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3D Cadastres: Fundamental enabler for future smart cities

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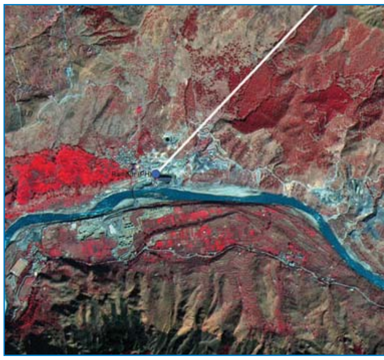

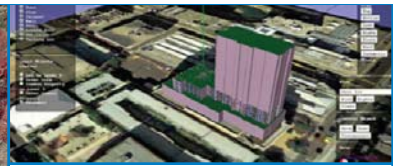

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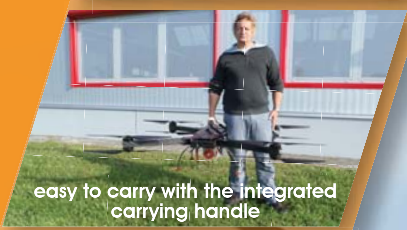

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Smart cities

The Government of India

Has a vision of developing 'one hundred Smart Cities',

As satellite towns of larger cities,

And by modernizing the existing mid-sized cities.

The government aspires

To manage the cities better

In view of increasing pressure on urban infrastructure

Due to fast pace of migration

From rural areas to the urban establishments.

However, one of the enablers

For this 'smart' proposition

Appears to be 3D cadastres.

Is India cadastre-ready?

Bal Krishna, Editor
bal@mycoordinates.org

Towards smart future cities: 3D cadastres as a fundamental enabler

It is essential that cadastral systems be linked with broader environmental information to support urban management

Professor Abbas Rajabifard
Head, Department of Infrastructure Engineering Director, Centre for SDIs and Land Administration, The University of Melbourne, Australia, Immediate Past- President of Global SDI (GSDI) Association

Serene Ho
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The relationship between people, place and data, infers a fundamental role for 3D digital cadastres in any smart city movement.

The rise of the smart city

Urbanisation is one of our most significant challenges (Suzuki et al, 2010). Rightly or wrongly, achieving sustainable urbanisation has been increasing reliant on high-rise, high-density buildings as the dominant urban form, and the stratified use of space to provide infrastructure, utilities and services both above and underground.

High-rise buildings, which have traditionally been used for commercial purposes, are now becoming a key urban response for housing in both developed and less developed countries, and is one that is endorsed both pedagogically and politically (e.g. Turkington et al, 2004; McConnell and Wiley, 2010; Yeh and Yuen, 2011; Rowley and Phibbs, 2012; Jackson, 2012). This drives a need for robust information about land and property rights, restrictions and responsibilities (RRRs), about which the cadastre has always had a fundamental role.

Residential developments also arguably drive an accompanying need for investment in infrastructure and services such as laying utilities (e.g. fibre optic networks), underground cities, large shopping complexes, subterranean rail systems. As spatial entities, these developments impact on the urban form with corollary impacts on urban flows (e.g. energy, travel, etc) and functions (e.g. land use) (Salat and Bourdic, 2012). We therefore need information about all aspects of the built form to facilitate better decision-making to support the functioning of our cities. In addition, the growing adoption of urban consolidation strategies around the world produces a range of other challenges associated with the increase in size and complexity of high-rise apartment buildings. These include facilitating an inclusive, vibrant and liveable community environmental concerns, and complexity in economic, political and regulatory forces (e.g. (Randolph, 2006).

Against this backdrop, attitudes towards developing and managing buildings are also evolving. For example, IBM now champions a "brick, mortar, data" philosophy that seeks to leverage the digital economy and the proliferation of data about buildings that is a by-product of its development (IBM, 2012). Governments are recognising the need to harness the wealth of information relevant to buildings to facilitate design, construction and management aspects of buildings for sustainable development (National Science and Technology Council, 2008). Such attitudes are encapsulated in the 'smart city' movement, a concept that has evolved from the notion of the 'intelligent city' (Allwinkle and Cruickshank, 2011).

Smart cities, have often been perceived to reflect cities that have become successful in using information and communication technologies – particularly those that help citizens connect – in aspects of city management and administration (Allwinkle and Cruickshank, 2011). However, there has been a more recent recognition that smart cities have emerged to respond to the specific challenges facing a city, and to do so by using ICT to connect people with place and data, thereby harnessing both social and physical capital to build intellectual capital and support participatory practices in governance of a city's resources (Hollands, 2008; Caragliu et al, 2011). This relationship between people, place and data, infers a fundamental role for 3D digital cadastres in any smart city movement.

Underpinning smart future cities: 3D Cadastres

Supporting the development of smart future cities will be a key strategy for urban sustainability, and the ability to plan for this will be incumbent on governments' ability to leverage the masses of data and information now available about many aspects of the built environment. Multi-dimensional data and information are becoming increasingly available, such as 3D land and property ownership information and land use census data, which have the potential to underpin better planning for healthy, liveable and productive cities. In particular, as the land administration industry has come to realise that there is a pressing need to better understand the vertical properties of our cities – yet most analyses of cities continue to be undertaken using aggregate boundaries and in 2D space.

Developments in 3D Digital Cadastres

Many of the statutory systems that currently administer accurate land administration information, including core cadastral systems (representing ownership boundaries), are legacies of a longstanding 2D-based paradigm in recording and representing land and property information. As the yield of information and data from complex urban environments grows exponentially, it is becoming evident that this 2D paradigm is of limited utility, and there is clear demand for more efficient approaches to information management and analysis for decision-making. This is essential to achieving sustainable planning outcomes and ongoing management of our cities.

With the maturation and accessibility of 3D technologies, there is now both opportunity and demand to embrace a 3D digital environment for land administration business practices. Significant progress has been made in advancing the concept of 3D digital cadastres, leveraging an object oriented approach to managing information about land and property rights, restrictions and responsibilities (RRRs). Research and development, often in collaboration with industry, is currently being undertaken in almost 30 different countries. This has culminated in several international workshops – most of which has only taken place over the last four years (under the stewardship of the International Federation of Surveyors), a telling indicator that a solution is being urgently sought. Research outcomes are gaining momentum: we have recently seen the endorsement of the Land Administration Domain Model as an ISO standard; there are now a number of jurisdictions developing prototype systems, and the number undertaking pilot trials are also significant (e.g. Russia, China, the Netherlands, Indonesia, Australia and Malaysia).

Other 3D Land and Property Models

The move towards 3D cadastres is occurring alongside significant momentum in the land development industry on producing and using 3D-enabled building information, evident in the successful international diffusion of Building Information Models (BIM).

There are numerous definitions as to what constitutes BIM, but it is essentially recognised as a an information model, i.e. a product, where information about all the elements of a building are visualised as a 3D model, which is underpinned by a collaborative process for producing building information to serve as a unified repository of information about all components of the building that is accessible to stakeholders (e.g. NBIMS-US, 2014; Eastman et al, 2011; Smith et al, 2012). BIM as both product and process innovation has delivered significant improvements in productivity across the land development industry, primarily in planning, coordinating and analysing building design across multiple stakeholders. The value in integrating building design information generated by multiple stakeholders in the development process lies in reducing the costs of design changes and improving project documentation. In modern developments where there can be up to 18 different stakeholders (Rahman, 2010), these costs have been estimated to be account for up to 30 percent of the total costs per project (Brown, 2008).

Associated with BIM is the concept of Precinct Information Modelling/Models (PIM), which extends the capabilities of BIM to the precinct level (Plume, 2013). This opens up new opportunities to evidence-based planning and precinct assessment. Currently, work on this area within Australia is occurring through a number of research groups and builds on research that uses IFC to store and represent cadastral boundary information.

Moving Towards Integrated Land and Property Systems

Given the increasingly complex (structural, social and administrative) attributes of our cities, there is a need for integrated land and property systems for evidence-based planning and decision-making. An integrated and collaborative approach to planning and management of our urban environment can result in reduced environmental impact through conservation of resources and lower emissions such as those being witnessed in places such as Stockholm (Gaffney et al, 2007), Singapore (Tortajada, 2006) and Curitiba (IPPUC, 2009).

Bringing together all the various and disparate sources of information about our built environment is therefore a sustainability imperative. However, efforts to harness the wealth of multi-dimensional information that is being generated, and will continue to be generated in the future through urban planning and land development processes, is being stymied by the current lack of capability in integrating existing statutory land administration systems (e.g. land registries) with the broader information environment. This integration is fundamental, as it will provide the element of accuracy to enable the delivery of an accurate and accessible integrated knowledge base necessary to support the multi-faceted decision-making: 3D cadastres can provide the accurate, authoritative and unambiguous foundation for understanding the urban form.

3D cadastres and smart future cities: Challenges and opportunities

Given the nature of the information held in land registries, there has always been recognition of the potential that cadastral systems have in supporting a broader range of environmental applications. This is evocative of previous discourses in the late 1970s around 'multipurpose cadastres' (e.g. McLaughlin, 1975), which arguably, is a notion that is still highly relevant today. More importantly in doing so, the connection of 3D cadastral information with the multiple information streams pertaining to the urban built environment preserves the relevancy and role of cadastral information as fundamental to all societies.

For this to occur, there is a need for the land administration industry to adopt a proactive approach to exploring solutions that extends beyond our traditional practicing paradigm to uncover the new connections that can be formed. For example, the use of BIM models has been growing exponentially – as much as 400 percent over the last five years in North America alone (McGraw-Hill, 2012); international trends also reflect a similar trajectory (Davis Langdon, 2012). BIM is no longer a disruptive phenomenon but represents a technological and an operational evolution that the land administration industry can ill afford to ignore. As national governments around the world begin to mandate the use of BIM, it certainly underscores the rationale of exploring BIM for cadastral purposes. This is also a sensible as it facilitates a bridge between land registries and cadastral organisations and the broader construction and management industries.

Preliminary investigations at our research centre demonstrates the potential of using BIM for managing and representing 3D cadastral information, in particular, this would give the user full control over building components and functions (Shojaei et al, 2014). Figure 1 show how the IFC data model was used to construct cadastral entities around ownership and easements. As an example, one legal property object is highlighted in green and associated legal information is represented in a window on screen.

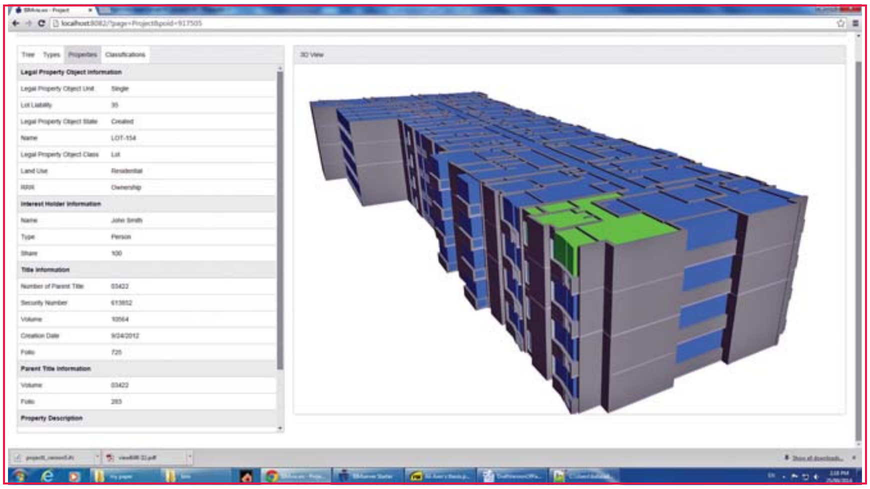

Figure 1: Managing legal/cadastral information in prototype cadastral BIM prototype model (Atazadeh et al, 2014).

It was also possible to provide the community and relevant stakeholders with a way to visualise the cadastral BIM prototype model online, where users could see the relationship between cadastral information and the physical built environment. Figure 2 shows the online environment where the visualisation application provided users with a range of controls for identifying, querying and visualising different parts and functions of the building.

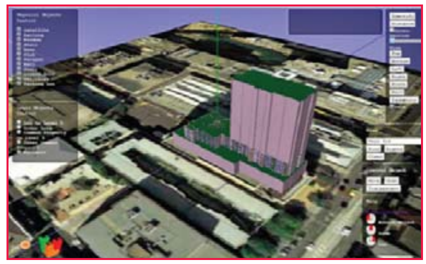

Figure 2: Visualising cadastral BIM prototype model online (Shojaei et al, 2014).

There are many other opportunities that present potential areas of research for supporting the vision of smart future cities. Some of these lie at the nexus of traditional silos such as those between land development and land management; integrating statutory data (e.g. property values) and socially-derived information (e.g. social media volunteered geographic information); bringing together data from multiple environmentally-oriented industries. Additionally, there are those opportunities driven by future needs, demands and expectations such as disaster management and public safety, planning and decision-making to secure liveability and productivity of cities, and urban resilience. The commonality across these various themes is that they all require a spatially accurate map base and 3D cadastres as foundations.

It is essential that cadastral systems be linked with broader environmental information to support urban management. The ability to do so is of growing importance especially in our current digital milieu, where an unprecedented volume of data being produced in cities. In this environment, digital interoperability, particularly spatial digital interoperability, is fundamental and is being recognised as a key challenge and policy imperative by governments around the world (an example being the United Kingdom's current public consultation on spatial digital standards). However, it is not only the role of government, but also the role of professional associations if there is to be a truly integrated approach to using 3D land and property information. While there is no doubt as to the increasing technological orientation of cadastres, it should not detract from the fundamental role that cadastres have in society, which continues to be central to facilitating the delivery of other national visions, digital economies, fundamental datasets and realising sustainable, resilient and smart cities of the future.

Acknowledgements

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and Property Information in 3D" being conducted at the Centre for SDIs and Land Administration at the University of Melbourne. More information about the project can be accessed from csdila.unimelb.edu.au/projects/3Dwebsite.

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Cadastre in a Changing World: Issues and directions

Experts discuss the issues and the directions in cadastre in a changing scenario

A well-tailored cadastral system is in fact acting as a backbone in society

Stig Enemark
FIG Honorary President, Professor of Land Management, Aalborg University, Denmark

In most countries, the cadastral system is just taken for granted, and the impact of the system in terms of facilitating an efficient land market and supporting effective land-use administration is often not fully recognised. The reality is that the impact of a well-functioning cadastral system can hardly be overestimated. A well-tailored cadastral system is in fact acting as a backbone in society. The Peruvian economist Hernando de Soto has put it this way: "Civilized living in market economies is not simply due to greater prosperity – but to the order that formalized property rights bring". The point is that the cadastral system provides security of property rights. The cadastral systems thereby paves the way for prosperity – provided that basic land policies are implemented to govern the land sensitive to contextual and cultural issues, and provided that sound institutions are in place to secure good governance of all issues related to land and property.

Evolution of cadastral systems

The human kind to land relationship is dynamic and is changing over time as a response to general trends in societal development. In the same way, the role of the cadastral systems is changing over time, as the systems underpin these societal development trends. Over the last few decades land is increasingly seen as a community scarce resource. The role of the cadastral systems has then evolved to be serving the need for comprehensive information regarding the combination of property rights, valuation and taxation, and planning and control of the use of land. New information technology provides the basis for this evolution. This forms the new role of the cadastral systems: the multi-purpose cadastre.

The UN-ECE Guidelines on Land Administration (UN-ECE 1996) was sensitive to there being too many strongly hold views in Europe of what constituted a cadastre. Another term was needed to describe these land-related activities. It was recognized that initiatives that primarily focused on improving the operation of land markets had to take a broader perspective to include land-use planning as well as land tax and valuation issues. As a result, the publication replaced "cadastre" with the term "land administration" that is now regarded as "an enabling infrastructure for implementing land policies and land management strategies in support of sustainable development" (Williamson, et.al. 2010).

> Secure property rights provide a sense of identity and belonging that goes far beyond and underpins the values of democracy and human freedom

The term "Land Governance" emerged in the late 2000s as a more holistic term covering the policies, processes and institutions by which land, property and natural resources are managed. This includes decisions on access to land, land rights, land use, and land development. Land administration is then the operational component of land governance.

Future directions

In the Western cultures it would be hard to imagine a society without having property rights as a basic driver for development and economic growth. Property is not only an economic asset. Secure property rights provide a sense of identity and belonging that goes far beyond and underpins the values of democracy and human freedom. Therefore, property rights are normally managed well in modern economies where cadastral information provides the basic layer of interactive land information systems in support of building spatially enabled societies (FIG pub. no. 58).

In contrast, most developing countries have a cadastral coverage of less than 30 per cent of the country. The cadastral systems normally operate with western procedures for cadastral surveys and the systems do not recognise the range of more informal or customary types of tenure. In these countries there is a need for a more flexible and "fit-for-purpose"

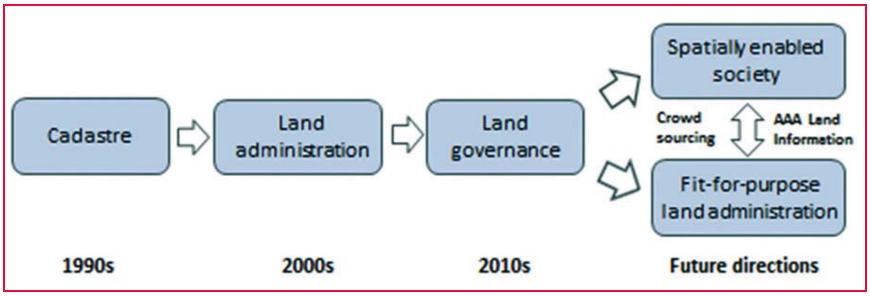

Figure 1: Cadastre in a changing world: Recent evolution and future directions

approach to building adequate cadastral systems. The term “fit-for-purpose” indicates that the systems should focus on the citizens´ needs, such as providing security of tenure and control of land use, rather the focusing on top-end technical solutions and high accuracy surveys. The systems can then be upgraded over time in response to societal needs and available resources. The Western style systems may well be seen as the end target, but not as the point of entry. (FIG pub. no. 60).

Furthermore, the spatial information revolution, through platforms such as Google Earth, has raised discussion around the use of crowd-sourcing for data collection and, on the other hand discussions about the need for data to be Accurate, Assured, and Authoritative (AAA). These discussions are driven by technology development that enables push-button access to a variety of data from various sources.

Closing remarks

Cadastral systems are normally understood as a parcel based and up-to-date land information system containing identification of the individual land parcels and a record of interests in land such as land ownership. The evolution of cadastral systems now points at two different future directions towards building spatially enabled societies (developed countries) and towards building basic fit-for-purpose land administration systems (developing countries). Importantly, the role of the cadastral systems is seen as the core component within both directions which are both impacted by the discussions around crowd sourcing as well as the quest for AAA land Information (FIG pub. no. 61).

Further readings

FIG publications Spatially Enabled Society, FIG Pub. no 58; Fit-for-Purpose Land Administration, FIG pub. no 60; Cadastre 2014 and beyond, FIG Pub. no 61. See FIG publications: http://www.fig.net/pub/figpub/index.htm.

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The need for fast, cheap and good land administration

Kees de Zeeuw
Director Kadaster International – The Netherlands

Estimations show that about 70% of the people-land relationships are not documented. This while population grows and the pressure on land and natural resources increases. Also in countries where (some level of) land administration is in place, the technological push and the evolving societal demand ask for continuous development of land administration systems. Appropriate administration of land is the start for conflict resolution, sustainable development and land use planning anywhere in the world. No time should be lost starting this important work.

The key question is: can we register the relevant people-land relations world wide within one generation? Or do we accept that this will take many more centuries, sticking to our present paradigms, methods, capacity and business models?

The introduction of Fit for Purpose Land Administration can be considered a new way of thinking in achieving faster, cheaper and more appropriate land administration systems for the world. The approach has been presented in FIG publication nº 60 and guidance for the application is under development within the GLTN partner network. The key-principal is that land administration should be developed in such a way, that it is appropriate to the needs of society.

Appropriate land administration can be defined by four aspects. First of all, the requirements of users (or citizens) should be the starting point, not the professional or technological standards. Fortunately, standards like the Land Administration Domain Model (LADM) and software like STDM or FLOSOLA exist and do help very much in getting systems in place. After the user requirements, three other important aspects should be in place: The quality of the data and systems (good), the acceptable timeframe to collect and register the data (fast) and the price of development and maintenance of the system (cheap).

In our present solutions we are thinking in the paradigm of making choices; Good and fast land administration won't be cheap, fast and cheap land administration won't be good and cheap and good land administration won't be fast. It is the challenge to abandon this mindset and to develop a new paradigm where cheap, good and fast go together.

> The private sector is developing user-centric approaches, while governments will focus on citizens, being citizen-centric

Boosting land administration is becoming also a concern outside the professional world of surveyors and land administration specialists. The developments at UN-GGIM (Global Geospatial Information Management) has become a good example of this. The world of statistics has encountered the geospatial world. And even the Remote Sensing world and the Land Administration world are joining in now. Four different professional groups, four different languages, converge for the benefit of all, including the need for appropriate land administration.

Recognizing the need for global registration of land rights, different organisations and professionals start acting and show leadership. UN FAO has developed the Voluntary Guidelines, UN-Habitat takes up the need for practical tools with it's GLTN program. The World Bank started monitoring good practices in the land sector with a land governance Assessment Framework (LGAF). Together with FIG, they also promote Fit for Purpose Land Administration approaches.

