

4th Questionnaire on 3D Land Administration: status December 2022



The Netherlands (draft)

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 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.”*
- 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 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).

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?	In principle it is possible to establish property rights with 3D boundaries in the Netherlands but the main registration entity is a 2D parcel.	

1.2. Are 2D and/ or 3D ambulatory² boundaries permitted?	http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%2005.html <i>Article 36.: Dient een muur, hek, heg of greppel, dan wel een niet bevaarbaar stromend water, een sloot, gracht of dergelijke watergang als afscheiding van twee erven, dan wordt het midden van deze afscheiding vermoed de grens tussen deze erven te zijn. Dit vermoeden geldt niet, indien een muur slechts aan één zijde een gebouw of werk steunt.</i> <i>Article 5:36 Waterway or a dense partition wall serving as boundary line; common ownership Where a wall, fence, hedge or trench or a non-navigable flowing water, ditch, canal or similar waterway serves as boundary between two properties, the middle of these objects is presumed to be the legal boundary line between the adjoining properties. This presumption does not apply if a wall supports a building or a construction only on one side.</i>	
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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)?	In the Dutch Civil Code Book 5 – the property rights are defined: http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%2005.html Article 5:20 and 5:21 are dealing with the ownership of land and the right to use the space above and under someone's land. Nevertheless through e.g. easement and leases it is possible to create rights that are defined by a space without a construction. Such a space can be described in the registered deed and may not have a specific spatial unit in the cadaster.	
1.4. Are disconnected parts of a single 3D parcel allowed?	n/a	
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)?	n/a	
1.6. Are curved surfaces to bound the 3D parcels allowed?	n/a	
1.7. Must the curved surfaces (if allowed) be cylindrical sections, or any other constraint?	n/a	
1.8. Any other constraints – e.g. all surfaces must be horizontal or vertical?	n/a	

1.9. Is there legislation (law and/or regulations) for 3D descriptions of parcels? If so please, mention law and article(s).	Within the civil code book 5 a specific 3D description can not be found but as mentioned in question 1.3 – “Article 5:21 Right to use the space above and under someone’s land - 1. The right of the owner of the land to use it includes the right to make use of the space above and under its surface.” (Note: translation – for real content of the Dutch Civil Code please use the link in 1.3)	
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.	Available in Dutch: http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%2005.html	
1.11. Is the legal text (relevant part) available in English translation at an official document?	It is available in English – but the official site is in Dutch: http://www.dutchcivillaw.com/civilcodebook055.htm	

1.12. Do you have example descriptions of typical 3D parcels; either 'prototype' or 'operational'?	Sources: https://www.mdpi.com/2220-9964/6/6/158 Registration of Multi-Level Property Rights in 3D in The Netherlands: Two Cases and Next Steps in Further Implementation by Stoter et. al. 2017 <i>The paper describes the first registration of an interactive 3D visualisation of legal volumes in the land registers. This registration was realised in The Netherlands to address both the limitations of a 2D parcel-based land administration, as well of solutions that do enable one to register 3D legal entities (i.e., legal volumes), but which do not include a proper way to represent this multi-level property situation in the cadastral registration. The developed registration consists of an interactive 3D visualisation of all legal volumes of one multi-level property situation. This 3D visualisation is registered as a legal document in the land registers</i>	
1.13. Is there a formal model for the 3D parcels (UML style); e.g. based on ISO TC211 series (especially LADM, ISO 19152)?	No, but there is development in regards to LADM: Source: https://www.sciencedirect.com/science/article/pii/S0264837722001016 The new, LADM inspired, data model of the Dutch cadastral map by Hagemans et. al. 2022	

