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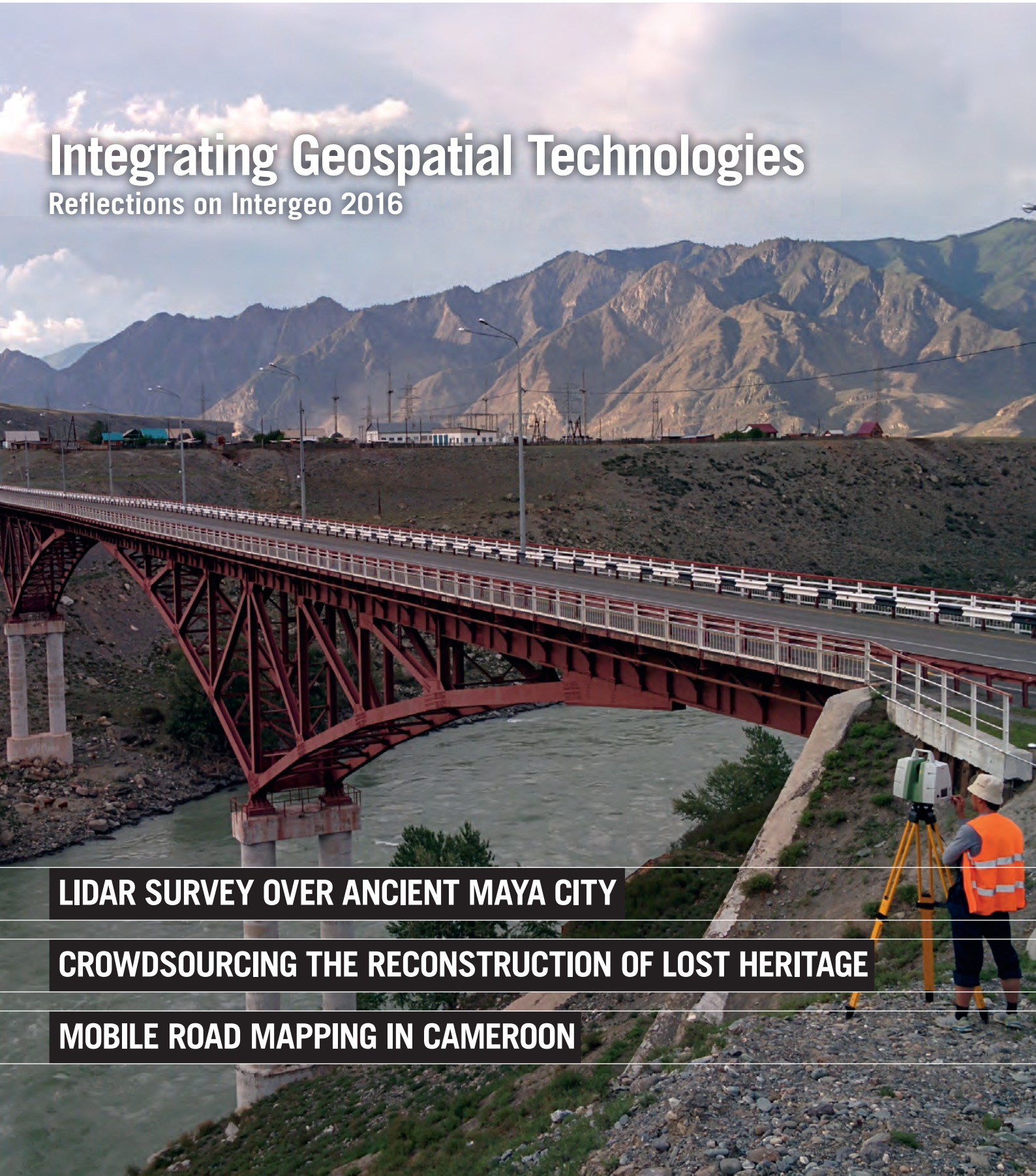

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The front cover of this monthís issue shows a 3D laser scanning project of a bridge carried out by the Russian consulting company Trimetari. This issue contains several articles on challenging geospatial projects, such as a Lidar survey over an ancient Maya city, a mobile road mapping project in Cameroon and a feature on post-conflict land administration.

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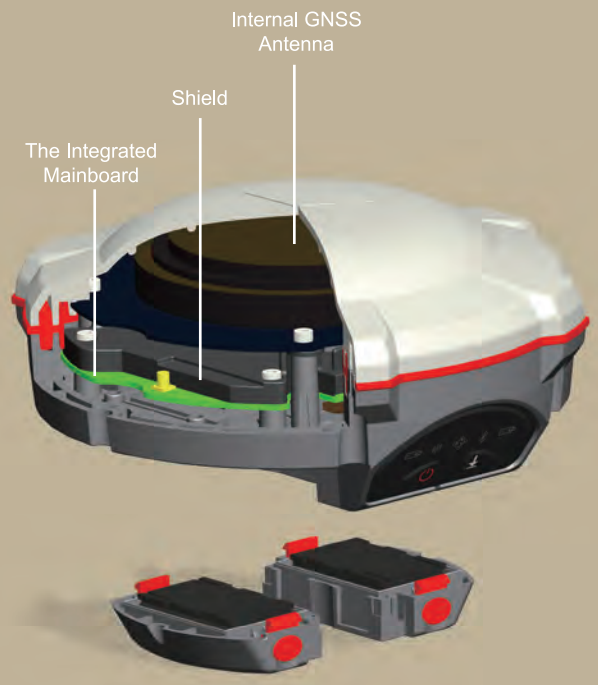

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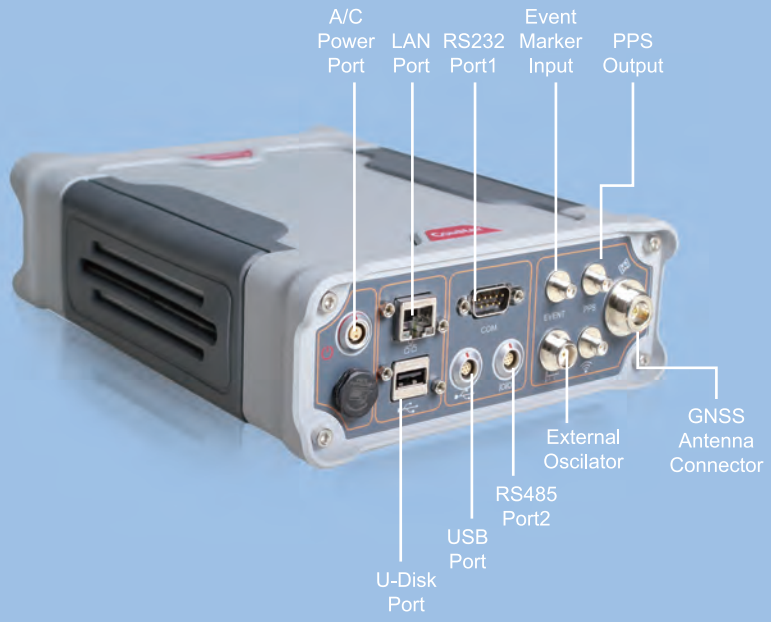

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Sparks

These days, watching the news, reading the newspaper or following social media doesn't fill one with much joy about the state of the world's economies, political stability and climate. At the risk of sounding like a grumpy old man insisting that things were better in the olden days, I have to admit that it is hard to find sparks of optimism in the day-to-day news. Our industry is being tossed around on the waves of international developments like the upcoming Brexit, the US elections, wars in the Middle East, low oil prices, and weak economies and currencies. As a result, you could generalise that the geomatics industry is barely growing, virtually stagnant, just riding out the storm and waiting for better times. But I'm so positive by nature that I simply have to search for those scarce sparks of optimism that surely must be out there! And the good news is, I've found a few to share with you. First of all, the economies in the BRICS countries – Brazil, Russia, India, China and South Africa – which just before the crisis of 2008 were regarded as the most promising emerging economies for the future. We haven't heard much about BRICS over the past few years, but it appears that the Russian rouble and the Brazilian real are amongst the world's fastest-rising currencies. And China and India are both showing growth figures of 6 and 7 percent respectively, numbers that politicians in the West can only dream about. The combined gross domestic products (GDPs) of the BRICS countries add up to USD16,600 billion – equivalent to 30 percent of the world's total. Besides the quiet growth of these countries, another snippet of good news is that, according to a recent report by the World Bank, the percentage of the world population who have less than USD1.90 per day to live on has decreased from above 30 percent in 1990 to below 10 percent in 2015. This means that hundreds of millions people are no longer living in extreme poverty. The last spark of optimism I would like to highlight is the growing support for developing a greener energy sector. According to the Organisation for Economic Co-operation and Development (OECD), more and more policymakers and businesses are committing to renewable energy targets, which should deliver environmental benefits by reducing greenhouse gas emissions and air pollution and decreasing our reliance on fossil fuels. Climate sceptics are losing ground, although still way too slowly for many. These three upbeat examples will hopefully go some way towards brightening the day of the many industry professionals who feel saddened by the consequences of the daily news reports for both their businesses in geomatics and the world as a whole. By its very nature, geomatics is well positioned to take up the challenge; it can put existing technologies to work and develop new ones, helping to boost economies in emerging markets, to further decrease poverty for many in other parts of the world and assisting in the search for new ways of generating renewable energy to safeguard the planet's future. I encourage you to go out and look for these and other sparks yourself, to boost not only your optimism but also your business.


Photography: Arie Bruinsma

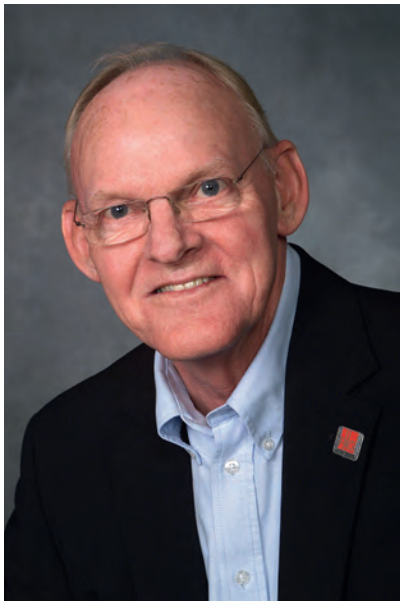
▲ *Durk Haarsma, publishing director*

The Call for a Data Revolution

There is growing recognition that the success of the new Sustainable Development Goals (SDGs) will depend on the ability of governments, businesses and civil society to collect and manage data for decision-making. The SDGs are ambitious and there is an urgent need to mobilise a data revolution in order to monitor progress, hold governments accountable and foster sustainable development.

A key lesson from completing the Millennium Development Goals (MDGs) over the last 15 years was the need for monitoring progress through publishing an annual status report on the MDGs. This enabled governments and the world community to assess improvements and gaps in achieving the goals at the global as well as regional and local levels.

This need for monitoring and assessment was further recognised in the report of the High-level Panel of Eminent Persons on the Post-2015 Development Agenda. The report called for a 'data revolution' which reflects the growing demand for better, faster, more accessible and more disaggregated data for reducing poverty and achieving sustainable development. The report also proposed a new international initiative, the Global Partnership on Development Data, which would collaborate with and build capacity of statistical offices around the globe. This is further supported by the UN-GGIM initiatives, and also recognised explicitly in the 2030 Global Agenda by statements on the need for an indicator framework, accountable data and annual reviews: "We need sustainable data to support sustainable development".



▲ *Stig Enemark*

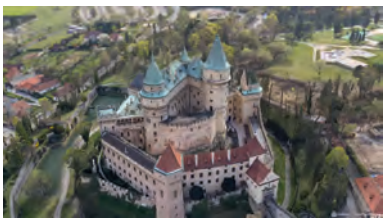
This call for a data revolution is also underlined by the phrase, "If we can measure it – we can better it". Experience shows that by monitoring and documenting the ongoing progress, governments can justify activities and costs, and also attract donor funding to help them meet country-specific targets.

Fortunately, advancements in information and communication technology have enabled a platform for such a data revolution, including innovative approaches such as the growing use of crowdsourcing and satellite imagery analysis. This is further expanded on in the UN-initiated report called 'A World that Counts: Mobilising the Data Revolution for Sustainable Development'. Despite this information boom in some parts of the world, however, in other parts of the globe there are still people and assets that we know very little about and for which the fundamental baseline data is missing. These people tend to be the most marginalised, the poorest, the vulnerable and the excluded.

This challenge is faced by the Africa Centre for Global Development in its report on 'Delivering on the Data Revolution in Sub-Sahara Africa' which identifies five 'data building blocks' for innovation: Births and Deaths; Growth and Poverty; Taxes and Trade; Sickness, Schooling and Safety; and Land and the Environment (including cadastral registries and administrative data).

Against this backdrop, and bearing in mind that six out of the 17 SDGs are directly land-related, it becomes essential to build basic and fit-for-purpose land administration systems in developing countries that cover all land and provide security of tenure for all. Such systems can deliver reliable and robust data for devising appropriate policies and interventions for the achievement of the SDGs and for holding governments and the international community accountable through monitoring and assessment. Land professionals have a key role to play in supporting this 'data revolution'.

Meixner Imaging and Capturing Reality Sign Distribution Agreement



RealityCapture.