The information technology as such, will continue to develop with respect to technology, size and protocols. It goes without saying that technology will be a driving force for making good, fast and cheap land administration systems happen. The development of software, both commercial and open source, is in full progress. Social media will fill in new communication possibilities and (consumer) hardware will keep on boosting the possibilities.

Capacity building will remain a concern for the near future. Are we able to develop a professional arena of sufficient size, in which people are willing to set the user demands central and change the paradigm to thinking in good AND fast AND cheap?

Finally, good public private partnership will help in meeting the objectives. However, essential roles for both private and public organisations will continue to exist (likewise, this goes for scientific organisations and NGO's). The private sector is developing user-centric approaches, while governments will focus on citizens, being citizen-centric. And no confusion should exists. *Users* are people who can potentially pay for a service or product of a company. *Citizens* are people that rely on their government, representing them. These are two different things. Both need attention, but they shouldn't be confused. It is also the reason that both private and public bodies will continue to be needed in the future.

Good, fast and cheap land administration must be achieved for the next generation. This can be done by mobilizing leadership and by stimulating international cooperation, innovation of methods and the adaptation of modern technologies. These are essential parts of the cadastral actions needed and can no longer be achieved by one professional sector alone.


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Is complacency the biggest threat to modern cadastres?

Today is an exciting time for cadastral reform

Ian P Williamson AM, FTSE
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In the developed world the majority of cadastral systems are complete with digital cadastral maps covering all land parcels linked in real time to land titles, land values and planning information. Importantly the parcels are linked to street addresses. Collectively this enables and underpins the spatial enablement of government and wider society in almost every aspect of human endeavor, from the support of land markets to environmental management, policing, recreation and emergency response to name a few.

At the same time we see the growth of 3D cadastres that are supporting the development of smart cities and vertical villages. Marine cadastres are also developing with the extremely sensitive coastal zone being better managed and integrated across the land-sea interface. The digital revolution, positioning technologies, smart phones and sensors all combine with and leverage off spatial enablement and the cadastre.

In the less developed world access to land, shelter, security of tenure, land markets and gender equity are just as urgent. The World Bank, the United Nations, NGOs like the FIG, and governments and academics are continually exploring more efficient and effective ways to manage land, provide land governance and develop systems that are affordable and fit for purpose.

While there are many challenges ahead, it is an exciting time indeed.

Many countries are looking to the future at how their cadastres can develop to better meet the needs of society. A good example is Australia where the Intergovernmental Committee on Surveying and Mapping (ICSM) has just released a national cadastral reform and innovation strategy titled CADASTRE 2034 (http://www.icsm.gov.au/cadastral/index.html#nscri). The vision is a cadastral system that enables people to readily and confidently identify the location and extent of all rights, restrictions and responsibilities related to land and real property.

Cadastre 2034 has five goals. Their purpose is to achieve a cadastral system that:

1. is fundamental to land and property ownership and is sustainably managed;
2. is truly accessible, easily visualized, and readily understood and used;
3. is fully integrated with broader legal and social interest on land;
4. provides a digital representation of the real world that is survey accurate, 3-dimensional and dynamic; and
5. is a federated cadastral system based on common standards.

An important strength of Cadastre 2034 is the recognition of the basics. All too often aspects such as the survey marks, cadastral plans, the legal framework, standards and registered surveyors are overlooked.

The Australian cadastral system plays a critically important role in the economic and social prosperity of the country. As stated in the strategy, at the end of 2014, there were $1.4 trillion in housing loans secured against land titles. At the same time the total value of all real property held in title in Australia is estimated as $5.2 trillion. The importance of the cadastral system is self evident given that the size of the Australian economy is $1.6 trillion (as at November, 2014).

However a problem of one and a half Centuries of cadastral endeavor, where excellent systems have been built and operate across Australia's states and territories, is that the system works so well. There is an ongoing challenge to convince our political masters that the cadastral system needs ongoing attention and improvement. It is not uncommon for them to question why we should spend funds to fix something that works!

There have been recent cases in Australia where government has seen the cadastre and title registration as a "cash cow" ripe for privatization without government oversight and management – a very high risk strategy. While some governments have been supportive of research and development in the cadastral area, it is becoming increasingly difficult to convince them of the need for an ongoing commitment.

At the higher education level we have seen a reduction over the years in the emphasis on cadastral and land administration issues in university degrees. This is not only an Australian phenomenon, but an international trend with university programs that historically educated professional land surveyors reducing their commitment or even ceasing to exist. This undermines the capacity of countries to design, build and manage the modern cadastres needed for the decades ahead.

So I pose the question that the biggest threat to modern, efficient and effective cadastres is complacency. In fact it is remarkable how well the current cadastral systems have evolved in the developed world at a time when the political commitment to them appears to be reducing at both a government and educational level.

I don't know the solution to complacency, however I applaud the Turkish Government for sponsoring The World Cadastre Summit as an important step in the right direction. Let us make the most of this event to ensure our future cadastres continue to evolve to serve the needs of an ever changing society.

GIS simplifies cadastre management

Brent A Jones
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Cadastral systems don't have to be expensive and complex. Esri pioneered a technology platform that's open, simple to set up, and easy to support. Being built on open standards, it simplifies integration with other systems and makes powerful use of configurable apps and web maps—in particular, commercial-off-the-shelf (COTS) software. With ArcGIS COTS solutions, you configure your cadastral data collection, management, and sharing needs with supported, proven technology instead of customizing costly, difficult-to-maintain systems.

ArcGIS gives you access to new technology without the need for software coding and updating custom or third-party software with each new release. This is a much more immediate solution than a custom-built system fraught with protracted workflows. A sensible cadastral system provides new tools, authoritative data, and fast deployment technology as it becomes available. ArcGIS essentially future-proofs your cadastral system with a secure, scalable, and sustainable platform.

Complete vs. Cobbled Together

ArcGIS is a unified platform for cadastral systems that supports surveying and data collection, recording rights and restrictions, digitizing documents from antiquated paper systems, and indexing information in modern spatial conventions. It integrates authoritative basemaps and high-quality satellite imagery and also provides comprehensive sharing technology to make the best use of those map and imagery resources. Importantly, it includes COTS apps and tools that only require light configuration to meet your agency-specific needs.

Light Configuration vs. Heavy Coding

Hardcoding systems limits the ability for a cadastral system to evolve. Why? With new technological capabilities being released every day, custom hardcoded systems can't take advantage of the latest technology and are extremely difficult to maintain—particularly with limited advanced technical skills. Configuring supported, feature-rich technology instead of coding eliminates the constant need for skilled technicians and hardens your system for the future.

Security vs. Vulnerability

Security is a challenge with custom-developed systems. Since cadastral systems are essentially banking systems for land, they require rigorous security for user/role authentication to maintain data accuracy, consistency, and system integrity. Esri more than meets those stringent security requirements. ArcGIS is certified to the highest independent, international, and industry-accepted privacy standards, including TRUSTe Certified Privacy Seal and EU Safe Harbor.

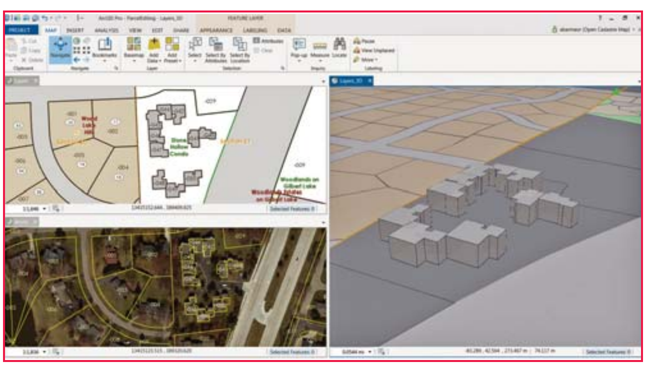

Figure 1: The ArcGIS platform manages cadastral data, integrates imagery, and works in a full 3D environment

Cadastral systems built without consideration of emerging new user requirements, evolving legal structures, and rapidly advancing technologies are less effective and have a limited lifespan

Connect vs Collect

In the past, cadastral surveyors created basemaps, downloaded satellite imagery, and built data sets that duplicated the mapping efforts of other organizations. With cloud technology (and, yes, cloud operations can work disconnected in challenging environments) and web services, modern, low-cost, fast-to-deploy systems connect to the data you need. This means that you no longer have to commit time and labor to building storage and management infrastructure for imagery, basemaps, and other common data layers. It's all consumable now from the office to the field.

Cohesive Platform vs. Disparate Applications

Many cadastral systems have been developed with customized implementations of disparate applications and technology. These individual applications have different update cycles, data requirements, require custom security measures and specific and often difficult-to-find support. Today, sustainable systems are configured (not custom developed) on a scalable, secure, complete COTS platform. Building sustainable cadastral systems requires proper design that allows for evolving technology, requirements, and data. Cadastral systems built without consideration of emerging new user requirements, evolving legal structures, and rapidly advancing technologies are less effective and have a limited lifespan. ArcGIS provides the platform for low-cost, easy-to-implement tools that all resilient cadastral systems require.

Why and what to standardize in Land Administration?

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Sustainable development, human rights or spatial planning: they are difficult to achieve without proper land administration. Land administration provides documentation that indicates the relationship between people and land. Land professionals know that a big majority of these people-to-land-relationships worldwide is not documented. This often results in uncontrolled development, land degradation, forced evictions, land disputes, conflicts and land grabbing. Apart from tenure insecurity the government can not fairly generate income from land taxation.

Need for land administration

Land administration systems are worldwide recognised as being important for governance. Governments need information to govern. Accessible information on 'people to land relationships' is crucial here; for sustainable economic and infrastructural development and interrelated spatial planning, for resource and environmental management, for disaster management. All this is about today's challenges as change in climate, problems with draught and access to water, unequal access to land and lacking social justice, food shortage and a growing urban population with a complex urban–rural interface.

Knowledge is fragmented

In many countries the responsibilities and tasks in land administration are distributed among different organisations. Sometimes those organisations deal with different administrative territories. All of which may have subdivisions again: central, regional and local responsibilities, with either public or private roles. As a result, the governance and quality aspects of the data sets vary. Land administrations worldwide are often incomplete, data are not up-to-date and not fit for purpose. At the same time, new Land Administration Systems (LASs) are being developed all over the world again and again. Sometimes countries even have more than one IT-system for land administration. The wheel keeps being re-invented. This has a huge impact on the continuity and effect of LASs.

ISO 1952

Just like social issues benefit from proper land administration, land administration systems themselves benefit from proper data standards. After more than a decade of development, within first FIG and next ISO TC211, the land administration domain model (LADM) was accepted in 2012 as an international standard ISO 19152.

Both paper-based systems and computerised systems require standards to identify elements. In existing land administrations and land registries, standardisation is generally limited to the region or jurisdiction where the land administration is in operation. A flexible (generic) system as LADM, concerns a elaborate standardisation. It does not only define the elements that provide a basis for any land administration set-up; it also defines them in such a way that it can be applied anywhere in the world.

> LADM is based on collective experience of experts from many countries and the International Federation of Surveyors. The model covers complete land administration spectrum: survey, cadastral maps, rights, restrictions, responsibilities, mortgages, persons, etc.

Motivation

The generic benefits of standards are in bringing parts together: meaningful exchange of data and building the future Spatial Data Infrastructure (SDI). This is about standardization as a condition for interoperability between the organisations responsible for the land data (land registry, cadastre, land taxation organisations, etc), the data providers (surveyors, conveyors, land professionals) and the users of the data (citizens, governments, companies, banks). Standardization enhances quality when based on knowledge and experience of the global community of professionals. And it increases effectiveness because components do fit better in industry+open source solutions.

The land administration standardization includes the alignment to ISO 19000 series of standards: earlier TC211 standardizes domain neutral: basics for geometry, topology, temporal aspects, reference systems, metadata, and more. Based on these TC211 standards both commercial and open source software has been developed for processing survey data, geo-DBMS, GIS, geo-webservices, etc. The LADM therefore allows efficient design/development of ICT systems.

What is included in LADM

First of all it is a reference domain model, covering basic information-related components of land administration. This means an abstract, conceptual model that includes information sets for:

1. parties (persons and organisations); a broad and extensible range of parties can be included,
2. basic administrative units, rights, responsibilities and restrictions (e.g. ownership and use rights), this concerns the implementation of the continuum of land rights from UN-Habitat and of the voluntary guidelines on the responsible governance of tenure of land fisheries and forests from FAO,
3. spatial units (e.g. parcels and the legal space of buildings and utility networks), including a subset for spatial sources (surveying) and spatial representations (geometry and topology). Again a very broad range of functionality is supported here: from point cadastre to 3D cadastre.

The LADM provides a uniform terminology for land administration, based on various national and international systems, that is as simple as possible in order to be useful in practice. The terminology allows a shared description of different formal or informal practices and procedures in various jurisdictions. LADM is the basis for development of national & regional profiles (application schemas).

Flexibility

It should be noted in relation to this that this that the functionality for implementation is very flexible. For example:

- An administration for customary tenure (in order to protect against 'external threats' as land grabbing): group person type, customary right type, spatial unit type with fuzzy boundaries
- An point cadastre in a slum area in order to improve services: natural person type, informal right type, point spatial unit type
- A conventional parcel based land administration in a residential area (taxation, tenure security): (non) natural person type, ownership right type, parcels type
- 3D Cadastre in business area: (non) natural person type, ownership holding, volume spatial unit type
- State lands: government person type, state land right type, set of lines spatial unit type

Conclusions

LADM is based on collective experience of experts from many countries and the International Federation of Surveyors. The model covers complete land administration spectrum: survey, cadastral maps, rights, restrictions, responsibilities, mortgages, persons, etc. The focus is on information, not on process/organization aspects, this is too country specific. LADM is modular (packages) and extensible and allows integrated 2D and 3D representation of spatial units. Formal, customary and informal rights are supported. LADM links essential land information data to source documents, both spatial (survey) and legal (title, deed).

Cadastre in a Changing World: A UN-GGIM Perspective

Dr Vanessa Lawrence CB
Co-Chair of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)

Cecille Blake
Secretariat of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)

It is widely acknowledged that land, including rights and ownership, plays an important role in promoting economic development, social inclusion and poverty reduction. However, significant land challenges still exist in our changing world, particularly in developing countries. As stated by the Dutch delegation during the Fourth Session of the Committee of Experts on UN-GGIM in August 2014: *"For an estimated 70% of the world population there is no registration of land - property relations. … Good land administration, considering both formal and informal rights of the use and ownership of land, is a basic requirement for social and economic development".* Based on this statement and a number of interventions and discussions on 'land', the UN-GGIM Committee of Experts approved its addition as a new work item.

As many will know, the UN-GGIM Committee of Experts was established by the United Nations Economic and Social Council (ECOSOC) in July 2011 as a formal inter-governmental mechanism, and consists of senior national Government representatives from Member States; the majority of which have responsibilities for geospatial information and land management. The Committee is mandated, among other tasks, to provide a platform for the development of effective strategies on how to build and strengthen national capacity on geospatial information management, as well as disseminating best practices and experiences related to legal instruments, management models and technical standards.

So, why is UN-GGIM focussing on land administration and management? Land is the single greatest resource in most countries. Land administration is an important component of the infrastructure for an efficient economy, which means that it touches all aspects of people's lives. Increasingly decision makers have come to recognise the value and importance of land information (by extension the cadastre, parcel information, ownership, valuation and related information - land use etc.) as a fundamental component to attaining sustainable development objectives of, economic development, social justice, environmental management and good governance. This has been fuelled by the ability to integrate disparate datasets and leverage data analysis across various functional areas and business processes using geospatial and information systems technologies. Furthermore, land will provide a number of critical inputs into the implementation of the Sustainable Development Goals (SDGs) currently being discussed and determined by the United Nations General Assembly in New York. The ability to measure and monitor the targets and indicators of the SDGs over time will require reliable and enduring data on land and its relationship with people and the environment.

The challenge is to define the extent of UN-GGIM participation in this large area of land management work, particularly given the organisations that are currently successfully working in the field and the need to avoid duplication of effort. UN-GGIM's niche is to be able to provide the appropriate policy context and the support for geospatial information management, more broadly, and land administration more specifically, to Member States as an important enabler for economic growth and sustainable development. UN-GGIM has the ability to collectively advocate for increased global awareness of the need for the collection and maintenance of comprehensive, current and credible land information; in addition to encouraging good land governance inclusive of the creation and use of applicable land polices and legal arrangements, and the adoption of appropriate enabling technologies, standards and best practices.

The UN-GGIM agenda item 'Application of geospatial information - land administration and management' is being advanced with the preparation of a discussion paper to be presented with a covering report to the Committee of Experts in August 2015. The paper will be a collaborative effort with international partners including: FIG, World Bank and United Nations bodies such as Habitat, and will detail: the current challenges impacting land administration and management and the specific issues to be addressed by the Committee of Experts.

The inclusive and expansive character of UN-GGIM provides the platform that enables interaction with, and among leaders across the World, who are able to articulate the benefits an effective and efficient land administration system can make to their country. Rwanda has been undertaking a very large land regularisation project and it is an example to us all how in five years, a difference can be made to everyone in the country. As HE Ambassador Protais Mitali, Ambassador of Rwanda to Ethiopia and Permanent Representative to the African Union said '"Rwanda has created an electronic land registry which is known as the Land Administration Information System (LAIS). The Electronic Land Registry now has been connected to all banks to ease the process of getting loans using the land as collateral. The electronic registry also clearly increased transparency about land ownership and has reduced fraud"

The cadastre remains increasingly relevant as a fundamental data theme that underpins and supports a plethora of developmental operations relevant to a country's economy. The mission is therfore for global players to work together to encourage and support Member States to employ fit for purpose policies, strategies, technologies, methodologies and practices for the good governance, management, monitoring and maintenance of its land assets.

The regional structure is vital

UN-GGIM: Arab States has excellent results from its inaugural meeting

The inaugural meeting of the United Nations Committee of Experts on Global Geospatial Information Management Regional Committee for Arab States has been held in Riyadh, Saudi Arabia. Organised by the Secretariat of UNGGIM, in partnership with the Government of Saudi Arabia represented by the General Commission for Survey (GCS), the two day event attracted senior delegations from Algeria, Bahrain, Egypt, Jordan, the Kingdom of Saudi Arabia, Lebanon, Morocco, Oman, Qatar, Tunisia, United Arab Emirates and GCC-Stat.

The meeting, chaired by Dr Vanessa Lawrence CB, Co-Chair of UNGGIM, was successful in electing an Executive Bureau. They also agreed on a work plan that ensures there is an integrated working agenda in the Arab States region between the new regional entity and the global Committee of UNGGIM. The four main Working Groups decided by the regional Committee build on the issues already identified by the global Committee of Experts and will help shape the region's contribution to UNGGIM.

The meeting opened with a Welcoming speech by His Excellency Morayyea Hassan Al Sharani, President of the General Commission of Survey and Chairman of the National Committee of GIS, Saudi Arabia. This was followed by short speeches by Amor Laaribi from the UNGGIM Secretariat and Dr Awni Khaswanah, one of the members of the transitional bureau, whilst UNGGIM: Arab States was being established.

Following discussions it was decided that four Working Groups would be established. The inaugural meetings of the Committee and the Working Groups have been set for 8^{th}-10^{th} June 2015 in Algeria. The Working Groups are as follows:

WG1: Institutional Arrangements, Legal and Policy Issues, Awareness and Capacity Building
WG2: Fundamental Data and Geo-Standards
WG3: Geodetic Reference Frame
WG4: Integration of Geospatial & Statistical Information

Elections were held in the middle of the second day for the roles of Chair and ViceChairs of UNGGIM: Arab States to lead the Executive Bureau. The Region appointed Saudi Arabia to be elected as their Chair and Algeria and Jordan to be Vice-Chairs. The General Commission for Survey of Saudi Arabia has accepted the proposal to assure the Secretariat of the Committee. Following the elections, His Excellency Morayyea Hassan Al Sharani kindly took over the role of Chair for the remainder of the meeting.

A further meeting of UNGGIM: Arab States is scheduled in New York during the Fifth Session of UNGGIM in August 2015 (3^{rd}-7^{th} August 2015).

Dr Vanessa Lawrence CB, Co-Chair of UNGGIM said on conclusion of the meeting: "Since UNGGIM was first convened in 2011 we have established firm foundations. The regional UNGGIM structure is now fully established in Asia Pacific, the Americas, Europe and now the Arab States region and is near to finalising its establishment in Africa. The regional structure is vital for decisionmakers globally to know where to turn to in each region for expert advice and thought-leadership on matters related to geospatial information and place-based decision-making. It also will help to realise the vision of UNGGIM – "To make accurate, reliable and authoritative geospatial information readily available to support national, regional and global development."

