4th Questionnaire on 3DLand Administration: status December 2022

Sweden

This questionnaire is an activity of the **FIG Working Group 3D Land Administration 2022-2026**. The purpose of the survey is to make a world-wide inventory of the status of 3D Land Administration Systems/ Cadastres at this moment (2022) and the plans/ expectations for the near future (2026).

This is the first time that the questionnaire 3D-Land Administration is conducted as a successor of the questionnaire on 3D-Cadastres that was conducted three times by the FIG working group on 3D-Cadastres. The first time was in 2010 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) and the third one conducted in 2018 (status of 2018 and plans for 2022).

The earlier responses have been analysed and reported on van Oosterom et al. 2011, Karki 2013, van Oosterom et al. 2014 and Shnaidman et al., 2019. The results of the three earlier questionnaires are available via the participants pages of the 3D Land Administration Working Group website: http://www.gdmc.nl/3DCadastres/participants/.

The purpose of this survey is to make a **world-wide inventory of the status of 3D Land Administration** at the current moment and the plans/ expectations for the near future (2026). By sharing this information, it should be **possible to improve cooperation, learn from each other and support future developments**.

A few notes and suggestions, which shall be helpful when completing the questionnaire, are given below:

- The conceptual model used as background for the 3D Land Administration questionnaire is the **ISO 19152:2012 standard** (ISO, 2012), **the Land Administration Domain Model (LADM).** A new edition of the LADM is **under further development in ISO/TC 211** and is being developed as multipart standard, comprised by the following parts: **Part 1** – Generic Conceptual Model; **Part 2** – Land Registration; **Part 3** – Marine Georegulation; **Part 4** – Valuation Information; **Part 5** – Spatial Plan Information and **Part 6** – Implementations.
- In this questionnaire the concept of 3D Land Administration 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 of the specific country/ state/ province. Therefore, **3D parcels include land and water spaces, both above and below the earth's surface.**
- A more **formal definition**: A **3D parcel** is defined as "*the spatial unit against which (one or more) unique and homogeneous*[1] *rights (e.g. ownership right, lease or other land use right),*

[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 (ISO19152:2012).

responsibilities or restrictions are associated to the whole entity, as included in a Land Administration system."

- 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 Land Administration is on the spaces of the legal objects and not the registration of the physical objects as such.
- As the definition above is quite abstract, at the questions below, more specific and real-world examples are being used. Inspecting some of the completed 2010, 2014 and 2018 questionnaires from other countries might help when formulation the answers for your jurisdiction.
- 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).
- Similar to the earlier Questionnaires on 3D- Land Administration, the completed forms will be made available on website of FIG Working Group on 3D Land Administration.
- Please complete this questionnaire before *15 December 2022* and send it to E.Kalogianni@tudelft.nl (the word document completed, or the link with the google document completed) and state as email subject **"Completed FIG Questionnaire on 3D Land Administration 2022-2026 for xxx"** and at the "xxx" name the country.

The questionnaire has been prepared by Peter van Oosterom, Eftychia Kalogianni, Abdullah Kara, Rod Thompson, Sudarshan Karki, Anna Shnaidman, Alias Abdul Rahman, Hendrik Ploeger, Christiaan Lemmen. The questionnaire is grouped in various 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.

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.

Questions	Status 2022	Expectations 2026
1.1. Are all 3D parcels (3D spatial units in LADM terminology) constrained to be within one surface 2D parcel?	3D parcels are independent of 2D parcels. Can e.g. stretch across two 2D parcels.	No change
1.2. Are 2D and/ or 3D ambulatory[2] boundaries permitted?	No. The boundaries are fixed. For National borders can be some cases similar to ambulatory, border in Torne Älv (Torne River).	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.

