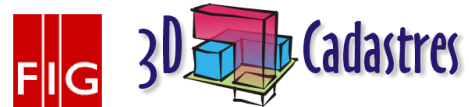


3rd Questionnaire 3D-Cadastral: status January 2019



Singapore

This questionnaire is an activity of the FIG working group 3D-Cadastral 2018-2022. The purpose of the survey is to make a world-wide inventory of the status of 3D-Cadastral at this moment and the plans/expectations for the near future (2022). By sharing this information, it should be possible to improve cooperation, learn from each other and support future developments. This is the third time that the questionnaire on 3D-Cadastral is conducted by the FIG working group on 3D-Cadastral. The first time was in 2010 in order to document the status in 2010 and expectations back then for 2014. This was followed by second questionnaire in 2014 (with status 2014 and expectations 2018). The earlier responses have been analysed and reported on (van Oosterom et al. 2011, Karki 2013, van Oosterom et al. 2014). For more information on the FIG working group on 3D-Cadastral see the website www.gdmc.nl/3DCadastral. Now a few notes and suggestions, which should be helpful when completing the questionnaire:

- The conceptual model used as background for the 3D Cadastres questionnaire is the ISO 19152 standard (ISO, 2012): the Land Administration Domain Model (LADM).
- In this questionnaire the concept of 3D-Cadastral with 3D parcels (or 3D spatial units in LADM terminology) is intended in the broadest possible sense. However, what exactly is (or could be) a 3D parcel is dependent on the legal and organizational context in the specific country (state, province). 3D parcels include land and water spaces, both above and below surface.
- A more formal definition: A 3D parcel is defined as the spatial unit against which (one or more) unique and homogeneous¹ rights (e.g. ownership right, lease or other land use right), responsibilities or restrictions are associated to the whole entity, as included in a Land Administration system.
- As the definition above is quite abstract, it is tried in the questions to be more specific and real world situations are used. Many examples with partial/preliminary answers from 2010 and 2014 are available on-line at <http://www.gdmc.nl/3DCadastral/participants/>. Inspecting some of the completed 2010 and 2014 questionnaires from different other countries might help when formulation the answers for your jurisdiction.
- A 3D parcel is a 'legal object' describing a part of the space. Often there is a relationship with a real world/physical object, which can also be described in 3D. Please be aware of the difference between these two types of objects and that the focus in the context of 3D-Cadastral is on spaces of the legal objects and not the registration of the physical objects as such.
- If a certain question is not relevant or if you have no clue what to respond, do not spend any time on this (and leave the field blank).
- The questionnaire has been prepared by Rod Thompson, Sudarshan Karki, Alias Abdul Rahman, Hendrik Ploeger, Christiaan Lemmen, Anna Shnaidman, Peter van Oosterom. The questionnaire is grouped in the number of blocks. This has no meaning in the sense of priority and it is often the case that a question could belong to multiple blocks. Please do not feel disturbed by this.
- Similar to the earlier Questionnaires on 3D-Cadastral, the completed forms will be made available on website of FIG working group on 3D Cadastres.
- Please complete this questionnaire before *15 December 2018* and send it to A.Shnaidman@tudelft.nl (or Anna Shnaidman, TU Delft, OTB, P.O. Box 5043, 2600 GA Delft, The Netherlands).

¹ Homogenous means that the same combination of rights equally apply within the whole 3D spatial unit. Unique means that this is the largest spatial unit for which this is true. Making the unit any larger would result in the combination of rights not being homogenous. Making the unit smaller would result in at least 2 neighbour 3D parcels with the same combinations of rights.

1. General/applicable 3D real-world situations

This part of the questionnaire refers to the applicable 3D real-world situations to be registered by 3D parcels. It also addressed the types of 3D geometries, which are considered to be valid 3D representations for these parcels.

