

GIM

INTERNATIONAL

THE GLOBAL MAGAZINE FOR GEOMATICS
WWW.GIM-INTERNATIONAL.COM



ISSUE 4 • VOLUME 30 • APRIL 2016

Collaborating on Solutions for Land Governance Issues

Interview with Oumar Sylla (GLTN)

DEVELOPING THE NAMIBIAN NATIONAL SPATIAL DATA INFRASTRUCTURE

LAND GOVERNANCE IN RWANDA

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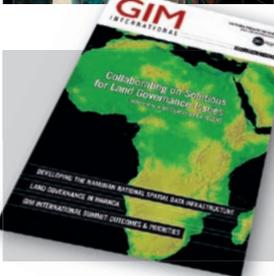
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Developing the Namibian National Spatial Data Infrastructure

Integration of Location Information and Statistical Data



This issue is focused on Africa and includes an interview with Oumar Sylla, the recently appointed leader of UN-Habitat's Land and GLTN Unit, and articles on the latest geospatial developments in Rwanda and Namibia. While the African continent still faces many challenges, it is also bursting with opportunities!

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Africa

This month's focus is on Africa, the continent of promise for which many challenges still lie ahead. At the GIM International Summit, which took place in Amsterdam in February, Africa was certainly on the programme. The main idea of the summit was to address global challenges to which geomatics might hold the solutions. A complete report on the summit by our editors Martin Kodde and Sabine de Milliano can be found on page 24 of this issue and there's lots more to see and learn on our website www.gim-international.com – videos, presentations and articles relating to the issues that were discussed during workshops and in plenary sessions. Morten Jerven, author of the book *Africa, Why Economists Get It Wrong* explained that a lot of data about Africa is simply incorrect and therefore difficult to work with. Vanessa Watson, professor of city planning at the University of Cape Town, South Africa, gave an inspiring presentation on the many unrealistic plans that are being drawn up for new cities by urban planners, some of whom have never even been to Africa. Reality checks and fact checks seem to be a good idea, and research into the rightful place of geoinformation in these processes even more so.

This month the UN-GGIM community is gathering during its Fourth High Level Forum in Addis Ababa, Ethiopia. The forum will have the overarching theme of 'Good



▲ Durk Haarsma, publishing director

Land Governance for the 2030 Agenda' and will focus on land administration and management. Land information, as we've known for years, is fundamental to successful development of nations and economic benefits – decreasing poverty – for citizens. At the meeting in Addis Ababa, the central focal point will be sharing experiences and demonstrating the practical implementation of digital land registers, cadastres and other examples of successful land administration. We will make sure that the outcomes of the GIM International Summit will be brought to the attention of the delegates at UN-GGIM's Fourth High Level Forum in Ethiopia.

This edition also contains details of a very successful initiative that has helped to establish a National Spatial Data Infrastructure in Namibia. In their article on 'Developing the Namibian National Spatial Data Infrastructure' on page 29, authors Alex Mudabeti of the Namibia Statistics Agency and Roger Longhorn, secretary-general of the GSDI Association, note the remarkable pace at which this has happened. Factors that have contributed to the success of this initiative include the 'happy marriage' between statistics and location information, political back-up and support, and the necessary legislation.

In some parts of Africa it may seem that anything is possible, and lack of technology is certainly no longer the problem, but elsewhere many problems still lurk just around the corner. One of the most pressing challenges is capacity: are there enough professionals to make this happen in the foreseeable future? One thing is for sure in this matter: it is essential for the geomatics industry to work together with educational institutes – not only all over the continent, but also in other developing regions of the world – to build that capacity. Furthermore, there will be an ongoing need to share, discuss and demonstrate examples from all over the globe in order to promote best practices.

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African Challenges and GIS Technology

Generalising about Africa is dangerous. With 47 countries (or 53 if you use the UN list and include island nations such as Cape Verde, Madagascar and the Comoros), it is hugely diverse. The state of economic development, social welfare, environmental quality, population growth and political development varies greatly across the continent. Yet there are many problems which are common, even if the incidence is variable. Environmental sustainability is just one of them.

Properly applied, ubiquitous and common GIS technology can vastly ease some of these problems. The colossal speed of adoption of mobile phones in India – rather than the creation of a landline infrastructure – is just one example of how disruptive technology can leap generations, rendering legacy technology obsolescent, and create new opportunities.

Geographic information science (GIScience) and geographic information systems (GIS) have already made a sizeable contribution to tackling environmental and other challenges in Africa. Perhaps the earliest example was the creation of a GIS facility in the UN Environment Program (UNEP) in the early 1980s in Nairobi, Kenya. In those days the biggest problems were continuity of electricity supply, existence of data and the presence of suitably skilled staff, plus low levels of acceptance of the potential value of GIS amongst decision-makers. Such problems are now less acute, even if resourcing remains a serious issue for many organisations.

Although the facility was primitive by current standards, the history of UNEP's GIS still has contemporary lessons, however. UNEP was established during the first United Nations Conference on the Human Environment in Stockholm, Sweden, in 1972 and its headquarters opened in Kenya two years later. Written details of the creation of the GIS facility have since become lost but an important factor was certainly the



▲ David Rhind.

contribution of Jack Dangermond, the founder of Esri. He gifted Esri's then-software to the embryonic facility and persuaded the president of Prime Computers – then one of the two leading mini-computer manufacturers – to donate suitable hardware. Esri is now the globally dominant commercial organisation in the GIS and related fields and two particularly important characteristics of Dangermond's approach have remained unchanged to this day. The first is the building of active partnerships with local communities: Esri has a very large number of government, not-for-profit and university bodies as partners comprising a vast ecosystem. The second characteristic is the fostering of education and GIS skills acquisition. Other vendors at the time typically took a short-term commercial view of access to their software by universities in particular. As a result, they lost out in the huge expansion of GIS student training and research applications which blossomed in universities across the world on the back of Esri software provided at low or no cost.

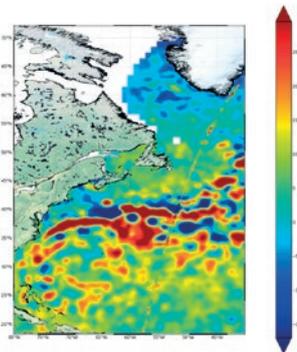
Thus UNEP and its GIS was part of the first GIS seeds sown in Africa. Later, UNEP GIS facilities were established in Norway, Poland and eventually everywhere. What happened in Nairobi was also an early demonstration of the benefits of long-term thinking on how to grow a business at the same time as supporting national and local communities in improving environmental sustainability.

Sentinel-3A Demonstrates Ability to Track Sea-level Change

Following the first impressive images from Sentinel-3A, the latest Copernicus satellite has now demonstrated how its altimeter can track sea-level change. Just after the radar altimeter instrument was turned on, it traced the height of the sea surface over a stretch of the North Atlantic, some of the most dynamic ocean waters in the world. Showing features relating to the Gulf Stream, the track compares very well with the background map of sea-surface height. The map, produced by the Copernicus Marine Environment Monitoring Service, comprises near-real-time data for one day from the CryoSat, Jason-2 and SARAL/AltiKa satellites.

► <http://bit.ly/1UaZs8a>

*Sea-level track from
Sentinel-3A.*



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



1. VGI in Land Administration: A Vision or a Necessity? - <http://bit.ly/1pXp3oJ>
2. Light Mobile Collection Tools for Land Administration - <http://bit.ly/1IHNLyA>
3. Germany's Progress towards a Multi-dimensional Cadastre - <http://bit.ly/1LBd8ab>
4. GPS for Land Surveyors: No Formulas Needed - [http:// bit.ly/1Rv3ZSF](http://bit.ly/1Rv3ZSF)
5. Facing the Post-2015 Global Agenda - <http://bit.ly/1MxlfPH>

Geo-matching.com Adds Rental Companies and Dealers

Geo-matching.com has recently added rental companies and dealers to its overview of products and solutions. Besides detailed information about the manufacturers of products and brands, Geo-matching.com users can now also find an overview of the companies that rent and/or deal in them and can request information from the relevant suppliers directly. The Geo-Swath Plus Compact 500kHz multibeam echosounder is just one example of a product listing rental and dealer opportunities; other brands include FARO, AML Oceanographic, Valeport, RIEGL, Kongsberg Maritime and various others. Moreover, it is now possible to search the listings based on operating region, field of application or product category to find a rental supplier or dealer. Visit Geo-matching.com for an overview of all current rental products and dealers.

► <http://bit.ly/1UaZEEI>

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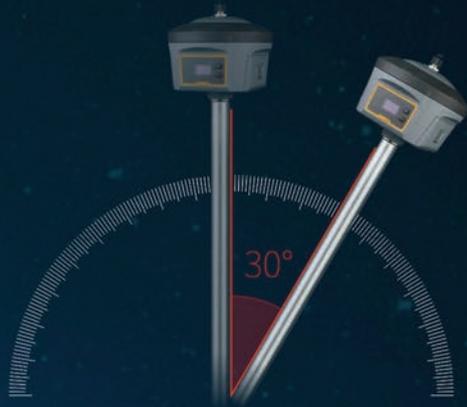
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- Electronic bubble correct
- Tilt Compensation
- NFC(Near Field Communication) function
- Positioning rate is up to 50Hz
- Rinex storage support
- Complete NTRIP Caster
- 8GB SSD storage
- OTG host



GALAXY G1

Intelligent Inertial RTK

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- Innovative structure design
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- Full satellite constellations support
- Electronic bubble correct
- Tilt compensation
- NFC(Near Field Communication) function
- Advanced datalink module
- Powerful new Bluetooth module
- Cloud service



SPAR 3D Adds More Hands-on Learning and Live Demonstrations

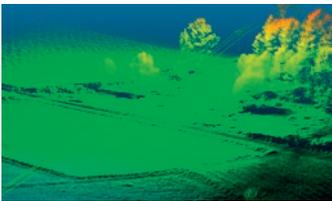


SPAR 3D Expo & Conference has added extra hands-on learning opportunities to its renowned 3D technology event to engage new users. The organisers have announced several new developments for the 13th edition, which will be held from 11-14 April 2016 in The Woodlands (near Houston, Texas), USA. The event is focused on 3D technology applications in key vertical markets. In addition to a full conference programme and a vendor-neutral exhibit hall, SPAR 3D will feature interactive workshops and demonstrations for hands-on learning of end-to-end 3D. Go to the URL below for an overview of the new activities.

► <http://bit.ly/1Ub0noU>

YellowScan Unveils Lidar Solution for Civil Engineering and Mining Professionals

YellowScan has announced the global launch of its new Lidar UAS surveying solution with highest accuracy and most dense georeferenced point cloud data. Weighing only 1.5kg, the YellowScan Surveyor has a 3cm accuracy and the capability to capture 300,000 shots per second. According to the French company, R&D development for the YellowScan Surveyor solution started in early 2015 with the same philosophy and technology foundation that has



YellowScan Lidar imagery.

made the YellowScan Mapper so successful. With a robust and fully integrated system designed to meet the needs of most demanding survey professionals and terrain, YellowScan Surveyor is quickly and easily adapted to any UAV.

► <http://bit.ly/1UaZlbe>

Vexcel Holdings Takes over Microsoft's UltraCam Business Unit

Vexcel Imaging GmbH, Microsoft's UltraCam business unit, has undergone an ownership change. After ten years of contributing to Microsoft as a subsidiary, Vexcel Imaging has once again become an independent company following acquisition by a private investment group on 11 March 2016. The new owner is Vexcel Holdings GmbH in the city of Graz, Austria, with the following shareholders: Erik Jorgensen, former Microsoft corporate vice president of Bing and MSN, who is leading Vexcel Holdings GmbH; Stephen Lawler, former CTO of Bing maps; Alexander Wiechert, CEO of Vexcel Imaging GmbH and running the UltraCam business; and Martin Ponticelli, development manager of the UltraCam Business Unit.



