06.10.1 Building Heights 2023

Introduction

There are several Environmental Atlas topics that detail Berlin's urban development and its effects both on the residential structure and the distribution and use of non-built-up areas:

- the Actual-Use maps and
- the Urban Structure / Urban Structure - Area Types Differentiated maps.

In addition to this information, the Urban Structural Density maps assess the degree of building use.

These individual separate findings, however, only provide limited insight into the vertical extent of the natural or artificial structures in the city. For this reason, the Environmental Atlas presents the height development of buildings ("Building Heights" map (06.10.1)) and that of vegetation ("Vegetation Heights" map (06.10.2)) in two topics.

Precise and detailed information on the height and structure of buildings and of vegetation areas may prove to be important in many a situation. There is a multitude of applications for these datasets. For built-up areas, for example, they may provide information for

- expert evaluations, e.g. registers of solar or green roof potential, or heat registers,
- urban climate modelling in the context of microclimates,
- detailed assessments of the extent of air and noise pollution in residential areas, and
- visualisations for a variety of planning projects.

The accuracy of each model strongly depends on the quality of the input data. For example, to enable a detailed calculation of the course of air channels and ventilation conditions, accurate information on the aerodynamic surface roughness, including its geometric dimensions, has to be available. Elevated objects, such as buildings or entire blocks of buildings, as well as high and dense tree structures present obstacles. They may have a wind-breaking effect or eliminate wind completely; or else these obstacles may have a channelling effect, accelerating the wind flow.

The first joint "Building and Vegetation Heights" map (06.10) was produced in 2009/ 2010, as part of a project with the Institute of Optical Sensor Systems of the German Aerospace Center (DLR). Today, an official, **regularly updated 3D building model in LoD2** is available for Berlin's building stock. The Environmental Atlas' two-dimensional geodatabase "Building Heights" (06.10.1) was developed using this model as a basis. The "Vegetation Heights" (06.10.2) map that complements the "Building Heights" map, however, is still based on the Environmental Atlas' own analysis of aerial photography data obtained during the respective summer flights.

Statistical Base

The map was developed based on the dataset of the

- three-dimensional building models of the State of Berlin in Level of Detail 2 (LoD2)

This dataset is not yet available via the Geoportal Berlin as a detailed map (as of August 2023). It is exclusively available via the download service.
The version of the LoD2 used here is based on the building data of the Official Real Estate Cadastre Information System (ALKIS), which refers to the **floor plan update of May 10, 2023** as recorded in the system. The difference between the LoD2 building stock and that of the current version of ALKIS is illustrated in the Berlin Geoportal, represented by the buildings that show through from the map in the background, which are not included in the Building Heights map. The planned annual update of the data stock will, however, gradually close these gaps.

Methodology

Different levels of detail (LoD) are distinguished for 3D models of the building exterior. The most important levels are:

- LoD1: all buildings and structures are represented as simple blocks, actual roof shapes are disregarded,
- LoD2: in addition to the LoD1 differentiation, standardised roof shapes are modelled,
- LoD3: in addition to the LoD2 differentiation, building walls include cutouts for doors and windows at this level. LoD3 is also referred to as the architectural model.

Fig. 1: Levels of Detail / LoD of 3D building models (Akmalia, R. et al. 2014)

Most official 3D building models either use LoD1 or LoD2.

The website of the Working Committee of the Surveying Authorities of the Laender of the Federal Republic of Germany provides a good overview of the basics and potential applications – information from the AdV.

An LoD2 building model for Berlin may be downloaded from the Geoportal Berlin (only in German). A map version is not available.

The LoD2 is derived from the relevant data and the building floor plans presented in ALKIS. The standardised roof shape is determined automatically, based on the digital surface model (DSM) or the image based surface model (iDSM). The height of the building as a whole or individual parts thereof are derived from the ridge height. The terrain elevation, i.e. the lower boundary of the building models, is obtained by intersecting the floor plans with the digital terrain model with a resolution of 1 m (DTM1). All data bases used to develop the building model may also be accessed free of charge at the Geoportal Berlin.

The 3D data was converted into a two-dimensional representation for the Environmental Atlas map.

The “(ridge) height” attribute information was adopted as is into the classified representation for all of the approximately 850,000 objects of the **ALKIS “buildings” class** (buildings and parts of buildings – defined according to ALKIS’ object type catalogue, only in German, cf. Figure 2). This information represents the calculated difference in metres between the highest reference point and the lowest reference point of the building or part thereof.