1.3. Regarding the legal/ physical relation of 3D objects: (a) Is it allowed to have 3D parcels (spatial units) not related to physical constructs or objects? (e.g. airspace, subsurface volumes) (b) If 1.3.a positive: approximately what proportion of new 3D parcels (spatial units) would involve such cases (not related to physical object)?	No. However, the building can be constructed after the formation of the 3D parcel	No change
1.4. Are disconnected parts of a single 3D parcel allowed?	Yes, multiple volumes can exist.	No change
1.5. Spatial limitations – e.g. the 3D parcel 'must 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).	Ordinance on Real Property Register, Land Code	In this context could be mentioned that at present a governmental inquiry as to the legislation for the Real Property Register is being carried out. The objective is to strengthen security protection for the register and create a more modern regulation for efficient information supply, which better meets society's needs for real property information.
1.10. Is the legal text available in original language? For example, professional or scientific papers/reports, which explain and justify the registration of 3D parcels.	Yes. There are papers on state of play prepared for conferences as well as material prepared for discussion with sister organisations in Europe. E.g presentation in Helsinki.	Preparation of more papers, reports on the topic.
1.11. Is the legal text (relevant part) available in English translation at an official document?	Yes, but not an official translation and no recent up-dates.	No change

1.12. Do you have example descriptions of typical 3D parcels; either 'prototype' or 'operational'?	Check our webpage: https://www.lantmateriet.se/sv/fastigheter/Andra-fastighet/andra-lagg-ihop-och-dela-en-fastighet/Tredimensionell-fastighetsindelning/ The webpage has information on advantages of 3D-properties, how to apply for property formation – 3D and prerequisites for forming a 3D property. Check e.g. webpage of the Cadastral Office, Stockholm City, similar information as mentioned above as well as some examples. https://kartor.stockholm/lantmateriforrattningar/tredimensionell-fastighetsbildning/	Further examples might be developed.
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 made. Sweden is taking part in reviewing and commenting as to standards.	No change
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 the earth's surface, such as polluted areas considered as 3D parcels?	No.	No change
1.16. Are spatial plans considered as 3D parcels (so rights or restrictions are related to them)? Sometimes they are called 'spatial development plans', 'zoning plans' or 'physical plans' (land use, urban, regional, environmental, ...).	No, they are not considered 3D parcels. There are detailed plans including 3D elements. Municipalities are responsible for detailed planning, in the Real Property Register the detailed plans are included and the register shows which properties are affected by a plan. With the new geodata platform developed within the smarter society building project new detailed plans should be delivered in digital form to be provided via the platform. This also goes for any 3D detailed plan. However, if to be able to visualize in 3D depends on users IT-systems and capabilities set up.	Continued development as to planning instruments and 3D.

1.17. Regarding the Marine Space: (a) Is there a Marine Cadastre established? And if so, are 3D parcels included in this registration? (b) Is the IHO Maritime Limits and Boundaries standard (S121) in use or under implementation? (c) Is there a Marine Spatial Plan established? And if so, are 3D marine parcels included in this registration?	No, but the question is being investigated and preparatory studies carried out. For the marine area there is a need of 3D, in some cases maybe also 4D. The Swedish Maritime Administration represents Sweden in IHO. Lantmäteriet works closely with the Maritime Administration as to different questions including standards. Sweden has established 3 Maritime Spatial Plans, the Swedish Agency for Marine and Water Management are responsible for the development and implementation. Lantmäteriet works closely with the Agency as to different questions.	Continued work as to Marine Cadastre Co-operation in the geodata area as a crucial factor for the continued work.
1.18. Is there any organised legal instrument for the management of common property? For example, does the law, regulations or systems recognize/require a specific right type for common property?	Yes, a joint facility can be formed.	No change
1.19. Which agency is responsible for the recording of titles information?	Lantmäteriet, i.e. the Swedish mapping, cadastral and land registration authority	No change

1.20. Which agency is responsible for recording cadastral transactions?	Lantmäteriet, i.e. the Swedish mapping, cadastral and land registration authority authority). Cadastral activities are also carried out by 39 municipalities. These municipalities carry out registration in the cadastral part of the Real Property Register. From January 2023 there will be 40 municipalities responsible for cadastral activities. The Real Property Register held by Lantmäteriet has national coverage and is up-dated by both Lantmäteriet and the municipalities as to the cadastral part.	No change As to number of municipalities responsible for cadastral activities there might be some change in number.
1.21. Are transactions for standard 2D lots and 3D lots done by the same agency or titles office?	Yes, refer to 1.20.	No change
1.22. Are there any 3D storage permissions recorded (e.g. underground storage of CO_2)?	No. Responsibility as to permits and geological prerequisites is held by the State Geological Survey, Sweden.	No change