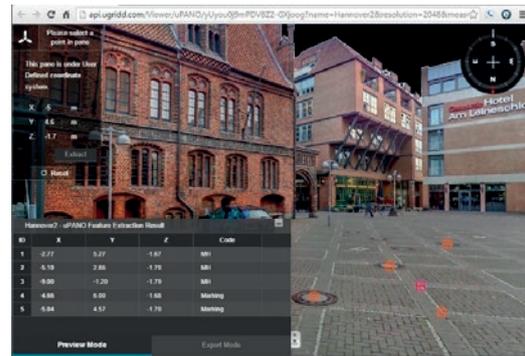
Microsoft UltraCam Osprey.

► <http://bit.ly/1Ub05P7>

New Feature Extraction Function Added to Popular Lidar Data Viewer

uGRIDD Corporation has released a new built-in feature in its popular Lidar data viewer, uPANO. This feature will offer uGRIDD customers a web-based tool to extract XYZ coordinates directly from uPANO, a proprietary panoramic viewing interface for Lidar data, panoramic photo and 3D CAD/BIM models. Lidar data, typically captured by terrestrial, mobile and airborne devices, has found its position during the last 20 years in many industries, such as infrastructure engineering and management. As a member in the big data family, Lidar data is worthy to bank. However, it can be difficult to manage and view due to its size and complexity. A specialised, complex and expensive software suite has usually been necessary to do the job, meaning that only professionals with the right training have had access to Lidar data.

► <http://bit.ly/1UaZU6f>

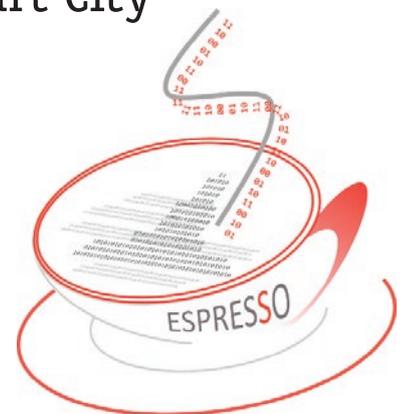


uPANO feature extraction result.

Ordnance Survey Seeking European Smart City Standards

Ordnance Survey (OS) is to create a smart city standards-based technologies business framework for the European Union's ESPRESSO project. ESPRESSO is being led by the Open Geospatial Consortium, and OS – working closely with key European bodies – will develop a strategic growth map for smart cities. Supported by PricewaterhouseCoopers, OS will also conduct analysis of existing and emerging economic, financial (including crowd-funding) and procurement models. OS is aiming to gather expert information and advice from commercial organisations and public-sector bodies across the globe and so is appealing to them to provide input into this framework and become key influencers in determining pan-global standards.

► <http://bit.ly/1UaZRY3>



The ESPRESSO project.

SPOT Programme Celebrates Three Decades in Orbit



SPOT 7 satellite.

Since the SPOT 1 launch 30 years ago, SPOT satellites have covered the land area of the Earth more than 700 times, setting a world record for spatial observation. The pioneering story began on 22 February 1986: Europe's first Earth observation satellite, SPOT 1, lifted off from Kourou on board an Ariane 1 launcher. It set off on a path to three decades of major technological innovations and a host of new applications. Today, SPOT 6 and SPOT 7 represent the most recent steps of success and innovation. SPOT 1, conceived and designed by the French space agency CNES (Centre national d'études spatiales), was equipped with steerable mirrors, enabling it to look to the right and left of its path, unlike other Earth observation satellites during that time. Thanks to this first technological revolution, it was able to observe a given site every five days and measure the elevation of the terrain. It acquired images with a resolution of 10m for a footprint of 60km, a swath/resolution ratio that was unique and one that has been retained by its successors.

► <http://bit.ly/1Ub09hP>

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RIEGL Launches Mobile Mapping Turnkey Systems at ILMF 2016

At ILMF 2016 in Denver, Colorado, USA, RIEGL launched two new high-speed mobile mapping turnkey systems featuring the high-performance VUX-1HA kinematic Lidar sensor. The first customers in the United States for these systems are David Evans and Associates, a surveying firm based in Portland, Oregon, and Surveying Solutions, a professional surveying firm based in Michigan. When looking for a second mobile laser scanning system to supplement its surveying and geomatics arsenal, David Evans and Associates, Inc. chose the RIEGL VMQ-1HA to assist with client requirements on transportation, water, land development and energy projects. According to Marcus Reedy, PLS director of surveying and geomatics with David Evans and Associates, the company was very impressed with the small size of RIEGL's VMQ and the extraordinary data resolution that can be achieved from the VUX1-HA laser.

► <http://bit.ly/1UaZtZP>



RIEGL launched two new high-speed mobile mapping turnkey systems at ILMF 2016.

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Education is Key

Our society is facing many complex challenges. Climate change is related to many issues today's governments are having to deal with. Think of food security, migration, social justice, urban planning and water supply – all topics that are under increasing pressure due to the effects of global warming. The growing world population is another important hazard that is pushing policymakers to the edge. The combination of these two major threats demands cost-efficient, innovative and smart solutions. The geomatics industry can deliver many of these solutions but, although there are some parties that are doing great work, the real transfer of knowledge still has to take shape.

According to current projections by the United Nations, the global population will reach eight billion by 2024 and will likely reach around nine billion by 2037. Various scenarios for 2050 range from a low of 7.4 billion to a high of more than 10.6 billion. The lion's share of this growth will take place in Africa and Asia, in developing countries. Migration to cities poses challenges for urban planners, who already have more than

system by past and predicted future greenhouse gas emissions. Without concerted action to reduce emissions, our planet is heading for 2°C warming by the middle of this century and 4°C by 2100.

Climate change is affecting agriculture in multiple ways, such as changes in rainfall, fluctuations in temperatures, climate excesses (heatwaves, extreme storms and floods). In other words, a cocktail of challenges is endangering our future. But let us stay optimistic and think in terms of solutions. Technological advances can play a vital role in tackling the effects of climate change and geomatics is definitely a key tool in this mission. I am not the first person to advocate this. However, it is one thing to be aware of the power of geomatics, but how can this power be used if so many people are still unaware of it?

There are some other obstacles too: it is great that the world's brightest brains have brought us so much advanced technology, but how can it be best utilised when funds are limited and there is a shortage of well-skilled



▲ Wim van Wegen.

all their know-how, can help less-developed countries move forward merely by providing them with access to the latest geospatial innovations. Technology certainly helps, but technology alone is not the whole solution. Local knowledge and the will to make things better are also fundamental. Geomatics is indeed a tool for overcoming the societal challenges of modern times, but not only in the sense of hardware and software products. It is also necessary to have knowledge of geomatics applications – preferably affordable ones. To stimulate the rise of geomatics in resolving the difficulties many countries face, the key lies in education.

So is education and geomatics the magic formula? Rather than speaking in superlatives, let's describe the situation in a more down-to-earth manner: there are still many opportunities left unutilised. *GIM International* is currently searching for methods to boost the transfer of geomatics knowledge. We will of course keep you updated. But I also welcome your suggestions on how geomatics and education can be deployed effectively. What are the biggest needs? ◀

HOW CAN THE POWER OF GEOMATICS BE USED IF SO MANY PEOPLE ARE STILL UNAWARE OF IT?

enough on their plate. And what about the agricultural sector and the food industry, with so many mouths to feed? A recent World Bank report explores the impact of climate change in Latin America and the Caribbean, the Middle East and North Africa, and Eastern Europe and Central Asia. It finds that warming of close to 1.5°C above pre-industrial times is already locked into Earth's atmospheric

professionals? To zoom in on a geospatial case: policymakers will probably all agree about the need for an efficient and well-functioning cadastral system, but they are often hindered by a lack of knowledge and the financial means to set up a good land administration system. It would be an oversimplification to think that the industrialised Western countries, with

Wim van Wegen is the editorial manager of *GIM International*. He is responsible for the content of the magazine, the website and the newsletter of world's leading geomatics publication. In his role he manages and allocates assignments to the editors, writers and journalists. He was instrumental in the successful launch of the annual UAS Special in 2013 and of the Spanish-language version of the *GIM International* in 2014. In his continual search for the latest industry developments to share with *GIM International's* highly valued readership, Wim van Wegen frequently attends relevant congresses and trade shows.

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Realising Solutions for Land Governance Issues

'Securing Land and Property Rights for All' is the slogan of the Global Land Tool Network (GLTN). This alliance of global regional and national partners is aimed at contributing to poverty alleviation through land reform, improved land management and security of tenure, particularly through the development and dissemination of pro-poor and gender-sensitive land tools. *GIM International* took the opportunity to interview Oumar Sylla, who was recently appointed as the new leader of UN-Habitat's Land and GLTN Unit.

Mr Sylla, you have been the leader of the Land and GLTN Unit since September last year. How do you look back on the first six months in your new role?

It was my great pleasure to be appointed as the new leader of the Global Land Tool Network unit thanks to my long-standing work on land governance. I've been really impressed by the diversity within GLTN as a network comprised of land professionals, bilateral and multilateral organisations, wider society and researchers. This is a great opportunity to work comprehensively on land governance issues which require a mix of disciplines such as surveyors,

lawyers, researchers and policy specialists. GLTN has demonstrated that it can add value by being able to generate a rich ecosystem that is critical in realising sustainable land management and governance. I've also been impressed by the solid foundation I found in place with the variety of innovative tools that are making the implementation of land policy all over the world more efficient and effective. For example, the relevance of GLTN tools in implementing the Voluntary Guidelines (FAO's Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests or 'VGGT', Ed.).

The Global Land Tool Network has developed a global partnership on land issues pulling together global partners as well as many individual members to take a more holistic approach to land issues. How does this work?

GLTN works by promoting and supporting the adoption and implementation of land policies, tools and approaches that are pro-poor, gender-appropriate, effective and sustainable. Land issues are notoriously complex and involve extensive vested interests. To design, test and implement pro-poor, gender-responsive land tools that can be used at scale requires inputs from various disciplines, professions and stakeholder groups. One aspect of GLTN's success has been its ability to integrate these various inputs and put together multidisciplinary teams; another is its ability to scale up by working with and through partners to maximise their contributions. The network now has 72 partners – global stakeholders who contribute with substantial knowledge or financial resources.

The 2030 Agenda for Sustainable Development was adopted by world leaders last September at the United Nations. What impact does this new agenda have on the activities of the GLTN?

The SDGs (Sustainable Development Goals, Ed.) coupled with other global agendas such as Habitat III provide a unique opportunity for GLTN partners to meaningfully engage in global events. As the perception of tenure security has evolved, challenges have also emerged in land and governance, and this



has called for fresh thinking that is relevant to and aligned with new political agendas at global, regional and national levels. The SDGs address the land question both directly and indirectly within the broader context of poverty reduction through combating hunger by stimulating agricultural production and access to basic services and agricultural land for women. In the past decade, the GLTN has made great strides and its unique achievements now provide a very solid foundation for the network to play an active role in the SDGs. Through coordination of the Global Land Indicators Initiative, the GLTN advocated for the inclusion of land tenure as an indicator in the SDGs. Today, under the SDG Goal 1 of 'End poverty in all its forms everywhere', Indicator 1.4.2 speaks directly to the core business of GLTN, that of securing tenure security. This opens up a new avenue for GLTN partners to become more relevant in the land governance arena and to devise new ways of partnering to inform the SDGs.

Your website states that the network contributes to poverty alleviation through land reform, improved land management and security of tenure, particularly through the development and dissemination of what are called 'pro-poor and gender-sensitive land tools'. Where do we stand on that now?