	Status 2018	Expectations 2022
1.1. Are all 3D parcels (3D spatial units in LADM terminology) constrained to be within one surface 2D parcel?	No 3D parcels available yet.	If 3D parcels are available, they should not be constrained to be within one surface 2D parcel
1.2. Are 2D and/or 3D ambulatory ² boundaries permitted?	No	No
1.3.a. Is it allowed to have 3D parcels (spatial units) not related to physical constructs or objects? (e.g. airspace, subsurface volumes)	Yes	Yes
1.3.b. If 1.3.a positive: approximately what proportion of new 3D parcels (spatial units) would involve such cases (not related to physical object)?		
1.4. Are disconnected parts of a single 3D parcel allowed?	Yes	Yes
1.5. Spatial limitation – e.g. must the 3D parcel be related to a closed volume or is it allowed to have ‘open’ or unbounded 3D parcels (e.g. towards the sky).?	No 3D parcels available yet.	Should be 3D closed volume parcels if available.
1.6. Are curved surfaces to bound the 3D parcels allowed?		
1.7. Must the curved surfaces (if allowed) be cylindrical sections, or any other constraint?		
1.8. Any other constraints – e.g. all surfaces must be horizontal or vertical?		
1.9. Is there legislation (law and/or regulations) for 3D descriptions of parcels? If so please, mention law and article(s).		
1.10. Is the legal text available in original language?	Yes	Yes
1.11. Is the legal text (relevant part) available in English translation?	Not applicable as the legal text is in English	Not applicable as the legal text is in English
1.12. Do you have example descriptions of typical 3D parcels; either ‘prototype’ or ‘operational’?	“Prototype” 3D parcels available	Expected to have “operational” 3D parcels
1.13. Is there a formal model for the 3D	yes	yes

² An ambulatory boundary is a boundary of a land parcel which follows the movements of a natural feature such as a river. Its position determined at points of time (when a survey is carried out), but between such “fixes”, the definition of the property is the position of the real world natural feature.

parcels (UML style); e.g. based on ISO TC211 series (especially LADM, ISO 19152)?		
1.14. Are natural resources (groundwater, mining rights, geo-thermal extraction and storage) shown in your land administration? If yes, are they considered as 3D parcels (spatial units) with RRRs attached? What about mining concessions (could be limited in time)?	No	No
1.15. Are legally restricted spaces, above or below, such as polluted areas considered as 3D parcels?	No	No
1.16. Are spatial plans considered as 3D parcels (as rights or restrictions are related to them)? Sometimes also called spatial development plans, zoning plans or physical plans (land use, urban, regional, environmental,...)	No	
1.17. Is there a Marine Cadastre? And if so, are 3D parcels included in this registration. Is the IHO Maritime Limits and Boundaries standard (S121) in use or under implementation?	No	
1.18. Is there any organised legal instrument for the management of common property?		
1.19. Which agency is responsible for the recording of titles information?	Singapore Land Authority	Singapore Land Authority
1.20. Which agency is responsible for recording cadastral transactions?	Singapore Land Authority	Singapore Land Authority
1.21. Are transactions for standard 2D lots and 3D lots done by the same agency or titles office?	Yes	Yes
1.22. Are there any 3D storage permissions recorded (e.g. underground storage of CO2)?	No	No
1.23. Any other geometric issues related to 3D parcels?	No	No

2. Infrastructure/utility networks

This refers to the situation where an infrastructure network is considered to be defined within the land administration. For example, in some jurisdictions, an underground network might be privately constructed for the purpose of leasing space in it for other organisations to run cabling. In this case, a network, or part of that network may be considered to be a real estate object.

	Status 2018	Expectations 2022
2.1. Do you register networks as an entity in the land administration? (e.g. subterranean conduit networks)	No	
2.2. If so, then (a) can the network structure be viewed graphically in the land administration? (b) can the network structure be traced in the database(s)? (c) are networks registered by means of a cadastral identifier (such as a 'parcel number')? (d) are RRRs and parties attached to these network objects?	Not Applicable	
2.3. Does the jurisdiction have private networks? If so please, mention law and article(s).	Standard and Specifications for Utility Survey in Singapore	
2.4. If so, are they registered as 3D property parcels (spatial units)?	No	
2.5. Is the text of relevant laws or regulations (question 2.3) available in original language? If so, give references to relevant document(s).	Yes	
2.6. Is the text of laws and regulations (relevant part) available in English translation?	Not Applicable as original text is in English	Not Applicable as original text is in English
2.7. Do you have example descriptions of typical 3D parcels (spatial units) for networks; either 'prototype' or 'operational'?	"Prototype"	
2.8. If the network (legal) objects break at the surface parcel, how do you deal with intersecting networks or vertically parallel networks?		
2.9. Any other geometric issues related to the registration of networks?	No	No

