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FAREWELL INTERVIEW WITH SENIOR EDITOR MATHIAS LEMMENS

DIGITAL TWINS FOR SPATIAL PLANNING

SATELLITE IMAGERY: AN AERIAL ALTERNATIVE


Nikon

GIM INTERNATIONAL
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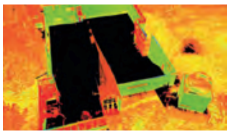

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COVER STORY

When it comes to impact evaluations, remotely sensed data can increase their timeliness, accuracy and relevance for decision-makers. 3ie and New Light Technologies are enhancing the use of geospatial analysis in IEs, as you can read in the article on this topic starting on page 28. The front cover of this November/December 2020 issue shows the detection of rice fields in a satellite image.

The rise of mapping

People have been mapping the environment for centuries and even millennia. On the walls of the famous Lascaux caves in France, primitive paintings dating back to 14500 BC show a part of the night sky. The oldest surviving map, showing a river valley between two hills, is on a Babylonian clay tablet, found in 1930 near present-day Kirkuk, Iraq. According to some estimates, the clay tablet is thought to have been produced in the 25th century BC.

The roots of modern cartography can be traced back to ancient Greece. Claudius Ptolemy's famous map shows the world as it was known to Hellenistic society in the 2nd century. A 2.7m-high wall painting of a town map, found in 1963 in Anatolia, dates back to around 6100-6300 BC. We also know about routes taken by the ancient Egyptians thanks to early representation of maps on papyrus. But there would be no maps without surveying. Did you know that maps in ancient Babylonia were created using accurate surveying techniques? On our website, you can find a well-read and much-shared article ('The Surveyors of Our World') by John F. Brock on the importance of surveying through the ages. It's well worth a read!

Fast forwarding to today's advanced mapping methods, the use of aircraft and – more recently – the availability of satellite imagery has made it possible to document our planet from the sky. In this issue of *GIM International*, we zoom in on mapping from above: both aerial and satellite-based imaging. To put things in perspective, it's good to remind ourselves that mapping from above is a relatively new phenomenon. Aerial photography was first put into practice by the French photographer and balloonist Gaspard-Félix Tournachon, back in 1858. Now, some 160 years later, aerial mapping has grown into a highly sophisticated profession as a result of the amazing evolution of aerial photography, inspection and mapping. Remote sensing technology has transformed spatial data into practical knowledge applied for a wide range of purposes.

In fact, this edition of our magazine contains a story titled 'Remotely Sensed Data for Efficient Data Collection' (page 28), contributed by Francis Rathinam, Ran Goldblatt et al. It gives a comprehensive overview of how Earth observation is crucial in impact evaluation, an assessment of how the intervention being evaluated affects outcomes, and whether those effects are intended or unintended. Remotely sensed data is converted into meaningful information related to the characteristics of land cover and land use, availability of surface water, food security, land productivity, cropping intensity and more. This is a complex topic but, in view of all the challenges planet Earth is facing, also a highly relevant one. The mapping profession has come a long way and its impact has moved far beyond what our ancestors in Lascaux, Babylon or Greece ever could have imagined!

Wim van Wegen,
content manager

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Hope

This issue of *GIM International* is tinged with sadness, but I will try to let some hope shine through on this page too. It's a sad occasion because we are saying farewell to our senior editor, Mathias Lemmens. Having stepped down from his geodesy teaching role at the Technical University in Delft last year, he is now leaving us too. We hope that he will fully enjoy his well-deserved retirement after 22 years of involvement with this publication. *GIM International* owes a lot to Mathias. He was the guardian of the quality and evolution of the magazine for so many years, contributing numerous articles and columns, always staying on top of the developments in the field, keeping his finger on the pulse of academia and research alike. He was a friendly and constructively critical member of the team who was always keen to ensure that the next edition of our magazine would be even better than the one before. We will have to do that ourselves from now on, but – on a hopeful note – we have learned so much from him over the years that I'm confident we will be able to continue his good work. Our content manager Wim van Wegen interviewed Mathias Lemmens on his illustrious career (see page 10 of this issue), and in a future edition we will publish a review of the new book by our soon-to-be former senior editor. Tjeu, many, many thanks!

Some sadness also stems from the fact that we are still caught up in the COVID-19 pandemic. Here in the Northern Hemisphere there is always a wave of colds and flu in the winter, but the situation is worsened this year by the potentially severe implications of coronavirus. This is our final issue of 2020… the first ever year in which an external factor of global proportions forced us to skip scheduled editions. Like me, you're no doubt hoping that we will soon be able to see light at the end of the tunnel. Encouragingly, there are already a few glimmers of hope now that the first vaccines have been announced. I'm sure we'd all like things to get 'back to normal', and not just for personal reasons, but for business reasons too. And while hope is not a solid company strategy, it can certainly help people to get through the winter in a more positive frame of mind. So let's hope for better times – but don't forget to put a strategy in place so that you'll be ready to seize new opportunities as they arise.

Bad things lead to good eventually, so I'm looking forward to 2021 bringing us better times. For now, have a good festive season and here's to a healthy and prosperous new year!

Durk Haarsma,
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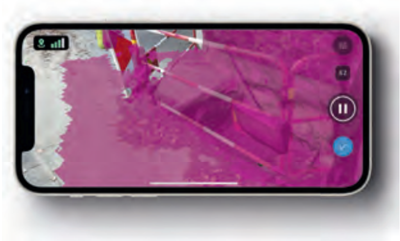
University of Colorado to Establish Trimble Technology Lab

▲ *Trimble is supporting the University of Colorado in establishing a Trimble Technology Lab.*

The University of Colorado in Denver, USA, has received a significant gift from Trimble to establish a state-of-the-art Technology Lab for the College of Engineering, Design and Computing. The gift will also support the departments or programmes in construction engineering and construction management, geography & environmental sciences, physics, and urban and regional planning. The lab will expand the university's access and expertise in a customized suite of construction hardware and software products. The Trimble Technology Lab will provide students enrolled across relevant programmes hands-on experience with a wide breadth of Trimble solutions. The lab will expand the university's access and expertise in project management, architectural and structural analysis, design and engineering, mixed reality, 3D scanning, office-to-field solutions, and GIS data collection and GNSS positioning. Partnering with Trimble allows the University of Colorado to integrate the latest technology into its curricula, empowering graduates to rapidly transform how buildings and living environments are designed and constructed.

▸ **https://bit.ly/38Qrovm**

Pix4D Launches New Ground Image Capture App for 3D Modelling



▲ *Pix4Dcatch iPhone mockup.*

Pix4D has released a new app for ground imagery acquisition: Pix4Dcatch. The app has been developed to empower users to easily create ground-based 3D models using an iOS mobile device. Users don't need to be experts; they can simply scan the area of interest with Pix4Dcatch. The app records pictures along with GPS positions. Compatible with recent iOS devices, but optimized for the newest iPad Pro and iPhone 12 Pro and Pro Max with Lidar sensors, scanning is done with real-time 3D meshing for scene completion feedback. This process of giving live feedback enables a workflow that secures optimal results. Images are then automatically uploaded to Pix4Dcloud for fast generation of scaled and georeferenced 3D models and points clouds that can be measured, shared and exported.

▸ **https://bit.ly/2KaQwTf**

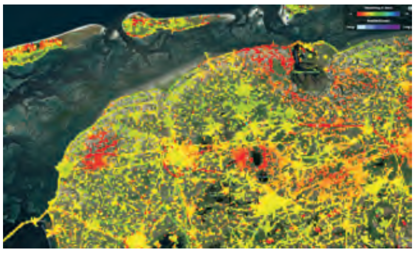
GAF and BKG Intensify Multi-source Remote Sensing Data

▲ *Delineation and grading map for the fire in the refugee camp at Moria, Lesbos, Greece. (Courtesy: BKG)*

GAF AG has won an international tendering process issued by the German Federal Agency for Cartography and Geodesy (BKG) for the provision of remote sensing data. The framework agreement includes consulting services and the granting of exclusive access for the BKG and its users to high-resolution and very high-resolution optical satellite images and radar images. GAF is one of the largest European providers of geographic information services with a focus on Earth observation. With its satellite-based crisis and situation service, the BKG makes an indispensable contribution to providing straightforward and rapidly-prepared information products derived from geodata and remote sensing to all the federal institutions. This enables a rapid response in the case of security-relevant and critical challenges.

▸ **https://bit.ly/36I6JXF**

New Land Subsidence Map Reveals the Netherlands' (In)Stability



▲ *Land Subsidence Map of the Netherlands (northern part of the province of Friesland). Courtesy: NCG/SKY GEO, TU Delft.*

Lopsided houses, subsiding streets, shifting dikes and nature reserves stricken by drought... all of this is revealed in the updated interactive Land Subsidence Map of the Netherlands, which was published recently. In the years ahead, there will need to be some serious investment in maintenance by citizens, businesses and government. Published jointly by the Netherlands Center for Geodesy and Geo-informatics (NCG), SkyGeo and TU Delft, the map shows the movement of billions of measurement points across the entire country. Whereas data of this kind previously needed to be collected manually, radio satellites have now been used, enabling new readings to be taken from each measurement point every few days. This provides a much more granular picture than the previous version of the map. In the first version, the satellite data was averaged out to boxes of four square kilometres. The new version shows each individual measuring point: more than 40 billion in total.

▸ **https://bit.ly/32SxebN**

Bentley Systems Commits US$100 Million of Venture Funding to Accelerate Infrastructure Digital Twins

▲ *Bentley Systems iTwin Platform.*

Bentley Systems, an infrastructure engineering software company, has announced the establishment of Bentley iTwin Ventures. The new organization will invest in promising technology companies addressing the emerging opportunity for infrastructure digital twin solutions for roadways, railways, waterways, bridges, utilities, industrial facilities and other infrastructure assets. Bentley iTwin Ventures is a US$100 million corporate venture capital fund which fosters innovation by co-investing in startups and emerging companies that are strategically relevant to Bentley Systems' objective of advancing infrastructure through going digital. The fund will target investments in transformational digital twin solutions supporting the design, simulation, construction and/or operation of physical infrastructure.

▸ **https://bit.ly/3nwCfi7**

Enview Unveils 3D AI as a Web Application

Enview, an innovator in the scalable processing of 3D geospatial data, has announced the launch of Enview Explore, a powerful web application that leverages artificial intelligence (AI) and cloud computing to automatically process 3D data at an unprecedented speed and scale. Additionally, Robert Cardillo, former director of the National Geospatial-Intelligence Agency (NGA), has joined the company's Board of Directors. Following an oversubscribed round of funding in May, the company continues to experience growth and momentum in the market. Enview's technology has been deployed on thousands of square miles worldwide to protect vital infrastructure and to support mission-critical operations. Its advanced method for classifying 3D data using neural networks and deep learning techniques reduces time to action by focusing on finding meaningful insights in 3D data. Previously offered as custom services for organizations such as Pacific Gas & Electric and the United States Air Force, this groundbreaking technology is now available for the first time as an easy-to-use, self-service web application.

▸ **https://bit.ly/3lE4uLb**

German Land Shifts Mapped by Sentinel-1 Satellite Imagery

Tiny shifts in the land surface across the whole of Germany have been mapped for the first time with the help of the Copernicus Sentinel-1 radar mission. Land-surface deformation, such as subsidence, often happens because of changes that take place underground like groundwater extraction, mining, natural consolidation of sediments and rapid urbanization. This ground motion can be a major threat in both urban and agricultural areas. Images from space offer cost-effective, systematic, high-precision measurements over most of Earth's land surface.