GLTN has developed several tools that are at various stages in their cycle of development. It's high time for the tools to be implemented at country level in order to demonstrate their potential to improve land governance and contribute to the implementation of both policies and institutional frameworks. I will prioritise the country-level work where there is a need to support the government to improve land governance and also an opportunity to develop an integrated approach in tool implementation by bringing in more than one partner to collaborate. The innovative concept is to combine the tools at the country level for improved efficiency. I recognise the huge government demand for GLTN assistance in several areas: land policy development and implementation, capacity development and land use planning, among others. This demand presents a unique opportunity for GLTN to gain political momentum at the country level with governments and the regional bodies such as the African Union/Land Policy Initiative, the Economic and Social Commission for Asia and the Pacific and the Regional Centre for Mapping of Resources for Development. When a tool is being developed, the concepts



▲ Oumar Sylla addressing the delegates at the opening session of the 6th GLTN Partners' Meeting in Nairobi, Kenya.

are proven in practice at the piloting/testing stage and this provides the developers with useful data and feedback about areas of improvement. We have 23 tools that have been finalised so far. Some of our more mature tools such as the STDM (Social Tenure Domain Model, Ed.) are already being used in parts of Kenya, Uganda and the Democratic Republic of Congo and have received some recognition and even support from national and local governments alike. This is because they address the unique challenges faced by the land sector, particularly in the developing economies. Another GLTN tool that more than 40 countries have been exposed to is the Gender Evaluation Criteria. These criteria specifically address the gender responsiveness of the land tool development process.

Do you expect the GLTN tools to achieve better coverage of land administration?

Land administration and information is just one of the four areas that GLTN works in. The relevant tools address spatial units and the modernisation of land agency budget approaches. For sure, all those tools will contribute to improving land administration delivery. Today we should be proud of the paradigm shift in land administration: the novel >>> fit-for-purpose (FFP) land administration approach has broken down some rigid, traditional views of land administration <<<, particularly in developing countries. Land administration should be flexible and adaptable to any country context

and should take into account cost effectiveness and the social realities on the ground. Fit-for-purpose land administration demonstrates a new way of doing business and a readiness to serve the community, given the fact that 70% of land in Africa is not covered by the formal cadastre. The FFP approach brings flexibility in dealing with a range of land rights.

What are the lessons learnt?

In the short term, we can acknowledge that collective action is key in achieving efficient land governance and management. GLTN partners have demonstrated their ability to work together and this has contributed to improved efficiency of financial resources and effectiveness of actions. One good experience has been the Global Land Indicators Initiative whereby GLTN direct and indirect partners successfully brought land into the SDGs process and content. The GLTN secretariat should continue to empower partners on the ground. The convening role of the GLTN secretariat can be best used to improve coordination and collective action at the country level, which is where we now want to make a difference. There is also a need to involve the local communities in tool development, with a focus on a people-centred bottom-up approach as a way of entrenching human rights in the GLTN tools.

How can governments improve their policy skills when it comes to land administration?

As we are all aware, land administrations in ▶

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Under Secretary of Defense for Intelligence





developing countries are facing lot of challenges. The recurring question is, which model of land administration should be promoted in those countries? The answer must take into consideration the following factors: cost, accessibility, quality of service delivery and design. Unfortunately, land administration has not been given lot of attention in the public arena, especially in terms of financial decision-making. Financial resources are rarely allocated to land administration in many developing countries. The first step is for the decision-makers to prioritise this sector, taking into consideration its contribution to revenue generation and attracting investments. Secondly, there is the need to develop comprehensive land policies to address the issues of land administration in the broader spectrum of land governance and ensure equal access to the services, including for women and young people. This calls for a fit-for-purpose land administration system that accounts for the social context on the ground. Policies should also help address the tenure need for a variety of land rights including customary and informall. The continuum of land rights brought about a major shift in the perception of land rights, going beyond titling. There is now a solid foundation for country-level land policy to become more efficient and relevant to address all governance and tenure security needs.

What is your advice with respect to how the geomatics industry can help countries to develop well-functioning cadastres and land administration policies?

The geomatics Industry should act as a 'solutions provider' and should be flexible in adopting and implementing solutions for the specific needs of the country. We can no

longer continue providing the same conventional solutions for various needs and contexts, particularly in developing countries. This is where fit-for-purpose land administration comes in. This approach should be mainstreamed in the geomatics industry, both at educational and training level as well as in project implementation. The shift should start with the geomatics industry and, if this happens, we can be confident that more appropriate, affordable and fit-for-purpose technical solutions will soon become better available.

Good land policy requires educated professionals. How would you describe the current situation?

The lack of capacity to deal with land governance issues efficiently has become a challenge in many developed countries. Because of that low capacity, national governments are facing numerous constraints in land policy development and implementation. Countries have relevant

policies, but they are still unsure of how to go about implementing them. Land experts are in short supply, and even completely non-existent in many countries. In terms of education, few schools and universities provide teaching about land and natural resources. In view of these circumstances, it comes as no surprise that there is a shortage of land experts in developing countries. It is for this reason that GLTN places emphasis on capacity development for institutions and on the inclusion of land governance in training. Kenya's University of Nairobi has already incorporated the STDM into the curriculum. There is, however, still a need to strengthen collaboration among institutions dealing in land issues and to give students an opportunity to embrace the subject matter in the early stages of their training. The universities of Twente and Munich have a critical role to play in this. Without capacity, land policy may suffer from ineffective implementation and an inability to serve the needs of the vulnerable communities.

Do you have a message for our readers?

I would like to thank the land professionals for their contribution to GLTN's relevance in improving tenure security for all. We should keep the momentum going and continue to develop collaborative action, both at country level and global level. The professionals are reservoirs of knowledge when it comes to land administration issues and I encourage them to further strengthen knowledge sharing in order to bridge the gap between them and the decision-makers in the land sector. I also acknowledge the contribution of FIG to the GLTN as we count down to the FIG Working Week in New Zealand in May. This will be another opportunity for us to strengthen our collaboration, guided by the new SDGs. ◀

Oumar Sylla

Oumar Sylla holds a master's degree in local government law from Saint Louis University in Senegal as well as two other MAs: one in African legal studies and legal anthropology focused on land and natural resources from Paris 1 Sorbonne and the other in territorial project management from Paris 13 Creteil. He brings to GLTN a wealth of both academic and practical experience in land, natural resources, conflict resolution, urban development and planning, urban safety and security, slum upgrading, regional cooperation and partnership. Oumar is continuing the efforts towards expansion of GLTN's work and networks at the country level. He advocates a wider incorporation of land governance in the overall urban agenda to bridge the gap between rural and urban to improve tenure security for the vulnerable. Prior to joining the Land and GLTN Unit, Oumar served as a senior advisor in UN-Habitat's Regional Office for Africa. Before that, he supported implementation of the GLTN programme and managed the UN-Habitat land programme in the Democratic Republic of Congo in a peace-building context as chief technical advisor. He also gained experience with the European Union framework as a land policy advisor in South Sudan and Burkina Faso.

Spatial Initiatives for Sustainable Land Management

Access to land and other natural resources is an important basis for the livelihood of underprivileged people around the globe. Access must be stable and secure if it is to provide an opportunity for economic growth and incentives to invest. The use of land must appropriately planned to ensure sustainable development and to pay respect to finite natural resources. Land administration agencies are charged with implementing land policies, such as planning for sustainable development, providing equitable land distribution and acting in accordance with the legal framework for land governance. Transparent and efficient land administration is a condition for economic development.

Rwanda has, in an African context, shown significant results to promote good land (and water) governance. Land is scarce and a prime resource in Rwanda, one of the most densely populated countries in Africa. Consequently, good land governance is essential to Rwanda achieving its ambitions to transform to a prosperous, food-secure and knowledge-based economy, to manage a

sustainable environment and to create equal social conditions. Besides implementing the nationwide land tenure regularisation (LTR) component of good land governance, Rwanda has strived to achieve a consistent approach to combine land administration and land use planning at both national and local level. Rwanda Natural Resources Authority (RNRA), an authority that promotes the

management of natural resources (land, water, forests, mines and geology), took the lead in these activities.

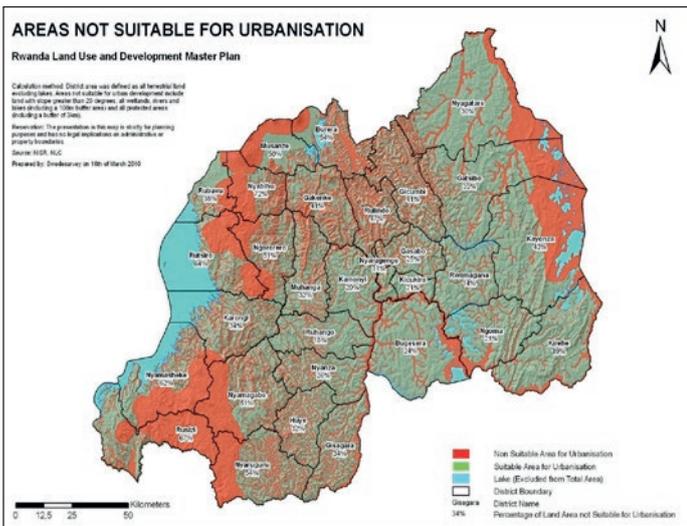
GEOINFORMATION AS A FOUNDATION

Geographic information systems (GIS) played a major role in the process of implementing a functioning land information system (LIS) and formulating a National Land Use and Development Plan (NLUDMP). At local level, land professionals were encouraged to take ownership of GI technology and a straightforward planning process was created with active public participation.

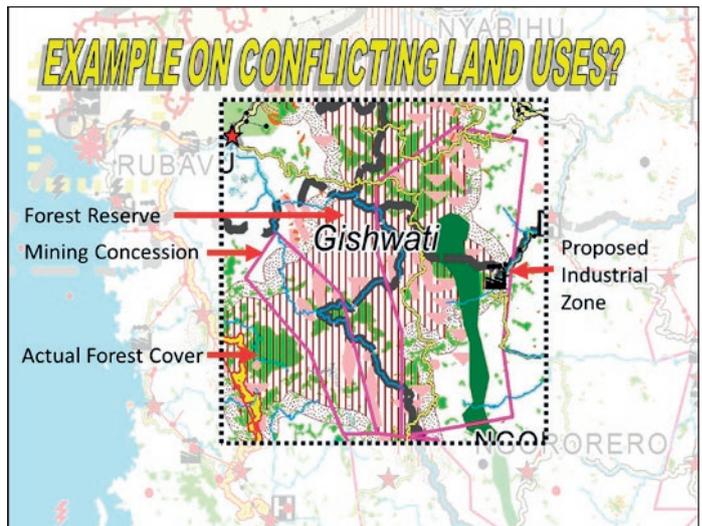
The first step was to provide updated and renewed geospatial data. Aerial photographs were produced for 96 percent of the whole country and satellite images were produced for the remaining 4 percent. Thereafter, digital orthophotos with a resolution of 0.25 metres were created using the photographs. The high-resolution orthophotos were instrumental in the preparation of the NLUDMP and in the LTR process. In addition, the images were used to produce base maps at 1:50 000 covering the entire country. The base maps were also used by other sectors for many purposes as well as to generate the first district land use plans (DLUPs).



▲ Going home with a land title.



▲ Thematic maps in the textbook complemented the directive of the plan.



▲ The plan identified many contradictions and conflicting sector land uses which had to be harmonised.