Meixner Imaging has signed an agreement with Slovakia-based Capturing Reality entitling Meixner Imaging and its worldwide network to distribute RealityCapture. This state-of-the-art, all-in-one photogrammetry software solution automatically extracts accurate 3D models from a set of ordinary images and/or laser scans. Combining input data from images, laser scans and unmanned aerial vehicles (UAVs) for 3D modelling, Capturing Reality brings in a lot of expertise and experience in 3D modelling to complement Meixner Imaging's own existing 3D data visualisation and data management solutions.

▸ **http://bit.ly/2emcsuJ**

Zoller + Fröhlich Launches New-generation Laser Scanners

At Intergeo 2016, held in Hamburg, Germany, Zoller + Fröhlich presented a new generation of laser scanners which are designed to allow surveyors to reach new levels in their projects. The new Z+F IMAGER 5016 series includes all features of the 5010 series like an integrated high-definition HDR camera and the indoor and outdoor positioning system. Totally new is the innovative design. Aside from the better grip on the basis of the ergonomic streamline design, set-ups with high tripods and overhead applications are much easier. In addition, the Z+F IMAGER 5016 is 30% smaller and lighter than the Z+F IMAGER 5010X. The maximum range of the new Z+F IMAGER 5016 has been extended to up to 360m, establishing new opportunities and applications. The maximum measurement rate of more than 1 million points/second guarantees highly accurate results, which makes it also suitable for long distances.

Z+F IMAGER 5016.

▸ **http://bit.ly/2ewbM1R**

Trimble Introduces SX10 Total Station

Trimble has unveiled the SX10 scanning total station. It merges high-speed 3D scanning, enhanced Trimble VISION imaging technology and high-accuracy total station measurements into familiar field and office workflows for surveyors. The solution provides surveyors and geospatial professionals with the capabilities and versatility to handle projects ranging from traditional surveys to complex 3D modelling. The SX10 with Trimble's patented technology enables the capture of both high-accuracy measurements critical for traditional survey projects and rich point cloud data at 26,600 points per second with a range of up to 600 metres. This means surveyors can include 3D scanning as part of everyday workflows, increasing productivity for topographic surveys, roadway and corridor surveys, volumetric surveys and infrastructure as-builts.

Trimble SX10.

▸ http://bit.ly/2ejm8oj

Hemisphere and Carlson Launch GNSS Receiver

Hemisphere GNSS and Carlson Software recently collaborated to produce the Hemisphere S321 and Carlson BRx6 – all-new, compact, GNSS receivers that are designed for the requirements and workflows of their customers' daily projects. The S321 and BRx6 receivers are optimised for land surveying, construction fieldwork and marine operations. Design and production of the new receiver focused on creating a lightweight and compact receiver with an intuitive interface and access to multiple satellite constellations, including GPS, GLONASS, BeiDou, and Galileo. The receivers also incorporate RTK and L-band corrections, including optimisation for Hemisphere's subscription-based, Atlas GNSS Global Correction Service.

Hemisphere S321.

▸ http://bit.ly/2emaDOq

Phase One Launches Aerial Cameras with Central Lens Shutter Design

Phase One iXU aerial cameras.

Phase One Industrial has introduced the iXU-RS aerial camera series featuring an innovative central lens shutter design. The new shutter technology is based on a direct drive concept with electronic charging that enhances exposure speed to as fast as 1/2,500s, while the company guarantees half a million exposures: an unprecedented shutter life span. The series' flagship 100MP iXU-RS1000 camera system, with the advanced lens shutter, a capture rate of 0.6 seconds per frame and its CMOS sensor with superior light sensitivity of 50-6400 ISO, is designed to expand the efficiency of aerial imaging operations, including under deteriorating weather conditions or on days that were previously not conducive to image capture, allowing faster flights and larger surface coverage.

▸ http://bit.ly/2ev4DxR

Ecometrica's Software Limitlessly Available to University of Edinburgh

Academics and students at the University of Edinburgh School of Geosciences, UK, are set to become the first to gain unlimited access to millions of pounds' worth of state-of-the-art Earth observation, geospatial intelligence and satellite mapping applications, thanks to a groundbreaking memorandum of understanding (MoU) signed between sustainability software and data company Ecometrica and the University of Edinburgh. The MoU formalises the ongoing collaboration between Ecometrica and the university, which is expected to be worth around GBP4.5 million to both parties over the next five years. Ecometrica will make its Mapping suite – a web-based, universal, disruptive geographic information system (GIS) – available on a limitless basis to the university so that it can be used for research and teaching purposes.

The Ecometrica platform.

▸ http://bit.ly/2dptOpl

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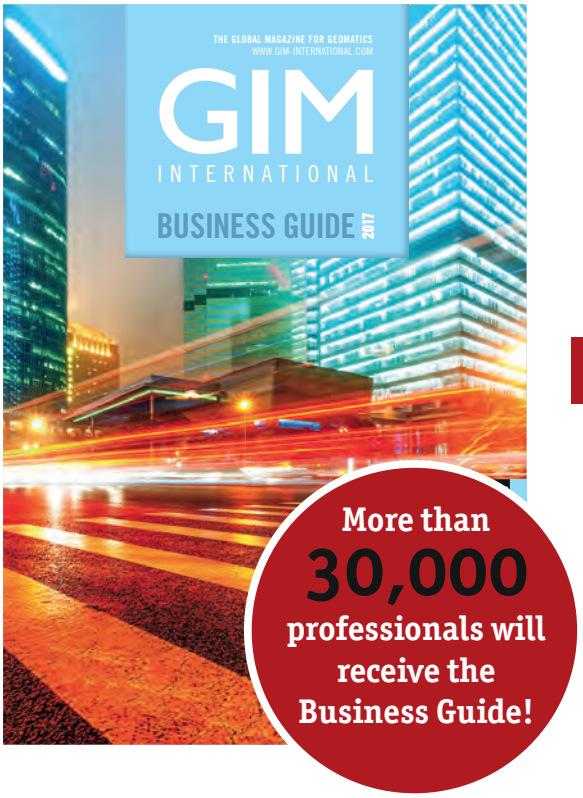

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Trimble Sells UAS Division to Delair-Tech

Trimble UX5 UAV.

Trimble announced that Delair-Tech has acquired its Belgium-based Gatewing unmanned aircraft system (UAS) engineering and manufacturing business. Delair-Tech is a leading provider of long-range, fixed-wing UAS solutions for industrial inspection and asset management applications headquartered in Toulouse, France. Delair-Tech intends to grow the acquired business as part of its portfolio. This transaction is part of Trimble's continuing programme to tighten the corporate focus, said Ron Bisio, vice president of Trimble's Geospatial Division. Trimble will remain actively engaged in the market by leveraging its brand-agnostic software technology for a broader range of UAS platforms, he added. In addition, Trimble has entered into strategic alliances with Delair-Tech and Microdrones of Siegen, Germany. Microdrones is a leading provider of multirotor UAS solutions. Under the agreements, Delair-Tech and Microdrones will become preferred providers of both fixed-wing and multirotor UAS solutions, with Trimble providing software, data processing and deliverables to UAS operators across multiple vertical markets.

▸ **http://bit.ly/2elZpDz**

Leica Solution Streamlines Deformation Monitoring for Surveyors

Leica GeoMoS Now!

Leica Geosystems has introduced its latest service module, Leica GeoMoS Now! Survey Edition. The module provides a service for surveyors and engineers for monitoring and managing 3D deformation of points of potentially unstable areas for surveying projects. The new streamlined workflow is developed to ease the critical and often time-consuming tasks of repeated field campaigns. Geomatics professionals receive immediate access to monitoring reports of man-made structures or natural dangers via their smart devices. Surveyors can use this service to easily upload coordinates, process and visualise deformations for project managers to immediately access results from any smart device. This cloud-enabled solution offers users one convenient platform for all their existing and previous survey field campaign data. With GeoMoS Now! Survey Edition, Leica Geosystems offers engineering companies a complete monitoring system for all their surveying projects without the complexity or expense of a traditional system.

▸ **http://bit.ly/2dC4x9T**

GIM INTERNATIONAL INTERVIEWS ARNULF CHRISTL

Open Geospatial Source Deserves Open Geospatial Minds

In recent years we have seen the rise of a broad range of new open source software in the geospatial industry. Today, proprietary and open source software solutions are used side by side by GIS professionals. At FOSS4G, the annual global event of the Open Source Geospatial Foundation (OSGeo), *GIM International* met with Arnulf Christl, president emeritus of OSGeo and geospatial systems architect, to discuss the role of the open source community within the geomatics world, the outlook for the long run and the opportunities open source offers to less developed countries.

The free and open source cross-platform desktop QGIS is very popular – but who is using it?

That question has a very simple answer: everybody! QGIS is probably the most used open source desktop GIS around, and it's used by people from within research and academia to businesses and public administrations. Interestingly, QGIS is really catching on within public authorities, because when they get new employees joining straight from university, they don't care which software they have to use. In many public authorities, especially in Germany, I know that they have a dual system. So they have Esri ArcGIS for the 'old guys' who don't want to switch and are happy with their software – they do their work and it's fine. But when someone new comes in, they work with QGIS instead of licensed, copyrighted proprietary ArcGIS software. The interesting thing is they get their work done all the same, so there's not a big difference.

What is GIS open source software? What's the business model?

Firstly, open source means that you can look into the functioning of the software. It's not just some kind of black box where you just push some buttons and something happens, but you can really check what's going on. The second aspect of open source is that you can actually change it – so you can extend it, you can look into the code, you can add special functionalities. The third aspect of open source is that you don't have to pay upfront fees for the software. Now this is the critical point where many people think: "Oh, then you can't do business with it". But when it comes to IT, the revenue from selling software licences is only 5 to 10% of the whole revenue around consulting, implementing, developing and operating software.

People may think, "Oh, if you can't sell software, how are you going to do business?" But there is such a big area of business opportunities besides selling the software licence that it's a perfectly valid business model. 90% of the IT business model revolves around something else, other than selling than proprietary licences.

When it comes to producing geospatial data, this becomes even more evident. The acquisition, i.e. surveying, and maintenance of complex geospatial data is incredibly expensive, time consuming and labour intensive. Compared to this, the cost of acquiring software is relatively small. At the same time, the need for service and support is a lot higher than with, for example, text processing or spreadsheet software. Conferences and events like FOSS4G give an overview and insight into businesses providing 'spatialised' services.

Is this a good business?

Apparently it is, otherwise it wouldn't be such a hot topic for so many years, and you wouldn't have a conference like FOSS4G in a venue like this (*the former German parliament in Bonn, Ed.*) – it's pretty amazing. People are paying quite a lot of money, and not just for the entrance fee of the conference; people have come from over 50 countries, that means they have to spend time away from their regular work for a week, they have to pay for accommodation and transport, so it's quite an investment to actually be here. And if you see the enthusiasm of the people here, and how much business is starting here – well, obviously it's a very good business model. The other aspect is that people sometimes get confused and think this is something like communism – that everything is being given away for free and open source is kind of soft and 'wishy-washy', but that's not actually what is happening. Open source software development is probably the most competitive area you can be in, because whatever you do is immediately visible in the whole world. If you do something that doesn't really work, then people are going to laugh at you. So you shouldn't publish anything unless it actually works. The competition between the different projects is so high that the innovation curve is really steep. Over the past years we've had annual benchmark sessions which reveal on screen to an audience of a thousand people which software is the fastest to actually achieve something. Every year the performance of the benchmarked software has increased by five percent, 50 percent or even 200 percent, which is pretty impressive. So yes, I think it's a hot topic and there is a lot of business in it.

What are typical applications of open source geospatial software?

Anything that has to do with spatial! I would turn it the other way round: which applications have not yet been permeated by

open source? There are very few, and those are usually highly specialised, ones where there is simply no market for anybody interested in open source to develop something. I would say 95 to 98 percent of what you do with location, you can also do with open source. Consequently there are lots of applications actually implemented with open source.

Is open source GIS complementary to commercial GIS?

First of all, the term 'commercial GIS' doesn't really make any sense because, as we have seen, business with GIS is absolutely open for open source as it is for proprietary. The right word if you want to differentiate between the different licensing models is to say 'open source' and 'proprietary'. The good thing is that, in many public authorities, they already have a stack of Oracle and ArcGIS Desktop and MapInfo and Intergraph and so on, but at the same time they're starting to use QGIS and OpenLayers, and what binds these applications with each other is standards. As long as you adhere to standards, there's really no problem working with them side by side. Another interesting fact is that geospatial data has a long lifespan. Therefore it's not so easy to simply say: OK, let's switch. If you work in an office and you write letters, then switching from Microsoft Windows to LibreOffice is just a matter of installing the new software and then writing your next letter. But in geospatial there are so many processes directly linked into the logic of the data, actually in the software, that it's much harder to get the data out and use it with different software. And again, if you adhere to standards and have a good architecture which separates the software from the data then it's much easier to move to open source software.
So yes, open source complements proprietary, but in many cases it has already replaced it. There are quite a few examples, like Ordnance Survey in Great Britain, where they have replaced all the components that were proprietary in the outward-facing services with open source components, and they are really happy with it. It is stable, fast and sustainable.

You're involved in the development of the Social Tenure Domain Model with the Global Land Tool Network. What is this development about?