His Excellency Morayyea Hassan Al Sharani, the inaugural Chair of UNGGIM: Arab States on behalf of Saudi Arabia said following the meeting: "Saudi Arabia is very honoured and proud to be elected as the first Chair of UNGGIM: Arab States and we will do our best to fulfil this role with the care and attention required, to ensure we liaise with colleagues throughout the region. We look forward to working with our colleagues in UNGGIM: Americas, UNGGIM: Asia Pacific, UNGGIM: Europe and the transitional team from Africa. Saudi Arabia truly believes that accurate, reliable, authoritative geospatial information is important to the region and to the globe. We know that accurate geospatial information already assists better decision-making in infrastructure and construction planning, water management, food supply, agricultural planning and sustainable energy. Finally, I should like to thank Dr Lawrence and Mr Laaribi for helping us organise this inaugural meeting" *http://ggim.un.org/*

Developing land registry and cadastre base data model to support Turkey national GIS initiative

In this study, TRGIS.TK application schema compatible with LADM has been summarized and evaluated

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Designing Land Registry-Cadastre Data Theme (TRGIS.TK) is presented and discussed in this study. This data theme is one of the base geo-data themes of Turkey National GIS (TRGIS) (Figure 1). Requirement analysis was carried out as part of TRGIS initiative. As a result of data requirement analysis of TRGIS stakeholders, ISO 19152 Land Administration Domain Model (LADM) was used and discussed as the base international standard in developing TRGIS.TK data theme standard. Features of INSPIRE Cadastral Parcels data theme were also taken into account. In addition, scientific studies (Kaufmann and Steudler, 1998; UN-ECE, 1996; van Oosterom et al., 2006; Inan et al., 2010) and data modelling foresights of TAKBIS were considered.

To support GIS applications, TRGIS stakeholders and various users need to share cadastral (land administration) data on the electronic network, which make this study and related future development very important. This article is adapted from a previous study (Aydinoglu and Inan, 2014).

Figure 1: TRGIS project

Turkey National GIS (TRGIS or TUCBS in Turkish)

Geo-data sets all over the world and also in Turkey were not produced to solve application driven requirements in various GIS projects and not designed to enable geo-data interoperability. Using interoperable geo-data sets on GIS applications will satisfy public institutions, private sector, research institutions, and citizens. However, technical, standard, and policy deficiencies cause problems on data production, management, and sharing.

In 2011, within Ministry of Environment and Urbanization, the General Directorate of GIS was established to coordinate all GIS activities and determining standards to build TRGIS. Framework legislation about TRGIS building and management was accepted and published recently in March 2015. TRGIS framework legislation includes TRGIS vision, aim, and definitions. TRGIS administrative structure with units, principles, and duties was defined to coordinate all TRGIS activities. TRGIS geo-data themes with definitions were determined. Principles about TRGIS metadata, network services, and interoperability were explained.

TRGIS project's aim is to determine TRGIS related legislation and to determine geo-data standards for TRGIS geo-portal. To develop geo-data standards, case and requirement analysis were utilized to all stakeholders of TRGIS, including 15 ministries, 86 general directorates, 88 departments, and 118 branches. As a result of fieldwork and workshops, 254 information products as map, application, and product were analyzed.

TRGIS conceptual model components, determined in 2012, provided general rules to create geo-data specification of TRGIS geo-data themes as a profile of ISO/TC211 and OGC standards. Geo-data specifications and exchange standards were developed for 10 base geo-data themes such as BI-Building, AD-Address, TK-Land Registry/Cadastre (TRGIS. TK), IB-Administrative Unit, UL-Transportation, HI-Hydrography, AO-Land Cover, OR-Orthophoto, TO-Topography, and JD-Geodesy that meet national geo-data requirements to serve geo-data sets on TRGIS portal infrastructure.

TRGIS can be accepted as a base and the domain geo-data model (see Figure 2). Different public institutions and sectors can share data sets based on TRGIS data themes. For example, Land Registry and Cadastre Data Model (TAKBIS), as a sector model, manages all cadastral data sets and activities in General Directorate of Land Registry and Cadastre (TKGM). TAKBIS should share Parcel and Ownership data sets with TUCBS.TK land registry and cadastre data theme, because other users need these data sets in their applications.

TRGIS geo-data themes, using UML application schemas, provide logical data structure for any geo-data theme, independent from platform and implementation. These UML schemas were encoded to Geography Markup Language (GML) accepted as a base of geo-data exchange format of TRGIS.

Model Development

The following methodology was used in the analysis stage for TRGIS.TK;

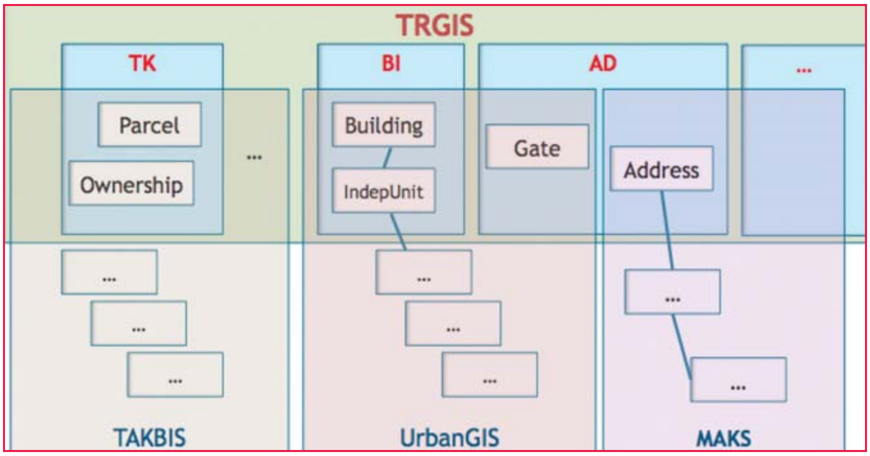

Figure 2: Interoperable sectors through TRGIS geo-data themes

- Existing Data Analysis was carried out by examining TAKBIS geo-database.
- ISO 19152 LADM was determined as the base international standard.
- It was determined that within 10 ministries, 24 general directorates, 25 departments, and 77 sub-departments, there were 77 map/applications using or producing land registry and cadastre data (59 of them were existing applications and the others were suggested ones) (GD-GIS, 2012b).
- A gap analysis was carried out that compares and evaluates the results of data requirement and existing data analysis.

During model development, extensions to LADM were focussed. Because the original language of the modelling was in Turkish, diagrams and all their content were presented in Turkish.

In connection with the LADM, the content of TRGIS.TK covers the following (GD-GIS, 2012c);

- Spatial units registered for constituting immovable or a part of immovable were even not registered (see KadastroKonumsalBirim package in Figure 3),
- Cadastral original data stored in cadastral archive (see KadastroOrjinalVeri package in Figure 3),
- Cadastral data structure that forms building blocks of the model (see KadastroVeriYapisi package in Figure 3),

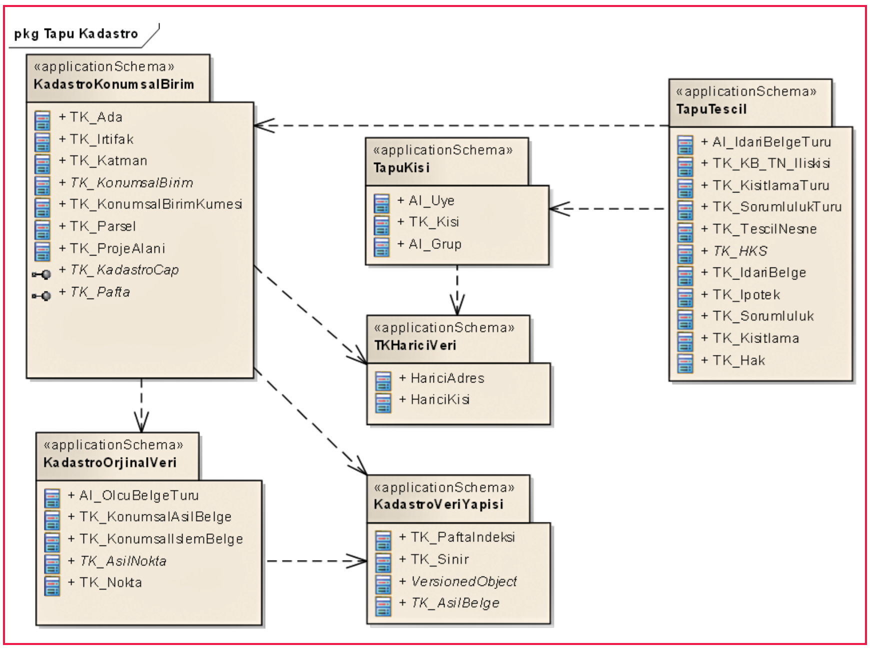

Figure 3: Data groups (packages) of the application schema

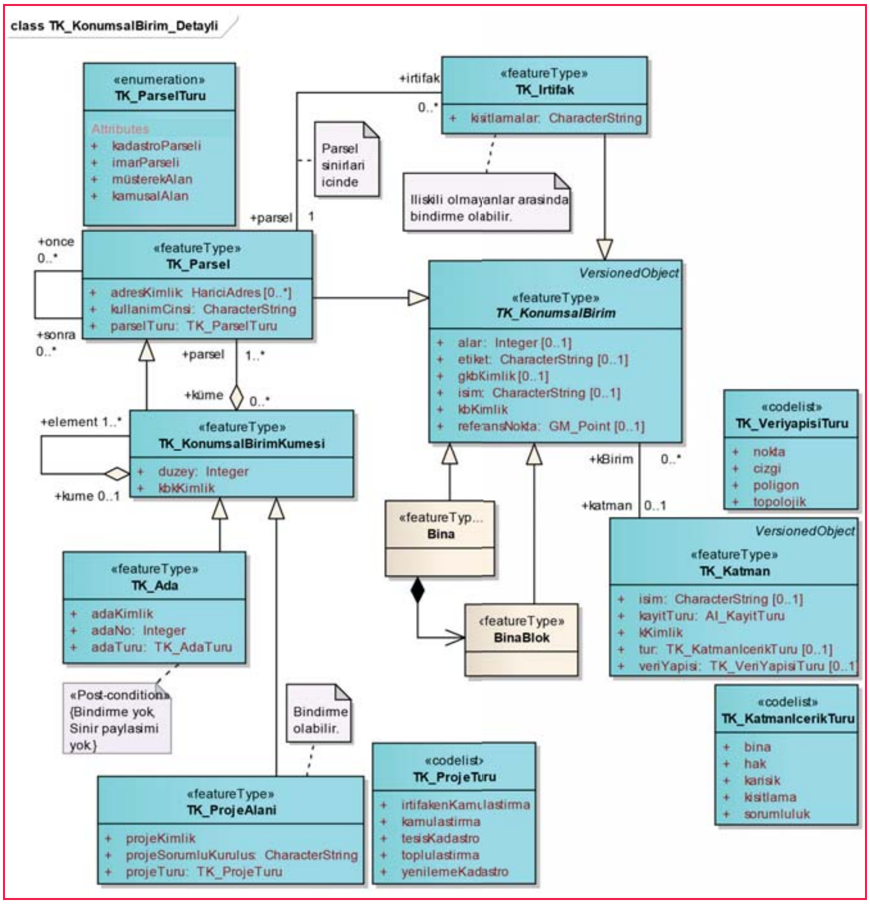

Figure 4: Feature classes of KonumsalBirim package and their relations

- Immovable objects registered in land registry that define rights on one, more or a part of whole spatial units (see TapuTescil package in Figure 3),
- Parties subject to property or responsibilities (see TapuKisi package in Figure 3),
- External data provided from other systems (see TKHariciVeri package in Figure 3).

All model components are presented in Figure 3. However, only spatial aspects of model design are presented in the rest of the article. In this respect, as sub classes of TK_KonumsalBirim (LA_SpatialUnit) class, TK_Parsel (LA_Parcel), TK_KonumsalBirimKümesi (LA_SpatialUnitGroup), TK_Ada (a group of land parcels surrounded by natural or manmade barriers), TK_ProjeAlani (a group of land parcels within a land management project) and TK_Irtifak (spatial location of an easement right within a land parcel) classes and also TK_Katman (LA_Layer) class, are included. Bina (LA_Building) and BinaBlok (LA_BuildingBlock) classes come from a different TRGIS data theme (see Figure 4).

TK_ParselTuru definition list (enumeration) as the data type of the attribute parselTuru (parcelType) in TK_Parcel (LA_Parcel) class, were defined to meet the needs of all TRGIS stakeholders. In the list, four basic (first order) parcel types kadastroParseli (land parcels in the areas without development plan; villages or suburbs of urban areas), imarParseli (land parcels produced in terms of a development plan), müsterekAlan (land parcels commonly serving for two or more land parcels; e.g., driveways) and kamusalAlan (publicly used areas; roads, parks, etc., owned by the state or local government to serve the public) were defined (see Figure 4).

TK_Irtifak (easement) class was defined as a kind of spatial unit in order to represent an easement right within a land parcel designated spatially with certain boundaries. It should exactly be within the boundaries of only one related land parcel (see Figure 4).

TK_Ada class was defined in order to represent a group of land parcels surrounded by natural or manmade barriers as an area which is the basis for planning, application (land management) activities and also for unique parcel numbering. TK_ProjeAlani class was defined as another kind of spatial unit group in order to represent boundaries of different land administration or land management project areas. Other kinds of project types (expropriation of easement right, expropriation of land, first cadastral surveys or renewal projects and land consolidation) were defined in TK_ProjeTuru definition class (see Figure 4).

TK_KadastroCap interface class was defined in order to represent the process of producing custom cadastral maps for specific cadastral land parcels. Similarly, TK_Pafta class was defined in order to represent the process of producing cadastral maps in standard shapes and content. Shapes of these cadastral maps (called as pafta in Turkish) are defined by TK_PaftaIndeksi (standard subdivision of space in 2D with special subdivision names) class, which was designed as an extension to spatial representation package of LADM (for more information see Aydinoglu and Inan (2014)).

TK_Nokta (LA_Point) class was designed to represent measured points in land administration system, except for control points. Only two types of points are included in TK_NoktaTuru (point type) definition class. For monumentation types of points in TK_ DetayIsaretTuru definition class, four types of monumentation (belirsiz: without any monumentation, digerDogalIsaret: existing natural monuments, digerYapayIsaret: existing manmade monumentation, koseTasi: special monumentation for land parcel corner points) are listed (GDGIS, 2012c), (for more information see Aydinoglu and Inan (2014)).

Discussion and conclusion

This study shows that LADM is a good template for further model development to meet county specific needs on land registry and cadastre-related development issues. In fact, all LADM classes, properties, relations, and also methods were examined and adapted to TRGIS. TK geo-data theme, and only exceptional ones were presented in this study as original contribution to LADM. However, for some rare cases, LADM should be revised for the adoption of a specific country. In this context, LA_ Building and LA_LegalSpaceBuildingUnit classes were replaced with external data sources. Similarly, LA_Point was revised in terms of included point types.

This study reflects contribution to LADM only in terms of the needs of TRGIS stakeholders. For full contribution, all land registry and cadastre process should be considered and presented as the Turkish country profile.

Easement as a spatial unit and group of land parcels surrounded by barriers (in Turkish Ada) may be considered as international contribution to LADM. Other extended contributions are specific to Turkey.

Application of TRGIS.TK geo-data theme is dependent on the application of both TRGIS and also accessibility of required quality data within land registry and cadastre organisation. In this stage, GML conversion of the model was carried out with some difficulties, which cause the loss of some modelling content. A pilot study for the implementation of the proposed model has been continued.

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Applicability of rotary UAV for vegetable crop investigation

This study deals with the applicability of a small rotary UAV for crop analysis of vegetables. The result shows that UAV photogrammetric technique proves to very useful for analyzing

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UAV (Unmanned Aerial Vehicle) is the latest photogrammetric system which has been used across many fields such as a military reconnaissance, heritage site documentation, a precise agriculture mapping, a construction site mapping, a real-time hazard mapping project, etc. In domestic sphere, National Emergency Management Agency (NEMA, 2007) performs the calculation of the amount of estimated damage and development of the module. In this task, low altitude UAV image correction and its improvement, image processing techniques developed to apply low altitude image to the damage information and the resolution analysis of low altitude image information were performed. Jung et al (2010) carried out 3D spatial data acquisition with UAV photogrammetry. Jung et al (2012) deals with the system development for crop growth management using unmanned aerial remote sensing technique. Kim et al (2010) analyzed the adaptability of damage from storm and flood monitoring using small UAV. It was then proved that UAV could contribute to various disaster prevention and measures such as river disaster, slope accident, sediment disaster (farmland flooding and sedimentation), shore disaster and wind disaster. Lee et al (2012) introduces the UAV focusing on cadastral enabled application in Korea Cadastral Survey Corp.

And Cunningham et al (2011) introduces the cadastral application in rural area in Alaska, USA. Bendig et al (2013) carried out crop surface model production based on UAV stereo-images for rice monitoring in northeast of China. Eisenbeiss (2009) performed the UAV Photogrammetry for agricultural applications. In USA, different agency and state will look for a variety of purposes for UAV utilization such as avalanche control (Washington State's Department of Transportation), fight fires (US Forest Services), a law enforcement tool (state and local police departments in Maryland, Alabama, Texas, Florida, Washington, Arkansas, and Utah) (Better world campaign, 2013), among others. Aeryon Labs Inc., shows how unmanned aerial vehicles help with construction projects (Dcnonl, 2012).

This study deals with UAV photogrammetry for crop analysis and considers its applicability for vegetable crops. The author tries to overlay seamless cadastral map with UAV digital image, supporting the crop statistics agency making a rapid and objective decision for crops. The results show that UAV photogrammetry is reasonable for identifying its crop growth status in terms of the image quality, time-saving and task-effectiveness.

Rural crop survey

The United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) has researched and used remote sensing technology for acreage estimation since the early 1970s. Significant advancements in recent years have enabled NASS to transition the use of remote sensing from primarily a research function to performing an integral role in the agency's crop acreage estimation program, covering all major crops grown in high producing states in the US (Bailey and Boryan., 2010). China is a big agricultural production, agricultural product consumption and trading country, the abundance of crops have long been paid much attention by society and government. China started to study remote sensing technology for crop acreage by National Bureau of Statistics of the People's Republic of China, 2003 (Zhang et al, 2010). With 3S (RS, GIS, GPS), the on-site survey system was constructed and the estimation of crop production with remote sensing is preceded rapidly. The crop model is developed successfully and is about to carry out a test survey (NSO, 2010). EU (Europe Union) is focusing on identifying the current situation of the food production, and is constructing the satellite image-based sample survey system in order to investigate 8 crop acreage with 60 image sample (40km*40km) in total. Through this, EU tries to predict the 11 crop production for 35 countries. In South Korea, the agency says that rural crop survey is carried out on the ground (10 times/year). This causes problems such as high-cost, low-accuracy, labor-intensive for crop survey, etc. Therefore, a government tries to substitute and supplement the existing method with remote sensing technology, making the statistics production to be scientific, precise, and resulted in cost- and labor effective. Nowadays, the agency tries to investigate the cultivated area with remote survey technique. In near future, remote sensing will be put to use at cultivated area acreages investigation. But, crop production and the estimated amount survey will need more high technology; therefore it should be planned in the long-term (NSO, 2010).

Figure 1: Test site (Courtesy of V-world)

Test site and data acquisition

Test site

The test site, Haenam-gun, Jeollanam-do is located to the southwest of South Korea. Haenam-gun's area is 992.87km^2, but the test site had an area of 2,523m^2, with one area of 1,792m^2 and the other one 731m^2, consisting of 2 cadastre parcels. The test site is very flat, no ground obstacles, no dense forest and open sky, which is no problem for UAV. Haenam is popular for nap cabbage which is harvested in winter.

UAV photogrammetric data acquisition

This pilot project was conducted by Department of Business of Korea Cadastral Survey Corp (KCSC), Spatial Information Research Institute (SIRI) attached to KCSC, and Korea Rural Economic Institute (KREI) in Haenam-gun. KREI is in charge of estimating the price and supply on demand of agricultural and stockbreeding products according to law, and then publishing it monthly.

In this study, UAV is manufactured by Spatial Research Institute (SIRI). The main components of the UAV are a remote control, the flight control software and its body. Equipped with six rotors, the UAV system possesses a maximum payload of 6.5 kg. Other important elements of the UAV are one GPS (Global Positioning System), one linear accelerometer, and two Gyros (e.g. IDG-500, IDZ-500). The detailed specification of UAV (Hexacopter) is prescribed in Table 1.

In particular, this UAV is just a prototype model for test. Hexacopter has 6 blades where 3 blades rotate in clockwise direction and 3 blades rotate counter-clockwise. Figure 2 shows an example of UAV (Hexacopter) and a digital image taken with a camera mounted on LX-UAV. In the test, UAV flies over 20 m ~ 100 m altitude.

Data processing and analysis

Figure (3a) shows the screenshot of the digital image overlapping the cadastral map. By rubber shifting method, the digital image and the seamless cadastral map were compulsory moved and rotated, and then overlapped together even though there is some inconsistency between them. Figure 3(b) shows the screenshot of digital image taken over about 100m and 20m altitude on the ground. This process is supposed to be reasonable and cost-effective for a rural agency to have a quick look of crop growth survey in the office instead on site.

Table 1: UAV specifications (The values are approximate)

Climb rate	Altitude hol : Max 6 m/s Normal : up to 10 m/s	Temperature	-10 ~ 50
Cruising speed	up to 5 m/s	Hovering Accuracy (Altitude Hold)/ (GPS Hold)	Vertical 1m Horizontal 5m
Peak thrust	10Kg (incl.batteries)	Max Angle / Max Yaw Angular Velocity	60 / 150
Empty weight	4.5Kg (incl. batteries)	wind tolerance	3m/s
Recommended payload	6.5Kg (incl. camera)	Flight radius	up to 1000m on RC
Dimensions	1200mm 1200mm 450mm	operation altitude	up to 1000m on RC
Maximum take-off-weight	10Kg (incl. body)	Flight time	up to 15 minutes

Figure 2: LX-UAV (Hexacopter) (a), and UAV digital image (b)

Figure 3: Screenshot of the digital image overlapped over the seamless cadastral map (a), and digital image for cabbage (b)

Conclusion

Small UAV images are taken in order to survey the farm products at the local province in South Korea as a pilot project. The results show that UAV digital images are enough to be reasonable for analyzing the parcel area, cabbage density, and crop. In high altitude flight (about 100m), it is possible to identify the crop approximately; in low altitude, it shows a good resolution image enough to distinguish leaf status and crop growth status. UAV digital images are expected to play a good role in providing objective data for crop analysis. And the seamless cadastral map was overlaid on top of the UAV digital image, encouraging rural agency to make a quick decision for crop analysis. In other words, it is required that the extension of flight duration time, image quality improvement due to wind, etc., and buying insurance for safety people, etc., should be considered for various applications.