CREATING THE LAND INFORMATION SYSTEM

In the LTR programme, nationwide systematic land registration started after piloting in 2009. The goal was to provide legally valid land documents to all rightful landholders and the programme was completed in 2013. A general boundaries approach was applied and data was collected in a highly participatory manner using the orthophotos. Teams of locally recruited and specially trained ‘para-surveyors’ outlined the parcel boundaries on the imagery printouts that were scanned, georeferenced and digitised. Printouts of the parcel plans became part of the legal parcel ownership document. The non-spatial data relating to owners’ rights and particulars were captured in claim registers by legally constituted adjudication committees. The information from the registers was entered into the land tenure regularisation support system, from which titles were processed and printed for first issuance. A land administration information system is used for processing transactions and for updating the register. By May 2013 about 11 million parcels had been registered and 9 million printed land lease certificates had been issued. The unit costs were about USD6 per parcel. It is interesting to observe that less than one parcel in 100 had a dispute registered against it. Where disputes did exist, 80 percent of them related to intra-family matters.

Rwanda’s well-functioning land information system aims to contribute to social harmony arising from reduced land conflicts and secure tenure, increased investment in land,

greater land productivity and a greater role for land as an economic resource in national development.

ENABLING SPATIAL PLANNING

Preparation of the NLUIMP started in 2007. Initially, the plan provided for three different scenarios. The red scenario was the predictive, ‘worst-case’ scenario, based on development continuing in an uncontrolled, laissez-faire mode. The yellow was considered an exploratory ‘fair’ scenario of land use based on development continuing in a relatively managed and controlled way. The green scenario was an alternative based on development continuing in a very controlled way. This normative scenario was ultimately developed.

The NLUIMP, among many other components, introduced National Binding Directives to be adhered to by central and local governments, private sector and the general public as regard to land use changes during the planning period. The demarcated areas and hubs of national interest on the map presenting the final plan (1:250,000) determine and designate the location and/or nature of guiding and binding land use development from 2010-2020. They indicate that the specified land use has the highest priority in the concerned areas and that other land uses have to respect that. The national sector (strategic) plans, (integrated) district development plans and urban development plans must explicitly show that they have observed the guiding and binding aspects of the plan and the associated reasons.

The NLUIMP was the subject of a rigorous consultation period involving central and local governments, private sector and the general public. Being the first of its kind for Rwanda, the 2010 version of the plan became a testing ground, especially with regard to implementing the directives at local level through the introduction of the DLUP in 2013.

The plan also revealed abnormal expansion of Kigali City and presented an approach for sustainable urbanisation. That formed the incentive for what has since been developed into the Secondary Town concept. Furthermore, it observed the importance of densification, mixed use development and mixed housing and provided examples of how to manage these issues.

INSPIRING DISTRICT LAND USE PLANS

Once the NLUIMP had been adopted by parliament in 2012, the next challenge was to inspire and direct cross-sector and local planning and to stimulate actual land use changes and building activities. A project was launched with a proposal for a land use plan component in the district development planning and skills development of land professionals to prepare such a plan using GIS. The DLUP could be seen as an ‘implementation tool’ to ensure that areas and hubs of national interest would be respected at local level. At the same time it enables districts to analyse locally initiated development projects with spatial implications.

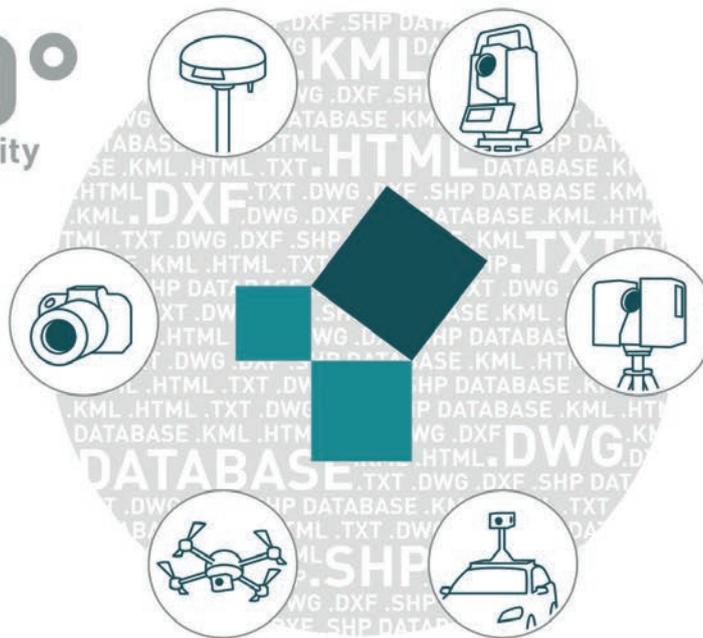
The training programme that ran in 2013 was unique for Rwanda. The participants,

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who were land use professionals at district headquarters, were not primarily focused on obtaining a certificate but rather on preparing a draft of a DLUP. All 30 districts were able to produce a draft during the training. These drafts formed the basis for a process of consultation – at both central and local level – which eventually resulted in a final draft for adoption by the District Council and approvals by the Cabinet.

KEEPING IT SIMPLE

Geographic information is embedded in over 80 percent of all goods and services the district provides. By visualising the existing situation of public service delivery and environmental promotion at local level, the DLUP has made it easier to analyse and

► *The map shows which schools (red or yellow symbols) in this district still have a long way to go to meet the Vision 2020 targets and can therefore help to optimise the allocation of resources.*

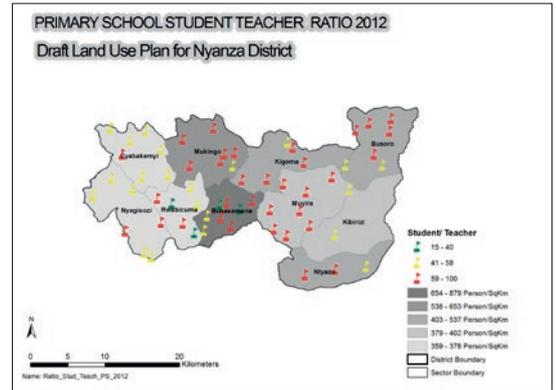
measure performance against many of the national Vision 2020 objectives in terms of targets that have a spatial implication. This is illustrated by the table below.

ACKNOWLEDGEMENTS

Thanks go to RNRA staff, in particular Director General Dr. Emmanuel Nkurunziza and Didier Sagashya, former deputy director of RNRA and now director general at Rwanda Housing Authority. ◀

VISION 2020 Indicator:	Status in 2000	Current Status	Vision 2020 Target
43A. Ratio of pupils – qualified teachers in primary schools	NA	58-1	40-1

▲ *The Vision 2020 has an indicator related to student/teacher ratio.*



More information

www.rwandalanduse.mra.rw

CHRISTER KJÖRNEBERG



Christer Kjørneberg is a senior architect planner with over 30 years' experience in land use and spatial information management derived from work in more than 25 countries. In Rwanda, he was the project manager for the NLUIMP and DLUP presented above.

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PROJECT POINTLESS

Pathfinding through Identified Empty Space in Point Clouds

Indoor point clouds are useful for many applications, such as for pathfinding through empty, collision-free space. Fast-performing methods are required to identify this empty space because the indoor environment changes frequently and often does not follow the architectural design. As part of the Synthesis Project 2015, students of the MSc in Geomatics programme at Delft University of Technology have developed a method to efficiently identify and structure connected empty space in point clouds.

During the Geomatics Synthesis Project 2015, themed 'explorative point cloud processing', three groups of students spent ten weeks building an application for either indoor, terrestrial or aerial point clouds. The group named 'Project Pointless' was to focus on indoor point clouds. For generating models of indoor space, focus lies often on identifying the boundaries of space and the objects inside it. But for indoor pathfinding it is much more logical to focus on the empty, pointless space, which is the space that can actually be used. Therefore, the group developed an algorithm which identifies and structures the empty space in point clouds.

An interior point cloud of the Faculty of Architecture's bar, the *Bouwpub* (measuring 9mx15mx5m), was obtained with a ZEB1 mobile laser scanner. A coloured point

cloud was used for visual display only, which was obtained using the Leica C10 laser scanner.

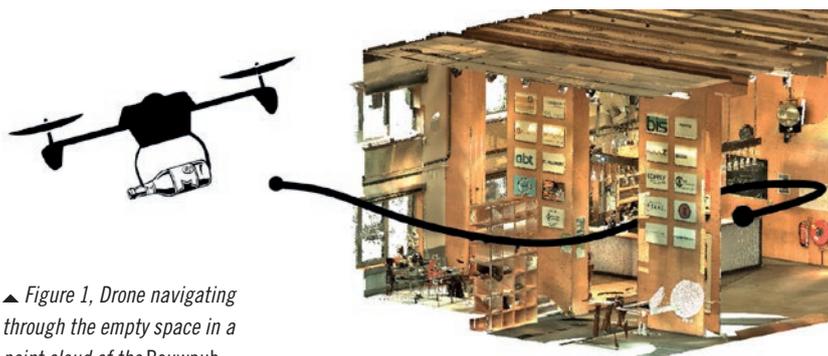
LINEAR OCTREE

A linear octree was used to derive and structure the empty space in the point cloud. An octree recursively subdivides the point cloud into eight equal-sized octants, up to a predefined maximum resolution. Octants are called grey nodes if they themselves contain smaller octants. Octants are called black (containing points) or white (empty) leaf nodes if they do not contain smaller octants. A locational code is generated for every leaf node using bitwise interleaving: a method that combines the x, y and z coordinates into a single binary string. The entire octree structure is implicitly stored in the resulting set of locational codes.

LEAF NODES

In the above procedure, black leaf nodes are created first. The white leaf nodes which contain the actual empty space can then be reconstructed from the linear octree structure of black leaf nodes. The developed method ensures that black leaf nodes always have the maximum specified resolution, thus the octree always reaches maximum resolution around points in the point cloud. The white leaf nodes are not further subdivided for efficient storage of empty space.

The usability of the empty space has been shown in a pathfinding application. For this purpose, a neighbour-finding algorithm was applied to the white leaf nodes, which retrieves the connected empty spaces. An A* algorithm was implemented that uses this connectivity to find the shortest path in three dimensions. ▶



▲ Figure 1, Drone navigating through the empty space in a point cloud of the Bouwpub.

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SPEED AND SCALABILITY

The method was implemented such that an octree of 6cm resolution was generated. The speed of the implementation was evaluated by comparing the processing time required for the generation of octrees with different maximum octree levels. Doubling caused only a small increase in total processing time, indicating that the method scales very well for increasing resolution. The method also scales well when increasing the size of the point cloud; for a four-times-larger point cloud, the required processing time increased only 3.5 times. The entire process, including the acquisition of the data with the ZEB1 laser scanner, can be completed in only a few minutes per room.

THE POTENTIAL OF EMPTY SPACE

Point clouds contain a wealth of potential information about scanned objects and surfaces, but also about the space which can be used to move through. Empty space can be derived and structured swiftly and efficiently from point clouds using the methods presented in this article. Having the empty space can be beneficial for applications such as 3D pathfinding, because it puts the focus on usable space instead of focusing on boundary points or objects. It could also be used for a whole gamut of other possible applications, such as estimating the volume of available storage space and calculating how to fit large objects through narrow spaces. The presented method is

currently being further developed for indoor navigation.