This is a whole new world for me. I was born and raised as a German and – clichés aside – that means I come from a hellishly well-organised culture, but maybe also a very narrow-minded one. So when I was exposed to the ideas of a Social Tenure Domain Model and continuum of land rights, I was a little confused. Because how can you have land rights to a place maybe every second year, if there's rain and there's some pasture growing, and otherwise you're not interested, you don't want the land? These are totally different concepts, and so we probably have to broaden our minds a lot when we're trying to help developing countries, because otherwise we're trying to impose our narrow mindset on those people, which just doesn't work in different cultures. So although I didn't really know much about it, for the past four years I've been working a lot in land administration and I've learnt a lot too. I think the Social Tenure Domain Model is really relevant if we want to get something done in developing countries, because it addresses those needs which are quite different to the needs that we have here. And, again, open source is the best tool to tackle these problems, because it helps to empower people locally. You give them a source code,

OPEN SOURCE IS THE BEST TOOL TO TACKLE PROBLEMS IN DEVELOPING COUNTRIES, BECAUSE IT HELPS TO EMPOWER PEOPLE LOCALLY

you give them the binary and they can start to work right away, but then they can also extend it and adjust it to their needs – which is exactly what is so difficult if you have a so-called commercial off-the-shelf (COTS) product. You can apply the same term to open source. So QGIS, in my view, is a COTS product, but it's extendable. In other contexts, other software providers give you a full solution and say, "We know what you need, you just have to install it and start working". This is precisely what doesn't work when for land administration, because it's so different in every culture and every place.

Is money a reason to choose open source in developing countries, or doesn't that have any bearing on the situation?

[Laughs] That's a good point! As director and president of OSGeo – which I co-founded in 2006 – I never ever said that open source is free, or that open source is cheaper. Because, as I've already mentioned, 90% of the costs involved in IT projects are not the licensing of the proprietary software. Having said that, yes – it does make a difference, especially in aid projects. For example, some projects have failed because they were tied to projects budgets; you might have a project runtime of three years and there's enough money to pay for three years, but after that there's a new version of the software and you have to renew the licence. If you can't, everything is lost. So from this point of view, yes it does make a difference, but it's not so much about the exact amount of money – after all, aid organisations do have money. Instead, it's more about what happens when the money runs out. That's a breaking point: if you can't use the software, you're done.

How will this evolve in the long run? Does the open source concept really work in developing countries?

Yes, I am very sure that it is probably the only solution that will help them, the only model that will be sustainable. So it fits perfectly because the initial costs are very low and, more importantly, in the long run you can build local competence, you can empower the right people in the right place. If we don't want another wave of colonialism – in which we tell people what do and make them dependent on us – then we should train them to help themselves. And this is exactly what happens with open source. Whenever I start somewhere, the first thing I think about is how to make myself superfluous, how to remove myself from the equation.

You have been very much involved in FOSS4G, especially concerning the FOSS4G 2016 event in Bonn. How would you describe this community?

It's a fantastic community! It's absolutely diverse: there are people from universities, there are people from businesses, there is interest from retired people...and the atmosphere is fantastic, FOSS4G is so much fun. But besides all the fun, it's still a hardcore 'tech' event. So if you're interested in the newest technology, bleeding-edge open source software then this is the place to be.

There are a great number of software developers, so companies' human resource departments can find new employees here. Another interesting aspect is that this is a place that attracts very small companies; for them, getting here involves quite a high investment so the people who are here are really committed, and you sense this everywhere.

It seems open source could be a solution for many societal challenges. What can the open source community do to become a bigger player and become more visible?

THERE ARE LOADS OF FANTASTIC OPEN SOURCE TECHNOLOGIES AND TOOLS READY TO BE USED, BOTH COTS AND INDIVIDUALLY CRAFTED

Now, that's the Achilles' heel of the open source geospatial community: they're not really big fans of marketing, it doesn't have a very good image in our community. Marketing is not necessarily something that fits well with the open source idea, i.e. that you have to be good to be recognised. However, organising events such as FOSS4G works in terms of creating visibility. There are up to a dozen regional FOSS4G conferences around the world each year, and one big annual worldwide conference. But, of course, it would be good to get some more attention, to spread the information more widely throughout the geomatics community.

At FOSS4G 2016 there was a special session on open source opportunities for land administration. I was there and I think it was quite a success with lots of potential. Do you agree?

Yes, exactly – it has a lot of potential. But we still have a long way to go! The room was not exactly crammed full. In fact, only around 20 people attended. But after the round of introductions I felt quite awed by the concentrated expertise and breadth of experience of the attendees. It became clear pretty soon that we have everything we need: we have a lot of expertise in the land information sector. Chrit Lemmen from Kadaster, The Netherlands, gave an introduction to the topic and pointed out some caveats as seen from the FIG and GLTN workgroups. Athina Trakas from the Open Geospatial Consortium (OGC) presented the standards perspective ensuring technical

interoperability and introduced a new workgroup. The ISO standard (LADM) has been around for a few years and the STDM has been broadly accepted as a fit-for-purpose implementation. Even UN-GGIM has a workgroup starting to focus on land management and governance issues. Last but not least, there are loads of fantastic open source technologies and tools ready to be used, both COTS and individually crafted. Yet it seems that these players have not yet convened and factored out solutions that actually work and get used. Frank Pichel from the Cadasta Foundation summed it up nicely: "[It is] really exciting to get people outside of the insular world of land governance thinking about the issue – that's where the real potential for innovation and scaling is given the breadth of the challenge ahead". Our Friday keynoter, Klaus Deininger from the World Bank Group, raised a firework of requirements for geospatial technology in all their work – most, if not all, of which is based on or related to land, location and place. So now it's up to us all to find ways to collaborate, open up the silos and start to get things done. The land domain page in the OSGeo Wiki [1] pulls together all the strings, so maybe it's a good starting place to get some activities underway. After all, OSGeo is governed by 'do-ocrats' who invariably get things done.

Is there anything else that you'd like to share with our readers?

There is one very important thing: I want to thank everyone who has made this possible. That involves every single developer, every single user of software and every single decision-maker who decides to go open source, even though they may have some second thoughts, that they dare to follow this path. So far there has been such good feedback from people who've switched to open source that I can recommend people to just go for it, just try it out. The cool thing is, for example in OSGeo Live, there are more than 50 software packages for geospatial analysis, viewing, libraries and so on. So just dive in, go to live.osgeo.org and it's an installed routine, it's very simple! ◂

More information

[1] https://wiki.osgeo.org/wiki/Land_Domain

ARNULF CHRISTL

Arnulf Christl is a geospatial systems architect and provides consultancy for clients throughout the world such as the United Nations, Ordnance Survey Great Britain, Siemens and IBM through his company Metaspatial. He has a thorough background in secure and quality-assured open source products based on open standards and is knowledgeable in open Data models. Arnulf Christl is president emeritus of the Open Source Geospatial Foundation (OSGeo) and a member of the Open Geospatial Consortium (OGC) Architecture Board. He is also founding member of the OSGeo initiative GeoForAll and sits on the advisory board of the GLTN Social Tenure Domain Model (STDM) project.

IMPROVING ARCHAEOLOGICAL MAPS AND IDENTIFYING HIDDEN STRUCTURES

Lidar Survey over Ancient Maya City

The ancient Maya site of Copan, Honduras, was captured during an airborne Lidar survey in May 2013. The resulting products are accessible through 2D and 3D WebGIS tools and enable archaeologists to collaborate online. This interdisciplinary project, named MayaArch3D, showed that Lidar data can improve archaeological maps, identify hidden structures as laser pulses partly penetrate jungle canopy, and facilitate collaborative research.

Copan, which is on the UNESCO World Heritage list, was once an important cultural and commercial centre on the south-eastern periphery of the Maya world. The landscape consists of alluvial terraces and foothills. The vegetation ranges from sub-tropical coverage in the valley to pine forests in the mountains. The environmental diversity within such a small area presents challenges in terms of locating and surveying archaeological structures (Figure 1).

PEDESTRIAN SURVEYS

Since the late 19th century, many pedestrian surveys and excavations have given archaeologists an insight into 4,000 years of human occupation at Copan. Between 426 and 822 CE, a powerful Maya kingdom emerged during which the 17 kings that reigned in that period continually reshaped the city. Early investigations focused on the city's main civic ceremonial zone – the Principal Group – comprising large temples and pyramids (Figure 2). From 1978 to 1980 the Copan Archaeological Project (PAC 1), led by French archaeologist Claude Baudez, surveyed and mapped an area of 24km^2 surrounding the Principal Group. In the 1983 project report, archaeologists William Fash and Kurt Long published 24 maps at scale 1:2,000 showing over 3,000 archaeological structures. From 2006 to 2008, the PAC 1 maps were digitised, georeferenced and enriched with attributes to create GIS data for studying accessibility and visibility.

LIDAR SURVEYS

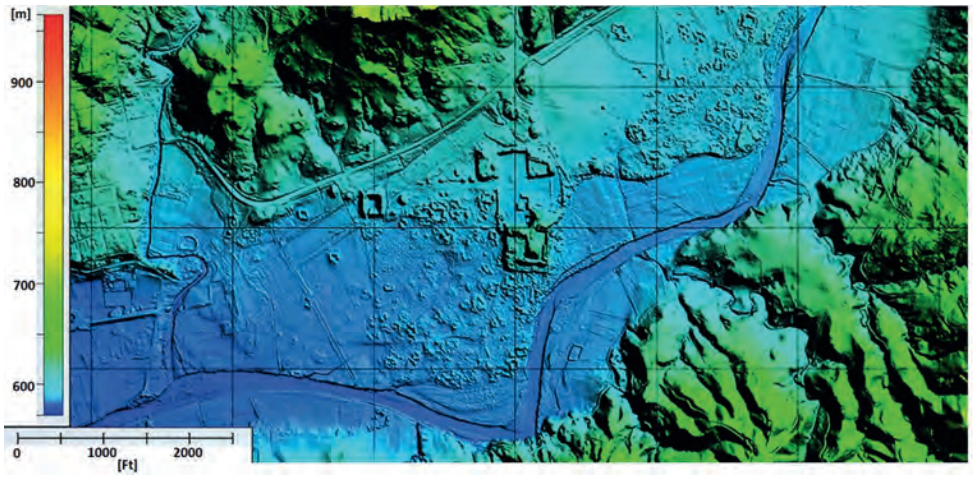
In 2000, the first Lidar survey over Copan was flown by the US Geological Survey (USGS) to assess flood and landslide damage following Hurricane Mitch. The data only captured the Principal Group. Within the present project Watershed Sciences Inc. (WSI) from Oregon, USA, collected Lidar data during four days in May 2013 using a Leica ALS50 Phase II system mounted in a Piper Aztec aircraft. This Lidar survey was aimed at: (1) identifying new archaeological sites, (2) evaluating site degradation/loss over time by comparing the Lidar data with

MAYAARCH3D PROJECT

Funded by the German government, MayaArch3D is a collaborative and interdisciplinary project led by the Commission for the Archaeology of Non-European Cultures at the German Archaeological Institute (DAI). The project involves the Institute of Geography at the University of Heidelberg (Germany), the Department of Anthropology and Center for Digital Research in the Humanities at the University of Nebraska-Lincoln (USA), the 3D Optical Metrology Unit at the Bruno Kessler Foundation (FBK) of Trento (Italy) and the Honduran Institute of Anthropology and History (IHAH). The project is aimed at capturing the Maya site of Copan and developing 2D and 3D WebGIS tools. These tools help archaeologists to integrate, visualise and query complex archaeological data online.

▲ *Figure 1, View of the Copan valley in Western Honduras.*

▲ *Figure 2, Ruins of the ball court in the centre of the ancient city of Copan.*



▲ *Figure 3, DEM resulting from WSI data processing.*

existing maps, (3) assessing the pros and cons of Lidar for locating and mapping archaeological sites in an ecologically and topographically diverse environment, and (4) developing new datasets to be combined with other archaeological data and hosted in a 3D WebGIS. The targeted point density was at least 15 points/m^2. This could be achieved through an across-track overlap of over 50%, effectively resulting in capturing the area twice. The average first-return density was 21.57 points/m^2, and for ground return the number was 2.91 points/m^2 on average, locally depending on topography and vegetation density. Where vegetation was dense, the point density of ground returns reduced to less than one point/m^2. Another challenge was that collapsed structures – mounds – are difficult to distinguish from natural topography in Lidar point clouds. At Copan, the distinction is even more difficult as constructions are incorporated into natural topography; mounds less than 0.25m in height proved particularly difficult to identify.

FILTERING

WSI delivered raw 3D points (LAS and ASCII), classified LAS data and raster data. Using proprietary automated and manual methods the 3D points were classified into bare earth, modern buildings and archaeological ruins. From these classified points, a bare earth model (DTM) and a DTM plus archaeological structures (DEM) were created (Figure 3). The filters distinguished bare earth from vegetation (DTM) but not bare earth from archaeological structures. The semi-automatic filters separated mounds from topographic features such as natural hills, but were not able to distinguish mounds lower than 80 centimetres from the natural terrain. The filters also removed important archaeological structures. This is typical of many Lidar filters that are customised ad-hoc to segment out vegetation and man-made structures. FBK refined and applied other filters based on landform and vegetation cover to extract a DTM without mounds and archaeological structures. Comparison between WSI's classified data and PAC 1 data showed that 14% of the features originally classified as bare earth were actually mounds. A classification workflow based on plane identification, seed points and region growing enabled three classes to be identified: ground, building and vegetation (Figure 4). Points classified as structures were then compared with PAC 1 data and WSI data, revealing several new mounds ranging in height from 0.5m to 1m and some positional and orientation shifts in structures. Of the 521 sites mapped in the PAC 1 maps, 468 sites were relocated. The new filtering strategy resulted in new DTMs, DEMs and contour lines with 0.2m, 1m and 5m intervals. Next, these products were employed for field work and archaeological analysis. Added to the above products, terrestrial laser scans and photogrammetric 3D models of selected structures, architectural sculptures and monuments were produced and merged for online access. Methods used to identify unmapped features included hill shading, principal component analysis, slope gradient computation, modelling local relief and applying sky view factors (SVFs) which were calculated as the fraction of sky visible when viewed from the ground up. Slope and SVF worked best to delineate low-lying mounds, and SVF was best for identifying terraces.

