LADM Valuation Information Model Compliant Prototype for Visualisation and Dissemination of 3D Valuation Units and Groups

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- **3D data in property valuation**

- **LADM Valuation Information Model – Why such a model is required?**

- **A prototype for visualisation and dissemination of 3D valuation units and groups**

  - **A multi-level visualisation prototype proposal for dissemination of property valuation information**

  - **Developed prototype**

- **Conclusion and future work**

3D data in property valuation

The usage of 3D data models in property valuation can be basically grouped in two main categories:

a) supporting **mathematical valuation models with variables** produced through 3D analyses (e.g. view) in order to better estimate the values of properties,

b) consuming 3D data models to **visualise valuation units in 3D** and disseminate values of properties associated with the visualised unit.

In the literature, it is observed that studies generally focused on the first category. **This study focuses on the second category in particular**.

For 3D visualisation and dissemination of valuation information the first requirement may be to **record the valuation information in a well-defined schema** (e.g. database, data exchange forma, etc.)

To disseminate property values, visualization prototypes developed for a different purpose (e.g. **3D cadastre**) are generally utilised. In such approach, **property value is included as a simple attribute attached to the 3D visualised unit** (e.g. **basic cadastral unit**).

This approach works well when **a cadastral registration unit** and **a valuation unit** represent the same object (and share the same conceptualisation)

However, it is not case all time. **The basic registration unit in cadastral systems (e.g. a cadastral parcel) can be different from the basic valuation unit (e.g. building) in several countries.**

- To solve this issue **LADM Valuation Information Model (LADM_VM)** is proposed.
- Since LADM_VM enables to represent valuation units in 3D, **a country profile developed using LADM_VM can be consumed as basis for a 3D visualisation and dissemination prototype for valuation information**.

LADM Valuation Information Model

- The LADM_VM is proposed for a **complete representation of valuation processes** in the context of land administration, including **valuation unit types** (e.g. condominium, building and parcel), **transaction prices**, **valuation unit groups**, **valuation procedures** (mass and individual valuations) and **statistics** on sales and valuation data.

The systematic review of ISO 19152 LADM has been started under ISO TC/211. **The Edition II of LADM will be multi-part standard**. One of the new parts, which is based on LADM_VM, will be possibly about property valuation (**Part 4 – Valuation Information**).
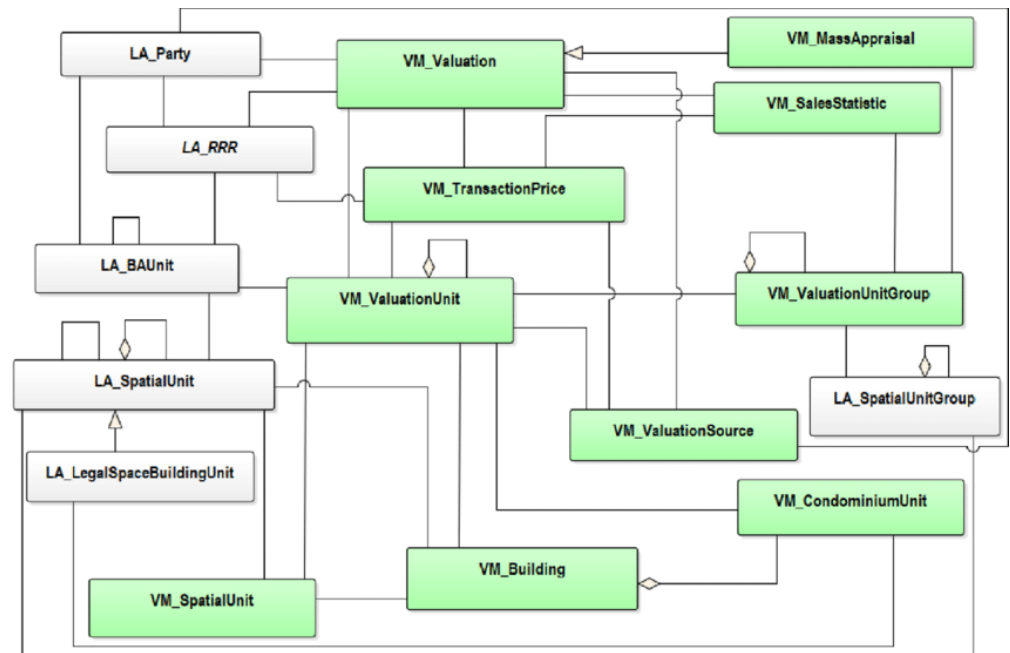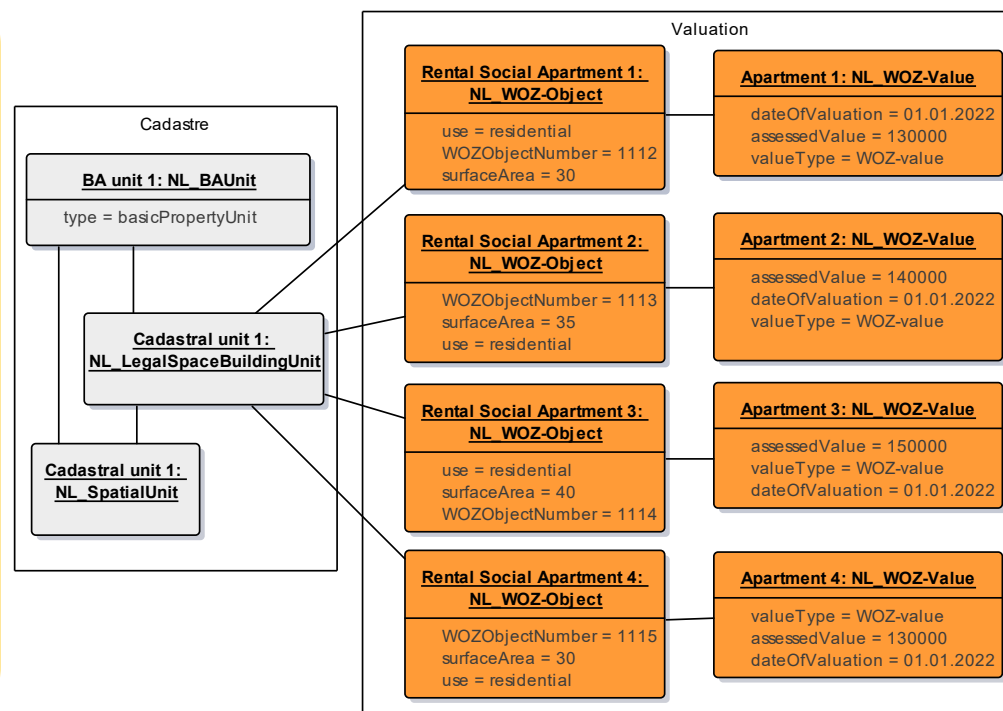

