An interactive design tool for urban planning using the size of the living space as unit of measurement

MSc Geomatics for the built environment

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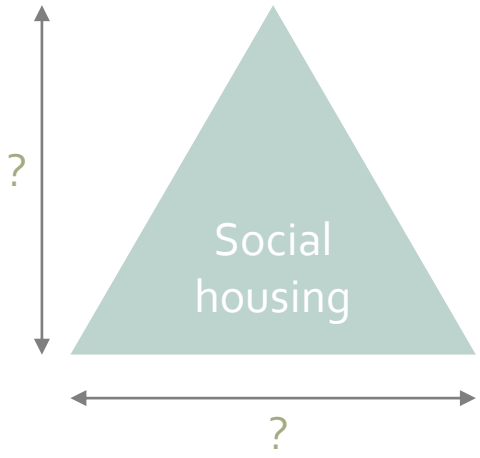
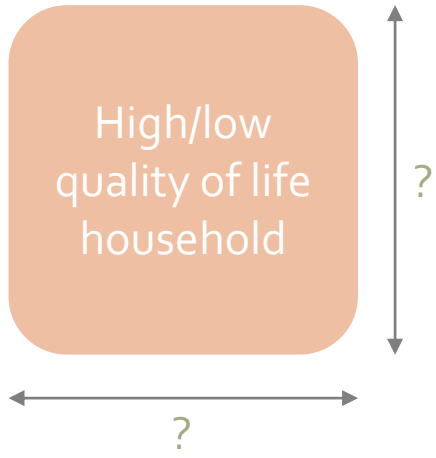
GeomaTics

FORM

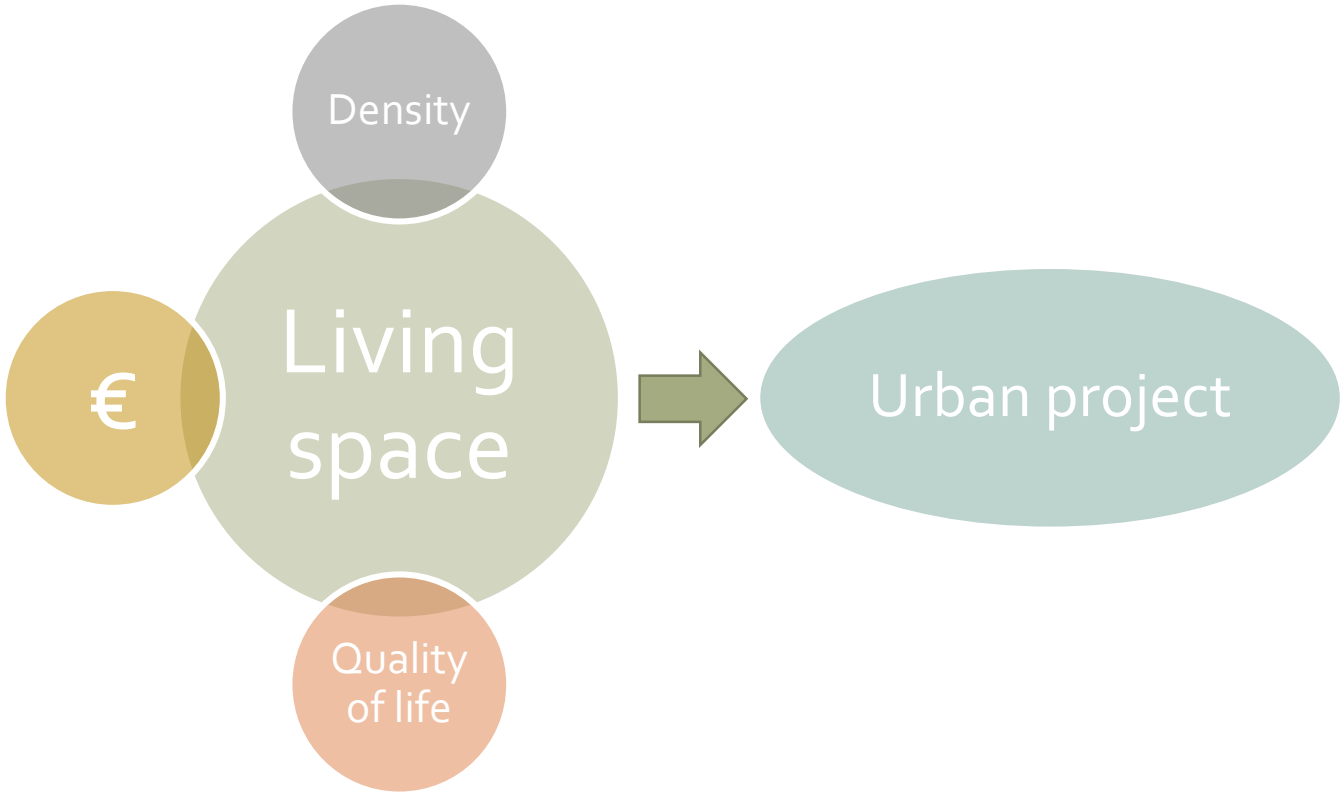
What is the size of the living space?





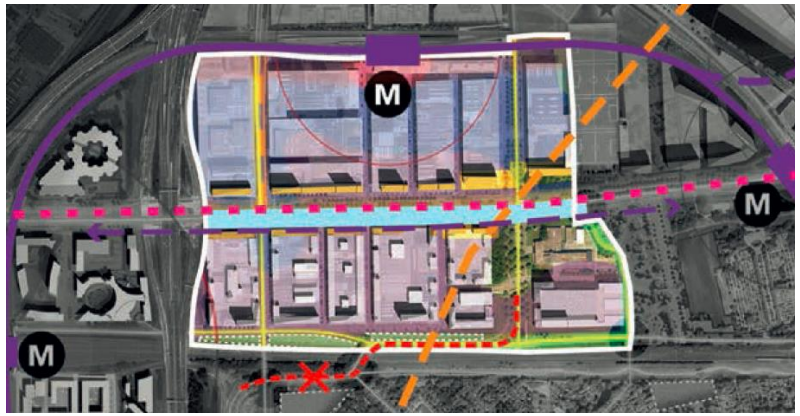
Research question

What is the size of the living space in Amsterdam in relation with housing density and housing prices, and how this dimension can be used as a unit of measurement for new housing developments like Sloterdijk One in the Haven-Stad project?



Test case Sloterdijk One, Haven-stad project - Amsterdam

Sloterdijk One



	Now	Future
m2	360.311	1.122.000
jobs	4.731	7.480
households	ø	11.220
schools	ø	8
hospitals	ø	8
m2 sport	ø	56.100

*Source: *Ontwikkelstrategie Haven-Stad 2017*.

