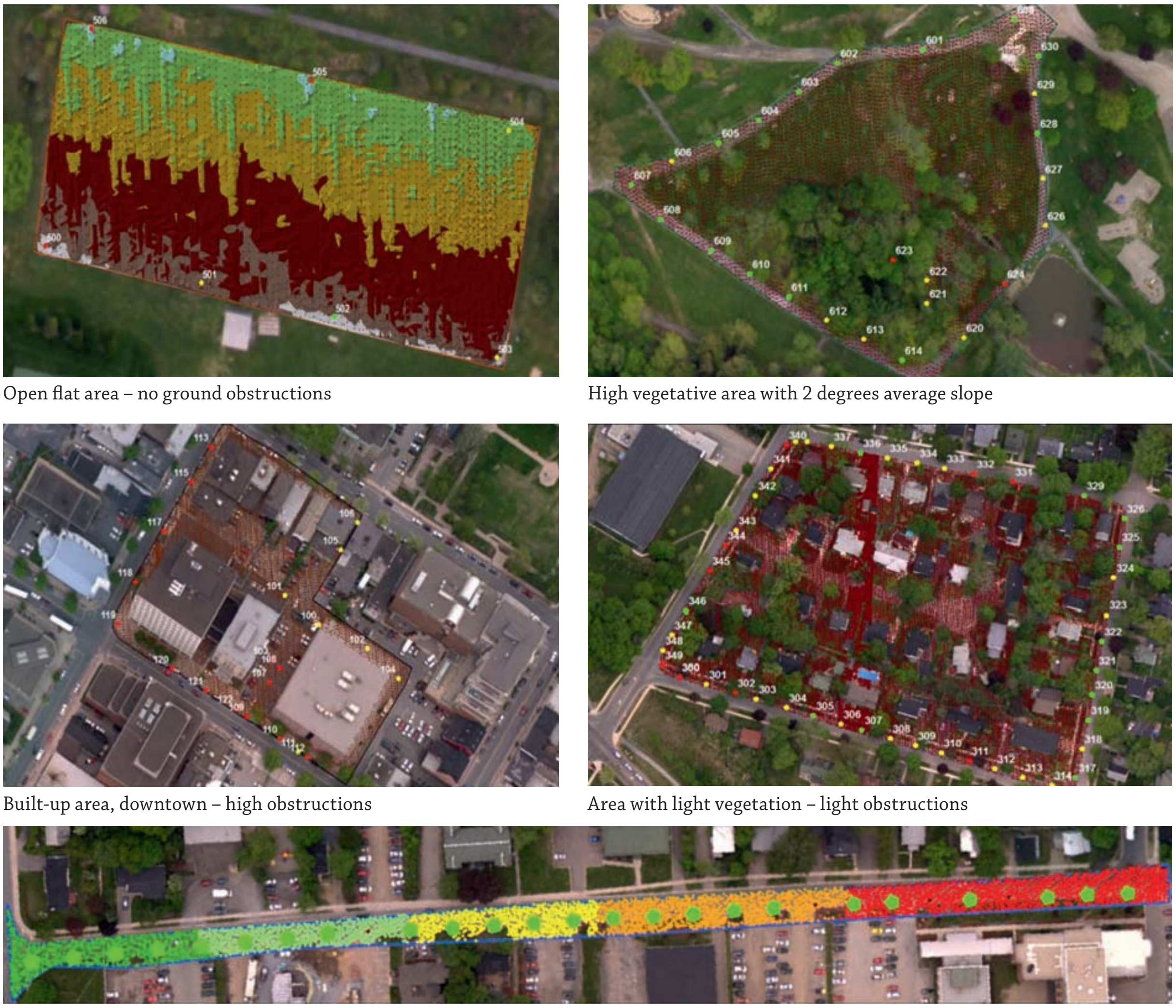

Figure 2, Five randomly selected checkpatches.

Open flat area – no ground obstructions

High vegetative area with 2 degrees average slope

Built-up area, downtown – high obstructions

Area with light vegetation – light obstructions

Street area with high slope: 5 to 6 degrees

Legend - Amount of ground cover obstruction per study area					
⬟	Clear	⬟	Light	⬟	Dense

checkpoints where it was not possible to use the RTK method. This may be due to long base distances or faults in the GNSS receivers – when radio communication between the base and rovers receivers is not possible, for instance.

The second survey employed the Network Real Time Kinematic (NRTK) for all the terrain morphologies except the built-up areas where obstructions due to tall buildings – including multipath – resulted in the NRTK measurements being unable to establish fixed points between the base and the rover. In this case, a total station (TS) survey was employed. Only RTK points with fixed solutions were accepted. The elevation misclosure of the TS survey using an open traverse method was 0.01m.

Using this control framework, checkpoints were surveyed within the five checkpatches to determine the RMSE between the checkpoints and corresponding Lidar elevations from airborne surveys in 2007 and 2011 in Fredericton. For the two sets of surveys, the RMSE of the elevations of the Quality Control Checkpoint (QCC) and the corresponding Lidar elevation at the same horizontal location was determined. The following table describes the differences in RMSE obtained during the two sets of QCC surveys under similar conditions in the same test areas with similar topographies.

From this airborne Lidar survey, it was found that employing incorrect data and/or procedures, such as GNSS Post Processing Kinematic (PPK) – whereby it is not possible to observe whether a fixed solution has been achieved – can result in up to ±1 metre in elevation errors in general. A fixed solution occurs in GNSS measurements when the ambiguities of transmitted signals between the base and rover stations have been resolved to achieve a required accuracy. In areas clear of vegetation, buildings and/or ground cover obstructions, the mean difference in RMSE between the erroneous PPK method and the superior network RTK method was ±11cm. In this case, both methods met the initial elevation accuracy specification set to ±0.30cm at 95% confidence interval. However, in areas with light and dense obstructions, while employing the NRTK and TS method met

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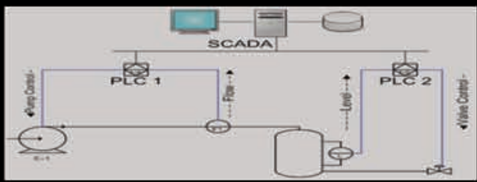

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Checkpatches in the test area and their amounts of obstruction		RMSE (±) m			RMSE (±) m differences
		PPK	NRTK	TS	
Areas clear of obstructions	Vegetation	0.14	0.03	-	0.11
	Open flat area	0.06	0.01	-	0.05
	Steep slope street	0.24	0.04	-	0.2
	Sparsely dense area	0.11	0.04	-	0.07
	Mean error	**0.14**	**0.03**		**0.11**
Areas with light obstructions	Vegetation	0.47	0.07	-	0.4
	Open flat area	0.97	0.1	-	0.87
	Sparsely dense area	0.58	0.07	-	0.51
	Built-up area	1.3	-	0.1	1.21
	Mean error	**0.83**	**0.08**		**0.75**
Areas with dense obstructions	Vegetation	1.16	0.21	-	0.95
	Open flat area	1.27	0.27	-	1
	Sparsely dense area	1.29	0.16	-	1.13
	Built-up area	1.45	-	0.2	1.28
	Mean error	**1.29**	**0.20**		**1.09**

Table 1, Differences in RMSE obtained during the two sets of quality control surveys. The first set employed PPK and the second set employed NRTK and TS.

the specifications, the PPK method produced a mean RMSE between ±0.83m and ±1.29m which failed the accuracy requirements. These particular differences are due to: (1) differences in accuracies of the survey methods employed in the field validation process; (2) limitations of available technology for interpolating corresponding Lidar elevations at a given (x,y) position of a QCC; and (3) the choice and/or configuration of QCCs considering the varying terrain morphologies and obstruction to ground cover.