Green: LADM_VM classes
Grey: Core LADM classes

- So far, several country profiles for LADM_VM was developed (i.e. **China, Croatia, the Netherlands, Serbia and Turkey**).
- In this study, **the Netherlands country profile** is utilised in order to to show why such a model is required .

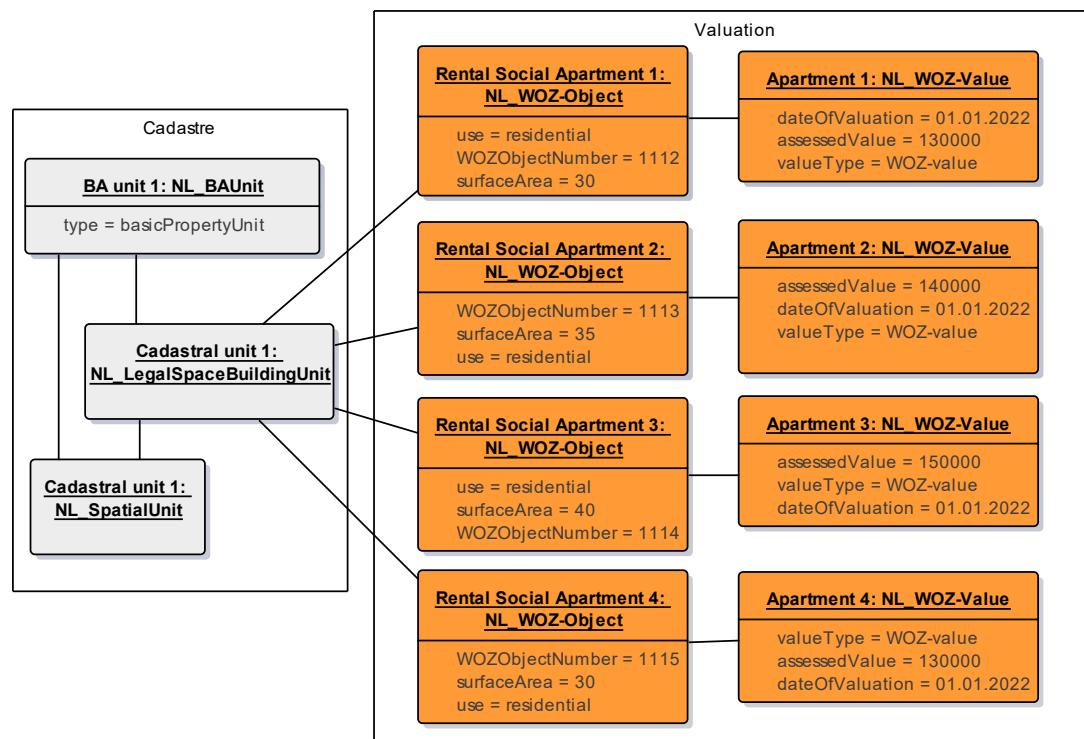**In the Netherlands, cadastral registration units can be different from valuation units in some cases**.

- The relationship between valuation units (**WOZ-objects**) and **cadastral units** (parcels and cadastral apartment rights) is actually very simple.
- **There can be several valuation units on one cadastral parcel for units that are rented out**, for instance houses that are rented out by a **social housing association** or **business units within a multi-company building**

Cadastre

BA unit 1: NL_BAUnit
type = basicPropertyUnit

Cadastral unit 1: NL_LegalSpaceBuildingUnit

Cadastral unit 1: NL_SpatialUnit

Valuation

Rental Social Apartment 1: NL_WOZ-Object
use = residential
WOZObjectNumber = 1112
surfaceArea = 30

Apartment 1: NL_WOZ-Value
dateOfValuation = 01.01.2022
assessedValue = 130000
valueType = WOZ-value

Rental Social Apartment 2: NL_WOZ-Object
WOZObjectNumber = 1113
surfaceArea = 35
use = residential

Apartment 2: NL_WOZ-Value
assessedValue = 140000
dateOfValuation = 01.01.2022
valueType = WOZ-value

Rental Social Apartment 3: NL_WOZ-Object
use = residential
surfaceArea = 40
WOZObjectNumber = 1114

Apartment 3: NL_WOZ-Value
assessedValue = 150000
valueType = WOZ-value
dateOfValuation = 01.01.2022

Rental Social Apartment 4: NL_WOZ-Object
WOZObjectNumber = 1115
surfaceArea = 30
use = residential