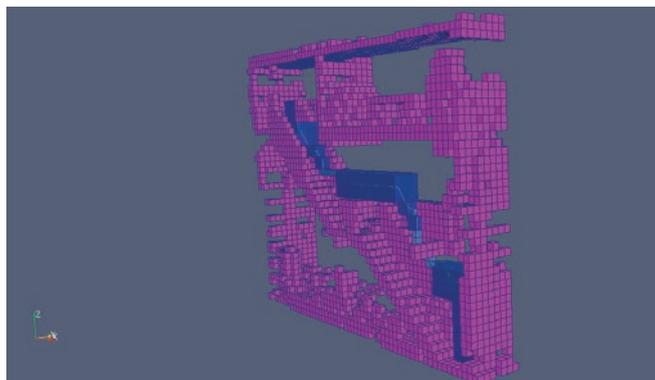
ACKNOWLEDGEMENTS

The authors would like to acknowledge their fellow members of Project Pointless: Olivier Rodenberg and Erik Heeres. Special thanks go to their supervisor at Delft University of Technology, Edward Verbree, and the rest of the Geomatics Department, as well as to Robert Voûte from CGI Netherlands. They have offered great support. ◀



◀ *Figure 2, Identified empty space (transparent octants) with octants containing points in yellow.*

▶ *Figure 3, Route (blue octants) through the Bouwpub (purple octants) using the identified empty space.*



◀ *Figure 4, A point cloud of the Project Pointless group: (from left to right) Ivo de Liefde, Florian Fichtner, Erik Heeres, Olivier Rodenberg and Tom Broersen.*

FURTHER READING

Broersen, T., Fichtner, F. W., Heeres, E. J., De Liefde, I., Rodenberg, O. B. P. M., Verbree, E. (2015). Project Pointless: Identifying, visualising and pathfinding through empty space in interior point clouds using an octree approach.

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GIM INTERNATIONAL SUMMIT 2016

Addressing Global Challenges

The first GIM International Summit was held in the very heart of Amsterdam, The Netherlands, from 10-12 February 2016. The programme comprised thought-provoking topics presented by top speakers from both inside and outside the geomatics field. Furthermore, the audience was engaged in interactive workshops on global issues such as urban planning, social justice and climate change. Delegates were challenged to think beyond the boundaries of their own fields to link the needs of society to geospatial solutions during this inspiring three-day summit.

The first two days of the three-day summit consisted of thought-provoking presentations in the morning and workshops on four different global topics in the afternoon. Starting off on Wednesday, Morten Jerven, author of the book *Africa: Why Economists Get It Wrong*, explained the problems with current statistical research. Presenting many interesting statements and graphs about African economies showing strange and improbable numbers, Jerven illustrated that using statistical data can be dangerous even if its source is known. Manipulation of statistics is universal: as soon as money is involved, evidence-based policy tends to change into policy-based evidence. Jerven's presentation made a clear point to all delegates: poor numbers are just too important to be merely dismissed as such. He called on the geomatics industry to come

up with solutions for using geospatial data to validate and improve statistical data.

BOTTOM-UP

The African theme continued in the presentation by Vanessa Watson, professor of city planning at the University of Cape Town, who demonstrated the enormous mismatch between what companies in developed countries plan to build in Africa and what local people actually need. It seems as if urban planners in architectural firms throughout the world regard Africa as a sandbox where they can build vast, futuristic districts, but none of those plans are ever executed in reality. They fail because the plans simply have no connection to the local environment and people's needs. For example, large glass-covered skyscrapers that offer housing priced at USD200,000

will never be within reach of a local citizen earning the equivalent of USD2-USD20 per day, which is the average salary for many people in Africa. To address this problem, Watson advocated shifting the focus of urban planning from top-down to bottom-up and creating housing projects that improve living conditions within the current environment instead of trying to (re)build entire cities.

PERCEPTION OF GEOGRAPHIC INFORMATION

Three further presentations were held on Wednesday morning: Christoph Fürst presented RIEGL's new laser scanner during the coffee break as a technical intermezzo; Joyeeta Gupta, professor at the UNESCO-IHE Institute of Water Education, showed that water scarcity in the world can only be understood and handled correctly with the right maps showing the right information, as the problem



▲ Pier Vellinga delivered a keynote on the simplification and visualisation of data.



▲ The participants enjoyed the Amsterdam canal cruise.

GIM INTERNATIONAL SUMMIT

OUTCOMES AND PRIORITIES - Engage, Listen, Act

From 10 to 12 February 2016, members of the international geospatial community came together in Amsterdam, the Netherlands, to engage with experts from other domains in order to confront global challenges and explore how the sector ought to respond – in essence, to seek space for future development.

We agreed that ...

Delivery of **social justice** requires local actors to be equipped with location information about disputes, justice points and services. A geospatial framework should be offered specifically for land disputes.

Social justice has a spatial component: it should be used to provide access, inform and protect and to make social justice evidence based.

Planning of **urban environments** can suffer from too little location information, but sometimes also too much. Urban planners engage in both top-down and bottom-up city creation initiatives. Either way, location information should be created and visualised in ways that better influence urban leadership, guidance and advocacy.

Food security, at all levels, means that actors have access to the right location information at the right time so that they can visualise, monitor and adapt food strategies, especially in the last mile. The cloud, the crowd and apps should all be used in the right way and in the right contexts.

Building **geo-ICT infrastructures** is really about creating networks and ground rules. However, these are a subset of information infrastructures rather than an end in themselves. Infrastructures are certainly not only about technology and standards, public versus private or even top-down versus bottom-up. The focus should be on linking real societal problems with the users and the services they require.

Debating and responding to **climate change** revolves around people and requires a geo-informed society. We should embrace the opportunities to visualise, simplify and present reliable climate-based location and time information and potential risks.

Managing **water and energy** demands location tools and actors that are able to conceptualise, model and integrate information flows. It is necessary to break down the institutional barriers and to support monitoring and impact evaluation. We should help our customers to match visions with reality.

Responding to the **migration** challenge demands knowledge of the spatial element. This refers to the social, economic and political drivers causing the mass movement of people. Insights into points of departure, arrival points and everything in between should be better integrated.

Land administration should be driven by a fit-for-purpose mindset, regardless of the location. Time, cost and quality constraints must drive data capture, design and implementation.

Summary of the GIM International Summit

During the GIM International Summit, participants approached location and time-related issues to explore the needs and demands, both within the geospatial sector and beyond.

The topics debated included: problems and solution-focused mindsets; societal pull/demand versus technology push/supply; market versus government versus network governance approaches; technology specialisation and commoditisation; bulk information versus specialised approaches; top-down and bottom-up initiatives; legitimacy versus legality; managing versus guiding; spatial literacy versus spatial awareness; evidence-based policy versus policy-based evidence; certainty versus fit-for-purpose approach; hype versus education versus communication; neutrality versus the political; and open data versus propriety software.

By looking 'from the outside in', we identified a need to find a shared language and to reach out proactively; to visualise and simplify; to explain the value of location information; to respond to user needs; and – most importantly – to engage, to listen and to act.



▲ Delegates take the opportunity to network during a coffee break.



▲ Morten Jerven: "New agenda for data for development in Africa is required."

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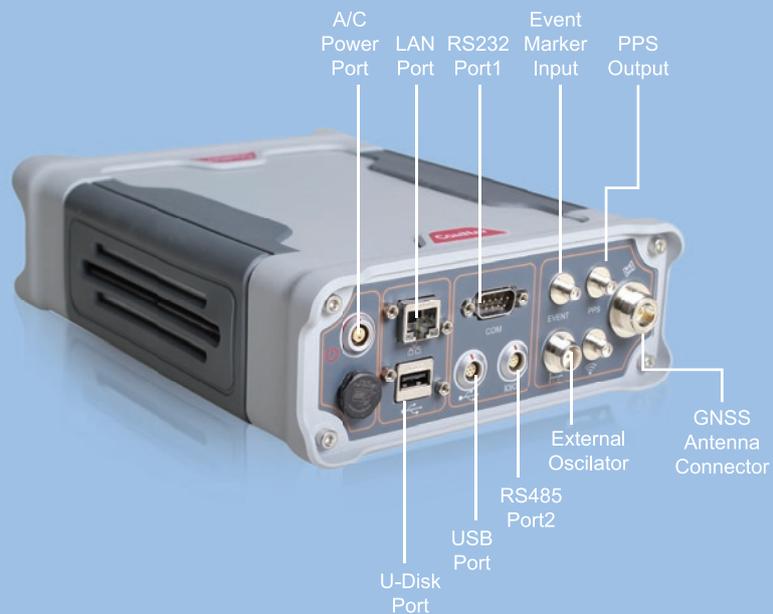
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▲ *Lively discussion during one of the interactive workshops.*

can be perceived differently depending on the maps used; and Daniel Steudler, scientific associate from the Swiss Federal Office of Topography, identified various current trends for the industry such as the Internet of Things, linked data, crowdsourcing, augmented reality and social media. Steudler explained the impact of these trends on the perception of geographic information systems, both now and in the future.

CONNECTING TECHNOLOGIES TO SOLUTIONS

Inspired by the morning sessions, delegates shared their own thoughts and opinions during four different interactive workshops in the afternoon. The workshop topics were urban planning, social justice, food security & agriculture, and infrastructure for geo-IT. Although each workshop differed in terms of content, they all shared a focus on linking geospatial technologies to real solutions and useful applications rather than concentrating on technological improvements alone, and on connecting geospatial infrastructures to existing IT infrastructures instead of designing new ones. The interactive sessions sparked much discussion and debate among the participants that continued well into the evening, which began with a boat trip on Amsterdam's canals and concluded with a delegate dinner.

THE IMPORTANCE OF ALIGNMENT

The GIM International Summit continued on Thursday with presentations on topics as varied as climate change, building information modelling (BIM) and smartphones. In his presentation on climate change, Pier Vellinga pitched that clear visualisation is crucial to achieve an understanding of the complex metrics that play a role in climate change. Communication should take the public's perception into account; a map showing the number of nights per year with uncomfortably

high temperatures conveys more information than a detailed report on the same topic. This line of thinking continued in the talk by Geert Bouckaert who showed the difficulty in aligning institutions and policies with spatial information. Ed Parsons from Google demonstrated that it is possible to put end users in the middle of a map, literally: using smartphones and the search power of Google it is possible to create a personalised map for every individual.

BUILDING INFORMATION MODELLING

When looking at the geospatial world from the outside in, the topic of BIM is unavoidable as the use of building information models has advanced rapidly, both in the construction phase and the maintenance phase of civil engineering projects. Within a BIM, 3D geoinformation is integrated with other aspects relevant to construction and asset management. Increasingly, users are expecting data delivery in a BIM context. James Kavanagh from the Royal Institution of Chartered Surveyors (RICS) presented examples and challenges of adopting BIM in the geospatial industry. In addition, in a technical session, Yury Sakovich of Trimble informed the delegates about technological trends, the applications and the benefits of geospatial data.

REMEMBER THE PEOPLE

The afternoon workshops provided yet another opportunity for highly interactive sessions revolving around the topics of climate change, migration, water & energy and property rights. Engaging participants from diverse backgrounds in open problem-solving discussions provided very interactive learning opportunities for everyone involved. Engineers in the geospatial industry tend to look for technical solutions, but – as one of the participants phrased it – often forget about

OUTCOMES AND PRIORITIES FROM THE GIM INTERNATIONAL SUMMIT

The GIM International Summit 2016 was held from 10-12 February in Amsterdam, The Netherlands. During this event, high-level delegates from all continents learned about, shared and discussed topics such as urban planning, climate change, food security & agriculture, water management, social justice and geo-IT infrastructure. Speakers included Morten Jerven, Vanessa Watson, Joyeeta Gupta and Ed Parsons, all inspiring figures in their own fields. They shared insights into the real-world problems they face and asked the geo community to help them think about solutions that geoinformation could deliver. For me personally, the GIM International Summit was an inspiring few days in which topics that are not touched upon at other conferences took centre stage in the debate in a way delegates hadn't experienced before. The GIM International Summit 2016 concluded with an interactive session with all delegates in which the outcomes were discussed and priorities for the global community of geoprofessionals were drawn up. We are delighted to share these outcomes and priorities with you, our readers. Anticipating and acting on this information will surely put you – whether as an individual or as a company, institute or organisation – at the forefront of developments. You can find the complete document here and can read up on the background information and discussions that led to this document on



our website www.gim-international.com. We plan on keeping the discussion alive – please join us!