It is also possible for a vendor to make blunders during Lidar data surveys. For instance, in a Lidar survey of Fredericton in 2007, a problem occurring during flight resulted in incorrect positional characteristics for the observed Lidar data. Checkpatching was employed using NRTK and/or the TS survey to validate the Lidar data. This revealed blunders at randomly selected locations in the dataset. The difference in the elevation of the Lidar data and surveyed checkpoints varied from 0.5cm to 2m. No amount of datum shift or adjustment could correct the error, and a Digital Terrain Model (DTM) of the surveyed error contained elevation errors of up to 2m. As a result, some houses could potentially be wrongly designated as prone to flooding. Such misleading public information undermines the authority of spatial data.

CONCLUSION

As well as through blunders during the Lidar data capture process, elevation errors of between 10cm and 2m can also be introduced by a user attempting to validate the data without using the right tools and processes. The checkpatching method helps to validate large datasets. The process employs only QCCs with accuracies at least three times better than the data to be verified. Moreover, the process acknowledges that it is not enough to just spread QCCs randomly around the project area to potentially avoid bias. Therefore it also considers varying terrain morphology and ground cover when choosing random checkpoints. Rigorous equipment testing before validation surveys always helps to detect system bias. An error trend exists in the derived elevations from either the PPK or the NRTK and TS survey results. Places with high obstructions recorded high RMSE values, and places clear of obstructions recorded lower RMSE values. This study is limited in determining whether this was result of field survey errors or the Lidar survey, or a combination of the two. Another factor worthy of further research is the effect of multipath on the survey results in the downtown area. Quantifying these error effects can refine the error estimation process.

ACKNOWLEDGEMENTS

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3D MODELLING OF A GOLD MINE USING LASER SCANNING

The Digital Mine

A gold mine in China's Shandong Province is the country's first underground mine to use 3D laser scanning. During a one-year project, 20km of major tunnels were scanned and the point clouds processed. The resulting 'digital mine' enables better planning and designing, checking of production quantities and monitoring of tunnelling and mining machines, as well as improved safety. The authors describe how laser scanning was used to model the gold mine in 3D.

China's key gold deposits are located in Shandong Province, where the region's largest producing mine is operated by the Shandong Gold Group (SGG), a state-owned enterprise of the Shandong provincial government. Underground mining is done under difficult working conditions, often at remote locations, and the profit margins are narrow.

CONVENTIONAL SURVEYING

Surveying is used throughout a mine's lifecycle, including planning and construction, operations, production, monitoring and reclamation. However, underground mines are demanding places for surveying and mapping. Cramped spaces and tough environmental conditions make it difficult to install and preserve survey marks; the long, narrow tunnels and drifts prevent the use of optimal techniques for precise control while the mine's layout and high operating costs demand high accuracy and efficient data capture. Total stations, gyros and levelling have limited applicability beneath the surface. Such equipment is good for control work, for layout and checking of tunnels and collecting individual points to build triangular irregular networks (TIN) for the creation of simple 3D models. However, it is virtually impossible to generate detailed 3D models of tunnels, drifts and ore bodies using conventional surveying. The Shandong Gold Group recognised the need for improved underground data collection

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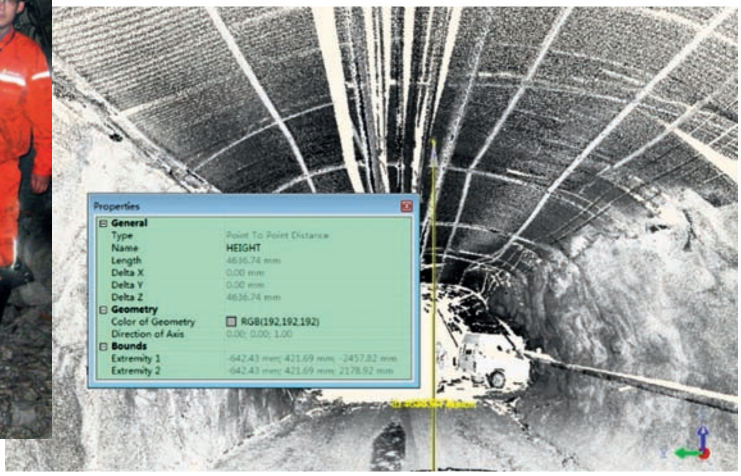
▲ *Figure 1, Laser scanner at work in a mine tunnel.*

▼ *Figure 2, Measuring in the 3D point cloud using Trimble RealWorks.*



to create a digital mine. 3D laser scanning could provide the required accuracy and completeness while reducing the time and effort involved in data capture.

DIGITAL MINE

Early concepts for the digital mine began back in the 1990s but have since matured into creating 3D digital models of a mine and its operations. The concept combines the visualisation and spatial data management of a GIS with the operational and decision capability of an enterprise resource planning (ERP) system. The digital mine is aimed at improving safety and efficiency, generating a greater yield and optimising the management of personnel, equipment and natural resources. It includes components for machine automation, maintenance and scheduling as well as geology, mine planning and hazard mitigation.