This data is supplemented by about 110,000 objects of the **ALKIS “structures” object type** (cf. Figure 3). These include a wide range of categories such as “towers”, “cranes” and “masts” of various types, “stadiums” including “stands”, historical buildings and objects as well as other building structures and facilities, which also contain “roofing” and “carports”.

This map does not display objects assigned to the categories “Function 51009_1750” – “Monument, memorial stone, statue”, which comprise around 7,700 objects and cover a total area of around 32 ha. The majority of these are not actual buildings but objects outside the building cubature, such as the “Holocaust Memorial”, the “Parliament of Trees”, the “Sophien-Kirchhof 1” (churchyard of the Sophienkirche) or the “Lilienthal-Gedenkstätte” (Otto Lilienthal memorial) in Berlin-Lichterfelde.

Any object that is part of the object type area “Buildings, facilities and other information” and has a calculated height of below 2 m is disregarded. The number of objects from the general LoD2 database thus omitted amounts to about 10 % of the total data with 110,000 objects in this object type group.

Fig. 2: Object distribution of the "Buildings" and "Parts of buildings" object type areas in the database of the LoD2 Berlin 3D building model (as of May 10, 2023)

Fig. 3: Object distribution of the "Buildings" object type area in the database of the LoD2 Berlin 3D building model (as of May 10, 2023)

Map Description

The vertical extent of Berlin's buildings is intertwined with the building history of the city, which includes the reconstruction measures after World War II. The descriptions for the Environmental Atlas maps "Urban Structure" (06.07) and "Urban Structure – Area Types Differentiated" (06.08) provide detailed information on the settlement development of the city. Berlin gained more political and economic importance swiftly, especially after the founding of the German Empire in 1871. Settlement therefore developed just as rapidly throughout the various building eras.

The publication "Berliner Pläne 1862-1994" (Berlin plans, only in German, SenStadt 2002) provides another detailed account of Berlin's building history.

The typical Berlin **block development** dominated tenement housing, initially only within the area of the Circle Line, which opened in 1877, later well beyond it and in some areas it has up to the present day. From 1853, the 'Baupolizeiordnung' (building regulations) laid down the height of buildings for Berlin amongst other things. It set the Berlin **eaves height at 22 m**, which still applies today in general (the map shows the calculated height of the building's roof ridge, however). Including the basement, this usually provides space for six to seven storeys in a building.

As a result of this regulation and the fact that the reconstruction after World War II also returned to the previous floor plans and height structures of existing buildings to a great extent, large parts of Berlin's inner city, even today, display a relatively uniform roofscape.

Approximately 3,400 ha, and thus about 10 % of the Urban and Environment Information System's (ISU) residential area types are part of the old building quarters in the inner city. They are directly affected by the eaves height restriction (cf. Map 06.08 "Urban Structure – Area Types Differentiated" as well as Figure 4 and Table 1).