LIDAR FILTERS ARE CUSTOMISED AD-HOC TO SEGMENT OUT VEGETATION AND MAN-MADE STRUCTURES

RESULTS

The products derived from the Lidar data using standard and newly developed methods allowed archaeologists to update the PAC 1 maps. In particular, five key differences were found between the PAC 1 maps and the Lidar products: internal composition, location, structure orientation, structure size and/or mound height. These differences demonstrate the usefulness of Lidar data, not only for locating archaeological sites but also for cost-efficient and time-efficient mapping, particularly across vast landscapes. The PAC 1 survey passed over some archaeological sites as there was no permission from the landowners to cut down vegetation and some

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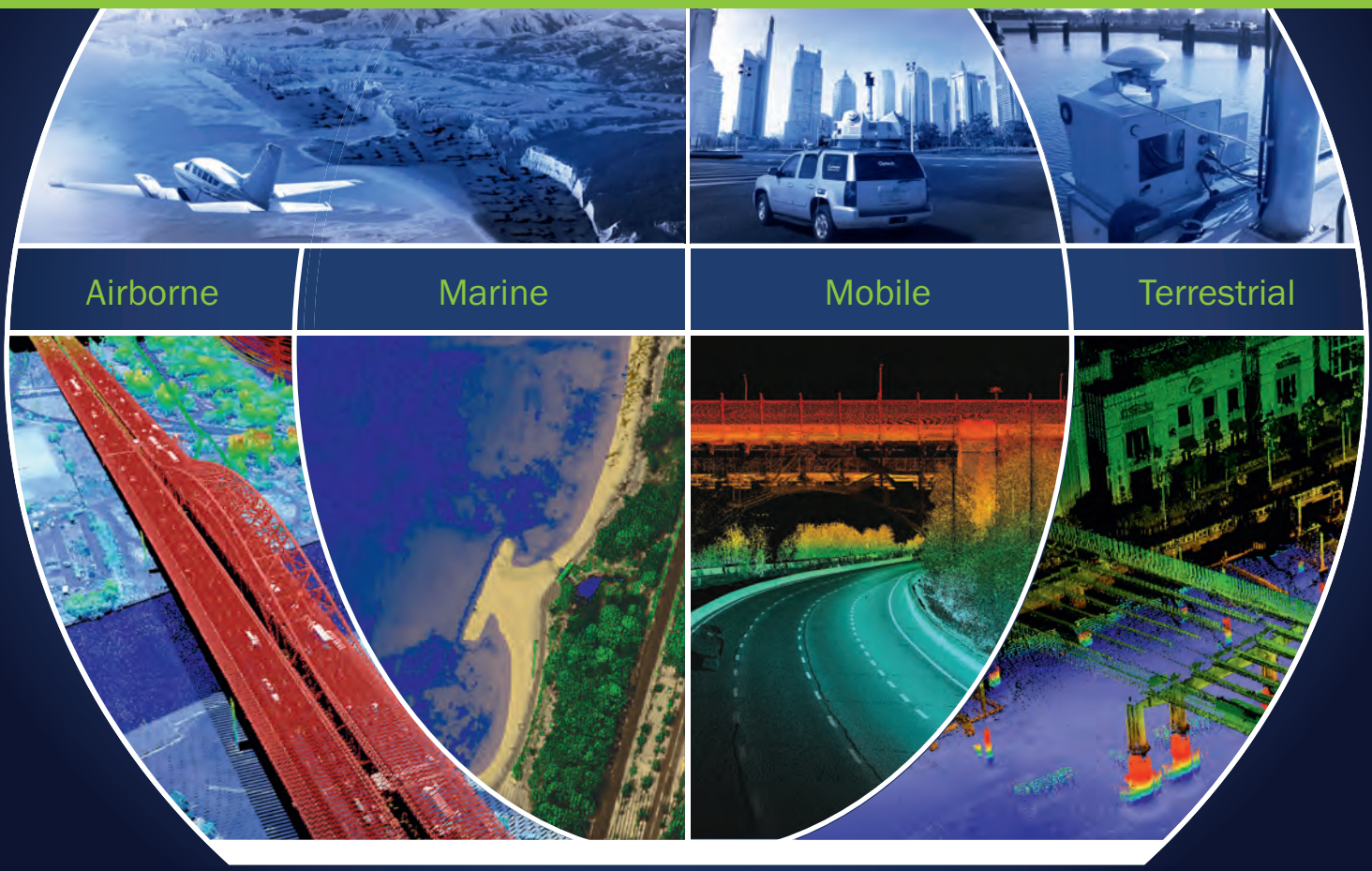

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▲ *Figure 4, Three classes: ground, building and vegetation.*

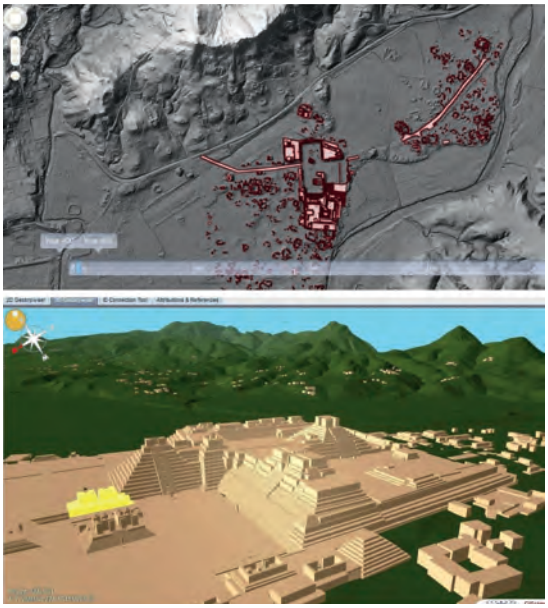
areas were too steep to access safely. These unmapped sites were identified from the Lidar data. While some sites identified from the Lidar data as potentially ancient were actually modern, such as piles of stones cleared from agricultural fields or historic house foundations, the field work confirmed the identification of 18 new archaeological mounds and these were mapped too. The Lidar data also allowed for the identification of unmapped agricultural terraces, and further investigation may help to expand knowledge about ancient agricultural systems in the valley. Heavily overgrown, hilly terrain can reduce the accuracy of Lidar products.

HEAVILY OVERGROWN, HILLY TERRAIN CAN REDUCE THE ACCURACY OF LIDAR PRODUCTS

Ground-checking enables archaeologists to assess their accuracy, but it is impossible to visit every nook and cranny of vast landscapes. So, calculations of accuracy linked to specific criteria, such as topography and vegetation, can help archaeologists to refine post-processing methods and develop new filters to increase accuracy.

CONCLUDING REMARKS

Various institutions have excavated at Copan since 1850. As a result, archaeological objects and documents are dispersed all around the world. Thanks to the MayaArch3D efforts, archaeologists can now use 2D and 3D WebGIS tools to bring distributed archaeological data together and collaborate online (Figure 5). ◀



▲ *Figure 5, 2D Geobrowser (top) showing archaeological structures overlaid on DTM; Scene Viewer (bottom) showing 3D city model overlaid on DTM.*

More information
www.mayaarch3d.org

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BY **MATTHEW VINCENT**, PHD CANDIDATE AT THE UNIVERSITY OF MURCIA, SPAIN, AND **CHANCE COUGHENOUR**, PHD CANDIDATE AT THE INSTITUTE FOR PHOTOGRAMMETRY OF THE UNIVERSITY OF STUTTGART, GERMANY

REKREI: RECREATING THE PAST

Crowdsourcing the Reconstruction of Lost Heritage

Cultural heritage stands as an important testament to how we perceive the past. Unfortunately its preservation cannot always be assured, due to destruction by human or natural means. In February 2015, a video was released which showed the destruction of artefacts in the Cultural Museum of Mosul, Iraq. A volunteer initiative (initially called 'Project Mosul') was launched about a week later with the aim of using crowdsourced images and computer vision to create 3D representations of the destroyed artefacts. Project Mosul was initiated by two PhD students from the University of Murcia in Spain and the University of Stuttgart in Germany, and soon expanded to other geographical regions. The project was therefore renamed 'Rekrei', which is Esperanto for 'recreate'. This article explains how Project Rekrei uses crowdsourcing and photogrammetry to recreate the past.

▲ *Figure 1, Relief from Hatra, Iraq. (Pedro Máximo, rekrei.org)*

An early version of the concept – the reconstruction of lost heritage based on existing photographs – was applied to the case of the Bamiyan Buddhas in Afghanistan by Armin Grün, Fabio Remondino and Li Zhang, after they were destroyed in 2001. Thanks to the subsequent advances in computer vision, web development and digital cameras, Rekrei was able to successfully reconstruct some of the Cultural Museum of Mosul's objects using the initial images provided by Suzanne E. Bott, Diane Siebrandt and Col. Mary Prophit. The further potential of this was quickly recognised as news emerged that the nearby sites of Hatra, Nimrud and Nineveh had suffered similar fates.

EXPANSION

As word about the project began to circulate, and thanks to the initial partnership with Sketchfab, more institutions, companies and volunteers began to join and contribute to the project's development, including by donating images. Individuals who did not have images or experience with photogrammetric software offered their help by scouring the internet for architectural drawings, archaeological

▲ *Figure 2, Entrance of Nimrud, Iraq. (Pedro Máximo, rekrei.org)*

▲ *Figure 3, Durbar Square, Kathmandu.(Konrad Wenzel, nframes.com)*

reports and other related documentation, or assisted with masking the objects in the uploaded images to improve the final step of 3D photogrammetric reconstruction. Since the challenge of cultural heritage preservation is not isolated to Northern Iraq nor caused by human destruction alone, the project's volunteers began to spread their efforts to cases in Syria, Egypt, Yemen and, following the massive earthquake in April 2015, also Nepal.

REKREI ONLINE PLATFORM

Rekrei's work starts online. The online platform provides the primary area for organising and managing the digital images that are used for photogrammetric reconstructions. Online, there are three primary tasks that volunteers participate in. First, users identify locations around the globe where heritage has been lost, due to either natural causes or human intervention. These locations serve as the major divisions in organising the work. The second task is uploading images of these locations, which anyone can do as long as they have created an account on the website. The third and final task is organising the images of each location into relevant groups for reconstruction. Images can belong to more than one group, as an image may contain one or more parts that should be included for photogrammetric processing. Likewise, some monuments are too large for processing in photogrammetric software or are simply not fully covered in the digital imagery. Breaking these monuments down into smaller groups allows for parts to be reconstructed and eventually merged together if more imagery becomes available at a later date. In some cases, these monuments may be reconstructed manually by digital artists who base their work on the photographs. Since the above reconstructions are not valid for scientific analysis but rather serve primarily as visual representations of the lost heritage, any process for recovering lost heritage is considered to be valid.

EXTENDING FUNCTIONALITY

As the platform continues to grow, new features will be incorporated to facilitate greater coverage and track the process by which models are created through the platform. One example is the integration of Flickr through its geolocation API. As each location on the Rekrei platform has a latitude and longitude, users will be presented with a section of the page that displays all the available images with non-restrictive Flickr licences that have been assigned to the same location. Users can adjust the search radius using a slider, extending it up to a kilometre away from the centre of the location that they are browsing. This allows for many more photos to be included by simply presenting the user with other possibilities on other platforms. Future development will attempt to do the same with similar online image repositories.

TRACKING CONTRIBUTIONS

It is important to track how models are produced using the Rekrei platform to ensure proper attribution. If a user wants to upload a photo but the image requires attribution, it is necessary that the metadata of that 3D model contains a complete list of the photographic sources that were used to produce that particular model. Therefore, further development is on implementing a metadata system on the platform that tracks users' work, who uploaded which image, which licence that image has, who organised it into which group, and finally who did the processing to generate a 3D model. This workflow makes is possible to track how each volunteer contributes to the recovery of lost heritage via the Rekrei platform.

ACHIEVING SOME GOALS, SETTING OTHERS

In November 2015, the initial dream of the project's founders was realised during a short exhibition in Amsterdam, The Netherlands, thanks to *The Economist* magazine's Media Lab. A virtual recreation of the museum was modelled and the 3D artefacts were 'virtually' returned to the museum, along with references to the

▲ *Figure 4, RecoVR Mosul Exhibition, DocLab at IDFA Amsterdam. (Nichon Glerum)*

▲ *Figure 5, 3D prints from crowdsourced data, RecoVR Mosul Exhibition. (Nichon Glerum)*

volunteers who recreated them. The models were enriched further with an audio track featuring interviews from cultural-heritage specialists. In addition to providing a virtual reality (VR) experience to the public, three 3D-printed artefacts were also on display, providing a dramatic representation of preserving the memory of lost cultural heritage. In May 2016 the virtual museum was released to the public for Google Cardboard (iOS and Android) and YouTube 360, and a Samsung Gear VR version is coming soon. At the time of writing, RecoVR: Mosul had received almost 100,000 views.