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)?	Within https://www.pdok.nl all different datasets can be found (e.g grondwater, natuur en milieu, water en vaarwegen, etc.)	
1.15. Are legally restricted spaces, above or below the earth's surface, such as polluted areas considered as 3D parcels?	Not considered as 3D parcels but as described in the Civil Code obligations can be described as well as pollutions are registered in 2D.	
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, ...).	Within https://www.pdok.nl the 3D Basic Facility can be found. It is a digital topographic file containing three-dimensional objects. The information in the facility is based on topography from the Large-Scale Topography Registry (BGT), the Addresses and Buildings Key Register (BAG), height generated from aerial photo images and the Netherlands Current Height File. The 3D Basic facility can be used at scales between 1:500 and 1:10,000. The description of the product can be found here (in dutch): https://docs.geostandaarden.nl/3dbv/prod/	

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?	See ministry https://www.rijkswaterstaat.nl/en Within pdok you can find all different kind of datasets related to the marine space: • https://www.pdok.nl/introductie/-/article/waterschapsdata • https://www.pdok.nl/introductie/-/article/basisregistratie-gewaspercelen-brp- • https://www.pdok.nl/introductie/-/article/zwemwater-provinciaal-en-rijkswateren- • https://www.pdok.nl/introductie/-/article/grondwaterbeschermingsgebieden • https://www.pdok.nl/introductie/-/article/schelpdierenpercelen • https://www.pdok.nl/introductie/-/article/projecten-deltaplan-agrarisch-waterbeheer • https://www.pdok.nl/introductie/-/article/kaderrichtlijn-water • https://www.pdok.nl/introductie/-/article/kaderrichtlijn-mariene-strategie • https://www.pdok.nl/introductie/-/article/beschermde-gebieden-wetlands-inspire-geharmoniseerd- • https://www.pdok.nl/introductie/-/article/hydrografie-inspire-geharmoniseerd- • https://www.pdok.nl/introductie/-/article/zeegebieden	
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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 see the Civil Code under question 1.3 http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%2005.html	
1.19. Which agency is responsible for the recording of titles information?	The Netherlands Cadastre, Land Registry and Mapping Agency (Kadaster)	
1.20. Which agency is responsible for recording cadastral transactions?	The Netherlands Cadastre, Land Registry and Mapping Agency (Kadaster)	
1.21. Are transactions for standard 2D lots and 3D lots done by the same agency or titles office?	Yes	
1.22. Are there any 3D storage permissions recorded (e.g. underground storage of CO ₂)?	n/a	

1.23 Has there been developed any country profile based on LADM ISO19152³? (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, ..)?	See Source: https://www.sciencedirect.com/science/article/pii/S0264837722001016 The new, LADM inspired, data model of the Dutch cadastral map by Hagemans et. al. 2022	
1.24. Any other geometric issues related to 3D parcels?	n/a	

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)	The Subsurface Base Register (Basisregistratie Ondergrond, BRO) is a central register of public data on the Dutch subsurface. Public authorities record the same, reliable general data for the same objects. From one central digital location, the national facility, users can retrieve data for information on soil and subsoil. he Subsurface Base Register (Basisregistratie Ondergrond, BRO) is a central register of public data on the Dutch subsurface. Public authorities record the same, reliable general data for the same objects. From one central digital location, the national facility, users can retrieve data for information on soil and subsoil. https://www.pdok.nl/introductie/-/article/basisregistratie-ondergrond-bro- https://www.pdok.nl/introductie/-/article/basisregistratie-ondergrond-bro-	

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	(a) Yes, via www.pdok.nl (b) Yes, via www.pdok.nl (c) Yes, via www.pdok.nl (d) Yes, via www.pdok.nl (e) see www.pdok.nl	
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utility networks submitted for registration (i.e. CityGML Utility ADE, IFC, MUDDI, shp, ...)?		
2.3. Does the jurisdiction have private networks? If so please, mention law and article(s).	Article 5:20 Scope of the right of ownership of land - 1. The ownership of land comprises, as far as the law does not provide otherwise: a. the topsoil; b. the layers of earth beneath the topsoil; c. the groundwater that comes to the surface naturally or through an installation; d. the water above the soil unless it has an open connection to water covering another's land; e. buildings and constructions permanently attached to the soil, either directly or through a connection with another building or construction, unless they are a component of someone else's immovable thing; f. plants (vegetation) and trees connected to the soil. - 2. Contrary to paragraph 1, the ownership of a network, existing of one or more cables or pipelines which are used for transporting fixed, liquid or gaseous substances, energy or information, which are or will be installed in, on or above the land of others, belongs to the person who has lawfully installed them or to his legal successors. http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%205.htm	
2.4. If so, are they registered as 3D property parcels	No, but there are pilots to include 3D information https://basisregistratieondergrond.nl/actueel/nieuws/nieuws/2021/november/meerwaarde-groningen-3d/	