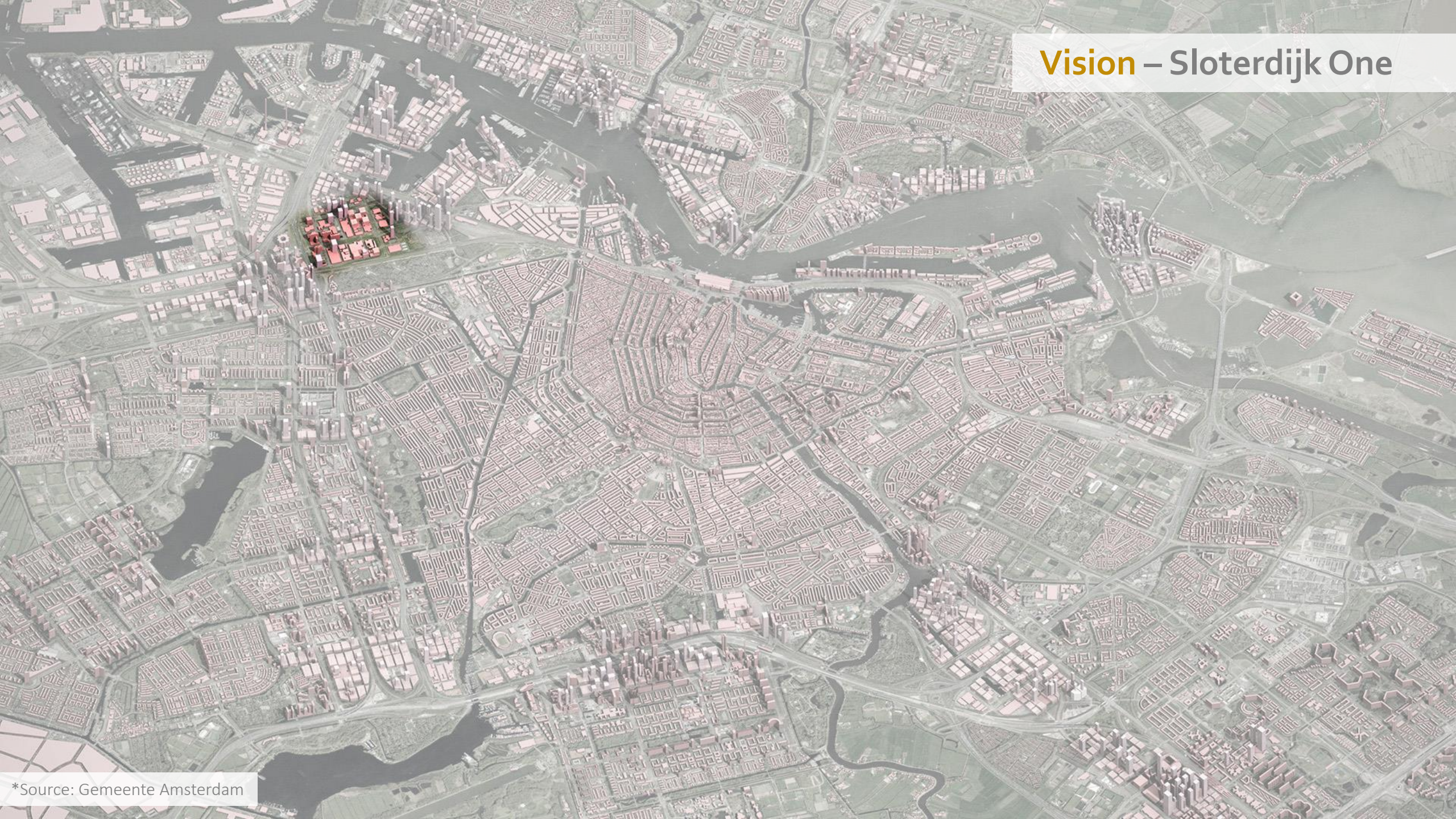
Vision – Amsterdam 2040

*Source: Gemeente Amsterdam

Vision – Ring A10

*Source: Gemeente Amsterdam

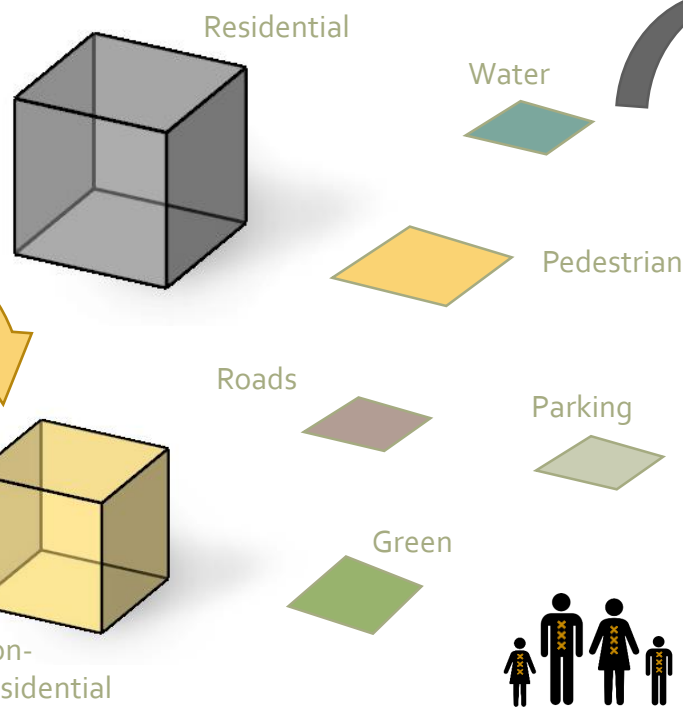
Vision – Sloterdijk One

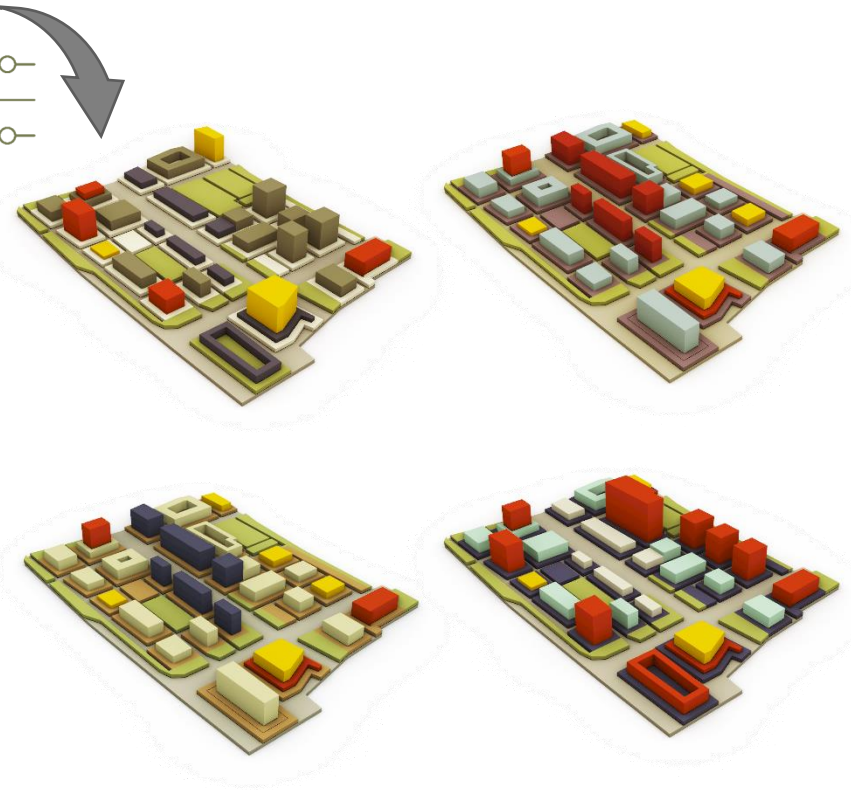


*Source: Gemeente Amsterdam

Methodology overview

Social housing
Medium-level housing
High-level housing





Virtual city model, Definition of KPIs, Selection of similar existing neighbourhoods

Step 1

Calculation of living space design parameters from the chosen neighbourhoods

Step 2

Interactive generation of multiple design proposals/scenarios for a new development area

Step 3

Step 1 – Selection of similar existing neighbourhoods

Social housing
Medium-level housing
High-level housing

FME / QGIS

Virtual city model, Definition of KPIs, Selection of similar existing neighbourhoods

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Step 3

Step 1 – KPIs definition based on the Municipality guidelines

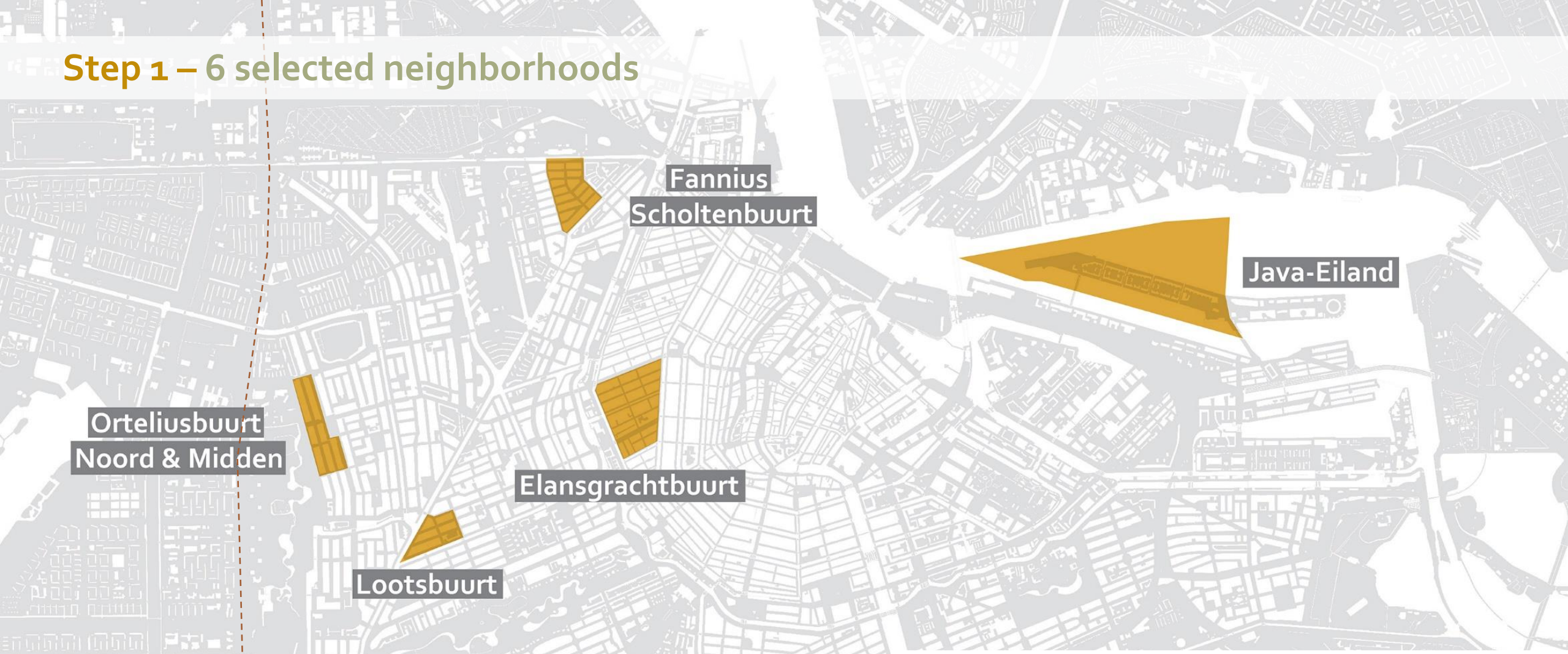
Sloterdijk One

Amsterdam Municipality

=

 Land use	 Quality of life	 Density	 Price per sq. meter
Residential 80% - Business 20%	**Super High**	**192** Households per hectare	Social - Medium - High

Step 1 – 6 selected neighborhoods



Neighborhood	Density (h/Ha)	Price per sq. meter	Quality of life	Year Index
Java-eiland	97	€ 4,885	8	1996
Elandsgrachtbuurt	151	€ 6,738	9	1593
Orteliusbuurt	203	€ 5,442	4	1931
Lootsbuurt	214	€ 6,422	7	1918
Hercules S.	221	€ 6,207	7	1920
Fannius S.	235	€ 6,151	4	1930

Java - 8 4,885 e 97 h/Ha 1996

Herc - 7 6,207 e 221 h/Ha 1920

Elan - 9 6,738 e 151 h/Ha 1593

Orte - 4 5,442 e 203 h/Ha 1931

Loots - 7 6,422 e 214 h/Ha 1918

Fann - 4 6,151 e 235 h/Ha 1930

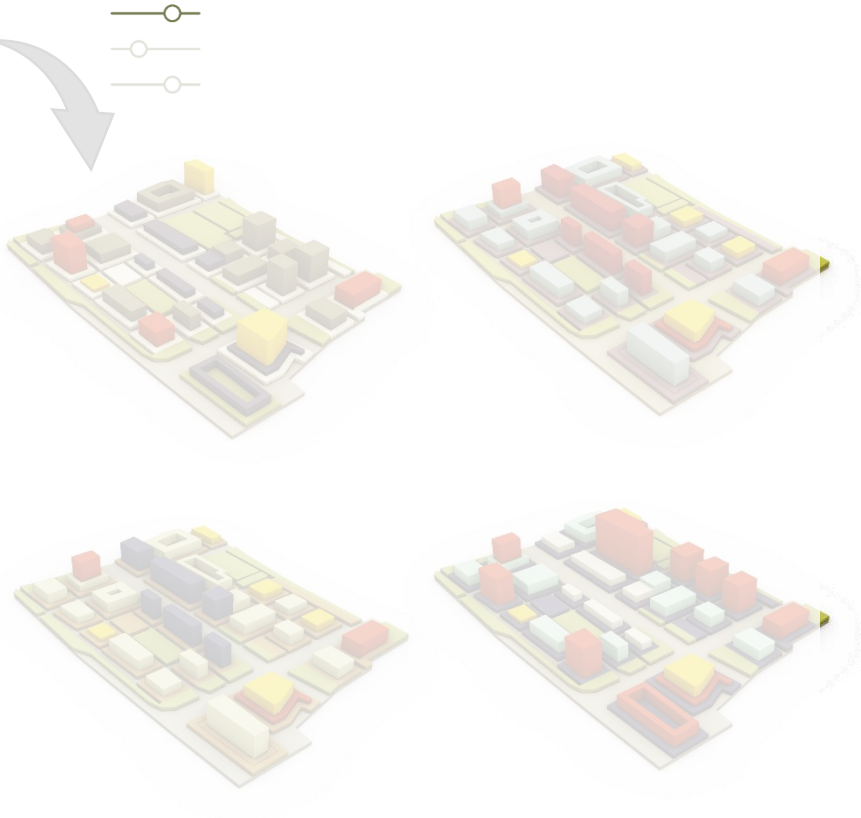
Step 2 – Living space calculation

Social housing
Medium-level housing
High-level housing

Residential
Water
Pedestrian
Roads
Parking
Green
Non-Residential

FME / QGIS

Calculation of living space design parameters from the chosen neighbourhoods



Virtual city model, Definition of KPIs, Selection of similar existing neighbourhoods