*Durk Haarsma,
publishing director*

the people. Approaching climate change as a social problem rather than a technical challenge, for instance, will result in different solutions that might be more fit for purpose.

THE GEOSPATIAL CONTRIBUTION

On Friday morning, Conference Chairman Steven Ramage explained the concept of what3words, a new addressing system that has pre-allocated three common words to each grid of 3 by 3 metres on Earth. Thus, what3words facilitates addresses for over four billion people who do not currently have one. This was an illustrative example of how geospatial technology can contribute to tackling major global challenges. The conference concluded with an interactive session in which the Summit Declaration was drawn up. It was agreed that, to face the global challenges of the future, the geomatics industry should look beyond technology and further improve collaboration with other industries and the people involved in them. ◀

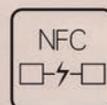
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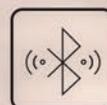
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INTEGRATION OF LOCATION INFORMATION AND STATISTICAL DATA

Developing the Namibian National Spatial Data Infrastructure

Namibia is establishing its National Spatial Data Infrastructure (NSDI) through the Namibia Statistics Agency (NSA). It has been a deliberate decision by the government of Namibia to marry location information with statistics in order to improve evidence-based development planning and socioeconomic intervention.

The approach in Namibia is not unlike that found in Europe and globally. In the European Union, the European Commission's Directorate-General for Statistics (Eurostat) is one of the three prime movers behind the pan-European Spatial Data Infrastructure (SDI) programme, INSPIRE. More than 20 years ago, GIS technology was introduced in Eurostat via the Geographical Information System at

the Commission (GISCO), a Eurostat service that promotes and stimulates the use of GIS within the European Statistical System and the Commission. At the global level, the United Nations Statistics Division (UNSD) has long supported development of the UN-wide and regional SDIs via the UN Regional Cartographic Conferences (UN-RCCs) in different regions of the world. UNSD also leads the new UN

Global Geospatial Information Management (UN-GGIM) initiative and regional UN-GGIM developments.

NATIONAL SDI POLICY

The NSDI in Namibia is covered by three articles in the Statistics Act while the rest of the articles relate to the production of other statistics. Since the operational requirements



▲ Signing a Memorandum of Understanding with a key stakeholder.



▲ NSDI strategy planning meeting in July 2015.

for establishing the NSDI were not fully addressed in the Statistics Act, a Committee for Spatial Data (CSD) finalised a national SDI Policy gazetted by parliament in March 2015. The aim of this policy is to amplify and operationalise the infrastructure by creating the framework for the development of a clear strategic plan. Through this policy, the NSA formulated a five-year Strategy and Action Plan.

SDI PRIORITIES

The aim is to set up an infrastructure that is viable and useful within available limited resources and technical expertise. Thus the country is building its infrastructure based on six elements, prioritised as follows:

1. *Legal framework.* This is laid out in the Statistics Act and NSDI Policy. A formal NSDI governance structure is approved and will soon be fully operational once a cooperation framework is established.
2. *Cooperation.* This is the main priority aiming at mobilising high-level involvement through partnership agreements with spatial data custodians. Major ministries and several state-owned enterprises are currently in the process of engaging on NSDI Memorandums of Understanding (MoUs). A collaborative platform will be established once MoUs have been signed, hopefully from June 2016 onwards. The first level of partnerships targets 16 national organisations which deal with data of national coverage. The second level of collaboration is aimed at local authorities, about 54 in total.
3. *Standards.* The current priority is to develop the data quality and metadata profiles

for the country. Draft profiles have been formulated and public inputs solicited. The Committee for Spatial Data is expected to approve the specifications in April 2016. Furthermore, specifications for the manner

competence in establishing NSDI.

5. *Advance Data Collection Calendar.* To immediately reduce duplications in data collection, thereby saving government limited resources, a national calendar

THE AIM IS TO SET UP AN INFRASTRUCTURE THAT IS VIABLE AND USEFUL WITHIN AVAILABLE LIMITED RESOURCES AND TECHNICAL EXPERTISE

of collection of national spatial data and any application for exemption from such specifications, as permitted within the Act and Policy, have been established.

4. *Competence.* Namibia needs to develop

will be set up as soon as the cooperation framework is established.

6. *Services.* The development of a metadata catalogue is a legal requirement. The catalogue will provide tangible evidence



▲ SDI stakeholders' engagement meeting.

to the public and decision-makers of the importance of spatial data. A national geoportal is planned to build appetite for access to geospatial data and applications, strengthen political will and ensure widespread access to spatial data. NSA will develop the geoportal to disseminate limited publicly available spatial data through a view service and web map services.

POLITICAL SUPPORT

In Namibia, there is high political willingness from government to establish the NSDI. There is also high-level commitment from government agencies earmarked to participate in this infrastructure. The citizens have been made aware of the importance and usefulness of location data and the benefits of the NSDI for access to such data and applications. Due to the high levels of public engagement, there are equally high expectations from politicians, decision-makers and the citizens for the NSA to deliver on the NSDI. Consumption of spatial data has increased since the start of the NSDI programme.

IMMEDIATE CHALLENGES

As coordinating body the NSA is facing several challenges, especially when looking a year ahead. The three most immediate challenges are:

- *Lack of technical capacity.* There is insufficient capacity to develop technical components of the infrastructure. The NSA needs to develop a metadata catalogue immediately as a pilot to showcase the relevance of this infrastructure. This requires assistance. Capacity is also required in the enforcement of the NSDI standards.
- *NSDI Secretariat Structure.* Because of the enormous scope of the NSDI and high public and institutional expectations, the NSA formulated a structure to increase the number of staff for the NSDI Unit. However, it will take time to fill all the positions due to limitations in funding. The Agency operates on the basis of government appropriations.
- *Competencies in data custodians.* Targeted custodians to participate in the NSDI have varying levels of technical competencies. To ensure compliance with both the spatial data quality and metadata standards, these organisations must first build that

competency where it does not exist at the moment.

CONCLUDING REMARKS

It is of interest to note how quickly Namibia has moved in terms of accepting the need for a national SDI and then enacting the legislation, strategies and action plan to implement the NSDI in a controlled, viable and sustainable manner. ◀

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No 2915

FUTURE TRENDS IN GEOSPATIAL INFORMATION MANAGEMENT

UN Expert Committee Regards Connectivity as Key to Growth

The most significant changes in the geospatial industry in the next decade will come not through a single technology, but rather from linking multiple technologies together. Especially the development of big data analytics will boost smart use of the location component to integrate data from many sources. The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) sees precise location information forming a core part of tomorrow's all-connecting IT infrastructure.

In December 2015 the United Nations published a second report in which 30 international public-sector experts on geoinformation outline the trends for the next 5 to 10 years, alongside input from 10 private companies and various universities and international organisations. "The paradigm of geospatial information is changing; no longer is it used just for mapping and visualisation, but for integrating with other data sources, data analytics, modelling. We need to link data together with the one thing they have in common: geospatial data." That is absolutely not a new message: Jack Dangermond first started advocating it more than 20 years ago. But, in the world of tomorrow, lots of things will act as a sensor, be connected and produce data. That creates a huge need for big data analytics, which opens up growth possibilities for this sector based on the concept of 'geo inside'.

ARTIFICIAL INTELLIGENCE LEADS THE WAY

The sheer volume of data produced today is already too huge to be processed manually and that situation will increasingly intensify as the Internet of Things continues to make progress. Success in addressing this problem will rely on the development of big data techniques including artificial intelligence or machine learning technologies that will enable the data to be processed more efficiently: computer



UN-GGIM
 UNITED NATIONS INITIATIVE ON
 GLOBAL GEOSPATIAL
 INFORMATION MANAGEMENT

algorithms seek structure within large quantities of seemingly unstructured data.

The application of the Internet of Things was originally designed to support the smart city concept, using IT to manage complex urban surroundings. A key factor in how this concept develops will be how geospatial information is integrated into the architecture and standards; this drives the demand for geospatial identifiers in the data.

The importance of location also becomes apparent as every sensor item connected to the internet has a location, and this location is often a vital piece of information that sets the context for the information transmitted. Artificial intelligence needs to represent

objects, properties, categories and relations between objects, and all these things can be represented in geospatial databases. Machines/robots equipped with artificial intelligence will be able to 'understand' geospatial information themselves and even 'survey' their surroundings to obtain the geospatial information they need to do their jobs, processing it in real time. Learning geospatial concepts will improve the interpretation of aerial and satellite imagery because it will be possible to identify geospatial features with more precision.

TIME IS OF THE ESSENCE

Software for processing 3D information will incorporate time information to create 4D products and services. The use of 4D

information is a growth area in a wide variety of industries including transport (driverless car technologies), building construction (integration into BIM) and environmental monitoring. The temporal element is also crucial to applications such as disaster management, emergency service response, simulations and analytics, and the tracking of moving objects.

Another area of growth is likely to be predictive analysis, with a focus on real-time social dynamic information. Such tools may run persistently on continuous streams of data; users will want to receive the right information at the right time. In light of the large volumes of data available, and also because of the time element, the geospatial computation required will therefore be increasingly automated in terms of both the generation and the direct provision of accurate results to the end user. Efforts should be devoted to integrating involuntary sensors – smartphones, RFID sensors and so on – which, aside from their primary purpose, may produce information regarding not only the location but also the time at which that information was collected. This includes the use of social media for providing real-time information.

Unmanned aerial vehicles (UAVs) can provide real-time remote-sensed information to decision-makers and are an invaluable tool when additional information is needed to improve vital decision-making capabilities. More and more regulations covering the use

THE INCREASING AMOUNT OF DATA CREATED OFFERS HUGE POTENTIAL FOR THE PRIVATE SECTOR TO ADD VALUE TO EXISTING GEOSPATIAL INFORMATION DATABASES

of UAVs will be developed over the next five to ten years, including tighter privacy and security laws. How governments decide to regulate the use of UAVs will have significant implications for their adoption and their value. However, technological advancement continues to outpace the changes in the legal and policy frameworks. As a result, new products and services that collect and use geospatial information will face increasing resistance due to outdated or inconsistent legislation and policies.

PROGRESS NEEDED IN LEGAL FRAMEWORK

With the increased ability to integrate data from different sources comes a growing possibility of determining a person's location based on the information they provide to different systems. Cybersecurity threats are not just related to personal information, but also to governmental and business information. Powerful encryption technologies and other security protection measures, in terms of both software and hardware, will gain in importance.

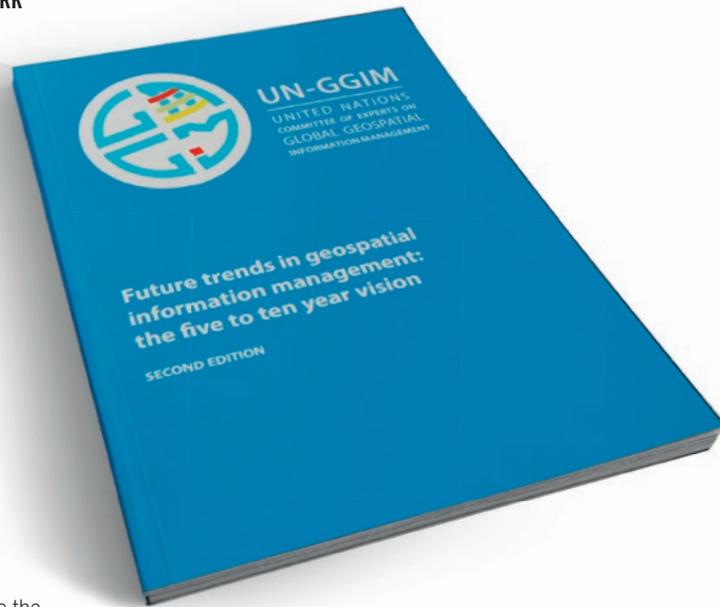
Data acquired in one country is increasingly likely to be processed in a second country by an organisation domiciled in a third country. Meanwhile the data itself is stored in the cloud. The lack of a multinational legal or policy framework to deal with these issues will need to be addressed. Furthermore, there is still a major possibility that significant disparities will emerge over the next five years between countries whose governments have developed legal and policy frameworks in line with technological changes to enable the growth of location-based or spatially enabled societies, and those countries where such frameworks have not been developed.