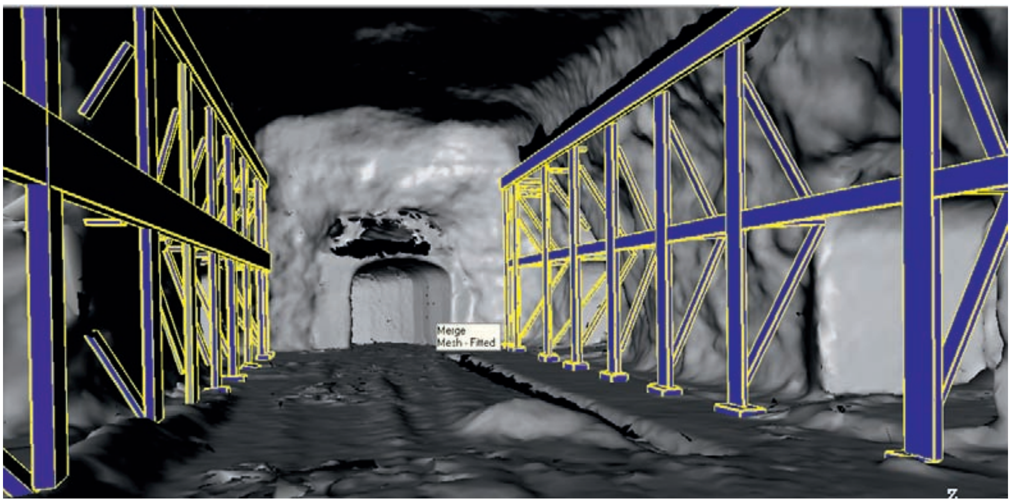
LASER SCANNING

During a one-year project, 20km of tunnels located 650m below the surface, in hot and humid conditions, were captured using a Trimble FX 3D scanner (Figure 1). This phase shift scanner operates at the medium range (depending upon reflectivity up to 100m) at temperatures varying from 5°C to 45°C. If offers millimetre-level accuracy. When exploring the full field of view of 360° x 270°, a single pass scan takes five minutes resulting in 65 million points. The tunnels are narrow, varying between 3 and 6m in width. Speed was crucial, as the measuring activities must not interfere with production. Using a combination of tripods, brackets and attachments, the scanner could be set up within a few minutes. Each scan required less than five minutes, and could be completed without levelling the scanner. To ensure sound fits between successive scans, target balls were placed in the overlaps of the scans. They acted as tie points. To connect the scans to the mine's coordinate system, points were marked on the tunnel walls such that they were visible in the scans. These marks were measured using reflectorless total stations. Rigorous error propagation based on least squares adjustment showed that one mark per four scans was enough to achieve the required accuracy for overall volume computations (uncertainty of <5%).

3D MODELS

From the georeferenced point clouds, 3D models of the tunnels were created using Trimble RealWorks (Figure 2). To obtain a manageable dataset, the spacing of the original point clouds was altered from 1cm to 5cm. This reduction with a factor of 25 did not affect the accuracy of the model nor subsequent calculations. The creation of a TIN of the tunnel walls and drifts required removal of unnecessary triangles and

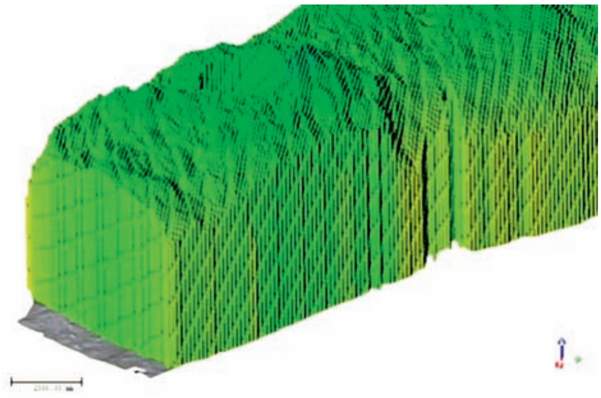
▼ *Figure 3, 3D model of a mine chamber showing the TIN model and manually extracted construction objects.*



compensation for voids in the data that resulted from obstructions or interference during scanning. Next, pipes and conduits, ducts, drainage channels and other objects were manually extracted (Figure 3). Those objects had regular shapes and were modelled as 3D surfaces, tubes and other features. The resulting digital mine was far more accurate and complete than would have been possible using conventional methods. All data was transported to CAD software. Because the Trimble FX system can generate data for use in the mining package SURPAC, the data could be quickly integrated with existing software.

APPLICATIONS

The digital mine provides up-to-date information on conditions, status and production quantities. One of the primary applications is computation of volumes, which requires definition of a reference surface located at the bottom of a tunnel segment. The ceiling is inspected on planar shapes which are modelled as small squares. Each square is projected onto the reference surface, resulting in cuboids of which the volumes can be calculated (Figure 4). Reducing the size of the squares corresponds to a denser sampling of the ceiling and thus increases precision of the volumes. The digital mine also enables comparison of the as-built tunnels against the original design, and detection of potential safety issues due to deformation or subsidence. Furthermore, the digital mine makes it possible to establish a detailed model of the ore body and a 3D model of the tunnels for trackless mining machines. By comparing the digital mine with the design, it is possible to monitor whether progress is being made according to plan, to visualise areas of over- or underbreak, and to verify the volume of material moved.



▲ *Figure 4, Cuboids and vertical planes created from the point cloud.*

BIOGRAPHY

Laura Norman is a fourth-year student of geomatics engineering at the University of Calgary's Schulich School of Engineering in Canada. She is currently president of the Geomatics Engineering Students Society which was established to promote the geomatics engineering department, foster ongoing connections with industry and enrich the social and academic experience of undergraduate students within the department. Laura is aspiring towards a graduate degree within the geomatics department. She is an avid outdoors person and her interests lie in all outdoor activities such as hiking, biking and cross-country skiing.

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Spreading the Word to Potential Students

Geomatics Engineering is the Way of the Future!

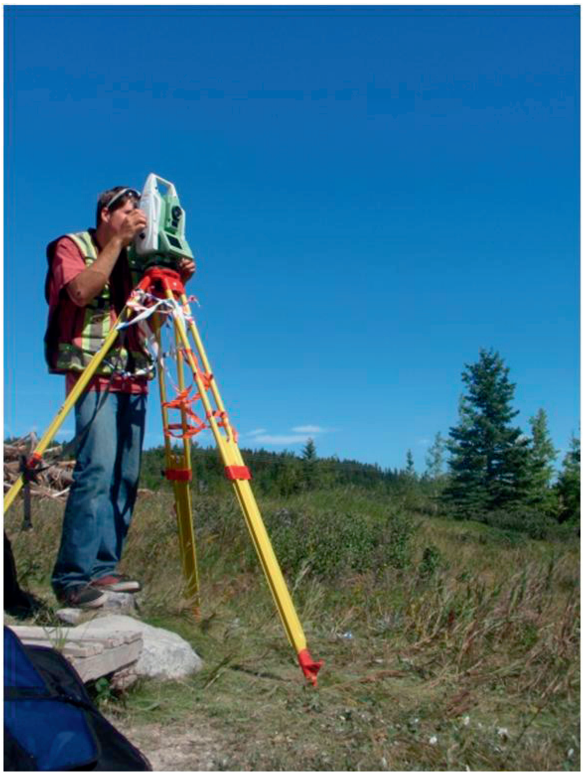
My name is Laura Norman. I am currently entering my fourth year of geomatics engineering at the Schulich School located in the University of Calgary, Alberta, Canada. I have been elected as the incoming Geomatics Engineering Students Society (GESS) president. The position involves coordinating the functions of the society, maintaining industry relationships and promoting the field of geomatics to young engineers who are trying to decide which stream to choose. As a result, I am interested in showcasing geomatics engineering as an exciting, rapidly growing science of the future, of which students could be a part.

Unfortunately, across the world, the field is experiencing a dearth of manpower. A big challenge is the lack of public knowledge as most people do not know what geomatics is, or what geomatics engineers do for society. When the time comes for engineering students to choose their specialisation, geomatics is not well understood and as a result not frequently selected. To increase the enrolment, geomatics engineering needs to receive greater exposure among potential candidates. If more high school students were informed, it may spark an interest not previously considered.

