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

## Bahrain

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? | Yes. Apart some special cases | It is expected to have a fully 3D representation by then. |
| 1.2. Are 2D and/ or 3D ambulatory[2] boundaries permitted? | Yes | Yes |
| 1.3. Regarding the legal/ physical relation of 3D objects:<br>(a) Is it allowed to have 3D parcels (spatial units) not related to physical constructs or objects? (e.g. airspace, subsurface volumes)<br>(b) If 1.3.a positive: approximately what proportion of new 3D parcels (spatial units) would involve such cases (not related to physical object)? | (a) No | It is under study |
| 1.4. Are disconnected parts of a single 3D parcel allowed? | Yes, for 2D parcels, however, large scale development projects arose the need of the topic and it is under study their regulation and representation. | It is expected to be allowed and be represented in 3D environment. |
| 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)? | Although this is not legally clarified, 3D parcel is related to close volume as per as built standards. | |
| 1.6. Are curved surfaces to bound the 3D parcels allowed? | Yes, again large development projects. (VillaMar, Spiral Orchid, Wyndham Grand etc.) | It is expected to be allowed and be represented in 3D environment. |
| 1.7. Must the curved surfaces (if allowed) be cylindrical sections, or any other constraint? | They can be defined, so no constraints. | No issues. |

[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.

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| 1.8. Any other constraints – e.g. all surfaces must be horizontal or vertical? | No | |
| 1.9. Is there legislation (law and/or regulations) for 3D descriptions of parcels? If so please, mention law and article(s). | There is no Law | Yes |
| 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. | No | Yes |
| 1.11. Is the legal text (relevant part) available in English translation at an official document? | No | Yes |
| 1.12. Do you have example descriptions of typical 3D parcels; either 'prototype' or 'operational'? | No | Yes |
| 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 | Probably yes |
| 1.14. Are natural resources (groundwater, mining rights, geo-thermal extraction and storage) shown in your land administration?<br>If yes, are they considered as 3D parcels (spatial units) with RRRs attached? What about mining concessions (could be limited in time)? | No | Same |
| 1.15. Are legally restricted spaces, above or below the earth's surface, such as polluted areas considered as 3D parcels? | No | Same |
| 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, spatial plans and the rights or restrictions related to them are considered as 2D parcels. | Not planned yet |

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| 1.17. Regarding the Marine Space:<br>(a) Is there a Marine Cadastre established? And if so, are 3D parcels included in this registration?<br>(b) Is the IHO Maritime Limits and Boundaries standard (S121) in use or under implementation?<br>(c) Is there a Marine Spatial Plan established? And if so, are 3D marine parcels included in this registration? | (a) There are some marine parcels already registered in 2D. There is no separate registry for marine cadastre.<br><br>(b) No, S-57 standards being used<br><br>(c) Not fully functional MSP, in progress | a) Yes<br><br>(b) Yes<br><br>(c) Yes |
| 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? | RERA Law27/2017 Article 62, Owners' Association | Fully regulated |
| 1.19. Which agency is responsible for the recording of titles information? | Survey and Land Registration Bureau / Technical Affairs Directorate | No Change |
| 1.20. Which agency is responsible for recording cadastral transactions? | Survey and Land Registration Bureau / Cadastral Survey Directorate | No Change |
| 1.21. Are transactions for standard 2D lots and 3D lots done by the same agency or titles office? | YES | Same |
| 1.22. Are there any 3D storage permissions recorded (e.g. underground storage of $CO_2$)? | No | Same |

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| 1.23 Has there been developed any country profile based on LADM ISO19152[3]?<br>(a) Does it support 2D spatial units?<br>(b) Does it support also 3D spatial units?<br>(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, ..)? | (a) Not yet<br>(b) It will<br>(c) YES | Yes, all under study, under a Modernisation of Cadastral Services Project |
| 1.24. Any other geometric issues related to 3D parcels? | There is no provision for 3D parcels in the Bahraini legislation. | To be studied if not regulated |