(spatial units)?		
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).	See 1.10	
2.6. Is the text of laws and regulations (relevant part) available in English translation of an official document?	See 1.11	
2.7. Do you have example descriptions of typical 3D parcels (spatial units) for networks; either 'prototype' or	Within https://www.pdok.nl the 3D Basic Facility can be found. It is a digital topographic file containing three-dimensional objects. The information in the facility is based on topography from the Large-Scale Topography Registry (BGT), the Addresses and Buildings Key Register (BAG), height generated from aerial photo images and the Netherlands Current Height File. The 3D Basic facility can be used at scales between 1:500 and 1:10,000.	

'operational'?	The description of the product can be found here (in dutch): https://docs.geostandaarden.nl/3dbv/prod/	
2.8. If the network (legal) objects break at the surface parcel, how do you deal with intersecting networks or vertically parallel networks?	n/a	
2.9. Any other geometric issues related to the registration of networks?	n/a	

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)?	In the Dutch Civil Code Book 5 – Title 9 Apartment rights are defined http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%205.html <i>- 4. An apartment right is a share in the assets (registered properties) which are involved in a split up, and which share includes the exclusive right to use certain parts of the building, which parts are to be used, according to their functional arrangement, as a separate private unit. The share may include the exclusive right to use certain parts.....</i>	
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	In Sources: https://www.mdpi.com/2220-9964/6/6/158 Registration of Multi-Level Property Rights in 3D in The Netherlands: Two Cases and Next Steps in Further Implementation by Stoter et. al. 2017 There the registration of the Dutch Railway Station a multi-level property rights in 3D is described.	

constructions (infra related; such as bridge, tunnel or even other, such as windmills, ...)		
3.3. Does the jurisdiction have construction/bui lding units? If so please, mention law and article(s).	n/a	
3.4. Is the legal text available in original language?	See 1.10	
3.5. Is the legal text (relevant part) available in English translation at an official document?	See 1.11	
3.6. Do you have example descriptions of typical 3D parcels; either 'prototype' or 'operational'?	In Sources: https://www.mdpi.com/2220-9964/6/6/158 Registration of Multi-Level Property Rights in 3D in The Netherlands: Two Cases and Next Steps in Further Implementation by Stoter et. al. 2017	

	And Within https://www.pdok.nl the 3D Basic Facility can be found. It is a digital topographic file containing three-dimensional objects. The information in the facility is based on topography from the Large-Scale Topography Registry (BGT), the Addresses and Buildings Key Register (BAG), height generated from aerial photo images and the Netherlands Current Height File. The 3D Basic facility can be used at scales between 1:500 and 1:10,000. The description of the product can be found here (in dutch): https://docs.geostandaarden.nl/3dbv/prod/	
3.7. Regarding the boundaries' definition: (a) What would be typical 3D 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	Not applicable - In the Dutch Civil Code Book 5 – Title 9 Apartment rights are defined http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%205.html <i>- 4. An apartment right is a share in the assets (registered properties) which are involved in a split up, and which share includes the exclusive right to use certain parts of the building, which parts are to be used, according to their functional arrangement, as a separate private unit. The share may include the exclusive right to use certain parts.....</i>	