3. Construction/building units

This refers to 3D properties that are related to constructions and apartment (condominium) buildings. The individual units are often defined by the actual walls and structure of a building, rather than by metes and bounds. E.g. “unit 5 on level 6 of ... building”.

	Status 2018	Expectations 2022
3.1. Do you register legal spaces for 3D construction/building units (separate from the land)?		
3.2. If so, what are the conditions for doing so, and what are the most important types? E.g. apartment units (at least 2 or more in building), or also other buildings or even more general constructions (infra related; such as bridge, tunnel or even other, such as windmills,..)		
3.3. Does the jurisdiction have construction/building units? If so please, mention law and article(s).	Strata Title Acts	Strata Title Acts
3.4. Is the legal text available in original language?	Yes	Yes
3.5. Is the legal text (relevant part) available in English translation?	Not Applicable as original text is in English	Not Applicable as original text is in English
3.6. Do you have example descriptions of typical 3D parcels; either ‘prototype’ or ‘operational’?	No	Expected to have
3.7. What would be typical 3D boundaries in an apartment complex: middle of the wall and floor/ceiling, or walls, floors/ceiling as neutral/shared 3D space? Is it mentioned in any legislation or is it the convention?	Middle of the wall and floors/ceiling	Middle of the wall and floors/ceiling
3.8. Is common property inside the building registered? If so, how?	No	No
3.9. Who owns the common property inside the building?	Management Corporation	Management Corporation
3.10. Who owns the land on which the apartment is built?	Land Owner	Land Owner
3.11. Do you allow sub-division of apartments or apartment blocks?	Yes	Yes
3.12. Can the land on which the building is built be sub-divided or sold or mortgaged without the consent of majority of the apartment owners?	No	No
3.13. What is the numbering convention for apartments (please specify in terms of cadastral parcel as well as street addressing)	All strata lot numbers starting with a prefix U	All strata lot numbers starting with a prefix U
3.14. Any other geometric issues?	No	No

4. X/Y Coordinates

	Status 2018	Expectations 2022
4.1. Do the plans of survey guarantee X/Y coordinates? (and are they relative or in an absolute spatial reference system?)	Yes and in absolute spatial reference system (i.e. Coordinated Cadastres)	Yes and in absolute spatial reference system (i.e. Coordinated Cadastres)
4.2. Are the cadastral database coordinates authoritative?	yes	yes
4.3. If not, what is the authoritative source of X/Y coordinates?	Not Applicable	Not Applicable
4.4. Do you have parcels defined by the walls of a building (with no recorded geometry)?	no	no
4.5. What is the spatial reference system for X/Y Coordinates?	SVY21	SVY21
4.6. When owners receive or purchase a copy of the plan what can they see on the plan to help them identify their parcel/lot (e.g. bearings and distance, identifying corners or recovery marks, neighbouring lots, coordinates etc.)?	Boundary marks, Coordinates, Area and Lot Number, neighbouring lots. For strata plans, building walls are shown.	Boundary marks, Coordinates, Area and Lot Number, neighbouring lots. For strata plans, building walls are shown.
4.7. Have there been any changes made in the way cadastral information is recorded and represented from a historical point of view?	The representation of cadastral information has been changed from hardcopy, electronic (scanned copy) and now to digital (LandXML)	The representation of cadastral information has been changed from hardcopy, electronic (scanned copy) and now to digital (LandXML)
4.8. Any other X/Y coordinate issues?	No	No