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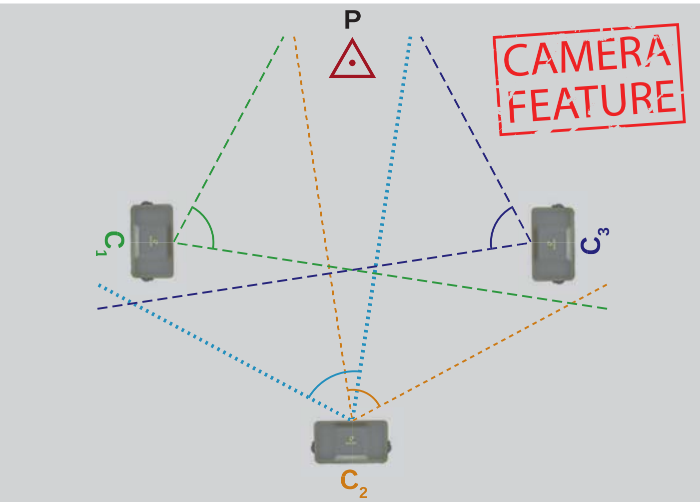
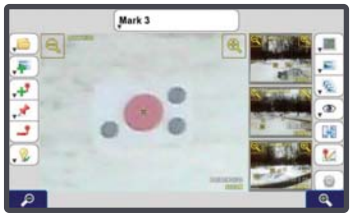
Offset Survey with built in camera

You can survey points with internal TRIUMPH-LS camera with accuracy of about 2 cm. Take pictures from at least three points. Leave a flag on points that you take pictures from, otherwise accuracy will be about 10 cm.



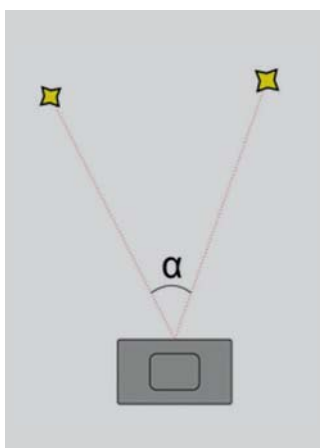


Visual Angle Measurement with Triumph LS

The new Visual Angle Measurement function of the TRIUMPH-LS allows measuring angles between points by using photos taken by the TRIUMPH-LS camera and use in CoGo tasks with the Accuracy of about 10 angular minutes.

To measure an angle:

- just take an image containing both objects of interest and open it in the Measure Angle screen
- select first and second point (using zoom to focus on necessary features)
- The angle between points is immediately displayed on the screen.



Precision with TRIUMPH-LS

Our friend from Javad GNSS, Michael Glutting, recently related that a surveyor in Minnesota asked how he could use his Triumph-LS and corrections from the MnCORS real time network to accurately work within his projects previously established with HARN. The MnDOT provides mount points for various adjustments of NAD83, however, a surveyor can quickly produce reliable, highly accurate transformation parameters for a local set of known positions as this paper describes.

In 2000, Stanger Surveying of Tyler, Texas, established a GPS control network consisting of 30 monuments for my hometown of Kilgore, Texas, over an area measuring about 7 miles square (50 square miles). Even after 15 years, the network proves to be incredibly accurate and was well constructed with ties to two different HARN PACS (High Accuracy Reference Network Primary Airport Control Stations) and multiple repeat and braced vectors. This network predated the modern proliferation of CORS stations, and so there is no precise relation to the CORS and therefore no precise relationship to NAD83_2011. This means that there is some unknown translation from the Kilgore GPS Control Network of 2000 and NAD83_2011. Because of this, we must resolve these transformation values by observation.

To do this, we conducted two field campaigns. In both sessions, I placed a Javad GNSS receiver on a stable monument, POST, located at our office. The first session, I used a Triumph-1, and for the second, I used a Triumph-2, both broadcasting corrections over the Internet via TCP. The NAD83_2011 position of POST has been accurately determined by hundreds of hours of data from several different GPS recievers processed through OPUS.

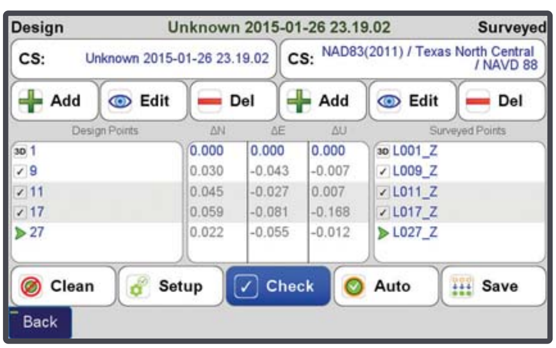
In the first session, my father, J.D., and I observed five different monuments from the Kilgore network with the Triumph-LS for 90-120 seconds each. These points were the primary control Stanger established from the HARN PACS. After observing those five points I performed a preliminary localization.

In this preliminary localization, I fixed only one point (point L011_A). Three of the remaining four show very low residuals, however point L017_A, with its noticeably higher vertical residual suggests this point has been displaced since it was established in 2000, or that there is an error in the observation itself - only a repeat occupation will tell.

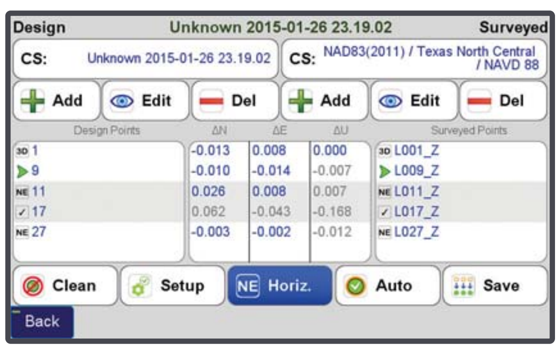
During the second session, we observed the five points again and used the average tool in J-Field to perform a weighted average of the two points. The second observations showed excellent agreement with the first observations. This chart shows the difference in the repeat observations for each of the five stations:

STATION	Base-Rover Vector Length (usft)	Δ 2D (usft)	Δ UP (usft)
L001	37342.30	.097	-0.029
L009	23155.70	.048-	0.139
L011	13559.4	0.049-	0.005
L017	24184.6	0.036	0.033
L027	2285.90	.032	-0.005

With the five control points averaged, I began the localization process again. First I performed a minimally constrained localization holding only point L001. Notice that point L017 still appears to be an outlier.



Next, I constrained horizontally to L001, L009, L011 and L027 while still only fixing point L001 vertically. The residuals predictably decrease among the points fixed.



OMEGA

Rugged GNSS Unit

OMEGA is the most advanced GNSS receiver. It does not include integrated antenna and controller. It is suited for applications like **machine control** and in **marine** and **avionics** applications.

Adding GrAnt and Victor-LS makes a complete RTK system.

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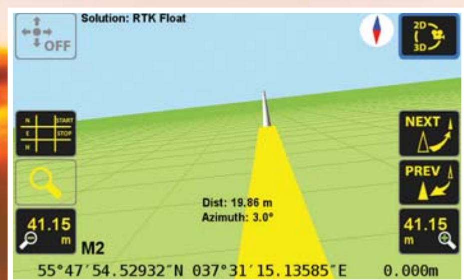
Receiver+Antenna+Radio Modem+Controller+Pole

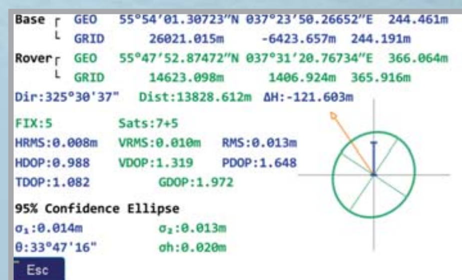


- **864 Channels for all GNSS signals**
- **24 Hours Battery Life**
- **Interference monitoring of all GNSS and UHF channels**
- **Visual Stake out**
- **Lift & Tilt**
- **6 parallel RTK engines**

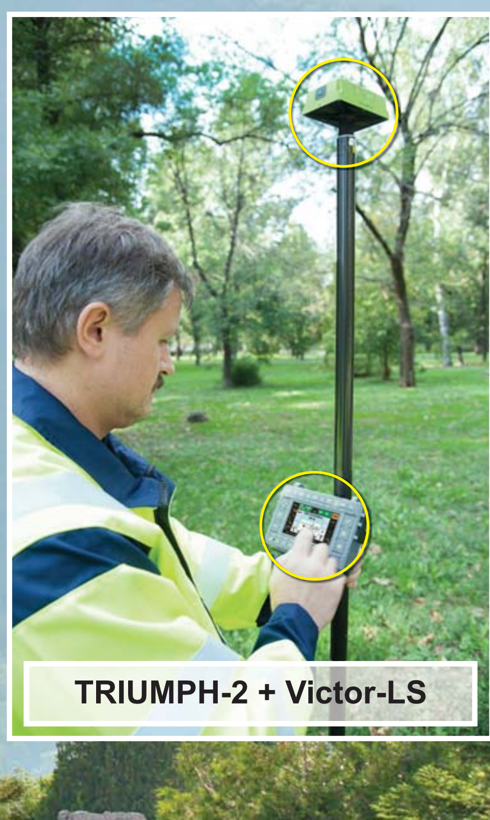
Victor-LS

The Rugged Field Controller

Victor-LS is a rugged field controller. It runs J-Field and can be used with TRIUMPH-1 and TRIUMPH-2.



TRIUMPH-1M + Victor-LS



TRIUMPH-2 + Victor-LS

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HPT401BT/HPT101BT/ HPT201BT

With the residuals indicating a good fit, I turn my attention to the parameters of the localization.

From these parameters, several observations can be made immediately. Because both surveys relied upon the same definition of North, it is expected that there would be little, or no rotation. Furthermore, because both surveys relied upon the same definition of the foot, US Survey foot measured along the same grid surface, Texas Coordinate System of 1983, North Central Zone, there should be little difference in the scale factor. The rotation determined is less than half of one arc second and the scale factor being applied to best fit my survey to Stanger's original work is only 1 part-per-million, revealing very good relative agreement between the surveys.

Finally, I am ready to perform a fully constrained localization, holding all four points (still disregarding the displaced monument L017) both horizontal and vertical.

I set both the rotation and scale to zero as I do not want to redefine North nor the US Survey Foot. Now that more than one point is involved vertically, a tilted plane is calculated. Because the Stanger survey was based on Geoid96 and today's survey is based on Geoid12A, I left the tilt values intact. In this case the inclination values are so small as to be practically insignificant.

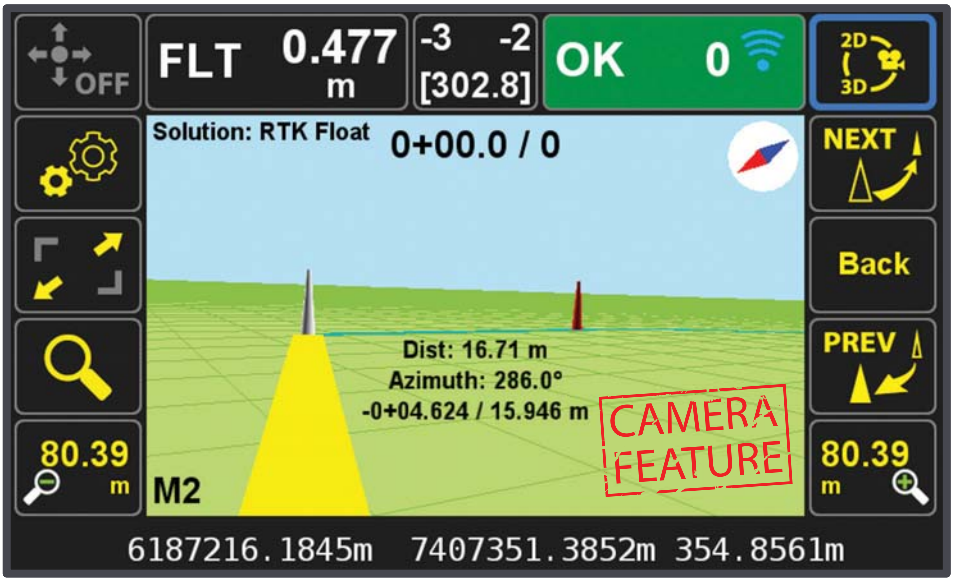
The final results indicate that the translation between the Kilgore GPS Control Network of 2000 and NAD83_2011, epoch 2010, (usft) is N: -0.0497 E: +0.1188 U: -0.0587. From this point forward, I can use this new localization system to survey in coordinates related to the Kilgore GPS Control Network of 2000 with a reference station broadcasting NAD83_2011 corrections, or I can transform coordinates from surveys related to the Kilgore GPS Control Network of 2000 to NAD83_2011.

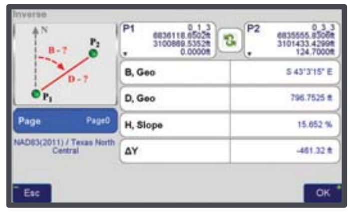
The final step in this exercise is to use this transformation to test on known points. In order to do this, we observed five additional points from the Kilgore network that were not used in the localization. Each point was observed for 120 seconds with the Triumph-LS with corrections from the Triumph-2 onPOST. The chart below depicts the difference in coordinates determined from the LS using the localization and the original Kilgore GPS Control Network of 2000 coordinates.

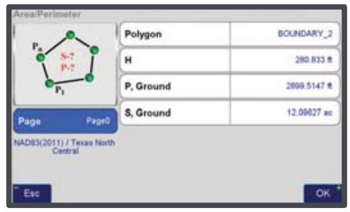
These residuals can be attributed to several different sources: orginal survey error, current survey error, displacement over 15 years, as well as errors in the localization/transformation being used. However these results, together with the residuals from the localization, indicate that the localization, as determined, will allow me to reproduce the Kilgore GPS Control Network of 2000 coordinates within a centimeter, anywhere within the network. The total time required to perform this exercise was 4.5 hours in the field (including redundant observations) and 30 minutes of calculations, which were all made within the Triumph-LS.

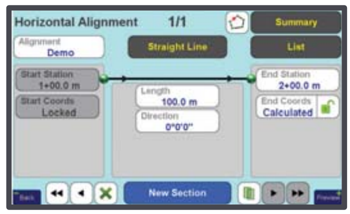
Shawn Billings, PLS

Station	Base-Rover Vector Length (usft)	2D Residual (usft)	Up Residual (usft)
L007	15363.30	.036	-0.006
L0121	4416.1	0.030	0.101
L0191	2900.90	.025	0.001
L021	7553.00	.048	0.121
L025	11238.80	.011	0.048









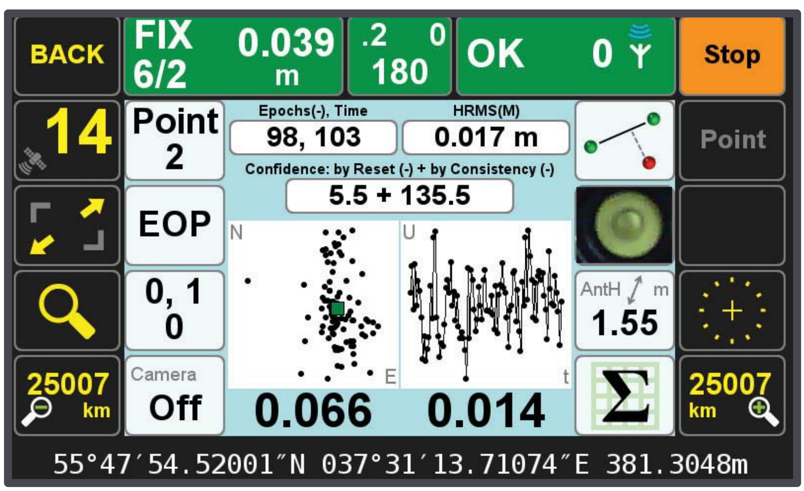
Store and Stake

Introducing GUIDE data collection in the TRIUMPH-LS. Visual Stake-out, navigation, six parallel RTK engines, over 3,000 coordinate conversions, advanced CoGo features, rich attribute tagging on a high resolution, large, bright 800x480 pixel display.
Versatile attribute tagging, feature coding and automatic photo and voice documentation.
The TRIUMPH-LS automatically updates all firmware when connected to a Wi-Fi internet connection.

View and Document your level

The downward camera of TRIUMPH-LS scans and finds the liquid bubble level mounted on the pole. Then focuses on the circular bubble automatically and shows its image on one of the eight white buttons of the Action Screen. You can:

• View the liquid bubble level on the screen.
• Document survey details including the leveling by taking automatic screen shots of the Action Screen, as shown here.
• Calibrate the electronic level of TRIUMPH-LS with the liquid bubble level for use in Lift and Tilt and automatic tilt corrections.



All these camera features are possible only in TRIUMPH-LS where camera, and GNSS antenna are co-located and all other modules integrated.

Automated digital workflows and transactions using machine readable language to represent 2D & 3D cadastral surveys

Readers may recall that in last month we published an article underlying survey database technology and workflows. As indicated, we present here the article on how the process is facilitating the representation of the survey plan in a machine readable file that is allowing automation of manual plan examination processes and transactions

Ian HARPER
Director, Geodata Australia, Australia

Background

Security of tenure and incontestable spatial definition of land is the major contributor to the economy of developed states and is the economic springboard for developing states. E-governance technology is now a major component of administering all aspects of this sector.

In the survey and mapping domain, digital transmissions and workflows have been in place for a considerable time but for the most part the 'digital' component has been an electronic image of a 'hard copy'. The automation of digital workflows and transactions is identified as a natural progression in efficiency as computing capacity and more intelligent data structures develop.

The survey title plan is a complex document that has a legal role as a supporting document to a title, and a spatial role that once validated, is guaranteed by government so spatial quality is critical. Validation of this type of survey information has always been a complex and laborious manual process.

Over 10 years ago the Australian Intergovernmental Committee on Survey & Mapping (ICSM) began a process to initiate a standard ePlan LandXML structure to represent the complete content of a survey plan in a machine readable format for digital automation purposes across all State jurisdictions.

NSW has developed an ePlan system based on the ICSM LandXML version which represents every component of the survey plan image. A Registered Surveyor submits their LandXML file to the Titles Office portal and the process then immediately checks the plan content for compliance with over 100 business and survey rules followed by spatial validation with a survey database of existing plans.

The Northern Territory (NT) has utilised a simpler structure used by Commercial-off –the- Shelf (COTS) software. The NT has reduced the machine readable content to that which is only relevant to the processes of updating and spatially upgrading the current cadastral database and satisfying business transactions for new Title creation. Formats to represent 3D Strata/Apartment Titles are being tested. Very few strata plans currently have a height (z) component but each unit will be uniquely represented in the cadastral database and height attributes can be added to existing strata plans as needed for 3D modelling requirements but new strata plans will require height definition attributes at lodgement.

This presentation outlines the background to the processes that has been successfully implemented in those two State jurisdictions. Geodata Australia technology has contributed to some of the outcomes outlined in this presentation.

Technology is facilitating e-governance and is also driving the transition from measurement based title systems to position based title systems, so it is important that there is also consideration as to whether existing survey practises, statutory requirements and even the content of a survey plan will still be relevant in the digital future. Spatial infrastructure like Continuously Operating Reference Stations (CORS) will challenge current Statutory Regulations developed for measurement based technologies.

Current technology determines survey methods and title definition

The available technology at the time has always determined survey and title processes. Early title definition of ownership was described by words or diagrams based on recognisable physical bounds (monuments) – rivers, mountains etc. As further division was required artificial monuments were placed and technology provided circumferenters and chains to measure and records of those were retained as a proof of the 'metes'. Written text became the most effective way to represent a survey inside the legal process by means of a Metes and Bounds description. As technology progressed measurement accuracy increased and copying technology saw diagrams and survey plans become the preferred method of representation for all stakeholders. Through all this the Torrens Title edict of 'Monument over Measurement' has remained.

Today, measurement as we knew it is changing as GNSS and the coordinated database underpins land administration. The survey plan in the hands of a Registered Surveyor still provides the core survey information and intuitive skills to spatially locate the boundaries of a property, but in a non legal scenario the database is rightfully or wrongfully challenging that role. The intensity of that challenge is increasing to where a database of a high spatial quality is starting to provide the coordinates that will be the evidence for a Registered Surveyor to reinstate a boundary on the ground.

The content of the modern digital survey Plan has been driven by the requirements to identify a new Title, the metadata associated with that Title and the survey information that satisfies plan examination scrutiny that adjoining titles are not spatially compromised. This content was designed to fit with historical technologies that are being superseded around us like CORS. Another aspect of the plan referred to above is that it is a local solution only linking that plan to the adjoining titles. Spatial technology is now providing global solutions so investigation of that progression will make surveyors relevant for the future to deal with precise coordinate issues like datums & time.

