

International Workshop on Modern Land Administration and Urban Data Analytics



International Symposium and Workshops

A SMART SUSTAINABLE FUTURE FOR ALL

Enhancing Resilience in a Changing Landscape

MELBOURNE, AUSTRALIA | 24 - 26 SEPTEMBER 2018

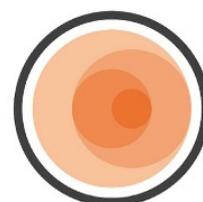
Conducted by

Centre for Spatial Data Infrastructures and Land Administration
The University of Melbourne, Australia

MELBOURNE | 24 SEPTEMBER 2018



THE UNIVERSITY OF
MELBOURNE



CSDILA

THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURES
& LAND ADMINISTRATION



Overview

Land and urban information systems provide the infrastructure to support determining, recording and disseminating data and analytics about land, buildings and properties in urban areas. Rapid urbanisation has resulted in an unprecedented pressure on development of land in cities around the world, triggering increased densification and demand for urban infrastructure facilities. Modern land and urban data management solutions are required to transform the physical and functional complexities of cities into 3D digital data environments (3D digital cadastre, Building Information Modelling or BIM and 3D city models). The growth in complex and high-rise urban structures poses new challenges for current 2D-based and fragmented land and urban information systems. The consequences of using 2D concepts for volumetric urban spaces that require definition in three dimensions (3D) can be summarised as:

- Abstract 2D version of reality can only be unambiguously clarified by the surveyor who produced the original drawings.
- Representation of complex vertical developments are provided using planar views and cross-sections, which are difficult to understand.
- Adequate representation of the legal extent of properties in complex buildings requires multiple pages of 2D subdivision plans, which are pushing the boundaries of representative and cognitive efficiency.
- Complex 3D spatial arrangements are not adequately visualised in land and property maps, or not visualised at all.
- Current land registration systems use a range of technical methods to register 3D property rights, where technical ambiguities leave open potential threats to security of tenure.
- Lack of adequate processes developed to support the definition of 3D digital land and property information.
- Fragmented data sources and data heterogeneity are the most challenging problems in urban data analytics.

To address these challenges, land and urban management agencies have been supporting research and practice for 3D digital management of land and urban information within complex city environments. In line with the need for an enhanced digital data infrastructure for managing land and spatial information, the Centre for Spatial Data Infrastructures and Land Administration (CSDILA) initiated and successfully completed several projects, in the context of modern land administration and urban data analytics infrastructure, to provide an innovative digital infrastructure for spatially enabled decision making.

Aim

The aim of this workshop is to provide training on development of digital data infrastructures to enable the integration, harmonisation, connectivity and scalability of multi-dimensional land information and urban datasets. This infrastructure is required to underpin the next generation of data-driven modelling and decision-support tools to enable the design of smart, productive and resilient cities. It would then be applied to data relevant to people, land and urban infrastructure to support comparative and multi-dimensional analytics.

The overall structure of the workshop is shown in Figure 1.