LEGITIMACY AS IMPORTANT AS LEGALITY

Governments remain in a unique position to provide a reliable, trusted and maintained geospatial information base. However,

convincing governments of the value of geospatial information and the benefits it offers remains a challenge. The authority and accuracy of the data but also the defined quality, the long term availability and the consistent maintenance, irrespective of commercial interests, must be underlined. The key challenge will be to secure sufficient funding.

Global brands and organisations have made digital mapping accessible to the masses. If this trend towards location data being



▲ *The UN-GGIM report 'Future trends in geospatial information management: the five to ten year vision.'*

provided by private-sector companies continues, there is a risk that the only unique attribute provided by public-sector organisations will be the certification of data as authoritative. Given different working methods and resourcing strategies, even this role could come under threat from the private sector. Cost and efficiency requirements will result in many government departments outsourcing many processes to the private sector. The increasing amount of data created offers huge potential for the private sector to add value to existing geospatial information databases through interpretation and analysis, and this is very likely to lead to more public private partnerships.

The issues of quality and accuracy may create a dividing line between crowdsourced and government/commercial data, but this gap will reduce in the next five to ten years as partnerships between all types of organisations increase. In countries where other sources of data are less readily available, public participation may be driven by necessity rather than choice.

STAFF MORE COSTLY

The importance of geoinformation experts will not diminish as data outputs will still need to be interpreted for policymakers and decision makers, and these experts are becoming ever-more comfortable with interpreting unstructured data. The adoption of data

driven rather than cartographically driven geospatial content will see a fundamental shift in the skills base and costs. National mapping and cadastre agencies are already finding that their data management staff are more costly to employ than the employees in their cartographic and data collection units. The techniques and processes developed through big data analysis and artificial intelligence will need data experts who understand the complexities of linking geospatial and non geospatial data together. This expertise will be spread across different sectors, such as computer science, mathematics and the games industry.

INTEROPERABILITY REMAINS CRUCIAL

For the full potential of multiple-sourced data to be realised, data needs to be interoperable and standardised. Deploying smart devices and appliances will increase the need for technological standards and information exchange protocols to achieve full interoperability of all systems. Furthermore, as location provides a vital link between the sensors – which will facilitate the Internet of

Things – and the uniform resource identifiers which are assigned to all objects within that connected world, standardised metadata as part of geospatial data is a must.

Another challenging issue is the development of standards for indoor location detection/computation technologies. The lack of such standards may continue to hold back the development of seamless indoor/outdoor location applications with miniaturised RFID devices/tags. The aim is to achieve seamless access to appropriate location information regardless of protocols, networks, frequency bands and physical environments, as the user moves between outdoor and indoor locations. Digital maps of all large public buildings are a prerequisite for indoor navigation, so 3D coverage should be included in procurement budgets – although some people predict that in the Internet of Things the interactive end devices will automatically map the indoor environments.

It will also be important to link geospatial information with statistical data to produce spatial statistics. One approach that may

develop further over the next five years is the development of a table joining service (TJS) standard. This standard offers a web-based interface that enables the automatic, service-oriented joining of tabular and geographic data via the internet while keeping the shared data at the data provider's source location. The diversity of the semantic terminology presents a challenge, however.

As well as the focus on linking geospatial and statistical information, there has been rising interest in the interoperability and integration of marine and terrestrial information, which is of the utmost importance to coastal and island states. The development of hydrographic data models, such as the IHO's Universal Hydrographic Data Model, will be a strong enabler of enhanced data sharing across a diverse range of applications.

Through a global effort over the next five to ten years, the UN-GGIM considers it feasible to develop a seamless, durable, unified geodetic infrastructure on land, in the air and at sea, based on uniform global referencing. ◀

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No 2914

Review of the Land and Poverty Conference 2016



The theme of the Land and Poverty Conference 2016, which was held in Washington DC, USA, from 14-18 March 2016, was 'Scaling up Responsible Land Governance'. A few highlights linked to this theme are given here.

The guiding principles for countrywide implementation of the fit-for-purpose (FFP) approach in land administration were presented and were well received. This approach provides new and innovative solutions to build affordable, pro-poor, scalable and sustainable systems in order to identify the way all land is occupied and used. It is a countrywide solution encompassing all tenure types. It creates integrated and scalable land administration solutions. It is highly participatory. It can be implemented quickly and provides security of tenure for all. Most importantly, the FFP approach can start very quickly using a low-risk entry point that requires minimal preparatory work. The concept is based on a joint FIG and World Bank publication from 2014.

During the Land and Poverty Conference 2016, the UN-GGIM group of experts on land administration and management was launched. There will be a high-level expert



group meeting at the end of April 2016 in Addis Ababa, Ethiopia, where integration of land administration in the Global Spatial Data Infrastructure will be the key theme. A work plan will be developed for this purpose.

An event on 'Architecture and Services for Imagery-based Land Administration Registration' took place, co-organised by the Open Geospatial Consortium (OGC), World Bank, the Global Land Tool Network, FIG and Kadaster International. One of the principles of the FFP approach is the use of imagery for boundary identification. During this event, the need for infrastructure for provision of the imagery was discussed in order to support the collection of evidence from the field. Services

for data access, transport and distribution are needed in this context. Requirements and the options for business models were also discussed. There are challenges in relation to the inclusion of spatial units for land administration linked with legal/administrative data on land use rights and rights holders. OGC is developing a draft charter for the establishment of an 'OGC Land Administration Domain Working Group'. Final decisions on the establishment and the organisation of the group are expected in June 2016. ◀

More information
www.fig.net

Spotlight on a GSDI Member: RCMRD Building Web-mapping capabilities



To improve web-mapping capabilities in its member states, the Regional Centre for Mapping of Resources for Development (RCMRD) has been hosting training workshops, most recently in Botswana, South Africa, Namibia, and Kenya. The interactive five-day training sessions, which include presentations, practical exercises and discussions, have been designed to introduce the attendees to basic theoretical and practical concepts of web mapping and teach them how to deliver and share geographic information online. The focus has been on web-mapping technology, including its architecture, application and tools.

Participants have typically been GIS professionals, cartographers and other technical personnel with a background in computer applications and the internet.

By the end of the workshops, the participants have been able to share GIS maps, data and workflows through the creation, building, publishing and sharing of GIS services accessible from desktop computers, web browsers and mobile devices. This training is an important contribution by RCMRD to enhancing the use of geographic information by government working groups, decision-makers and the general public. The training

also strengthens the exchange of knowledge between the participants and RCMRD staff, both for the duration of the training and beyond.

RCMRD is a non-profit inter-governmental organisation and currently has 20 contracting member states in the Eastern and Southern Africa regions: Botswana, Burundi, Comoros, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Namibia, Rwanda, Seychelles, Somali, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. Since its establishment in 1975, RCMRD has been instrumental in capacity building for ▶



resource survey, mapping, remote sensing, GIS and natural resources assessment and management in Africa. More recently, RCMRD has been advancing the management and use of geospatial data via online platforms,

ultimately to enhance decision-making processes within member states.

RCMRD's GeoPortal, for example, is a platform for disseminating open geospatial

datasets and maps for the Eastern and Southern Africa region. The Geoportal runs on GeoNode, an open-source platform that facilitates the creation, sharing and collaborative use of geospatial data.

RCMRD is a valued, long-standing member of the GSDI Association (www.gsdiassociation.org) and currently represents the African region on the GSDI Board. ◀

More information

- www.rcmrd.org
- <http://apps.rcmrd.org>
- www.gsdi.org



IGS Analysis Workshop Held in Australia for the First Time

The International GNSS Service (IGS) Workshop was held in Sydney, Australia, from 8-12 February 2016, marking the first time the workshop had been held on the Australian continent. The event attracted about 180 participants, two thirds of which were from countries other than Australia, and was hosted in the new conference facilities of the University of New South Wales (UNSW). There were 62 papers and 89 poster presentations.

Three keynote presentations were made:

- 'Precise Positioning for the Mass Market' by Todd Humphreys
- 'GNSS Radio Occultation Science & Applications' by Jan Weiss
- 'Sea Level Change: A Scientific & Social Challenge for the 21st Century' by John Church

All previous IGS workshops had been held on a biennial basis in either North America or Europe (with the last one in Pasadena, USA,

from 23-27 June 2014). It is noteworthy that from the very beginning Australia contributed GPS tracking data from its core Australian receiver stations to the IGS data centres. Peter Morgan and John Manning were early members of the IGS Governing Board (GB). Over the years Australia has provided GNSS data from ever-more stations, on the Australian continent, from its territories, from Antarctica and from a dozen sites across the South Pacific. It participates in the Multi-GNSS Experiment (MGEX) and the Real-Time Service (RTS). The GB current chair is Gary Johnston from Geoscience Australia (GA). The new analysis centre coordinators both have links to Australia: one is based at GA (Michael Moore) and the other at Massachusetts Institute of Technology (MIT)(Tom Herring). Australia also contributes to the development of eGeodesy standards and to a number of working groups (WGs) Hence the hosting of this workshop in Australia acknowledges the important contributions made by Australian GNSS geodesists.



▲ IGS Workshop participants at UNSW from 8-12 February 2016.

The IGS Workshop provides an opportunity for the IGS community to come together to present the latest results in high-accuracy GNSS techniques, to discuss the quality of the IGS products and to decide future strategies.

In particular the IGS working groups (such as Analysis Centres, Data Centres, Infrastructure, Bias & Calibration, RTS, MGEX, Troposphere, Ionosphere, Orbit Modelling and others) meet to decide on changes to software, models, analysis methodologies, data management, GNSS network operations, etc, that will improve the quality, timeliness and relevance of current (and planned) IGS data products. The IGS GB also met twice to set future directions and consider a series of recommendations from the workshop. Amongst the highlights of the IGS Workshop were an analysis of IGS's contribution to the

recent ITRF2014 solution (see article in the March 2016 edition of GIM International), progress in the MGEX, progress of the RTS and the role of IGS in the International GNSS Monitoring & Assessment initiative proposed by the UN's International Committee on GNSS (ICG). However, the most important outcome is that IGS reaffirmed its commitment to increase the range of its products to include the BeiDou, Galileo, QZSS and IRNSS constellations.

IGS continues to evolve into a true multi-GNSS service, providing unique high-quality

products to support many scientific and societal applications of GNSS. All workshop presentations will be available from the IGS website: www.igs.org. ◀

Chris Rizos

More information
www.iag-aig.org

A Comprehensive News Service



The impressive newsletter of ICA, *ICA News / Nouvelles de l'ACI*, was last mentioned in this column nearly ten years ago. This biannual publication has been re-designed and faithfully edited since then by Igor Drecki (University of Auckland, New Zealand), and

those unfamiliar with it are encouraged to access *ICA News* through the ICA website at <http://icaci.org/ica-news>. The current issue, from December 2015, documents a very active half-year for ICA, with a breadth of informative accounts of events, projects,

reports, opinions and illustrations all connected with ICA.

