

3rd Questionnaire 3D-Cadastral: status December 2018



Sweden

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 are independent of 2D parcels. Can e.g. stretch over two 2D parcels.	No change.
1.2. Are 2D and/or 3D ambulatory ² boundaries permitted?	No. The boundaries are fixed.	No change.
1.3.a. Is it allowed to have 3D parcels (spatial units) not related to physical constructs or objects? (e.g. airspace, subsurface volumes)	No. However, the building can be constructed after the formation of the 3D parcel	No change.
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, multiple volumes can exist.	No change.
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).?	Spatial limitation is mandatory. No “open space” allowed.	No change.
1.6. Are curved surfaces to bound the 3D parcels allowed?	Yes.	No change.
1.7. Must the curved surfaces (if allowed) be cylindrical sections, or any other constraint?	Free geometry is allowed.	No change.
1.8. Any other constraints – e.g. all surfaces must be horizontal or vertical?	Free geometry is allowed.	No change.
1.9. Is there legislation (law and/or regulations) for 3D descriptions of parcels? If so please, mention law and article(s).	No specific legal descriptions, but instructions in regulations exist. (Förordning för Fastighetsregister) [Real Property Register Ordinance]	No change.
1.10. Is the legal text available in original language?	Yes.	No change.
1.11. Is the legal text (relevant part) available in English translation?	Yes, but the text has not been updated in recent years.	No change.
1.12. Do you have example	Yes, but the text has not been	No change.

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.

descriptions of typical 3D parcels; either 'prototype' or 'operational'?	updated in recent years.	
1.13. Is there a formal model for the 3D parcels (UML style); e.g. based on ISO TC211 series (especially LADM, ISO 19152)?	LADM is used conceptually, but no "real" implementation has been achieved yet.	Difficult to estimate.
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)?	Rights (water and mining rights, etc.) are shown in the national Real Property Register and Index Map. They are not considered 3D parcels.	No change.
1.15. Are legally restricted spaces, above or below, such as polluted areas considered as 3D parcels?	No.	No change.
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, they are not considered 3D parcels. However, more and more plans can contain information on e.g. building heights, etc. Municipal zoning plans may contain 3D information on e.g. common areas.	No change.
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, but an implementation project is currently being discussed.	No change.
1.18. Is there any organised legal instrument for the management of common property?	Yes, a joint facility can be formed.	No change.
1.19. Which agency is responsible for the recording of titles information?	Lantmäteriet (Swedish mapping, cadastral and land registration authority)	No change.
1.20. Which agency is responsible for recording cadastral transactions?	Lantmäteriet (Swedish mapping, cadastral and land registration authority)	No change.
1.21. Are transactions for standard 2D lots and 3D lots done by the same agency or titles office?	Yes.	No change.
1.22. Are there any 3D storage permissions recorded (e.g. underground storage of CO2)?	No.	No change.
1.23. Any other geometric issues	No.	

related to 3D parcels?		
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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)	Yes.	No change.
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?	See above. When we do, then: a) Yes. b) Yes c) Yes d) Yes	No change.
2.3. Does the jurisdiction have private networks? If so please, mention law and article(s).	We have private overhead and underground cable networks, but they are not registered as 3D, but regulated through rights, mostly Utility easements.	No change.
2.4. If so, are they registered as 3D property parcels (spatial units)?	Yes. We sometimes register large e.g. road tunnels as 3D property. They are also regulated through other legislation, e.g. Utility Easements Act. In 3D property formation the RRR boundaries shall match the physical entities. Can be viewed as 2D only, with special text and visualisation for 3D parcel.	No change.
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. E.g. Real Property Formation act Real property Register Act	
2.6. Is the text of laws and regulations (relevant part) available in English translation?	Yes, but the text has not been updated in recent years.	Difficult to estimate