[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) | No | |
| 2.2. If so, then:<br>(a) can the network structure be viewed graphically in the land administration?<br>(b) can the network structure be traced in the database(s)?<br>(c) are networks registered by means of a cadastral identifier (such as a 'parcel number')?<br>(d) are RRRs and parties attached to these network objects?<br>(e) in which format are usually the utility networks submitted for registration (i.e. CityGML Utility ADE, IFC, MUDDI, shp, …)? | (a) Yes<br>(b) Yes<br>(c) Only Roads<br>(d) Yes<br>(e) N/A | |
| 2.3. Does the jurisdiction have private networks? If so please, mention law and article(s). | Yes, private underground cable networks do exist. No related articles not registered. | |
| 2.4. If so, are they registered as 3D property parcels (spatial units)? | N/A | |
| 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). | N/A | |
| 2.6. Is the text of laws and regulations (relevant part) available in English translation of an official document? | N/A | |
| 2.7. Do you have example descriptions of typical 3D parcels (spatial units) for networks; either 'prototype' or 'operational'? | N/A | |

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| 2.8. If the network (legal) objects break at the surface parcel, how do you deal with intersecting networks or vertically parallel networks? | Stored as 2D footprint in DCDB. Manual Check | Yes |
| 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)? | No | |
| 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, ...) | Apartments and parking lots in different building at the same mother plot | Under study, more such cases, need to be regulated and be 3D represented. |
| 3.3. Does the jurisdiction have construction/building units? If so please, mention law and article(s). | YES, L13/2013 | |
| 3.4. Is the legal text available in original language? | YES | |
| 3.5. Is the legal text (relevant part) available in English translation at an official document? | YES | |
| 3.6. Do you have example descriptions of typical 3D parcels; either 'prototype' or 'operational'? | Strata Parcels (Vertical/Apartments or Joint Villas) | |
| 3.7. Regarding the boundaries' definition:<br>(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?<br>(b). Is it mentioned in any legislation or is it the convention? | (a) i) Middle of the wall and floor/ceiling<br>(b) BPMS/2019 Bahrain Property Measurement Standards, adoption of IPMS | Same |
| 3.8. Is common property inside the building registered? If so, how? | Not yet | Yes |
| 3.9. Who owns the common property inside the building? | Owners/ Owners Association | |
| 3.10. Who owns the land on which the apartment is built? | Owners/ Owners Association | |

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| 3.11. Do you allow sub-division of apartments or apartment blocks? | Yes, for apartment blocks.<br>Yes, but with constraints for flats | |
| 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 | |
| 3.13. What is the numbering convention for apartments (please specify in terms of cadastral parcel as well as street addressing) | Address Cards for all the units (Issued by IGA/Information and E-Government Authority) | |
| 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)? | BPMS/2019 Bahrain Property Measurement Standards, adoption of IPMS | More specifications and standards (e.g. BIM) |
| 3.15. Are there any operational or in prototype stage platforms. implementations that reuse BIM information from design as cadastral/ land administration input? | Not yet | |
| 3.16. Any other geometric issues? | | |

[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?) | Yes | |
| 4.2. Are the cadastral database coordinates authoritative? | Yes | |
| 4.3. If not, what is the authoritative source of X/Y coordinates? | | |
| 4.4. Do you have parcels defined by the walls of a building (with no recorded geometry)? | No | |
| 4.5. What is the spatial reference system for X/Y Coordinates? (Please , provide the EPSG) | Ain Al Abd<br>- EPSG:20499 | |
| 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.)? | Location Description, Location Map, Distances, corners, neighbouring plots, and coordinates | |
| 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? | All cadastral plots are georeferenced. | |
| 4.8. Any other X/Y coordinate issues? | No | |

## 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? | In progress | YES |
| 5.2. Are height values reduced to a standard datum (absolute)? If so, what is the spatial reference system for this 3rd ordinate? | Ain-al-Abd datum based in 1976 Mina Salman average tidal gauge readings | |
| 5.3. In principle, is it possible to store both relative and absolute height/ depth values? | In progress | YES |
| 5.4. Is the earth surface (elevation) explicitly stored (in the DCDB or other accessible register)? | In progress | YES |
| 5.5. What is the source of height values for the 2D surface parcel? | Cadastral Field Surveys | |
| 5.6. How is elevation information recorded in the cadastral plan or database? | Under study | YES |
| 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.)? | - Yes, Z value is important for other purposes such as DTM for example<br>- Small pilot projects (Nabeeh Saleh 3D Context Capture / UAV) | |
| 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? | No | |
| 5.9. Any other 3rd dimension ordinate value issues? | No | |