5. Representation of 3rd dimension: height (or depth)

	Status 2018	Expectations 2022
5.1. Are the height values of 3D parcels relative to local ground?	Yes	Yes
5.2. Are height values reduced to a standard datum (absolute)? If so, what is the spatial reference system for this 3 rd ordinate?	Singapore Height Datum (SHD)	Singapore Height Datum (SHD)
5.3. In principle possible to store both relative and absolute height values?	Yes	Yes
5.4. Is the earth surface (elevation) explicitly stored (in the DCDB or other accessible register)?	Yes	Yes
5.5. What is the source of height values for the 2D surface parcel?	Vertical Control Points based on SHD	Vertical Control Points based on SHD
5.6. How is elevation information recorded in the cadastral plan or database?	Recorded as a table field in the database	Recorded as a table field in the database
5.7. Do you expect the elevation recorded in cadastral plans to be used for any other purpose (e.g. city models or civil constructions etc.)?	Yes for 3D City Models	Yes for 3D City Models
5.8. Any other 3rd dimension ordinate value issues?	No	No

6. Temporal Issues

	Status 2018	Expectations 2022
6.1. Are temporal limits part of the definition of a parcel (2D or 3D)?	no	no
6.2. Are moving parcels allowed?	No	no
6.3. Are there any limitations on the range of temporal limits? (e.g. only on 3D apartments).	Not applicable	Not applicable
6.4. Are there any attempt to integrate 3D space and temporal representations, into a single 4D space/time representation?	Temporal information is stored as individual attributes (i.e. BeginLifeSpan Version and EndLifeSpan Version)	Temporal information is stored as individual attributes (i.e. BeginLifeSpan Version and EndLifeSpan Version)
6.5. In the case of tidal boundaries, what happens to the 3D ambulatory parcel if the 2D land parcel changes extent due to the movement of High Water Mark?	Boundaries do not change due to tidal movement	Boundaries do not change due to tidal movement
6.6. In case 3D Marine Cadastre is present and moving boundaries are allowed, how is this represented? E.g. using 4D geometry and topology.	Not Applicable	Not Applicable
6.7. Can time bound rights be created and extinguished in the title? (e.g. temporary titles created for a period and when the time is up it can be extinguished)?	Yes	Yes
6.8. Is it possible to identify all the changes made by any operator to the cadastral plans or database and to rollback if there is an error made?	Yes	Yes
6.9. For Cadastral transactions, how far in time do buyers need to make a search to ensure the title or deed is legal?	After a plan is approved, the buyers can buy the plan immediately.	After a plan is approved, the buyers can buy the plan immediately.
6.10. Any other temporal issues?	No	No

7. Rights, Restrictions and Responsibilities

	Status 2018	Expectations 2022
7.1. Range of RRR on 3D parcels.		
7.2. Are there any limitations on the range of rights related to 3D spatial units? (e.g. subterranean parcels must be owned by Govt).	Limited Depth – land under 30 meter of depth belongs to the Government	Limited Depth – land under 30 meter of depth belongs to the Government
7.3. Are there any limitations on the range of restrictions or responsibilities related to 3D spatial units? (i.e. currently in use and related to 2D spatial units, but that would not be applicable to 3D).	Limited Depth – land under 30 meter of depth belongs to the Government	Limited Depth – land under 30 meter of depth belongs to the Government
7.4. Are there RRRs that are only allowed in 3D (and not valid for 2D)		
7.5. Is there specific legislation (laws, regulations) defining 3D RRR types? If so, provide details, e.g. references to documents/ articles.		
7.6. Can 3D sub-surface/above-surface parcel be owned by someone other than the person owning the land parcel?	Yes	Yes
7.7. What applications do you foresee for 3D land administration?	Representation of void	Representation of void
7.8. Are the administrative source documents (source of RRRs) title or deed based?	Title	Title
7.9 Who is responsible for the correctness of the specified 3D boundaries in spatial source documents (which authority)?	Singapore Land Authority	Singapore Land Authority
7.10. Is registration of 3D parcels done inside the cadastral mapping agency, the land registry or elsewhere?	The cadastral mapping agency	The cadastral mapping agency
7.11. Are 3D registrations handled by the same organisation that handles traditional (2D) land administration?	Yes	Yes
7.12. Do you supply paper-based titles or deeds or proof of ownership? If yes, does this contain depictions of the 2D or 3D parcel?	Yes, in 2D	Yes, in 2D (may be in 3D)
7.13. Is the 3D registry separate or integrated with the 2D registry?		
7.14. Any other RRR issues?	No	No