Initially GIS cadastral databases were based on mapping tools such as digitising charting maps. Whilst updating with modern accurate survey data can directly populate a precise cadastral database, older survey plans representing current titles are not of the same precision, so 'fitting' those titles into a seamless fabric is difficult. All the survey issues to consider are variable and any method to categorise precision in the database can only truly be done with a comparison of the coordinates of a particular point with those determined by a Registered Surveyor in the field.

A tool that links survey data and accuracy is the Survey Database technology 'GeoCadastre' and the ESRI 'Parcel Editor'.

The difference with previous mapping based cadastral databases is that the original parcel 'ground' dimensions stated on the plan are always stored as the defining parcel dimensions and are used in the adjustment to generate parcel coordinates. The process also automates resolution of azimuth, measurement types (Feet, links etc) and grid conversions. The 'grid' dimensions of the parcel in the cadastral fabric model will vary from the original ground dimensions as all the parcels are adjusted to provide a seamless geodetic 'fabric'.

In areas of modern development with accurate surveys, that adjustment will be minimal but in areas of older inaccurate subdivisions the difference between the plan dimensions and the model dimensions will be greater as more accurate representation of the distances between monuments is provided by the fabric database.

Geodetic survey control points or accurately coordinated cadastral points are the location foundation of the Parcel Fabric Survey Database. It contains all the components that a surveyor would expect in a dynamic survey database with several levels of validation.

Electronic lodgement and automated examination of survey plans

All title boundary measurements, other survey measurements and jurisdictional information can now be represented in a

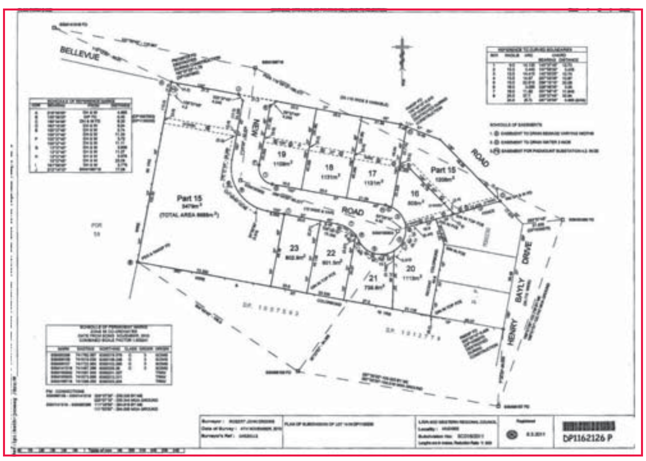


Figure 1: Survey Plan DP1162126

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Figure 2: Part of the LandXML file representing DP1162126

text file as machine readable data. This opens the door to automated examination and transaction processes. Diagrams 1 & 2 represent the old and new way of survey plan lodgement in NSW.

An XML representation of the plan goes through initial automated examination processes that can happen in seconds. After the file passes the initial examination, the survey is then matched by joining the new parcel corners with those in an existing cadastral Survey Database. Transformation residuals of that matching points provide metrics for spatial validation. The business outcome has been that most of the manual assessment tasks have been automated and in the best case scenario (matching a new plan to an accurate locality database) the time to create new titles can be reduced to several days rather than 1 – 2 months as per existing manual processes.

In Australia, the original government ePlan process began ten years ago with a committee under the auspices of the Intergovernmental Committee on Survey & Mapping (ICSM) to initiate a standard ePlan LandXML structure to represent the complete content of a survey plan in a machine readable format for digital automation purposes. The committee developed a standard schema which was based initially on a variation of LandXML that has matured from a basic to an expanded schema when the various state entities (including New Zealand) have added requirements to meet their individual requirements.

The ICSM committee engaged the major survey software vendors to provide an internal tool to the surveyors to output an ICSM LandXML compliant file to lodge with the relevant Titles Office. Due to each jurisdiction having different data protocols, the vendors needed to develop separate tools for each jurisdiction. At this stage only 3 States have progressed to an implementation stage based on the ICSM schema while the others are reviewing that progression.

In New South Wales (NSW) and the Northern Territory (NT) processes of this type are being implemented with the assistance of the Geodata Australia team, but with different approaches as outlined further below. One point of difference is the validation tools in the NSW system are built into the portal for online validation whereas in the NT the surveyors are required to complete similar validation in GeoCadastre software prior to lodging.

The real benefit is a self validation for the surveyor. As many 'errors' in plans are minor, early statistics are showing that the initial validation is finding in the order of 50% to 80% of the errors that would normally be found in the departmental manual examination process. So they are being highlighted by the technology before it is accepted by the Titles Office.

NSW

In NSW the ICSM Australian LandXML structure has been in implementation for several years and is in ongoing development for better presentation outcomes. Upon lodgement the LandXML file is converted to a COTS Survey Database format for processing using a tool developed by the Geodata Australia team. NSW LPI also uses on-line tools for automated Portal examinations. The underlying survey database for spatial matching purposes is generated in GeoCadastre and the outcome of the registration process is then migrated to the Survey Database managed by the ESRI Parcel Fabric platform.

The automated Portal examination process checks the survey for compliance with over 100 business and survey rules that include:

- Correct XML syntax and correct XML entities
- Accuracy of parcel and traverse closes
- Currency of geodetic survey control coordinates
- Statutory requirements for survey reference marks
- Correct jurisdictional names (County, Parish and Local Government names)

If a survey plan file fails any of the tests the surveyor can withdraw the file, rectify them as identified in a comprehensive report and re-lodge the file. This could take a matter of minutes and the Plan file then goes on to the next stage of spatial assessment using Parcel Fabric based tools.

For the NSW Titles Office there were initial concerns that the bulk of their plan examination team had been in that role for many years and there may not have been an acceptance of a digital way of analysis rather than the manual way they had been doing the spatial examination for many years. These concerns were not warranted as once the experienced examiners understood it, they could see how the process simplified their jobs.

The process has meant that in optimum conditions a less experienced plan examiner can verify that the file passes all the automated portal examinations and then undertakes the process of matching the topology to an underlying accurate Survey Database fabric. If the residuals at all points are within a certain tolerance (10-15mm in urban areas) and the underlying principles of land title boundary definition are met, they are able to register that plan without the involvement of experienced plan examiners. Any jurisdiction that has an aging plan examiner workforce would recognise how this technology will benefit a diminishing resource at a time where the government business pressure is to do more with less.

Whilst the NSW Titles Office has been vigorous in assisting surveyors to utilise the technology, acceptance and take-up by the Survey profession has been slow. While the concept of a faster turnaround is accepted, the implementation involves time in understanding and setting up of the survey detail to match the ICSM schema, so there is an orientation component that costs the surveyor that they must overcome. Currently 78 LandXML plan files have been lodged and registered through the NSW Titles Office Portal.

NSW Registered Surveyor Graham Hall of Craig & Rhodes Pty Ltd who has lodged over 25 LandXML files comments that “once you understand the process, have the systems in place and there is no duplication with manual workflows, efficiencies for the surveyor and all stakeholders should be achievable”.

The future scenario would be that the cost component of manually drafting a survey plan would be replaced by the time taken to populate the respective attribute fields that would otherwise represent geometry or text components that would have been shown on the plan.

If preparation of the LandXML digital output is greater than the manual methods, that cost should be passed on to the client and justified by the fact that they will benefit in the longer term by faster Title creation. Diagram 3 is a screen shot of the automated LandXML Validation tool. This is accompanied by a PDF file which lists the full description checked.

The process offers considerable benefits to the NSW Titles Office so they will push for it to become compulsory in the future.

Northern territory

The Northern Territory (NT) has to deal with extremes in cadastral definition, from standard urban parcels to Pastoral Leases in remote areas that can cover over 5000ha with 80km boundaries that are historically defined by Latitude & Longitude. Computations of long lines also introduce the geodetic complication that each survey line is an arc and will have different azimuths along its length.

The NT is fortunate that it has been implementing the Parcel Fabric Survey Database process for over 20 years to generate a Numerical Cadastral Data Base (NCDB) built from plan measurements. It has nearly completed the manual data entry of all the current survey plans for each parcel (historical plans not entered) into the NCDB so they have a foundation for modern digital survey processes using intelligent XML data structures. Where no existing survey plan is available the existing Digital Cadastral DataBase (DCDB) data has been reverse engineered into the NCDB as the current parcel.

Figure 3: NSW LandXML validation portal screen

Recognising how technology will drive measurement and Title definition, over 10 years ago the NT enacted legislation to allow coordinates to be the prima facie evidence to define the location of a Title. The NT Surveyor-General recently ‘declared’ 3 Coordinated Survey Areas to come under that legislation. As all measurement in rural and remote areas of the NT is already done by GNSS, work practises will not change. It will mean that the effort required in computations and statutory survey outcomes is significantly reduced.

In the NT a less complicated ePlan standard that escapes the burden of the requirements of other jurisdictions inherent in the ICSM LandXML standard has been implemented. Amendments to the NT Survey Practice Directions have been made to enable all surveyors to lodge single survey plan files or larger survey databases that hold many plan files that have externally been joined and adjusted to geodetic control in a fabric. These will be lodged in a GeoCadastre file format which is the same as the ESRI Cadastral Editor XML (CEXML). This is also a point of difference between the ICSM ePlan Process which has been designed for the lodgement and examination of one survey plan file. The NT system will expand the capability of spatial examination and efficient updating of the NCDB with larger survey databases. In the near future, the Surveyor General will only accept lodgement of survey plans electronically through the departmental portal.

In the NT there will be no legislative requirement for the survey plan to be a completely digital based plan. In this process, data that is only relevant to updating and upgrading the cadastral database and satisfying business transactions is required to be held in the lodged XML file. Other plan data which is only relevant to surveyors for boundary reinstatement and plan examination purposes is still available in a ‘tiff’ format.

The NT Department of Lands, Planning and the Environment has met the challenge in the remote areas to not only electronically represent the geodetic

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computations, but also integrate the historical survey records which will be captured on an as required basis. Extensive ground traverses have been done over many years to locate the lease boundaries on the ground. Those survey plans defining the boundaries have been registered at the Titles Office, so the marks placed by those surveys legally define the boundary and will be represented in the NCDB and by future title coordinates.

The authoritive survey and title database will be accessible to surveyors from a web-based service that will maximise the benefits of real time technology. This however is still a number of years into the future.

Northern Territory – 3D Cadastre

Whilst there are only a couple of cities or towns in the NT that have multi story buildings, the data structure and capability to represent 3D title entities is being developed within the GC technology for the NT as part of the digital workflow implementations.

'Strata' plans defining a cubic space will be included in the NCDB. Current Strata Plans have limited measurement information in either x, y or z directions. Each cubic entity is defined by digitising the footprint of the structural elements that provide the legal definition of the Strata boundaries, being the internal faces of structural walls, floors, ceilings and other features supporting and defining that cubic space. Initially that geometry representation will be transferred to the NCDB so each unique legal cubic entity will be spatially represented in the NCDB. When required, lower & upper height attributes can be added when they are needed or become available so that 3D modelling of that data in a GIS is then possible.

3D Strata Titles are an internal division of a current parcel in the NCDB. That NCDB parcel location will be spatially affected as the NCDB is constantly upgraded. Horizontal geometry connections to the 3D Strata Titles ensure that as the external parcels are more accurately located, the position of the internal 3D Strata footprints will also be spatially upgraded. Adjustments in the NCDB will only affect the X,Y or horizontal location as there is no need for adjustment of height definition.

As the detail of the process is refined over time, strata boundaries may be populated from various sources if it is of benefit. Initially, hard copy building plans could provide better dimensions to define the digitised 3D entities. The next progression would be to import digital boundaries from CAD drawings or extracted from detailed Building Information Models (BIM). The Spatial definition of the cubic space may be held in an xml format so it will be readily accessible to more advanced 3D modelling technology.

Whilst these sources would provide accurate design dimensions, if a higher level of accuracy is required to produce a spatially authoritive dataset a Registered/Licensed Surveyor would be required to validate that boundary location. This would be a significant undertaking and it is doubtful it would be commercially justifiable, particularly in the NT.

Figure 4 shows the Ground Floor Level of the Strata Plan. Figure 5 highlights the digital geometry of the Common Property 'parcel' which has a legal status as a parcel in the Strata scheme. In the future surveyors will be required to populate all the X, Y & Z components of the strata parcel in a format of this type. The parcel identified is Common Property so no Lower & Upper Height limits have been noted like a normal strata parcel which is limited in height, usually by floor & ceiling levels.

The future

The focus of the digital survey tools discussed is representing relevant survey plan data in a machine readable format that facilitates the automation of existing survey quality validation processes. This will then flow through to improving the quality of the Cadastral Database. This is not an issue for new development areas but it is important that the best data structure is put in place for efficiently upgrading areas of older surveys where accuracy is either uncertain or poor. If the data is in the Survey Database structure, the digital workflows outlined in this paper will assist in the most efficient spatial upgrading with the least resources.

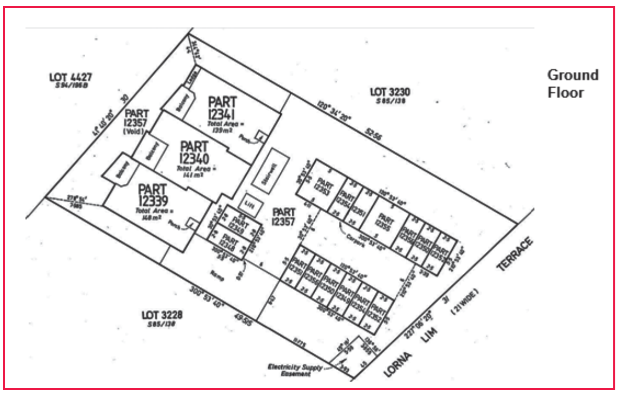

Figure 4: Strata Plan – Ground Floor as per Strata Plan

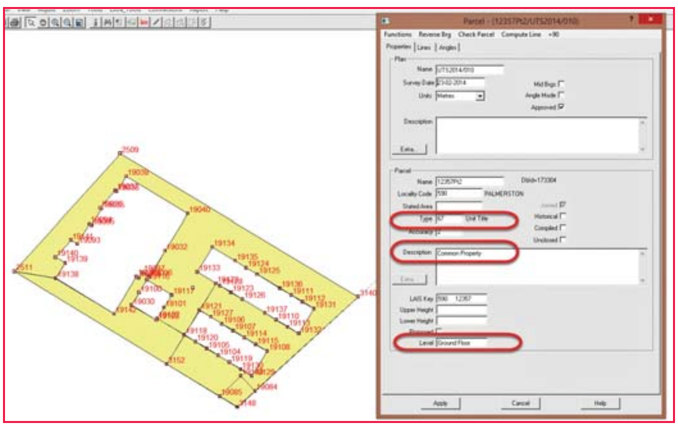

Figure 5: Parcel Geometry representing the Common Property 'Parcel' which provides a unique spatial entity to be referenced in the land Administration database – Specific Parcel Attributes are highlighted in red

Many of the processes being implemented in NSW and NT have been built on COTS processes and the different jurisdictional needs are managed by linking to a specific Configuration file that automatically sets up the tables required to populate statutory or other specific jurisdictional needs.

The 3D cadastral model is now in demand to match advances in 3D visualisation and administration technology. Since the Strata Plan Legislation in NSW was enacted in 1961 the format of the Strata Title Plan has changed very little. It is an elegant way to represent a complex ownership arrangement. Thick lines represent walls and it was defined that the face of the structural wall, floors and ceilings is the limit of private ownership while the wall itself is deemed Common Property. Survey measurements were only required where no structure existed and rather than being related to the cadastral definition of boundaries, external private cubic spaces were defined relative to recognisable structural features in X,Y & Z directions. Many other jurisdictions follow a similar protocol.

BIM models (See Figure 6) now offer a wealth of detailed information for construction as shown in the Figure 6 below. The issues of the location of Common Property and infrastructure like pipes & cables that service all the separate Strata Titles spaces are well defined and provide clear visualisation for trouble shooting at the design and construction stage. The BIM could be a useful spatial data source but they are only currently generated for a small percentage of Strata Plans.

The Strata Plan (See Figure 7) provides the antithesis of the BIM where a basic diagram effectively identifies the legal entities and implied easements protect the private services that run throughout the Strata scheme.

To add a 3D component to the cadastral database for digital visualisation and administration of legal cubic spaces, we believe the pragmatic approach being adopted by the NT can begin the process. It is difficult to see where a higher level of definition of actual Strata unit boundaries would be commercially justified. Figure 8 shows a conceptual 3D model built from a 2D footprint with upper and lower heights defining cubic spaces.

Quantifying a pragmatic level of ePlan and 3D cadastral database development with all the stakeholders is the key to engaging them. Complexity in the process will delay implementation and alienate many stakeholders.

We can move forward with complex modern technologies guiding our processes but integrating the manual outcomes that define our past and current lands must also be addressed in a pragmatic way.

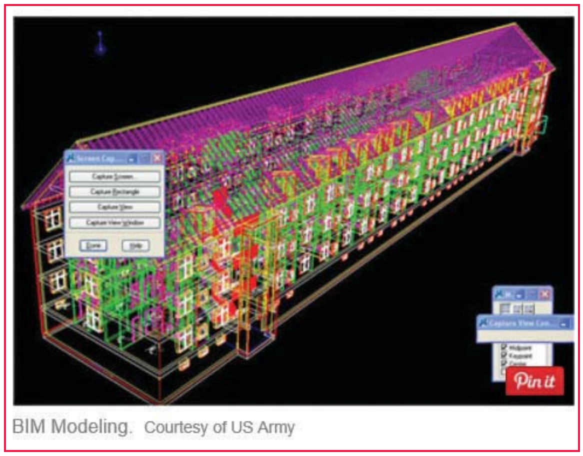

Figure 6: BIM model showing extensive detail of all components

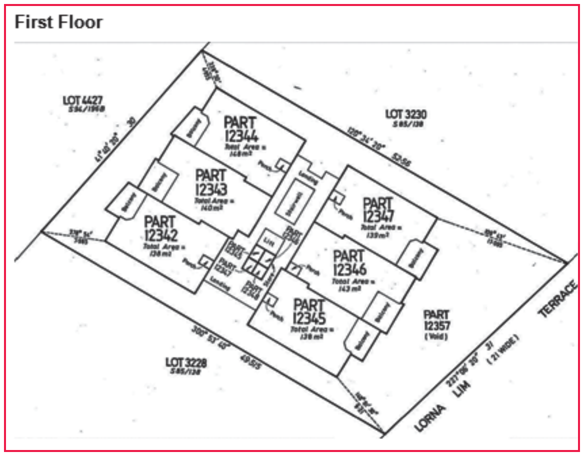

Figure 7: Strata Plan

Figure 8: 3D Cadastral Modelling Concept – Courtesy ESRI

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Keera Morrish – Instructor, ESRI, Redlands, California, USA

CADASTRE 2034 – Cadastral Reform and Innovation for Australia – A National Strategy Intergovernmental Committee on Survey and Mapping.

Modern acquisition technology of spatial data

UAV technology and the technology of laser scanning of the terrain and buildings are becoming more dominant techniques of mass gathering of spatial information

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During the last ten years, the possibilities for data acquisition in geodesy have been rapidly improved. The devices have become cheaper, smaller and more accurate and, on the other hand, they are capable of gathering a large number of data within a very short time interval. Also, mobile platforms have been developed as carriers for different devices such as LIDAR (Light Detection and Ranging) platforms, platforms for cameras, etc. Unmanned aerial vehicles (UAV) are of special interest. Their primary use concerns the three-dimensional terrain mapping and they are applied in various domains, among which is geodesy. These devices are light, mobile, completely automated, providing access to even the most unavailable terrains. The satellite high-resolution frames have demonstrated immense potential in forming the frames to national maps (charts) of all kinds and purposes. In addition to geometric data offered by the digital terrain model for the necessities of determining spatial form of urban planning, a very important role belongs to the orthophoto map as a geocoded digital raster photograph, on the basis of which different space forms can be identified. The satellite high-resolution frames have demonstrated a high potential in forming the frames to planning and designing of various kinds and purposes. What is attractive to many potential users is just the meter resolution which, practically, makes it possible to extract the objects appearing in the majority of digital cartographic products. The technology of preparation of digital topographic layouts in vector and raster format is in expansion. Great number of satellites with sensors for remote sensing provides a resolution better than 1 meter. Also, laser scanning technology is often used in urban design and space planning project.

Technology of laser scanning of terrain and buildings

For the purpose of solving practical problems in many branches of engineering industry, there is a need for measuring and modeling of measured data as per real display of spatial surroundings. By development of laser scanning technology the conditions for application of 3D measuring of points of very high density have been met in a way that modeling of subject survey can be carried out by using this data. The necessity for highly detailed 3D terrain and building coordinates occurs in different engineering disciplines, such as [3]:

- Quality control, supervision and comparison of construction with plans, especially on complex construction sites;
- Virtual planning, analysis of spatial relations between buildings themselves, but also between a building and surroundings (complex buildings);
- Digital archiving of infrastructure (tunnels, bridges and road network) in order to provide the basis for efficient management; and
- Control of different deformations on construction sites (landslides, strains, faults on facilities) and surveying of entire construction sites with not only the previously determined selected points.

Detailed survey of culturally significant buildings, monuments, churches and towers, with very accurate documentation of their condition (interior and exterior), is required to repair them in case of collapse or destruction of any kind.

Laser scanning LIDAR

Laser scanning of the terrain from the air (LIDAR) today represents one of the most

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contemporary technologies used in surveying and preparation of topographic plans and maps for different purposes. Laser scanning data can be combined with satellite images in order to make 3D terrain model and create a photorealistic view of the terrain (Figure 1).