Geomatics engineering is the future. Often unbeknown to themselves, citizens utilise the products of this discipline daily. Consider personal navigation devices, either handheld or implemented in vehicles, property layouts, medical x-rays, and even emergency response teams. The career possibilities are truly endless, ranging from working in digital imaging, Earth observation, satellite-based navigation and global positioning systems to geographic information systems (GIS) and land tenure.

All components involved in geomatics engineering are based around developing and using state-of-the-art technology, not only to assist in furthering the research of spatial information but also to help the global population. Digital imaging encompasses a whole slew of applications such as in the areas of mapping like Google Earth, medical applications involving biomedical engineering in the form of x-ray or MRI imaging, and farming or structural engineering. Observing the different interacting surfaces included in the dynamic state of the Earth using remote sensing and geodesy allows a geomatics engineer to monitor the planet for natural disasters and climate change and hence contribute to a feasible future for the Earth.

Positioning, navigation and wireless location incorporates the use of multiple global navigation satellite systems. Location can be found in many different situations including in



▲ Gayle Noonan (left), Jesse Vanneste (middle) and Thomas Kranjcevic (right), fourth year geomatics students at the University of Calgary, participating in the annual 'Lost Peg Competition' at the Kananaskis Survey Camp.

◀ Jesse Vanneste, a fourth year geomatics student at the University of Calgary, taking observations for a dam deformation survey at the Kananskis Survey Camp.

the air (aircraft), on land or underwater (hydrography). In all of these situations, positioning can be acquired in static or dynamic states.

GIS is software designed to guide in areas such as land tenure (the relationship between people and their property) or environmental modelling. This form of geomatics engineering covers land use management, land surveying, and environmental modelling. Environmental modelling includes agriculture, water, ecology, oil and gas, forestry and mining applications.

For those students who are interested in engineering, but would also like to spend time outdoors or are keen athletes, geomatics engineering is an amazing fit. The majority of data collection is done out in the field: climbing mountains, hiking trails, travelling through prairies or even in the dense urban landscapes of cities. Land plots across countries could be surveyed for boundary lines. Different types of receivers can be tested for reliability levels in diverse situations; for example, with clear views of the sky and under foliage or overpasses with obstructed views of the sky, to assess the impact of more or fewer satellite connections to the receiver.

Personally, I was exposed to geomatics engineering at a young age, although I was unaware of it at the time. While growing up, I flew with my dad recreationally which exposed me to the higher-end geodetic-grade navigation equipment used in aircraft. At the same time, I came into contact with a consumer-grade navigation system through the use of GPS-based heart rate monitoring that was a necessary part of training for competitive cross-country skiing. From both of these experiences, I knew that I would like to work in the field of navigation. However, at that time I had no idea that geomatics even existed. When I thought of engineering, my mind automatically jumped to civil, mechanical or chemical engineering, since they are the most advertised and most popular engineering faculties. It was not until I started researching engineering while I was in grade ten at high school that I realised there were many more choices, including geomatics engineering. Upon making this discovery, I knew it was the place for me in view of my passion for being outdoors and my love of navigation equipment. All of the hands-on experience that I had gained dealing with these instruments triggered my interest in geomatics and left me keen to enter into the field that would help me expand my knowledge on the subject. Therefore, it was a very easy decision for me when it came to choosing my specialisation as an engineer.

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Two survey teams performing the real-time kinematic GPS surveying hike at the fourth-year geomatics engineering Kananaskis Survey Camp. From left to right: Umer Choudhry, Nauman Waheed, Matthew Herasymiuk, Gavin Humphrey, Matt Sakatch, Kayoung (Sophia) Kim, Luke Meister, Laura Norman and Victoria Mantey.

For the engineering programmes that start with a generic first year, a more geomatics-based course should be offered

The key as I see it is to start advertising the field in high schools in order to motivate potential future students. Perhaps distributing posters to high schools or having speakers talk to graduating classes would help to showcase the excitement of a future in geomatics engineering. For the engineering programmes that start with a generic first year, a more geomatics-based course should be offered. This course would not only highlight the main areas of geomatics to first-year students, but it could also allow them to experience how exciting data collection can be using both surveying and GPS equipment. Such activities could be completed under the supervision of older, more experienced geomatics students in the final years of either their undergraduate or graduate studies. Hosting fun and informative 'meet and greet'-type faculty events throughout the year would also give first-year students who have yet to choose their discipline the opportunity to meet and question professors, council members and older students, thus improving their understanding of the profession.

Geomatics engineers are in great demand. In order to meet current and future requirements, it is necessary to encourage capable students into the faculty. There are many perks to being enrolled in the geomatics engineering faculty at the University of Calgary: smaller class sizes, world-renowned professors who are involved in revolutionary research (and who are always available to assist with answering questions) and lots of field experience. Field experiences come in the form of lab periods designed to help students further their understanding of the different classes offered each year, along with a 'survey block week' course in the third year and a survey camp at the beginning of the fourth year. This survey camp requires all fourth-year geomatics students to spend ten days in the Kananaskis Country in the front ranges of the Canadian Rockies to experience real-life surveying projects in the field. Working in the beautiful outdoors during our undergraduate degree allows us to get a glimpse of what working life will be like, showing us how to complete not only a proper surveying project but also a GPS project.

Geomatics engineering is the way of the future! This is the time for geomatics engineers to prosper. It is time to spread the word, and to get involved in the technological revolution of tomorrow!

Your story in *GIM International*?
Are you also interested in contributing a Young Geo article to *GIM International*? We are keen to encourage young professionals in the geomatics sector to share their thoughts on, experiences in and enthusiasm for this wide-ranging industry. If you would like to see your story published in *GIM International*, please contact Wim van Wegen, editorial manager: wim.van.wegen@geomares.nl.

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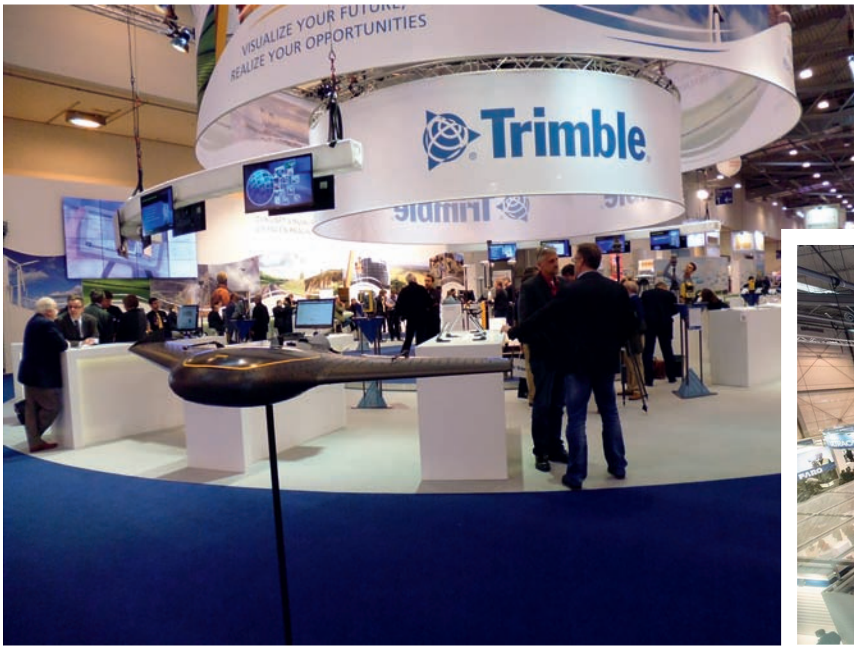
Geomatics for Solving Socio-political Issues