2.7. Do you have example descriptions of typical 3D parcels (spatial units) for networks; either 'prototype' or 'operational'?	Yes, but not in English.	No change.
2.8. If the network (legal) objects break at the surface parcel, how do you deal with intersecting networks or vertically parallel networks?	We do not register legal objects as networks.	No change.
2.9. Any other geometric issues related to the registration of networks?	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)?	Yes. We reg. 3D property units which shall consist of a building (or part of a building)	No change.
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,...)	Equally important. Apartment units are slightly more common than other 3D units.	No change.
3.3. Does the jurisdiction have construction/building units? If so please, mention law and article(s).	All 3D property units must contain a building or other facility or part of the same, Swedish Real Property Formation Act, Chapter 3, Section 1a.	No change.
3.4. Is the legal text available in original language?	Yes.	
3.5. Is the legal text (relevant part) available in English translation?	Some 3D legislation is translated into English, but the text has not been updated in recent years.	Difficult to estimate.
3.6. Do you have example descriptions of typical 3D parcels; either ‘prototype’ or ‘operational’?	Lantmäteriet (Swedish mapping, cadastral and land registration authority) has examples in Swedish.	No change.
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?	Ownership apartments consist of a volume and the area necessary to allow practical use of the apartment, e.g. to hammer in nails in the wall. Other general constructions have normally in the middle of the common wall as boundary or the outside of the wall (surface).	No change.
3.8. Is common property inside the building registered? If so, how?	Yes, for apartment units the common	No change.

	property usually forms a joint property unit, which is registered with a cadastral number. They can also remain within the residual property unit from which the apartment units were subdivided and the apartments units must be given the right to use the residual property for different purposes.	
3.9. Who owns the common property inside the building?	If it is a joint property unit, it will belong jointly to the apartment units.	No change.
3.10. Who owns the land on which the apartment is built?	The apartment owners own the land through shares in a joint property unit for the building. See 3.9.	No change.
3.11. Do you allow sub-division of apartments or apartment blocks?	Yes.	No change.
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. The land is owned by the owners through their shares in the joint property unit. See 3.9.	No change.
3.13. What is the numbering convention for apartments (please specify in terms of cadastral parcel as well as street addressing)	The apartment number consists of 4 digits. The first two specify the floor no. and the last two the location on the floor. The entrance floor starts with 10. Upper floors are 1, 12 etc., and lower floors are 09, 08 etc.	No change.
3.14. Any other geometric issues?	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?)	X/Y coordinates are defined in the survey documents. Both national and relative coordinates exist, depending on new or older measurements. The relative coordinates are converted into nat. coordinates. National surveyed coordinates may be used in connection with new property formation.	No change.
4.2. Are the cadastral database coordinates authoritative?	No. Only informative information.	No change.
4.3. If not, what is the authoritative source of X/Y coordinates?	The legal property formation documents are authoritative.	No change.
4.4. Do you have parcels defined by the walls of a building (with no recorded geometry)?	Yes.	No change.
4.5. What is the spatial reference system for X/Y Coordinates?	EPSG 3006	No change.
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.)?	The cadastral map in the dossier contains boundaries, neighbouring properties, RRRs, coordinates, main building details and other identifying features	No change
4.7. Have there been any changes made in the way cadastral information is recorded and represented from a historical point of view?	Yes	No change
4.8. Any other X/Y coordinate issues?	Older parcels are often measured in local reference systems, but shown with transformed into (not legally valid) coordinates on the index map. See 4.1.	No change.

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?	They can be relative to local ground, but normally not. 3D property is registered in the same way as 2D property, adding the size of the area and relative height. For apartment units, only living area and floor number is registered.	No change.
5.2. Are height values reduced to a standard datum (absolute)? If so, what is the spatial reference system for this 3 rd ordinate?	See 5.1.	No change.
5.3. In principle possible to store both relative and absolute height values?	No. Only the relative height is registered. Z-coordinates can be used, but they are not registered in the cadastre.	No change.
5.4. Is the earth surface (elevation) explicitly stored (in the DCDB or other accessible register)?	No.	No change.
5.5. What is the source of height values for the 2D surface parcel?	Surface elevations are not recorded in the DCDB. (Unsure of question)	No change.
5.6. How is elevation information recorded in the cadastral plan or database?	Heights are given as national coordinates or relative coordinates in relation to the building. It is specified in the cadastral documentation.	No change.
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.)?	Maybe, but there are no specific development plans yet.	Difficult to estimate.
5.8. Any other 3rd dimension ordinate value issues?	The actual floor no (of condominiums) can be registered, e.g. “the property is located on the 3 rd floor of the building”.	