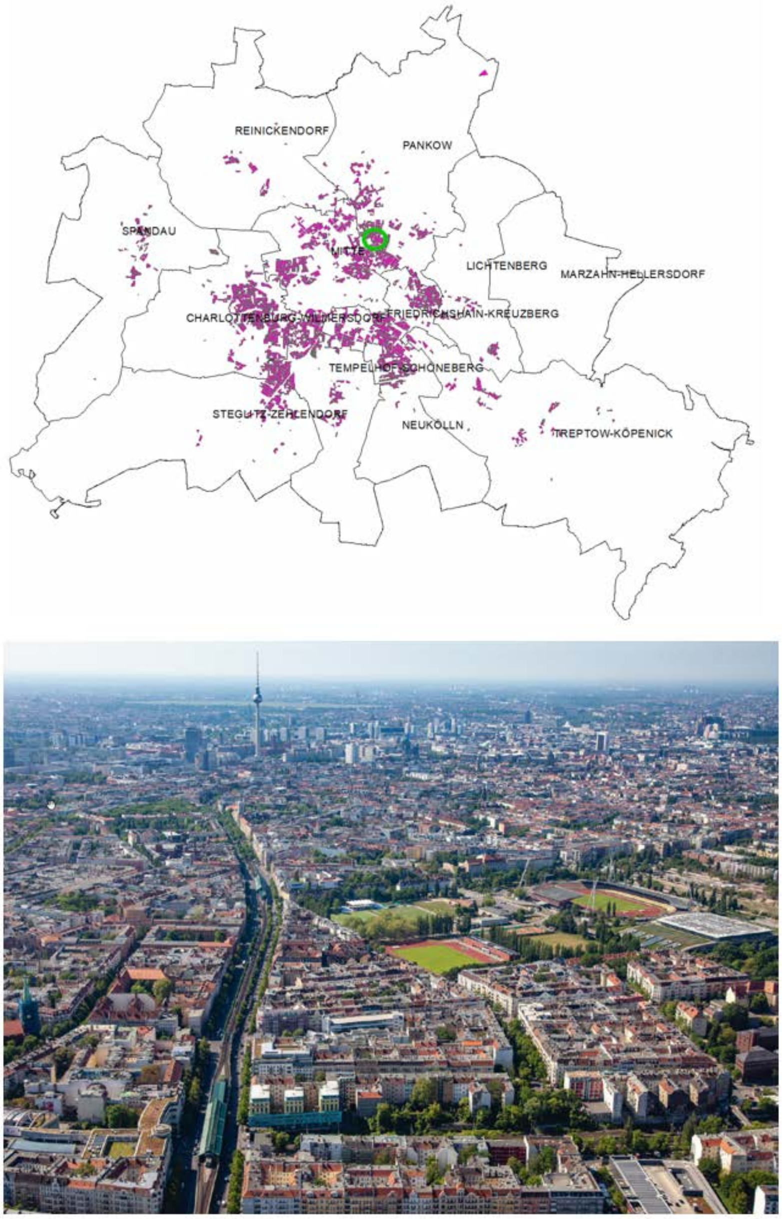

Fig. 4: top: Distribution of the block and block-edge development area types (types 1, 2, 3, 7) in Berlin (green circle: location of the area depicted in the photo); bottom: view from the North facing the TV tower / Alexanderplatz along Schönhauser Allee (centre right: Friedrich-Ludwig-Jahn Stadion (stadium)) (Photo: SenSBW, Dirk Laubner).

Both in terms of their location and the time of their origin, these old quarters contrast the types of single-family housing estates, as well as row houses and duplexes. Situated predominantly on the outskirts of the city, the latter account for about 45 % of the block (segment) areas that are assigned to area types of residential development and cover an area of about 11,500 ha. Here, buildings with ridge heights of up to about 12 m dominate the settlement pattern (cf. Figure 5 and Table 1).

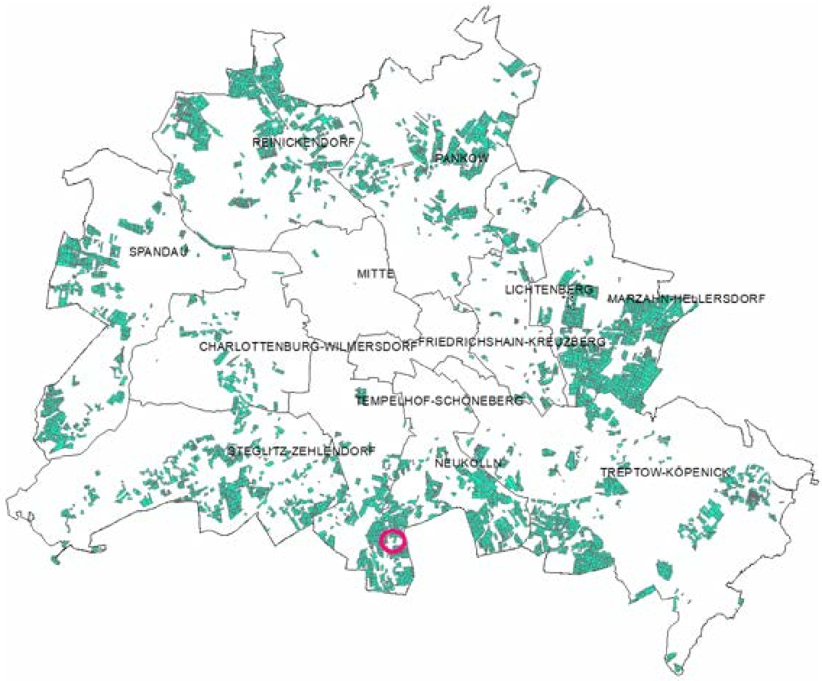

Fig. 5: top: Distribution of area types 22 "Row houses and duplexes" and 23 "Detached single-family homes with yards" in Berlin (red circle: location of the area depicted in the aerial photograph); bottom: Section of aerial photograph on the southern edge of the city (Lichtenrade district) (Aerial photograph: Geoportal Berlin, TrueDOP20RGB – summer flight).