The technology is based on gathering three different sets of data. The position of a sensor is determined by the use of Global Positioning System (GPS) using a phase measuring in the regime of relative kinematics, and the orientation is determined by use of Inertial Measurement Unit (IMU). A laser scanner is the last component. The laser sends an infrared beam to the earth and it reflects to the sensor. Time lapsed from emission to reception of signal with knowledge of sensor and orientation position, enables for the 3D coordinates on Earth to be calculated [1], [2].

During flight speed of approximately 250 km/h and altitude of approximately 1,000 meters with standard characteristics of a sensor (130,000 emissions / second), the data on position of points on the ground with density of up to 100 dots/m² have been gathered. Usual relative accuracy of a model with calculated omission of GPS and inertial system amounts to 5-7 cm. Absolute error is always better than 15 cm and it can be significantly reduced by use of control points on the ground. Almost all modern LIDAR systems, next to GPS, IMU and laser scanner, also integrate RGB/NIR (Red – Green-Blue, Near Infra Red) cameras of high resolution which enable the making of quality orthophoto plans of resolution of up to 2 cm (depending on the height of flight above sea level). Survey with LIDAR is carried out while moving and the system can be mounted to a vehicle in the aim of a scanning corridor, such as roads or similar line facilities or to an aircraft for scanning the corridor from the air. LIDAR has a very simple principle of measuring. The scanner emits high frequency impulses and it reflects from the surface to the instrument. The mirror inside laser transmitter moves by rotating perpendicular to the flight direction which enables the measuring in wide belt. Time elapsed from the emission to the return of each impulse and angle of divergence from the vertical axes of the instrument are used for determining relative position of each measured point. Data from laser scanning are combined with scanner position and orientation, in order to obtain three dimensional coordinate of laser print on the surface of the terrain [3].

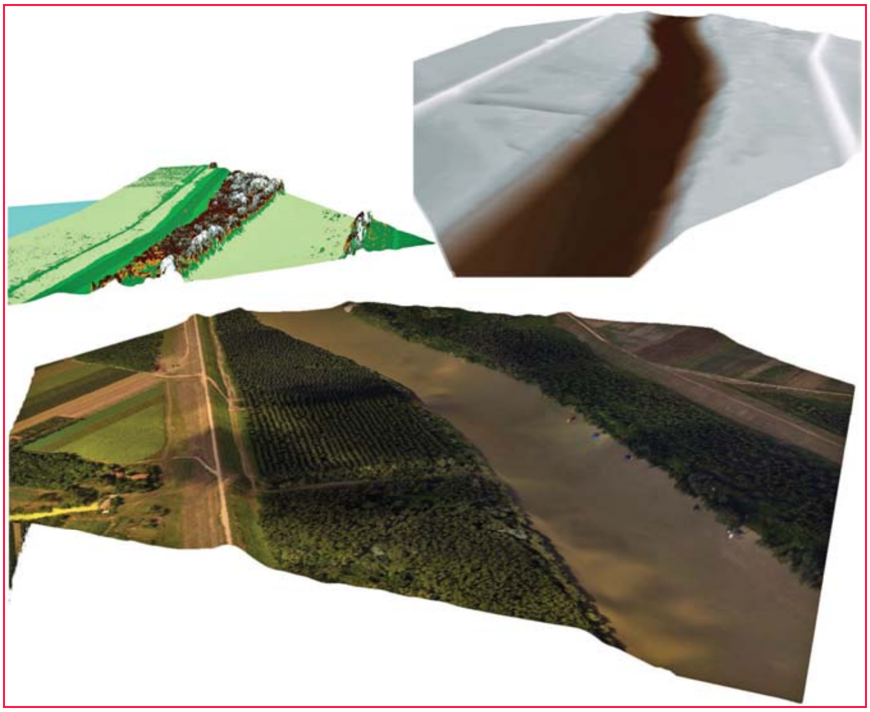

Figure 1: Products of laser scanning of Tisa river in Serbia (Digital Surface Model - top left, Digital Terrain Model - top right, Orto-foto map on DTM - down), [1], [2]

After the processing of GPS vector from base stations to each measured sensor position, orientation and determining relative position on the ground in regard to the sensor, the following data are obtained:

- The cloud of points of first and last echo
- DSM first and last echo
- RGB and NIR recording

Technique of mobile laser scanning

The implementation of the most recent laser scanning technique combined with the high-precision navigation system, yields a system for 3D scanning of roads, buildings and trees from moving vehicles. The device utilizes several laser scanners where each of them performs up to 10,000 measurements per second with a scanning speed of at most 100 acts of scanning per second. In this system, different scanners located at different places of the car platform can be utilized.

In Figure 2, the technique of mobile laser scanning by using the ‘MDL Dynascan’ system, model 250, is presented.

The system is specially designed for a rapid 3D mapping of motorways, roads, runways, railways, infrastructure objects, etc. The data can be registered in a normal drive speed. The survey of urban environments over a relatively short time is also possible. Such a system makes it possible to register every detail along the scanning corridor, including road verges, traffic signs, surface lines, object facades and everything entering the view field of the scanner. Combining the data scanned by laser with the video

Figure 2: Mobile mapper system MDL DynaScan model 250

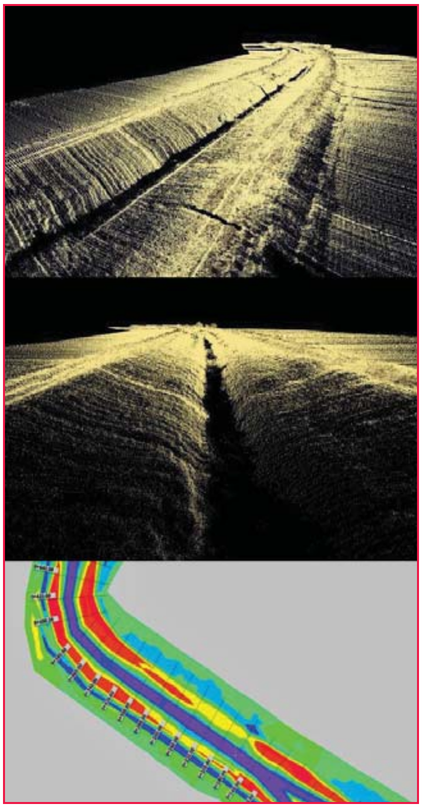

Figure 3: Cloud of points for scanned canal with 3D model

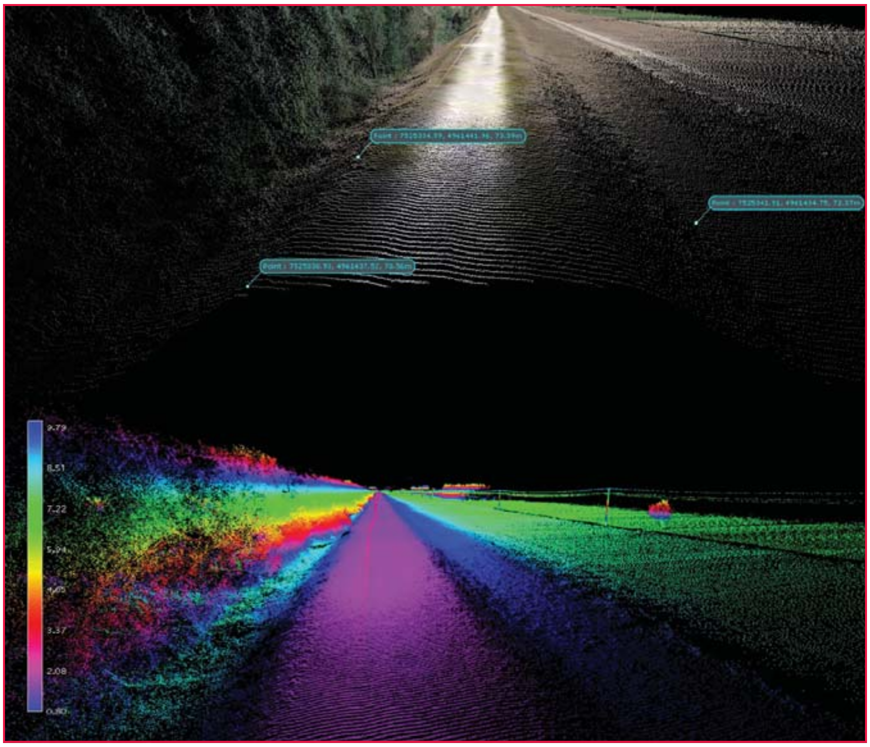

Figure 4: Surveying the river embankment by using mobile laser scanning technology

and photographs make it possible to produce a very precise 3D model [4]. Such a system makes it possible to scan the corridor very quickly (even 60km/h – recommended not higher than 30 km/h) with high precision satisfying various necessities. One of them would also be the canal scanning for the purposes of reconstructing and designing (Damaturu, The State of Yobe, Nigeria) [5].

LIDAR scanning, even with a speed of 350,000 points per second, can scan a large number of points with georeference coordinates. Such a set of points is not suitable to any application in the process of designing, consequently, a data treatment is unavoidable. To generate 3D models with all technical characteristics necessary to all kinds of space analyses and new designing is possible by means of a numerico-graphical data treatment, by using a specialised software. One day of scanning requires about 7 days for data treatment in order to obtain the corresponding formats of graphical presentations suitable to standard designing in space planning, urbanism and other engineering branches [5].

By a computer treatment of the collected cloud of points, it is possible to generate a 3D model and from it the characteristic profiles (Figure 3 and Figure 4). By comparing them to the profiles generated from the existing topographic documentation or to the profiles from the same measurement after a time interval, it is possible to quantify the changes and determine the degree of terrain degradation.

UAV technology in regional and urban planning

Unmanned aerial vehicles (UAV) are of special interest. Their primary use concerns the three-dimensional terrain mapping and they are applied in various domains, among which is geodesy. These devices are light, mobile, completely automated, providing access to even most unavailable terrains. They are simple for use so that, in addition to the mapping, they are also used for various purposes of concept and other kinds of regional and urban planning, and design. It is also important to mention its application in engineering geodesy. Here we explain the procedure of creating a digital terrain model and cadastre-topographic map with the minimal application of the conventional measuring methods; we also present a short specification of the eBee SenseFly (Figure 5). The SenseFly UAV System is exceptionally light, and with a mass of 0.7 kg, it is one of the lightest UAV systems available in the market. The flexible polystyrene construction and the propeller mounted in the rear part of the construction are designed to provide the security of both the system itself and people on the terrain.

The device takes off, flies and lands fully automatically. The vehicle gathers photographs from the air, its range is 1-10 sq km for a single flight and it reaches a precision up to 5 cm (Figure 6). The maximum duration of its flight is 45 minutes which makes it possible to cover even 10 sq km in a single flight. Its 16MP camera produces photographs from the air with a resolution of 3cm per pixel. The images can be used in creating maps and digital elevation models with a precision attaining 5 cm. The reverse-buoyancy technology and innovative terrain sensor make possible landing even in limited areas. SenseFly has built an intuitive software 'eMotion 2' with which one can plan, simulate, track and control the device trajectory, both before the flight and during it. The artificial intelligence built in SenseFly autopilot analyses the data from the inertial measuring unit and GPS

Figure 5: Unmanned aerial vehicle Swinglet CAM (GeoGIS Konsultanti, Beograd 2013)

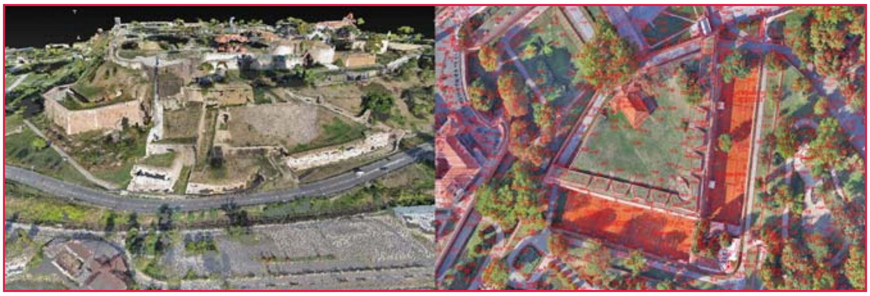

Figure 6: Point cloud (left) and ortho-photo map by using UAV technology overlapped with cadastral data for the location Kalemegdan fortress in Belgrade

incessantly, and takes care about all aspects of the flight mission. The Ebee autopilot saves all data and gathered images of the flight trajectory. These data can be taken by use of a USB. They are directly compatible with the Postflight Terra 3D-EB software. This software offers the possibility of automatic treatment of georeferenced orthomosaics and digital elevation models (DEM) to an accuracy of 5 cm (relative accuracy). The ground control points can be used for the purpose of improving accuracy.

The main problem arising in the treatment of a large number of points (Point Cloud) is the classification. By classifying the terrain points, one can group the points within classes so that it becomes possible to reach a very precise digital terrain model (DTM). In the case of UAV everything is visible, but the problem is due to roofs and roof constructions. On the basis of visible roof constructions, one can obtain information concerning the position of the principal axial points of an object. Where the scanning is performed by using the UAV system only, the characteristic object points must be scanned by applying one of the classical methods or by applying mobile laser scanning; whereas in the case of objects for which the details are scanned by using both systems, it is possible to determine the characteristic points by combining the obtained data.

Conclusion

The application of devices for gathering large bodies of data has become essential in recent times. The technological development of these devices is very rapid. The accuracy of measurements has improved, which is followed by an intense software development concerning data treatment. The conventional manner of the presentation of spatial data in 2D form enriched with information at sea level of certain points (isohypses) is slowly abandoned, and has been replaced by the modern concept of 3D presentation of altitude display of terrain and buildings. Here, in regard to recent experiences, more geometrical and visual information on terrain configuration and artificial buildings have been obtained by manipulating 3D model in suitable software surroundings. For that purpose, UAV technology and the technology of laser scanning of the terrain and buildings are becoming more dominant techniques of mass gathering of spatial information in regard to recent techniques, with great saving in time and money. Modern data-collecting methods can to a high extent quicken and improve the formation quality for 3D topographic frames which are necessary, because the quality of urban planning carried out depends on the quality of geodetic maps. Modern technological procedures of gathering and processing of spatial data enable 3D display of spatial forms (terrains and buildings) in full-color regime. Practically all most-recent geo-information systems have an integrated module for 3D visualization that enables a 3D positioning of the buildings in relative and absolute model, i.e., coordinate system. Many of them have some additional possibilities such as the extraction of building height, flight simulation over the digital terrain model, etc. Engineers of different professions connected with spatial planning shall consider this 3D analysis as extremely useful for regional and urban planning, designing of transport and telecommunications, environment protection, etc.

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Monitoring the changing landscape of Sutlej catchment

The objective of the paper is to assess spatio-temporal changes in landscape in and around hydel-electricity projects of Sutlej catchment in Himachal Pradesh, India

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Background

Himachal Pradesh has been experiencing massive growth in hydel electricity projects during the last two decades or so. It was mainly on account of successive state government's policy and emphasis on harnessing the hydel power potential of the state. As Himachal Pradesh (HP) is a mountainous state, it is home to many famous rivers and provides water to both the Indus and the Ganges basins. The drainage systems of the region are Chandra Bhaga or Chenab, Ravi, Beas, Sutlej and Yamuna. These rivers are perennial and are fed by snow and rainfall. The revised hydro-power potential of the State is estimated to the tune of 27,436 MW (about 25% of the national potential), of which 129 projects with aggregate capacity of about 9442 MW stand commissioned while 72 projects of total capacity of about 3000 MW are at construction stage and remaining at other stages of implementation. The current paper discusses about the Sutlej catchment (Figure – 1), which comprises of about 40 percent of total geographical area (TGA) of the state.

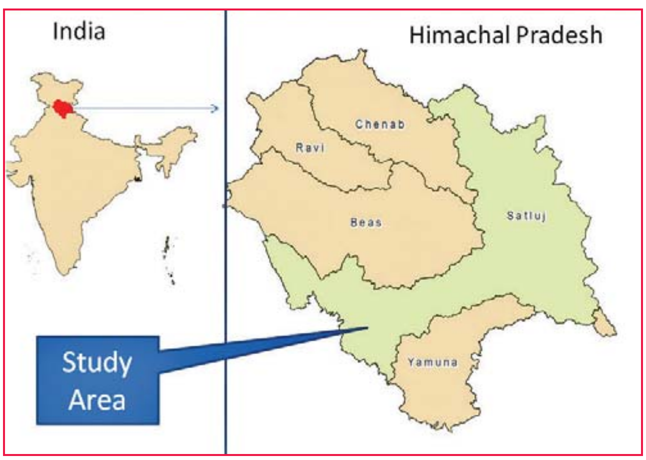


Figure 1: Study Area – Sutlej Catchment in Himachal Pradesh

Landsat satellite data

The long time-series landsat satellite data available (since 1972) in public domain with a good temporal repetition, a ready-to-use format (calibrated), global coverage, free-of-charge availability, possibility to transfer the data over the Internet, etc., make the landsat satellite images the most sought after dataset. After careful examination of the above points, it was decided to use landsat satellite data for this study. Landsat 5 & 7 satellite data (sensors being TM and ETM+), for the years 1989, 1990, 2000 and 2011, were used for the current study.

Normalized difference vegetation index

The Normalized Difference Vegetation Index (NDVI) is a widely used vegetation index in forestry assessment and its management. It is an equation that takes into account that healthy vegetation, which reflects very well in the near-infrared part of the electromagnetic spectrum and strongly absorbs visible light (from 0.4 to 0.7 µm) for use in photosynthesis. Live green plants absorb solar radiation, which they use as a source of energy in the process of photosynthesis. Hence, live green plants appear relatively dark in the red and relatively bright in the near-infrared. By contrast, clouds and snow tend to be rather bright in the red (as well as other visible wavelengths) and quite dark in the near-infrared. All the geospatial analyses were conducted with the help of ArcGIS 10 and Erdas Imagine 9.2 softwares.

Equation of NDVI = (NIR – RED)/NRI+RED)

where RED and NIR stand for the spectral reflectance measurements acquired in the red and near-infrared regions.

It can be seen from its mathematical definition that the NDVI of an area containing a dense vegetation canopy will tend towards positive values (say 0.3 to

0.8), while clouds and snow fields will be characterized by negative values of this index. Other targets on Earth visible from space include free standing water (e.g., lakes and rivers) which have a rather low reflectance in both spectral bands. Thus they result in very low positive or even slightly negative NDVI values. Soils which generally exhibit a near-infrared spectral reflectance somewhat larger than the red, and tend to also generate rather small positive NDVI values (say 0.1 to 0.2).

1. Barren rocks, sand, or snow show very low NDVI values - (-0.1 to 0.1)
2. Shrubs and grasslands or crops – 0.2 to 0.5
3. Dense vegetation or tropical rainforest – 0.6 to 0.9
4. Deep water - 1

Methodology & calibration

The main purpose for applying radiometric corrections is to reduce the influence of errors or inconsistencies in image brightness values that may limit one's ability to interpret or quantitatively process, and analyze digital remotely sensed images. Two radiometric corrections were employed to normalize landsat satellite images for time series inter-comparison. In addition, radiometric properties of the target images were also adjusted/ stretched to match the base layer (i.e., 1989), particularly for the data having very high cloud contamination. The variability between scenes were normalized (i.e., subtraction of illumination differences) by applying the following corrections in the images, which facilitated a better temporal analysis.

It is possible to convert these DNs to ToA Reflectance using a two-step process.

The first step is to convert the DNs to radiance values using the bias and gain values specific to the individual scene. The second step converts the radiance data to ToA (Top of Atmospheric) reflectance.

Calibrated DN to Spectral Radiance Conversion

There are two formulae that can be used to convert DNs to radiance. One method uses the Gain and Bias (or Offset) values from the header file. The longer method uses the *LMIN* and *LMAX* spectral radiance scaling factors. In the current study, the latter (b) was used for spectral radiance calculation based on the metafile of the ortho-corrected datasets.

a) Gain and Bias Method

The formula to convert DN to radiance using gain and bias values is:

$L_\lambda = \text{gain} * DN + bias$

Where:

L_λ = the cell value as radiance;
DN = the cell value digital number;
gain = the gain value for a specific band;
bias = the bias value for a specific band.