Step 1

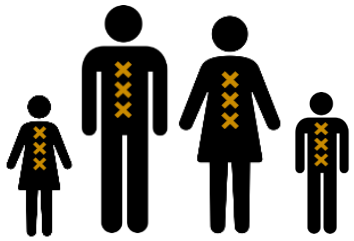
Step 2

Interactive generation of multiple design proposals/scenarios for the new development area

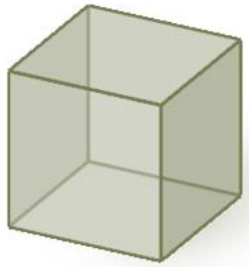
Step 3

Step 2 – Living space calculation _ Classification

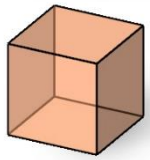
1
Household



Indoor Space
3D

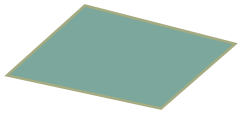


Residential → Households



Non residential → Retail, Food, Religion, Health, Education, Meeting, Tourism, Sports, Hotel, etc..

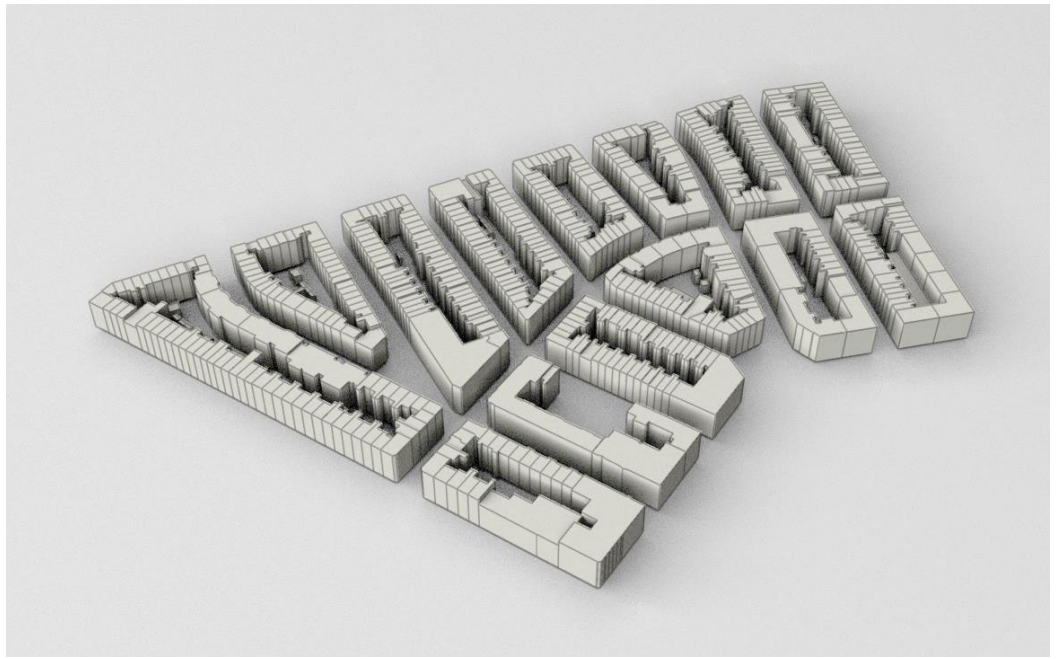
Open Space
2D



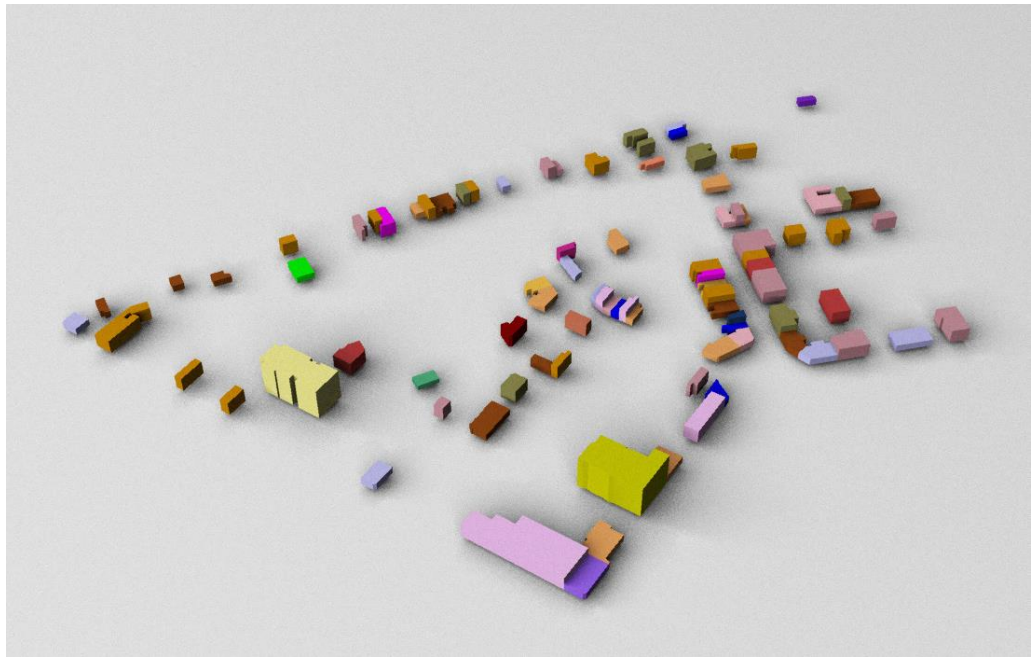
Public → Pedestrian, Roads, Parking, Bike lines, Water, Green areas

Private → Open space

Step 2 – Example of living space calculation (Fannius S.)