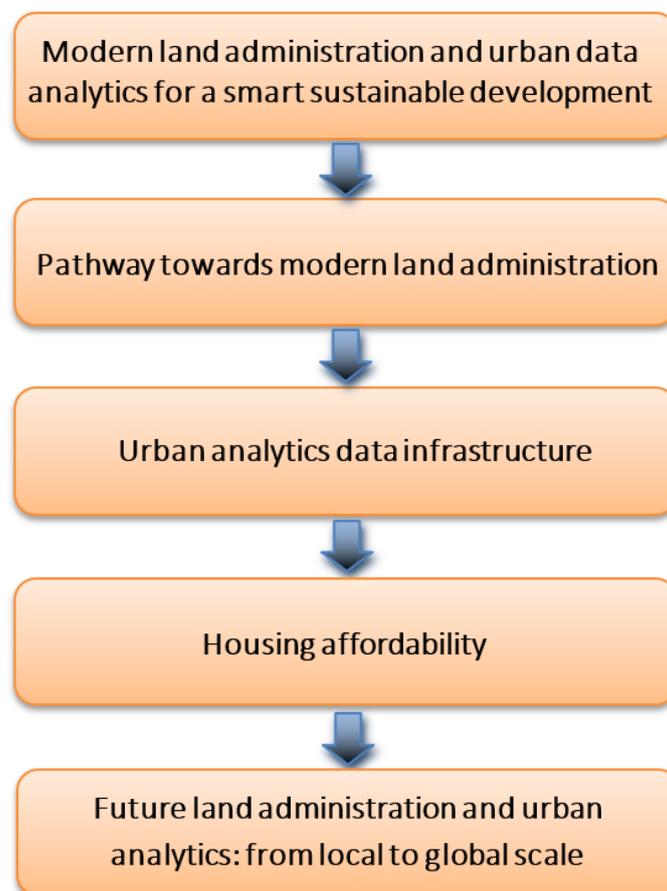


Figure 1, Workshop structure



Program

This workshop includes 4 sessions describing new components in modern land administration and urban data analytics. The current research and practice in digitising and modernising land administration processes is presented. New dimensions of urban analytics data infrastructure and housing affordability are also covered in this workshop. These will underpin the development of future land administration and urban analytics from a local level to an international scope.

Session 1: Introduction and Setting the Scene (9 am – 10:15 am)	
Topic	Presenter
Modern land administration and urban data analytics: new components and dimensions	Prof Abbas Rajabifard
Modern land administration for a smart sustainable development	Prof Ian Williamson
A roadmap from 2D to 3D land information infrastructure	Dr Mohsen Kalantari
From 2D to 3D: thinking about 3D-enabled land administration as an emerging Technological Innovation System	Dr Serene Ho
Morning Tea (10:15 am – 10:40 am)	
Session 2: Modern Land Administration & ePlan (10:40 am – 12:00 pm)	
Spatial data acquisition for modern land administration – an overview of sensing technologies and methodologies	Dr Kourosh Khoshelham
BIM-driven modern land administration	Dr Behnam Atazadeh
An overview of the Victorian ePlan journey	Mr Mark Briffa Dr Hamed Olfat Dr Davood Shojaei
Lunch (12:00 pm – 01:00 pm)	
Session 3: Urban Analytics Data Infrastructure & Housing Affordability (1:00 pm – 01:45 pm)	
Urban analytics data infrastructure, the new generation of SDIs	Dr Soheil Sabri
Three-dimensional (3D) analytics platform for smart liveable city planning in singapore	Dr Yiqun Chen
Urban analytics infrastructure for assessing housing affordability	Dr Muyiwa Agunbiade
Session 4: Discussion and Final Remarks (1:45 pm – 02:45 pm)	
Panel discussion Future land administration and urban analytics: from local to global scale	Mr Greg Scott Dr Mika-Petteri Törhönen Mr Craig Sandy Mr Brian Marwick Mr Tom Champion Prof Ian Williamson
Final remarks and key messages	Prof Abbas Rajabifard
Afternoon Tea (2:45 pm – 3:00 pm)	



Session One

Introduction



Topic

Modern land administration and urban data analytics: new components and dimensions

Overview

There is no comprehensive and holistic approach in advancing knowledge to support a move towards modern land administration and urban data analytics, which addresses the problem of modelling, integrating, managing and connecting multiple dimensions of urban spaces in our rapidly growing built environments.

As we move towards a digital government with broader digital economy agendas, there is a requirement for an integrated land information and urban data analytics systems that can support this digital world to consistently model and visualise the 3D complexity of the real-world. There is a need to cater for temporal change in land related rights, restrictions and responsibilities, and a flexibility to meet user needs that constantly change over time. An integrated, 3D digital, harmonised land and urban information system must be accurate, consistent, correct, complete, current and unambiguous. It must support the searching and retrieval of rich 3D digital data, the automated validation of 3D digital data and the use of 3D data, but only where it is needed.

This presentation provides an overview new components and dimensions in modernising land information and urban analytics that can be maintained and delivered to a broader community of stakeholders.

Intended Learning Outcomes

- To understand the critical need for a modern land and urban information infrastructure to deliver harmonized, interoperable data environments and support integrated design, planning and management of cities
- To describe the desired capabilities of modern land administration and urban data analytics infrastructure

References

- Rajabifard, A., Atazadeh, B., & Kalantari, M. (2018). A critical evaluation of 3D spatial information models for managing legal arrangements of multi-owned developments in Victoria, Australia. *International Journal of Geographical Information Science*, 32(10), 2098-2122.
- Rajabifard, A., Ho, S. and Sabri, S. (2016) 'Urban Analytics Data Infrastructure: Critical SDI for Urban Management in Australia', in Coleman, D. J., Rajabifard, A., and Cromptoets, J. (eds) *Spatial Enablement in a Smart World*. Gilberville, UAS: GSDI ASSOCIATION PRESS, pp. 95-109.