6. Temporal Issues

	Status 2018	Expectations 2022
6.1. Are temporal limits part of the definition of a parcel (2D or 3D)?	No.	No change.
6.2. Are moving parcels allowed?	No.	No change.
6.3. Are there any limitations on the range of temporal limits? (e.g. only on 3D apartments).	Not relevant.	No change.
6.4. Are there any attempt to integrate 3D space and temporal representations, into a single 4D space/time representation?	No.	No change.
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?	No relevant.	No change.
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 relevant.	No change.
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)?	Privately agreed easements (i.e. easements not created by a governmental authority) may be limited in time, but it is not very common.	No change.
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. The history for each object is recorded in the database.	No change.
6.9. For Cadastral transactions, how far in time do buyers need to make a search to ensure the title or deed is legal?	The national real property register and cadastral index map are updated continuously as part of the property formation process.	No change.
6.10. Any other temporal issues?	No.	

7. Rights, Restrictions and Responsibilities

	Status 2018	Expectations 2022
7.1. Range of RRR on 3D parcels.	Same as for 2D property.	No change.
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).	No.	
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).	No.	No change.
7.4. Are there RRRs that are only allowed in 3D (and not valid for 2D)	No.	No change.
7.5. Is there specific legislation (laws, regulations) defining 3D RRR types? If so, provide details, e.g. references to documents/ articles.	No, part of “normal” property law and regulations.	No change.
7.6. Can 3D sub-surface/above-surface parcel be owned by someone other than the person owning the land parcel?	Yes.	No change.
7.7. What applications do you foresee for 3D land administration?	More effective use of buildings (ownership and different industry in the same building) and other constructions (tunnels, etc.). Use of digital terrain models in property formation procedure.	No change.
7.8. Are the administrative source documents (source of RRRs) title or deed based?	Mainly title based.	No change.
7.9 Who is responsible for the correctness of the specified 3D boundaries in spatial source documents (which authority)?	Same as by 2D property formation, i.e. Lantmäteriet (Swedish mapping, cadastral and land registration authority) or the (limited number of) municipalities having permission to conduct property formation. The property owner supplies drawings, etc. They are reviewed by the authority and used as source for legal decisions.	No change.
7.10. Is registration of 3D parcels done inside the cadastral mapping agency,	Inside the cadastral mapping agency and the land registry	No change.

the land registry or elsewhere?	are integrated within the same organisation: Lantmäteriet (Swedish mapping, cadastral and land registration authority). Some large municipalities are responsible for their own property formation, under supervision by Lantmäteriet.	
7.11. Are 3D registrations handled by the same organisation that handles traditional (2D) land administration?	Yes.	No change.
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?	The deed of purchase is paper based, but registered digitally and on paper in our systems. The Swedish mortgages are digital	No change.
7.13. Is the 3D registry separate or integrated with the 2D registry?	Integrated in the national Real Property Register and the Cadastral Index Map.	No change.
7.14. Any other RRR issues?	No.	

8. DCDB (The Cadastral Database)

	Status 2018	Expectations 2022
8.0. Is database schema LADM based?	No. Using the LADM is not a prioritised action at the moment due to other development.	Difficult to say.
8.1. Does the DCDB contain representation of 3D parcels (in any form)?	Yes.	No change.
8.2. If so, how are they represented (in the DCDB)?	By textual information, e.g. "3D property".	No change.
8.3. If so, how are they presented on cadastral "maps" (including screen presentations)?	By dotted lines, special surface texture and text (e.g. "\1:32\"). Different from 2D presentation.	No change.
8.4. Are there possibilities to store geometry of 3D parcels in the DCDB?	No.	No change.
8.5. Is it possible to manage a 3D topological structure in the DCDB?	No.	No change.
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?	Same as for 2D, since 3D is only stored as 2D extension (X and Y coordinates).	No change.
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,...)?	Only on a 2D map with a specific boundary layout and shading is shown. Research on 3D visualization in progress.	Difficult to say. No specific plans exist.
8.8. What Spatial DBMS software do you use? Any 3D capabilities included and used?	Oracle ArcCadaastre BANKIR (own developed software). ArcGIS No 3D capabilities.	Development is expected.
8.9. Do you have any validation rules for 3D representation in the database?	No. The same rules as for 2D (topology, no gaps, etc.)	No change.
8.10. What (GIS/CAD) software is used for updating, editing, analysis, and visualization of the cadastral data? Any 3D capabilities included and used?	ArcCadaastre No 3D capabilities included. A number of large municipalities update the index map for their region. They may use other	No change.

	software.	
8.11. What web software is used for remote data access/distribution and visualization? Any 3D capabilities included and used?	Different software is used. No 3D capabilities.	No change.
8.12. Is your DCDB organised as Multi-Layers or Object Oriented or some other data model?	Multi-Layers.	Lantmäteriet (Swedish mapping, cadastral and land registration authority) is working on moving its information to an object orientated environment.
8.13. How do you query 3D objects in your DCDB?	By query 3D objects by area (e.g. municipality) and/or type of 3D property, e.g. ownership apartments.	No change.
8.14. Is it possible to query neighbourhood parcels to a 3D object, vertically as well as horizontally?	No.	No change.
8.15. Any other DCDB issues?	No.	