Looking back at Intergeo 2013



The 19th edition of Intergeo, held this year in Essen, Germany, once again showcased the newest technology and trends in geomatics. The combined conference and trade show, which featured over 500 exhibitors, attracted a total of 16,000 participants. The Intergeo conference focused on Germany's energy transition from nuclear power towards alternative sources of energy and the important role of geomatics during that transition. Meanwhile, at the trade show, visitors gained insights into the latest developments in the geomatics industry. An exceptionally high number of UAS and auxiliary devices were on display. The show also highlighted further developments related to 3D façade point cloud handling, large dataset handling and survey equipment.

The transition from nuclear energy towards renewable energy is having a major impact on Germany's energy re-design of the national energy grid, which in turn creates demand for a wide variety of geomatics solutions. Techniques such as photogrammetry, positioning, spatial planning and more have a key role to play in all phases of this huge transition, from planning and construction to daily operations.

An exceptionally high number of UAS and auxiliary devices were on display

landscape. Various new plants to produce alternative energy have been developed and built across the country, including solar, wind, biogas, etc. The challenge lies in integrating these 'green' energy sources with the existing energy production. This requires a

On Intergeo's show floor, innovative products were showcased by hundreds of different companies. Trimble, for example, was demonstrating its new Trimble V10 Imaging Rover with an integrated camera system that precisely captures 360-degree digital

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panoramic images for visual documentation and measurement. The Trimble V10 Imaging Rover includes a total of 12 calibrated cameras, of which seven are panoramic and five are downward-looking. FARO, meanwhile, has increased its scanning range with the newly introduced Laser Scanner Focus3D X 330. The range has been extended to 330 metres, which is about three times greater than previous models, and it includes a Class 1'eye safe' laser for optimum safety. Leica announced the purchase of the Swedish bathymetric Lidar company Airborne Hydrography. With this acquisition, Leica is expanding to serve its customers who are facing sea-level rise in the coastal zones. At the same time, Airborne Hydrography introduced a new hydrographic Lidar scanner, Hawkeye III.

Many vertical markets are making use of 3D laser scanning software systems nowadays, and this is also influencing the development of 3D point cloud software. Hardware manufacturers are reducing noise levels, while feature modelling from point clouds is becoming increasingly automated. A newcomer, Pointfuse, presented its solution for fast and automatic vector modelling from point clouds. Pointfuse is capable of creating a vector model from any laser or Lidar scanner, whether terrestrial or mobile.

Feature modelling from point clouds is becoming increasingly automated

Just like last year, UAS were once again well represented, this time with even more focus on safety as Aibotix demonstrated with its development of a UAS with rotor protection. Additionally, with its low-cost and easy-to-use entry-level model, Pix4D is a rapidly growing player in the UAS sector. The software allows UAS manufacturers to generate high-quality results.

The next Intergeo will be held in Berlin, Germany, from 7 to 9 October 2014. But before then, another major geomatics event will be taking place: Intergeo Eurasia in Istanbul, Turkey, from 28 to 29 April 2014. ◀

Mark Pronk, technical editor, GIM International

MORE INFORMATION
www.intergeo.de

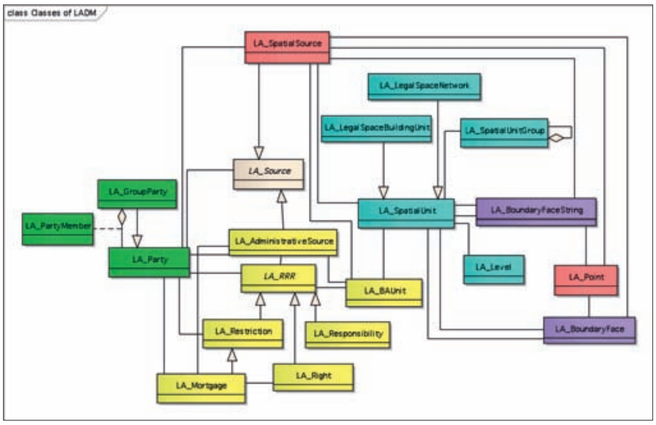
Modernising Land Agencies' Budgetary Approaches

In collaboration with FIG together with Kadaster International (The Netherlands) and Lantmäteriet (Sweden), key partners and stakeholders, GLTN has embarked on a process to develop a tool that can assist policymakers and those responsible for land administration in adopting appropriate technologies and methodologies that will provide and sustain land administration services most efficiently, cost effectively and with options most appropriately tailored for incorporating varying tenure types. In recognition of the challenges, this tool will help to find optimal solutions to accommodate the new reality and multiple trends, making land agencies relevant to the time and the public they serve. The tool will guide decision-makers through appropriate and incremental processes towards improving efficiency and effectiveness, but without compromising the quality of services provided or limiting access to those services, especially for the poor and vulnerable. Lantmäteriet hosted a two-day GLTN Validation Workshop in Gävle, Sweden, on 14-15 October 2013.

LADM2013

The 5th international edition of the Land Administration Domain Model workshop series was successfully held on 24-25 September 2013 at the modernised Kuala Lumpur campus of the Universiti Teknologi Malaysia (UTM). Over 40 participants attended the workshop and a total of 25 peer-reviewed papers were presented. Broad themes included: the industry perspective on LADM, the linkage between LADM and information infrastructures, refined LADM modelling (including legal package extension, 3D representations and formalising LADM semantics), specific LADM country profiles, and implementation aspects. The final discussion session concluded that:

- The need for exploration of whether, and how, LADM can contribute to the post-2015 global development agenda
- LADM is capable of supporting the progressive improvement of cadastres, including both the geographic and other elements
- LADM is capable of supporting fit-for-purpose cadastral requirements
- LADM can be integrated, and should be integrated, with other geoinformation standards (e.g. to link legal spaces to their physical counterparts represented in cityGML, landXML, BIM/IFC)
- LADM can potentially be used to support organisational integration, for example, between often disparate land registry and cadastral agencies
- LADM can help to reconcile superfluous government databases and reduce the large amount of data redundancy that currently exists
- LADM code lists could provide the basis for establishing a complete catalogue of global land-people relationships – if such a database is deemed necessary
- The LADM user community should make all efforts to interact on an annual or biannual basis to further share and develop the standard
- While ISO maintains its own maintenance approach, another form of governance structure is needed to further progress the refinement and maintenance of the standard.



All the LADM modelling is done in the UML language. The image shows such a UML diagram with a separate colour for every component.