8. DCDB (The Cadastral Database)

	Status 2018	Expectations 2022
8.0. Is database schema LADM based?	Yes	Yes
8.1. Does the DCDB contain representation of 3D parcels (in any form)?	No	Yes
8.2. If so, how are they represented (in the DCDB)?	as SDO_Geometry (Oracle Spatial)	as SDO_Geometry (Oracle Spatial)
8.3. If so, how are they presented on cadastral “maps” (including screen presentations)?	As 2D Map	Expected to be represented in 3D
8.4. Are there possibilities to store geometry of 3D parcels in the DCDB?	Yes	Expected to be represented in 3D
8.5. Is it possible to manage a 3D topological structure in the DCDB?	No 3D objects in the database	Expected to have 3D topological structure in the database
8.6. Are constraints/rules defined for valid 3D objects (closed volume, no overlap, no gap in 3D)? What about rules for a mix of 2D and 3D representations?	No	Expected to have constraints/rules defined for 3D objects
8.7. How can internal and external user query and visualize the 3D content supporting rotating, slicing, transparency, perspective (3D web/view service, 3D pdf documents,)?	Using commercial GIS software	Using commercial GIS software
8.8. What Spatial DBMS software do you use? Any 3D capabilities included and used?	Oracle Spatial	Oracle Spatial
8.9. Do you have any validation rules for 3D representation in the database?	Validation rules for 2D representations only	Expected to have 3D validation rules
8.10. What (GIS/CAD) software is used for updating, editing, analysis, and visualization of the cadastral data? Any 3D capabilities included and used?	Bentley Map, ArcGIS, Autodesk, etc	Bentley Map, ArcGIS, Autodesk, etc
8.11. What web software is used for remote data access/distribution and visualization? Any 3D capabilities included and used?	Bentley Web Publishing	Bentley Web Publishing
8.12. Is your DCDB organised as Multi-Layers or Object Oriented or some other data model?	Based on LADM	Based on LADM
8.13. How do you query 3D objects in your DCDB?	Not Applicable	Using commercial GIS software
8.14. Is it possible to query neighbourhood parcels to a 3D object, vertically as well as horizontally?	Not Applicable	Expected to have this capability
8.15. Any other DCDB issues?	No	No

9. Plans of Survey (including field sketches)

	Status 2018	Expectations 2022
9.1. Do the survey plans carry 3D parcel representations?	No	Expected to have 3D parcel representations
9.2. If so, how are they represented?	As normal 2D plan with heights shown on the plans	Possibly in 3D PDF, 3D maps
9.3. Is there specific legislation (regulations) describing the requirements for Plans of Survey in 3D? This could cover: a. accuracy/quality, b. 3D survey method, c. conceptual information model survey plan, d. portrayal rules for graphic representation, e. format or encoding for submission. If so, please give link to the relevant documents.	Legislations are currently in revision to support 3D	Expected to have the legislations revised.
9.4. Is sketch level allowed (low geometric quality, but in principle enough to indicate the 3D object)?	Not Applicable	
9.5. Is it possible to define a 3D parcel by referring to other 3D real world objects/ topography (and not specifying coordinates)?	No	
9.6. In what format are the 3D parcels submitted for registration; attached to legal document in a single pdf (which has good 3D capabilities) or in an extension of (city)GML for 3D parcels, or....?	Currently in 2D LandXML	Expected to be in 3D LandXML
9.7. Are the 3D parcels somehow checked for spatial validity; e.g. volume is closed, does not overlap with neighbour volume (and also no unwanted 3D gaps)?	Not Applicable	Expected to have spatial validity checks for 3D parcels
9.8. Do you have examples of (prototype or production) 3D survey plans available?	No	Expected to have 3D survey plans
9.9. Are any reference objects visible on the survey plan (e.g. real buildings, roads, that is 3D topography)?	No	Expected to have 3D objects
9.10. What form of 3D data acquisition is used (CAD, terrestrial surveying, sketches, stereo/oblique images, laser scanning,...)?	Not Applicable	Expected to use laser scanning technology
9.11. What software do you use for creating and processing survey plans? Any 3D capabilities included and used?	DataStream 2018, GeoCadastre 2018, and Listech Neo for 2D LandXML submissions	Expected the software to support 3D LandXML