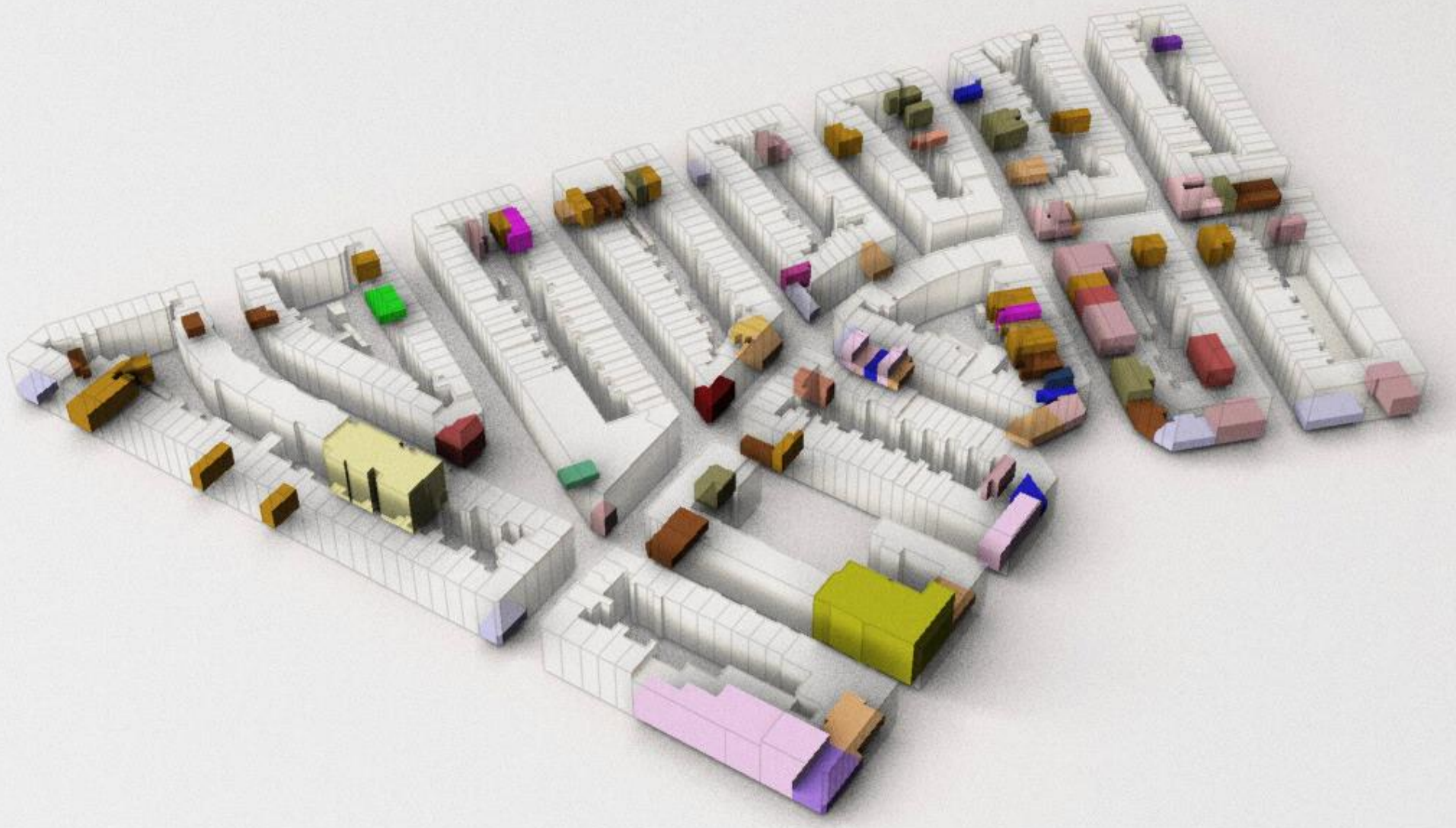


LoD1 Buildings



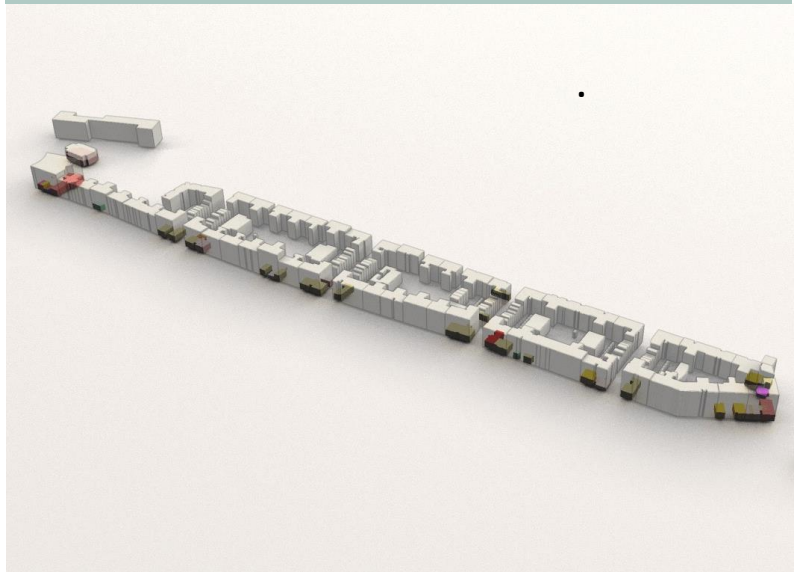
Non-residential functions

Step 2 – Volume calculations



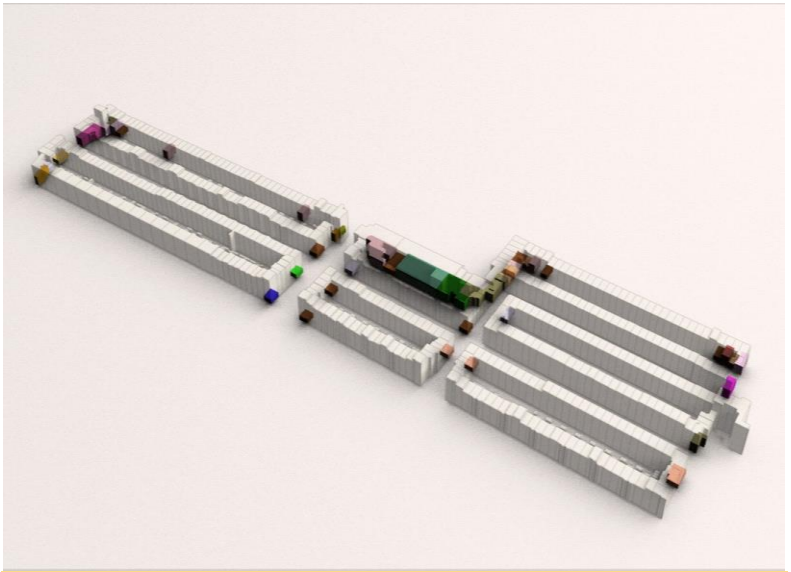
Colour: non-residential **White: LoD1 Buildings**

Java - 8 4,885 e 97 h/Ha 1996

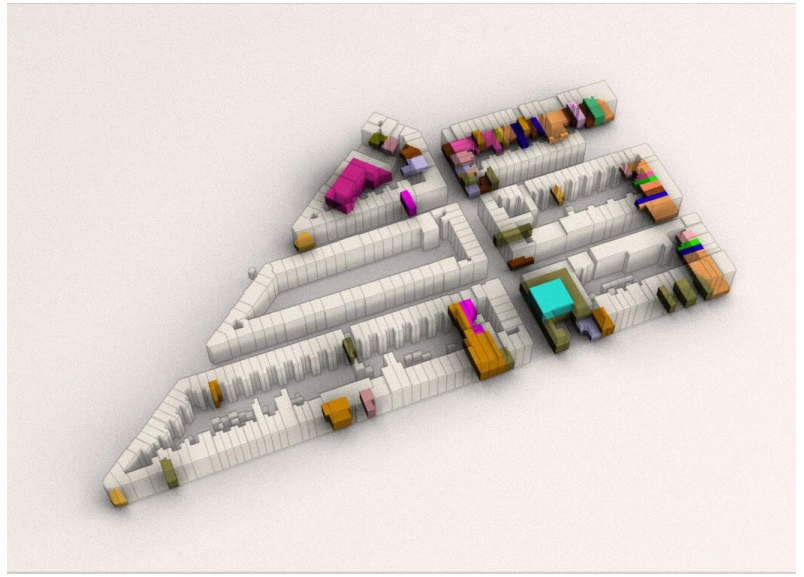


Herc - 7 6,207 e 221 h/Ha 1920

Elan - 9 6,738 e 151 h/Ha 1593



Orte - 4 5,442 e 203 h/Ha 1931

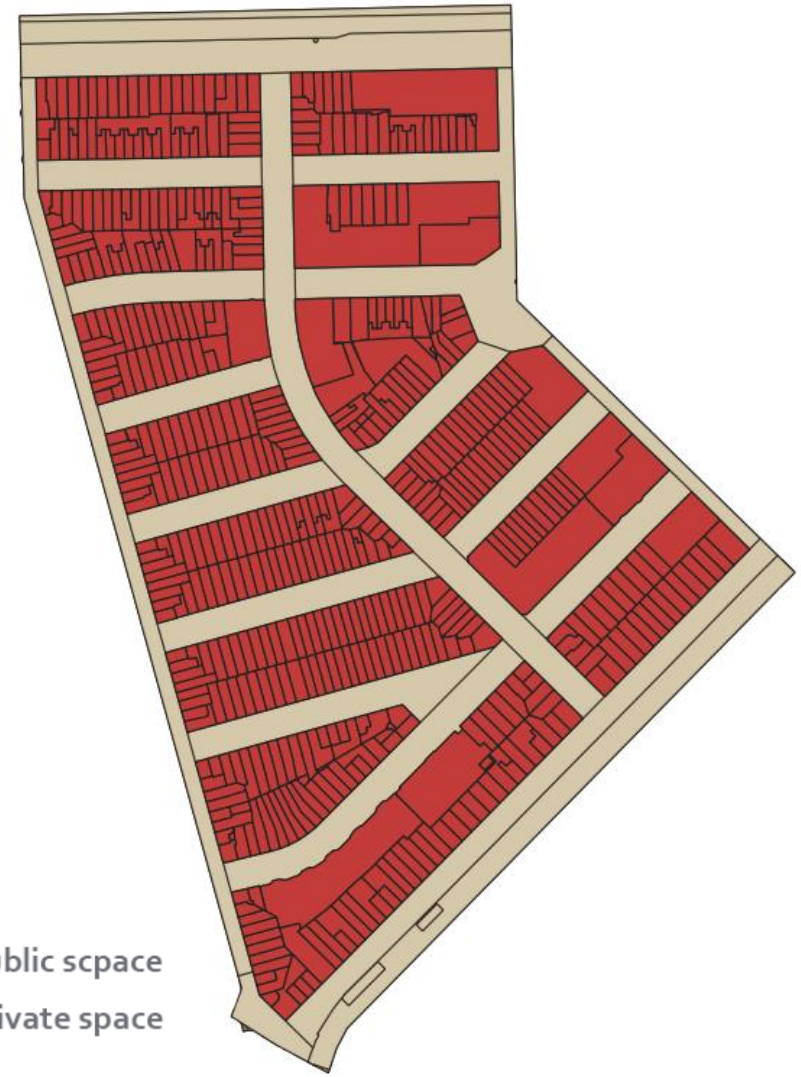


Loots - 7 6,422 e 214 h/Ha 1918

Fann - 4 6,151 e 235 h/Ha 1930

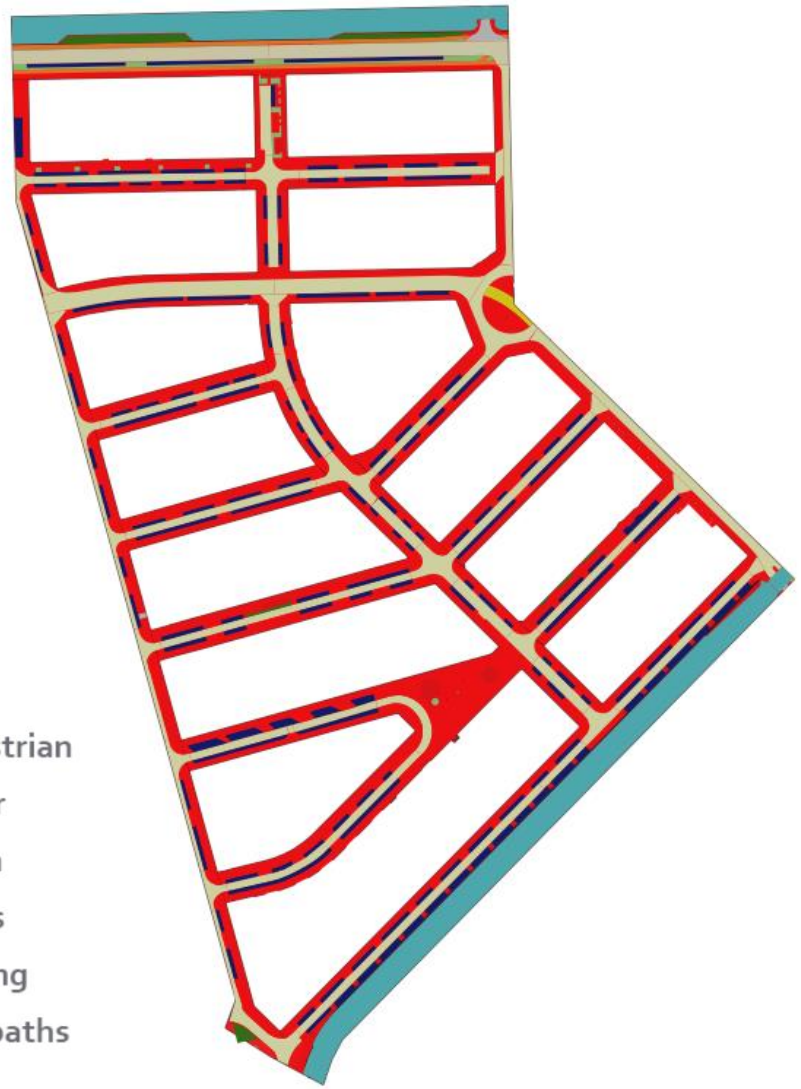
Step 2 – Living space calculation – Open space