9. Plans of Survey (including field sketches)

	Status 2018	Expectations 2022
9.1. Do the survey plans carry 3D parcel representations?	Yes.	No change.
9.2. If so, how are they represented?	Construction drawings in plan and height. The heights are relative to the building. Each floor is represented on a separate diagram. The specific use on specific levels/floors and properties. Presented by using different colours.	No change.
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.	No specific legislations, but general instructions stating that it should be possible to see the difference between 2D and 3D are given in the Real Property Register Ordinance (SFS 2000:308). Lantmäteriet (Swedish mapping, cadastral and land registration authority) has issued guidelines for the capture and documentation of 3D.	No change.
9.4. Is sketch level allowed (low geometric quality, but in principle enough to indicate the 3D object)?	The survey plan shall be of sufficient geometric quality to identify boundaries. A survey plan does not have to include coordinates (it can be shown in relation to existing boundaries), but the 3D property is registered with coordinates, no of floors or building heights in the national Real Property Register.	No change.
9.5. Is it possible to define a 3D parcel by referring to other 3D real world objects/ topography (and not specifying coordinates)?	Yes, e.g. by referring to floors.	No change.
9.6. In what format are the 3D parcels submitted for registration; attached to	Attached to legal documents as pdf for registration in	No change.

legal document in a single pdf (which has good 3D capabilities) or in an extension of (city)GML for 3D parcels, or....?	textual part of the real property register. Submitted to digital index map in own developed file format.	
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)?	We do not register volumes.	No change.
9.8. Do you have examples of (prototype or production) 3D survey plans available?	Yes, Lantmäteriet (Swedish mapping, cadastral and land registration authority) have examples.	No change.
9.9. Are any reference objects visible on the survey plan (e.g. real buildings, roads, that is 3D topography)?	Yes. Buildings, roads, etc.	No change.
9.10. What form of 3D data acquisition is used (CAD, terrestrial surveying, sketches, stereo/oblique images, laser scanning,...)?	CAD plans supplied by the entrepreneurs. Cadastral surveys are sometimes done, but not frequently.	No change.
9.11. What software do you use for creating and processing survey plans? Any 3D capabilities included and used?	Lantmäteriet (Swedish mapping, cadastral and land registration authority) has developed software: <i>Trossen</i> and <i>ArcCadastré</i> No 3D capabilities included.	No change.
9.12. Can 3D parcels be subdivided, consolidated or nullified?	Yes. Same as for 2D property formation.	No change.
9.13. Is there any existing technical circular or directive to assist Surveyors in 3D data collection in the field?	Yes. Lantmäteriet (Swedish mapping, cadastral and land registration authority) has produced guidelines concerning data collection and registration.	No change.
9.14. Are the surveyors required to undertake a field survey for 3D cadastral data?	No. We seldom survey 3D property.	No change.
9.15. Are building construction plans used to compile 3D cadastral information for apartments?	Yes, construction plans and textual descriptions.	No change.
9.16. Is 2D/3D field survey done by private licensed surveyors or by	Government or municipal surveyors depending on	No change.