The Social Tenure Domain Model (STDM) was also introduced in Malaysia. This pro-poor land information system was welcomed by a group of 35 land professionals and experts. The STDM is a concept and tool developed by UN Habitat Global Land Tool Network (GLTN) in close co-operation with FIG. Building on the LADM, the STDM is a new way of thinking in support to poverty alleviation and in serving the needs of the poor related to tenure security and land issues. The STDM is highly flexible and can include all people-to-land relationships, whether formal, informal or customary. ◂

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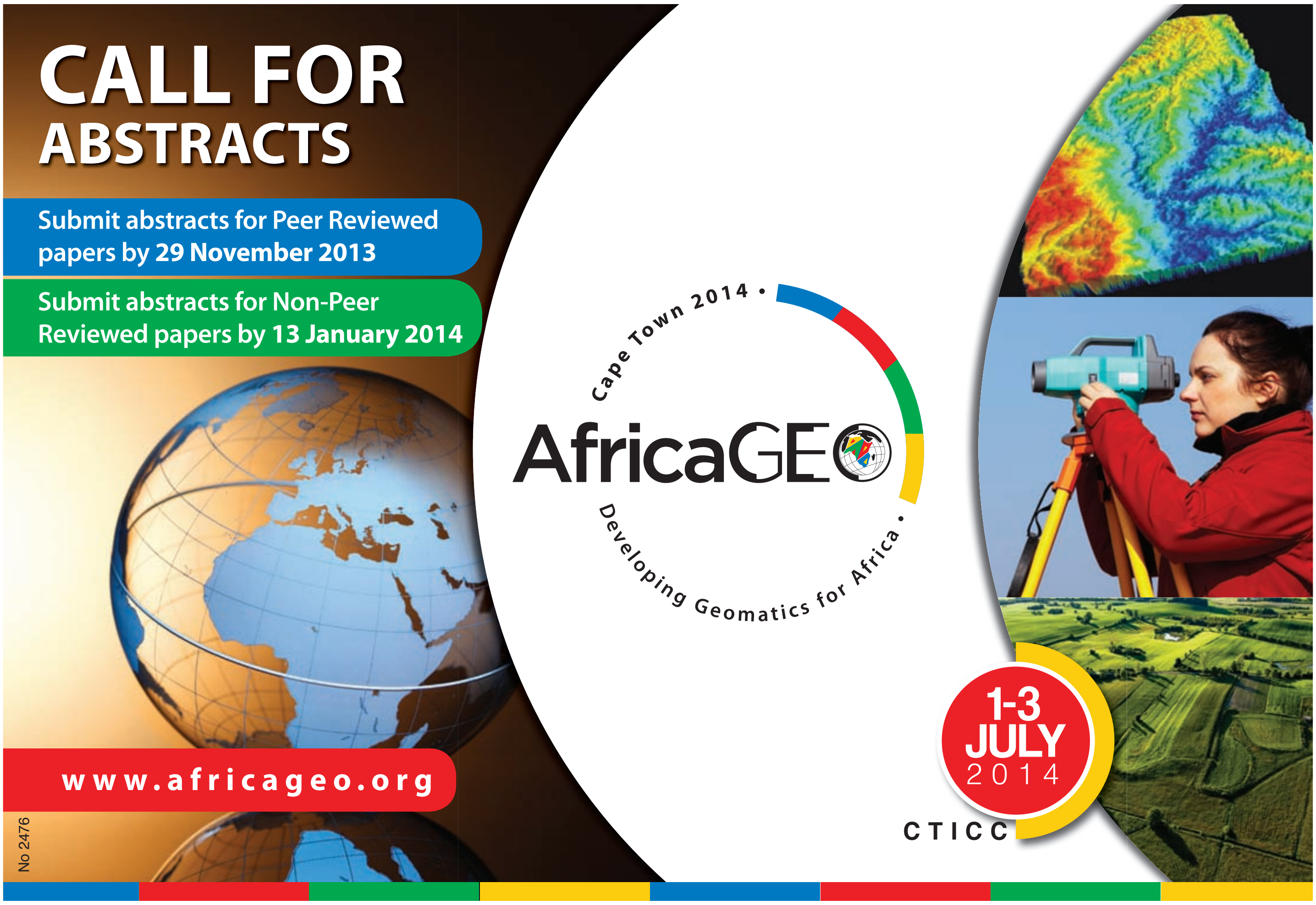
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A Great Line-up of Speakers for the Global Geospatial Conference 2013

The Global Geospatial Conference 2013 in Addis Ababa, Ethiopia, will run from 4-8 November 2013. Originally mentioned in the GSDI column in the May 2013 edition of *GIM International*, this event brings together the GSDI 14 World Conference [1], the AfricaGIS 2013 Conference and the AfriGEOSS initiative launch in one location at the UN Conference Centre of the UN Economic Commission for Africa (UNECA).

The joint theme for this conference is 'Spatial Enablement in Support of Economic Development and Poverty Reduction'. An excellent technical programme of more than 170 papers, 9 workshops and many meetings has been arranged, speakers from five continents are already registered, and the exhibit space is almost fully booked. The following keynote speakers have been confirmed (listed in alphabetical order):

- Jack Dangermond, president, Esri
- Peter Gilruth, director, Division of Early Warning and Assessment (DEWA), United Nations Environment Programme
- Carlos Lopes, executive secretary, United Nations Economic Commission for Africa
- Helge Onsrud, director, Norwegian Mapping Authority Centre for Property Rights and Development
- Wilber Khasilwa Ottichilo, member of parliament, Emuhaya Constituency, Kenya
- Barbara Ryan, Secretariat Director, Group on Earth Observations (GEO)
- Lee Schwartz, director, Office of the Geographer and Global Issues, US Department of State
- Carrie Stokes, USAID GeoCenter
- Stanley Wood, Gates Foundation.

The conference will also feature speakers from leading international geospatial technology firms, including Stan Tillman (Integraph), Mark Cygan (Esri), Ed Parsons (Google) and Andrea Smith (DigitalGlobe).

Jacqueline McGlade, the former executive director of the European Environment Agency (EEA), has been named as recipient of the 2013 GSDI Global Citizen Award and will also be delivering a keynote presentation.

Founded in 1886 and known as 'the political capital of Africa', Addis Ababa is the capital city of Ethiopia and home of the African Union and its Commission, the United Nations Economic Commission for Africa, and Addis Ababa University. Bole International Airport is a hub to and from many international destinations, and the airport is just a short distance away from all the major hotels and conference venues in the central business district of Addis Ababa. The GSDI Association and EIS-Africa [2], together with the Addis Ababa University, the Ethiopian Mapping Agency and the UNECA, are working together to ensure that this conference attracts global and local experts, students, professionals, researchers and policymakers all under one roof in November 2013. We are looking forward to seeing you there.

David Coleman.

Dr David Coleman is president of the GSDI Association, a professor of geomatics engineering and dean of the Faculty of Engineering at the University of New Brunswick in Canada.