Even with this milestone in place, Rekrei continues to look towards the future. It will continue to participate in retelling the story of lost heritage, such as by partnering with the Dutch National Museum of Antiquities and its upcoming international exhibition on the Assyrian Empire's city of Nineveh. Rekrei will also be participating in the Web Summit in Lisbon, Portugal, in November 2016. At the same time, the initiators will continue to push the platform's tools forward, progressing with ambitious goals such as automated cloud processing of the photogrammetric sets and an overhaul of the user interface to streamline the process and make it easier to recover the world's collective, lost heritage. ◂

FURTHER READING

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Low-power Wide-area Networks: **Enabling Geo-IoT**

Although the term Internet of Things (IoT) has actually been around since the end of the last millennium, the true potential of IoT has only started to unfold beyond the interest of pioneers in the last couple of years. One of the reasons IoT is now booming is the emergence of more low-power wide-area networks (LPWANs) that enable location-aware devices to interconnect in a power-efficient manner. This Technology in Focus article explains the concept of LPWANs and the link to geographic information.

LPWANs are designed to allow wireless communication over a long range at a low data rate. These two distinctive characteristics open up a whole new range of applications, in particular because of the lower power consumption and lower costs that are associated with LPWANs as opposed to traditional machine-to-machine (M2M) communication using SIM cards. For example, installing and maintaining numerous water-quality sensors in a river, canal or other water body becomes a lot more cost efficient if you do not have to replace batteries every few months nor pay for an expensive mobile data subscription for each of your sensors. Provided the hardware is designed efficiently, you could now leave sensors unattended in the field for up to several years, plus the network costs per sensor drop significantly. Additional emerging technologies such as energy harvesting – in which devices collect small amounts of energy in various ways to replenish their power – can even potentially make sensors and devices completely autonomous throughout their entire product lifetime.

PROTOCOLS

There are various types of LPWANs, and both the technology and the commercial market are still in development. For the purpose of simplicity, this article will briefly compare the most widely known LPWANs: LoRaWAN, Sigfox, Narrow-Band IoT (NB-IOT) and LTE-M. These LPWANs all differ in their communication implementation, individual power consumption, bandwidth and type of band, geolocation capabilities, type of native security, current coverage for deployment and whether they make use of open standards or proprietary technology. LoRaWAN, for example, is a wideband system that requires a specialised chip developed by Semtech (which implies it is not an open standard), but there are a couple of network suppliers to choose from. The French system Sigfox, which is a type of ultra-narrow band (UNB) network, is considered to be one of the most power-efficient networks currently available but its bandwidth is very limited and more suitable for one-way than two-way communication. And although it uses an open standard – so anyone can potentially develop a device for use with Sigfox – it still requires you to use the Sigfox network. Both NB-IOT and LTE-M differ from LoRaWAN and UNB in that they make use of existing cellular networks. For example, NB-IOT reallocates part of the 4G band for the LPWAN. This means there is no new network infrastructure required, as the technology uses existing cellular network towers.

▲ *Figure 1, The port of Rotterdam, The Netherlands. LPWANs enable many new applications, such as continuous water-quality monitoring over extensive areas. Image courtesy: Sabine de Milliano.*

COMPETITION

Table 1 gives an overview of the relative advantages and disadvantages of the four LPWANs. The question that often arises from such comparisons is: who is going to win the LPWAN battle? Sigfox and LoRaWAN have the time advantage as they are currently more mature than NB-IOT and LTE-M. The latter two, however, will probably become strong competitors (if – arguably – not winners eventually) thanks to their different business model and promising technical characteristics. But the future battle is not just between the four IoT enablers discussed here; there are also various current initiatives to launch an IoT network into space based on small (nano-) satellites that together deliver global coverage for internet access and tracking services. It is just a matter of time before these plans become reality.

POSITIONING

One service that is of particular interest to the geomatics industry is the delivery of positioning by LPWAN providers without

	LoRaWAN	Sigfox	NB-IOT	LTE-M
Power consumption	low	very low	very low	low
Amount of data transfer	low, amount depends on local providers	very low, mainly suitable for one-way communication	low	medium
Native localisation available	yes, differential time of arrival calculated at network	yes, differential time of arrival calculated at network	possible to inherit from existing LTE positioning	possible to inherit from existing LTE positioning
Suitable for time-critical applications	no	yes	yes	yes
Type of band	unlicensed	unlicensed	licensed	licensed
Potential choice of network	multiple network initiatives	requires Sigfox network to be used	delivered by cellular network providers	delivered by cellular network providers
Potential choice of hardware	requires Semtech chip	no restrictions	no restrictions	no restrictions
Current coverage for deployment	initiatives worldwide, but still mainly operational in Europe	parts of Europe, some other countries planned for roll-out	first trials operational	still in development phase

▲ *Table 1, An overview of the relative advantages and disadvantages of the four LPWANs.*

the need for GNSS. LoRaWAN and Sigfox enable medium-accuracy geolocation of devices through different time of arrival that is calculated by the network itself, which sends back the location information to the device. In this way, the device requires no additional hardware or power to become a smart, location-aware end node. Similarly, NB-IOT and LTE-M can inherit the existing LTE positioning technology to provide native localisation.

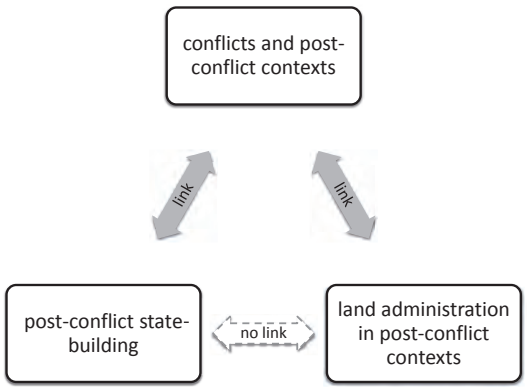
LOCATION IS KEY

The market for new IoT applications is expected to become very big. LPWANs enable many new applications with a geographic component. The growing number of devices can either gather large amounts of geographic data, or they can be triggered to perform specific actions based on their location. In both cases geographic data plays a vital role, which opens up a wide range of opportunities for the geomatics industry to enter the world of geo-IoT. ◀

Post-conflict Land Administration

The most serious concerns in armed conflicts are human casualties, destroyed infrastructure and houses, and displacement of populations. Destruction and displacement have a big influence on land and property-related issues during, and specifically in the aftermath of, a conflict (Unruh & Williams, 2013). Land issues grow in complexity immediately after the conflict as many displaced people return to their places of origin to find their houses and properties destroyed, damaged or illegally occupied by secondary occupants. Land and its administration are always negatively affected during conflicts and in post-conflict situations. The author argues that, if land and its administration are neglected or not properly addressed after a conflict has ended, land can become a cause for renewed armed conflict and an obstacle in the rebuilding of a post-conflict society.

Post-conflict situations lead to a dysfunctional land administration system characterised by: limited prioritisation of land policy; discriminatory land law; poor institutional and regulatory frameworks that allow the grabbing of public and private land by powerful individuals and groups; poor management of geoinformation systems for record-keeping; and a weak government that is incapable of helping internally displaced people and refugees. Accordingly, land administration suffers mostly from the loss of land records and loss of land professionals. Investigations in the area of land administration for post-conflict contexts have identified a knowledge gap in the relation between land administration and post-conflict state-building (Figure 1).



▲ *Figure 1: The knowledge gap. (Todorovski, 2016)*

CASE STUDY INVESTIGATIONS

Guided by the goal 'to identify which interventions in land administration facilitate post-conflict state-building and under which circumstances', five case studies are explored in detail. Two main case studies are explored based on fieldwork activities, reports and literature, and three supportive case studies are explored based on available literature. Kosovo and Rwanda are the two main case studies, and Mozambique, Cambodia and Timor-Leste are the supportive case studies. Table 1 shows the results on interventions in post-conflict land administration that occurred in the specific case study.

The relationship between land, conflict and post-conflict contexts was also explored and the specific findings were presented as a framework for rebuilding post-conflict states under components including institutional weaknesses, economic and social problems, and serious security problems.

LAND, CONFLICT AND POST-CONFLICT

In some of the cases, land was either a major cause or was one of many factors that influenced the eruption of armed conflict. Therefore, land issues required specific attention during state-building in post-conflict contexts. This confirmed the recognition that all conflicts have a land dimension. Additional confirmation from the cases shows it is beneficial that specific interventions in land administration and land-related issues should be included in the peace agreement

Parameter	Kosovo	Rwanda	Mozambique	Cambodia	Timor-Leste
National land policy	√	√	√	√	√
Cadastre / land law	√	√	√	√	√
Land administration organisations	√	√	√	√	√
Land-claims commissions	√	√	√	√	√
Implementation program / project	√	√		√	√
Ad hoc land policies: Land sharing, state land for housing and village settlements		√			
Specific land management / administration issues in PAD	√	√			√
Land registration improved/created	√	√	√	√	√
Recover/create land records	√	√	√	√	√
Train/educate land professionals	√	√	√	√	√
Cadastre products and services for displaced population and destroyed infrastructure and houses	√				
Land dispute mechanisms (by mediation or adjudication)	√	√	√		√

▲ *Table 1, Interventions in land administration for post-conflict state-building. (Todorovski, Zevenbergen and Van der Molen, 2016)*

documents integrated in the United Nations (UN) operations. Findings show that, when that was not the case, the development of the land segment occurred later resulting in complications to and a slowing down of post-conflict state-building. Where applicable, it was beneficial to quickly adopt ad-hoc land policies which strengthened the legitimacy of the state and supported political stability, as was shown in the case of Rwanda. The explored cases showed developments in the land sectors regarding creation of land legislation, organisations with enforcement mandates and participation by citizens and authorities involved, and these contributed to the rule of law in post-conflict contexts.

OVERCOMING INSTITUTIONAL WEAKNESSES

Development of a National Land Policy in post-conflict contexts benefited all related users. This was most efficient when it was developed within a broader National Development Strategy, jointly created and accepted by all relevant stakeholders. The land policy needs to contain clear directions about the development of the land law and appointment of specific organisations with a mandate for enforcement of the law and the policy. In all five explored cases, the creation of specific organisations such as land administration organisations and land-claim commissions revealed that this supported the governmental structure and strengthened the weak post-conflict political system. In addition, capacity building was required and implemented in relation to the legal framework, the creation of organisations, the education and training of land professionals, and equipment. In all cases, capacity building was supported by assistance from international actors or development partners. Findings have shown that the mentioned land-related activities are most effective and efficient when developed with international assistance and through implementation programmes or projects. Interventions in land administration contributed to improvement in the political leaders' low legitimacy and also to the legitimacy of the state. In the case of Rwanda, findings showed that building the legitimacy of the state was initially based on the ad-hoc land sharing policy, allocation of state land, and housing and village settlements. Interventions in land administration, as discussed here, support overcoming post-conflict institutional weaknesses.

ECONOMIC AND SOCIAL IMPROVEMENTS

Addressing the specific land management/administration interventions within the peace agreement documents in three explored cases, and addressing land issues as regards displaced persons as in all five cases, was a first step towards involving land and its administration in the improvement of the economic and social situation in post-conflict contexts. In addition, the creation of specific land-claim commissions and land administration organisations supported the population, and specifically the displaced people, in settling the land disputes and reduced the social and security tensions. The aim of land administration organisations is the creation or improvement of the land registration and land administration system. The explored cases showed that this was successfully realised, supported by implementation programmes or projects, which further contributed to sustainable development and supported the property market. The success of the implementation programmes and projects, as was the case in both main-case studies, is visible through the economic development and reduced social tensions. Development of land administration, specifically in the creation of land records in four cases (or recovery of the land records as in the case of Kosovo), contributed to the service provision to all land-related sectors and significantly increased the security of land rights. This supported the establishment of the land market and improved the overall economic development. When land records became available, provision of land products and services assisted the requirements of displacement and destroyed properties. Interventions in housing and property rights and land administration are identified as elements that contributed to solving the prevailing social and economic problems.

ESTABLISHING SECURITY

Addressing specific land management, administration (in three cases) – and land-related issues in the peace agreement document – was shown in all cases to contribute to some degree to improving security situations with regards to the displaced population. Land dispute and claim mechanisms were adequately developed in each of the five explored cases. In addition, findings reveal that these mechanisms are seen as instruments that support the settlement of land disputes and reduce conflict tensions.

▲ *Stenkovec refugee camp in Macedonia.*

The interventions in land administration identified here are recognised as facilitators of post-conflict state-building (Todorovski, 2016). ◀

FURTHER READING:

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DIMO TODOROVSKI

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Mobile Road Mapping in Cameroon

In Yaoundé, Cameroon, little cartographic data of the road network, public assets and utilities is available. To efficiently renovate the city's drinking water network, mobile mapping technology was used, taking extra care to ensure planimetric accuracy near the equator. It provided the GIS data for the road maps needed for the project planning. The experimental methodology used – with GIS and web suites integrated in the network construction project at all stages – was a good fit with the current African context and offers promising potential for future projects.

The Cameroon Water Utilities Corporation and Water Cameroonian are jointly in charge of creating and renovating infrastructures to provide drinking water to the Cameroonian population. Although the situation in this West African country is improving, in the capital Yaoundé for instance – which has a population of 2.5 million – still only a minority have access to drinking water via an individual connection. Renovation of Yaoundé's drinking water infrastructure was necessary; a new underground water network had to be built. But the construction company to which the work was subcontracted – Razel Bec Fayat – needed accurate road maps for its implementation plans, and they were not available.