1.23 Has there been developed any country profile based on LADM ISO19152[3]? (a) Does it support 2D spatial units? (b) Does it support also 3D spatial units? (c) Is there any provision to include/ align with the new LADM developments of the second Edition of the standard (inclusion of valuation information, marine spaces, spatial plans, interoperability/ reuse of BIM/IFC, ..)?	Sweden is participating actively in answering questions as to development of standards. No country profile has been prepared.	No change
1.24. Any other geometric issues related to 3D parcels?	No	

[3] If yes, is it included at the index presented at the Table 1 of the publication Kalogianni et al. 2021? If it is included, are there any further developments/ publications related to it apart from those mentioned at the table? In case there are, could you please provide with a link of a relevant publication?

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.

Questions	Status 2022	Expectations 2026
2.1. Do you register utility 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? (e) in which format are usually the utility networks submitted for registration (i.e. CityGML Utility ADE, IFC, MUDDI, shp, …)?	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. Larger e.g. road tunnels, underground areas (metro) can be registered as 3D property. They are also regulated through other legislation, e.g. Utility Easements Act. Also 3D rights (reinforcements in tunnels etc). In 3D property formation the	No change

	RRR boundaries shall match the physical entities. Can be viewed as 2D only, with special text and visualisation for 3D parcel.	
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 of an official document?	Yes, but not official translations and no recent up-dates.	No change
2.7. Do you have example descriptions of typical 3D parcels (spatial units) for networks; either 'prototype' or 'operational'?	Yes.	Maybe more examples will be prepared.
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*".

Questions	Status 2022	Expectations 2026
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, depends on needs, requirements, conditions etc. Variation between municipalities, e.g. Malmö has a bigger number of ownership apartments. In Stockholm more areas/ spaces than ownership apartments.	Might vary over time Depends on needs, requirements, conditions, other forms.
3.3. Does the jurisdiction have construction/building units? If so please, mention law and article(s).	Yes, it is possible to have constructions/building units. 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. Adaptation of texts into Plain Swedish and work in accordance with Accessibility Directive.	
3.5. Is the legal text (relevant part) available in English translation at an official document?	Some 3D legislation is translated into English, but not official translation and no recent up-dates.	
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.	Further examples might be prepared
3.7. Regarding the boundaries' definition: (a) What would be typical 3D	Ownership apartments consist of a volume and the area necessary to allow practical use of the	No change

boundaries in an apartment complex: i) middle of the wall and floor/ceiling, ii) interior/ exterior of the wall or iii) walls, floor/ceiling as neutral/ shared 3D space? (b). Is it mentioned in any legislation or is it the convention?	apartment. Other general constructions have normally in the middle of the common wall as boundary or the outside of the wall (surface).	
3.8. Is common property inside the building registered? If so, how?	Yes, for apartment units the common 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.	No change
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 normally 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)	An apartment number describes the apartment's location in a building. In Sweden the apartment number is linked to the building and floor within the building; thereby indirectly to the real property. The apartment number is	No change

	added to the address by the National Tax Agency when linking person to address and apartment in the population register. 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.	
3.14. Are there any mandates[4] that set specifications on the delivery of design/ construction drawing of properties in BIM-based format, when registering new 3D parcels (from design)?	No.	
3.15. Are there any operational or in prototype stage platforms. implementations that reuse BIM information from design as cadastral/ land administration input?	Activities as to buildings, BIM, CityGML. Further development of specifications for the building objects in connection to the new national platform for geodata.	On-going development will be continued.
3.16. Any other geometric issues?	No	

[4] That arise through legislation or from the procurement process.

4. COORDINATES

This refers to the use of **x, y coordinates** and the relevant issues.

Questions	Status 2022	Expectations 2026
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? (Please , provide the EPSG)	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, w.r.t. the spatial reference system, made in the way cadastral information is recorded and represented from a historical point of view?	Yes	Continuous development
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.	Increased importance of metadata. Quality aspects. Digitalization.

5. REPRESENTATION OF 3rd DIMENSION: HEIGHT (OR DEPTH)

This section refers to the representation and registration of the **third dimension**.