MORE INFORMATION
1. www.gsdi.org/gsdiconf/gsdi14
2. www.eis-africa.org

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IAG implements its mission by:

- advancing geodetic theory through research and teaching,
- collecting, analysing and modelling observational data,
- stimulating technological development, and
- providing a consistent representation of the figure, rotation and gravity field of the Earth and planets, and their temporal variations.

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Since the predecessor of the IAG, the 'Mitteleuropäische Gradmessung', was established back in 1862, IAG celebrated its 150th anniversary in 2012. Celebrations climaxed in September 2013 at the IAG Scientific Assembly in Potsdam, Germany. This location is particularly significant since the first ever meeting, in April 1862, was organised by General Baeyer, as representative of the Kingdom of Prussia, in Berlin. The participants were several geodesists from the Kingdom of Saxony and the Austrian-Hungarian Empire.

150 Years of International Co-operation: Scientific Assembly of the International Association of Geodesy

In 1862, the Prussian General Johann Jacob Baeyer initiated the Central European Arc Measurement (*Mitteleuropäische Gradmessung*) project. By the end of that year 15 countries had affirmed their participation, and in 1864 the first General Conference was held in Berlin. General Baeyer's project is considered the forerunner of today's IAG. The IAG celebrated its 150th anniversary with a Scientific Assembly in Potsdam, Germany, from 2-6 September 2013.

Participants at the IAG Scientific Assembly.

Over 500 scientists from 50 countries attended the Assembly. The conference opened with several welcome speeches, including one by Christian Heipke on behalf of the Joint Board of Geospatial Information Societies (JBGIS) and one by Michael Sideris, vice-president of the International Union of Geodesy and Geophysics (IUGG). The IAG is also a foundation association of the IUGG, which today comprises eight associations covering all fields of the geosciences.

A programme of 241 presentations and 234 posters highlighted the contributions of modern geodesy to science and society, under the following themes:

- Theme 1: Definition, Implementation and Scientific Applications of Reference Frames
- Theme 2: Gravity Field Determination and Applications
- Theme 3: Observing, Understanding and Assessing Earth Hazards
- Theme 4: Science and Applications of Earth Rotation and Dynamics
- Theme 5: Observation Systems and Services
- Theme 6: Imaging & Positioning Techniques and Applications

There were 40 oral presentations in the following Theme 1 sessions: Interaction Between the Celestial & Terrestrial Reference Frames; Regional Reference Frames; Reference Frames (Theory, History, Realisation); Strengths, Weaknesses, Modelling Standards & Processing Strategies of Space Geodetic Techniques; Scientific & Other Applications of Terrestrial Reference Frames.

There were 75 oral presentations in the following Theme 2 sessions: Regional Gravity & Geoid Studies (Developments in the Gravity Field Theory / Gravimetry / Improvements in Gravity Field Methodology / Developments in Approaches Related to Geoid Determination / Regional & Local Geoid Determination); Unification of Height Systems; Global Gravity Field Models; Satellite Altimetry Analysis & Applications; Mass Transport Studies; Actual & Future Satellite Gravity Missions (GOCE / GRACE / Future Missions & General Studies).
There were 31 oral presentations in the following Theme 3 sessions: Technologies & Methodologies of Hazard Warning Systems; Geometric & Gravimetric Techniques in Observing & Assessing Earthquake Hazards; Geodetic Imaging for Regional & Local Case Studies; Innovative Use of Geodetic Techniques for Volcanic & Meteorological Hazards; The Challenges of Assessing Hazards From Geodetic (and Other) Observations.

There were 11 oral presentations in the Theme 4 session: Science & Applications of Earth Rotation & Dynamics.

There were 18 oral presentations in the following Theme 5 sessions: Observation Systems & Services (Services / Services & Infrastructure / GGOS).

There were 40 oral presentations in the following Theme 6 sessions: GNSS Algorithms & Methods; Trends in GNSS Positioning, Navigation & Timing; Multi-Constellation GNSS & Emerging GNSS; Imaging & RF Senor Integration & Modelling.

A future article will cover some of the highlights of the Scientific Assembly. In the meantime the IAG is looking forward to another 150 exciting years!

MORE INFORMATION
www.iag-aig.org
www.iag2013.org

Kiváló Térképészek[1]

Last month's column concentrating on the valuable collection of National Reports on cartographic activity, prepared by ICA member countries and archived on the website [1], did not specifically mention Hungary, a long-standing member of the ICA family of nations. Its lengthy (72-page) account of governmental and private mapping activities has many useful illustrations and statistics, and extraordinarily extensive details of cartographic and geodetic practices and products. Specific topics range from the work of the state border surveyors to the nationwide ragweed risk-mapping project, and from the national vineyard GIS to the creation of a fascinating (and highly recommended) Virtual Globes Museum on the web [2].

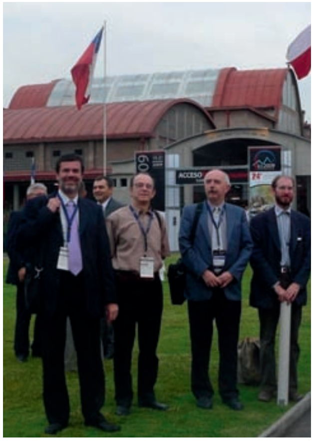
Although ICA has member nations rather than individual members, this column highlights three notable cartographers connected with Hungary, and mentions others who have contributed to Hungary's distinguished history within ICA.

Professor István Klinghammer is an Honorary Fellow of the ICA, a distinction awarded in 2003 to commemorate his long association with the modernisation of cartographic education in Hungary and worldwide. He has welcomed ICA to formal meetings in Budapest over many years, including the memorable 14th International Cartographic Conference in the summer of 1989, precisely when the borders were opening across Eastern Europe. Then, he was a staff member in the Department of Cartography at the Eotvos Lorand University in Budapest, and from 2000 to 2006 he was the rector of the University. His experience in higher education has recently led to him to be called out of retirement to become the State Secretary for Higher Education in the Hungarian government, a notable accolade.

An earlier Hungarian cartographic personality, Dr Árpád Papp-Váry, head of mapping at the National Office of Lands and Mapping in Budapest, was actually the main organiser of the 1989 conference, served ICA for two terms as vice-president (1987-1995), and was also awarded an Honorary Fellowship in 1995.

Klinghammer's successor as head of the Department of Cartography and Geoinformatics from 2005 has been **Professor Laszlo Zentai**. Zentai continues Hungary's strong commitment to ICA, working with several Commissions, becoming chair of the Education and Training Commission in 2003, and currently as secretary-general and treasurer, a role to which he was elected in 2011. He is also an active orienteer, so is experienced in using cartographic products in practice, and sits on the executive committee of the International Orienteering Federation, having previously been the chair of its Map Commission.
The honouring of the third cartographer distinguished in this column has previously been reported in the August 2013 issue of *GIM International* which noted the award of an honorary doctorate by the Eötvös Loránd University to **Professor Ferjan Ormeling**, a long-standing friend of Hungarian cartography and eminent international cartographer. Ormeling first visited Budapest in 1971 and has collaborated on an annual basis with the university department there for over 40 years.