▸ **https://bit.ly/3nxGXfD**

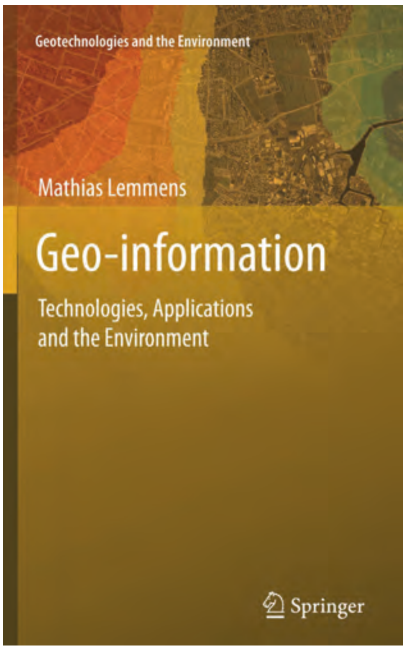
FAREWELL INTERVIEW WITH SENIOR EDITOR MATHIAS LEMMENS

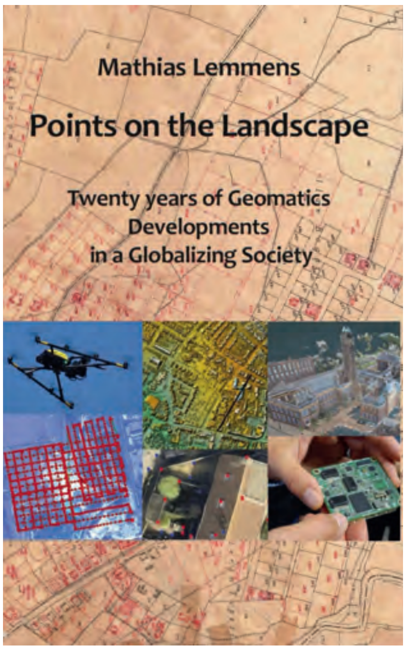
Shedding Valuable Light on the Geomatics Industry

After 23 years, senior editor and industry figurehead Mathias Lemmens is stepping down from his position on the *GIM International* editorial board. He has played such a significant role in the evolution, quality and reputation of this publication that we cannot allow this moment to pass unnoticed. In this extensive farewell interview, Lemmens looks not only back but also forwards as he takes us on a journey through his career in the field of geomatics. A 'must read' for everyone involved in the surveying profession!

You started your career at* GIM International *with a clear focus: to publish high-quality articles on cutting-edge technological developments, new application areas and societal developments that could influence the surveying profession's future. Looking back on the past couple of decades, did you succeed?

It was not so much a career, but rather a sideline to my main activities: research, teaching and consultancy. I'd been a voluntary editor of a national geomatics journal since 1990. When I was approached to become editor of *GIM International* in 1997, I hesitated at first. Just as today, the magazine was sponsored by the industry. How would that balance with my academic independence? Would it lead to a conflict of interests and infringe my ethical standards? But I also recognized its potential for disseminating new technologies to a worldwide audience. Having guaranteed my independence, I agreed. Since then I have written hundreds of columns, articles and interviews with leading scientists and industry decision-makers. Often provocative and thought-provoking, my writings have covered not only technology and technological trends in geomatics, but also and above all the fate of our planet and the people living on it – societal issues, education, Earth's vulnerability (climate change, natural disasters, etc.) and the relationship between poverty and our monetary system and the organization of aid. My major ethical principle was to refrain from promoting individual interests from the realms of industry or science. The eagerness of practitioners and scientists alike to be published in *GIM International* and the use of articles from it in academic education prove how well the magazine has been appreciated. So my answer is definitely yes, I have succeeded!





Your clear and understandable interpretations of the impact of wider developments on the geomatics profession have consistently provided a foundation for learning and debate. What drove you to always take such a broad view?

My broad view stems from my concern about the inequality of wealth in the world. Why are some countries rich and others poor? Why is there such an extreme divide between rich households and poor ones within a particular country? And how can geomatics help to lessen those extreme? I collected many ideas in Part 1 of my book *Points on the Landscape* under the heading 'Wealth and the Art of Map Maintenance'. The first chapter covers land, debt and poverty. Poverty expresses itself through a lack of food, proper sanitation or potable water, but finds its roots in power imbalance and thus money. Land administration systems, a major branch of geomatics, cannot be established without recognizing that our monetary system leads to corruption. The only way to fight corruption is to change the way money is created and implemented in society. It is a misconception that reducing poverty is just a matter of giving money; you can't fight fire with fire. Improving the fate of the billion or so poor people on this planet should be a supported bottom-up process, not a top-down one.

Tell us about your passion for writing.

As a youngster I discovered that I was not that stupid as they thought. I discovered that I had some talent for it, but not enough to make a living out of it, so for my career I decided to focus on my second passion: the Earth and how it is mapped. My editorships enabled me to combine those two passions.

You have always regarded* GIM International *as a platform for the exchange of ideas. How did you encourage knowledge sharing in the magazine?

One way I encouraged the exchange of ideas was in the Invited Reply series, in which I approached experts to comment on ideas presented by one or more authors in previous features. I also organized several series of articles – such as on geomatics education, land administration and other topics – and summarized the findings in concluding articles. As disasters became an increasingly relevant application area for geomatics, I introduced a monthly column called GIMasters and Disasters in 2007, which ran for several years. And to help our readers keep pace with the rapid implementation of technological advancements in geomatics instruments, my former colleague, Henk Key, and I introduced a long-running monthly column called Technology in Focus. Such initiatives take lots of time and require a deep understanding of the potential of geomatics and its role in society, of course.

In January 2000, you wrote in a column that "…beyond 2000, the geomatics industry will be primarily focused upon consumer-orientated services, end-to-end solutions and fast adaptation to user needs". Is this statement still applicable today?

The geomatics industry consists of three layers. The bedrock is made up of the manufacturers of GNSS receivers, total stations, photogrammetric cameras, laser scanners, image processing software, GIS software and so on. These are the primary sponsors of *GIM International* and their messages are directed towards the second layer, which consists of geodata acquisition firms that use instruments and software to serve a wide variety of customers – who form the third layer – such as national cadastres, mapping agencies, municipalities and water boards. In my column, I foresaw that the first layer would take a shortcut to provide end-to-end services to the third layer through dedicated solutions for applications such as construction, firefighting, agriculture and city planning. Today, they are known as 'verticals'. This shortcut has been enabled by cheaper, more intelligent and more productive technologies combined with an understanding of the relevant workflows so that customers in the third layer can perform specialized tasks themselves. The growth of this customer base is ongoing, and I still firmly stand by the words I wrote in another early column: "The future of geomatics is bright".

The geospatial industry has seen its fair share of hypes over the years. Some turned out to be real game changers, some have added a useful solution to the surveyor's toolbox and some have simply vanished. In your view, which of them have made an essential contribution to the industry and what was just a soap bubble?

There are business hypes and research hypes. One research hype back in the 1980s/90s was the use of artificial intelligence (AI) for object recognition. Many researchers working on it – including me – believed that it would soon be possible to feed images captured from the air or space into a computer to produce maps without any human intervention at all, but we were disappointed. The basic flaw in thinking was that computers can mimic the human brain. But now, due to the gigantic volumes of geodata produced today, AI has resurfaced as the Holy Grail for automatic

object recognition. In today's academic papers, researchers complain that the complexity of Earth-related scenes, such as the presence of shadows and occlusions, cause 'challenges'. These are the same problems we faced three decades ago, so I am sceptical about the potential of machine learning and deep learning, notwithstanding the huge increase in computer power, storage capacities, and speed of data transport. As for business hypes, one around the turn of the millennium was location-based services (LBS). It didn't actually vanish, but did become invisible, hidden as it is in navigation apps and affected by privacy regulations. And a hype which turned out to be a great success is of course unmanned airborne systems (UASs). Equipped with cameras and/or Lidar and supported by dedicated software, such as dense image matching (DIM), they have become a mainstream surveying tool and have contributed to a huge extension of application domains. By the way, DIM has made a big contribution to the revitalization of photogrammetry as a major source of point clouds after Lidar initially caused its relevance to fade around 2010.

In 2005 you became a self-employed geomatics consultant. Why did you decide to move in that direction after two decades in academia?

Actually, it was not the first time. In my graduation year I co-founded an engineering firm – Geodelta – together with fellow student Robert Kroon. It was my Plan B, because the economic crisis in the early 1980s had caused high unemployment and because the PhD research proposal I planned to work on didn't secure funding. After some time I got a second chance to do PhD research and sold my shares. Today, the firm is owned by a fellow former editor, Martin Kodde. I really enjoyed working in education right from the start. The aim of a university should not be to make a profit, but to fulfil its societal tasks (see box).

SOCIETAL TASKS OF UNIVERSITIES

1. Creation of new knowledge through research to help society to maintain wealth, welfare and civilization and to prevent poverty and starvation
2. Transfer of knowledge to youngsters, practitioners and society as a whole through lectures and publications in professional journals
3. Structuring of knowledge through textbooks
4. Conservation of knowledge through libraries and – increasingly today – open-access repositories.

I am primarily committed to the second and third tasks. As my career unfolded, research got hoisted into the zenith and university managers gained ever-more power. Rather than being respected as proud professionals committed to high standards, teaching staff became part of the 'production machine'. After a burnout, I decided to become self-employed but I continued supporting geomatics students through a small teaching appointment. It turned out to be one of my best decisions ever. Around three years before I retired, I was asked to become Director of the MSc in Geomatics – recognition of my dedication to education at last, albeit a little late!

The surveying profession is a supplier of geospatial data to many users in many disciplines for many purposes, yet there seems to be a lack of awareness of this. How can education contribute?

Geomatics combines various technologies to produce geodata and convert it into geoinformation, often as 2D or 3D maps. The applications are virtually infinite. At the end of a project, the surveyor heads back to the office armed with data, leaving barely a physical trace of all the hard work that has taken place, and airborne or satellite-based data collection is even more 'invisible'. Is that a problem? I don't think so. There are many other professions people are unaware of. When talking about geomatics, I explain that it's a combination of the words geography and informatics in which the data are GPS coordinates, digital maps, images and laser measurements. I emphasize that geomatics forms the basis for Google Maps, Street View, satellite navigation and other well-known services. High schools can contribute to greater awareness by teaching about maps in geography lessons, doing geomatics exercises in mathematics, and – in history – discussing the role of surveyors in food supply in ancient Egypt or the role of maps in exploring the world in the 15th and 16th centuries. For example, how many people know that Mount Everest is named after a surveyor? Geomatics societies could play a stimulating role to grow awarness among pupils.

What are the career prospects for young people in geomatics?

There is a shortage of geomatics professionals to meet the ever-growing need for geoinformation. In 2018, I conducted a survey among Dutch employers which revealed that geomatics graduates are in high demand due to their extensive geodata knowledge combined with ICT skills. Therefore, geomatics graduates can expect their career to get off to a flying start. Where they stand ten or 20 years later depends on their intelligence, commitment to continuous learning, zeal and also a bit of luck.

Climate change – and the associated carbon crisis – is one of the biggest challenges the world is facing today. How can the geomatics profession help society to address this? Are you optimistic or pessimistic?

Satellites record multispectral images with one or more near-infrared (NIR) bands. Topographic airborne Lidar also exploits the NIR band. Both technologies are used for determining biomass, monitoring its fluctuation over time, and mapping vegetation parcels. Climate change causes sea-level rise and heavy rainfall, increasing the risk of flooding and destruction by mudslides. Geomatics technologies are used on a regular basis to monitor the condition of dikes and dunes. Water boards in the Netherlands were among the first to recognize the potential of airborne Lidar. The country's dense DEM originates from its centuries-long battle against water. I am optimistic about the future and believe that humans will continue to dominate the planet for another million years, although not in such huge numbers as today. In line with Darwin's 'survival of the fittest' theory, we should accept that life evolves over time and that we cannot fully control nature.

You worked in academia for many years. How has the way of educating students evolved over the decades?