Apartment 4: NL_WOZ-Value
valueType = WOZ-value
assessedValue = 130000
dateOfValuation = 01.01.2022

It should be noted that **if adjacent buildings or parcels of land are owned and used by the same person, then these parcels and buildings together form a single WOZ-object**.
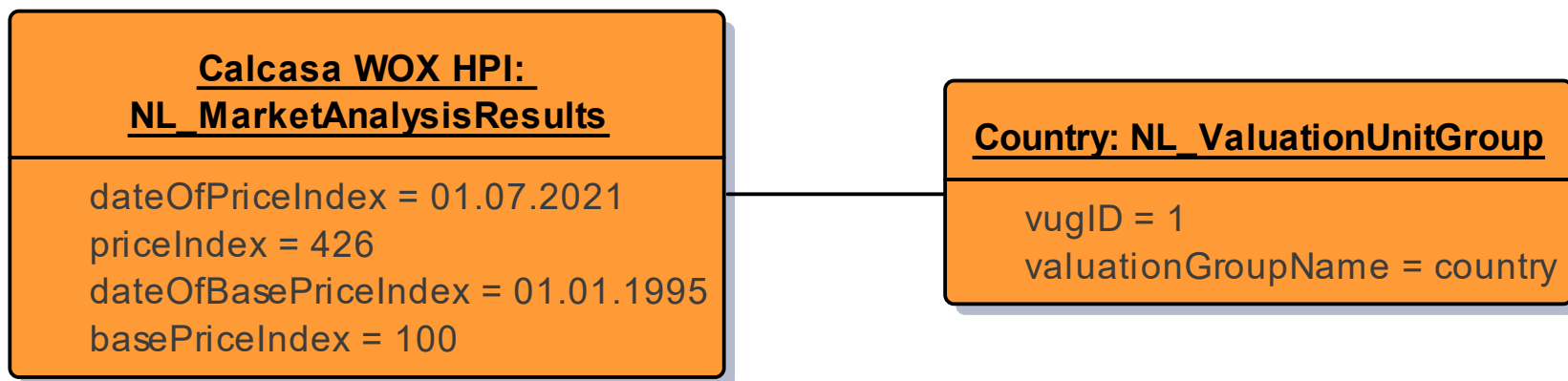
Moreover, **multiple adjacent cadastral parcels that are owned by the same owner constitute one object that is one valuation unit**. This results in a m:n relation between valuation units and cadastral units.

Cadastre

BA unit 1: NL_BAUnit

type = basicPropertyUnit

Cadastral unit 1: NL_LegalSpaceBuildingUnit

Cadastral unit 1: NL_SpatialUnit

Valuation

Rental Social Apartment 1: NL_WOZ-Object

use = residential
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WOZObjectNumber = 1115
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Apartment 4: NL_WOZ-Value

valueType = WOZ-value
assessedValue = 130000
dateOfValuation = 01.01.2022

LADM_VM can also be used to **record sales/valuations statistics** related to a valuation units group (e.g. neighbourhood, municipality, district and country).

The diagram below shows basePriceIndex and dateOfBasePriceIndex attributes to record the value and date for specification of the base index (e.g. **Base Index Value = 100 at 1995 January**), and priceIndex and dateOfPriceIndex attributes to record the calculated price index at a given date (e.g. **Index Value = 426 at 2021 July**).

Calcasa WOX HPI: NL_MarketAnalysisResults

dateOfPriceIndex = 01.07.2021
priceIndex = 426
dateOfBasePriceIndex = 01.01.1995
basePriceIndex = 100

Country: NL_ValuationUnitGroup

vugID = 1
valuationGroupName = country

A prototype for visualisation and dissemination of 3D valuation units and groups

A schema produced through LADM_VM country profile and enriched with real data sets **can be directly used as basis to developed a prototype for the visualisation of valuation units in 3D and dissemination of them on the Web**.

In this study, **the Netherlands LADM_VM country profile** (see Kara et al., 2019) is used to developed the prototype.

In the Netherlands, **assessed values** together with **valuation dates** and some characteristics (e.g. **construction year**, **property function/type**, **floor size**) of **residential properties** are **publicly disseminated** through **footprints of apartment buildings** ('WOZ-waardeloket' - https://www.wozwaardeloket.nl/).

The Central Agency for Statistics (CBS) regularly publishes **statistical analyses on house price changes** (e.g. Price index of existing own homes, Price index purchase prices). **The shared statistical analyses is just textual information**, **not associated with spatial (legal) component(s) of valuation information.**

Publishing statistical analyses associated with 3D visualised valuation units and valuation unit groups may increase the **transparency, reliability** and **communication level between users**.