mentioned in any legislation or is it the convention?		
3.8. Is common property inside the building registered? If so, how?	Yes	
3.9. Who owns the common property inside the building?	All owners are member of the Association of Owners – hence all own the common property <i>Article 5:112</i> ... <i>e. the incorporation (establishment) of an Association of Owners which has as objective to look after the common interests of the apartment owners, and its articles of association.</i> http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%205.html	
3.10. Who owns the land on which the apartment is built?	All owners are member of the Association of Owners – hence all own the land	
3.11. Do you allow sub-division of apartments or apartment blocks?	Yes	
3.12. Can the land on	Consent is a condition	

which the building is built be sub-divided or sold or mortgaged without the consent of majority of the apartment owners?	<i>Article 5:114 Seizure, mortgage or privilege existing at the moment that the apartment rights are established</i> - 1. When all of the assets (registered properties) involved in the split up are burdened with one and the same seizure, mortgage or privilege at the moment of registration of the notarial deed by which the apartment rights are established, then this seizure, mortgage or privilege will, as of then, become attached to each of the established apartment rights for the entire debt. - 2. When only a part of the assets (registered properties) involved in the split up are burdened with one and the same seizure, mortgage or privilege at the moment of registration of... http://www.wetboek-online.nl/wet/Burgerlijk%20Wetboek%20Boek%205.html	
3.13. What is the numbering convention for apartments (please specify in terms of cadastral parcel as well as street addressing)	https://docs.geostandaarden.nl/md/mdprofiel-iso19115/#appendix-c	
3.14. Are there any mandates ⁴ that set specifications on the delivery	n/a	

⁴ That arise through legislation or from the procurement process.

of design/ construction drawing of properties in BIM-based format, when registering new 3D parcels (from design)?		
3.15. Are there any operational or in prototype stage platforms. implementations that reuse BIM information from design as cadastral/ land administration input?	Within https://www.pdok.nl the 3D Basic Facility can be found. It is a digital topographic file containing three-dimensional objects. The information in the facility is based on topography from the Large-Scale Topography Registry (BGT), the Addresses and Buildings Key Register (BAG), height generated from aerial photo images and the Netherlands Current Height File. The 3D Basic facility can be used at scales between 1:500 and 1:10,000. The description of the product can be found here (in dutch): https://docs.geostandaarden.nl/3dbv/prod/	
3.16. Any other geometric issues?	n/a	

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?)	Yes plans of survey guarantee X/Y coordinates. Cadastral observations can be based on measurements with tapes, total stations, GPS etc. Observations are related to reference points (geodetic control points) or to other points that are known in coordinates, for examples corners of buildings. Today the surveyors can make a choice for the location of the instrument in any place, georeferencing can be done on the spot. The measurements and observations on the field sketch are documented digital and/or paper based, at the end of a survey process everything is digitally available and accessible.	
4.2. Are the cadastral database coordinates authoritative?	No – but the Cadastral Map Next program, aiming at the development of a methodology for the development of a new version of the cadastral map. The aim of this new version is that the location of boundaries is so accurate, that the boundary coordinates from the map are usable for a better approximation of the boundary location in the field and can accommodate future demands and developments. For reconstruction purposes the coordinates calculated in a local reference are used.	
4.3. If not, what is the authoritative	See 4.2	

tive source of X/Y coordinat es?		
4.4. Do you have parcels defined by the walls of a building (with no recorded geometry)?	Yes	
4.5. What is the spatial reference system for X/Y Coordina tes? (Please , provide the EPSG)	The Dutch Triangulation System (RD), in Dutch Rijksdriehoeksstelsel, has a history dating from the 19th Century. Following a century of traditional triangulations GPS started to replace triangulation measurements in 1987. The increasing use of GPS resulted in a redefinition of RD in 2000, whereby from 2000 onwards RD was linked directly to ETRS89 through a transformation procedure called RDNAPTRANS. EPSG:28992 EPSG:9286 And others	
4.6. When owners receive or	See https://cadastraltemplate.org/netherlands.php For an example of an cadastral map	