Not that much. A lecturer still stands in front of a class of students. The ubiquitous spread of the internet sparked predictions of a distance learning revolution some 25 years ago. The message was that lecturing is just like giving a presentation, resulting in the delusion that academics should follow a drama course to improve their skills. Blackboards were deemed old-fashioned and removed from lecture rooms. Guess what – they are back again, and many students still make notes using pencil and paper! There have been some benefits of digitalization, of course, such as computer projections replacing overhead sheets and the ability to post lecture notes or messages in digital learning environments. But the way young brains absorb knowledge and adopt skills hasn't changed much throughout history. Learning is also a social activity. Students empower each other. The transfer of knowledge is based on talent and motivation; technology is just an aid. If distance learning were a real alternative, it would have been in place already. After all, the invention of the printing press and introduction of regular postal services could have enabled it centuries ago. In that context, today's massive open online courses (MOOCs) are just another tool.

Coming back to your farewell as senior editor of* GIM International*, how can the publication continue to address readers' needs?

The internet inundates us with an abundance of articles, images and videos. But as more information becomes available, the trustworthiness of the source becomes increasingly important. Independent content is essential and high quality standards are rewarded in the long run. The fact that *GIM International* has been flourishing for over three decades is proof of this! There is a continued need for articles that illustrate the potential of promising technological developments not based on claims, but through use cases in which the technologies have been applied successfully. Don't talk, show! Regular articles on state-of-the-art geomatics technologies will provide valuable ongoing support to professionals, especially when combined with product surveys from the high-end segment. New technologies are rapidly implemented in instruments and it remains important to help practitioners understand how they work so that they can judge the suitability of such instruments for their existing or planned workflows.

How are you spending your well-earned free time now that you have retired from your decades-long career at TU Delft and also from* GIM International*?

I recently finished a monograph which I had been working on for four years. The book, entitled *An Introduction to Pointcloudmetry – Point clouds from laser scanning and photogrammetry*, will be issued by Whittles Publishing (ISBN: 978-1-84995-479-2) next year. I regard it as my legacy and hope it inspires students and practitioners. I have also written a chapter – on airborne and ground-based laser scanning – for the forthcoming publication called *The Routledge Handbook of Geospatial Technologies and Society*. Now, I am switching to other pursuits. I have written a novel, in Dutch, that is set on a university campus, which was published at the end of October. As a long-distance cyclist I also have plenty of exciting travel plans, but unfortunately they are currently being thwarted by the coronavirus measures. I hope to be able to set out on new adventures very soon! ◂

BIOGRAPHY

Mathias Lemmens (1953) started his career as a draughtsman and reckoner at Kadaster (the Dutch cadastre). He received his MSc in Geodesy from Delft University of Technology (TU Delft) in 1983 and was appointed as assistant professor there in 1987, specialized in geodata acquisition technologies and geodata quality. He completed his PhD thesis on photogrammetry and computer vision in 1996. In 2005 he started as a self-employed geomatics consultant while retaining a small teaching appointment at TU Delft, where he recently retired from the position of Director MSc Geomatics. Lemmens is author of over 500 publications, including scientific and professional papers, books, chapters and lecture notes, and has supervised over 50 MSc and four PhD students. As team leader and GIS advisor he has led major EU and World Bank projects in Estonia, Nigeria and Kenya. His popular book *Geoinformation – Technologies, Applications and The Environment*, published by Springer in 2011, provides a unique and in-depth survey of geomatics. In November 2019, to mark his retirement from TU Delft, he published *Points on the Landscape – Twenty Years of Geomatics Developments in a Globalizing Society*, a compilation of 150 selected columns published since 2000. He is also author of the monograph *An introduction to Pointcloudmetry – Point clouds from laser scanning and photogrammetry*, to be issued by Whittles Publishing in 2021. Lemmens is married with three children and one grandson. In his spare time, his biggest passion is travelling through Europe and Asia on a bicycle loaded with survival kit. He has written two books about his long-distance cycling adventures (in Dutch).

IMMERSIVE AND INTERACTIVE SURVEYING LABS

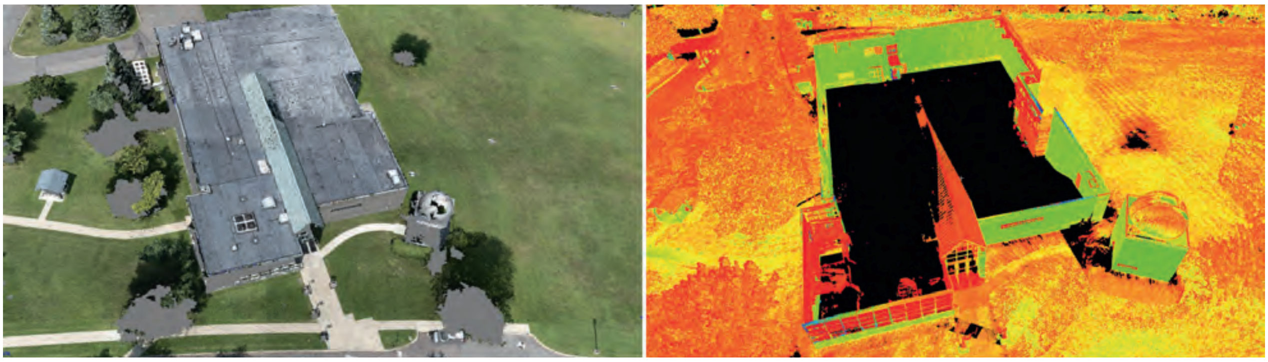
Realistic Virtual Reality Environments from Point Clouds

The advent of cost-effective head-mounted displays marked a new era in immersive virtual reality and sparked widespread applications in engineering, science and education. An integral component of any virtual reality application is the virtual environment. While some applications may have a completely imaginary virtual environment, others require the realistic recreation of a site or building. Relevant examples can be found in gaming, heritage site preservation and building information modelling. This article discusses how point cloud technologies were used to create a realistic virtual environment for use in immersive and interactive surveying labs.

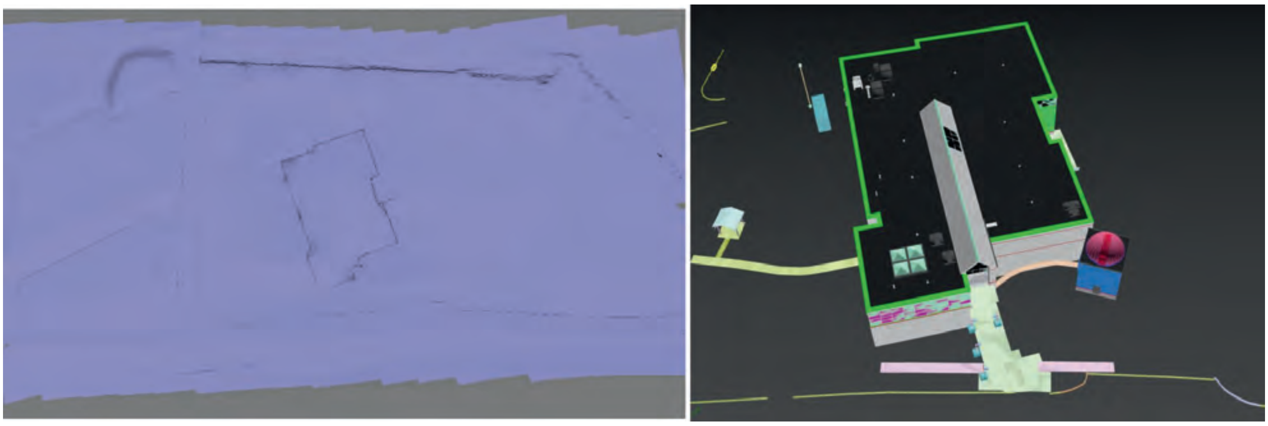
Creating a virtual environment that is based on a physical site necessitates geometric information to a high level of detail. Technologies such as unmanned aerial systems (UASs) and terrestrial laser scanning (TLS) generate dense and accurate 3D point clouds. Each method offers advantages and disadvantages that complement each other. For example, a UAS maps at an altitude with a downward-looking view angle, while scanners are set at vantage locations limited by line-of-sight obstructions. Identifying data gaps and merging their point clouds can create datasets that are more complete. For research purposes, a recent study recreated part of the Penn State Wilkes-Barre campus. The authors conducted UAS flights with nadir imaging and collected TLS scans from various locations, mostly around the building, and merged the point clouds through a custom merging algorithm. Figure 1 shows an example of the data gaps in the UAS and TLS datasets. For example, in this case the UAS point cloud has gaps around tree areas and captured the top of the building but not its vertical walls. In contrast, the TLS dataset could not capture the top of the building but did capture the building's vertical walls. The TLS dataset was used as the reference and consisted of 180 million points. The UAS point cloud had 70 million points, and 25 million points were kept to fill gaps in the TLS dataset.

MODELLING THE TERRAIN AND STRUCTURES

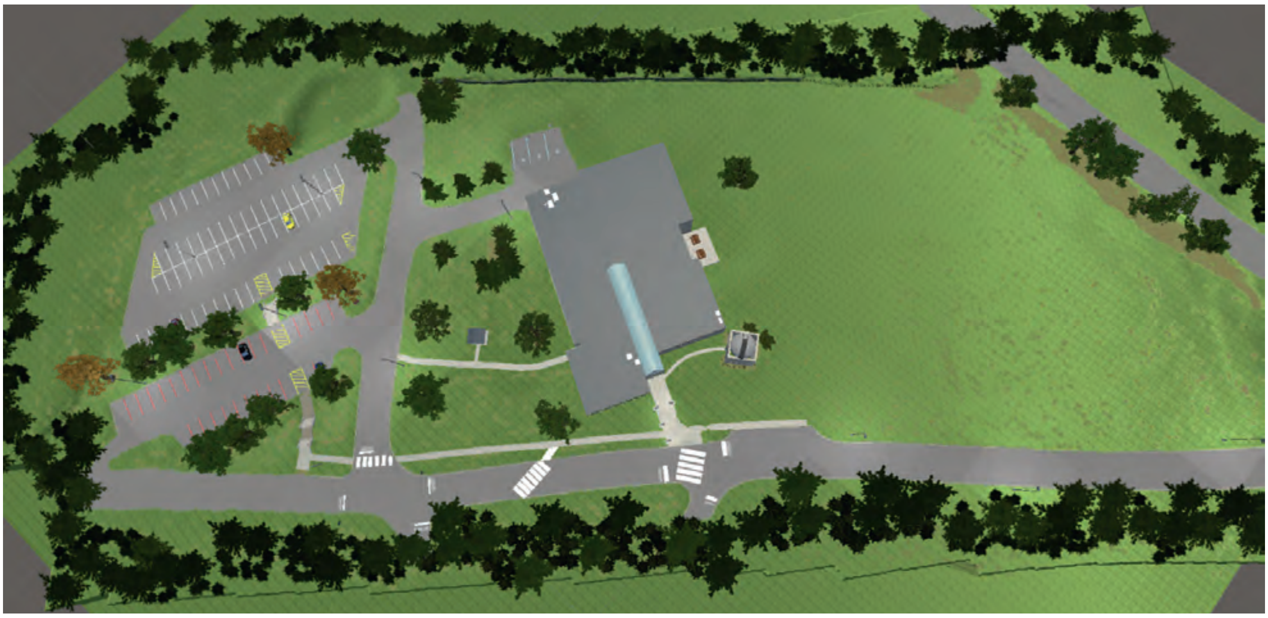
The terrain and any man-made structures can be modelled based on the merged point cloud. Using existing segmentation algorithms, it is relatively easy to separate the point cloud into ground and non-ground and create a terrain mesh from the ground points. While detail meshes of several million faces can be created, this introduces challenges to game engines (such as Unity and Unreal) that are often used to create virtual environments. For a pleasant virtual experience, it is important to always maintain a minimum of 60 frames per second (FPS), while other virtual-reality hardware manufacturers often recommend at least 90 FPS. This means that