9.12. Can 3D parcels be subdivided, consolidated or nullified?	Not Applicable	Expected
9.13. Is there any existing technical circular or directive to assist Surveyors in 3D data collection in the field?	Yes	Yes
9.14. Are the surveyors required to undertake a field survey for 3D cadastral data?	No	Expected
9.15. Are building construction plans used to compile 3D cadastral information for apartments?	No	Expected
9.16. Is 2D/3D field survey done by private licensed surveyors or by government surveyors?	by private registered surveyors	by private registered surveyors
9.17. Are plans of survey created for each new 2D/3D parcel or are they updated in an index map or a cadastral database.	New plan will be created and the information will be updated into the cadastral database directly.	New plan will be created and the information will be updated into the cadastral database directly.
9.18. Do you show dimensions or isometric views of 3D parcels on survey plans (do you also store this in a database)	Not applicable	
9.19. Do the cadastral survey plans differentiate between different types (e.g. volumetric plans, building plans and standard 2D plans)?	Currently all are still in 2D plans	
9.20. What are the usual elements shown on the plan (e.g. North Arrow, Marks table, Observation table, Administrative data, Plan face and dimensions etc.?)	Coordinate tables, Arrow, Boundaries	
9.21. Are authoritative cadastral surveys carried out by government surveyors or private licensed surveyors or both?	by private registered surveyors	by private registered surveyors
9.22. What is the legal description of a cadastral boundary (e.g. coordinates or bearing and distance or lines on plan or any other)?	Coordinates	Coordinates
9.23. How much time does it usually take for a subdivision process to complete?	About a week depending on the complexity of the submission.	Expected to be shorter with LandXML submissions
9.24. What is the legal source for cadastral representation (e.g. cadastral plans, or DCDB or index plans or descriptive sketch/text etc.?)	Cadastral plans	Cadastral plans
9.25. What is the positional accuracy of the cadastral plans (e.g. boundaries may be accurate but may not be referenced in datum properly)?	Coordinates are in millimetre accuracy	Coordinates are in millimetre accuracy
9.26. Any other survey plan issues?	No	No

10. Dissemination of 3D Cadastral information

	Status 2018	Expectations 2022
10.1. Is there a general purpose web-based dissemination of 2D cadastral (graphical or text) information (e.g. a portal for the public or for professionals)? If yes, does it include 3D data?	The registered surveyors are able to download 2D cadastral data from the RS Portal.	Expected the registered surveyors to be able to download 3D cadastral data from the RS Portal.
10.2. Are specific file formats or standards used to distribute 3D Cadastral information? (e.g. LandXML, CityGML, BIM/IFC, 3D pdf,...)	2D LandXML	3D LandXML
10.3. Are there specific cartographic styling rules for representing 3D cadastral plans, or to represent 3D cadastral objects on 2D cadastral maps?	Yes for 2D only	Expected the same for 3D plans
10.4. Are there specific cartographic styling rules for 3D cadastral maps (models; e.g. as disseminated in 3D pdf)? If yes, are there 3D specific cartographic rules developed or being developed?	Not Applicable	Expected to have the rules developed
10.5. Is the 3D Cadastral information accessible in integrated manner with the 2D Cadastral information?	No	Expected
10.6. Are there specific symbols on the 2D cadastral map (paper, digital or web-based) indicating the presence of 3D Cadastral objects (and in web-context perhaps even linked)?	No	
10.7. Is the legal information (RRRs and Parties) available in integrated manner in dissemination portal with the 3D Cadastral objects? (even if source of legal data may be a different organization, but then use information infrastructure approach)	No	
10.8. Are 2D/3D cadastral data available to the general public or just to the relevant parties?	2D plans can be publicly purchased online	
10.9. Any other 3D cadastral information dissemination issues?	No	No

11. Statistical information

This part of the questionnaire refers to statistical information (and is most relevant for jurisdictions with parts of 3D Cadastre registration operational, but all are encouraged to complete this section, and especially the expectations for 2022).