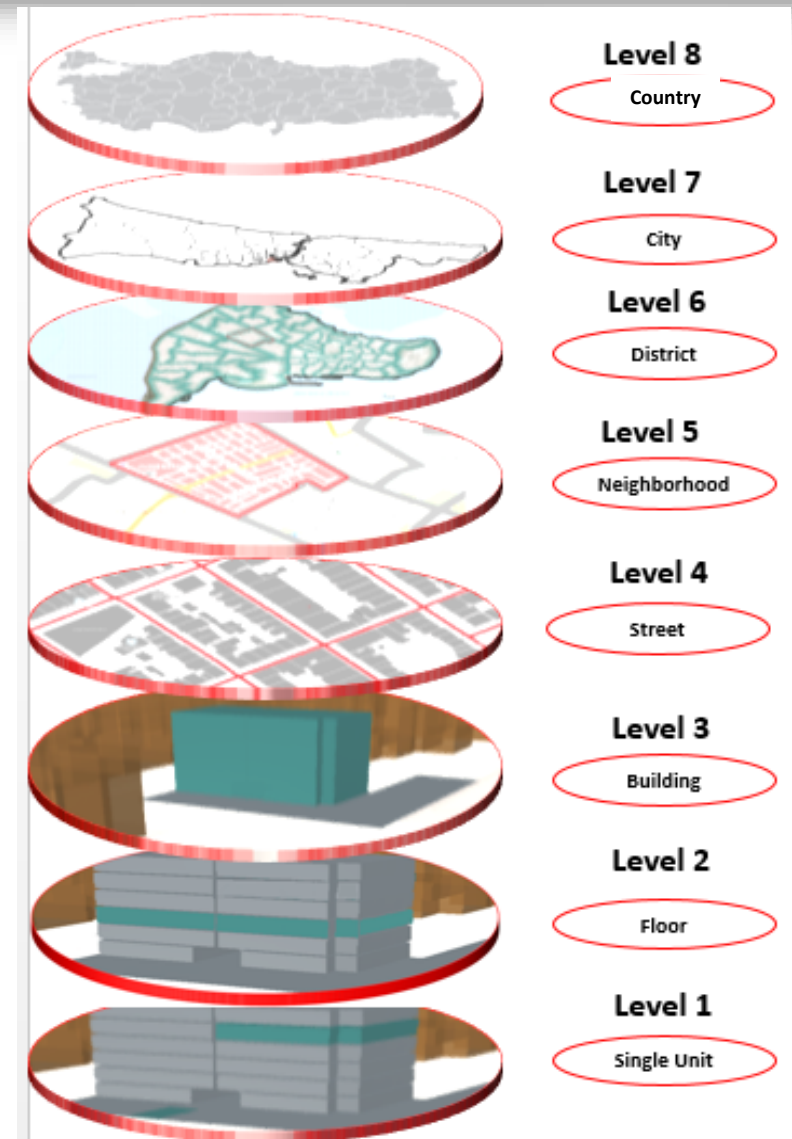cbs.nl/en-gb/figures/detail/83906ENG

Existing own homes; purchase prices, price indices 2015=100

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[Edit table] [Download CSV] [Show description]

Periods	Price index of existing own homes (2015=100)	Changes compared to the previous period (%)	Changes compared to the previous year (%)	Number of sold dwellings (number)	Changes compared to the previous period (%)	Changes compared to the previous year (%)	Average purchase price (euros)	Total value purchase prices (million euros)
1995	42.5			154,568			93,750	14,491
2000	80.5	18.2	18.2	189,358	-7.4	-7.4	172,050	32,579
2005	106.6	3.9	3.9	206,629	7.7	7.7	222,706	46,017
2010	115.0	-2.2	-2.2	126,127	-1.1	-1.1	239,530	30,211
2015	100.0	2.8	2.8	178,293	16.1	16.1	230,194	41,042
2016	105.0	5.0	5.0	214,793	20.5	20.5	243,837	52,374
2017	113.0	7.6	7.6	241,860	12.6	12.6	263,295	63,680
2018	123.2	9.0	9.0	218,491	-9.7	-9.7	287,267	62,765
2019	131.7	6.9	6.9	218,595	0.0	0.0	307,978	67,322
2020	141.9	7.8	7.8	235,511	7.7	7.7	334,488	78,776
2021 January	149.7	2.5	9.5	24,516	-6.5	39.9	357,458	8,763
2021 February	151.4	1.2	10.4	16,871	-31.2	9.4	369,070	6,227
2021 March	153.9	1.6	11.5	25,240	49.6	55.5	407,014	10,275
2021 April	155.3	0.9	11.5	18,954	-24.9	0.5	362,525	6,871
2021 May	158.4	2.0	12.9	16,126	-14.9	-12.1	361,001	5,822
2021 June	161.4	1.9	14.6	17,707	9.8	-0.1	373,584	6,612
2021 July	165.3	2.4	16.3	19,043	7.5	-15.6	395,786	7,537
2021 August	168.9	2.1	17.8	17,257	-9.4	-9.3	402,308	6,943
2021 September	171.5	1.6	18.5	17,575	1.8	-14.7	405,165	7,121
2021 October	173.2	1.0	18.3	16,191	-7.9	-26.9	408,987	6,622
2021 November	176.3	1.8	20.1	16,048	-0.9	-13.0	403,941	6,482
2021 December	175.8	-0.5	20.4	20,559	28.1	-21.6	396,848	8,159

For effective and efficient sharing of valuation/sales data, Kara et al. (2021) propose a classification for the **aggregation of valuation units into valuation units groups**. This classification can be used as basis to develop a prototype for dissemination of valuation information.

Level 8 — Country
Level 7 — City
Level 6 — District
Level 5 — Neighborhood
Level 4 — Street
Level 3 — Building
Level 2 — Floor
Level 1 — Single Unit

A multi-level visualisation prototype proposal for dissemination of valuation information