Topic

Modern land administration for a smart sustainable development

Overview

Land, in a modern sense, includes resources and buildings as well as the marine environment – essentially, the land itself and all things on it, attached to it, or under the surface. The cornerstone of a modern land administration system is the land management paradigm in which land tenure, value, use, and development are considered holistically as essential and omnipresent functions performed by organised societies. The underpinning role of a land administration system in delivery of smart sustainable development relies on using the land management paradigm to guide the selection of appropriate tools, such as 3D digital cadastre, for managing land and property. Modern land administration systems rely on well-built, technically designed digital cadastres, which are unique for each jurisdiction.

This presentation provides major dimensions pertinent to the development, implementation, and use of land administration systems in the global context of the smart sustainable development. It reviews the land administration journey with a focus on the role that land administration can play in smart sustainable development and in supporting a spatially enabled society. It recognizes the inherent dynamism of land administration and the importance of planning its future directions

Intended Learning Outcomes

- To understand grand challenges in a modern land administration system
- To explain the underpinning role of modern land administration systems in achieving a smart sustainable future for all

References

- Williamson, I., Enemark, S., Wallace, J., & Rajabifard, A. (2010). Land administration for sustainable development. Redlands, CA: ESRI Press Academic.
- Williamson, I., and Jude Wallace. (2007) "New roles of land administration systems."
- Williamson, I., Rajabifard, A., Wallace, J., & Bennett, R. (2011). Spatially enabled society.



Topic

A roadmap from 2D to 3D land information infrastructure

Overview

Current 2D approaches in land administration are not adequate for the growing number of high-rise and complex infrastructures. High-rise developments demand a paradigm shift so the complexities they possess in terms of entitlements of people in the 3rd dimension of height can be managed in a modern land administration system. This paradigm shift requires a holistic study on the nature of the high-rise developments in realising 3D land information infrastructure, including both institutional and technical aspects.

This presentation aims to discuss a roadmap for upgrading current 2D land administration systems into 3D digital environments, including important factors that can be used by land administration organisations when adopting 3D cadastres. These factors include consideration of organisational motivation, institutional arrangements, information interpretation, information organisation, involvement in the land governance and capacity building.

Intended Learning Outcomes

- To describe 3D cadastral system components
- To apply a system approach in implementing 3D Cadastres

References

- Kalantari, M. and Rajabifard, A., 2014, November. A roadmap to accomplish 3D cadastres. In Proceedings of the 4th International Workshop on 3D Cadastres.
- Kalantari, M., and Rajabifard, A. Williamson, A., Atazadeh B. 2017. 3D Property Ownership Map Base for Smart Urban Land Administration.



Topic

From 2D to 3D - thinking about 3D-enabled land administration as an emerging technological innovation system

Overview

Innovation drives economic growth but the ability to derive value is largely determined by the institutional environment in which the innovation occurs. This infers the need to consider and analyse the strengths and weaknesses of this environment not only for enabling adoption, but importantly, scaling of innovation.

We know that investing in 3D-enabled land administration systems (3DLAS) generates significant public value and the question is no longer if but how we realise change. This presentation invites participants to think about 3DLAS as an emerging Technological Innovation System (TIS). This draws attention to structural conditions created by institutions, organisations, networks and technologies, and how these function to impact on innovation, specifically around technologies. Whether you are thinking of, or in the process of transitioning from a 2D to 3D paradigm for your LAS, this change necessarily implies a reconfiguration of the TIS, in particular, the institutional component.

This presentation overviews the TIS approach and applies this to empirical examples to demonstrate how a systemic perspective provides a useful heuristic for practitioners to evaluate their respective TIS. This cultivates awareness of external factors impacting on the development, adoption, implementation and scaling of specific technologies, which enables the identification of intervention strategies for sustainable socio-technical change to realise 3DLAS.