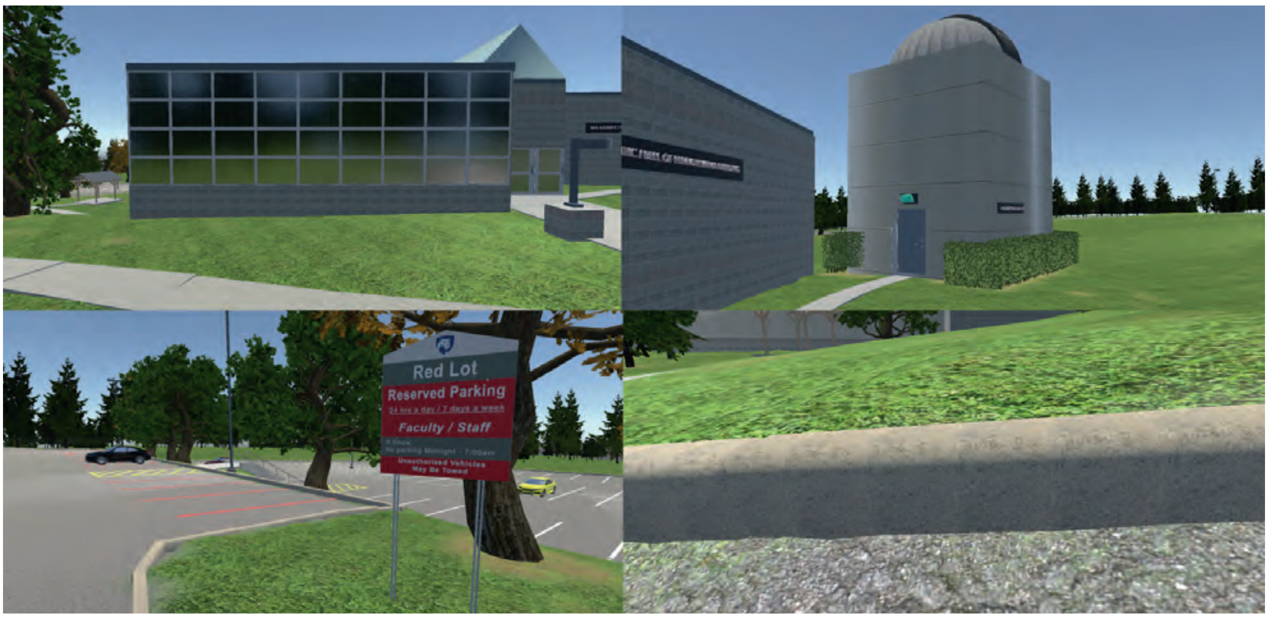
▲ *Figure 1: Point clouds from the UAS (left) and TLS (right).*



▲ *Figure 2: Modeling of Terrain (left) and man-made objects (right).*



▲ *Figure 3: Top view of the virtual environment.*



▲ *Figure 4: Examples of texture and environment. View of the Bell Technology Center (top left); Friedman Observatory (top right); Faculty and staff car park (bottom left); kerb, grass and asphalt textures (bottom right).*

detailed meshes of a few million faces need to be simplified to a few thousand without compromising the accuracy of the terrain. For example, in this implementation the initial terrain mesh had 4 million faces; however, when approaching complex areas (such as around the building), the FPS dropped to less than 60. The authors simplified the terrain and used 50,000 faces with a difference of 5cm in root mean square error (RMSE). Figure 2 (left) shows this simplified terrain. The terrain mesh was then converted to a Unity Terrain to take advantage of Unity's occlusion-culling rendering process. This only renders objects that are visible in the user's field of view, thus ensuring that 90 FPS is consistently maintained.

It was time-consuming to geometrically model man-made structures such as buildings and curbs. While some automatic shape detection algorithms exist, they detect primitive shapes such as boxes, spheres, cylinders and so on. While these are sufficient for applications that do not require a high level of modelling detail, this is not acceptable for immersive virtual environments. Consider that a building has complex windows and door structures, arched walkways, handrails, car-park stripes, letter markings on asphalt (e.g. 'STOP') and so on. In this case, man-made objects were modelled manually from the point cloud, which was laborious. Figure 2 (right) shows an example of these 3D models in Autodesk 3DS Max. The accuracy of the modelled 3D structures was compared with 93 checkpoints on building corners and car-park stripes, which showed an agreement within 10-20cm. Improved shape detection algorithms in the future will enhance the automation of structure extraction from point clouds, making it an easier process. For trees, a different approach was followed. A tree random generator (from Unity's Asset store) was used and they were placed on the corresponding locations, identified from the merged point cloud.

TEXTURES

Textures are an essential component of virtual environments. Creating and applying textures that look like their physical counterparts creates a sense of realism. While point clouds give important geometric information, images captured using UASs and TLS do not have sufficient resolution to create textures. As users can get very close to 3D objects in virtual reality, they will be able to see the pixels from the aerial imagery. Built-in materials in game development software can be used if they are similar enough to their physical counterparts, which can be an easy solution. This is the case for asphalt and grass textures. However, some physical objects – such as exterior building walls – have unique and complicated patterns, so textures need to be developed from scratch. To create such textures, the authors used close-up photography and created patterns that resemble the physical ones in Adobe Photoshop.

It is important that these textures are accompanied by normal maps that give an illusion of depth in virtual reality. The textures were used to create materials that were then applied to the 3D objects. Figure 3 shows a top view of the virtual environment created, while Figure 4 shows close-up examples of the textures. Of note are the custom textures in the buildings and the surrounding environment. For instance, in Figure 4 (top left), the windows were made reflective and in Figure 4 (bottom left), the car-park sign was faithfully recreated. In addition, ambient sounds were added such as birds and the movement of tree branches and rustling leaves in the wind. These add realism, which is important to create a sense of immersion.

RESEARCH RESULTS

This article has presented a workflow for utilizing point cloud technologies to create realistic virtual environments. The authors plan to use such realistic environments in surveying labs in immersive and interactive virtual reality. Merging point clouds generated from different acquisition methods can be used to obtain complete and high-detail geometric information. 3D modelling and texturing are important steps to make the environment realistic, but these processes take time and effort. Virtual reality technology is rapidly advancing and is quickly finding its way into surveying and engineering, increasing the demand for replicating physical environments into virtual ones, and opening the door for new professional endeavours.

ACKNOWLEDGEMENTS

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FURTHER READING

- Bolkas, D., Chiampi, J., Chapman, J., & Pavill, V. F. (2020). Creating a virtual reality environment with a fusion of sUAS and TLS point clouds. *International Journal of Image and Data Fusion*, 1-26.
- Bolkas, D., Chiampi, J., Chapman, J., Fioti, J., & Pavill IV, V. F. (2020). Creating Immersive And Interactive Surveying Laboratories In Virtual Reality: A Differential Leveling Example. *ISPRS Annals of Photogrammetry, Remote Sensing & Spatial Information Sciences*, 5(5).

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Bright Perspectives of Mapping from Above

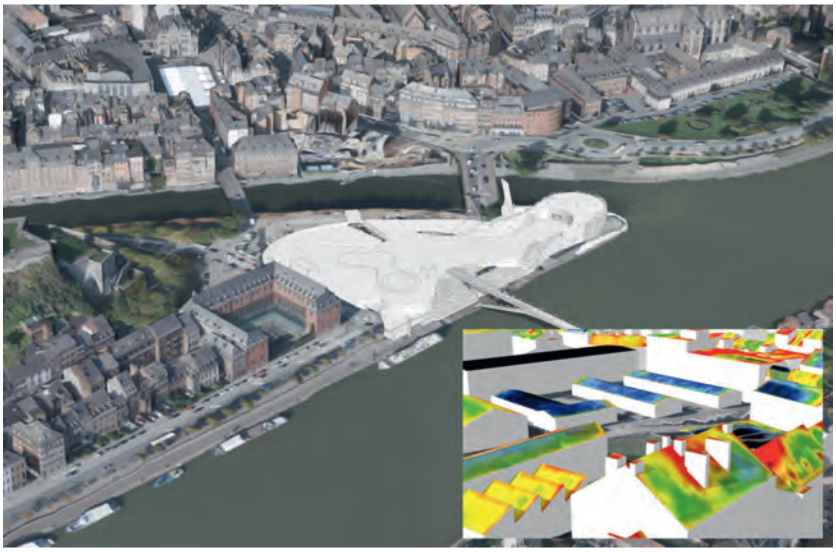
Recent technological developments have made aerial surveying more exciting than ever. For imagery, ground resolutions of 2cm can now be reached, whereas for Lidar, pulse frequencies of 4GHz and point clouds of 30-40 points/m^2 are no longer unusual. Simultaneous acquisition of imagery and Lidar is becoming increasingly popular.

To optimize the production chain and improve the workflow, many survey companies are looking to artificial intelligence (AI) and deep learning (DL) as the holy grail. Given the impressive amount of training data available, the continuously better performing CPUs and GPUs and the many hours of research invested in this subject, there is no doubt that AI and DL will play a bigger role in our industry in the near future. For example, the automatic extraction of trees remains a challenge many would like to tackle, and Eurosense is obtaining good results in that regard. However, AI is not magic, so it would be wise to exercise a certain level of caution in its application.

AI IS NOT MAGIC, SO IT WOULD BE WISE TO EXERCISE A CERTAIN LEVEL OF CAUTION IN ITS APPLICATION

The combination of recent technological developments and workflow improvements has led to better, faster and more accurate 3D models, pushing the limits towards (textured) LOD 3.3 and making an array of applications accessible to more customers every day. Such applications of 3D city models in GIS environments include automatic approval of building permits and complex analysis such as green-roof potential, water storage capacity and air pollution simulations. In these challenging times due to COVID-19, we are all encouraged to work from home and substantially limit the number of site visits. With a precise and recent 3D model, we can visualize and analyse a virtual clone of the reality, dubbed a 'digital twin', from behind our desks instead.

To build the ultimate 3D model, aerial 3D models (based on Lidar and imagery captured from the sky) could be completed with thermography and in situ data. The main challenges encountered in this regard are the different workflows and accuracies to deal with, and the automatic vectorization of Lidar point clouds. A right balance between XYZ accuracy, and time as well as cost, will have to be found.



Recently our industry has witnessed an improvement in the 'look and feel' of 3D models. An aesthetically attractive, interactive and immersive model reaches a wider public as it increases engagement, improves understanding and optimizes the experience. Rich 3D models lead to strong visual communication, superior insights and better decisions.

Sharing the 3D model with a broad audience is also an important part of a successful 3D model. Esri software offers an integrated platform for 3D visualization and analysis, and also makes the link with building information modelling (BIM) and indoor mapping. To add an extra dimension, Internet of Things (IoT) sensors can easily be integrated in the 3D model and dashboards to provide real-time information.

In conclusion, Eurosense sees a bright future for 'mapping from above', especially with regards to 3D products and applications. Demand is continuously increasing for better 3D products, and technological evolutions make a larger offering available at a more attractive price. These are exciting times indeed for our sector, and… the sky is the limit! ◂

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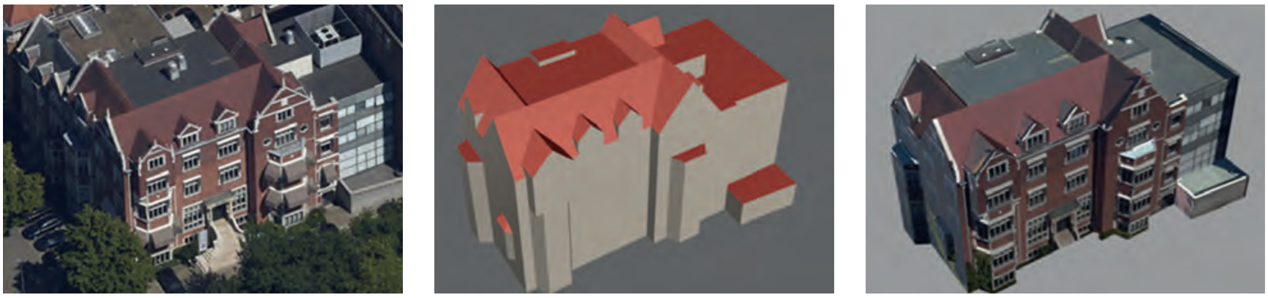
DIGITAL TWINS FOR SPATIAL PLANNING

Developing an Online 3D Model of the City of Groningen

The Dutch city of Groningen wants to follow in the footsteps of other cities such as Rotterdam, Hamburg, Singapore and Helsinki by developing a 3D digital model. For the team working on the 3D Digital City of Groningen project, the aim is for the image on the computer screen to be an identical replica of the reality outside.