Questions	Status 2022	Expectations 2026
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 3rd ordinate?	See 5.1.	No change
5.3. In principle, is it possible to store both relative and absolute height/ depth values?	No. Only the relative height is registered. Z-coordinates can be used, but they are not registered in the cadastre.	Might be some continued studies as to this question, e.g. in connection to overview of legislation for the Real Property Register.
5.4. Is the earth surface (elevation) explicitly stored (in the DCDB or other accessible register)?	Yes. Lantmäteriet also has elevation data for Sweden	Continuous development
5.5. What is the source of height values for the 2D surface parcel?	Hight values are registered in the cadastral dossier for each property. Surface elevations are not recorded in the Cadastral Index Map	
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.	
5.7. Do you expect the elevation recorded in cadastral plans to be used for any other purpose (e.g. development of 3D city models or civil constructions etc.)?	Maybe, but there are no specific development plans yet.	Continuous development

5.8. Are there any 3D City Model/ Digital Twin developments carried out at a national or city level that can be used for orientation or reference purposes?	The actual floor no (of condominiums) can be registered, e.g. "the property is located on the 3rd floor of the building". Lantmäteriet participates in activities with other authorities, organizations as to questions on digital twins. Building specification that is being produced can relatively easy be transformed to CityGML.	Continuous development
5.9. Any other 3rd dimension ordinate value issues?		

6. TEMPORAL ISSUES (4th DIMENSION)

This section refers to the representation and registration of the **fourth dimension**.

Questions	Status 2022	Expectations 2026
6.1. Are temporal limits part of the definition of a parcel (2D or 3D)?	No.	
6.2. Are moving parcels allowed?	No It could be mentioned that when physically moving a building there are cases when also the property designation is moved.	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. Is 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?	Tidal boundaries are not used in Sweden since its coastlines are only marginally affected by tides.	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.	The 4th dimension is interesting in the marine environment. The question concerning marine cadastre is being investigated.	Continuous development as to this question
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	No change

	property formation process.	
6.10. Are there object classes in the registration that require both real-world (or valid) times and database load (or system) times, i.e. bi-temporal support?	No.	No change
6.11. Any other temporal issues?	No	

7. RIGHTS, RESTRICTIONS AND RESPONSIBILITIES (RRRs)

This section refers to the **RRRs and their registration at the LA system.** At a vast majority of the countries, the restrictions and the responsibilities are not registered at the LAS.

Questions	Status 2022	Expectations 2026
7.1. Please provide the range of RRRs on 3D parcels. If there is an online depository, provide the link.	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.	No change
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 that 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. Some activities as to innovation within Lantmäteriet as well, e.g. digital twin. Also co-operation with other authorities as to these issues.	Further development and innovations in the area will assist as to land administration. Further possibilities to provide and store 3D information. This will facilitate for interested parties to create applications.

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 municipalities carrying out cadastral activities. 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, the land registry or elsewhere?	Registration is made by Lantmäteriet (Swedish mapping, cadastral and land registration authority). Some large municipalities are responsible for their own property formation, and carry out registration in the Real Property Register. The responsibility for storage and for the Real Property Register as such is held by Lantmäteriet.	No change
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 in our systems. The Swedish mortgages are digital. It is possible to receive extracts from the register in digital form or in paper format, e.g. according to principle of public access to official records.	No change

	Also an e-application called my property can be used, requires BankID (unique ID).	
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. THE CADASTRAL DATABASE (Digital Cadastral Database - DCDB)

This section refers to the **structure and functionalities of the cadastral database**.

Questions	Status 2022	Expectations 2026
8.0. Is the database schema LADM based?	No. Sweden is participating actively as to inputs on standards, e.g. LADM.	No change
8.1. Does the DCDB contain representation of 3D parcels (in any form)?	Yes. Textual in the register, dossier that can be accessed in the archive. Shown in the cadastral map with their separate representation.	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. Participation in activities with other parties as to Digital Twins. Innovation activities.	Continuous development
8.8. What Spatial DBMS software do you use? Any 3D capabilities included and used?	Oracle/ PostGIS GeoSecma BANKIR (own developed software). ArcGIS No 3D capabilities.	Might be some changes as to e.g. our own developed software which by now is quite old.
8.9. Do you have any validation rules	No. The same rules as for	