In **residential development**, area type 9, "Large estate with tower high-rise buildings (1960s-1990), 4-11 storeys and more", contains the **highest single buildings**. When looking at the area types at an aggregated level of block (segment) areas, however, this is indiscernible, due to the large share of smaller (ancillary) buildings (cf. Table 1).

Although Berlin only has a small number of exposed high-rise buildings compared to other metropolises (cf. Figure 6), it does, however, feature Germany's tallest structure, the TV Tower, at Alexanderplatz (total height 368 m, recorded shaft height according to LoD2: 253 m).

Fig. 6: Location of completed buildings and structures with a minimum height of 100 m in Berlin, displaying core areas only, due to scale (as of April 7, 2021)

The following buildings and building complexes, for example, exceed 100 m in height:

- Reuter West combined heat and power plant (cf. Figure 7),
- Bahn Tower and Kollhoff Tower at Potsdamer Platz
- Potsdamer Platz
- Ku'damm-Karree-Hochhaus (high-rise building part of the Ku'damm Karree building complex)
- Treptowers (complex of high-rise buildings in Treptow)
- Zoofenster and Upper West in City West (two high-rise buildings in the western part of central Berlin) (cf. Fig 8)
- Park Inn Hotel

as well as the two towers:

- TV tower at Alexanderplatz and
- Fernmeldeturm Schäferberg (telecommunications tower atop Schäferberg hill).

Fig. 7: Reuter West combined heat and power plant, view from the south-east, photo taken in 2005 (Photo: Partner für Berlin/FTB-Werbefotografie)

Fig. 8: “Upper West” and “Zoofenster” high-rise buildings on Breitscheidplatz, 2022 (Photo: Kathrin Schellhardt)

Table 1 presents the classification of the mean building heights and additional statistical parameters. It focusses on area types at the level of block (segment) areas, based on the Urban and Environmental Information System (ISU). It is striking that even types with large (expected) building heights (e.g. area type 9, “Large estate with tower high-rise buildings (1960s-1990s), 4-11 storeys and more” and area type 29 “Core area”) display an ‘unremarkable’ mean height. This is mainly because individual heights vary greatly, as blocks or block segment areas of these area types contain a large share of low buildings or parts of buildings. The maximum heights of these area types, however, match the expected heights (89 m for type 9 and 123 m single building height for type 29).

Tab. 1: Key characteristics of area types with structural character (as of April 2021)