Basisregistratie Kadaster (BRK)



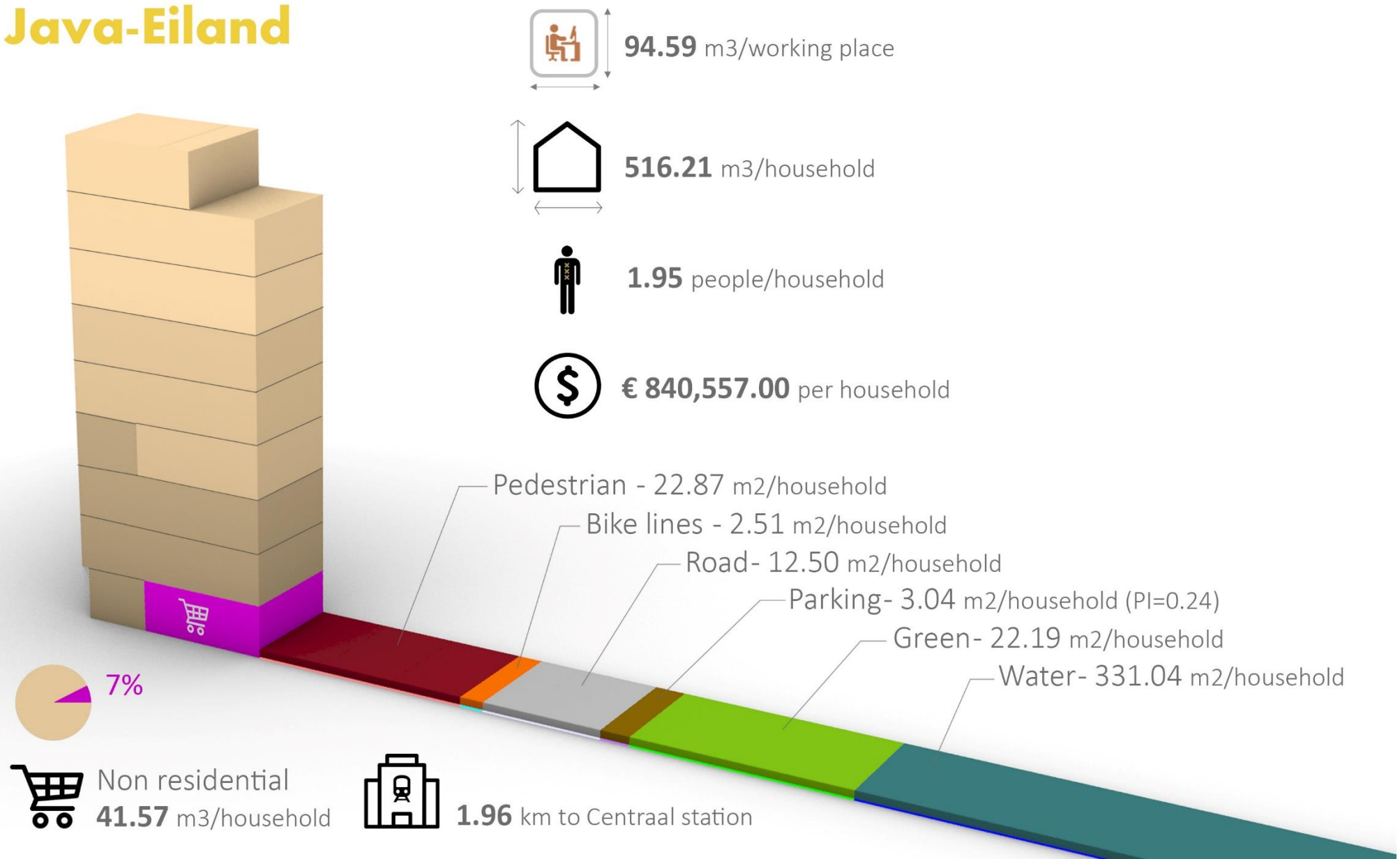
Public scpace
Private space

Basisregistratie Grootschalige Topografie (BGT)



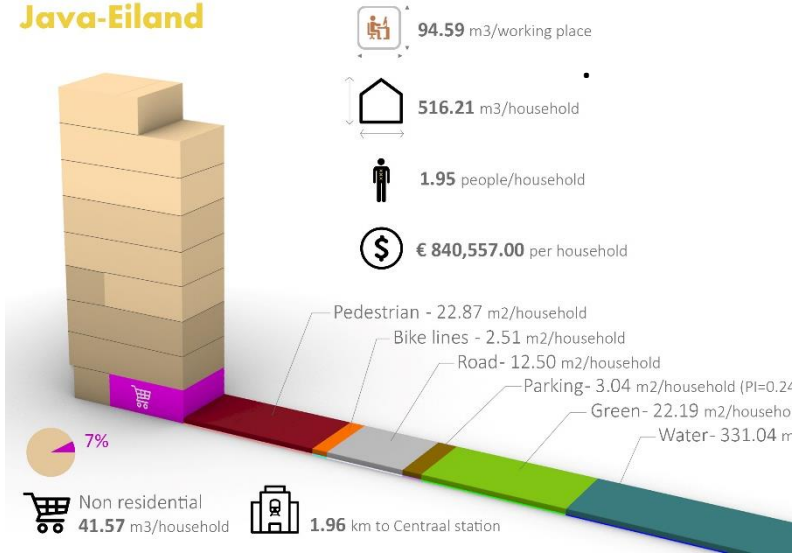
Pedestrian
Water
Green
Roads
Parking
Bike paths