Tight deadlines and the lack of up-to-date surveys and GIS data about Yaoundé led Razel to choose a mobile mapping system (MMS) for city surveying purposes. The mobile collection of georeferenced images would enable a fast and effective field survey. The surveys had to be performed as quickly as possible, since 230 kilometres of urban roads needed to be covered before the start of the rainy season.

FIELD DATA COLLECTION

The company Immergis was asked to help manage this mapping and GIS project, and the Imajbox MMS (by the French company Imajing) was chosen as the equipment to be used. Imajbox could be easily mounted on any vehicle suitable for the challenging local road conditions. A large part of the city's road network is neither paved nor maintained, which makes access and surveying difficult. The mobile collection of georeferenced images proved to facilitate field surveying in record time. The surveys were optimised by using two synchronised systems oriented towards two different angles. Each road was covered in both directions. Field operation teams had to deal with unforeseen events. Confronted with traffic jams and busy streets crowded with markets and small businesses, the teams adapted their surveying times to early morning and non-working days. The MMS enabled quick installation and automated calibration at any time. The Yaoundé survey took just eight days, so work was completed before the rainy season.

IMPROVING THE GNSS SIGNAL

In areas close to the equator, like Cameroon, global navigation satellite system (GNSS) signals are affected by strong atmospheric influences such as ionospheric errors. Consequently, GNSS-based survey results

Difficult surveying: a large part of the city's road network is neither paved nor maintained.

Two synchronised Imajbox mobile mapping systems were used, which could be easily mounted on any vehicle suitable for the road conditions in Yaoundé.

▲ *Survey data, map and GIS layers displayed in the Immergis Web GIS platform.*

often are not as good as in mid-latitude areas, such as in Europe. Hence, GIS data cannot be extracted for road map creation without extra steps to improve the absolute planimetric accuracy. In Yaoundé, no RTK infrastructure with ground reference base station network was available. Therefore, the project team decided to use an additional external receiver, synchronised in time with the Imajbox system, to receive real-time geostationary satellite constellation corrections. In post-processing, the results calculated by the receiver and inertial data from the MMS were merged to enable geographical positioning of each image surveyed. This configuration made it possible to collect GIS data with sufficient accuracy for road map design.

IN AREAS CLOSE TO THE EQUATOR, LIKE CAMEROON, GNSS SIGNALS ARE AFFECTED BY STRONG ATMOSPHERIC INFLUENCES SUCH AS IONOSPHERIC ERRORS

MAP PRODUCTION

DWG maps with detailed roads and asset locations, positions and dimensions were required for end usage in CAD software. Other elements of the Imajing software suite were used to extract GIS data from the survey results and also to make 3D measurements in images. Points and lines were produced to identify road shoulders, roadside slopes and all urban assets and road environments. A GIS database was built. The insufficient number of geodetic markers located within the city boundaries proved to be challenging. It is difficult to unify data – especially the altimetry data – derived from modern technologies and traditional levelling methods that were used in Cameroon. Existing geodetic markers combined with local cadastral data were used to recalibrate the survey data and provide reliable Z coordinates. The database was smoothed and readjusted based on the different sources of information available. Within three months, Immergis had produced the road maps and provided DWG maps each week. This enabled constructor Razel to perform all the pre-work planning before making a start on the new water network. Furthermore, the usage of the mobile mapping technology aroused the interest of other companies in road construction and linear infrastructure projects. They all require up-to-date spatial data, and this project demonstrated that acquisition can be quick, efficient and reliable.

WORK PLANNING AND SUPERVISION

To display road maps, the location of project water pipes and survey images, the Immergis Web GIS platform was used. It helped the project team during work planning, reduced the number of field visits and accelerated the production of execution drawings. But planning and implementing construction works for 230km of underground water pipes in less than two years in a city like Yaoundé is a sizable challenge. The project manager at engineering company Razel needed the GIS to go further; it had to become part of the everyday life of the project at all stages. He requested that the GIS should assist with the work supervision, ease day-to-day decision-making and speed up the production of hundreds of mails to be sent to the project partners, such as the city council and the existing telecom, water and electricity network operators. Adapting the software to the project needs and to the local context, such as fluctuating internet access, was also challenging, but Immergis Web was successfully adapted to include a document management system, allowing the automatic generation of the mails (such as works authorisations or network cuts) that needed to be sent in each project phase. Other functionalities such as real-time display of the progress at each worksite were also developed.

The successful implementation of GIS software and web suites in this project has made the engineering company rethink and adapt its work procedures in order to integrate the approach into its internal processes. 25 project members at Razel, ranging from engineers and quality, safety and environment managers (QSEs) to project managers and designers, are now using the platform on a daily basis. ◀

ACKNOWLEDGEMENTS

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Inès Guth is marketing and business developer at Imajing s.a.s. and is involved in several international projects.

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BY **TOBIAS KURZ**, VOG GROUP, UNI RESEARCH AS, NORWAY

REVIEW OF THE 2ND VIRTUAL GEOLOGY CONFERENCE IN BERGEN, NORWAY

Where **Geomatics** Meets **Geosciences**

At the 2nd Virtual Geology Conference (VGC 2016) from 22-23 September 2016, geomatics met the geosciences in the beautiful fjord town of Bergen in western Norway. This follow-up to the VGC 2014 in Lausanne, Switzerland, which at that time was named the 'Vertical' Geology Conference, established the beginnings of a biannual VGC conference series. The conference is intended as a multidisciplinary forum for researchers in geosciences, geomatics and related disciplines to share their latest developments and applications in the growing field of close-range data collection techniques.

VGC 2016 was hosted by the Virtual Outcrop Geology (VOG) group at Uni Research in Bergen. Conference chair Simon Buckley was supported by his team of Nicole Nauman, Tobias Kurz and Christian Eide. Over 140 participants from more than 25 countries attended, facilitating a technical programme of 12 conference sessions including 41 oral presentations, 56 poster presentations, five interactive presentations, two keynote speakers and a closing plenary discussion.

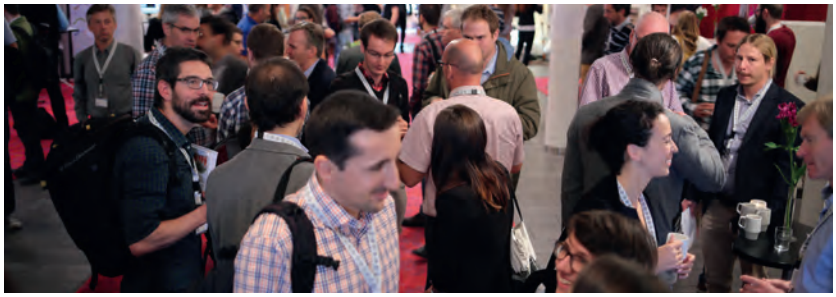
The cross-disciplinary conference theme brought together a mix of researchers: geologists, geomorphologists (landslide, coastal, glacial, periglacial), volcanologists, photogrammetrists and computer scientists involved in visualisation and virtual reality. The keynote speaker Lars Harald Blikra (Norwegian Water Resource and Energy Directorate) emphasised the importance of geomatics in geohazard management in Norway. He presented a number of cases from Norway, integrating different mapping and monitoring methods to understand landslide processes and estimate risk and uncertainty. The second keynote speaker of the conference, Helwig Hauser (University of Bergen), linked the conference theme to computer sciences. He demonstrated that innovative visualisation can provide more than nice graphic visualisation, in that it allows analysis and understanding of complex data and presents information which is otherwise difficult to extract.

Two presentations were particularly memorable. Sam Thiele (Monash University, Australia) analysed lava-dome growth by applying photography and thermal imaging. This presentation indicated the potential of thermal imaging techniques in close-range geoscience applications, a field which is seeing growing interest at the moment due to the increasing availability of acceptably priced instruments. The group of Demetrius N. Alves (Vale do Rio dos Sinos University, Brazil) presented a fully immersive 3D virtual reality environment using a head-mounted display which allows users to immerge themselves in a fully virtual world. This new generation of 3D model visualisation allows, for example, virtual geological exploration of outcrop models complete with interactive measurements and mapping.

Two short courses were held the day prior to the conference. The Virtual Geoscience course led by Simon Buckley and Tobias Kurz gave an overview and better understanding of the advantages and limitations of 3D modelling techniques such as terrestrial Lidar and SfM photogrammetry including various visualisation opportunities. Participants were also introduced to the use of ground-based hyperspectral imaging to complement 3D models with complex material information. The second course was held by Daniel Girardeau-Montaut (CloudCompare project), one of the creators of the freely available 3D point-cloud processing software CloudCompare which has become a standard tool in the geosciences. Participants learned more about point-cloud processing and how they can apply CloudCompare in their own projects.

The organising committee would like to thank all partners and sponsors for their support. Thanks particularly to the significant interest from researchers, and to the deputies from public authorities and industry, this gathering was a great success and the organisers look forward to welcoming and seeing all presenters and participants again at the next VGC event.

✉ Tobias.Kurz@uni.no



▲ *The VGC 2016 exhibition: meeting point for coffee and discussions.*

REFLECTIONS ON INTERGEO 2016

Integrating **Geospatial Technologies**

As the leading event for the global geoinformation community, Intergeo 2016 provided a forum for 531 exhibitors to present their latest products and around 150 speakers to disseminate their innovative thoughts. 17,000 visitors and 1,300 conference delegates from more than 100 countries travelled to Germany's main harbour city, Hamburg, to see the latest developments and applications in the geospatial sector.

▲ *Intergeo 2016 press conference.*

A GENERAL OVERVIEW OF THE GEOMATICS SECTOR FROM AN INTERGEO 2016 PERSPECTIVE

Throughout the last decade, the affordable technologies from other sectors such as navigation, robotics, automotive and industrial surveying have been adopted by the geoinformation sector to seamlessly integrate them in new geodata capturing and processing workflows such as UAV photogrammetry, laser scanning and multi-sensor surveying set-ups. Introducing new technology and data processing capabilities into current geobusiness models and business processes has scaled up the contribution of the geoinformation sector in other sectors and businesses. This de-facto situation has resulted in increasing market demand for the whole geoinformation sector, from technology production to services and users.

Since the current market demand is mainly dominated by the public sector, there is still a gap in the perception of leading technology vendors and service providers. However, this gap is narrowing in view of the strong demand from mobile individuals, efforts to improve public services in the context of smart cities and due to the ecosystem of cloud computation and the Internet of Things (IoT). In response to these trends, the leading market players are continually developing innovative technology to provide total solutions for the GI sector as well as for geo-fuelled sectors ranging from automotive to transportation and from agriculture to urbanisation.

The speakers, talks and technology presentations covered open geoinformation acquisition, management and servicing policies, and strategic plans at national and urban level for various sectors.

The leading topic of the event was 'Smart Cities – digitalisation of urban life'. In his case study on Manchester, keynote speaker Nigel Clifford, CEO of Ordnance Survey UK, clarified solutions to challenges such as transportation, population growth, health and the continual generation of big data. Other conference speakers, including governmental institutions and private companies, presented examples of German cities and particularly of Hamburg. Top executives from Trimble and Leica Geosystems highlighted the technology supporting the concepts of 'urban digitisation', Building Information Modelling (BIM), Geospatial 4.0 and interaction with other sectors such as agriculture and transportation.

INNOVATIVE FACE

With so much innovation on display at the exhibition, it is difficult to select the absolute 'newest' and 'most innovative' developments. There were innovative new technologies which aim at excellence in operation, accuracy and size minimisation for the purpose of terrestrial surveying, engineering surveying, satellite surveying, mobile mapping, laser scanning, navigation, unmanned aerial vehicles (UAVs) at Interaerial Soutions, big data analytics, BIM and services particularly for realisation of smart cities, to name but a few. But the innovative face of Intergeo 2016 can

be characterised by keywords such as 'workflow efficiency', 'excellence in integrating multiple sensor, hardware and software' and 'excellence in one-point solutions as a complete service'. Furthermore, while wearable devices are not new, the capability for visualisation and real-time processing in augmented reality looks promising for new application fields.

SMART CITIES AND SDI

Together, the exhibition and conference provided the technological and implementation base for realisation of the smart city concept which has been in development for more than a decade. Solutions and technologies covering observation, mobile mapping, online monitoring and processing were seamlessly integrated in GIS/BIM-enabled analytics software to support digitalisation of urban management.
German national institutions including the Federal Agency for Cartography and Geodesy (BKG), the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV), the Bundeswehr Geoinformation Centre (BGIC) and the German Society for Geodesy, Geoinformation and Land Management (DVW) shared their experiences to contribute to the national and international geospatial framework.

UAVS AND MOBILE MAPPING

Almost 25% of the exhibitors presented equipment or software solutions for single or multi-sensor UAVs, some of which were capable of real-time data processing. An increase in the positional accuracy was mainly provided by the post-processing kinematic (PPK) technique. Demonstrations in the flight zone showed planning, operation, take-off and landing as well as in-air stability of various UAVs.
There is a growing number of mobile mapping systems available from various vendors for cars, quadros, backpacks and trolleys, for both outdoor and indoor applications. As most of them rely on common OEM parts (GNSS/IMU, camera and laser scanner), the differences lie in operational reputation, integration, data processing, interoperability and the vendors' support networks.