for 3D representation in the database?	2D (topology, no gaps, etc.)	
8.10. What (GIS/CAD) software is used for updating, editing, analysis, and visualization of the cadastral data? Any 3D capabilities included and used?	GeoSecma No 3D capabilities included. A number of large municipalities update the index map for their region. Municipalities may also use other softwares.	Might be some changes
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.	Might be some changes
8.12. Is your DCDB organised as Multi-Layers or Object Oriented or some other data model?	Multi-Layers.	Might be some changes
8.13. How do you query 3D objects in your DCDB?	By property designation, address, using e-services "my property". Technical possibilities to query 3D objects by area (e.g. municipality) and/or type of 3D property, e.g. ownership apartments.	Might be some changes
8.14. Is it possible to query neighbourhood parcels to a 3D object, vertically as well as horizontally?	No.	Might be some changes
8.15. Any other DCDB issues?	No.	

9. PLANS OF SURVEY (INCLUDING FIELD SKETCHES)

This section poses questions about the data acquisition process and **cadastral survey plans**.

Questions	Status 2022	Expectations 2026
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). Also more detailed guidelines exist.	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 legal document in a single pdf (which has good 3D capabilities) or in an extension of (city) GML for 3D parcels, or….?	Attached to legal documents as pdf for registration in textual part of the real property register. Submitted to digital index map in own developed file format.	No change
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)?	Topology is checked. No registration of volumes. The volumes can be calculated as to information in dossiers.	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.	More examples might be developed
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 has developed their own software for handling process. Project is now on-going as to replacement and renewal of systems. No 3D capabilities included for visualization.	On-going development
9.12. Can 3D parcels be subdivided, consolidated or nullified?	Yes. Same as for 2D property formation.	
9.13. Is there any existing technical circular or directive to assist Surveyors in 3D data collection in the field?	Yes. Lantmäteriet has produced guidelines concerning data collection and registration. Municipalities can also produce extra guidelines for their municipality.	No change
9.14. Are the surveyors required to undertake a field survey for 3D	No.	

cadastral data?		
9.15. Are building construction plans used to compile 3D cadastral information for apartments?	Yes, construction plans and textual descriptions.	
9.16. Is 2D/3D field survey done by private licensed surveyors or by government surveyors?	Government or municipal surveyors depending on location in Sweden.	No change
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.	No change
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 or municipal 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.	No change
9.23. How much time does it usually take for a subdivision process to complete?	Depends on complexity, work load etc.	
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.	No change
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	No change

	analogue maps.	
9.26. Any other survey plan issues?	No.	

10. DISSEMINATION OF 3D LAND ADMINISTRATION INFORMATION

This section refers to the **dissemination of 3D LA-related information** and the advances in this domain.

Questions	Status 2022	Expectations 2026
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, please provide the link and refer it includes 3D data?	Yes. It includes 3D property, but not visualised in 3D.	There might be further development in connection with project on smarter community building process etc.
10.2. Are there specific file formats or standards used to distribute 3D LA/ Cadastral information? (e.g. LandXML, CityGML, BIM/IFC, 3D pdf,…)	Mainly XML ÖFF (own developed format) ÖFF is going to be replaced.	Development as to formats used.
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, but no visualisation in 3D.	Might be some development.
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.	Might be some development.
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	Yes. The Real Property Register	No change.

approach)		
10.8. Are 2D/3D cadastral data available to the general public or just to the relevant parties?	Available to the general public, but not visualised in 3D if extract from the Real Property Register.	Might be some development.
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).

Questions	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 Needs to be a functional 2D or 3D property	No changes
11.2. What is the largest 2D and 3D parcel that is present allowed to be registered in the land administration?	Needs to be a functional 2D or 3D property	No changes
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: 3594841 3D parcels: 5248 per September 30th 2022	Slight increase
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?	More in urban areas	
11.7. Please specify names of cities or towns or suburbs or regions or locations where there are significant numbers of 3D parcels.	The five cities in Sweden with largest amount of 3D parcels: Stockholm Gothenburg Malmö Solna Helsingborg	

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 City: a: 187 km2 b: 60899 c: 268 d: 978 770 Gothenburg City: a: 463 km2 b: 71646 c: 153 d: 587 549 Malmö City: a: 158 km2 b: 32585 c: 71 d: 351 749	
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)?	Statistics from 2021: 3D Properties: 1290 3D Joint facilities:24 3D Ownership apartments: 3331 In total:4645	
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 at the moment.	
11.11. Any other interesting statistical fact(s)?	No.	