The prominent profile of Hungary within ICA can be seen in the current National Report, but has been high during most of its history: earlier personalities such as Sandor Rado and Erno Csati have been succeeded by contemporary leaders such as Jesus Reyes (chair, ICA Commission on Children and Cartography) and Henrik Hargitai (chair, ICA Commission on Planetary Cartography).



Hungarian cartographers at the 2009 ICC: (L to R) Jesus Reyes, Bela Pokoly, Laszlo Zentai and Henrik Hargitai.

[1] Hungarian for 'Outstanding cartographers'.

MORE INFORMATION
1. http://icaci.org/national-reports
2. http://terkeptar.elte.hu/vgm

www.icaci.org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UNGGIM-ISPRS Project: 'Status of Mapping in the World'

ISPRS embarked on a co-operative project with the United Nations Global Geospatial Information Management Secretariat in New York, USA, in 2011. Gottfried Konecny from the Leibniz University Hannover, Germany, reported on its progress at the UNGGIM2 Conference in New York in August 2012, at the UNGGIM Geospatial Forum in Qatar in February 2013 and at the UNGGIM3 Conference in Cambridge, UK, in July 2013.

A form with 27 questions about the status of mapping was jointly drafted and sent out to the UN member states. The questions concerned the coverage and the age of topographic base maps at the various scale ranges from 1:5,000 to 1:250,000. The questions also asked for information on the infrastructure of the mapping agencies, such as the availability of geospatial data to the public, whether free of charge or for purchase, the existence of a national map updating programme and its technical details, the use of satellite imagery for updating, the existence of a cadastral system, and the financial and personnel resources.

Out of the 193 UN member states, 94 replies have so far been received. The responses indicate that restrictions on availability of maps to the public exist mainly in Asia. In Europe, parts of Asia and Australia, maps are sold to the public, whereas in North and most of South America maps are either freely available or issued at cost. While most of the countries in the Americas lack nationwide cadastral systems, these do exist in Europe, Asia and Australia.
Analysis of the responses from the questionnaires can be downloaded in map format from the UNGGIM3 website [1].

Delegates discuss the UN-GGIM/ISPRS project during their meeting in New York in August 2013.

To assess the status of the global map coverage at the scales relevant for sustainable development (1:25,000 to 1:50,000) the databases of Eastview Geospatial were used. They contain not only maps or digital data produced by the countries themselves but also produced by US and former Soviet Union military sources. In reviewing this material, it can be concluded that the land surface of the Earth, excluding some Arctic and Antarctic territories, is mapped at the scale 1:50,000. However, some material may be more than 40 years old. The exceptions are Europe and North America, with an average map age of less than 10 years. This illustrates the huge potential of using recent, global high-resolution satellite imagery coverage for the purpose updating maps at these relevant scales.
ISPRS has created Working Group IV/2 to make the effort sustainable. In August 2013, the UN Regional Cartographic Conference for the Americas in New York passed the following resolution to UN-ECOSOC: "To acknowledge the work carried out by the United Nations Group of Experts on Global Information Management and the International Society for Photogrammetry and Remote Sensing to collect information on authoritative governmental mapping by the Member States, to propose the completion of the work and to recommend those countries that have not yet responded to do so."

Gottfried Konecny

MORE INFORMATION
1. http://bit.ly/1gNdEyQ
www.isprs.org

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Future events

NOVEMBER

AfricaGIS 2013 and GSDI14
Addis Ababa, Ethiopia
from **04-08 November**
For more information:
W: www.gsdi.org/gsdiconf/gsdi14

SPAR Europe/European LiDAR Mapping Forum
Amsterdam, The Netherlands
from **11-13 November**
For more information:
E: lcorkhill@divcom.com
W: www.sparpointgroup.com/Europe

ISPRS Workshop Laser Scanning 2013
Antalya, Turkey
from **11-17 November**
For more information:
E: francesco.pirotti@unipd.it
W: www.cirgeo.unipd.it/laserscan-ning2013

Smart Geospatial Expo 2013
Seoul, Korea
from **13-15 November**
For more information:
E: exhibit@smartgeoexpo.kr
W: http://smartgeoexpo.kr

SDI & SIM 2013
Skopje, FYRoM, Macedonia
from **13-16 November**
For more information:
E: sdisim2013@gmail.com
W: http://conf2013.geo-see.org

Pacific Islands GIS&RS User Conference
Suva, Fiji Islands
from **18-22 November**
For more information:
E: wforstreuter@yahoo.co.uk
W: http://picgisrs.appspot.com

8th 3D GeoInfo Conference
Istanbul, Turkey
from **27-29 November**
For more information:
E: info@3dgeoinfo.com
W: http://3dgeoinfo.com

DECEMBER

AGSE 2013 International Conference
Ahmedabad, India
from **16-19 December**
For more information:
E: agse2013@cept.ac.in
W: www.agse2013-cept.in

ISPRS workshop on 'Innovative learning tools'
Ahmedabad, India
from **20-21 December**
For more information:
E: isprs2013@cept.ac.in
W: www.isprs.org

2014

FEBRUARY

Oldenburger 3D Tage
Oldenburg, Germany
from **12-13 February**
For more information:
E: christina.mueller@jade-hs.de
W: http://bit.ly/182z8mO

International LiDAR Mapping Forum
Denver, CO, USA
from **17-19 February**
For more information:
E: lcorkhill@divcom.com
W: www.lidarmap.org/international

APRIL

AAG Annual Meeting 2014
Tampa, FL, USA
from **8-12 April**
For more information:
W: www.aag.org/annualmeeting

ENC-GNSS 2014
Rotterdam, The Netherlands
from **14-17 April**
For more information:
W: www.enc-gnss2014.com

Interexpo GEO-SIBERIA-2014
Novosibirsk, Russia
from **16-18 April**
For more information:
E: argina.novitskaya@gmail.com
W: http://expo-geo.ru/event/27_Interexpo-GEO-Siberia-2013

Intergeo Eurasia 2014
Istanbul, Turkey
from **28-29 April**
For more information:
E: ofreier@hinte-messe.de
W: www.intergeo-eurasia.com

MAY

Geospatial World Forum 2014
Geneva, Switzerland
from **05-09 May**
For more information:
E: info@geospatialworldforum.org
W: www.geospatialworldforum.org

Esri Africa User Conference 2014
Cape Town, South Africa
from **06-08 May**
For more information:
E: auc@esri.com
W: www.esri.com/events/auc

MundoGEO#Connect Latin America 2014
Sao Paulo, Brazil
from **07-09 May**
For more information:
E: connect@mundogeo.com
W: http://mundogeoconnect.com/2014/en/

JUNE

XXV FIG International Congress 2014
Kuala Lumpur, Malaysia
from **16-21 June**
For more information:
E: fig@fig.net
W: www.fig.net/fig2014

JULY

AfricaGEO 2014
Cape Town, South Africa
from **01-03 July**
For more information:
E: aparker@ruraldevelopment.gov.za
W: www.africageo.org

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