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.)?		
4.7. Have there been any changes, w.r.t. the spatial reference	Yes there are continuous improvements done: See Source: https://www.sciencedirect.com/science/article/pii/S0264837722001016 The new, LADM inspired, data model of the Dutch cadastral map by Hagemans et. al. 2022	

system, made in the way cadastral informati on is recorded and represent ed from a historical point of view?	See Source: https://www.fig.net/resources/proceedings/fig_proceedings/fig2022/papers/ts08g/TS08G_van_den_heuvel_lucassen_et_al_11408.pdf Renewal of the Cadastral Map of The Netherlands, an iterative adjustment approach by Heuvel et. al. 2022	
4.8. Any other X/Y coordinat e issues?	n/a	

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?	n/a	
5.2. Are height values reduced to a standard datum (absolute)? If so, what is the spatial reference system for this 3rd ordinate?	n/a	
5.3. In principle, is it possible to store both relative and absolute height/ depth values?	For the https://www.pdok.nl the 3D Basic Facility the height is obtained by applying semi-global matching to the stereo photos acquired from the national imagery facility. For height determination from imagery, stereo photographs from the winter flight are used.	
5.4. Is the earth surface (elevation) explicitly stored (in the DCDB or other accessible register)?	n/a	
5.5. What is the source of height values for the 2D surface parcel?	The 1st national precise levelling dates from the period 1875-1885, including 410 already existing points and 2100 km of continuous levelling lines. To distinguish the newly derived heights from previous results the name Normaal Amsterdams Peil (NAP), the Amsterdam Ordnance Datum, was introduced. The 2nd precise levelling was carried out between 1926-1940. Work on	

	the 3rd precise levelling started in 1950. The 3rd levelling was also needed to get insight into the reliability of the underground reference points.. The 4th precise levelling was carried out between 1965-1978. The network of the 5th precise levelling was also connected to the German and Belgian networks. These connections played an important role in the establishment of a European Vertical Reference System (EVRS) which uses the same "Amsterdam" datum as the NAP grid. The first geoid model was improved in 2004, resulting in the NLGEO2004 model that is used by RDNAPTRANS, see Figure 8.9. The improvements resulted from using additional gravitational measurements on Belgian and German territory and a set of 84 GPS / levelling points from the 5th precise levelling to connect NAP and ETRS89. From then on further improvements followed over time. Very accurate elevation model is available via the ministry: https://www.rijkswaterstaat.nl/zakelijk/open-data/actueel-hoogtebestand-nederland https://www.ahn.nl/ahn-viewer	
5.6. How is elevation information recorded in the cadastral plan or database?	The Amsterdam Ordnance Datum, in Dutch Normaal Amsterdams Peil (NAP), is the official reference system for heights in the Netherlands. It is also the datum for	

	the European Vertical Reference System (EVRS).	
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.)?	• https://www.pdok.nl/introductie/-/article/3d-geluid-1 • https://www.pdok.nl/-/actueel-3d-basisbestand-van-nederland-is-genomineerd- • https://www.pdok.nl/introductie/-/article/actueel-hoogtebestand-nederland-ahn3-	
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?	Within https://www.pdok.nl the 3D Basic Facility can be found. It is a digital topographic file containing three-dimensional objects. The information in the facility is based on topography from the Large-Scale Topography Registry (BGT), the Addresses and Buildings Key Register (BAG), height generated from aerial photo images and the Netherlands Current Height File. The 3D Basic facility can be used at scales between 1:500 and 1:10,000. The description of the product can be found here (in dutch): https://docs.geostandaarden.nl/3dbv/prod/	
5.9. Any other 3 rd dimension	n/a	