Area type[1]		Area covered by buildings (m²)	Area covered by buildings (ha)	Total area per type (ha)	Share (%) of the total area that is covered by buildings	Maximum height (m)	Mean height (m)	Height standard deviation	5th percentile (m)	95th percentile (m)	No. of buildings / parts of buildings per type
1	Dense block development, closed rear courtyards (1870s-1918), 5-6 storeys	1,761,654.8	176.2	278.00	63.4	42.65	21.89	4.5535	7.71	25.34	13,323
2	Closed block development, rear courtyards (1870s-1918), 5-storeys	8,805,991.8	880.6	1,655.00	53.2	48.69	20.48	5.6710	5.12	25.11	66,663
3	Closed and semi-open block construction, decorative and garden courtyards (1870s-1918), 4-storeys	2,621,869.8	262.2	648	40.5	53.66	17.44	5.3441	4.57	22.07	20,155
6	Mixed development, semi-open and open shed courtyard, 2-4 storeys	640,943.0	64.1	196	32.7	40.79	12.52	5.2151	3.78	19.34	6,078
7	De-cored block edge development, post-1945 gap closures	3,452,546.9	345.3	841	41.1	58.16	18.89	6.2754	4.65	25.39	26,034
8	Heterogeneous inner-city mixed development, post-1945 gap closures	1,066,258.3	106.6	278	38.4	80.13	18.22	7.8464	4.19	25.56	7,863
9	Large estate with tower high-rise buildings (1960s-1990s), 4-11 storeys and more	4,962,133.1	496.2	2,390	20.8	89.25	21.79	12.2447	3.77	42.51	28,500
10	Block-edge development with large quadrangles (1920-1940s), 2-5 storeys	2,937,654.4	293.8	850	34.6	63.82	17.60	4.7924	6.85	23.12	16,114
11	Free row development, landscaped residential greenery (1950s-1970s), 2-6 storeys	5,104,599.7	510.5	2,468	20.7	69.91	14.48	5.8031	4.25	23.41	29,981
12	Old school (built before 1945)	819,501.1	82.0	320	25.6	46.34	16.92	7.5147	4.04	26.66	4,614
13	New school (built after 1945)	2,093,422.9	209.3	969	21.6	72.78	11.10	6.5172	3.77	22.46	8,833
21	Village-like mixed development	639,346.3	63.9	394	16.2	24.94	8.51	3.0645	3.74	13.21	6,754
22	Row houses and duplexes with yards	3,009,871.8	301.0	1,807	16.7	41.07	9.10	2.8289	3.85	12.73	52,815
23	Detached single-family homes with yards	14,574,100.2	1,457.4	9,689	15.0	35.17	8.33	3.0302	3.74	12.55	223,596
24	Villas and town villas with park-like gardens (mostly 1870s-1945)	2,727,538.6	272.8	1,526	17.9	42.67	11.10	4.0849	3.91	16.68	37,535
25	Densification in single-family home areas, mixed development with yards and semi-private greening (1870s to present)	1,868,335.9	186.8	944	19.8	43.58	10.91	3.9625	3.67	22.23	21,570
29	Core area	2,283,886.7	228.4	407	56.1	123.47	21.89	12.4892	4.57	37.35	10,478
30	Commercial and industrial area, large-scale retail, sparse development	11,271,561.4	1,127.2	4,349	25.9	86.72	10.65	6.7937	3.82	22.95	26,478
31	Commercial and industrial area, large-scale retail, dense development	4,637,137.6	463.7	939	49.4	80.54	12.53	8.8764	4.13	28.25	8,891
32	Utility area	1,137,062.3	113.7	751	15.1	136.89	14.80	12.2138	3.96	36.51	3,702
33	Non-residential mixed use area, sparse development	1,307,557.8	130.8	472	27.7	75.64	11.62	6.2292	3.83	21.68	8,803
38	Non-residential mixed use area, dense development	577,732.6	57.8	136	42.5	60.72	16.46	8.0237	3.65	11.95	3,629
41	Security and order	899,137.3	89.9	582	15.4	49.22	12.99	6.9479	3.95	24.52	2,645
43	Administrative	1,071,173.6	107.1	322	33.3	98.60	20.68	10.0546	4.15	31.40	3,876
44	University and research	1,096,182.5	109.6	487	22.5	61.05	14.00	7.8067	4.05	27.48	4,236
45	Culture	573,090.2	57.3	295	19.4	79.16	16.70	8.9351	3.64	26.38	2,230
46	Hospital	1,182,400.8	118.2	565	20.9	83.62	14.78	7.6704	3.99	25.44	5,331
47	Children’s day care centre	277,325.2	27.7	205	13.5	64.75	9.61	6.2962	3.92	21.82	1,528
49	Church	176,636.1	17.7	103	17.1	85.35	16.40	9.5884	3.83	28.17	1,200
51	Other youth facility	132,809.2	13.3	172	7.7	26.54	8.54	5.0750	3.63	19.04	874
59	Weekend cottage and allotment-garden-type area	390,603.0	39.1	851	4.6	34.94	6.03	4.8486	3.57	20.98	7,578
60	Other and miscellaneous public facility/ special use area	1,378,756.9	137.9	885	15.6	253.40	14.64	8.1346	3.81	24.21	6,564
72	Parallel row buildings with architectural green strips (1920-1930s), 2-5 storeys	1,649,534.3	165.0	635	26.0	33.51	15.15	4.5308	4.80	20.35	10,390
73	Rental-flat buildings of the 1990s and later	2,940,741.6	294.1	1,166	25.2	64.83	15.80	5.6796	5.07	23.43	28,145
92	Railway station and railway ground, without track area	570,259.3	57.0	367	15.5	59.65	14.09	8.9763	3.94	26.61	1,243
93	Airport	166,065.8	16.6	444	3.7	40.11	9.96	6.6863	3.78	25.71	264

[1] Only buildings higher than 3.50 m and area types with a building share of more than 10% were taken into account.