▲ *Aerial imagery of the impressive Groninger Forum building.*



▲ *The company Avineon creates a state-of-the-art 3D city model with a level of detail LOD2.3, with a z-accuracy of 10cm and flawless alignment with the 2D large-scale base map.*

The City of Groningen in the Netherlands is committed to working in 3D whenever possible; in fact, its motto is 'We work in 3D unless...'. The municipality's City Engineers, City Design and Geo & Data departments are currently working together to develop a digital 3D model of Groningen, both above and below ground. Stakeholders regard this '3D Digital City' project as a next step to optimize the entire construction chain, since the 3D model will enable spatial projects to be carried out faster, more cost effectively and more transparently.

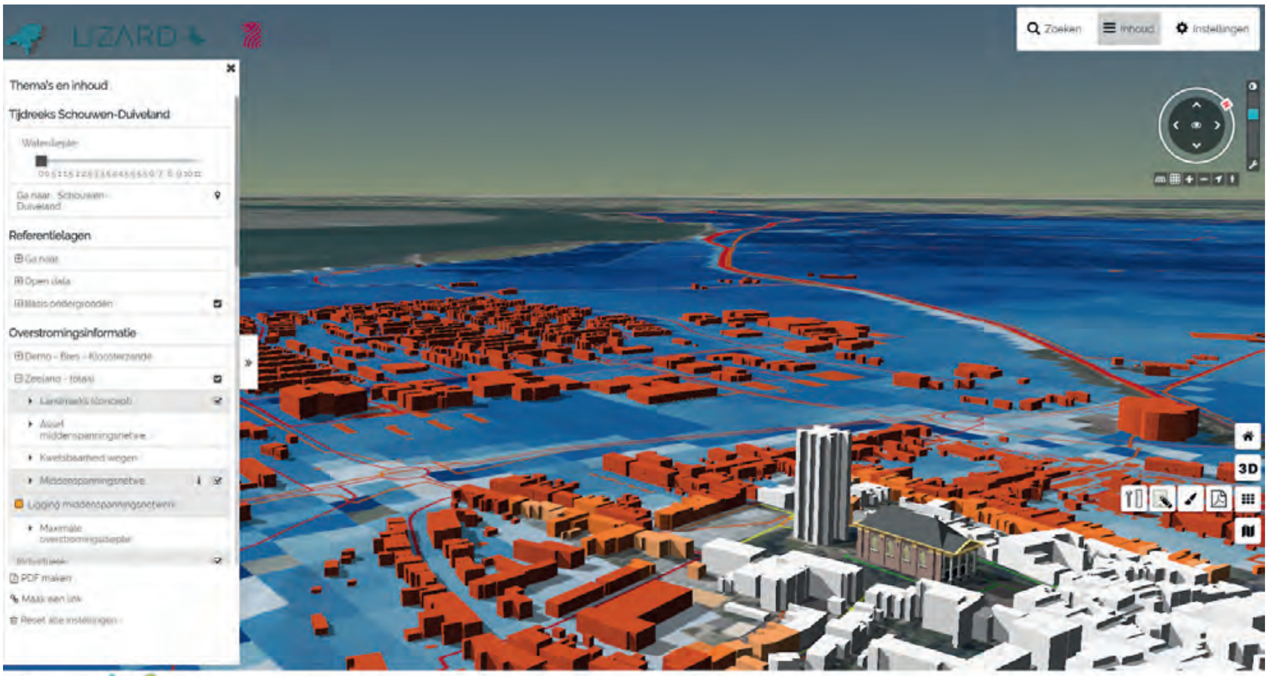
THE IMPORTANCE OF COLLABORATION

In November 2019, the impressive Groninger Forum building opened in the city centre, serving as a meeting place and hub for inhabitants, students, government, business and cultural organizations. This building embodies the municipality's focus on collaboration. The importance of cooperation between spatial departments in the spatial planning and development process also became clearly apparent during the construction of the Groninger Forum and other projects to renew the city centre. The municipality embraced the principles of Building Information Management (BIM) used in several construction processes and prepared a vision document on 3D. This vision corresponded completely with the coalition agreement document of the municipality.

PILOT PROJECTS

In 2019, Groningen successfully conducted two pilot projects. The first was a pilot project of the 3D underground of the former sugar factory complex called 'Suikerunieterrein'. The largely vacant site is to be redesigned, but there are objects in the subsoil that must be taken into account during the design. These were visualized in a 3D web map. The second pilot project was to build a 3D digital twin of the village of Ten Post, which is a few miles outside the city of Groningen, that the municipality could use for citizen participation, communication, planning and policymaking. Thanks to the success of these two pilot projects, the tender process for executing the 3D Digital City project as intended in the vision document was given the green light.

One company that got on board with the project at that point was Future Insight, which has been focused on 3D digital cities since 2014, for the City of Rotterdam. It is currently involved in numerous 3D digital twin projects worldwide based on the combination of 3D city models with, for example, sensor information, simulations and BIM designs. This makes a digital twin widely applicable for authorities to use in the different phases of a project, from planning and communication to completion.



▲ *Modelling floods is one of the many applications of a 3d city model.*

Future Insight's most important principle regarding a 3D digital twin is the use of open standards and technologies like CityGML and IFC as the basis for the solutions. This ensures that the solutions are flexible and scalable and can easily be reproduced by other customers or countries, while also offering the opportunity to connect with the newest open technologies that are available worldwide.

For the 3D Digital City project in Groningen, Future Insight's role is the storage of 3D city data and making it easily available online. But first, accurate 3D data is needed. Kavel 10 – a company with a lot of international experience in collecting high-quality aerial imagery and Lidar point cloud data on a large scale – handled the 3D data collection aspect. The city of Groningen was flown with a 2.5cm GSD for the images and approximately 400 points per square metre with an overlap of 80/80%. The biggest advantage of this approach is the possibility for multiple use of the data that is acquired in one flight.

3D CITY MODEL

Based on the resulting high-quality datasets, the company Avineon is creating a state-of-the-art 3D city model with a level of detail LOD2.3 (realistic roof modelling, taking into account dormers and roof overhangs, for buildings), with a z-accuracy of 10cm and flawless alignment with the 2D large-scale base map. Moreover, Avineon will add textures to the buildings, using its innovative, and largely automated, 3D modelling process which chains multiple tools together in a smart way. Avineon has developed this semi-automatic 3D modelling process based on many years of experience acquired working with customers such as Rotterdam, Brussels, Geneva, Bern and Neuchâtel.

Besides the buildings, Avineon will also model other attributes from the 2D base map, such as bridges, walls, steps and trees, to make the 3D Digital City representation even more true to life.

CONVENIENT AND APPEALING

Lastly, all of this 3D information will be made available to the users, and it is important that this is done in a convenient and appealing way. First, the data will be stored in an open 3D CityGML database and the different layers will be published into open 3D Tiles services. This will make it easy to use the 3D data in multiple online tools without it having to be converted or distributed. As a result, all tools will automatically have up-to-date 3D data available directly from the source at the municipality of Groningen. Additionally, a download service will be made available, enabling everyone to download parts of the model to use in their own modelling tools such as SketchUp or Autocad.

The collaboration between the 3D specialists is enabling the requirements set by the City of Groningen to be met efficiently, and the municipality is taking an important and high-quality step closer to meeting its 3D digital ambitions. Groningen values cooperation highly, and this partnership between experts and the city is another example of how Groningen wants to work together to meet its innovative goals.

The development of the 3D Digital City will help Groningen to become a smart city, not only by optimizing communication with the inhabitants of the city and other stakeholders, but also by supporting faster and better decision-making. Above all, a better understanding of the design stage of the construction process will help to prevent failure costs in the realization phase. The 3D model that is now being developed will provide the foundation for ensuring that spatial projects can be carried out faster, more cost effectively and more transparently. ◄

▲ *Kavel 10 handled the 3D data collection aspect.*

ABOUT THE AUTHORS

Rick Klooster is CCO of Future Insight and project manager of the 3D Groningen project with years of experience in similar projects. He was one of the initiators of the Dutch 3D pilot that resulted in a national 3D standard based on CityGML. He is the initiator of Nederlandin3D.nl, where the collaboration with Kavel 10 and Avineon originated.
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FIG Commission 7: AGM 2020 Wrap-up

The 2020 FIG Commission 7 Annual General Meeting (AGM) has wrapped up! Over the course of three days, which were based around the joint themes of 'Building community resilience through urban-rural land linkages' and 'Strategies to deal with COVID-19', 200 registered participants attended 11 parallel sessions, with upwards of 50 expert presenters, across three major time zones. The initial positive feedback shows that the Commission is continuing to deliver on its 2018-2022 workplan despite the disruption during the COVID-19 period.

The 2020 AGM was certainly different to previous years. Fully online, it enabled participants to join from anywhere, at any time, at much-reduced financial and carbon costs. This resulted in a larger than usual attendance, meaning even more engagement with the Commission's key activities. The event was multi-lingual, including dedicated French, Spanish and Mandarin sessions, enabling a more inclusive discourse. In addition, all profits from the event have been donated to the FIG Foundation.

CONCERNS, CONSENSUS, COMMUNITY

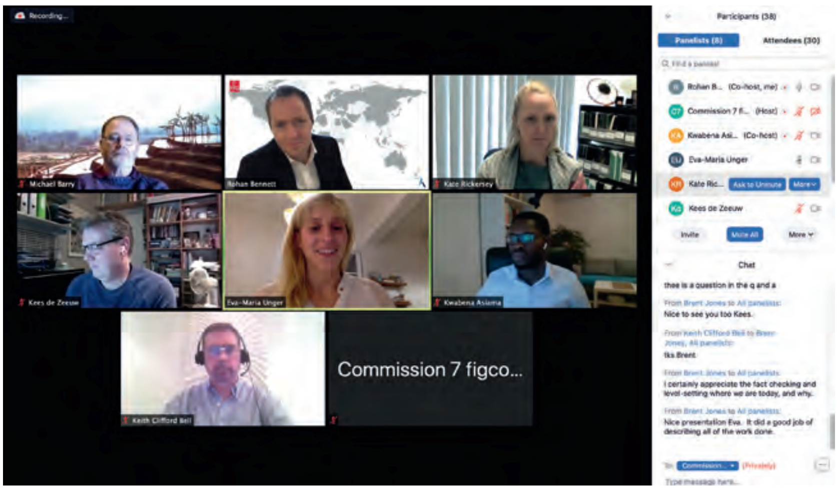
The meeting kicked off with the Asia-Pacific Opening (Session 1), with Keith Bell, Kees de Zeeuw, Eva-Maria Unger, Michael Barry and Kate Rickersey giving their views on the current state of play and future directions for the global land administration sector. Concerns were raised about future land administration initiatives; donor restructures and that redirected funds will have an impact. Consensus-building activities – such as the recently endorsed UN-GGIM 'Framework for Effective Land Administration' (FELA) and the mindset for integrated community-led development – provide pathways forward.

EDUCATION AT DISTANCE

Session 2, moderated by Commission 2 Chair David Mitchell, saw Chetna Ben, Dimo Todorovski and Kelly Lickley discuss the challenges and opportunities for surveying and spatial education brought about by the pandemic. The rapid transition to 'fully online' enabled continuity of training programmes and even increased engagement. However, challenges around delivering practical classes and matching face-to-face student experience were acknowledged.