BLURRING THE BOUNDARIES BETWEEN SURVEYING, GIS AND BIM

The boundary between GIS/photogrammetry and surveying is becoming invisible, resulting in seamless interaction. The multi-sensor surveying equipment provides more data and 'awareness' to surveyors, who in turn are more or less becoming GIS technologists. On the other hand, the one-button, easy-to-use surveying and processing provided by new technology such as UAV photogrammetry, including laser scanning, means that GIS professionals are becoming natural surveyors and field data experts.

▲ *Geoinformation provides support for solving societal and urban challenges.*

▲ *All-in-one geosensing mobile mapping set-up on a quadro.*

Companies such as Trimble, Leica Geosystems and Topcon displayed their complete solutions of technology and software, with end-to-end, one-point solutions for geomatics and geoinformation processing. These solutions cover processes ranging from mobile mapping to UAV photogrammetry, engineering surveying to rail monitoring, and terrestrial to offshore laser scanning.
Esri and Autodesk exhibited their evolutionary products, solutions and services from GIS and CAD perspectives, respectively, aimed at solving societal problems related to smart cities, utility management and BIM.

GNSS, POSITIONING AND NAVIGATION

Despite the ever-decreasing size of GNSS antennas and receivers, they provide high accuracy (for sub-centimetre level geodetic or sub-metre level GIS data acquisition purposes) and reliability as well as wireless connectivity to data management software. There were notably few exhibitors of indoor positioning systems (IPSs) based on vision-based positioning or radio-frequency navigation technologies. As the boundary between positioning and indoor/outdoor navigation becomes blurred, the Internet of Things will become more geointelligent, which will open up new geobusiness opportunities and markets.

INTERFACING WITH OTHER BUSINESSES

Business-oriented visitors were attracted by geoinformation technology and software solutions for engineering, smart grids, electricity, construction, mining, land management, road/rail maintenance, ground visualisation (geotechnical monitoring) and agriculture. Numerous companies and European institutions in the field of satellite imagery and services, aerial imagery, geovisualisation, mapping, GIS, geodata analytics and web publishing presented their solutions and took advantage of the opportunity to hold business meetings.

YOUNG PROFESSIONALS

The Intergeo 2016 platform encouraged emerging new business developers and start-ups to compete with established market players by introducing efficient new technologies and one-point solution service models. This year's event attracted an impressive number of young visitors and junior geomatics professionals who showed incredible enthusiasm for learning and keenness to embark on a good career in a technology-driven company.
Looking ahead to Intergeo 2017, which will be held from 26-28 September in Berlin, as geospatial technologies are becoming an important component across many verticals the geomatics community can expect to see innovative applications in mining, agriculture, transportation (roads, rail and inland waterways), robotics and automotive. ◀

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TATUKGIS

Expanding GIS Custom-development Possibilities

Located in Gdynia, Poland, TatukGIS develops and licenses GIS software development toolkit (SDK) products supporting multiple development environments and frameworks, e.g. Embarcadero Delphi/VCL & FireMonkey, Microsoft .NET, ASP.NET and ActiveX, and Java. TatukGIS products enable the development of custom GIS applications for the Microsoft Windows, Apple OSX and iOS, Android and Linux operating systems.

TatukGIS is a private company founded as a start-up business in 2000 with the objective of providing superior GIS software and custom GIS development tools in terms of price and quality. While much has changed in the GIS software industry since that time, TatukGIS has steadily persevered with further developing its in-house GIS technology and products. Today, customers in over 50 countries use TatukGIS products for custom GIS applications and solutions in industries such as transportation and energy infrastructure management, environmental engineering, utilities, agriculture, forestry, mining, telecommunications, military and more. TatukGIS products reflect the company's own intellectual property, without reliance on third-party software or components except as may be required to support certain proprietary data formats.

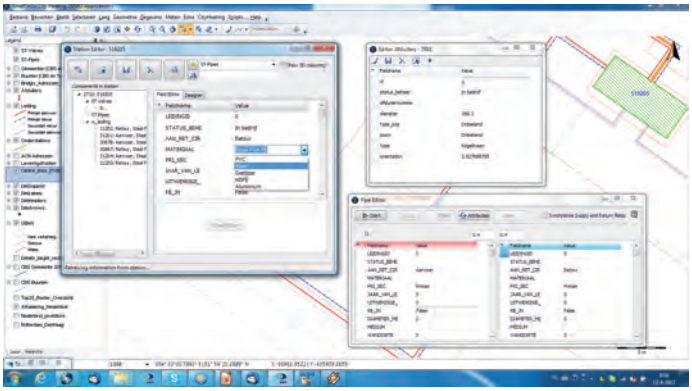
WEB-CENTRIC BUSINESS MODEL

The philosophy of TatukGIS is to support all widely used data formats, databases and technologies for the benefit of its customers. Products are compatible with most GIS/CAD industry data formats, most geodatabases and database engines, and many open GIS standards. TatukGIS enthusiastically supports open data formats and, unlike some GIS software companies, never pressures customers to store their data in proprietary (i.e. not publicly documented) formats.

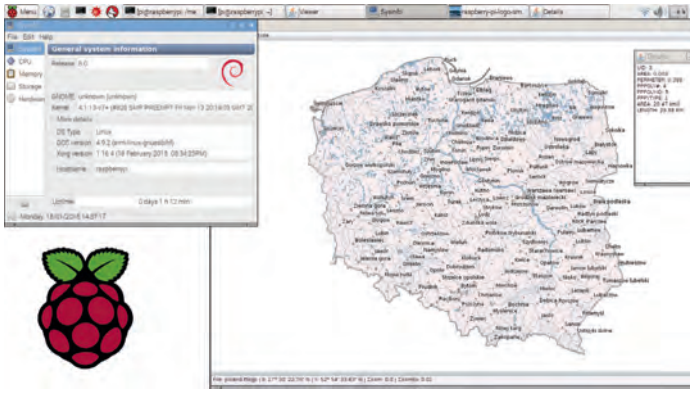
When starting the company, TatukGIS briefly considered using its in-house GIS technology/intellectual property to provide GIS subcontracting services for large IT contracts. After some time, the team realised their real strength was developing the underlying GIS technology – and SDK products created from that technology – to enable TatukGIS customers to create great custom GIS applications and final solutions. TatukGIS have remained true to that objective ever since. After all, it is the customers who really understand the GIS solution requirements of their respective industries and markets.

TatukGIS licenses its SDK products free of royalties or run-time fees, which helps customers also make their GIS solutions available to less specialised users for whom GIS access might otherwise not be practical

▲ *DK-developed GIS application running on iPad, Android tablet and Mac.*



▲ *TatukGIS Editor application to manage city water heating networks, by SmalltoGo.*



▲ *DK.Java-developed application for Linux running on Raspberry Pi computer.*

or economical. Partly because TatukGIS customers are scattered across industries, geographies and time zones, the company employs a web-centric business model. Licence sales, sales support, product delivery, product technical support and upgrades are all performed online, managed from the TatukGIS office in Poland. In other words, customer technical support is provided by the same software engineers who develop the products.

DEVELOPMENT SCOPE

TatukGIS licenses Developer Kernel (GIS SDK) product editions for the following development environments and frameworks:

- Embarcadero RAD Studio (Delphi/C++) for VCL framework for Microsoft Windows 32 and 64 bit applications
- Embarcadero RAD Studio (Delphi/C++) for FireMonkey (FMX) framework for Microsoft Windows 32 and 64 bit, Apple OSX and iOS, and Android applications
- Microsoft .NET for WinForms and WPF (support for Xamarin under development) for 32 and 64 bit applications
- Microsoft ASP.NET for WebGIS applications
- Microsoft ActiveX for Microsoft Windows 32 and 64 bit applications
- Java for Windows, Linux, Unix, OSX (and other Java-enabled platform) applications.

Key features include the extensive TatukGIS object API, state-of-the-art support for coordinate systems, efficient on-the-fly vector/raster map layer reprojection between approximately 5,000 pre-defined coordinate systems, 3D visualisation, top performance with huge datasets and royalty-free SDK licensing. For enterprise-level solutions, TatukGIS supports most spatial geodatabases, including PostGIS, Oracle Spatial and GeoRaster, Microsoft SQL Spatial Server, and IBM DB2 Spatial Extender and Informix Spatial DataBlade.

CUSTOMISABLE AND EXTENDABLE

The desktop TatukGIS Editor presents an additional GIS development option because its built-in scripting capabilities (Pascal & Basic syntax) and full API access make the product so customisable and extendable. The Editor is an interesting development option because the starting point of development is a highly functional, well-tested and seasoned desktop GIS. This can dramatically reduce development costs, project risk and time to completion. For others, the Editor is attractive because the default features fulfil the requirements of many GIS users without the overwhelming complexity, learning requirements and expense of some market-leading desktop GIS products. The popular desktop TatukGIS Viewer and Coordinate Calculator are excellent free demo applications of the TatukGIS technology.

TatukGIS makes a big effort to support multiple development technologies because this offers its customers tremendous possibilities and reduced risk. For example, TatukGIS continues to accommodate customers of its ActiveX SDK edition by supporting and upgrading this product, even though Microsoft depreciated the ActiveX technology long ago. When these customers eventually decide to migrate their application development from ActiveX to a more modern development platform, TatukGIS gives them options. They might move to the pure .NET SDK edition with C# or VB.NET, or perhaps to the native Delphi SDK edition with Embarcadero C++Builder, or even to Java, without having to redevelop their applications or learn a different GIS technology. TatukGIS customers are never locked into a development technology or data storage format.

LOOKING AHEAD

In 2016 TatukGIS is releasing the latest generation of its GIS SDK product line (version 11) enabling, for the first time, development for non-Windows operating systems, e.g. Apple OSX and iOS, Android, Linux and Unix. The full TatukGIS API is now available for mobile development, meaning any TatukGIS-supported GIS mapping functionality can be developed, royalty-free, into an iPad or Android tablet application. Furthermore, existing TatukGIS SDK-developed desktop GIS applications can be run on an iPad or Android tablet relatively easily. For Embarcadero RAD Studio developers, TatukGIS offers the world's only high-level native Delphi source code GIS SDK. The new TatukGIS SDK for Java may be the only Java GIS development product available.

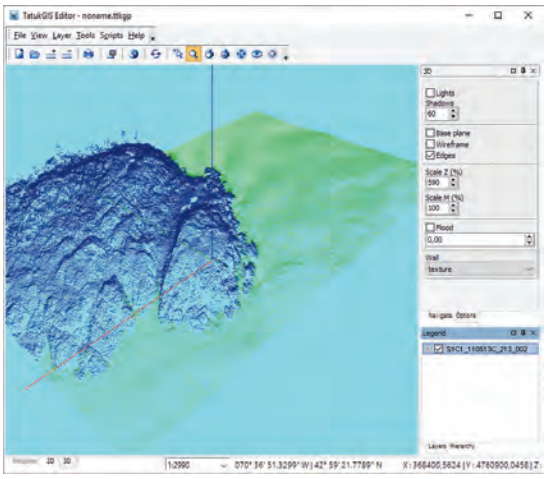
Version 11 introduces other important features including GPU acceleration for improved map rendering performance, high-resolution 'retina' map rendering support for new-generation 4K monitors, redesigned support for pixel operations with vector-to-grid interpolation algorithms for Kriging, IDW and Splines, heat-map algorithm and enhanced 3D mapping functionality. The same features will appear later this year in the Version 5 upgrade of TatukGIS Editor.

Although historically stronger on the vector mapping side, the redesigned support for pixel operations paves the way for more grid analysis functionality. TatukGIS is also working on native topological layer support. TatukGIS recently introduced a new online help system with full API documentation and regularly updated content.

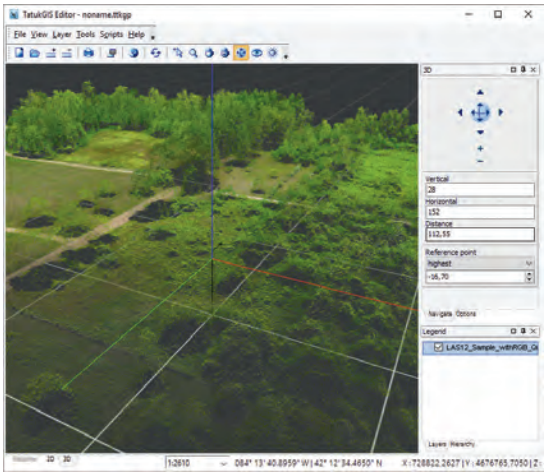
In the future, TatukGIS intends to continue what it has done in the past, which is to provide and support its customers with the best and most cost-effective GIS development tools in the industry, develop support for useful new technologies and attract new customers. ◀

More information
www.tatukgis.com

Every month GIM International invites a company to introduce itself in these pages. The resulting article, entitled Company's View, is subject to the usual copy editing procedures, but the publisher takes no responsibility for the content and the views expressed are not necessarily those of the magazine.