## 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 | Not planned yet |
| 6.2. Are moving parcels allowed? | No | |
| 6.3. Are there any limitations on the range of temporal limits? (e.g. only on 3D apartments). | No | |
| 6.4. Is there any attempt to integrate 3D space and temporal representations, into a single 4D space/time representation? | Not yet | Maybe |
| 6.5. In the case of tidal boundaries, what happens to the 3D ambulatory parcel if the 2D land parcel changes extent due to the movement of High Water Mark? | No 3D ambulatory parcel exists. | Not planned yet |
| 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. | 3D marine cadastre does not exist yet. | Not planned yet |
| 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)? | Not yet | Long-time leases, limited real-property rights are under consideration to be registered as time-bound rights in the future. |
| 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, archived cadastral history is available. | |
| 6.9. For Cadastral transactions, how far in time do buyers need to make a search to ensure the title or deed is legal? | One day | |
| 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 | |
| 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. | N/A | |
| 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). | First registration is always in the name of Government of Bahrain, thereafter parcels are transferred to citizens. | |
| 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) | No | |
| 7.5. Is there specific legislation (laws, regulations) defining 3D RRR types? If so, provide details, e.g. references to documents/ articles. | No | |
| 7.6. Can 3D sub-surface/above-surface parcel be owned by someone other that the person owning the land parcel? | Under study | |
| 7.7. What applications do you foresee for 3D land administration? | | The planned 3D cadastral registration along with 3D modelling representation, are expected to solve all the arising issues due to the new style urbanisation with many complex buildings in Bahrain and in Middle East in general.<br>The new geospatial system will support applications related to 3D Land Administration, tools for planning, management and decision making. |
| 7.8. Are the administrative source | Combined Title and Deed | |

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| documents (source of RRRs) title or deed based? | together | |
| 7.9 Who is responsible for the correctness of the specified 3D boundaries in spatial source documents (which authority)? | Survey and Land Registration Bureau<br>Cadastral Directorate | |
| 7.10. Is registration of 3D parcels done inside the cadastral mapping agency, the land registry or elsewhere? | All parcels registration happens in land registry function of SLRB. | |
| 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? | Digital and paper-based title deeds are issued.<br>Yes, deed map has depiction of 2D as well as 3D. | Hope to issue all block chained title deeds. |
| 7.13. Is the 3D registry separate or integrated with the 2D registry? | There is no 3D registry | |
| 7.14. Any other RRR issues? | | |

## 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? | YES | Will be updated to latest standards |
| 8.1. Does the DCDB contain representation of 3D parcels (in any form)? | Only a few special cases, still not regulated | YES |
| 8.2. If so, how are they represented (in the DCDB)? | 2D land parcels | Expected to include the volume of strata parcels. |
| 8.3. If so, how are they presented on cadastral "maps" (including screen presentations)? | Overlapping 3D parcels in plan | In true 3D |
| 8.4. Are there possibilities to store geometry of 3D parcels in the DCDB? | YES, in progress | YES |
| 8.5. Is it possible to manage a 3D topological structure in the DCDB? | YES, in progress | YES |
| 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? | All parcels are closed parcels FOR SURE. There is no overlapping. Exception occurs if there is an ownership litigation in court. | 3D parcels are expected to follow topological rules |
| 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, ..)? | Not available yet | Will be in place |
| 8.8. What Spatial DBMS software do you use? Any 3D capabilities included and used? | PostgreSQL*server with postGIS 3D capabilities as per CityGML 2.0<br>Existing 2D OracleDB still in operation | |
| 8.9. Do you have any validation rules for 3D representation in the database? | No | YES |
| 8.10. What (GIS/CAD) software is used for updating, editing, analysis, and visualization of the cadastral data? Any 3D capabilities included and used? | MicroStation and In-house software called Surveyor 4. General Directorate of Land Registration uses ESRI SDE format for cadastral parcels. Its open to accept 3D capabilities. | Modernisation Project includes replacement of existing software with advanced ones. Presently in progress |

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| 8.11. What web software is used for remote data access/distribution and visualization? Any 3D capabilities included and used? | ESRI suite is used in General Directorate of Land Registration. | |
| 8.12. Is your DCDB organised as Multi-Layers or Object Oriented or some other data model? | It is Object Oriented | |
| 8.13. How do you query 3D objects in your DCDB? | Parcel number or registration number, but returned results are in plan [2D] | To be developed in 2023/24 |
| 8.14. Is it possible to query neighbourhood parcels to a 3D object, vertically as well as horizontally? | No. 3D capability. | Yes |
| 8.15. Any other DCDB issues? | Presently in progress migration to new system. | |