	Status 2018	Expectations 2022
11.1. What is the smallest 2D and 3D parcel that is present/ allowed to be registered in the land administration?	The smallest 2D parcel is 0.1m ²	May be still the same
11.2. What is the largest 2D and 3D parcel that is present allowed to be registered in the land administration?	The largest 2D parcel is 22855683m ²	May be still the same
11.3. What is the typical (or average) size of 2D and 3D parcels which are registered in the land administration? Subdivide by nature of 3D parcel when relevant (e.g. related to building, apartment, airspace, tunnel,...)		
11.4. How many 2D and 3D parcels do you currently have in your land administration?	(as January 2019) 2D Land Lots: 145566 2D Strata Lots: 1616718	
11.5. Which year did you start registering 3D parcels in the land administration?	Not Applicable	
11.6. What is the ratio of 3D parcels in rural vs. urban areas?	Not Available	
11.7. Please specify names of cities or towns or suburbs or regions or locations where there are significant numbers of 3D parcels.	Not Available	Expected to have in downtown areas, and subway stations
11.8. Please provide the following data: (a) Size of jurisdiction in square kilometres (b) Current number of 2D parcels (c) Current number of 3D parcels (d) Current population	(as of 2017) (a) 721.5 km ² (b) 145566 + 1616718 = 1762284 (c) Not Available (d) 5.61 million	
11.9. Approximately what are the proportions of various types of the 3D parcels (related to apartments, subsurface parking, subsurface shopping centres, bridges, tunnels, airspace, utility networks, etc)?	Not Applicable	
11.10. Approximately what surface area of the jurisdiction is affected by 3D parcels (the total area of all the footprint of all 3D parcels).	Not Applicable	
11.11. Any other interesting statistical fact(s)?	No	No

12. Reflection

This section is only relevant in case also in 2010 and/or in 2014 the 3D cadastres questionnaire for your jurisdictions was completed (otherwise skip this section).

	Remarks
12.1. Compared to the 2010 and 2014 expectations, which 3D land administration developments did go faster than expected?	3D technology in term of data collection, management and visualisation.
12.2. Same question, but now, which developments did go slower than expected?	Legal aspect.
12.3. If some (limited) form of 3D Land administration functionality has become available, what are the observed benefits? And for who?	3D PDF has allowed property owners to visualise their property more easily and from different views.
12.4. What are the (top-3) challenges of issues to be addressed to realize further 3D Land administration progress?	1) Legal aspect – to formalise certain legislations related to vertical dimension is time consuming; 2) Organisational aspect – change management in surveyors to make 3D submissions; 3) Software – software developers should be fast enough to develop and support their software for 3D submissions.
12.5. In case of not yet fully operational status, were there any 3D Cadastre registration pilots to take steps towards more full implementation?	Yes
12.6. In case of known legal barriers, have there been made progress in creating and adopting new legislation to support 3D land administration?	Legislations are in revision to support 3D.
12.7. Any other reflections?	No

13. Other Issues

Please include any other issues that may be of interest in an international context. For example, in some foreign jurisdictions 3D parcels can only be separated by horizontal planes.

	Remarks
13.1. Country (State, Province)	Singapore
13.2. Your name, function/position and your organization	Kean Huat SOON, Principal Surveyor, Singapore Land Authority
13.3. Contact details: address email, telephone	55 Newton Road, Revenue House, #12-01, Singapore 307987 soon_kean_huat@sla.gov.sg (+65) 6478 3537
13.4. Other issues	No

References

ISO 19152:2012 'Geographic information - Land Administration Domain Model (LADM),
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