The **proposed levels may vary in different countries because of administrative classifications**. Therefore, each country may add new levels to the proposed structure. For example, **two extra levels** (i.e. province and region) are added to the proposed classification for the Netherlands.
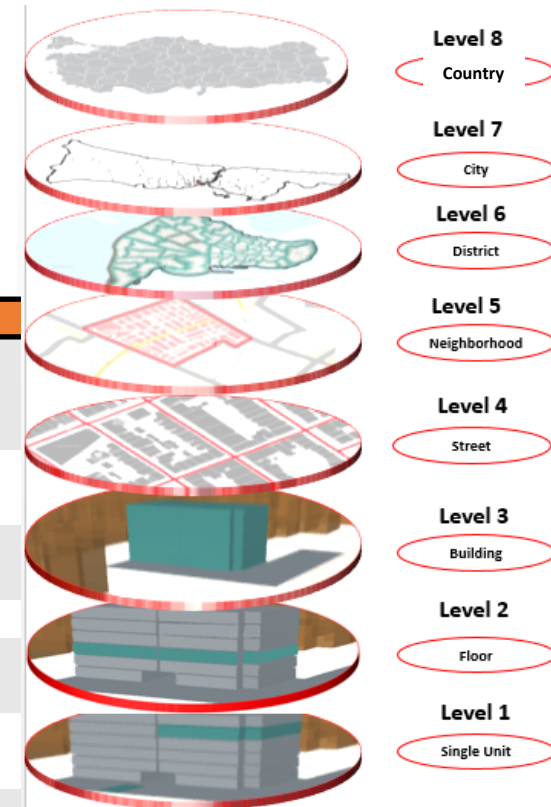
Levels	Attributes
Level 1 – Single unit (condominium, apartment, residence unit)	WOZ-value, date, floor area, use type, energy label, …
Level 2 – Building floor	Average WOZ-value, date, average WOZ-value per square meter, average floor area, …
Level 3 – Building (multi-occupied building)	Average WOZ-value, average WOZ-value per square meter, total unit number, average floor area, energy label, …
Level 4 – Street	Average WOZ-value, date, average building age, use types, …
Level 5 – Neighbourhood	Average WOZ-value, date, average building age, use types, index value, index date …
Level 6 – District	Average WOZ-value, date, average building age, use types, index value, index date …
Level 7 – Municipality	Average WOZ-value, date, average building age, use types, index value, index date, …
Level 8 – Province	Average WOZ-value, date, index value, index date, …
Level 9 – Region	Average WOZ-value, date, index value, index date, …
Level 10 – Country	Average WOZ-value, date, index value, index date, …

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Papendrecht is selected as study area. It is a town in the **province of South Holland**. In the municipality of Papendrecht there are **15.000 valuation units**.
For the prototype developed, 4 adjoined multi-occupied buildings were chosen as a starting point.

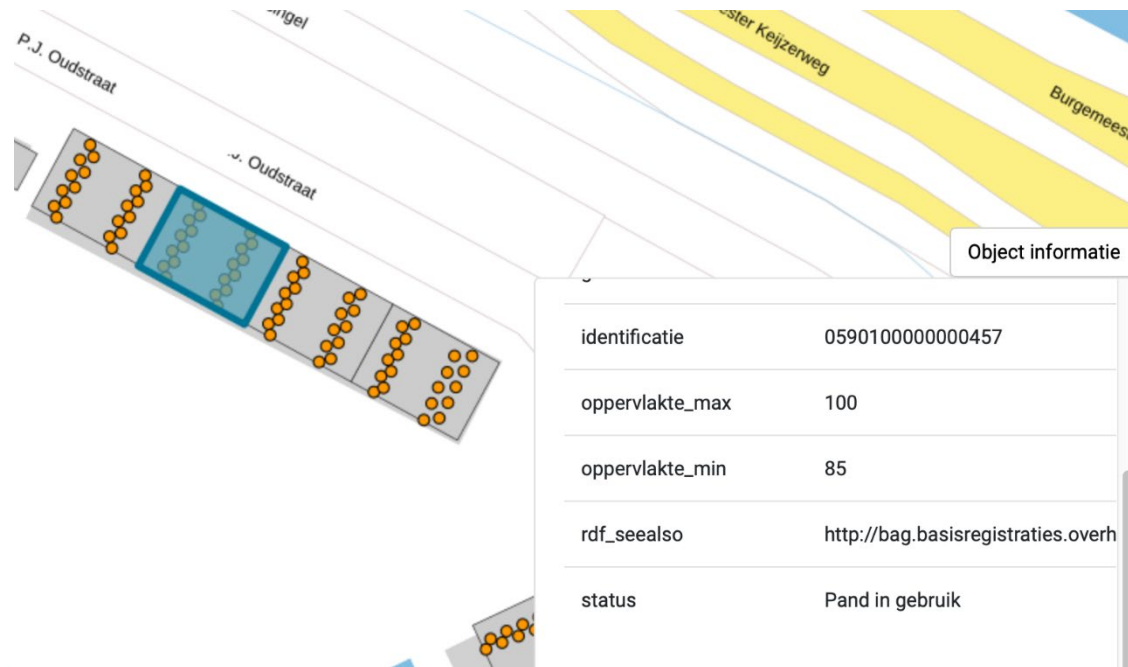Selected multi- occupied buildings for prototype (source: Google)

- The Netherlands has a well-established addressing system that is kept and presented in a national data set called the **Addresses and Buildings Key Register** (**BAG**).

- BAG provides **2D geometries** and **some basic attributes of buildings** such as **year of construction**, **purpose of use**, **total number of building units** and **status of the buildings**.
- However, the **building height**, **number of floors**, and **number of residential units per floor** are not included in this register.