ordinate value issues?		
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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)?	n/a	
6.2. Are moving parcels allowed?	Ships and house boats/floating parcels	
6.3. Are there any limitations on the range of temporal limits? (e.g. only on 3D apartments).	n/a	
6.4. Is there any attempt to integrate 3D space and temporal representations, into a single 4D space/time representation?	n/a	
6.5. In the case of tidal boundaries, what happens to the 3D ambulatory parcel if the 2D land parcel changes	Dutch Civil Code Book 5: <i>Article 5:29 Land at a bank line</i> <i>The boundary of land alongside water moves together with the bank line, except in case of intentional draining or a temporary flood. A flood</i>	

extent due to the movement of High Water Mark?	<i>is not temporary if, ten years after it first occurred, the land is still flooded and drainage has not yet begun.</i> https://wetten.overheid.nl/BWBR0005288/2018-09-19	
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.	n/a	
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, e.g. leasehold <i>Title 5.7 Long leasehold</i> <i>Article 5:85 Definition of 'long leasehold' and 'ground rent'</i> - 1. A long leasehold is a limited property right which gives its proprietor, the 'leaseholder', the right to hold and use an immovable thing of someone else. - 2. The notarial deed by which the long leasehold has been established, may impose an obligation on the leaseholder to pay a sum of money, the 'ground rent', at regular or irregular intervals to the owner of the immovable thing which is encumbered with the long leasehold. <i>Article 5:86 Duration of a long leasehold</i>	

	<i>Parties may regulate the duration of the long leasehold in the notarial deed by which the long leasehold has been established.</i> https://wetten.overheid.nl/BWBR0005288/2018-09-19	
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	
6.9. For Cadastral transactions, how far in time do buyers need to make a search to ensure the title or deed is legal?	In theory all the time back till the establishment of the cadastre (deed system). In practise a notary will look in the last deed of transfer. Also important here is to mention the rule of adverse possession.	
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?	n/a	

6.11. Any other temporal issues?	n/a	
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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 to 2D parcels – Dutch Civil Code Book 5 https://wetten.overheid.nl/BWBR0005288/2018-09-19	
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).	n/a	
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).	n/a	
7.4. Are there RRRs that are only allowed in 3D (and not valid for 2D)	n/a	

7.5. Is there specific legislation (laws, regulations) defining 3D RRR types? If so, provide details, e.g. references to documents/ articles.	n/a	
7.6. Can 3D sub-surface/above-surface parcel be owned by someone other than the person owning the land parcel?	Yes applicable for e.g. utilities and others.	
7.7. What applications do you foresee for 3D land administration?	3D Valuation	
7.8. Are the administrative source documents (source of RRRs) title or deed based?	deed	
7.9 Who is responsible for the correctness of the specified 3D boundaries in spatial source documents (which authority)?	n/a	
7.10. Is registration of 3D parcels done inside the cadastral mapping agency, the land registry or elsewhere?	Yes inside the cadastral mapping agency	

7.11. Are 3D registrations handled by the same organisation that handles traditional (2D) land administration?	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	
7.13. Is the 3D registry separate or integrated with the 2D registry?	Integrated – 3D pdfs	
7.14. Any other RRR issues?	n/a	

8. THE CADASTRAL DATABASE (Digital DCDB)

Cadastral Database -

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?	Yes Source: https://www.sciencedirect.com/science/article/pii/S0264837722001016 The new, LADM inspired, data model of the Dutch cadastral map by Hagemans et. al. 2022	
8.1. Does the DCDB contain representation of 3D parcels (in any form)?	Yes	
8.2. If so, how are they represented (in the DCDB)?	In pdf	
8.3. If so, how are they presented on cadastral "maps" (including screen presentations)?	n/a	
8.4. Are there possibilities to store geometry of 3D parcels in	n/a	

the DCDB?		
8.5. Is it possible to manage a 3D topological structure in the DCDB?	n/a	
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?	n/a	
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, ..)?	Via www.pdok.nl	
8.8. What Spatial DBMS software	n/a	

do you use? Any 3D capabilities included and used?		
8.9. Do you have any validation rules for 3D representation in the database?	n/a	
8.10. What (GIS/CAD) software is used for updating, editing, analysis, and visualization of the cadastral data? Any 3D capabilities included and used?	n/a	
8.11. What web software is used for remote data access/distribution and visualization? Any 3D capabilities included and used?	n/a	
8.12. Is your DCDB	n/a	

organised as Multi-Layers or Object Oriented or some other data model?		
8.13. How do you query 3D objects in your DCDB?	n/a	
8.14. Is it possible to query neighbourhood parcels to a 3D object, vertically as well as horizontally?	n/a	
8.15. Any other DCDB issues?	n/a	