## 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? | No | |
| 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:<br>(a) accuracy/ quality,<br>(b) 3D survey method,<br>(c) conceptual information model survey plan,<br>(d) portrayal rules for graphic representation,<br>(e) format or encoding for submission.<br>If so, please give link to the relevant documents. | No | |
| 9.4. Is sketch level allowed (low geometric quality, but in principle enough to indicate the 3D object)? | No | |
| 9.5. Is it possible to define a 3D parcel by referring to other 3D real world objects/ topography (and not specifying coordinates)? | No | |
| 9.6. In what format are the 3D parcels submitted for registration; attached to legal document in a single pdf (which has good 3D capabilities) or in an extension of (city) GML for 3D parcels, or….? | Not yet | |
| 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)? | No | |
| 9.8. Do you have examples of (prototype or production) 3D survey plans available? | No | |
| 9.9. Are any reference objects visible on the survey plan (e.g. real buildings, roads, that is 3D | No | |

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| topography)? | | |
| 9.10. What form of 3D data acquisition is used (CAD, terrestrial surveying, sketches, stereo/oblique images, laser scanning, …)? | CAD & field survey | |
| 9.11. What software do you use for creating and processing survey plans? Any 3D capabilities included and used? | MicroStation, in-house application Surveyor 4 and oracle. 3D capabilities are being explored | |
| 9.12. Can 3D parcels be subdivided, consolidated or nullified? | Theoretically yes. | |
| 9.13. Is there any existing technical circular or directive to assist Surveyors in 3D data collection in the field? | Left to the wisdom of surveyor 4. | |
| 9.14. Are the surveyors required to undertake a field survey for 3D cadastral data? | No | |
| 9.15. Are building construction plans used to compile 3D cadastral information for apartments? | Building drawings and plans are used only to separate a building to horizontal properties, but not necessarily construction plans | |
| 9.16. Is 2D/3D field survey done by private licensed surveyors or by government surveyors? | Yes, by Private Licensed Survey Offices and by the Bureau. | |
| 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 new parcel and are used to update the DCDB. | |
| 9.18. Do you show dimensions or isometric views of 3D parcels on survey plans (do you also store this in a database) | Dimensions are shown on survey plans. No provision of isometric views, nor stored in the database. | |
| 9.19. Do the cadastral survey plans differentiate between different types (e.g. volumetric plans, building plans and standard 2D plans)? | No | |
| 9.20. What are the usual elements shown on the plan (e.g. North Arrow, Marks table, Observation table, Administrative data, Plan face and dimensions etc.?) | Neighbouring lots' boundaries, coordinates of the parcel, Cadastral Number (unique ID), privately owned space in vertical ownerships (if any), servitudes (if any), | |

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| | administrative boundaries, roads' names, north arrow | |
| 9.21. Are authoritative cadastral surveys carried out by government surveyors or private licensed surveyors or both? | By Private Licensed Survey Offices and by the Bureau. | |
| 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)? | Lines and points on the cadastral plan accompanied by their coordinates. | |
| 9.23. How much time does it usually take for a subdivision process to complete? | It depends on the parcel that will be subdivided, the restrictions within the area that the parcel is located and the involved parties. | |
| 9.24. What is the legal source for cadastral representation (e.g. cadastral plans, or DCDB or index plans or descriptive sketch/text etc.?) | Title Deeds or any other legal documentation. | |
| 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)? | Plot Boundary Marks 0.05m<br>Plot dimensions/Title Deeds 0.1m<br>Plot Dimensions LC/CoS 0.01m | |
| 9.26. Any other survey plan issues? | | |