Step 2 – Comparison panels



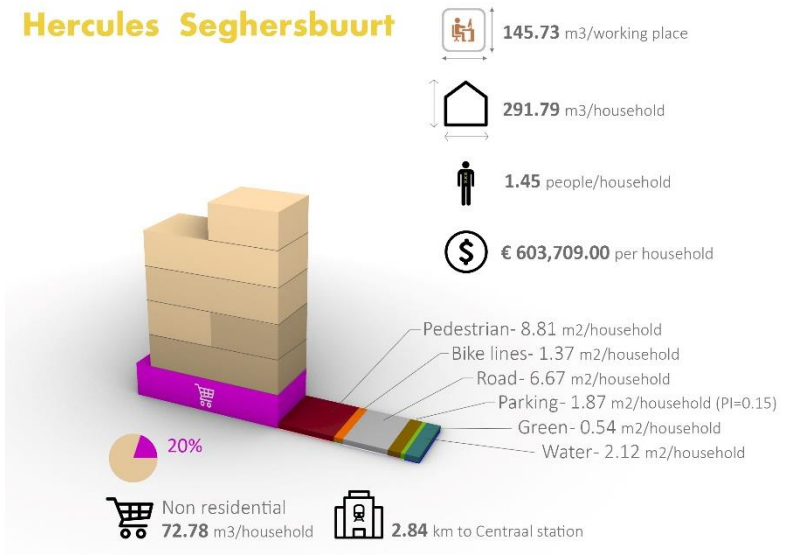
Java - 8 4,885 e 97 h/Ha 1996

Java-Eiland



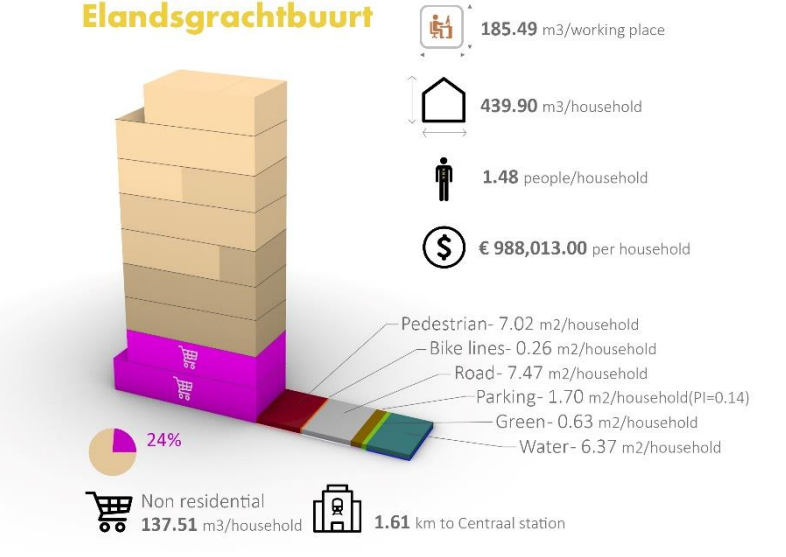
Herc - 7 6,207 e 221 h/Ha 1920

Hercules Seghersbuurt

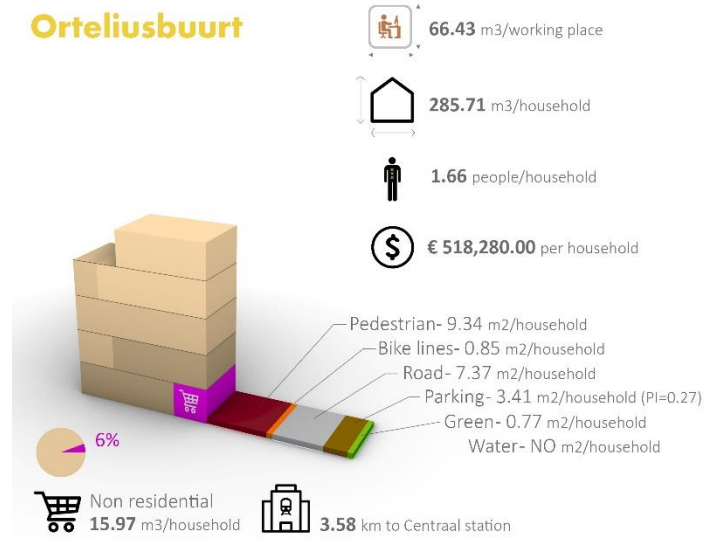


Elan - 9 6,738 e 151 h/Ha 1593

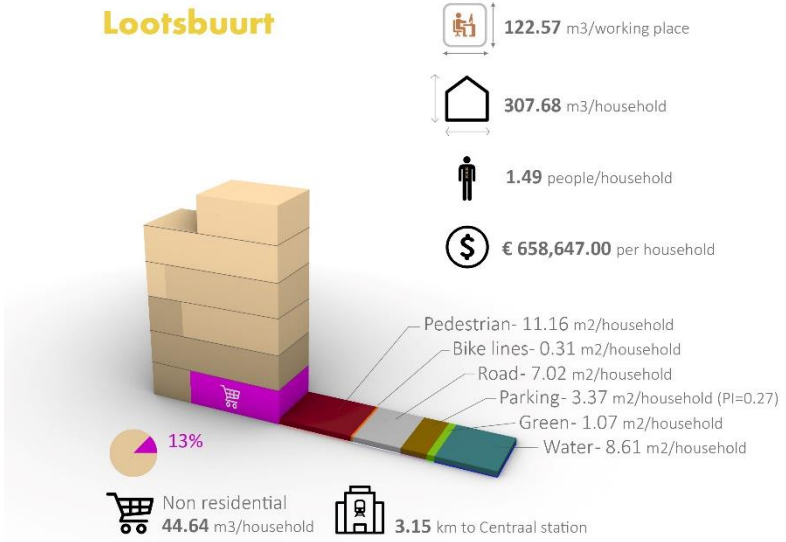
Elandsgrachtbuurt



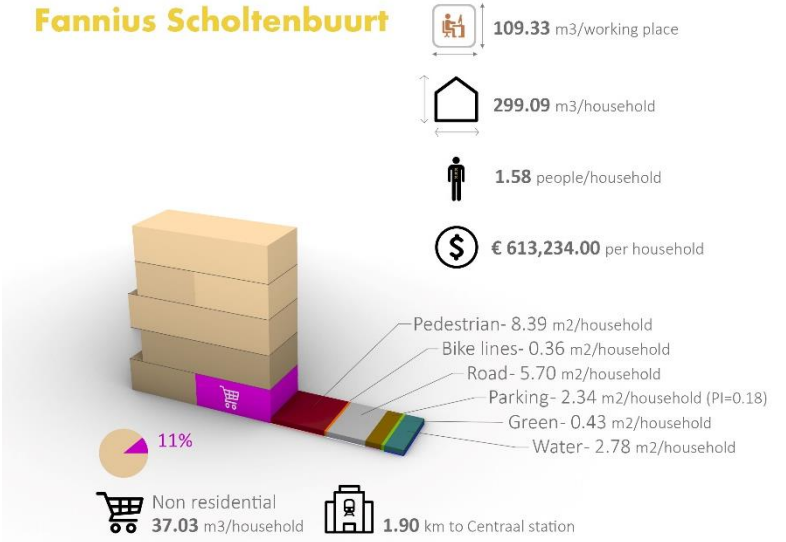
Orteliusbuurt



Lootsbuurt



Fannius Scholtenbuurt

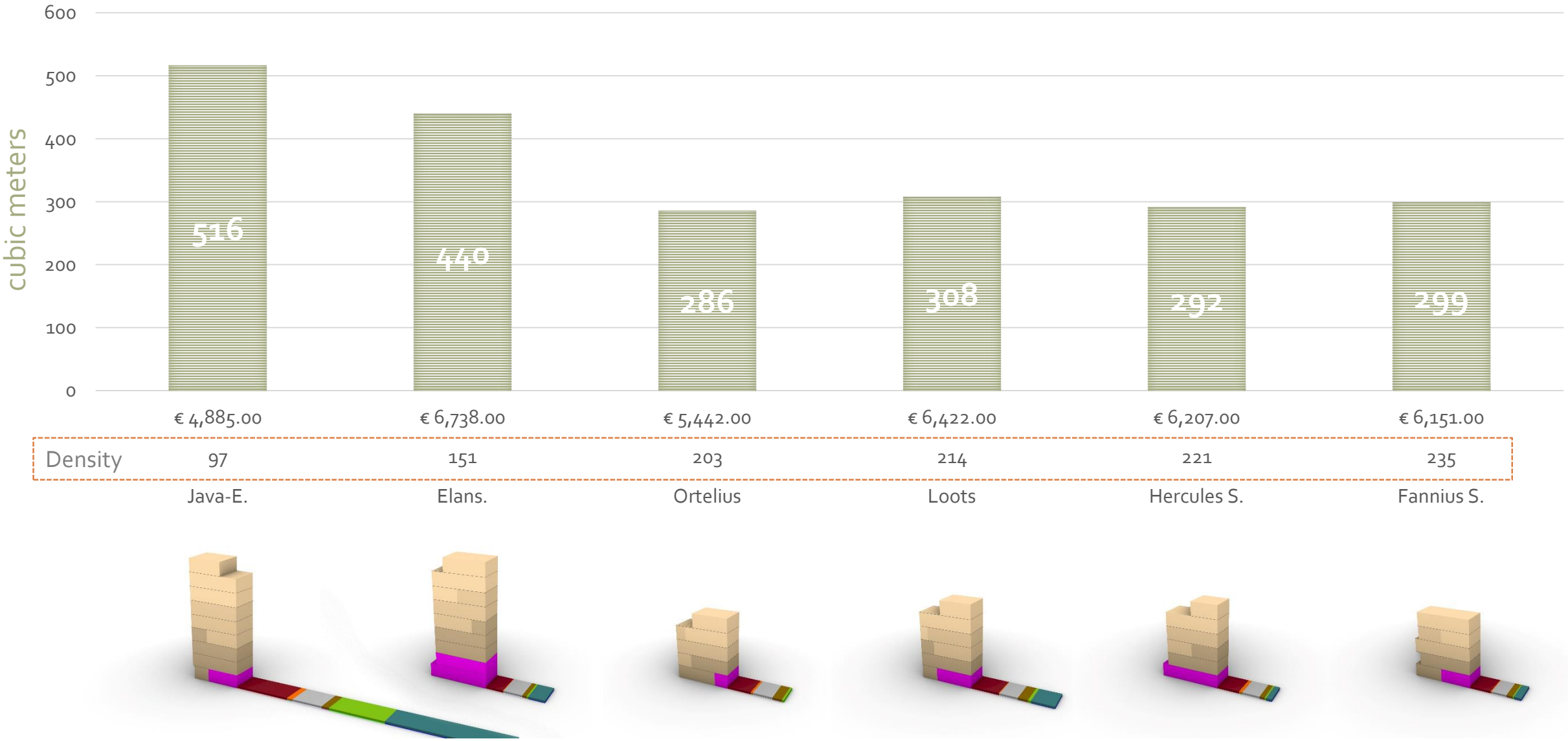


Orte - 4 5,442 e 203 h/Ha 1931

Loots - 7 6,422 e 214 h/Ha 1918

Fann - 4 6,151 e 235 h/Ha 1930

Step 2 – Relation density-indoor space size



Step 3 – Interactive generation of multiple design proposals

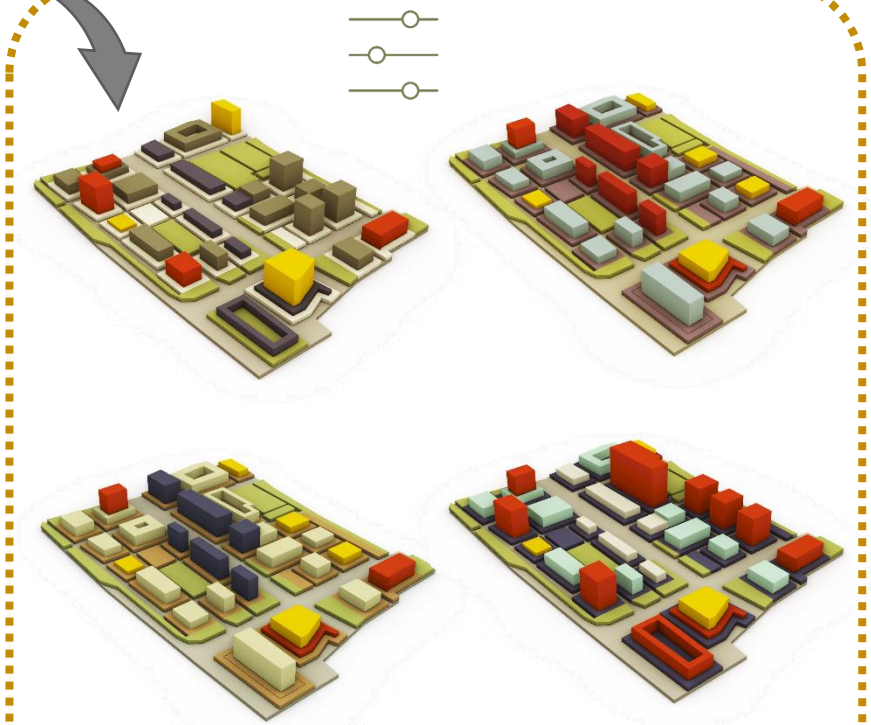
Social housing
Medium-level housing
High-level housing

Virtual city model, Definition of KPIs, Selection of similar existing neighbourhoods

Step 1

Calculation of living space design parameters from the chosen neighbourhoods

Step 2



Rhino / Grasshopper / Python

Interactive generation of multiple design proposals/scenarios for the new development area