BAG also provides **information on residence units as well**, such as **area**, **status**, **address information** (house number, house letter, postal code, public space, residence area). **The residence units are geometrically represented as points on building foorprints.**

For 3D visualization of residence units
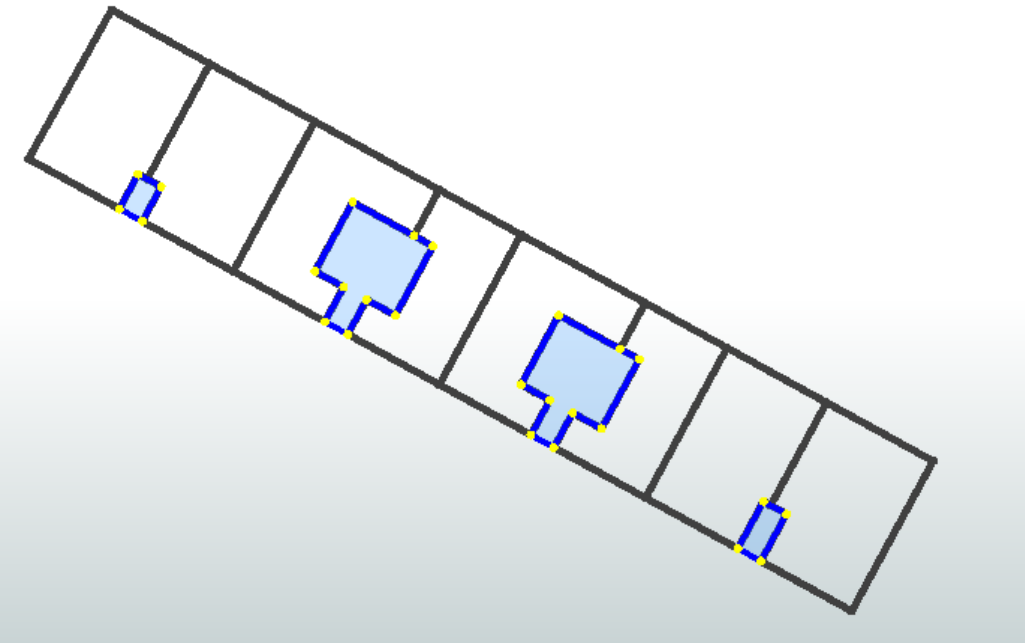
(a) **total residence unit number of each building**: obtained from BAG

(b) **total residence units on a floor**: estimated considering total floor number and BAG data

(c) **total number of floors**: estimated through AHN data (national height data) and photo of the buildings.

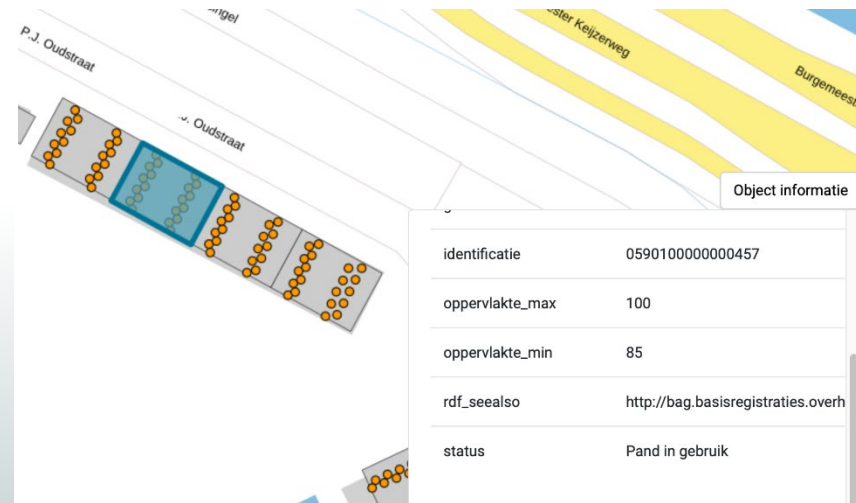(d) **height of buildings**: obtained from 3D BAG (produced using the national height data AHN)

| Object informatie	
identificatie	0590100000000457
oppervlakte_max	100
oppervlakte_min	85
rdf_seealso	http://bag.basisregistraties.overh
status	Pand in gebruik

BAG data of the selected buildings and residence units

(e) height of each floor in the buildings: estimated through buildings' height and total floor number.

(f) footprints of residence units and common places: estimated through the area of residential units (obtained from BAG) and foorprint area of the buildings.

(g) direction of residence units: estimated using BAG data (the locations of points that represent the residence units in BAG is considered consistent with the reality)

Estimated footprints of residence units and common places

|	
identificatie	0590100000000457
oppervlakte_max	100
oppervlakte_min	85
rdf_seealso	http://bag.basisregistraties.overh
status	Pand in gebruik