INTEGRATION, IMPACTS AND INTROSPECTION

Session 3, the European Opening, saw FIG President Rudolf Staiger, Commission 7 Chair Daniel Paez, Danilo Antonio (GLTN) and Uchendu Eugene Chigbu discuss directly on both themes of the AGM. The key to urban and rural linkage is better policy, legal, technical and professional integration. Meanwhile, an introspective study of the impacts of COVID-19 on the surveyor profession showed, contrary to standard thinking, that over 30% of the community had actually experienced an increase in business and work – whether due to government stimulus or that fact that many land agencies are already fully digitally transformed.



PROGRESS, PERFORMANCE, PRINDEX

Sessions 4, 5, and 6 were conducted fully in French, Spanish and Mandarin, respectively. The French session, led by former Commission 7 Chair Daniel Roberge, saw Claire Galpin, Rafic Khouri and Jean-Philippe Lestang detail the growing support and expansion of land administration implementations in both Francophone and non-Francophone countries. The Spanish session saw Ivonne Moreno, Juan Daniel Oveido, Mika Mora, Malcolm Childress and Stephane Palicot outline the really significant land sector progress happening in contexts like Colombia, and also the scaling up of the increasingly focused upon PRIndex land tenure security index. The Mandarin session, with inputs from Dong Jiang, Changgen Zhan, Liang Huang, Huanle He and UngYong Park, touched upon themes of cadastral data unification, codification and combinations of data sources.

DISRUPTION, IMPROVEMENT, VALUE

Session 7 included a keynote from Rafael Tuts (UN-Habitat), alongside a presentation from Vladimire Evtimov (FAO), both focused on the importance of cross-agency collaboration when it comes to urban-rural linkages, especially in these disrupted times. Kim Taikjin and Simon Jeon (LX) provided the innovations from South Korea, whilst James Kavanagh and former FIG President Chryssy Potsiou updated attendees on initiatives around unregistered land valuation and work from UN-ECE.

NECESSITY BEFORE IDEOLOGY

In Session 8, Kirsikka Riekkinen led a debate discussion on the roles of PPPs in the land sector, with inputs and examples from Peter Creuzer and Della R. Abdullah. Opportunities and cautionary examples were explored, with a key message being that PPPs should be driven by necessity in terms of finance and skills, not by ideology.

READY TO SCALE!

Session 9 illustrated how many land administration innovations developed over the last decades, including LADM II, FFPLA and the participatory toolsets of Cadasta and Meridia, have reached new levels of maturity and are scaling in terms of county-level uptake. Here, Christiaan Lemmen, Eftychia Kalogianna, Frank Pichel, Amy Coughenour, Paula Dijkstra and Simon Ulvund shared stories.

CONVERGENT INNOVATION INSPIRES

Session 10 looked at more leading-edge technology developments relating to 3D cadastre, digital twins and artificial intelligence (AI). Peter van Oosterom, Mila Koeva, Brent Jones and Abbas Rajabifard delivered insights into the latest trends, also showing how many of the new developments are converging on different platforms and encouraging more engagement with other sectors.

COUNTRY REPORTS AND CLOSE-OUT

The final session was opened up to all participants, enabling freer interaction and the use of breakout groups. Country updates from Australia, the Netherlands, Russia, Indonesia, Croatia, Japan, Turkey and Portugal were delivered. The meeting concluded that the COVID-19 period has already changed the global land administration sector and is likely to increase tenure insecurity, rather than improve it. However, the situation also creates opportunities, and so it's more important than ever to continue to come together, share the local lessons at the global level and keep strength within the FIG Commission 7 community.

BIG THANKS!

A big thanks to all the session moderators and rapporteurs, including Kwabena Asiama (YSN Chair), David Mitchell (Commission 2 Chair), Chethna Ben, Jean Pierre Habiyaremye, Daniel Roberge (Former Commission 7 Chair), Michel Morneau, Ivonne Moreno (The World Bank), Huayi Wu, Yue Ying, Mohsen Kalantari, Sylion Muramira, Kirsikka Riekkinen, Mila Koeva, Charles Atakora, Christiaan Lemmen, Rohan Bennett and Daniel Paez, and of course the FIG Office – in particular Louise Friis-Hansen and Claudia Stormoen Pedersen – for making the online event possible. ◂

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Satellite Imagery: An Aerial Alternative

Remote sensing projects often begin with a question: Should I use aerial imagery or satellite imagery? This question may reoccur throughout long-term projects, particularly when unforeseen circumstances change the ability to collect data, the reliability of the data or the scope of the work. Budgets, technology and government restrictions are under constant transformation, making it critical to choose the right data inputs. There are a number of key parameters that must be taken into account when beginning any remote sensing project. These include the size and accessibility of the area of interest, the timeliness of the data, whether the data can be sourced from existing imagery or if a new collection is required, and – perhaps the most important aspect – the project budget.

EFFICIENCY AND SCALE

Satellites can complete remote sensing projects more efficiently than aircraft, resulting in enormous impacts on cost-benefit analysis. The key difference is the speed and ease with which satellites can collect thousands of square kilometres in minutes without the complicated logistics of aircraft flight planning. Aircraft face greater restrictions; they must obtain airspace permits, plan for suitable take-off and landing points and adhere to ever-changing border and travel restrictions. Aircraft are also vulnerable to weather conditions such as heavy winds. Satellites simply don't have any of these issues. They can collect isolated, conflicted or cross-border locations with ease. This applies particularly for large-scale mapping projects that may require multiple flights for manned or unmanned aircraft. These savings are significantly important in budget/time-sensitive government mapping projects.

TASKING AND PROCESSING

The planning of satellite tasking is fully customizable. This allows users to prioritize their areas for collection, define the resolution and spectral bands as well as specify collection angles. There is added flexibility for complex projects to adjust these requirements shortly before the acquisition takes place. Real-time weather updates ensure that the data acquisition will be as cloud-free as possible, further narrowing the competitive gap between aerial data and satellite imagery. After collection, satellite Imagery is directly downloaded through a ground station where it can be delivered to the user within hours of collection. Users may choose from several processing options and delivery methods.

COLLECTION CAPABILITIES

Satellite imagery providers can collect data in various multispectral band combinations as well as stereo imagery in a single pass, eliminating the need for multiple flights by multiple specialized aircraft. Stereo imagery offers reliable data for the creation of digital elevation models (DEMs) and virtual 3D reconstructions. The suitability of 30cm satellite imagery for aerial imaging applications is confirmed by the National Imagery Interpretability Rating Scale (NIIRS), which is used by the imaging community to define and measure the quality of images and performance of imaging systems. Imagery captured in 30cm from Maxar's WorldView-3 has a rating of NIIRS 5.7. This means that it is possible to identify objects such as above-ground utility lines in a residential neighbourhood, impervious surfaces, crop species and their boundaries, vehicle types, manhole covers and much more.

▲ *Figure 2: European Space Imaging's ground station located at the German Aerospace Center (DLR).*

▲ *Figure 1: Frankfurt Airport captured with WorldView-3 while borders were closed during the coronavirus pandemic.*

PERMANENT FOCUS

Satellites can reach areas of interest that are difficult or inaccessible by other means and offer predictable and frequent refresh schedules. With high-frequency refresh rates, users can confidently request the exact same area of interest to be collected at specific intervals. This is a crucial feature for automated analysis. As with aerial data, satellite imagery can also be integrated into programmes using artificial intelligence to automatically extract and classify features and thereby streamline workflows. The amount of imagery collected over time by satellites compared to aerial solutions offers increased training data for machine learning applications. Additionally, users can take advantage of this historical data to model predictive analytics that are incredibly useful for trend analysis, anomaly detection at a mass scale and profitability estimates. ◀

ABOUT THE AUTHOR

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A CLOSER LOOK AT IMPACT FROM HIGH ABOVE THE EARTH

Remotely Sensed Data to Increase the Efficiency of Data Collection

Rigorous evaluation of the outcomes of international development programmes and interventions has been a perennial challenge across multiple sectors and disciplines. Because of their ability to determine intervention effectiveness (and cost effectiveness), the demand for and production of impact evaluations (IEs) has grown substantially in recent decades, and they have been evolving to fill a critical gap in evidence. Remotely sensed data allows IEs to be improved in multiple ways, increasing their timeliness, accuracy and relevance for decision-makers. This article outlines how 3ie and New Light Technologies aim to enhance the generation, use and transparency of geospatial analysis in IEs.

Given the importance of international development to promote social, health, economic and environmental well-being and equity around the world, combined with the magnitude of investments in such efforts, it is essential to know whether or not such efforts are actually achieving the targeted outcomes for the beneficiary population. Making this determination is often far from straightforward, in part because it requires isolating and estimating the effect attributable to the programme or intervention, as compared to what would have otherwise happened for the same population in the absence of the intervention.

▲ *Satellite images are fundamental for flood detection.*

THE CRITICAL ROLE OF IMPACT EVALUATIONS

The field of impact evaluation has emerged and evolved over the past several decades to address this challenge and the associated gap in rigorous evidence on the effectiveness of development interventions. Study designs used to quantify attributable effects are typically experimental (which use random assignment to establish control groups) or quasi-experimental (which use statistical procedures to identify comparison groups to construct a valid counterfactual), often incorporating qualitative evidence as part of a mixed-methods approach.

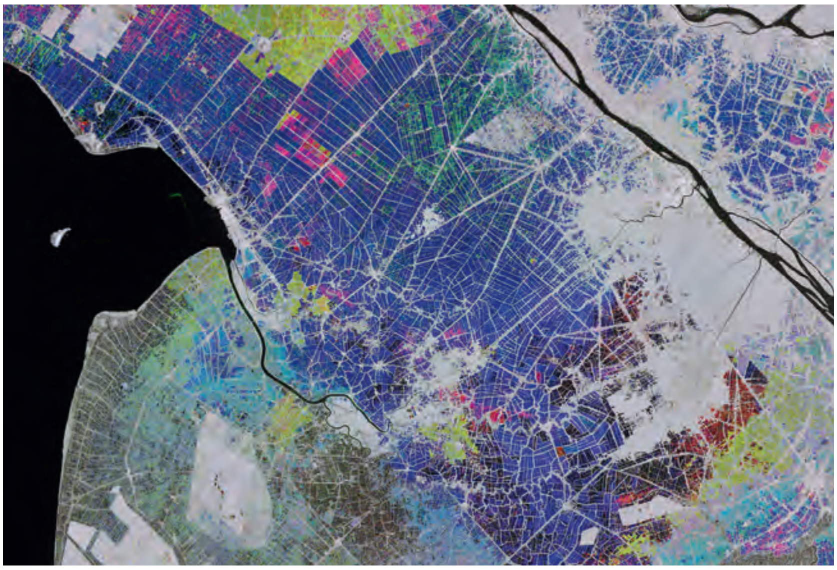
Because of their ability to determine intervention effectiveness (and cost-effectiveness), the demand for and production of IEs has grown substantially in recent decades. Policymakers and programme implementers increasingly seek evidence from rigorous IEs to guide investments toward interventions that are most likely to work, to produce the largest benefits, to reach the most people, and to do so at the lowest cost. At the same time, the limitations of IEs have also come under increasing scrutiny in the development community, including for example their often substantial time and resource costs and the challenges of accounting for important but unobserved variables and phenomena that may influence the outcomes of interest in the study population.

CHALLENGES AND LIMITATIONS

Impact evaluations often rely on primary data collection or existing large-scale representative survey data to construct key outcome variables and other covariates. However, when programmes are implemented at larger geographical scales than the individual or the household scale (e.g. in villages, counties, forests or for agricultural plots), conventional data collection methods may be inadequate. For example, many key outcome variables cannot be measured using conventional data collection methods (e.g. small-area economic activity) or are riddled with measurement errors (e.g. plot productivity).