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?	Data acquisition is in 3D (GNSS) archiving in 2D	
9.2. If so, how are they represented?	n/a	
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.	n/a	
9.4. Is sketch level allowed (low geometric quality, but in principle enough to indicate the 3D object)?	n/a	
9.5. Is it possible to define a 3D parcel by referring to other 3D real world objects/ topography (and not	n/a	

specifying coordinates)?		
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....?	n/a	
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)?	n/a	
9.8. Do you have examples of (prototype or production) 3D survey plans available?	Sources: https://www.mdpi.com/2220-9964/6/6/158 Registration of Multi-Level Property Rights in 3D in The Netherlands: Two Cases and Next Steps in Further Implementation by Stoter et. al. 2017	
9.9. Are any reference objects visible on the survey plan (e.g. real buildings, roads, that is 3D topography)?	Within https://www.pdok.nl the 3D Basic Facility can be found. It is a digital topographic file containing three-dimensional objects. The information in the facility is based on topography from the Large-Scale Topography Registry (BGT), the Addresses and Buildings Key Register (BAG), height generated from aerial photo images and the Netherlands Current Height File. The 3D Basic facility can be used at scales between 1:500 and 1:10,000.	

	The description of the product can be found here (in dutch): https://docs.geostandaarden.nl/3dbv/prod/	
9.10. What form of 3D data acquisition is used (CAD, terrestrial surveying, sketches, stereo/oblique images, laser scanning, ...)?	n/a	
9.11. What software do you use for creating and processing survey plans? Any 3D capabilities included and used?	n/a	
9.12. Can 3D parcels be subdivided, consolidated or nullified?	n/a	
9.13. Is there any existing technical circular or directive to assist Surveyors in 3D data collection in the field?	n/a	
9.14. Are the surveyors required to undertake a field survey for 3D cadastral data?	n/a	
9.15. Are building construction plans used to compile 3D cadastral information for apartments?	n/a	
9.16. Is 2D/3D field survey done by private licensed	All cadastral surveys are performed by land surveyors employed by Kadaster. As such there is no involvement of	

surveyors or by government surveyors?	the private sector. However, the private sector plays a role in the sense of being contracted to do specific jobs under the supervision and responsibility of Kadaster.	
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.	For the survey a new map is created which is then later used to update the cadastral map in the database.	
9.18. Do you show dimensions or isometric views of 3D parcels on survey plans (do you also store this in a database)	n/a	
9.19. Do the cadastral survey plans differentiate between different types (e.g. volumetric plans, building plans and standard 2D plans)?	n/a	
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.?)	Here you can find an example of an cadastral map: Source: https://www.sciencedirect.com/science/article/pii/S0264837722001016 The new, LADM inspired, data model of the Dutch cadastral map by Hagemans et. al. 2022	
9.21. Are authoritative cadastral surveys carried out by government surveyors or private	See answer 9.16	

licensed surveyors or both?		
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)?	Observations of the surveyor (Bearings, distances, coordinates) combined with the names of the owners and the historical data (earlier fieldwork)	
9.23. How much time does it usually take for a subdivision process to complete?		
9.24. What is the legal source for cadastral representation (e.g. cadastral plans, or DCDB or index plans or descriptive sketch/text etc.?)	See 9.22	
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)?	The difference between the registered area and the calculated area may not be more than $q \sqrt{a}$. a in are (100 sqm) where q depends originally on the quality cadastral map: $q = 10$ cm (rural), $q = 5$ cm (urban). The area in the registry is the registered area, the area as derived from the map is supportive during subdivisions. Kadaster does not display calculated areas to citizens. Source: https://www.sciencedirect.com/science/article/pii/S0264837722001016 The new, LADM inspired, data model of the Dutch cadastral map by Hagemans et. al. 2022	