(h) the values (WOZ-value) of each residence unit: obtained from WOZ register (values between 2014 and 2020)
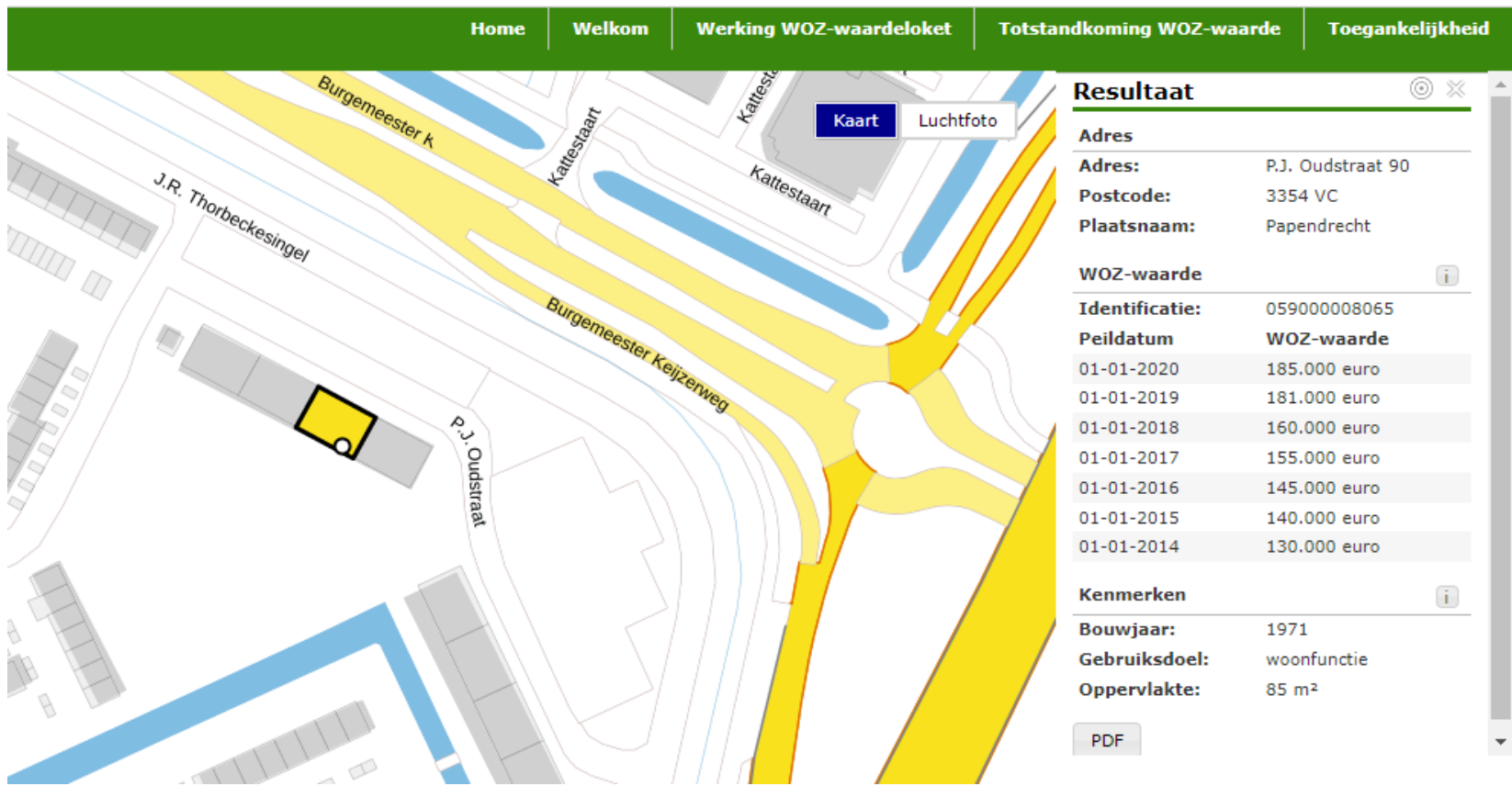
WOZ register view of the selected building