Tab. 1: Mean building heights and other statistical parameters per area type with structural character (area type mapping as of December 31, 2020, building heights according to LoD2 as of April 6, 2021).

The variance, also evident in Table 1, is illustrated by Figure 9 with the help of three examples and their distribution reflected by means and the standard deviation. While the means of the selected area types are almost identical (cf. Table 1), they differ greatly in their variance. For type 1 “Dense block development, closed rear courtyards (1870s-1918), 5-6 storeys”, the respective building heights hover around the mean (smallest standard deviation), while for type 9 “Large estate with tower high-rise buildings (1960s-1990s), 4-11 storeys and more” and for type 29 “Core area”, these are widely scattered with a large standard deviation. This indicates that the blocks of these types contain a wide range of different heights.

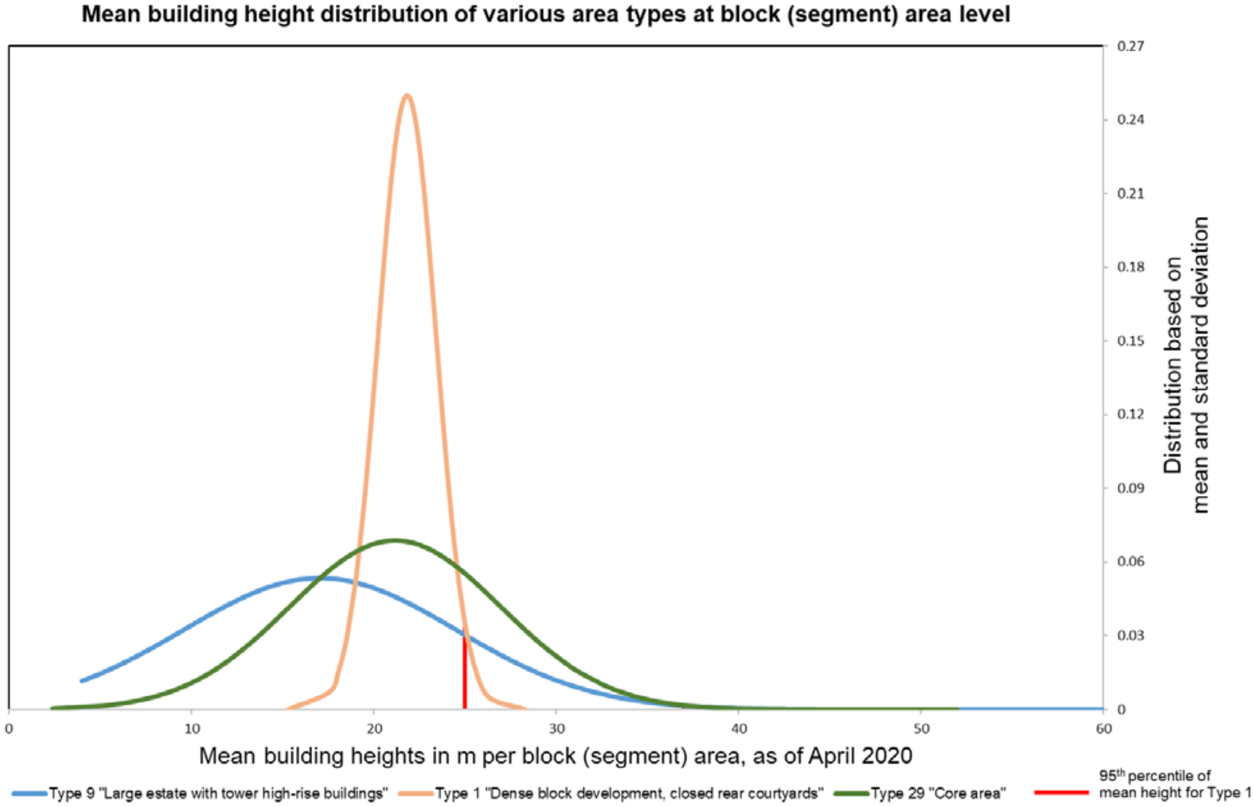

Fig. 9: Statistical distribution of mean building heights of various area types at block (segment) area level (area type mapping as of December 31, 2020, building heights according to LoD2 as of April 6, 2021.)

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