Step 3

Step 3 – Interactive 3D model _ Implementation

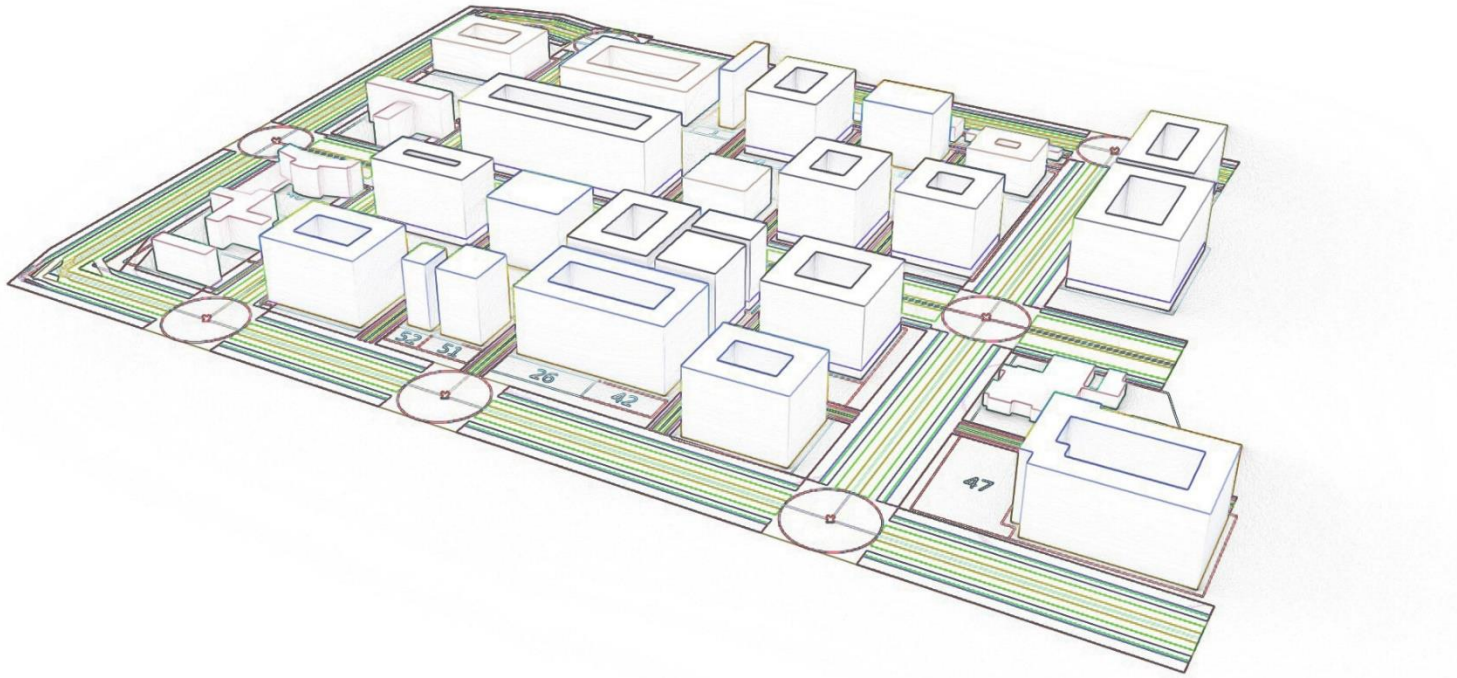
Size of the living space

×

11,220 households

= 3D City Model

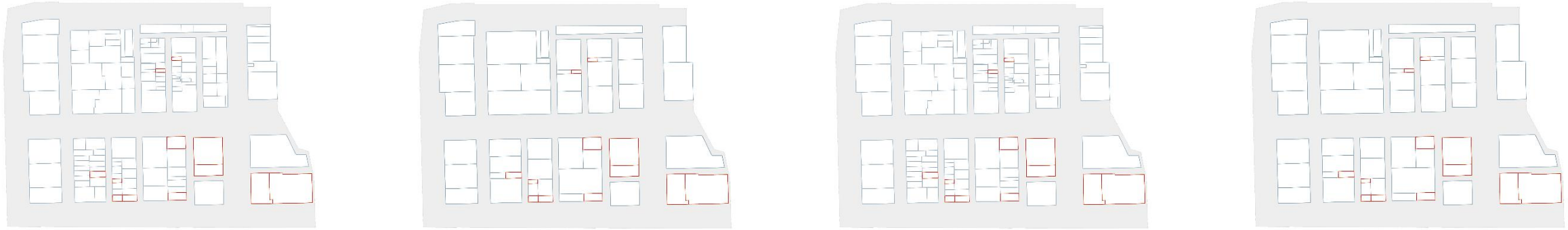
LOD 1



Rhinoceros®
modeling tools for designers

python

Step 3– Input geometries (user)

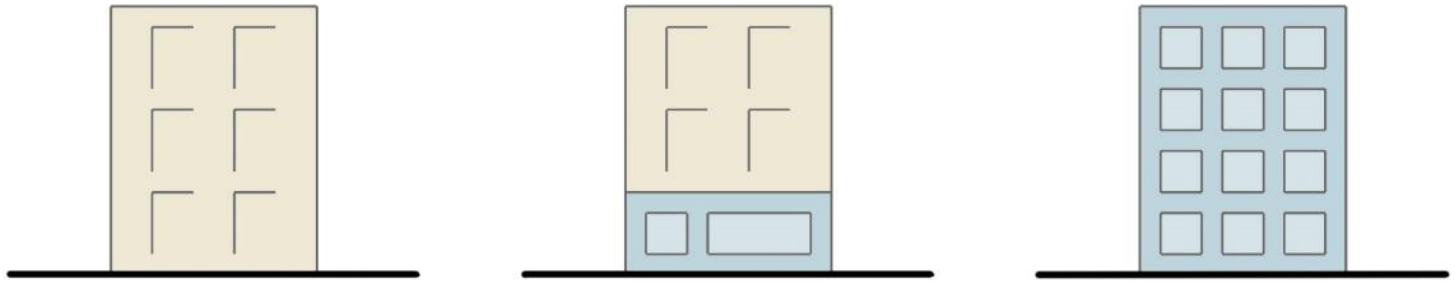


Parcellations (plots) Closed polygons (polylines)

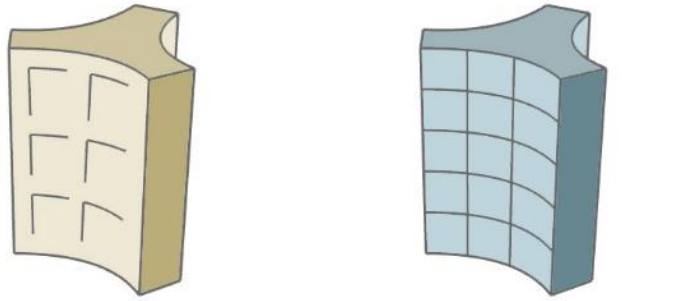
Road lines Lines & polylines

Existing buildings
LOD 1 solids

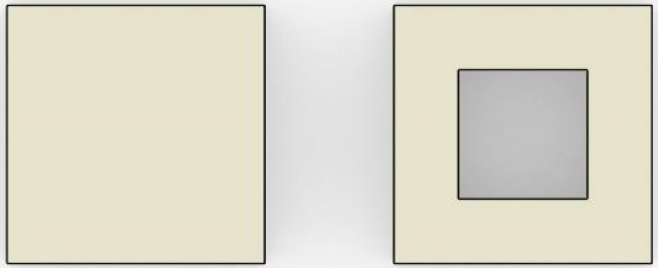
Step 3 – Options to create buildings



Residential | Mixed-use | Non-residential



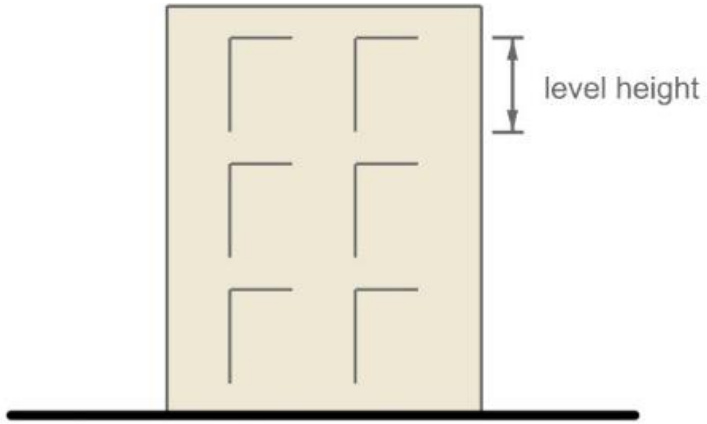
Existing Residential | Existing Non-residential



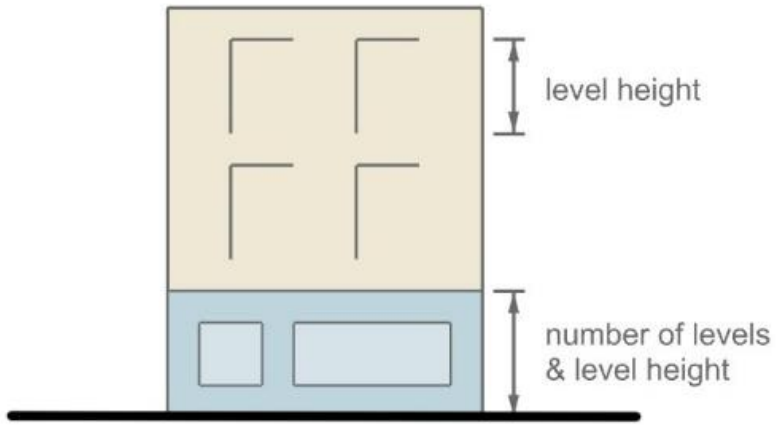
Solid building | Courtyard building

(top view - only for new buildings)

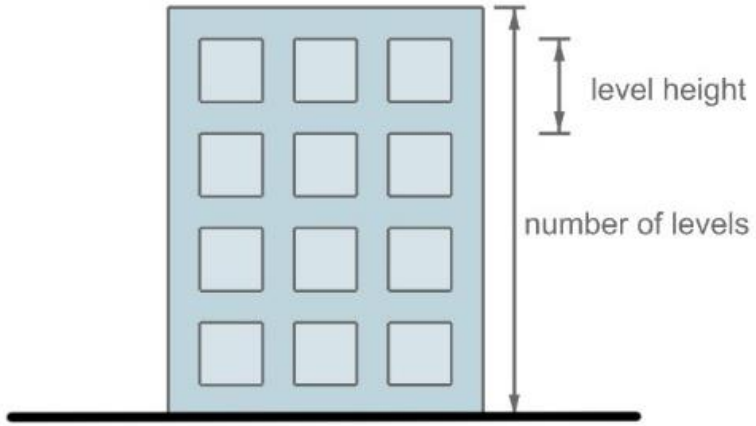
Step 3 – Geometrical parameters for new buildings