- Six different levels can be implemented for the selected study area.
- It is noted that only two levels (i.e. single unit and building) are fully implemented so far.
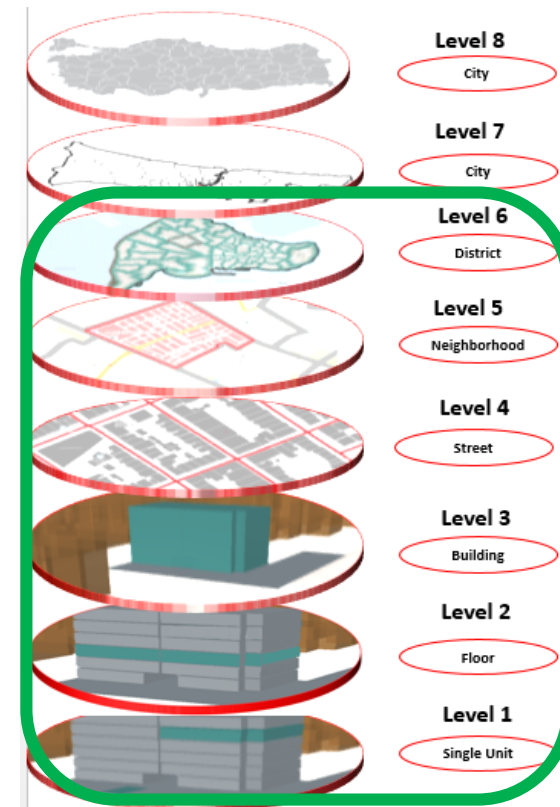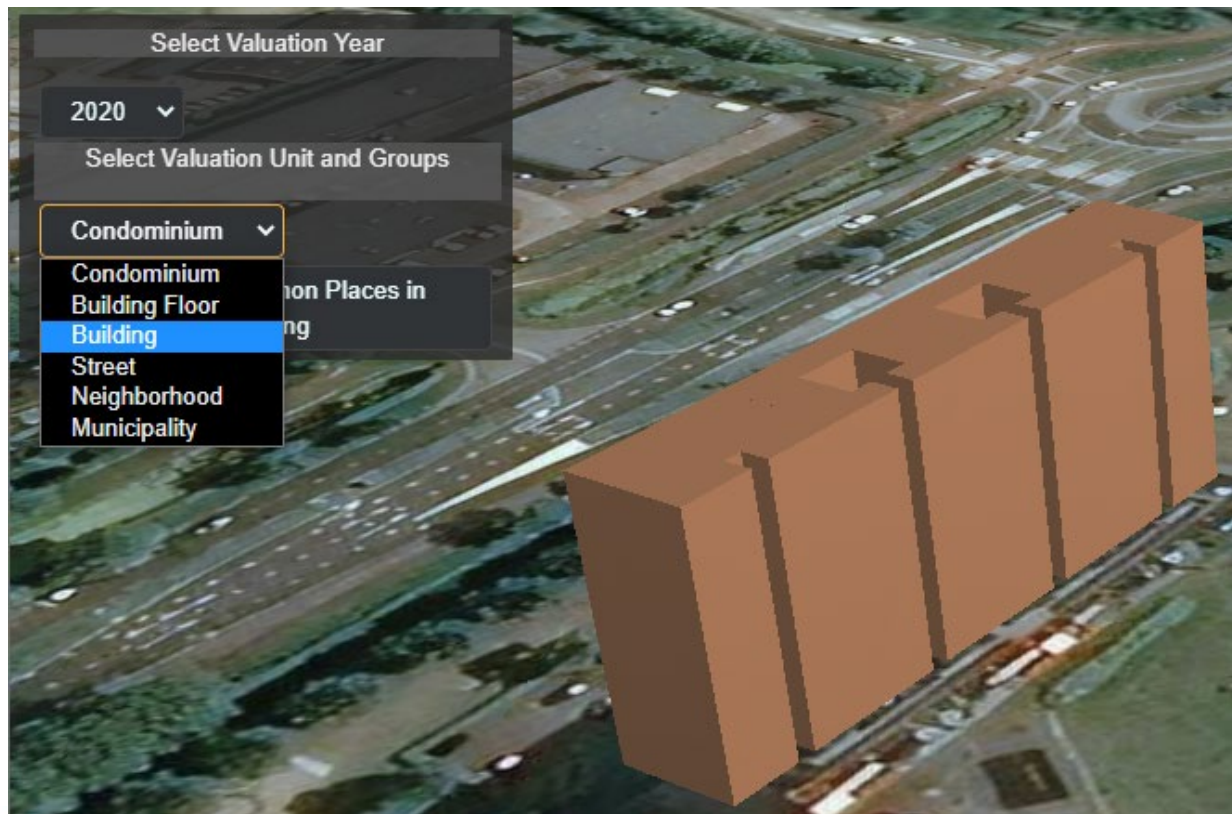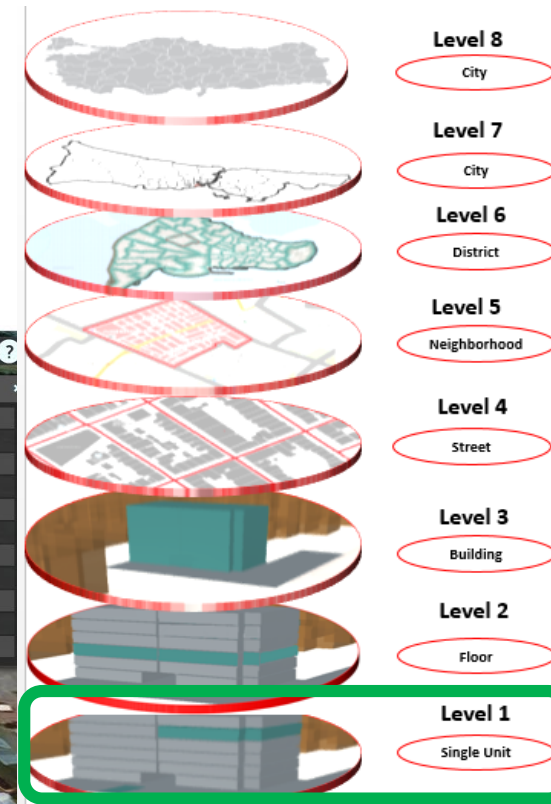
The prototype allows users to query the values for each residence unit in a selected year (between 2014 and 2020)

Attributes of a residence unit and its value in 2017

Level 8	City
Level 7	City
Level 6	District
Level 5	Neighborhood
Level 4	Street
Level 3	Building
Level 2	Floor
Level 1	Single Unit

Select Valuation Year
2017

Select Valuation Unit and Groups
Condominium
☐ Show Common Places in Building

3354VB

Condominium Id	0590010000010732
Purpose of use	woonfunctie
Status	Verblijfsobject in gebruik
Public Space	P.J. Oudstraat
Building ID	0590100000000457
Year of construction	1971
Post code	3354VB
Floor Number	8
House Number	74
Area (m²)	100
Value	170000 euro

The average residence unit values and values per square meter for each building in each year is calculated and shared in building level implementation.

Select Valuation Year
2020
Select Valuation Unit and Groups
Building
☐ Show Common Places in Building

0590100000000457	
Building ID	0590100000000457
Purpose of use	woonfunctie
Status	Pand in gebruik
Year of construction	1971
Min area (m²)	85
Max area (m²)	100
Number of condominiums	20
Value (mean)	205000 euro
Value (per m²)	2050 euro

Level 8 — City
Level 7 — City
Level 6 — District
Level 5 — Neighborhood
Level 4 — Street
Level 3 — Building
Level 2 — Floor
Level 1 — Single Unit

Conclusion and Future Works

- In this study, **an initial prototype system** to disseminate valuation information through 3D single valuation units (e.g. residence unit) and valuation unit groups (e.g. multi-occupied building) for the Netherlands is developed based on a **proposed classification for the aggregation of valuation units into valuation units groups** and **using open datasets with some assumptions**.

- **LADM_VM based country profile** can be directly used **as basis to develop a prototype** for the dissemination of valuation information.

- When developing the prototype, **the half of the efforts are devoted to data collection** (query restriction in WOZ register). Therefore, a collabration with Papendrecht Municipality can speed up the development process.

- Assumptions are made to visualize multi-occupied building in 3D, some of them sustainable some of them not (e.g. determining number of floor in buildings). They should be refined.

Future works

- This is an **ongoing work**. The developed prototype is not completed yet and there is a lot still to be done (e.g. implement all proposed levels).

- Further research questions: (a) is privacy an issue to disseminate valuation information associated with 3D visualised valuation units (e.g. apartment), more than visualizing the value on a 2D map? (b) how can the possible value of airspace or underground areas be included in such a prototype?

Thank you for your attention!