Intended Learning Outcomes

- Understand the implications of the institutional environment on enabling 3D LAS
- Gain a basic understanding of how to apply the TIS framework for evaluating the institutional environment to identify potential areas for targeting change strategies

References

- Ho, S.; Cromptvoets, J.; Stoter, J. 3D Geo-Information Innovation in Europe's Public Mapping Agencies: A Public Value Perspective. *Land*. 2018.
- Carlsson, B.; Stankiewicz, R. On the Nature, Function and Composition of Technological Systems. *J. Evol. Econ.* 1991, 1 (2), 93–118.
- Hekkert, M. P.; Suurs, R. A. A.; Negro, S. O.; Kuhlmann, S.; Smits, R. E. H. M. Functions of Innovation Systems: A New Approach for Analysing Technological Change. *Technol. Forecast. Soc. Change* 2007, 74 (4), 413–432.
- Wieczorek, A. J.; Hekkert, M. P. Systemic Instruments for Systemic Innovation Problems: A Framework for Policy Makers and Innovation Scholars. *Sci. Public Policy* 2012, 39 (1), 74–87.

Modern Land Administration and Urban Data Analytics

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Session Two

Modern Land Administration & ePlan



Topic

Spatial data acquisition for modern land administration – an overview of sensing technologies and methodologies

Overview

This study provides an overview of the main technologies for 3D spatial data acquisition in urban areas, namely photogrammetry, LIDAR, and handheld SLAM (simultaneous localisation and mapping) sensors. The presentation discusses basic data processing and visualisation methods and provide a comparative evaluation of the methods in terms of coverage, accuracy, and efficiency.

This component considers the potential implementation of photogrammetry, laser scanning, mobile mapping as sources of 3D spatial data. A framework is suggested to outline the requirements of 3D data sourcing for land parcel and building information in the land and urban development process.

Intended Learning Outcomes

- Describe the main principles of photogrammetry, lidar, and SLAM;
- Select suitable visualisation methods to highlight certain features of the data;
- Compare different data acquisition methods in terms of coverage, accuracy, and efficiency.

References

- Wehr, A. and U. Lohr, Airborne laser scanning – an introduction and overview. *ISPRS Journal of Photogrammetry and Remote Sensing*, 1999. 54(1999): p. 68-82.
- Furukawa, Y. and J. Ponce, Accurate, Dense, and Robust Multiview Stereopsis. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2010. 32(8): p. 1362-1376.
- Bosse, M., R. Zlot, and P. Flick, Zebedee: Design of a Spring-Mounted 3-D Range Sensor with Application to Mobile Mapping. *IEEE Transactions on Robotics*, 2012. 28(5): p. 1104-1119.



Topic

BIM-driven modern land administration

Overview

In this study, the feasibility of a widely used modern approach in the architecture and construction industry – Building Information Modelling (BIM) – was investigated for 3D-enabled land administration in multi-storey developments. BIM provides a common and 3D digital data sharing space, underpinning a reliable basis for facilitating collaboration and decision making over the lifecycle of buildings. However, legal attributes and spatial structure of legal arrangements inside and around buildings are yet to be accommodated within the BIM data environment.

An extension to the BIM standard is proposed and a prototype BIM model of a complex building is implemented to showcase the potential capability of BIM for modern land administration in multi-storey buildings. The proposed extension of BIM standard demonstrated how legal information could be logically embedded in this standard and the implemented prototype model showcased the potential benefits of BIM for modern land administration. Conversely, encapsulating legal information into the BIM standard could potentially support those stakeholders who are already using BIM by providing richer information about ownership of properties which is fundamental to modern management of buildings.

Intended Learning Outcomes

- Understand management and communication challenges in current land administration practices for complex built environments
- Describe the potential benefits of a BIM-driven land administration system for broader community of stakeholders

References

- Atazadeh B., Kalantari M., Rajabifard A., Ho S. (2017) Modelling building ownership boundaries within BIM environment: a case study in Victoria, Australia. *Computers, Environment and Urban Systems*, Volume 61, Part A, January 2017, Pages 24–38
- Atazadeh B., Kalantari M., Rajabifard A., Ho S., Champion T. (2017), Extending a BIM-based data model to support 3D digital management of complex ownership spaces. *International Journal of Geographical Information Science*.
- Atazadeh B., Kalantari M., Rajabifard A., Ho S., Ngo T. (2017) Building information modelling for high-rise land administration. *Transactions in GIS*.
- Atazadeh B., Rajabifard A., Kalantari M. (2017), Assessing performance of three BIM-based views of buildings for communication and management of vertically stratified legal interests, *ISPRS International Journal of Geo-Information - Open Access Journal*



Topic

An overview of the Victorian ePlan journey

Overview

This study aims to discuss the Victorian land administration system modernisation program. It first reviews the cadastral data transition from paper to digital. Then, it discusses the concepts, benefits and progress of the ePlan project aiming at replacing paper and PDF cadastral plans with an intelligent digital file (ePlan). Next, it reviews the ePlan cycle including 'ePlan preparation', 'validation', 'visualisation', 'visualisation enhancement', 'storage' and 'digital data download' steps.