12. REFLECTION

This section is only relevant in case also one of the previous questionnaires for your jurisdiction (2010, 2014 and/ or 2018) was completed (otherwise skip this section).

Statements	Remarks
12.1. Compared to the 2010, 2014, 2018 and 2022 expectations, which 3D land administration developments did go faster than expected?	An increase in 3D objects in larger cities. Connecting BIM with GIS – an area that is moving forward.
12.2. Same question, but now, which developments did go slower than expected?	Standards are lacking for the 3D – GIS area for land administration, this might hinder the development. If further progress in this area – more activities might be possible. For BIM 3D – standards in place.
12.3. If some (limited) form of 3D Land administration functionality has become available, what are the observed benefits? And for who?	Possibility to provide information for 3D detailed plans in the national geodata platform. Co-operation with others, digital twins, etc, will provide further benefits, taking advantage of possibilities with on-going digitalization.
12.4. What are the (top 3) challenges of issues to be addressed to realize further 3D Land administration progress?	Standards as to 3D – GIS area for land administration. The role of BIM in the area, development is on-going. Capacity, resources, technical possibilities.
12.5. In case of not, yet, fully operational status, were there any 3D LA/ Cadastre registration pilots to take steps towards a more complete implementation?	There is e.g. a pilot project in Stockholm area for looking into the process and handling of 3D. However, the Real Property Register is not able to store and visualize volumes at present.
12.6. In case of known legal barriers, have there been made progress in creating and adopting new legislation to support 3D land administration?	Right now, a review is made of the Real Property Register Law.
12.7. Any other reflections?	

13. OTHER ISSUES

At this section, 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).

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REFERENCES

ISO 19152:2012 'Geographic information - Land Administration Domain Model (LADM), http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=51206.

Kalogianni, E., Janečka, K., Kalantari, M., Dimopoulou, E., Bydłosz, J., Radulović, A., Vučić, N., Sladić, D., Govedarica, M., Lemmen, C.H.J. and van Oosterom, P.J.M. (2021). Methodology for the development of LADM country profiles, In: Land Use Policy, Elsevier, 105(105380), pp. 1-12, 2021. Available at: http://www.gdmc.nl/publications/2021/LUP_CountryProfile.pdf

Karki, S. (2013). 3D Cadastre Implementation Issues in Australia. MSc Thesis, University of Southern Queensland (Master of Spatial Science Research), 162 p., Available at: http://eprints.usq.edu.au/23560/1/Karki_2013_whole.pdf.

Shnaidman, A., van Oosterom, P.J.M., Lemmen, C.H.J., Ploeger, H., Karki, S. and Abdul Rahman, A. (2019). Analysis of the Third FIG 3D Cadastres Questionnaire: Status in 2018 and Expectations for 2022, Proceedings FIG Working Week 2019: Geospatial Information for a Smarter Life and Environmental Resilience. Available at: https://repository.tudelft.nl/islandora/object/uuid%3A1c65db49-404c-4b88-8b78-11dca1bc151b

van Oosterom, P.J.M., Stoter, J., Ploeger, H., Thompson, R. and Karki, S. (2011). World-wide Inventory of the Status of 3D Cadastres in 2010 and Expectations for 2014. presented at the FIG Working Week 2011, Marrakech, 21 p. Available at: http://www.gdmc.nl/3DCadastres/literature/3Dcad_2011_02.pdf.

van Oosterom, P.J.M., Stoter, J., Ploeger, H., Lemmen, C.H.J., Thompson, R. and Karki, S. (2014), Initial Analysis of the Second FIG 3D Cadastres Questionnaire: Status in 2014 and Expectations for 2018, In: Proceedings 4th International Workshop on 3D Cadastres, pp. 55-74, Available at: http://www.gdmc.nl/publications/2014/Second_FIG_3D_Cadastres_Questionnaire.pdf.