9.26. Any other survey plan issues?	n/a	

10. DISSEMINATION OF 3D LAND INFORMATION

ADMINISTRATION

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?	www.pdok.nl Contains all different kind of datasets 2D aswell as 3D	
10.2. Are there specific file formats or standards used to distribute 3D LA/ Cadastral information? (e.g. LandXML, CityGML, BIM/IFC, 3D pdf,...)	For the 3D Basic Facility Open Standard CityJSON https://docs.geostandaarden.nl/3dbv/prod/	
10.3. Are there specific cartographic styling rules for representing 3D cadastral plans, or to represent 3D cadastral objects on 2D cadastral maps?	n/a	
10.4. Are there specific cartographic styling rules for 3D cadastral	3D pdf	

maps (models; e.g. as disseminated in 3D pdf)? If yes, are there 3D specific cartographic rules developed or being developed?		
10.5. Is the 3D Cadastral information accessible in integrated manner with the 2D Cadastral information?	Yes	
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)?	n/a	
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)	n/a	
10.8. Are 2D/3D cadastral	All cadastral data is available to the general	

data available to the general public or just to the relevant parties?	public via www.pdok.nl	
10.9. Any other 3D cadastral information dissemination issues?	n/a	

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 2026).

Questions	Status 2022	Expectations 2026
11.1. What is the smallest 2D and 3D parcel that is present/ allowed to be registered in the land administration?	2D: 10x10cm	
11.2. What is the largest 2D and 3D parcel that is present allowed to be registered in the land administration?		
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?	App. 9 mio parcels	

11.5. Which year did you start registering 3D parcels in the land administration?	2016	
11.6. What is the ratio of 3D parcels in rural vs. urban areas?	n/a	
11.7. Please specify names of cities or towns or suburbs or regions or locations where there are significant numbers of 3D parcels.	Delft, the Netherlands	
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	(a) 33.883km ² land and 7.643km ² water (b) app. 9.000.000 (c) 2? (d) app. 17.500.000	
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)?	n/a	

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).	n/a	
11.11. Any other interesting statistical fact(s)?	n/a	

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?	
12.2. Same question, but now, which developments did go slower than expected?	
12.3. If some (limited) form of 3D Land administration functionality has become available, what are the observed benefits? And for who?	
12.4. What are the (top 3) challenges of issues to be addressed to realize further 3D Land administration progress?	• Legal Framework (Civil Code) • Technical Implementation/Finance • Maintenance
12.5. In case of not, yet, fully operational status, were there any 3D LA/ Cadastre registration pilots to take steps	Sources: https://www.mdpi.com/2220-9964/6/6/158 Registration of Multi-Level Property Rights in 3D in The Netherlands: Two Cases and Next Steps in

towards a more complete implementation?	Further Implementation by Stoter et. al. 2017
12.6. In case of known legal barriers, have there been made progress in creating and adopting new legislation to support 3D land administration?	
12.7. Any other reflections?	n/a

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).

Contact Details & other issues	Remarks
13.1. Country (State, Province)	The Netherlands
13.2. Name	Eva-Maria Unger Martin Salzmann, Eric Hagemans, Jaques Vos, Rohan Bennett
Function/ Position	
Organization	Cadastre, Land Registry and Mapping Agency (Kadaster)
13.3. Contact details:	Hofstraat 110, 7311 KZ Apeldoorn
Address	Hofstraat 110, 7311 KZ Apeldoorn
Email	Eva-Maria.Unger@kadaster.nl
Telephone	+31 6 11 29 19 38
13.4. Other issues	

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