The presentation continues with an overview of the 3D digital cadastre investigation progress in Victoria. The outcomes of the 3D data modelling, validation and visualisation studies will be presented. In addition, a 3D digital cadastre prototype system will be demonstrated. The presentation concludes with a brief overview of the Victorian 3D digital cadastre roadmap development progress to-date.

Intended Learning Outcomes

- Understanding the Victorian land administration modernisation program
- Understanding the progress of 2D and 3D digital cadastre in Victoria

References

- Olfat, H., Shojaei, D., Briffa, M., Maley, S. and Rajabifard, A. (2018). Strategic Actions for Increasing the Submission of Digital Cadastral Data by the Surveying Industry Based on Lessons Learned from Victoria, Australia. *ISPRS International Journal of Geo-Information*, 7(2).
- Shojaei, D., Olfat, H., Faundez, S., Kalantari, M., Rajabifard, A. and Briffa, M. (2017). Geometrical data validation in 3D digital cadastre – A case study for Victoria, Australia. *Land Use Policy Journal*, 66, pp. 638–648.
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- Shojaei, D., Olfat, H., Briffa, M. and Rajabifard, A. (2017). 3D Digital Cadastre Journey in Victoria, Australia. WG IV/1, WG IV/5 & WG IV/10 12th 3D Geoinfo Conference 2017 (Volume IV-4/W5) 26–27 October 2017, Melbourne, Australia.
- Olfat, H., Shojaei, D. and Briffa, M. (2016). The Victorian Digital Cadastre: Challenges and Investigations, Proc. of the 3rd Annual Conference of Research@Locate, Melbourne, Australia, 47-52.



Session Three

Urban Analytics Data Infrastructure & Housing Affordability



Topic

Urban analytics data infrastructure, the new generation of SDIs

Overview

Data heterogeneity is one of the most challenging problems in urban data analytics. When obtained from various providers or custodians, datasets for the same domain themes may dramatically differ in formats due to many reasons such as historical legacies, changing definitions or standards across jurisdictions etc. It hinders urban analysts and researchers from understanding and using these data and makes results comparison and interpretation obscure. Ontology, usually created by domain experts, offers a comprehensive representation of knowledge including concepts, relations and properties in a domain. It defines the real world in abstract and offers a universal and stable schema for data harmonisation.

This presentation proposes a fast, extensible solution for eliminating data heterogeneity by using ontology. Starting from conceptualising domain knowledge to domain ontology, we discuss a two-level mapping mechanism which bonds the nexus between data and ontology using mapping rules. A semantic translation engine is also introduced to automate the data harmonisation process. A real case - urban density indicators computation - also demonstrates the usability of the proposed framework and the results show strong potentials for applying this method to broader urban analytics application scenarios.

Intended Learning Outcomes

- Understanding the role of ontology in harmonising spatial data and a snapshot of the methods and tools for ontology development.
- Understanding how the ontology framework can improve the capabilities of Spatial Data Infrastructures in harmonising spatial data and analysis across multi-jurisdictions

References

- Chen, Y. et al. (2018) 'An ontology-based spatial data harmonisation for urban analytics', *Computers, Environment and Urban Systems*. doi: 10.1016/j.compenurbysys.2018.06.009.
- Rajabifard, A., Ho, S. and Sabri, S. (2016) 'Urban Analytics Data Infrastructure: Critical SDI for Urban Management in Australia', in Coleman, D. J., Rajabifard, A., and Cromptoets, J. (eds) *Spatial Enablement in a Smart World*. Gilberville, UAS: GSDI ASSOCIATION PRESS, pp. 95–109.
- Sabri, S. et al. (2015) 'Alternative Planning and Land Administration for Future Smart Cities', *IEEE T&S*, December, pp. 33–36. doi: 10.1109/MTS.2015.2494298.
- Sun, Y. et al. (2017) 'A flexible accessibility analysis tool for enhanced urban analytics', in *Australasian Transport Research Forum 2017 Proceedings*. Auckland, New Zealand: Australasian Transport Research Forum, pp. 1–7.