government surveyors?	location in Sweden.	
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.	Plans of survey are created for each 2D/3D parcel, which is used to update the cadastral index map.	No change.
9.18. Do you show dimensions or isometric views of 3D parcels on survey plans (do you also store this in a database)	Yes, on survey plans, but not in our databases.	No change.
9.19. Do the cadastral survey plans differentiate between different types (e.g. volumetric plans, building plans and standard 2D plans)?	No.	
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.?)	“Standard” cartographic features, such as North Arrow, legend, boundary measurements and coordinates for boundary markers, if any.	No change.
9.21. Are authoritative cadastral surveys carried out by government surveyors or private licensed surveyors or both?	Government surveyors.	No change.
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 and distance between boundary markers and segments.	
9.23. How much time does it usually take for a subdivision process to complete?	Difficult to say. There is a very large backlog at the cadastral authorities at the moment.	
9.24. What is the legal source for cadastral representation (e.g. cadastral plans, or DCDB or index plans or descriptive sketch/text etc.?)	The legal source are the map(s) and description(s) which are part of the cadastral dossier.	
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)?	Difficult to say, ranging from centimetres to meters depending on terrestrial measurement or digitalisation of small scale analogue maps.	
9.26. Any other survey plan issues?	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?	Yes. It includes 3D property.	No change.
10.2. Are specific file formats or standards used to distribute 3D Cadastral information? (e.g. LandXML, CityGML, BIM/IFC, 3D pdf,...)	Mainly XML ÖFF (own developed format)	No change.
10.3. Are there specific cartographic styling rules for representing 3D cadastral plans, or to represent 3D cadastral objects on 2D cadastral maps?	Yes. By dotted lines, special surface texture and text (e.g. “\1:32\”).	No change.
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?	Same rules in the cadastral survey plan and the index map. Also see 10.3.	No change.
10.5. Is the 3D Cadastral information accessible in integrated manner with the 2D Cadastral information?	Yes.	No change.
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)?	Yes, see 10.3. Not indexed. Only possible to go via the textual part of the real property register.	No change.
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)	Yes.	No change.
10.8. Are 2D/3D cadastral data available to the general public or just to the relevant parties?	Available to the general public.	No change.
10.9. Any other 3D cadastral information dissemination issues?	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?	Smallest 2D parcel: 0.3 m2. Smallest 3D parcel: 1 m2).	
11.2. What is the largest 2D and 3D parcel that is present allowed to be registered in the land administration?	No legal limits.	No change.
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,...)	No statistics available.	
11.4. How many 2D and 3D parcels do you currently have in your land administration?	2D parcels: 3522957 3D parcels: 2270 per June 30 th 2018	
11.5. Which year did you start registering 3D parcels in the land administration?	2004 (3D parcels, excl. ownership apartments). 2009 (ownership apartments)	
11.6. What is the ratio of 3D parcels in rural vs. urban areas?	No statistics available.	
11.7. Please specify names of cities or towns or suburbs or regions or locations where there are significant numbers of 3D parcels.	Stockholm Gothenburg Malmö	
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	Stockholm municipality: a: 187 km2 b: 60017 c: 213 d: 960 000 Malmö municipality: a: 158 km2 b: 32055 c: 153 d: 338 000 Göteborg municipality: a: 463 km2 b: 69567 70683 c: 55 103 d: 550000 570_000	
11.9. Approximately what are the	No statistics available for	

proportions of various types of the 3D parcels (related to apartments, subsurface parking, subsurface shopping centres, bridges, tunnels, airspace, utility networks, etc)?	each city.	
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).	No statistics available for each city.	
11.11. Any other interesting statistical fact(s)?	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?	Difficult to say, but large building projects are using 3D property formation for tunnels, garages, street overhang, etc. An example is the New Karolinska hospital in Stockholm.
12.2. Same question, but now, which developments did go slower than expected?	The restructuring towards object orientation of the real property register is not finished yet. The formation of ownership apartments has not accelerated as much as expected. Probably due to a well-functioning tenant-ownership system in Sweden and the general economic crisis.
12.3. If some (limited) form of 3D Land administration functionality has become available, what are the observed benefits? And for who?	The benefit is easy access to information in the real property register. Although the GIS possibilities for e.g. analytical purposes are limited due to no full 3D (volume) registration.
12.4. What are the (top-3) challenges of issues to be addressed to realize further 3D Land administration progress?	• To further the formation of 3D properties. There is a lower number of 3D property than expected. • A governmental investigation has suggested creating 3D ownership apartments in existing tenancy apartments. That has to be addressed if decided.
12.5. In case of not yet fully operational status, were there any 3D Cadastre registration pilots to take steps towards more full implementation?	The Swedish 3D cadastre is fully operational. The 3D geometric visualisation can however be improved in the future. There are ongoing research projects.
12.6. In case of known legal barriers, have there been made progress in creating and adopting new legislation to support 3D land administration?	At the moment we are not aware of any legal barriers for 3D land administration.
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)	Sweden
13.2. Your name, function/position and your organization	Jesper M. Paasch and Anders Larsen, Lantmäteriet, the Swedish mapping, cadastral and land registration authority. Jenny Paulsson, KTH Royal Institute of Technology.
13.3. Contact details: address email, telephone	Jesper M. Paasch jesper.paasch@lm.se Jenny Paulsson jenny.paulsson@abe.kth.se
13.4. Other issues	No.

References

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