

Integration of LADM and CityGML for 3D Cadastre of Turkey

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Introduction



- 3D cadastre is defined as a system where RRRs (legal models) of buildings and properties correspond to their physical models (provision of registered rights above and below the 3D terrain surface) with advanced policies, standards, and models. (Aien, 2013; Atazadeh et al., 2016; Alkan et al., 2020; Sürmeneli H.G. et al., 2020).
- An integrated cadastre system based on common standards should be established.
- While a legal model is a real or virtual spatial unit with homogeneous RRRs that can be represented in different forms such as text, sketch, point, lines, surface, or 3D volume, a physical model is the structure of the permanent construction such as walls, ceilings, columns, windows, doors and similar architectural elements (Lemmen et al., 2010; Atazadeh et al., 2016; Kalogianni et al., 2020).





Aim & Summary



The aim of the current research,

➤ To develop a database model that supports the regulation and analysis of 3D land rights, restrictions, and responsibilities for the Turkish Cadastral System.

For this,

- We use the ISO 19152 (ISO, 2012), Land Administration Domain Model (LADM) that represents RRR on the real estate, and the CityGML that represents the physical side of this object for the conceptual model.
- The PostgreSQL database development platform is used for the 3D database.





Methodology





CityGML is a Modular Standard



Database management system



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Results Turkish cadastral system based on LADM

Table 1. shows the definitions of the RRR in the Turkish cadastralsystem according to LADM.

RRR	Definition
Rights	It is the state of being able to make all kinds of transactions on real estate. The person has the Property right and Limited Real Rights on the real estate. The limited real rights are divided into two as Mortgage and Easement.
Restrictions	It is the part where the information is restricting the use of limited real rights in the land register. These restrictions can be listed as representations, rights, and liabilities, annotations, mortgages and easement.
Responsibilities	These are the obligations that an interest holder must fulfill on the real estate.



Proposed implementation of LADM classes for the Turkish cadastral conceptual model







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Results Proposed model (integration of LADM and CityGML)

New proposed model for the Turkish cadastral system using, LADM and CityGML combining legal and physical model



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Results 3D RRR Queries in a PostgreSQL Environment



The overview of the 3D database procedure packages





Shows the relationships between the Real estate class and the other classes in the PostgreSQL database management

system.



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23 RRRID

Results 3D RRR Queries in a PostgreSQL Environment

Query 1) Showing the mortgaged independent sections between years 2012-2020: The following is the SQL code written to show the mortgaged independent sections within the specified date range.

Data query TR_Mortgage table using PostgreSQL, there are mortgages in 8 real estates.





SELECT MT."MortgageTypeText" AS "Mortgage Type",

M."RealEstateID" AS "Real Estate ID", (100 * M."Share" / M."ShareTotal") || '%' AS "Share", P."FirstName" || ' ' || P."LastName" AS "Payer", PRT."PayeeRoleTypeText" AS "Payee Role Type", PC."ParcelNo" AS "Parcel No",

Mortgage Type	Real Estate ID	Share	Payer	Payee Role Type	Parcel No	Block No	Building No	Building Unit ID	Net Area	Storey	Section No	Mortgage Start Date	Mortgage End Date
Mortgage	64	1	FN015 LN015	İşbankası	3	600	3013675	51906591	124.38 m2	2	6	2013-05-16 16:00	2019-05-17 11:00
Mortgage	71	1	FN013 LN013	Garanti Bankası	3	600	3013675	51906598	124.48 m2	4	13	2012-12-12 12:00	2020-12-14 09:00
Mortgage	73	1	FN011 LN011	Garanti Bankası	3	600	3013675	51906599	120.88 m2	4	15	2012-12-03 12:00	2020-08-03 09:00
Mortgage	80	1	FN022 LN022	Ziraat Bankası	1	1100	3018678	3354122	23.37 m2	1	22	2015-06-05 10:00	2020-07-05 10:00
Mortgage	87	1	FN025 LN025	Garanti Bankası	1	1100	3018678	3354050	83.55 m2	2	5	2014-03-02 11:00	2020-03-02 11:00
Mortgage	94	1	FN016 LN016	HalkBan k	1	1100	3018678	3253059	82.76 m2	4	12	2014-07-14 11:00	2020-07-14 11:00
Mortgage	139	1	FN021 LN021	YapıKred i Bankası	3	1100	3157372	5333375	89.71 m2	2	7	2012-06-21 14:00	2020-04-21 14:00
Mortgage	140	1	FN007 LN007	İşbankası	3	1100	3157372	5333376	89.71 m2	2	8	2012-03-15 13:00	2020-01-15 13:00



Results 3D RRR Queries in a PostgreSQL Environment



Query 2) Showing the sold real estates with an area of more than 120 m2 between the years of 2015-2021: In query 2, both the real estate sold within a certain date range (2015-2021) and those real estates are requested to be larger than 120 m^2 .

Data query result table using PostgreSQL, there are 9 real estate that has an area of more than 120 m^2 .



Right Share Type	Real Estate ID	Share	Parcel No	Block No	Building No	Building Unit ID	Net Area	Storey	Section No	RE Sale Date	
Whole Ownership	68	1	3	600	3013675	51906595	124.38 m2	3	10	2015-08-25 11:18	
Whole Ownership	69	1	3	600	3013675	51906596	120.88 m2	3	11	2015-09-18 10:55	
Whole Ownership	71	1	3	600	3013675	51906598	124.48 m2	4	13	2016-01-22 09:30	
Whole Ownership	73	1	3	600	3013675	51906599	120.88 m2	4	15	2015-03-29 09:55	
Whole Ownership	40	1	2	600	3016815	82738452	246.10 m2	0	18	2018-05-17 09:30	
Whole Ownership	46	1	2	600	3016815	82738441	123.33 m2	2	6	2018-11-26 10:30	
Whole Ownership	48	1	2	600	3016815	82738443	129.40 m2	2	8	2015-05-14 15:30	
Whole Ownership	49	1	2	600	3016815	82738453	127.79 m2	3	9	2016-12-20 09:25	
Whole Ownership	54	1	2	600	3016815	82738448	123.33 m2	4	14	2015-10-12 14:20	





Conclusion





This study proposes a general framework for integrating cadastral information with LADM on the legal objects and CityGML on physical objects.

- An integrated model should be used to represent the physical provisions of legal interests.
- The LADM is used to create 3D terminology and establish a common ontology for the legal side.
- The CityGML is used to represent the physical side of 3D objects and can be integrated into national projects.
- The database design was carried out with PostgreSQL based on the conceptual model.

Thus, it enabled introduction to the Turkish cadastral system in national and international platforms during the transition to 3D cadastre with its legal aspects. With the help of the integrated data model, RRRs on real estate can be queried spatially by SQL querying.

In this context, two important outputs were developed for this study.

- The development of the 3D RRR conceptual model for the Turkish cadastral system using, LADM and CityGML combining legal and physical.
- The development of a 3D database design using PostgreSQL that allows editing and querying of RRR.

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