Table 1: Solar Spectral Irradiances

Watts/ (meter squared * µm (generated using the Thuillier solar spectrum)		
Band	**Landsat 7 (ETM+)**	**Landsat 5 (TM)**
1	1997	1983
2	1812	1796
3	1533	1536
4	1039	1031
5	230.8	220
7	84.90	83.44
(**Source:** Landsat 7 Science Data Users Handbooks, pp-119 & A Straight Forward Guide for Processing Radiance and Reflectance for EO-1 ALI, Landsat 5 TM, Landsat 7 ETM+, and ASTER)		

b) Spectral Radiance Scaling Method

$L_\lambda = ((LMAX_\lambda - LMIN_\lambda)/(QCALMAX-QCALMIN)) * (QCAL-QCALMIN) + LMIN_\lambda$

Where:

L_λ = spectral radiance at the sensor's aperture;
QCAL = the quantized calibrated pixel value in DN;
$LMIN_\lambda$ = the spectral radiance scaled to QCALMIN in watts/ (meter squared * ster * µm);
$LMAX_\lambda$ = the spectral radiance scaled to QCALMAX in watts/ (meter squared * ster * µm);
QCALMIN = the minimum quantized calibrated pixel value (corresponding to $LMIN_\lambda$) in DN; 1 for LPGS products, 0 for NLAPS products
QCALMAX = the maximum quantized calibrated pixel value; (Corresponding to $LMAX_\lambda$) in DN = 255.
(All above parameters obtained from the scene's .MTL file)

Spectral Radiance to TOA Reflectance Conversion

$P\rho = \pi * L_\lambda * d^2 / ESUN_\lambda * \cos(\vartheta)_S$

Table 2: Earth-Sun Distance in Astronomical Units

Day of Year	Distance	Day of Year	Distance	Day of Year	Distance	Day of Year	Distance	Day of Year	Distance
1	.98331	74	.99446	152	1.01403	227	1.01281	305	.99253
15	.98365	91	.99926	166	1.01577	242	1.00969	319	.98916
32	.98536	106	1.00353	182	1.01667	258	1.00566	335	.98608
46	.98774	121	1.00756	196	1.01646	274	1.00119	349	.98426
60	.99084	135	1.01087	213	1.01497	288	.99718	365	.98333
(**Source:** Landsat 7 Science Data Users Handbook, pp-119)									

Where:

$P\rho$ = unitless TOA or planetary reflectance;

L_λ = spectral radiance at the sensor's aperture (calculated earlier);

d = Earth-Sun distance in astronomical units is derived by taking the Calendar date of the scene and converting it to a Julian date, and then obtaining the distance from Table – 2;

$ESUN_\lambda$ = mean solar exoatmospheric spectral irradiance was obtained from Table-1 for TM and ETM+ sensors separately;

$cos(\vartheta)_S$ = solar zenith angle in degrees (sun elevation from the scene's .MTL file).

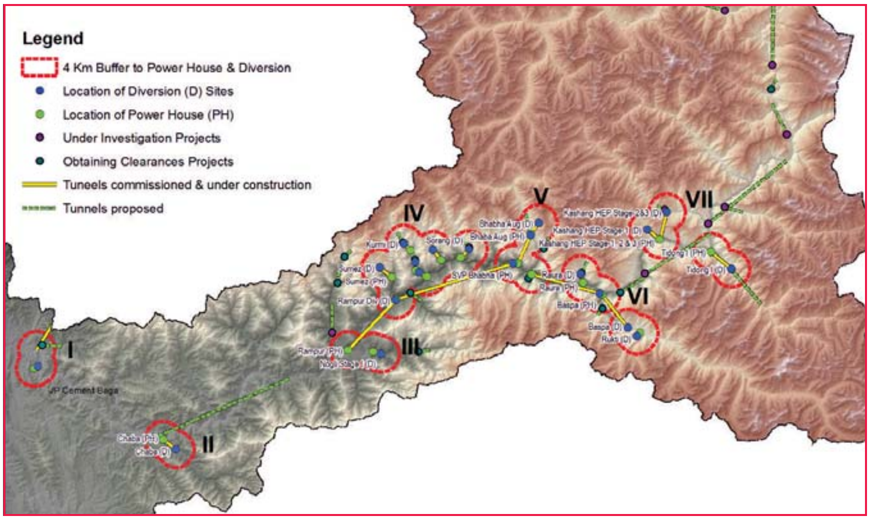


Figure 2: Identified circles for spatio-temporal assessment

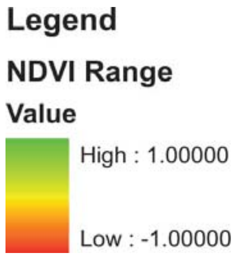
Results and discussion

Since most of the muck dumping sites and major construction activities of hydel power projects were located near to a power house or diversion sites or in between, therefore, assessments around these locations are of utmost importance. Project proponents identify and select their dumping sites near the project components such as tunnels, weir, power house etc. This is to avoid transportation cost and utilize mucks generated from the tunnel excavation in their utility development and access road construction activities. In view of the above, 4 km aerial buffer has been identified around the power house (PH) and diversion (D) sites, which virtually covers many kilometers in terms of surface distance. Red buffers shown in Figure - 2 around the power house and diversion sites depict actual area of spatial-temporal assessment.

Based on the above map, red circles numbered at various locations have been assessed visually in the following time-series NDVI maps, wherein changes in landscape and land cover are depicted. The changes were analyzed based on the base image of 1989 and 1990.

I. Kol Dam (800 MW – under construction and nearing commissioning stage) & Sutlej – Beas Link (990 MW – commissioned)

The Koldam Dam Hydropower Project of the NTPC Limited, is an under construction embankment dam on the Sutlej River near Barmana, Bilaspur District. Due to problems associated with habitat and forest loss, the project has been delayed. Attempts to impound the reservoir first failed in December 2013 due to problems with sealing the diversion tunnels. By 18 March 2014, a fourth attempt to seal the tunnels and fill the lake was underway.



NDVI based on TM image dated 9th October 1989

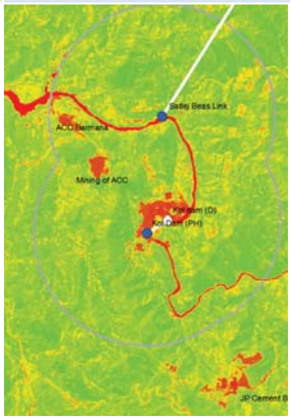
NDVI analysis indicates high positive value (green), thus suggesting the presence of healthy green cover all around.

On the positive side, in areas north to Sutlej near Beas and ACC Barmana, the red/ orange tint seems to diminish in later images indicating emergence of vegetation cover as well.

NDVI based on ETM+ image dated 15th October 2000

NDVI indicates the effects of ACC Barmana and its mining activities which are located in the north-western part of the image. Orange and red colors have gained prominence in the image, thereby indicating decline in vegetation reflectance. The negative value (in orange and red) has further deepened during this period.

NDVI based on TM image dated 22nd October 2011



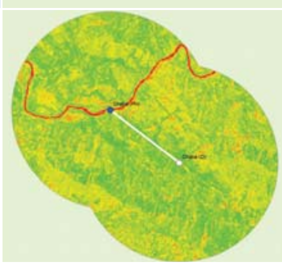
Areas around Koldam have seen tremendous changes in NDVI value than earlier images, indicating a huge change in landuse reflectance. The south-eastern part of the image also indicates the presence of JP Cement at Baga, District Solan, and indicates large land use conversion as well.

II. Chhaba (2 MW – commissioned) & Luhri (775 MW – under investigation)

NDVI based on TM image dated 9th October 1989

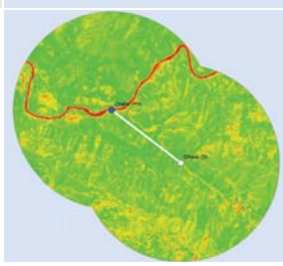
The base image.

NDVI based on ETM+ image dated 15th October 2000)



NDVI mimics the earlier image of 1989. However there are few small changes which may be attributed to developmental activities.

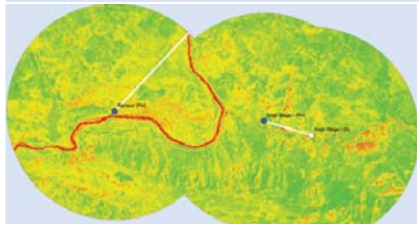
NDVI based on TM image dated 22nd October 2011



Orange color has been consolidated in the image indicating development works expanded in their surroundings.

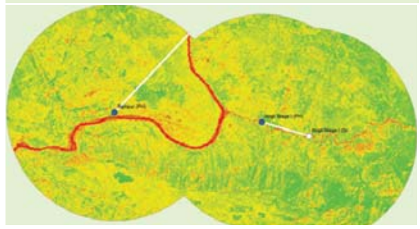
III. Rampur (412 MW – under construction) & Nogli Stage -1 (2.5 MW – Commissioned)

NDVI based on TM image dated 9th October 1989



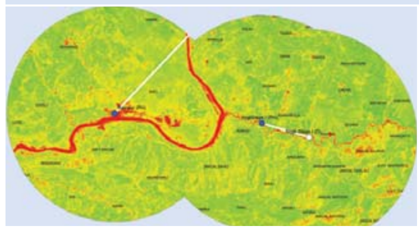
The base image.

NDVI based on ETM+ image dated 15th October 2000)



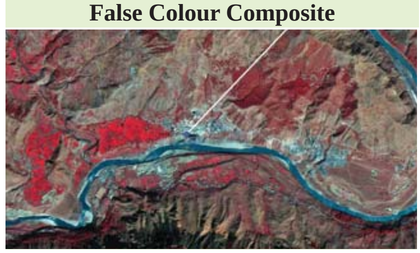
Partial changes are observed along the river Sutlej and its tributary Nogli Khad. Though the Rampur project was not initiated at that stage, the earth works increased around.

NDVI based on TM image dated 22nd October 2011



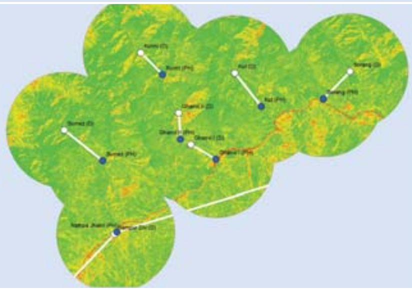
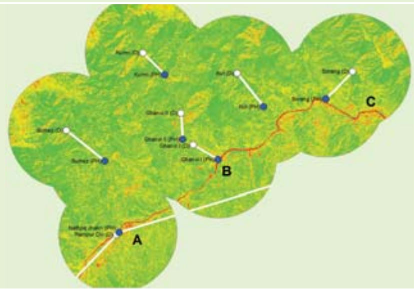
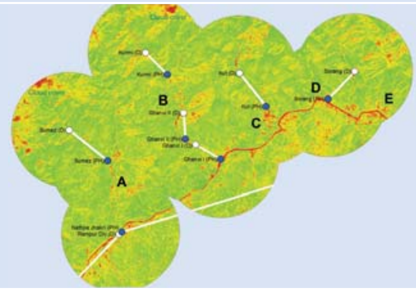
The NDVI Image of 2011 adequately reveals the abundance of construction activities in the northern parts of River Sutlej, which is the location of Rampur power house. Red color indicates a strong negative value, thereby an increase in earth work activities. Slight decline in orange color is also observed in south of Rampur HEP.

False Colour Composite

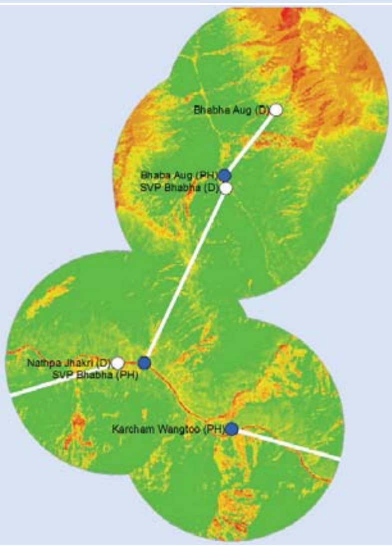
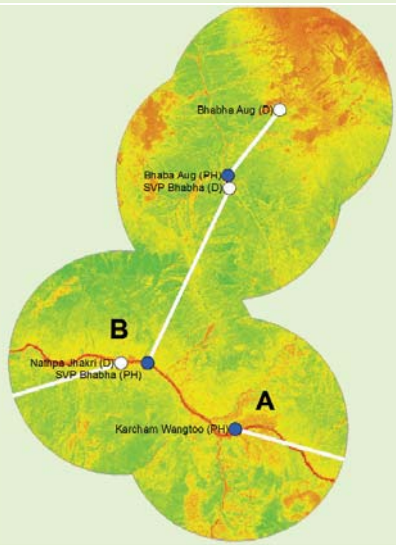
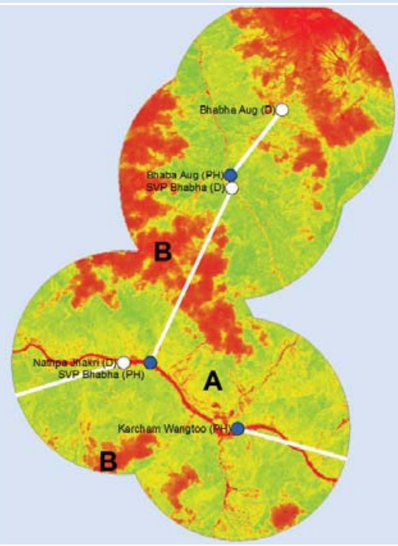


One pan-sharpened image of March 2013 indicates huge ongoing development works in and around Rampur power house area.

IV. Nathpa Jhakri Power house (1500 MW - commissioned), Ramur HEP Diversion (412 MW – under construction) and Sumej Power Project (14 MW Commissioned) Sorang (100 MW – under construction), Ganvi – I (22.5 MW – commissioned) and Ganvi -II (10 MW under construction), Kut (24 MW under construction) and Kurmi (8 MW under construction)

NDVI based on TM image dated 9th October 1989	NDVI based on ETM+ image dated 15th October 2000)	NDVI based on TM image dated 22nd October 2011
		
The image indicates higher greenery all along and human settlements are located in the left bank of the river.	Three major changes in NDVI image are located at A, B and C areas. 'A' is located at Jhakri village, where power house of Nathpa Paower Project is located. 'B' is located near to Ghanvi-I power house, while 'C' is located near the diversion of Nathpa Jhakri and Sorang power projects. The area has witnessed massive changes in reflection of land use and land cover, particularly along the left bank of River Sutlej. Changes took place around villages near Jhakri, Gharola, Sharon, Mangta, etc. Most changes were attributed to the Nathpa Jhakri and its neighboring power projects.	Along River Sutlej, further consolidation of orange and red color indicates the increase in construction activities and non-vegetative reflections, particularly along left bank of the river near Jhakri, Gharola, Sharon and Mangta villages. Major changes are observed near the locations at A, B, C, D & E. Further expansion of residential and utility colonies is observed near villages such as Makola, Bari, Jarind, Jhakri, Kindla, and Gaso.

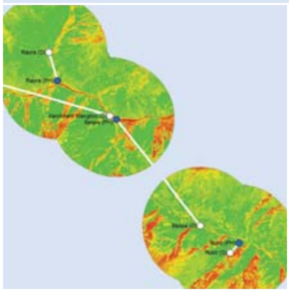
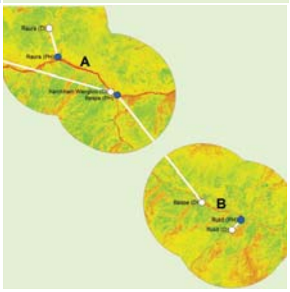
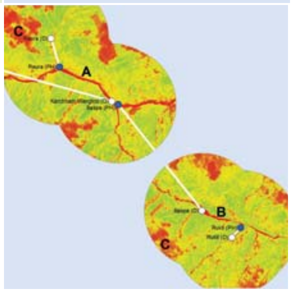
V. Nathpa Jhakri Diversion (800 MW - commissioned) & Karchham Wangtoo Power House (1000 MW - commissioned), SPV Bhaba (120 Commissioned), and Bhaba Aug (4.5 commissioned)

NDVI based on TM image dated 21st October 1990	NDVI based on ETM+ image dated 2nd June 2000.	NDVI based on TM image dated 13th September 2011
		
Dominance of green in the base image.	Orange/ red color is prominant around Nathpa diversion and Karchcham power house, reflecting changes in landuse/ landcover. At locations at A, B & C, effects of Nathpa Jhakri, Karchcham Wangtoo are visible. Upper red dominance is due to cloud contamination and presence of snow-cover.	The image has been histogramatically stretched in the yellow and orange portion. Places shown at 'A' reflects higher changes in landscape, while 'B' is the cloud cover. However, the image witnesses high cloud contamination.

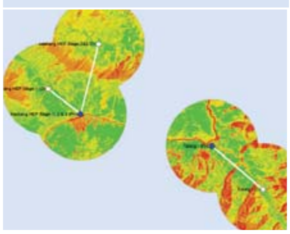
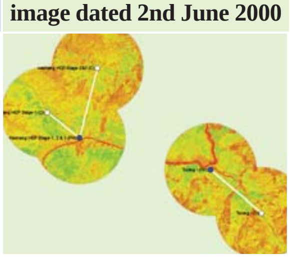
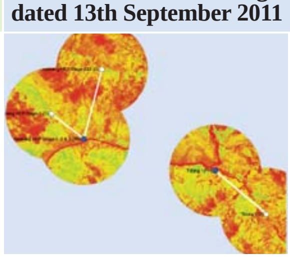
Conclusion

From the above assessment based on multi-temporal vegetation indices (NDVI), it is clear that many areas close to hydel projects did reflect changes in land use and land cover properties. Of them, areas under scrubland or pasturelands have also shown changes, thus activities did take place there as well. Some areas showing positive value in earlier images have shown high negative value indicating large scale changes in landscape. It also indicated that landuse changes were also observed near mining areas of Cement plants (ACC and JP) in addition to hydel projects. It is the river valleys that have thrown more changes than higher reaches. The decade of 2000-2010 has shown greater changes in their landscape than the preceding decade of 1990-2000, clearly indicating the faster pace of development during the last decade. However, some enhancement in green reflection was also observed in many areas indicating new plantation activities as well. The spatio-temporal changes could have been assessed with greater precision at micro-level if the higher spatial resolution of multi-spectral (MS) datasets have been employed, which is the beyond the scope of this paper.

VI. Karchham Wangtoo Diversion (1000 MW - commissioned), Raura (120 MW Commissioned), and Baspa-II (4.5 MW commissioned) and Rukti (1.5 MW commissioned)

NDVI based on TM image dated 21st October 1990	NDVI based on ETM+ image dated 2nd June 2000	NDVI based on TM image dated 13th September 2011
		
NDVI value around power projects seems to have positive value, thus reflecting healthier plantation.	NDVI value diminishes towards negative side near to Karchcham Wangtoo diversion, Baspa power house and near Raura HEP as well.	The image has very high cloud containimation particularly in higher reaches. Though partial landscape change is visible along Rivers Baspa and Sutlej.

VII. Kashang Stage – 1,2&3 (1000 MW – under construction) and Tidong -I (120MW under construction)

NDVI based on TM image dated 21st October 1990	NDVI based on ETM+ image dated 2nd June 2000	NDVI based on TM image dated 13th September 2011
		
Base image.	Partial change is observed in this image.	Cloud cover and snow cover make the analysis difficult in the scene.
The above NDVI does reflect increased uncertainties inherited from their surface reflectance source data in areas where atmospheric correction is affected by adverse conditions such as snow-covered regions, low sun angle conditions, and areas with extensive cloud contamination.		

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Galileo update

Europe launches two satellites in the Galileo constellation

With the launch of Galileo 7 and 8, the EU's Galileo satellite navigation system now has a total eight satellites in orbit. Galileo 7 & 8 lifted off at 21:46 GMT on March 27 from Europe's Spaceport in French Guiana on top of a Soyuz rocket.

All the Soyuz stages performed as planned, with the Fregat upper stage releasing the satellites into their target orbit close to 23 500 km altitude, around 3 hours 48 minutes after liftoff. The launch is designated VS11 in Arianespace's numbering system. Flight VS11's passengers — built by OHB System, with Surrey Satellite Technology Ltd. supplying the navigation payloads — are the third and fourth Full Operational Capability (FOC) satellites in the Galileo program, which is creating a European-operated space-based navigation system.

Following initial checks, run jointly by ESA and France's CNES space agency from the CNES Toulouse centre, the two satellites will be handed over to the Galileo Control Centre in Oberpfaffenhofen, Germany and the Galileo in-orbit testing facility in Redu, Belgium for testing before they are commissioned for operational service. This is expected in mid-year. ESA

ESA successfully corrects sixth Galileo satellite's orbit

The ESA has successfully corrected the orbit of its sixth Galileo satellite following its launch into an elongated orbit in August 2014. It took 14 maneuvers to reposition the probe, which is designed to form part of a new global navigation system on par with existing GPS and Glonass solutions.

The fifth and six Galileo satellites were launched together in August 2014, and are designed to follow the same path on their course around Earth, orbiting on opposite sides of the planet. Due to a malfunction during assent, the two satellites were launched into a lower orbit than intended, with the sixth probe hitting altitudes of between 13,713 km (8,521 miles) and 25,900 km (16,094 miles), bring it into contact with the harmful Van Allen Belt.

The plan to recover the sixth satellite to an operational orbit was devised by the ESA's Galileo team in conjunction with the agency's ESOC operations center, SpaceOpal and the CNES space agency. The operation began in January, taking six weeks and including 14 separate maneuvers. The team worked to slowly raise the lowest point of the orbit by more than 3,500 km (2,175 miles) while making it more circular.

The sixth satellite joins the fifth, the orbit of which also required correction after launch, with 11 adjustments being completed in November 2014. The two probes will now work in tandem, but they'll require significant testing before they can become operational. *ESA*

Satellite data centre to come up at ANU

A Satellite Data Analysis and Application Centre (SDAAC) will be established on the premises of Acharya Nagarjuna University in India. ANU has signed an MoU with the Indian Space Research Organisation (ISRO) to establish the centre. The SDAAC being established will be developed into a research centre dealing with satellite remote sensing technology, to develop expertise in space science research in area of satellite remote sensing, capacity building by starting a M.Tech course in Geo Informatics. *www.thehindu.com*

Drone industry to get an edge in Japan

The government of Japan, a country with a proven track record in electronics and robotics, is looking to fast track industry-friendly regulation to give its drone sector an edge over the United States.