## 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? | Intranet portal titled "Case File Application System" operational since 2005. It is strictly available to authorised staffs related to property registration function in SLRB.<br><br>In 2012, SLRB attempted use of 3D cadastral parcels (>12,000) for property registration based on the simple cylindrical model extracted based on 2D shape and calculated height from submitted CAD drawings. But discontinued due to lack of resources after a year. | It is planned under the Modernisation Project. It is expected to be ready before 2025 |
| 10.2. Are there specific file formats or standards used to distribute 3D LA/ Cadastral information? (e.g. LandXML, CityGML, BIM/IFC, 3D pdf,…) | Simple file format based on ESRI Shape file. | It is planned under the Modernisation Project. |
| 10.3. Are there specific cartographic styling rules for representing 3D cadastral plans, or to represent 3D cadastral objects on 2D cadastral maps? | Custom viewer developed using ESRI tool kit to represent and register 3D cadastral parcels. | It is planned under the Modernisation Project. |
| 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? | Each cadastral parcel is an entity itself. No correlation with neighbouring parcel at as not yet 3D cadastral maps. | It is planned under the Modernisation Project. |
| 10.5. Is the 3D Cadastral information accessible in integrated manner with the 2D Cadastral information? | 3D property entities are registered to the 2D DCDB, 2D and 3D attributes are in the same interface. | Bureau created a Geospatial Database where 3D information will be store before 2025 |
| 10.6. Are there specific symbols on the 2D cadastral map (paper, digital or web-based) indicating the | Yes, 2D parcels having height represented differently. Click on any one of these parcels | It is planned under the Modernisation Project. |

| | | |
|---|---|---|
| presence of 3D Cadastral objects (and in web-context perhaps even linked)? | will take to 3D interface. 3D interface is complete in itself – search, view and register. Attribute change in 3D or 2D is immediately available in another interface. Polygons or points are used to depict the presence of 3D cadastral objects | |
| 10.7. Is the legal information (RRRs and Parties) available in integrated manner in dissemination portal with the 3D Cadastral objects? (even if source of legal data may be a different organization, but then use information infrastructure approach) | Yes, even for 2D parcels it is reported in Title Deed. | It is under study |
| 10.8. Are 2D/3D cadastral data available to the general public or just to the relevant parties? | No, 2D parcels are available only to stakeholders.<br>Also available on demand basis. | Under study |
| 10.9. Any other 3D cadastral information dissemination issues? | It is part of the next phase of the Modernisation Project | Under study |

## 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? | Urban planning regulations define the smallest 2D parcel suitable for construction, while smaller parcels may exist. No provisions regarding 3D parcels.<br>Parcels registered since Jan'2019 –<br>Min Area = 2 sqm<br>Max Area = 41,174,458 sqm | |
| 11.2. What is the largest 2D and 3D parcel that is present allowed to be registered in the land administration? | There are no limitations for 2D parcels. No provisions for 3D parcels. | |
| 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,…) | Median area of all parcels is 297 sqm.<br><br>Median area of 3D parcels is 125 sqm. | |
| 11.4. How many 2D and 3D parcels do you currently have in your land administration? | There are 13.7% parcels which have potential for 3D | |
| 11.5. Which year did you start registering 3D parcels in the land administration? | 3D parcels are being registered as 2D parcel since 2007. | |
| 11.6. What is the ratio of 3D parcels in rural vs. urban areas? | There are no 3D parcels in rural areas | |
| 11.7. Please specify names of cities or towns or suburbs or regions or locations where there are significant numbers of 3D parcels. | Seef, Diyar Al Muharraq, Bahrain Bay, Financial Harbour | |
| 11.8. Please provide the following data: (a) Size of jurisdiction in square kilometres<br>(b) Current number of 2D parcels<br>(c) Current number of 3D parcels<br>(d) Current population | (a) 786.5 sq.km<br>(b) & (c) 255.436 2D parcels (including the 2D parcels with 3D aspects).<br>(d) 1.463 million (2021) | |

| | | |
|---|---|---|
| 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)? | There are no available data, however, the majority is related to apartments, subsurface parking, and complex shopping centres | |
| 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). | 4.73 m sqm | |
| 11.11. Any other interesting statistical fact(s)? | | |

## 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? | Geospatial Database and 3D representations |
| 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? | None, due to the cost of data capture. |
| 12.4. What are the (top 3) challenges of issues to be addressed to realize further 3D Land administration progress? | Cost, Training Private Sector to produce accurate As-Builts, Dissemination, Data Sharing |
| 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? | Yes, in small scale to solve the arisen issues. |
| 12.6. In case of known legal barriers, have there been made progress in creating and adopting new legislation to support 3D land administration? | Yes, amendments of the Real Estate 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).

| Contact Details & other issues | Remarks |
|---|---|
| 13.1. Country (State, Province) | Bahrain |
| 13.2. Name | Eleni Tziortzioti |
| Function/ Position | Advisor / Consultant |
| Organization | Survey & Land Registration Bureau, General Directorate of Survey |
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| 13.4. Other issues | |

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