Conventional data collection methods are also limited in their ability to measure a vast array of potentially critical control variables, such as the physical properties of areas where a programme is implemented (e.g. topography, land productivity, accessibility, proximity to services, etc.), which could significantly affect the impact of the programme. Furthermore, collecting several years of pre-programme baseline information or conducting follow-up surveys several years after programme implementation to measure long-term impacts is either prohibitively costly and/or not feasible. The high spatial and temporal resolution of satellite data allows the construction of multiple comparison groups to account for spillover effects and spatial heterogeneity.

In other cases, conventional survey data collection methods, such as face-to-face interviews, prove to be challenging, such as when it is necessary to reach migrant populations or populations residing in inaccessible regions. Overall, the logistical feasibility and the cost associated with the collection of conventional survey data often limits the sample size and statistical power of the analysis. When location matters for programme effect, remote sensing can add enormous value to impact measurement, especially when: 1) the programme placement has a spatial element (location/area/plots); 2) the outcome of interest is spatially measurable (directly or indirectly), and; 3) information on programme placement and timing is available and can be clearly demarcated retrospectively.



▲ *Detection of rice fields in a satellite image.*

AVAILABILITY OF AIRBORNE GEOSPATIAL DATA

Until recently, the cost and availability of satellite imagery, together with the computational cost associated with data storage and analysis, have hindered the accessibility to high-quality and timely satellite data for IEs. Today, there is an exponential increase in the availability of sources that provide freely accessible and reusable satellite data. Remotely sensed observations (e.g. observations collected by satellites or airborne instruments such as unmanned aerial vehicles) offer unique possibilities for IEs, especially when high-quality and reliable data is in short supply.

With the increasing availability, quality, granularity and frequency of satellite data, it is now possible to collect data from almost every location on Earth. According to the USA's Union of Concerned Scientists (UCS), more than 2,600 satellites currently orbit Earth, with close to 40% of them collecting data specifically for Earth and space observations and for scientific applications. For example, NASA's/USGS's Landsat programme has been collecting data since the 1970s, making these observations the longest continuous space-based record of Earth. Between them, the two current operating Landsat satellites (Landsat 7 and 8, which were launched in 1999 and 2013, respectively) capture every location on Earth every eight days in a spatial resolution of 30m. Since 2014, the European Space Agency (ESA) Sentinel mission has been providing a wide range of publicly available Earth observation data, including synthetic aperture radar (SAR) and electro-optical (EO) recordings. Sentinel-2, for example, provides observations of every location on Earth at a temporal frequency of up to every five days in a spatial resolution of 10m. This is compared to NASA's MODIS instrument, which provides almost daily images of Earth, but in a coarser spatial resolution (down to 1km).

With terabytes of data collected by multiple sources every day, it is essential to rethink the way all this data is managed, stored and analysed. Personal computers are no longer able to process this vast amount of data. On the other hand, cloud-based computational platforms (such as Google Earth Engine, AWS, Azure and more) now allow researchers to scale up the analysis across space and time. Parallel computing and cloud storage optimize the way the data is stored, managed and processed. With the decreasing cost of such cloud-based platforms (some of which are free for non-commercial use), it is now feasible to perform impact evaluation on scales that were until recently impossible. These recent technological advancements enable rapid and scalable conversion of the vast amount of remotely sensed data into meaningful information related to economic activity, distribution of the population groups, the characteristics of land cover and land use, availability of surface water, food security, land productivity, cropping intensity and more.

IMPROVING IMPACT EVALUATION

Remote sensing enables researchers to better meet the needs of policymakers by measuring outcomes and constructing comparison groups in ways that until recently were not possible. It strengthens the analysis, for example, through controlling for confounders and pre-programme trends, and makes the evaluations more feasible, for example, due to the reduction of data collection costs and more cost-effective retrospective and remote analysis.

1. Measuring the unmeasurable

- **Measuring outcomes:** Outcomes such as economic growth, GDP, poverty or wealth at the sub-national level, infrastructure quality, population distribution, etc., are difficult to measure accurately and/or at a required temporal and spatial scale using conventional data collection methods. Remotely sensed nighttime light data may serve as a proxy for these outcomes. For example, human-generated light at night is used as a proxy for local area economic activity.
- **Constructing the comparison group:** Remotely sensed data enables the matching of comparison units based on relevant pre-programme characteristics at the appropriate unit level or based on spatial discontinuity. A common method for identifying comparison groups is to perform pipeline or sequential allocation, where untreated segments function as a comparison group until they are treated; a regression discontinuity design includes units within a specified cut-off (e.g. within a given radius around the programme), thus creating a comparison group from a pre-specified contiguous space. The fact that satellite data covers all areas and is always 'on' (both temporally and spatially) also means that it is not susceptible to self-selection bias like other sources of big data (e.g. call detail records, interest-based online searches, social media data, etc.).
- **Long-term impact:** Collecting several years of pre- and post-programme data through a face-to-face survey is expensive and, in many cases, not feasible. The possibility to collect pre- and post-programme data, and especially the follow-up data, without the need for going to the field enables measurement of the long-term programme impact, and can help analyse how the impacts evolve over time and how long they last.

▲ *Band combination techniques can be used to highlight green vegetation in a satellite image.*

2. Overcoming analytical challenges

- **Assessing pre-programme trends:** Quasi-experimental designs require pre-programme similarity between the treatment and the control group, both in levels and distribution, potentially for several years before the programme. Historical time series of satellite data make it possible to evaluate parallel trend assumptions.
- **Controlling for covariates:** Failing to control for confounding factors will lead to omitted variable bias. Remote sensing can help control for local-area, time-varying factors through fixed effects at the level of individual cells or pixels in aerial or satellite imagery, and for time-invariant factors, such as physical attributes, through directly measuring them.
- **Heterogeneous effects:** IEs often measure the average treatment effect for an entire treatment group rather than heterogeneous effects for sub-groups, largely due to the unavailability of data and statistical power limitations. Remote sensing allows researchers to estimate heterogeneous effects based on observable baseline conditions such as population density at the cell level with sufficient power for sub-group analysis.
- **Robustness analysis:** Remotely sensed data can help conduct robustness analysis by allowing for the identification of multiple comparison groups that would have been expensive or infeasible using traditional data collection methods. Similarly, placebo tests can be conducted by testing the treatment effect on the treated for an arbitrary pre-programme date.
- **External validity and generalizability:** Remotely sensed data is available not only for the programme area, but also for the country/regional context. However, one needs to be mindful of the challenges in generalizing it beyond the country from which the training data comes.

3. Overcoming logistical challenges

- **Cost of data collection:** A fundamental challenge of IEs is the cost of survey data collection. For example, the average cost of a 3ie-funded multi-year, multi-round survey impact evaluation is approximately US$400,000, whereby the survey alone costs US$175,000. In comparison, the cost of a desk-based impact evaluation with free remotely sensed data would be around US$150,000.
- **Retrospective, desk-based evaluation:** For certain types of programmes, historical time series satellite data allows retrospective assessment of interventions already implemented, and in most cases the evaluation can be implemented remotely.

KEY LIMITATIONS OF REMOTELY SENSED DATA

For some applications, such as counting the number of trees or detecting building footprints, there is a need for the highest possible spatial resolution; for other applications, the temporal or spectral resolution may prove to be more important (for example, a high spectral resolution will be necessary to automatically detect types of crop fields, and a high temporal resolution will be essential to monitor daily changes in agricultural land productivity). In general, there is an inherent trade-off between each of these characteristics. For example, high spatial resolution imagery will often have a lower spectral resolution, while high spatial resolution imagery will often be associated with a lower temporal resolution, a smaller area covered and costlier imagery.

Nonetheless, the number and types of commercial imaging satellites are continuing to increase while small and micro satellites become significantly cheaper to build and launch. Simultaneously, the cost associated with data storage, management and analysis is continuing to decrease. Despite the increasing availability and use of satellite data, there are some important considerations that must be taken into account, including cloud coverage (which may limit the collection of remotely sensed data), the revisit period of the satellites (which tends to be lower as the spatial resolution increases), sensor limitations (e.g. the failure of the Landsat-7 Scan Line Corrector (SLC) in 2003, which resulted in significant data gaps in the acquired scenes), and the need for robust and scientifically sound data cleaning and post-processing. Importantly, it is essential to take the necessary steps in order to be able to make assumptions and generalize the interpretations. For example, machine learning and artificial intelligence-based approaches are often used to convert remotely sensed data into meaningful information about the

Earth. Some of these approaches rely on supervised machine learning techniques, which require reference data for training and validation. It is important to ensure the generalization of the reference data; for example, reference data for any supervised image classification must be collected from diverse geographical regions and a wide range of examples.

From an ethical perspective, it is important to consider risks of re-identification of study subjects and infringement of privacy, particularly if/when using ultra-high-resolution images (e.g. less than 1m). In practice, these risks can be mitigated by using areas or regions as the unit of analysis or using geomasking methods to protect privacy while maintaining spatial resolution.

REMOTE SENSING AS A COMPLEMENT

As implied by the above considerations, remote sensing should be approached as a way to complement rather than replace conventional forms of data collection, with an emphasis on those aspects of IEs where it is most likely to add value. One initial and perhaps obvious consideration is the type of intervention and research question, as remote sensing will be much more relevant for some than others. For instance, satellite or airborne imagery of agricultural fields is likely to be more accurate, unbiased, affordable and faster for measuring crop yields than self-reports or direct observation (e.g. crop cuts). In contrast, images from above will not tell us much about interventions to improve employee productivity and satisfaction within a workplace, nor in the context of agricultural productivity will they help us understand why crop yields are changing and the underlying causal mechanisms.

A second important consideration is that there are multiple critical aspects of development research that are more difficult to do remotely. For example, meaningful and ongoing engagement with policymakers, implementers, beneficiaries, and other stakeholders is essential to ensure that an impact evaluation is responsive to local needs and policy questions. Despite the growing use of virtual meeting platforms, this is still difficult (and sometimes impossible) to do effectively from afar. An increasing emphasis on process evaluation and mixed-method impact evaluations similarly highlights the limitations of remote sensing, as satellites and airborne images do not provide qualitative information about the political, social and operational context in which an intervention is conducted or how it is understood and experienced by implementers and beneficiaries.

CONCLUSION

Rigorous evaluation of development interventions and their outcomes has been a perennial challenge across multiple sectors and disciplines. This is due, in part, to the fact that conventional evaluation methods, such as household surveys, are typically costly, time-consuming and often unable to capture important spatial aspects of these programmes. Remotely sensed data, such as satellite and aerial imagery, can contribute significantly to increasing the efficiency of data collection for some variables and open up the possibility of accounting for others that were previously so onerous to collect or meaningfully synthesize that they were effectively 'unmeasurable'. However, a naïve use and interpretation of this data in IEs may result in misleading conclusions. As shown in this article, a number of technical challenges – such as cloud coverage, time of data capture, data gaps due to technical glitches and data comparability – must be accounted for carefully. Furthermore, the need to validate the predictions and interpretation (e.g. by means of machine learning techniques), the continued importance of meaningful stakeholder engagement and the growing emphasis on process evaluations and mixed methods to understand implementation and context point to the complementarity between conventional surveys and remotely sensed data, rather than the latter replacing the former. ◀

ABOUT 3IE AND NLT

The International Initiative for Impact Evaluation (3ie) and New Light Technologies Inc. (NLT) have partnered up to enhance the generation, use and transparency of geospatial analysis in impact evaluation, with an emphasis on informing development decision-making and strengthening research capacity globally, and in particular for stakeholders in low-income and middle-income countries. This comes in light of the increasing demand for geospatial analysis in impact evaluation, the rapid recent advancements in access to geospatial and remotely sensed data and the development of new methods to convert this data into information that is fundamental of IE.

ABOUT THE AUTHORS

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Dr Douglas Glandon provides technical guidance and quality assurance at 3ie to impact evaluations, systematic reviews, evidence gap maps and replication studies and supports members in strengthening organizational research capacity and evidence-informed decision-making. Glandon has a PhD in Health Systems from the Johns Hopkins Bloomberg School of Public Health, a Master's in Public Health from the Tufts University School of Medicine, and a Bachelor of Arts in International Relations and Community Health from Tufts University.