Companies from motorcycle maker Yamaha Motor to security firm Secom Co are readying drone technology and services, as advisers to Prime Minister Shinzo Abe drive a regulatory overhaul The Robot Revolution Realization Committee, an advisory panel appointed by Abe, will review existing radio and civil aeronautics laws and set up industry-run best practice for drones. Another panel is asking companies for ideas on how to open up new special economic zones in Tokyo and other big cities to drones on a test basis.

The only aviation regulations covering drones in Japan require that they fly below 150 meters and at least 9 kms (5.6 miles) away from airports. Drones used in agriculture need two operators, with precautions for the surrounding environment. ©*Thomson Reuters 2015*

KOMPSAT-3A launched

KOMPSAT-3A was recently deployed in space from Yasny Launch Base, Russia. The major goal of the KOMPSAT-3A programme is to obtain imagery for GIS applications related to environment, agriculture, oceanographic studies as well as natural disasters using its 5.5m resolution IR (Infrared) sensor and 0.55m very high resolution EO (Electro-Optical). KOMPSAT-3A has been designed and built by Korea Aerospace Research Institute (KARI)

European Space Imaging to provide 30 cm imagery

European Space Imaging has announced that they would supply 30 cm imagery from the WorldView-3 satellite to European and North African customers. Imagery of this resolution was previously only available from aerial platforms, which are difficult, costly, or impossible to access in many parts of the world. *European Space Imaging*

Exelis to track drones with its new system

Exelis has been working on launching low-altitude surveillance system for drones to aid the authorities in safeguarding the airspace. NASA is working with Exelis and other companies, universities and government agencies, to develop an air traffic management system that could persuade the FAA to allow flights beyond the line of sight, provided the operator is using such a tracking system.

Exelis' products - Symphony UAS-Vue and RangeVue, are significant because it has the exclusive right to use a data feed it already supplies the FAA to track manned aircraft, using 650 ground stations. These stations will augment the feed with lower-altitude data that pinpoint drone locations. Exelis plans to announce the products this soon.

IGN France International Opts for SimActive's Correlator3D™

SimActive Inc has announced the purchase of Correlator3D™ by IGN France International, the international subsidiary of IGN France (French National Institute of Geographic and Forest Information). IGN France International required software for major mapping projects in Africa. *www.ignfi.com*

New satellite for GPS navigation network

Recently, a new GPS satellite was launched to benefit U.S. military operations and civilian society as a whole. The new satellite will be checked out and enter service in a month's time, becoming the ninth Block 2F spacecraft in the constellation. The Boeing-built satellites feature improved accuracy, enhanced anti-jamming and longer design lives. GPS 2F-9 will replace the GPS 2A-22 satellite originally launched aboard Delta 222 on August 30, 1993. *http://spaceflightnow.com*

The Russian-produced ERA-GLONASS emergency call system

"The systems operating in the EEU countries will be harmonized with the European eCall [system] and, eventually, a common road safety space will be created to cover all of Eurasia – everybody is a winner," GLONASS Union Vice President for Strategic Development Evgeniy Belaynko told RIA Novosti.

The ERA-GLONASS system provides data to emergency responders from Glonass. The system calls an emergency service number automatically if the on-board transponder signals an accident. China will train its satellite navigation experts on Russian soil as part of a broader plan to expand cooperation on satellite navigation systems *http://sputniknews.com*

EGNOS Set to Improve Maritime Navigation Safety

The European GNSS Agency (GSA) is looking for *maritime and river authorities interested* in a pilot project to test new, cost-effective ways to increase the safety of vessels without the need to invest in costly new equipment. The project's objective is to demonstrate the added value of transmitting differential corrections and local integrity checks for satellite navigation data using the EGNOS Data Access Service (EDAS) via existing Automatic Identification System (AIS) shore stations. In the future this process will also include the VHF Data Exchange System (VDES). *www.gsa.europa.eu*

European spatial data research and development framework

EuroGeographics and EuroSDR have announced that they will work together to provide a framework for European spatial data research and development. As a result, members of both not-for-profit organisations will be able to take part in joint projects and hand over tasks more appropriate to the other organisation's expertise. Both organizations are committed to supporting wide range of initiatives that will benefit people across Europe. These include the European Spatial Data Infrastructure, Copernicus, Galileo, Horizon2020, European Location Framework and the European Digital Single Market. *www.eurogeographics.org*

Nigel Clifford to be new the new Chief Executive of OS

Business Minister of UK, Matthew Hancock has announced the appointment of Nigel Clifford as the new Chief Executive of the Ordnance Survey (OS).

Ordnance Survey releases mapping tool

A mapping tool that gives a detailed picture of local information in almost every corner of Great Britain has been released by Ordnance Survey (OS). The free data set brings together information about crime, business rates, property types, local transport and geographical information. The OS expects developers and designers to use the tool to improve information people can access via the web. *www.bbc.com*

Printing technology at Survey of India goes digital from offset

Survey of India has recently installed A0 size colour LED Plotters at four offices namely Bhubaneshwar, Dehradun, Ranchi and Shillong. The high speed print on-demand LED plotters will subsequently replace the existing printing system comprising of Offset Press and Computer to Plate Equipment. This LED plotter is more economical in cost per print as compared to offset printing process, which was used by Survey of India since long.

Seoul to digitize N Korean cadastral maps

The S. Korea government is mulling over to digitise over 300,000 cadastral maps of North Korea for permanent storage which it has kept since the division of the peninsula in 1953. The aim is to prevent disputes and confusion over land ownership in the event of reunification. *www.Chosun.co*

Bhutan's geo-portal to be set up by 2017

According to Bhutan's National Land Commission (NLC) secretary, Pema Chewan, 'by 2017, the government will offer access to geospatial data through its geo-portal'. He, however, added that to define who will have access to what level of geospatial data, a data sharing policy is a must..The land commission with technical assistance from the Japan International Corporation Agency (JICA) has already begun the process of gathering data for the seven districts in the southern belt.. *KuenselOnline*

India successfully launches fourth navigation satellite

On March 27, the Indian Space Research Organisation (ISRO) launched its fourth navigational satellite IRNSS-ID from Sriharikota in Andhra Pradesh. The launch makes India move closer to have its own Global Positional System (GPS), on the lines of the one US has. At 5.19, the rocket — Polar Satellite Launch Vehicle (PSLV-C27), 44 metres tall and weighing around 320 tonne — blasted off from the second launch pad at the Satish Dhawan Space Centre. The satellite was injected into the orbit after 21 minutes. Talking about the launch, Kiran Kumar, Chairman, ISRO said, "We have had a successful launch. I congratulate the entire Isro team for the 28th straight successful PSLV mission, which has put the IRNSS-1D, the fourth of the navigation constellation satellite successfully.

IRNSS-1D is the fourth out of seven satellites in the Indian Regional Navigational Satellite System (IRNSS) series after IRNSS-1A, IRNSS-1B and IRNSS-IC. The satellite is one among the seven IRNSS constellation of satellites slated to be launched to provide navigational services to the region.The system would provide two types of services — Standard Positioning Service, which is provided to all users and Restricted Service, which is an encrypted service provided only to authorised users. The satellite will provide navigation, tracking and mapping services.

SuperPad unveils NTRIP Solution for cm level accuracy

Supergeo has released NTRIP solution on its Windows Mobile GIS app, SuperPad, for high accurate field data collection and geospatial workflow enhancement. SuperPad is a feature-rich mobile GIS application for field-based personnel to collect, edit, display and measure spatial data at a reasonable budget.

Rolta and Hitachi India sign MoU

Rolta India and Hitachi India have signed an MoU for jointly addressing significant market opportunities in high-growth business segments in India The companies will work closely together to explore strategic business collaborations for infrastructure systems in large verticals, to offer comprehensive and seamlessly integrated solutions.

Multi-year NGA contract for Intergraph

Intergraph Government Solutions (IGS) has been awarded a five-year contract by the National Geospatial-Intelligence Agency (NGA). The contract provides for the purchase of IGS and Hexagon Geospatial software and related software maintenance.

Burkina Faso updates its base map

In 2011, IGN France International was awarded the project to update the national base map of Burkina Faso. It was funded by the European Union under its 10th European Development Fund. Completed between 2011 and 2015, this project consisted in the creation of 34 topographic maps at a scale of 1.200 000 as well as the updating of the national topographic database. The previous base map had not been updated since the 1950's and did not reflect any longer the changes that have occurred in Burkina in the recent years. *IGN France*

Rwanda unveils its land-use portal

The government of Rwanda has launched its National Land Use Planning Portal (NLUPP) to give its citizens easy access to land-use plans and other spatial data on the web. Built on Esri's ArcGIS platform by the Rwanda Natural Resources Authority with the support of the USAID, NLUPP is the first portal of its kind on the continent of Africa.

Rohde & Schwarz adds ERA GLONASS to its reliable test solution

Rohde & Schwarz recently demonstrated an ERA-GLONASS test setup consisting of the R&S CMW500 wideband radio communication tester and R&S SMBV100A vector signal generator as a GNSS simulator. This setup allows manufacturers and suppliers of automatic in-vehicle systems (IVS) to perform reliable and reproducible preconformance tests on their ERA GLONASS modules in the lab.

In the Russian Federation, ERA-GLONASS works much like the EU's eCall system. When an accident occurs, the IVS connects with a public safety answering point (PSAP) via the local wireless communications network and transmits a standardized minimum set of data (MSD). In addition to GLONASS or GPS coordinates, the MSD also contains additional data with information about the accident vehicle as specified in ERA GLONASS. Rohde & Schwarz developed its R&S CMW-KA095 application software to meet ERA GLONASS requirements in line with Russia's GOST specification.

Based on the R&S CMW-KA094 eCall software, the R&S CMW-KA095 simulates a PSAP and controls the R&S CMW500 emulating a wireless communications network in the lab. The software also controls the GNSS simulator that supplies the coordinates required for vehicle localization. *www.press.rohde-schwarz.com*

Sao Paolo based company chooses ProMark GNSS Receivers

Saneamento Basico do Estado de São Paulo (SABESP), a Brazilian water and sewage collection utility owned by São Paulo state and Latin America's largest water company by market capitalization, has selected Spectra Precision ProMark 120 and 220 GNSS receivers to assist in gathering the geographic location of all SABESP network assets and the location of all customers.

To help improve revenue generation and reduce water loss SABESP developed two projects: LigGeo, to geo-reference the water meter location of approximately 4.8 million SABESP customers; and CadGeo, to geo-reference and register the location of the SABESP water and sewage network infrastructure www.*spectraprecision.com*

Spectra Precision launches FOCUS DL-15 Digital Level

Spectra Precision has launched its new FOCUS DL-15 Digital Level. Its electronic height measurement capability provides the accuracy and range for a wide range of survey and construction tasks. It provides consistent height measurement precision through an electronic reading of a standard bar code staff to an accuracy of 1.5 mm (0.005 feet). It has in-built data storage and offers a distance measurement range of 100 metres (328 feet). *Spectra Precision*

Sub-decimetre accuracy and instant re-convergence solution by Novatel

NovAtel has announced significant performance improvements to its PPP positioning solution. NovAtel CORRECT™ with PPP will now offer the new TerraStar-C correction service as its exclusive source for satellite delivered PPP correction data. TerraStar-C contains an enhanced correction data set which enables up to 4 centimetre accuracy and instant re-convergence when combined with the state-of-the-art receiver error models and positioning algorithms offered by NovAtel CORRECT. This new level of PPP performance is available on NovAtel's OEM6® receivers with firmware version 6.600. *www.novatel.com*

GNSS Software by Credo-Dialogue

The Russian company Credo-Dialogue has released Credo GNSS 1.0, a GNSS processing software. It is designed for processing of satellite geodetic measurements in differential mode. In this mode, the simultaneous operation of two or more receivers forms the baseline. Also in the program, users can view images from web services such as Google Maps, Bing and Express Kosmosnimki.

Fugro introduces G2+ service

Fugro has introduced its high accuracy G2+ service, designed to benefit offshore operators around the globe who require positioning and measurement accuracy at centimeter level. It is an enhancement of Fugro's highly regarded G2 service (based on GPS and GLONASS) and utilizes highly advanced GNSS augmentation algorithms developed in-house. *www.oedigital.com*

Spirent announces enhancements to its GNSS record and playback system

Spirent Communications has announced additional capabilities for its ultra-wideband GSS6425, which enable recording up to 150MHz bandwidth of GNSS signals. Users can now record up to three RF frequency bands at any one time with 10, 30 or 50 MHz bandwidth each1. Other enhancements include ability to record up to four video streams, USB 3.0 support and easy remote control using tablet or smartphone.

A single portable test system, the ultra-wideband GSS6425 allows customers to record GPS L1 and L2 and GLONASS L1 and L2 signals commonly needed for applications requiring very high accuracy such as surveying, precision agriculture, automotive research, and advanced navigation. *www.spirent.com*

Indoor and anti-theft location based positioning solution by KCS TraceMe

KCS BV has extended their successful TraceMe product line with an intelligent location based positioning solution for indoor and anti-theft applications. The solution is based on RF with an intelligent algorithm of measuring the propagation time of transmitted (proprietary protocol) signals.

'Listen before talk' algorithm makes it practically impossible to locate the module which secures the valuable vehicle or asset. Supporting GPRS/SMS and optional 3G, Wifi, Bluetooth LE, ANT/ANT+ and iBeacon provides easy integration with existing wireless networks and mobile apps. *www.trace.me*

New 3D laser scanner of Zoller + Fröhlich

The Z+F IMAGER® 5010X – a new 3D laser scanner by Zoller + Fröhlich, comes with a unique navigation system which works outdoors and indoors too! It will estimate the scanner position and orientation without any external targets in order to enable automatic registration. It also tracks the movements while carrying the device on to the next scanning position. Combining the Z+F IMAGER® 5010X with the newly presented software Z+F LaserControl® Scout, results in a totally new laser scanning workflow, called Blue Workflow, which allows you to register and check scans (completeness, etc.) already in the field – without using any targets.

BeiDou Leap Second issue successfully handled

During the preparation of playback scenarios for the upcoming leap second event this year, engineers at Racelogic identified a potential pitfall for GNSS engineers. The difficulty arises from the fact that BeiDou uses a different 'day number' for the date to apply the leap second compared with GPS and Galileo. GPS and Galileo use 1-7 as week day numbers, and BeiDou uses

0-6. If this fact has been missed during development, then the result is that the leap second may be implemented a day early on GNSS engines which are tracking the BeiDou constellation.

Indeed, four different Beidou enabled receivers, from four leading GNSS companies have been tested, and none of them appeared to handle the Beidou leap second correctly. This included an engine which originates from China!

Racelogic has since been in contact with two of these companies who have confirmed that their hardware does have a bug in the leap second code due to the numbering of the days. The error presents itself when the receiver is running on the BeiDou constellation alone, and when the date is the 29th of June this year. In some cases, the BeiDou leap second will be adjusted from 2s to 3s from midnight on the 29th June, which should in fact occur on midnight of the 30th. This will result in an error for the reported UTC time of 1s for the period of this day. In other cases, the leap second was not implemented at all when running on Beidou alone.

In order to help companies test for this problem, simulated RF data have been generated for the 29th and 30th of June, starting 15 minutes before midnight. Racelogic has two sets of files, one set contains Bediou only signals and the other contains a combination of BeiDou and GPS signals. Note that on some of the receivers that have been tested, when GPS is being tracked as well, the GPS leap second message overrides the one coming from Beidou and applies the leap second correctly. These scenarios are compatible with the LabSat3 triple constellation simulator, which is available on a free 15 day loan or can be purchased from Racelogic. *www.labsat.co.uk*

Trimble VRS Now available in Australia

Trimble together with its distribution partner Ultimate Positioning Group (UPG), announced the availability of Trimble® VRS Now™ correction service in Queensland, New South Wales, South Australia, Tasmania and Victoria. The commercial subscription service provides surveyors, civil engineers, geospatial professionals and other industry specialists in these areas with instant access to RTK GNSS corrections without the need for a base station. *www.trimble.com*

Mobile Builder for Forestry by Trimble

Mobile Builder is a new platform that enables forestry clients to quickly create and deploy customized forms to field workers. The solution provides companies a cost-effective method for field personnel to access enterprise data, update data in the field and synchronize the data back to the office in real time on iOS, Android and Windows Embedded mobile devices.

It enables to mobilize existing workflows while retaining business rules already in place.

Microsemi Integrated GNSS Master solution

Microsemi has announced its Integrated GNSS Master (IGM) solution for small cell synchronization. The IGM is the company's first solution that fully integrates a 1588v2 PTP grandmaster with a GNSS receiver and antenna in a small, fully-contained package, designed to mount indoors. It solves the often documented challenge of indoor synchronization which has been a significant hurdle for cost-effective small cell indoor deployments in the past. *www.electropages.com*

Inertial Positioning to Reduce Power Consumption in GPS Watches

Invensense offers inertial navigation software that calculates the position of the device based on its movements between two GPS fixes. Therefore GPS does not need to run continuously.

This can expand the battery life from two to five times. This inertial positioning system was developed by Trusted positioning, Calgary, Canada, bought by Invensense last summer. *www.gpsbusinessnews.com*

Leica News

Nova MS50

The Leica Nova MS50 combines every significant measuring technology in one device and opens the doors to a fascinating new dimension of the geospatial world. All functions, including precision 3D scanning, extensive and precise total station capabilities, digital imagery and GNSS connectivity are now brought together in the Leica Nova MultiStation.

Viva GS14

The Leica Viva GS14 is the most compact and powerful GNSS receiver and easy to use. Together with the leading GNSS RTK the Leica Viva GS14 meets the highest standards for measurement technology.

ScanStation P20

Leica ScanStation P20 also brings data quality at range (120m, max), plus outstanding environmental capabilities, survey-grade tilt compensation, and an industry first "Check & Adjust" capability. Friendly touch screen or remote operation, plus a compact design make it easy-to-use.

Esri and RouteSmart Help Postal Carriers Reduce Operating Costs

Esri and RouteSmart Technologies, Inc., are collaborating to help postal organizations deliver packages reliably, efficiently, and accurately. The companies provide comprehensive dynamic routing solutions based on Esri's ArcGIS platform. National postal and global and regional parcel delivery services, including Whistl, Posti, and Swiss Post, are among the customers that leverage these routing solutions. Most customers have experienced cost savings of 15 percent, on average, through reduced working hours, mileage, and new vehicle acquisition.

MARK YOUR CALENDAR

May 2015

AUVSI's Unmanned Systems 2015
4-7 May
Atlanta, USA
http://www.auvsi.org/

ASPRS 2015 Annual Conference
4 - 8 May
Tampa, Florida, USA
http://conferences.asprs.org/Tampa-2015

RIEGL LiDAR 2015 Conferences
5 – 8 May
Hong Kong and Guangzhou, China
www.riegllidar.com/

MundoGeo Connect
May 5 to 7, 2015
Sao Paulo - Brazil
http://mundogeoconnect.com/2015/en/

Baska GNSS Conference 2015
10 - 12 May
Baska, Krk Island, Croatia
www.baskagnssconference.org

10th National GIS Synposium in Saudi Arabia
11 - 14 May
Dammam, Saudi Arabia
www.saudigis.org

6th China Satellite Navigation Conference
13 - 15 May
Xi'an, China
www.beidou.org

FIG Working Week and General Assembly
17 – 21 May
Sofia, Bulgaria
www.fig.net

UN/Russian Federation Workshop on the Applications of GNSS,
18 - 22 May 2015
Krasnoyarsk, Russian Federation

GEO Business 2015
27 - 28 May
London, UK
http://geobusinessshow.com/

June 2015

HxGN LIVE Las Vegas 2015
1 – 4 June
Las Vegas, Nevada USA
http://hxgnlive.com/las.htm

Bentley CONNECTION Event
9th - 10th June
Chennai, India
http://connection.bentley.com

TransNav 2015
17 - 19 June
Gdynia, Poland
http://transnav2015.am.gdynia.pl

July 2015

IGNSS 2015
14-16 July
Queensland, Australia
www.ignss.org

13th South East Asian Survey Congress
28 – 31 July, Singapore
www.seasc2015.org.sg

August 2015

The Fifth Session of the UN-GGIM
3-7 August
United Nations Headquarters,
New York, USA
http://ggim.un.org

UAV-g 2015
30 August - 2 September
Toronto, Canada
www.uav-g-2015.ca

September 2015

ION GNSS+
14-18 September
Tampa, Florida, USA
www.ion.org

INTERGEO 2015
15 – 17 September
Stuttgart, Germany
www.intergeo.de/intergeo-en/

October 2015

Commercial UAV Expo
5 - 7 October
Las Vegas, Nevada, USA
www.expouav.com

DIGITAL EARTH 2015
October 5-9
Halifax, Canada
www.digitalearth2015.ca

20th UN Regional Cartographic Conference for Asia and the Pacific
5-9 October
Jeju Island, Republic of Korea
http://unstats.un.org/unsd/geoinfo/RCC/

Intelligent Transportation Systems: 22nd ITS World Congress
5 - 9 October
Bordeaux, France
http://itsworldcongress.com

36th Asian Conference on Remote Sensing
19 - 23 October
Manila, Philippines
www.acrs2015.org

2015 IAIN World Congress
20 – 23 October
Prague, Czech Republic
www.iain2015.org

Joint International Geoinformation Conference
28 - 30 October
Kuala Lumpur, Malaysia
www.geoinfo.utm.my/jointgeoinfo2015/index.html

November 2015

ISGNSS 2015
16 - 19 November
Kyoto, Japan
http://www.isgnss2015.org/