Topic

Three-dimensional (3D) Analytics Platform for Smart Liveable City Planning in Singapore

Overview

This joint research project, with a collaboration of the Urban Redevelopment Authority (URA), Singapore Land Authority (SLA), National Environment Agency (NEA), Singapore, the University of Melbourne's Centre for Spatial Data Infrastructures and Land Administration (CSDILA) and Centre for Disaster Management and Public Safety (CDMPS), aims to develop a prototype of 3D data analysis, visualisation and integration platform to support modelling and simulation requirements for urban planning in Singapore by adopting open standards and open-source solutions.

Intended Learning Outcomes

- The architecture design of a comprehensive and scalable 3D urban analytics platform built upon open-source tools, libraries and projects.
- The capabilities of integrating, visualising, and interacting 3D models (i.e., IFC BIM and CityGML) with geospatial datasets (i.e., vector, raster) on one platform reveal the power of multi-granularity urban analyses.

References

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- Chen, Y., Sabri, S., Rajabifard, A., & Agunbiade, M. E. (2018). An ontology-based spatial data harmonisation for urban analytics. *Computers, Environment and Urban Systems*, 72, 177–190. <https://doi-org.ezp.lib.unimelb.edu.au/10.1016/j.compenvurbsys.2018.06.009>



Topic

Urban analytics infrastructure for assessing housing affordability

Overview

There have been several attempts in the past to assess housing affordability in Australia. Most of these have been anchored on the interactions of demand and supply, which is logically reasonable, at least from the classical economic point of view. The previous attempts have been based on some simplistic assumptions, and limited scope of variables considered in the assessments. It is considered that housing affordability should be viewed from measuring or assessing the ability to pay for a house that meets one's needs in a place one wants to live. This presentation uses the innovative approach of Urban Analytic Infrastructure to stimulate evidence informed discussions regarding the interrelated parameters needed to engage in a dynamic discourse of housing affordability in Australia. This is structured within the analytical framework of Smart Cities Plan and framed within Multi Criteria Decision Model's (MCDM) approach. The proposition is that, instead of dealing with individual variables, the analysis will be based on analytical concepts. Specifically, four clusters of concepts are thought to be significant in this regard: income to assess ability to pay, demographic and housing profile to determine house that meets one's needs; and location to determine the place one wants to live.

This presentation demonstrates the utility of developing Urban Analytic Infrastructure that responds to the need of bringing different datasets together, with the capability to semantically enrich the data, through the development of ontologies while facilitating better data interrogation and analysis.

Intended Learning Outcomes

- Understanding the limitations of the current approaches of assessing housing affordability
- Leveraging the existing initiatives such as AURIN, open data by local authorities, Urban Analytics infrastructure etc. to facilitate the harmonisation and standardisation of data and integration of multi-domain analytics.

References

- Agunbiade, M. 2012. Land Administration for Housing Production. PhD thesis, The University of Melbourne.
- Battellino, R. 2008. Background Notes for Opening Remarks to Senate Select Committee On Housing Affordability In Australia, Melbourne
- Burke, T., Pinnegar, S., Phibbs, P., Neske, C., Gabriel, M., Ralston, L. & Ruming, K. 2007 Experiencing The Housing Affordability Problem: Blocked Aspirations, Trade-Offs And Financial Hardships Australian Housing And Urban Research Institute [Online], Research Paper No. 9.
- Dacquisto, D. J. & Rodda, D. T. 2006. Housing Impact Analysis, Available at: [Http://www.Dca.State.Fl.Us/Fdcp/Dcp/Affordablehousing/Files/Hsgimpact.Pdf](http://www.Dca.State.Fl.Us/Fdcp/Dcp/Affordablehousing/Files/Hsgimpact.Pdf).



Session Four

Discussion and Final Remarks

Modern Land Administration and Urban Data Analytics

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Topic

Future land administration and urban analytics: from local to global scale

Overview

The final session of the workshop will focus on summarising the presentations and reviewing the future trends and challenges in the domains of modern land administration and urban data analytics. First, the panel will discuss future directions of modern land administration and urban data analytics as well as their relationships in both local and global scales. In this context, the future impact of 3D digital land information and urban data analytics on smart management of cities will be discussed. More specifically, the discussion will be about the potential impact of technological trends in capturing, visualisation, modelling of multi-dimensional datasets on modern land administration and urban analytics. Finally, the discussion will outline the key elements of a feasible road-map smart land and urban data management.