Ghermay Araya, GISP, founded New Light Technologies in 2001, building the company into the GIS and IT powerhouse it is today with a mix of business development strategy and information technology expertise. He graduated from the University of Maryland College Park Geography Department with a focus on geographic information systems in the mid-1990s and is currently back at his alma mater working his way through a master's degree in GIS.

FIG Working Week 2021 Now Transformed into FIG e-Working Week 2021

Everyone is affected by the impact of the COVID-19 pandemic. Back in May, we had to do some creative thinking when it became no longer possible to meet up in Amsterdam for the FIG Working Week 2020. Instead, 25 articles highlighting the content of the conference were published in cooperation with this magazine, *GIM International*. This supported one element of a conference – to learn. However, a conference is about much more than gaining knowledge. A conference should also provide inspiration and offer the opportunity to connect with people. At FIG Working Weeks, other crucial elements are networking and gaining a sense of community. It has now become clear that the possibility for people from all continents to travel to the Netherlands to meet up in person next summer will remain limited and is therefore unrealistic. The alternative is to go virtual, to create an e-Working Week – and this will take place in June 2021. The Dutch local organizers have thankfully agreed to stay on board and there will be a Dutch touch to this e-Working Week. This is already reflected in the overall theme: 'Smart surveyors for land and water management – challenges in a new reality'. This different approach naturally gives rise to questions such as: Why should I attend a conference online? Do I get anything out of it? Is it just an online webinar? Our aim is to create a Working Week that combines face-to-face elements such as networking and lively debates with sessions that – in line with the strengths of FIG – blends the different areas of surveying and geospatial science. Meeting with your peers and active engagement and interaction will be core principles for the e-Working Week. The ten FIG commissions are already working on designing these interactive sessions with topics such as: What does the Global Geodetic Centre of Excellence that was accepted by UN-GGIM mean for a surveyor?; Blended learning in a COVID-19 reality; where the water meets the land; The future of BIM in construction; Geohazards detection and monitoring; GIS and planning (strategic to applied); Point cloud-based monitoring in engineering surveying – urban/rural linkages; Climate change; and User-generated geospatial content, to name but a few.

To ensure a holistic approach and experience, the Dutch local organizers and FIG have formulated the following core principles for this new and innovative virtual event:
FIG e-Working Week 2021 will:

- inspire and connect
- be a global event
- provide an attractive virtual programme
- bring qualitatively good sessions
- provide an opportunity to exchange knowledge
- provide an opportunity to network and socialize
- bring different professional groups together.

Therefore, after attending FIG e-Working Week 2021, you will be inspired, (re)connected, energized, armed with new knowledge, and feel part of a community – in other words, it will be much more than 'just another webinar'…

A call for abstracts has been published. It is possible to submit abstracts for peer review and regular papers. All papers will be included in the proceedings and as material for the technical sessions. Submit now to be a part of this unique and different experience. The deadline is 4 January 2021.

More information
www.fig.net/fig2021

IAG Commission 2: Gravity Field

Commission 2: Gravity Field of the International Association of Geodesy (IAG) was originally established within the new structure of IAG in 2003 (IUGG XXXIII General Assembly, Sapporo), with the mission to address, coordinate and promote the study of scientific problems related to the accurate determination of the Earth's gravity field and its temporal variations. The Earth's gravity field is one of the three fundamental pillars of modern geodesy (besides geometry/kinematics and Earth rotation) and accurate knowledge of it is essential for applications in positioning and navigation, civil and aerospace engineering, metrology, geophysics, geodynamics, oceanography, hydrology, cryospheric sciences and other disciplines related to the Earth's climate and environment.

SCOPE AND OBJECTIVES

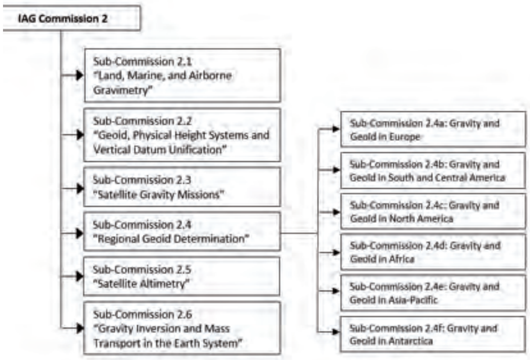
Commission 2's activities and objectives deal with the establishment of an International Gravity Reference System and Frame (IGRS/IGRF), support of the realization of an International Height Reference System (IHRS), support of the realization of a Global Geodetic Reference System (GGRS), analysis of current and future satellite data and release of improved global gravity field models (satellite-only models and combined models including terrestrial data), promotion of future gravity mission constellations for assuring the continued monitoring of the global gravity field and mass transport processes in the Earth system, foster regional gravity and geoid determination and integration of regional models into a global reference, understand the physics and dynamics of the sub-systems and mass transport processes in the Earth system, and investigate modern relativistic methods and geodetic metrology with a special focus on gravity and height determination.

STRUCTURE AND LIAISONS

In order to streamline and appraise the research efforts towards the above objectives, Commission 2 is organized into six Sub-Commissions (see Figure 1) with an advisory Steering Committee consisting of the Commission President and Vice-President, the Chairs of Sub-Commissions, representatives of IAG Services and other members-at-large from the international geodetic community and the immediate Past Commission President. About 170 scientists from 55 countries are currently affiliated with 12 different Working Groups and 10 Study Groups that have been established under the auspices of Commission 2 for the four-year period of 2019-2023.

Commission 2 closely interacts with the other IAG Commissions and Services, the Inter-Commission Committee on Theory (ICCT), the newly established Inter-Commission Committees on Geodesy for Climate Research (ICCC) and Marine Geodesy (ICCM), and the components of the Global Geodetic Observing System (GGOS).

More information
https://www.iag-aig.org/iag-commissions
https://com2.iag-aig.org



▲ *Figure 1: The basic structure of IAG Commission 2.*

ICA – A Professional Organization with a Special Focus towards Young People

The International Cartographic Association (ICA) is a professional organization that was founded 61 years ago, but is still young at heart. The ICA has a multi-purpose focus that includes topics ranging from ancient history to scientific development to professional practice within the discipline. One of the most important tasks for cartographers is delivering geospatial information to different kinds of users. The best way to do this is to have very close contact between the map maker and the user. This engagement not only includes experienced people, but also seeks to entice younger generations, including young children, to the world of maps.

During the last online Executive Meeting of ICA (17 October 2020), two ICA activities connected to young people were approved:
1. ICA Scholarships Guidelines and Criteria
2. Call for entries for the Barbara Petchenik Children's Map Competition 2021.

ICA scholarships for young scientists or professionals in cartography and GIScience can be used to participate in official ICA events (International Cartographic Conferences, Regional Cartographic Conferences, or events organized by ICA Commissions). The goal of these grants is to stimulate young scientists or professionals to direct their careers toward fundamental studies in the fields of cartography and GISciences. The opportunity for future applicants to apply is available. A list of previous awardees can be found at online.

▲ *Figure 1: Winner of the creativity award. Title: It Is All In Our Hands. By artist Ugne Rimkute, age 15, from Lithuania.*

The announcement of the official call for the Barbara Petchenik Children's Map Competition 2021 was made in October, 2020. This year there are no significant changes for the participants in the competition. The new theme of the competition 'A map of my future world' was selected with 31% of the votes given by many colleagues who contributed their suggestions from 17 countries.

The Barbara Petchenik Competition is a biennial map-drawing competition for children. It was created by the ICA in 1993 as a memorial to Barbara Petchenik, a past vice president of the ICA and a cartographer who had a lifelong interest in maps for children. The aim of the contest is to promote the creative representation of the world in graphic form by children. We encourage all ICA national members to participate.

Cartographers, GI specialists, young scientists and business-oriented colleagues are invited to attend our upcoming events:
- 25-26 Nov 2020: Geomatics Atlantic 2020 – Visualizing a Resilient Future Virtual Conference by the Canadian Institute of Geomatics – Newfoundland and Labrador Branch (Canada)
- 16-17 Dec 2020: SilkGIS2020, Ghent (Belgium)
- 21-24 Apr 2021: Atlases in Time – National and Regional Issues. Symposium organized by the ICA Commission on Atlases and the ICA/IGU Commission on Toponomy together with the National Geographic Institute of Spain (IGN), Madrid (Spain)
- 14-19 Jun 2021: 8th International Conference on Cartography and GIS, Nessebar (Bulgaria)
- 13-17 Dec 2021: 30th International Cartographic Conference, Florence (Italy)

More information about all ICA activities and events can be found in our journal, *ICA News*, edited by Igor Drecki, New Zealand. Rich information about cartography, news and maps can also be found in our monthly *eCARTO* newsletter edited by David Fraser, retired professor of RMIT University Melbourne, Australia.

More information
https://icaci.org/scholarship/
https://icaci.org/petchenik/
geoweb.ugent.be/silkgis2020
map-service.de/madrid2020/
iccgis2020.cartography-gis.com/
https://www.icc2021.net/
https://icaci.org/ica-news/
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ICEYE Imagery: A Key Resource for Global Near Real-time 3D Change Detection

Satellite-based change detection has been widely investigated in the last decades and has been recognized to be of high interest in several contexts, including urban (building/infrastructure/urban canopy change), environment (forest/biomass dynamics, landslides estimation, glacier mass change, coastal line monitoring, volcanic eruption), disaster assessment (earthquake-destroyed buildings, flood water height/volume) and civil/industrial (construction/mining progress, stockpiles). Due to the complexity of the processing task and the limitations in spatial and temporal resolutions of available satellite data, the morphological changes at a large/global scale have been mainly detected in two dimensions; 3D change detection has been traditionally limited at local/regional scale, using airborne Lidar and photogrammetry, and more rarely using stereo satellite imagery.

Nowadays, innovative satellite constellations such as the one developed by the company ICEYE represent a groundbreaking approach for near real-time 3D change detection at the global scale. ICEYE X-band SAR satellites form a constantly growing constellation, providing very high spatial resolution imagery (0.25×0.5 metres for Spotlight High, 0.5×0.5 metres for Spotlight, 0.5×2.5-3 metres for Stripmap High, 0.5-1.5×2.5-3 metres for Stripmap, in range×azimuth respectively) with an ever-improving revisit time. The system that can acquire 24h ground track repeat on a global scale will be further developed by ICEYE in 2021 and beyond. This will enable the acquisition of images with different incidence angles multiple times a day for specified areas of interest, benefiting from SAR independence from cloudy weather and sunlight illumination.

These are outstanding features, not only for daily interferometry and coherent 2D change detection but also for near real-time 3D change detection based on multi-view stereo-SAR data. The different image geometries allow mitigation/elimination of occlusions over urban and complex morphology areas overcoming the limitation of single stereo pairs. Therefore, with the almost continuous availability of ICEYE SAR imagery, 3D change detection is now entering a new era. It is also receiving a substantial boost from the recent developments of the stereo-SAR approach, which has attracted renewed attention in recent years thanks to the already available last-generation satellite SAR sensors at high spatial resolution (TerraSAR-X, Cosmo-SkyMed). The first experiments with dedicated scientific radargrammetric software assessed the 3D geometric capability of an ICEYE imagery dataset acquired in northern America. The results show that the 3D information can be extracted with an accuracy of a few metres with respect to Lidar ground truth data using a single stereo pair. Ongoing investigations highlight the possibility of improving the accuracy and completeness of the 3D reconstruction, exploiting the multi-view SAR geometries provided by several ascending and descending orbits.

By Andrea Nascetti, who is from Politecnico di Bari, Italy, and KTH Stockholm, Sweden, as well as Valeria Belloni, Roberta Ravanelli and Mattia Crespi, all from Sapienza University of Rome, Italy, ISPRS WG III/3 – SAR-based Surface Generation and Deformation Monitoring

More information
www.gsw2019.org
www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/IV-5/53/2018/
https://bit.ly/2SQ4ARy


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