▲ *LAS point cloud 3D mesh in the TatukGIS Editor.*



▲ *Coloured LAS 3D Lidar data in the TatukGIS Editor.*

Two FIG Events in Athens, Greece

3D CADASTRES

The 5th International FIG Workshop on 3D Cadastres was recently organised in Athens, Greece. Together with the 11th 3D GeoInfo Conference and the ISPRS 3D Indoor Workshop, it formed part of the very successful Joint 3D Athens 2016 Conference from 18-21 October 2016. Participants from all continents presented 90 papers at the joint event. The majority of the 70-80 3D Cadastres attendees also participated in 3D GeoInfo/ Indoor 3D, illustrating the synergy between the events. The reviewers had been very active in preparation and it was great to see that various authors/ presenters acknowledged this in public. Based on the full paper reviews, the 3D Cadastres 2016 Best Paper Award was given to Katerina Athanasiou, Efi Dimopoulou, Christos Kastrisios and Lysandros Tsoulos for their paper on 'Management of Marine Rights, Restrictions and Responsibilities according to International Standards'. There was an open and collegial attitude, resulting in a lot of fruitful discussion and interaction between participants from government, industry and academia. The active participation by Hellenic Cadastre was also an important element. Moreover the plenary joint session between the 3D Cadastres and 3D GeoInfo conferences covered the latest developments in dynamic 3D city models, nD point clouds and 3D standards evolution. FIG president and 'Athens local', Chryssy Potsiou, put the conference in context of supporting mega-cities, fit-for-purpose solutions and the global UN agenda. Besides 3D cadastres, the joint event also covered the most recent 3D developments in the fields of big data, data management, city modelling and environmental and infrastructure management. In addition to the scientific programme, the participants also tasted traditional dinners in a warm and hospitable social programme. Many thanks to the authors, presenters, active participants, reviewers and the local organising team for making this an unforgettable event due to the great content, amazing historic venue and the Greek personal touch. Looking forward to seeing you in Melbourne 2017, Delft 2018 and Singapore 2019.

Prof Efi Dimopoulou and Prof Peter van Oosterom

Sustainable Real Estate Markets – Policy Framework and Necessary Reforms

In September 2016, FIG and the Global Land Tool Network jointly organised in Athens an Expert Group Meeting on 'Valuation of Unregistered Lands' together with a high-level FIG and World Bank conference on 'Sustainable Real Estate Markets – Policy Framework and Necessary Reforms'. The conference was supported by the International Real Estate Federation and aimed to raise awareness of the necessary strategic and policy framework in order to formalise and create sustainable real estate markets as a pillar on which to build robust economic urban growth, eliminate urban poverty and achieve the vision of the global sustainable development agenda of 2030. FIG President Prof Potsiou planned this conference in collaboration with Mr Zakout Wael from the World Bank. About 200 delegates from 25 countries participated in the conference and 73 interesting presentations were given. The Hellenic Government was represented by the Deputy Minister for the Environment and Energy, Mr Tsironis, and the General Secretary of the Ministry of Economy, Prof Lamprianidis.

FIG President Prof Chryssy Potsiou.

More information
https://www.fig.net/news/news_2016/2016_09_gltn-egm.asp

GSDI at INSPIRE 2016

The annual INSPIRE Conference took place in Barcelona, Spain, from 26-30 September 2016, and several GSDI members participated. INSPIRE conferences aim to show how the implementation of the EU's INSPIRE Directive contributes to the European Interoperability Framework and the EU's digital economy in general.

Organisations from across the EU present their work, concerns, challenges and successes in implementing INSPIRE.

GSDI member sponsors or exhibitors included Esri, open source GIS specialists GeoCat and regional bodies EuroGeographics, EUROGI and UNIGIS. Mick Cory, EuroGeographics' secretary general and executive director, was a plenary speaker on 29 September.

Among the 220-plus oral presentations at the conference, ones by GSDI members included:

- Roger Longhorn, GSDI secretary-general, on 'Role of Coastal/Marine Atlases in Human-centric SDIs' reporting on the work of the International Coastal Atlas Network (ICAN) and GSDI's participation in the IHO Marine SDI Working Group.
- Dutch Kadaster's Caroline Groot presented the 'Dutch One Portal', Haico van der Vegt introduced 'PDOK, the Public SDI in The Netherlands' and Renske van Setten offered 'GeoDCAT and Linked Data'.
- GeoCat presenters included Joana Simoes on 'Catalog Support in QGIS' and Paul van Genuchten with 'INSPIRE Data and the Search Engines', 'GeoDataStore' and 'What's New in GeoNetwork for INSPIRE'.
- TU Delft's Glenn Vancauwenberghe offered 'Reviewing the EU Member States' Governance of INSPIRE' and 'Governance and Performance of Open Spatial Data Policies in the Context of INSPIRE'.
- National Land Survey of Finland's Jani Kylmaaho presented the 'Arctic Spatial Data Infrastructure (Arctic SDI)' and Teemu Saloriutta looked at 'Implementing INSPIRE Services without Commercial Software'.
- EuroGeographic's Saulius Urbanas updated the audience on the 'European Location Framework (ELF) Acting as a Facilitator Implementing INSPIRE'.
- Open Geospatial Consortium's Athina Trakis presented 'Smart Cities for a Resilient Future'.

INSPIRE workshops and training sessions by GSDI members:

- Roger Longhorn, GSDI secretary-general, and Dr Jade Georis-Creuseveau, of GSDI member LETG-BREST GEOMER, presented the 'SDI Marine/Coastal SDI Capacity Building Workshop' based on the work of the GSDI Marine SDI Best Practice Project.
- Esri provided a workshop on 'ArcGIS – the Open Platform' and training sessions on 'What is Web GIS?'.
- GeoCat held a training session on 'An Easy-to-use Solution for INSPIRE Data Publishing and Hosting'.

All presentations are on the INSPIRE 2016 website at: http://inspire.ec.europa.eu/events/conferences/inspire_2016.

View the special conference issue of *GIM International* at: https://www.gim-international.com/magazine/inspire-special-2016
Visit the GSDI 15 World Conference in Taipei, from 29 November to 2 December 2016, to learn even more about SDI and smart territories. See http://gsdi15.org.tw for information.

▲ *The INSPIRE EC booth.*

More information
www.gsdi.org

12th International Geoid School

The International Service for the Geoid (ISG) was established in 1992 and is an official service of the IAG. One of the main tasks of the ISG is organising or supporting technical schools on geoid estimation and related topics. The most recent Geoid School – the 12th of the series – was held in Ulaanbaatar, Mongolia, from 6-20 June 2016.

To manage this Geoid School, a Local Organising Committee was established consisting of representatives from the Mongolian University of Science and Technology (MUS) and MonMap Engineering Services Co. Ltd. as well as the Mongolian Association of Geodesy, Photogrammetry and Cartography, the Administration of Land Affairs, Geodesy and Cartography, and the Ministry of Construction and Urban Development.

The number participants was 30, consisting of 15 domestic attendees and 15 foreigners from nine different countries: Bhutan, China, India, Latvia, Mongolia, Philippines, Poland, Russia and Sri Lanka. Five teachers were invited from Canada, Denmark, Italy and USA to hold lectures and supervise practical exercises during four full-day sessions. The teachers that gave lessons during the school were: Prof R. Barzaghi (Politecnico di Milano, Italy), Prof F. Sansò (Politecnico di Milano, Italy), Prof R. Forsberg (National Space Institute, Denmark), Prof M. Sideris (University of Calgary, Canada) and Dr S. Holmes (SGT Inc., USA).

The topics were:
- General theory of the gravity field
- Height datum unification
- Terrain effect computations
- Geoid estimation
- Global geopotential models
- Case studies

More information
www.iag-aig.org

Learning about – and with – Atlases

A joint meeting of the ICA Commissions on Atlases with Education & Training took place at the ETH Zurich at the end of August 2016. Common areas of interest, reflected in the variety of presentations, included the contemporary changing concepts of atlases, the nature of educational atlases, the development of educational curricula through a proposed Body of Knowledge, and the future of the atlas as a data integration device and an educational tool.

▲ *Participants at the Zurich symposium, pictured at the ETH Institute for Cartography (with lead chair, Lorenz Hurni, front centre).*

The keynote was given by Prof Ferjan Ormeling who elucidated the development of atlas concepts since antiquity, stressing the characteristics of atlases which demonstrate unity of form, unity of print and unity of content. He further investigated the traditional role of atlases as organising devices and reference frameworks, but also their utility in enabling comparison, examining temporal patterns and establishing causal relationships. Extending these to the functionalities of digital atlases was also discussed.

Practical examples of national and educational atlas cartography were considered by several speakers, whilst specific atlas projects such as the atlas of ageing, an atlas for environmental education in East Africa and statistical atlas production in Switzerland were introduced. More theoretical investigations of atlas content/structure and the use of atlases as examples

of modern cartographic development were presented, notably from attendees from Ukraine. The use of atlases, both in schools and in wider society, was covered by speakers from the Czech Republic and Germany. The meeting participants were pleased to hear about the discussions at the Atlas-Zukunfte event (held in June 2016 in Leipzig), a German-language workshop which considered the atlas of the future.
A session on the education of cartographers included accounts of the history of cartographic education in Hungary, what is needed for cartographers to face the challenges and opportunities in digital atlases, the role of contextual education in maths for cartographers and, most wide-ranging, the nature of the Body of Knowledge project for cartography being run by the Commission on Education & Training. The role of design in the education of cartographers was also considered.
The meeting was most generously supported by the Institute for Cartography at ETH, the home of the famous national 'Atlas der Schweiz' and the educational 'Schweizer WeltAtlas', and organised by René Sieber of that institute. Two fascinating excursions – to the extensive Map Library of the Zentralbibliothek of the Canton of Zurich and to the local Uetliberg mountain for a panoramic view of the city – were part of the efficiently arranged and intellectually stimulating symposium.

More information
www.icaci.org

Status Report on the *ISPRS Journal of Photogrammetry and Remote Sensing*

In this article we highlight some key aspects of our report presented to the General Assembly at the ISPRS Congress in Prague in July 2016.

HIGHLIGHTS

The 2012-2015 reporting period saw rapid growth for the *ISPRS Journal of Photogrammetry and Remote Sensing* in terms of submitted and published papers and impact. Since 2011, the number of submitted manuscripts has more than doubled, plateauing at just over 650 in 2014 and 2015. The number of 2016 submissions follows this trend. Published articles increased from 100 in eight volumes in 2012 to 187 in 12 volumes in 2015. The impact factor (IF), consistently around 3.0 for several years, reached 4.188 in 2016. The journal now ranks number 2 among all remote sensing journals.

Thanks to finding process efficiencies, the mean article handling time (from submission to final decision) improved from 44.2 to 29.4 weeks. Author satisfaction reflected in Elsevier's author survey is positive in all evaluation categories (reputation, reviewing standard and speed, IF, production speed and others).

ENGAGEMENT

Outreach activities are important to promote the journal and help potential authors, and young scientists in particular, to understand the peer review and publication processes as well as publication ethics. We have engaged in a number of activities over the past several years including author workshops, guest lectures and international editor panel discussion forums.

The most recent event was the author workshop delivered in two 90-minute sessions at the Prague Congress: 'How to Publish (and Review) in a Top Journal', presented by us, and 'Changes in the Publishing Landscape', presented by EJ van Lanen from Elsevier. There were about 40 attendees and we received very positive feedback from several participants.

We held a very successful editorial meeting in Prague with 23 attendees (pictured) including editors, Editorial Advisory Board members, ISPRS Councillors and Elsevier representation. A status report was followed by very fruitful discussion on current issues facing the journal and suggestions for future improvements. It proved to be an excellent opportunity to obtain feedback and advice.

The successes enjoyed by the journal are the result of contributions from many people whom we wish to thank: authors, reviewers, Editorial Advisory Board members, associate editors and guest editors, past EiC George Vosselman, the UV Helava Award jurors, ISPRS Council and the publishers and Elsevier support staff.

Derek Lichti
Qihao Weng
Editors-in-chief

More information
www.isprs.org

NOVEMBER

FROM IMAGERY TO THE MAP
Agra, India
from 13-17 November
For more information:
W: http://conf.racurs.ru/conf2016/eng

TRIMBLE DIMENSIONS
Las Vegas, USA
from 7-9 November
For more information:
W: www.trimbledimensions.com

LOCATION BASED SERVICES
Vienna, Austria
from 14-16 November
For more information:
W: http://lbsconference.org

CHINTERGEO
Suzhou, China
From 24-26 November
For more information:
W: www.chintergeo.com

GSDI 15TH WORLD CONFERENCE
Taipei, Taiwan
from 28 November - 2 December
For more information:
gsdi15.org.tw

2017

JANUARY

GLOBAL SPACE CONGRESS
Abu Dhabi, United Arab Emirates
from 31 January - 1 February
For more information:
globalspacecongress.com

APRIL

GISTAM 2017
Porto, Portugal
From 27-27 April
For more information:
W: www.gistam.org/?y=2017

MAY

XPONENTIAL 2017
Dallas, USA
from 8-11 May
For more information:
www.xponential.org/xponential2017

GEO BUSINESS 2017
London, UK
from 23-24 May
For more information:
http://geobusinessshow.com

FIG WORKING WEEK 2017
Helsinki, Finland
from 29 May - 2 June
For more information:
www.fig.net/fig2017

JULY

INTERNATIONAL CARTOGRAPHIC CONFERENCE
Washington, USA
from 2-7 July
For more information:
icc2017.org

SEPTEMBER

UAV-G 2017
Bonn, Germany
from 4-7 September
For more information:
uavg17.ipb.uni-bonn.de

ISPRS GEOSPATIAL WEEK
Wuhan, China
from 18-22 September
For more information:
zhuanti.3snews.net/2016/ISPRS

CALENDAR NOTICES
Please send notices at least 3 months before the event date to: Trea Fledderus, marketing assistant, email: trea.fledderus@geomares.nl

For extended information on the shows mentioned on this page, see our website: www.gim-international.com.

INTRODUCING THE

Trimble SX10