As 2015 was a quadrennial year for ICA, involving a General Assembly and International Cartographic Conference (ICC), ▶

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there is plenty related to governance in the current issue of *ICA News*. The new ICA president introduces himself – reporting on his first major collaborative activity, meeting with all Commission chairs in Vienna in November 2015 (see also *GIM International*, January 2016) – and there are portraits of the new Executive Committee. There are several reports from the Rio conference detailing awards made, exhibitions presented, outcomes from the General Assembly, results of competitions (from Map Awards and Children’s prizes to the regular orienteering races), lists of ICA Research Scholarship winners, summaries of the sessions and attendance, conference-related publications, picture galleries and personal reflections on ten days in Brazil last August.

Further articles in that issue include: updates on International Map Year (IMY 2015-16); the regular profiles of an organisation (here, USGS), a journal publication (Croatian journal *Kartografija i Geoinformacije*) and an individual (Marianna Serebryakova, ETH Zurich); a host of reports from ICA Commissions describing their activities in 2015; interesting accounts of meetings and events held recently, from EuroCarto 2015 (Vienna) and the celebration of IMY in the United Arab Emirates to the 21st Joint Czech and Slovak Cartographic Conference and IMY in New Zealand; a summary report from the ICA Publications Committee and an introduction to the 2017 ICC in Washington DC. ◀



▲ *ICA News presents information about ICA activities worldwide.*

More information
www.icaci.org

Students at the ISPRS Prague Congress



The next time you meet someone involved in the International Society for Photogrammetry and Remote Sensing (ISPRS), ask them, “What was the first ISPRS Congress that you attended?”. You are guaranteed to see their eyes light up and a smile cross their face, but be prepared to sit back and listen as stories unfold about an event that brings together geospatial experts from all eight ISPRS Technical Commissions. Just like the Olympics, ISPRS Congresses are held only once every four years in different parts of the world, including Vienna (1913), The Hague (1948), Washington, D.C. (1952), Lisbon (1964), Ottawa (1972), Rio de Janeiro (1984), Istanbul (2004), Beijing (2008) and Melbourne (2012), to name but a few. The XXIII Congress will be held from 12-19 July 2016 in Prague, Czech Republic. Students and young professionals of photogrammetry, remote sensing and spatial information systems should, as the expression goes, move heaven and earth to be there.

The ISPRS Student Consortium, established at the 2004 Istanbul Congress and representing more than 500 members from over 75 countries, has assisted Congress Director Professor Lena Halounova and her team in organising several youth activities. A Pre-Congress Summer School entitled ‘Natural Resource Management: from Data Processing to Web Publishing’ will be held



▲ *Students of photogrammetry, remote sensing and spatial information systems should move heaven and earth to attend the ISPRS Congress in Prague.*

from 5-10 July in Telc, a town in southern Moravia founded in the 13th century at the crossroads of merchant routes. There, young scientists will join international experts in GIS and Lidar for lectures and hands-on exercises using popular software such as LAsTools, FreeGIS and ArcGIS for geospatial data processing, analysis and open-source publication.

Congress activities will follow in Prague, from inspirational plenaries and informative technical sessions to exhibits of state-of-the-art geospatial technologies. A special Youth Forum will be held on 17 July featuring

oral and interactive sessions organised by the Student Consortium, with awards for the best Youth Forum posters and papers. Sampling world-renowned Czech beer at the Young Scientists Ice-Breaker Party on 15 July and joining in with the outdoor soccer matches on 16 July will provide excellent opportunities for students and young scientists to make new friends, form life-long connections and create memories of their first ISPRS Congress. ◀

More information
www.isprs.org

Documenting the Trans-Atlantic Slave Trade Using 3D Technologies

The Atlantic Slave Trade Project

In the autumn of 2014, Trimble embarked on a joint programme with CyArk to digitally preserve 10 cultural heritage sites across western Africa and the Americas that were associated with the extensive and exploitative Trans-Atlantic slave trade prior to the American Civil War.



An interior room of the William Johnson House, captured with the TX8 scanner and displayed here as a 3D colour point cloud.



Robert, with the NEI team, captures data of the slave quarters on the Melrose Estate.



A colour 3D point cloud model of the William Johnson House, captured by Trimble TX8 scanners and processed in Trimble RealWorks software.

CyArk is a California-based non-profit organisation dedicated to the digital preservation of the world's cultural heritage sites; the name comes from the combination of the words 'cyber' and 'archive'. Its mission is to create a free, 3D online library of the world's cultural heritage sites to ensure that they are available to future generations, while making them uniquely accessible today. CyArk offers a publicly accessible web archive for its documented archaeological sites: <http://cyark.org>.

**The First Site:
Natchez National Historical Park**

CyArk and Trimble kicked off the Atlantic Slave Trade Project with the digital preservation of Natchez National Historical Park in Natchez, Mississippi. Resting along the Mississippi River, the city of Natchez played a significant role in the landscape of slavery in America. Prior to the Emancipation Proclamation of 1863 – which changed the federal legal status of more than 3 million enslaved persons in designated areas of the South from 'slave' to 'free' – Natchez was home to the second-largest slave auction site in the country, with traders transporting tens of thousands of enslaved people from Virginia, Maryland, the Carolinas and Kentucky to the markets and auction sites of New Orleans and Natchez.

The Natchez National Historical Park includes two prominent historical residences: the William Johnson House, an iconic brick house that provides valuable insight into the less-documented experiences of the free black

community living in Natchez in the early 1800s, and the Melrose House, a Greek Revival estate home that allows for a closer understanding of the daily life of those enslaved.

Onsite at Natchez, Trimble TX8 and TX5 3D laser scanners were used to document the Johnson and Melrose Houses, as well as four slave quarters on the Melrose Estate property. In addition to 3D laser scanning, GIS and survey data with photo panoramas were collected using the Trimble V10 imaging rover. Professionals from geospatial solution provider Navigation Electronics, Inc. (NEI) helped capture the data.

In just three days, the field capture team scanned and surveyed the interior and exterior of both houses, as well as their surroundings. During this time, the field team also captured high-resolution photography and conducted interviews with the park superintendent as well as park managers, volunteers, Natchez experts and prominent figures at the Natchez Museum of African Art and Heritage.

While the data field capture provides a baseline for documentation of the Natchez National Historical Park site, derivatives from the data make it possible for the public to interact with the site in new ways. Online visitors can take a virtual tour of both the Johnson House and the Melrose House and explore them through panoramic photography. A detailed 3D model, created from the panoramic imagery using Trimble's SketchUp 3D modelling software, is also available on the website to introduce virtual tourists to the

style, structure and geographic location of the slave quarters at the Melrose House.

In March and April of 2015, two other significant sites – the Annaberg Sugar Plantation on St. John in the US Virgin Islands, and the Cidade Velha on Cabo (Cape) Verde, an island republic off the coast of Western Africa – were also documented.

The Second Site: Annaberg Sugar Plantation

Denmark took control of St. John in 1754, establishing and operating sugar plantations all over the island until 1848, when slavery ended in the region. The Annaberg Sugar Plantation ruins are one of the finest remaining examples of Dutch Colonial Era industrial agriculture on the island.

A modest holding in 1722, the plantation was enlarged and modernised in 1796 when James Murphy purchased and consolidated several plantations, adding one of the largest windmills on the island, plus the sugar factory. The ruins of Annaberg encompass the slave quarters, windmill and processing factory, a guard house and the owner’s mansion.

Situated in the eastern Caribbean, St. John was one of the worst places a person captured and transported across the Atlantic Ocean could disembark. Working brutal 18- to 20-hour days during the sugar harvest, enslaved workers suffered the relentless heat of the Caribbean sun and boiling-house furnaces, along with



An interactive map showing some of the Atlantic Slave Trade routes and sites is the starting point for exploring the project.

exposure to dangerous machinery and scalding liquids. The Annaberg slaves farmed 1,300 acres of sugarcane and produced 100,000 tons of sugar a year.

In 1917, the US purchased St. John from Denmark for USD25 million in order to establish a naval base, making the island an unincorporated US territory. Since 1956, approximately 60 percent of St. John has been protected as Virgin Islands National Park, administered by the US National Park Service. CyArk and Trimble worked closely with the Virgin Islands National Park archaeologist, Ken Wilde, to identify key areas of interest and to better understand how to document them. It took a team of nine people five days to completely capture the Annaberg site. Digital surface models, high-resolution orthorectified imagery, detailed point clouds of the structures, SketchUp 3D models of the site and panoramic terrestrial imagery of specific

features paint a comprehensive picture of the entire area. Several Trimble technologies were used to document the Annaberg Sugar Plantation, including TX8 scanning, UX5 unmanned aircraft system aerial photogrammetry and the V10 imaging rover with GNSS. The scale, variety and quality of captured data is one of the most complete and comprehensive site documentation efforts on record for a project of this type.

View the Annaberg site, find in-depth information and see the full media gallery.

The Third Site: Cidade Velha

The Cidade Velha site capture has been completed, with data processing still underway. Expect live datasets in the coming months, which can be viewed online.

In addition to contributing to a greater understanding of the complex Trans-Atlantic slave trade system, these digital preservation projects will enable free public access and standards-based curriculum around individual sites and the global slave trade at large. Documentation and inclusion in the digital preservation of the Atlantic slave trade theme will greatly enhance the visibility of these sites, while bringing cutting-edge technologies to assist in site conservation and interpretation.

Read more about these preservation projects in the March issue of *LiDAR Magazine*, a SketchUp blog post or on the project website itself.



The back facade of the Melrose House and the side buildings that contained the kitchen and dairy processing rooms on the lower levels and slave quarters above.



A 3D model of the Melrose House slave quarters, created using Trimble V10 imagery and Trimble SketchUp.

More Information:
www.cyark.org/themes/atlantic-slave-trade

The information and views set out in this sponsored article are those of Trimble and do not necessarily reflect the opinion of GIM International.

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For more information:
www.cyprusremotesensing.com/rscy2016/

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Houston, TX, USA
from 11-16 April
For more information:
www.sparpointgroup.com/international

INTEREXPO GEO-SIBERIA

Novosibirsk, Russia
from 20-22 April
For more information:
www.expo-geo.ru

GISTAM 2016

Rome, Italy
from 26-27 April
For more information:
E: gistam.secretariat@insticc.org
www.gistam.org

► **MAY**

FIG WORKING WEEK 2016

Christchurch, New Zealand
from 2-6 May
For more information:
E: nzis@surveyors.org.nz
www.fig.net/fig2016

GEO BUSINESS 2016

London, UK
from 24-25 May
For more information:
E: info@geobusinessshow.com
www.geobusinessshow.com

EUROPEAN SPACE SOLUTIONS 2016

The Hague, The Netherlands
from 30 May - 3 June
For more information:
www.european-space-solutions.eu

► **JUNE**

NORDIC UAS EVENT

Odense, Denmark
from 1-3 June
For more information:
www.nordicuasevent.com

HXGN LIVE

Anaheim, CA, USA
from 13-16 June
For more information:
hxgnlive.com

ESRI USER CONFERENCE

San Diego, CA, USA
from 27 June - 1 July
For more information:
www.esri.com

► **JULY**

XXIII ISPRS CONGRESS

Prague, Czech Republic
from 12-19 July
For more information:
E: info@isprs2016-prague.com
www.isprs2016-prague.com

► **SEPTEMBER**

GEOBIA

Enschede, The Netherlands
from 14-16 September
For more information:
www.geobia2016.com

INSPIRE CONFERENCE 2016

Barcelona, Spain
from 26-30 September
For more information:
<http://inspire.ec.europa.eu>

► **OCTOBER**

INTERGEO

Hamburg, Germany
from 11-13 October
For more information:
www.intergeo.de

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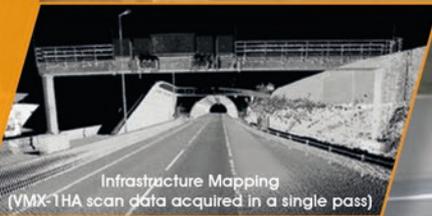
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