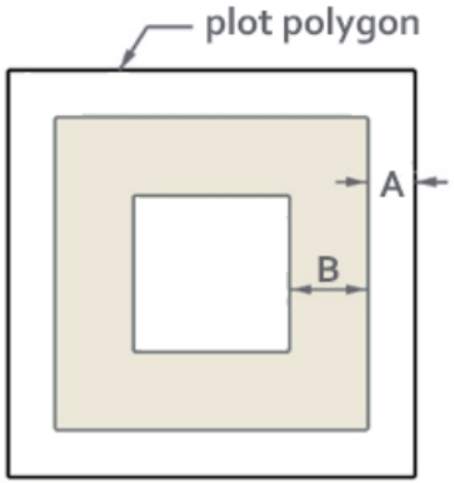
Residential



Mixed-use



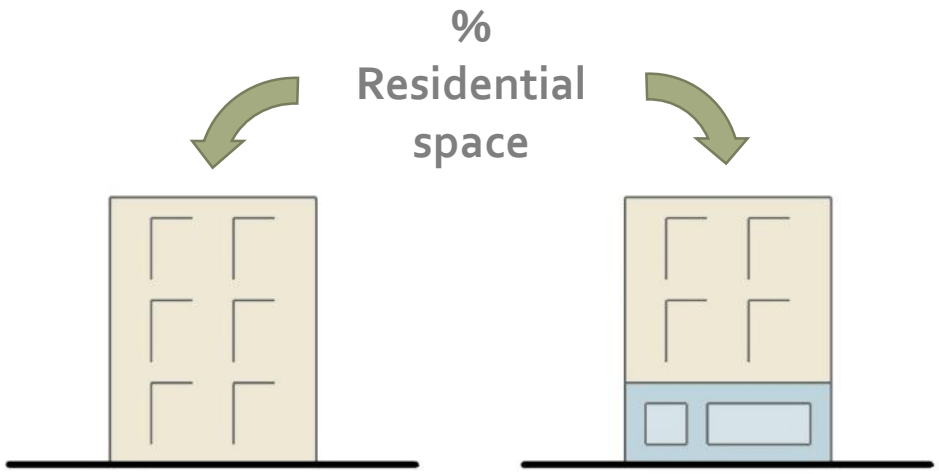
Non-residential

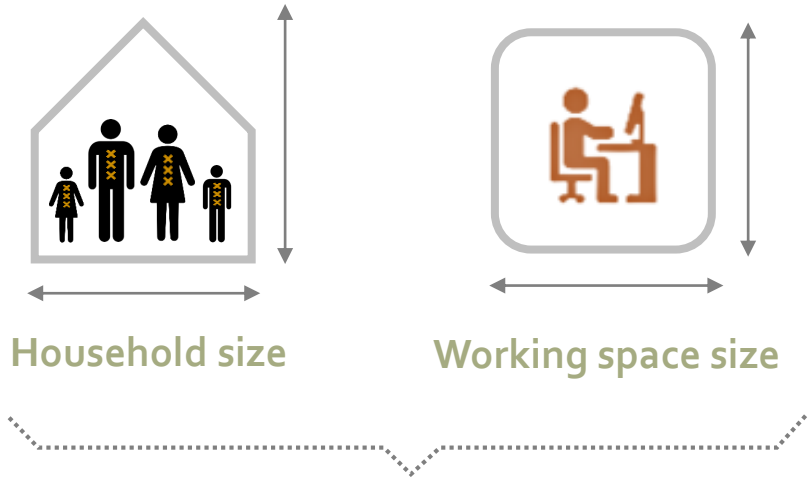


A = Distance from the plot border based on the height of the building

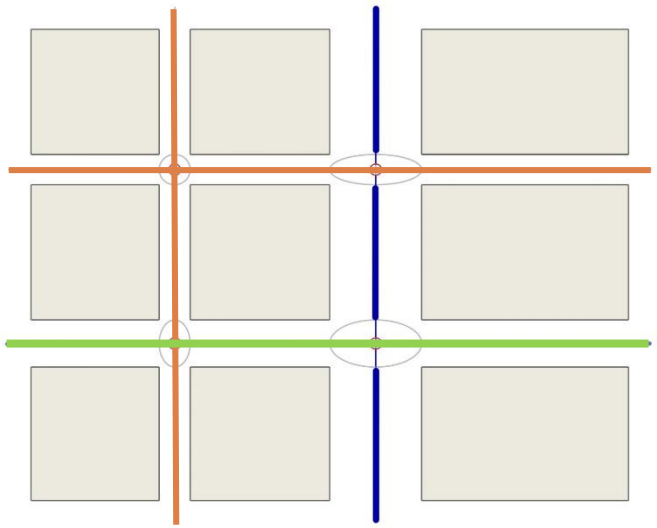
B = Thickness of the building

Step 3 – Other inputs for indoor space

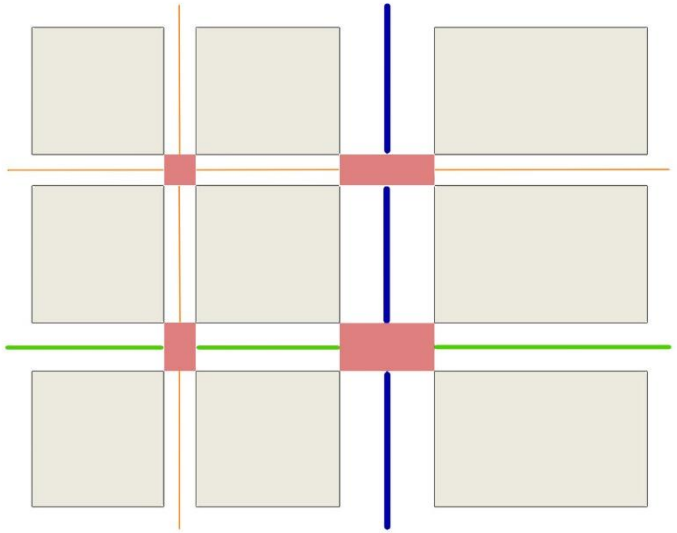




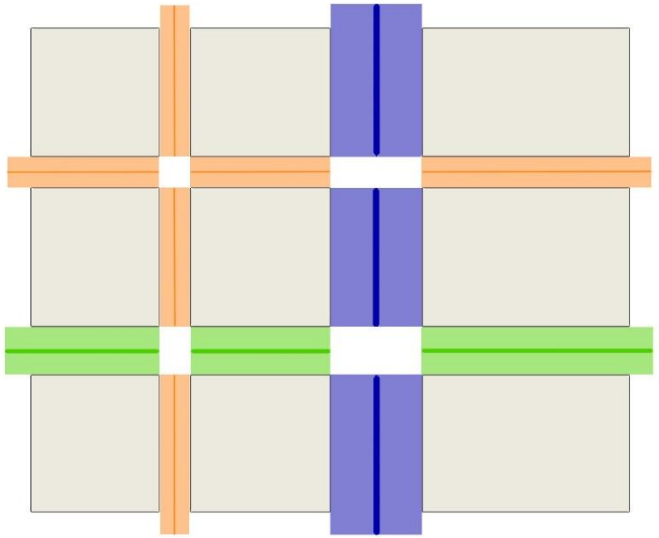
Step 3 – Open space calculation



- Search for intersections
- Define the size of the intersections based on road sizes

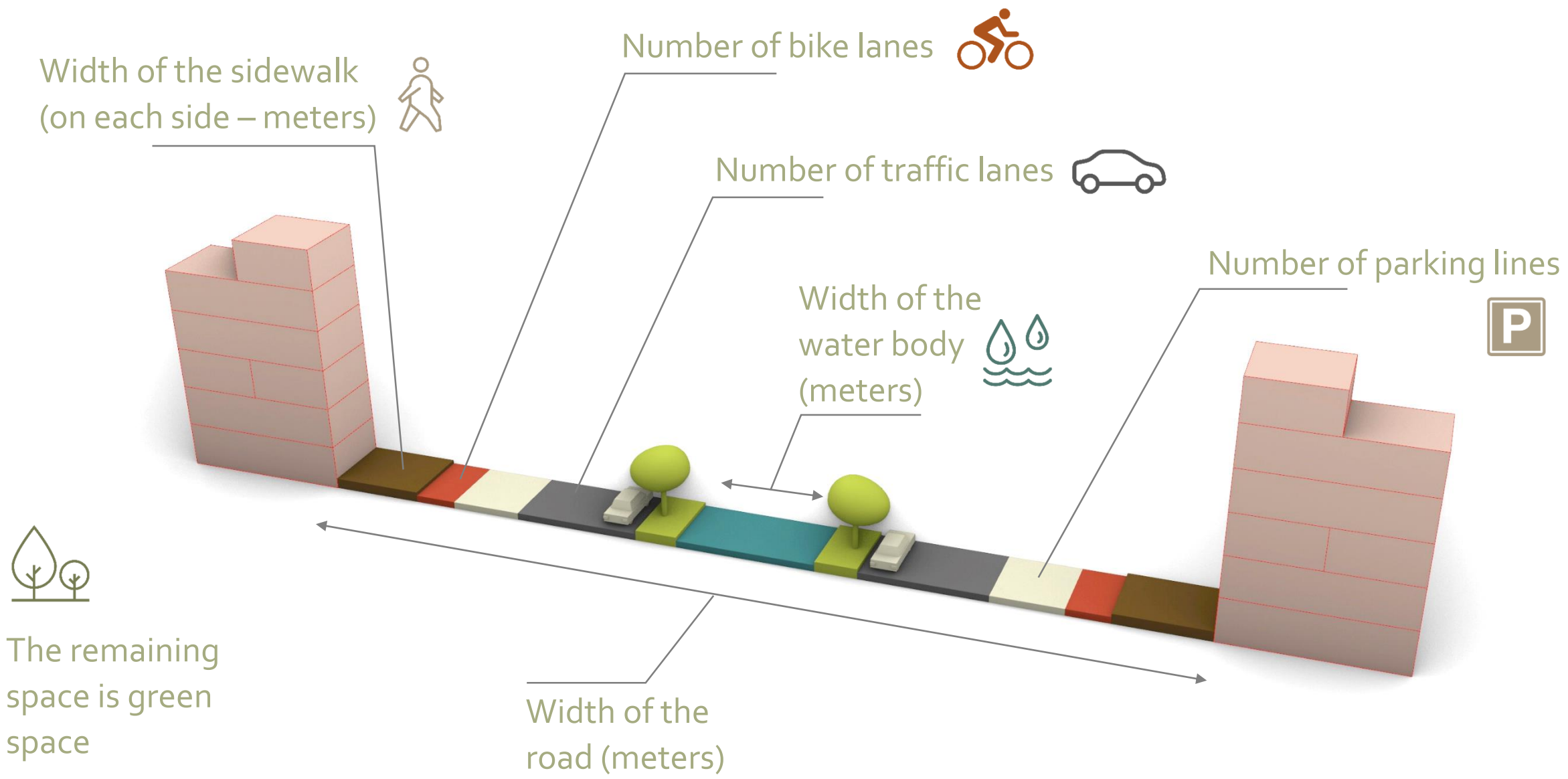


- Intersections considered as driving space

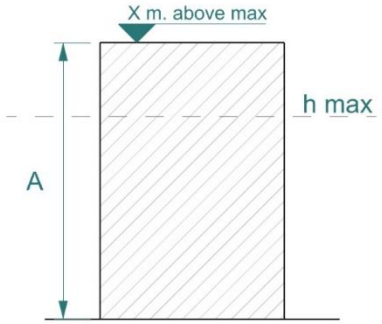


- The remaining segments are considered for open space calculations
- Each road typology is customized separately

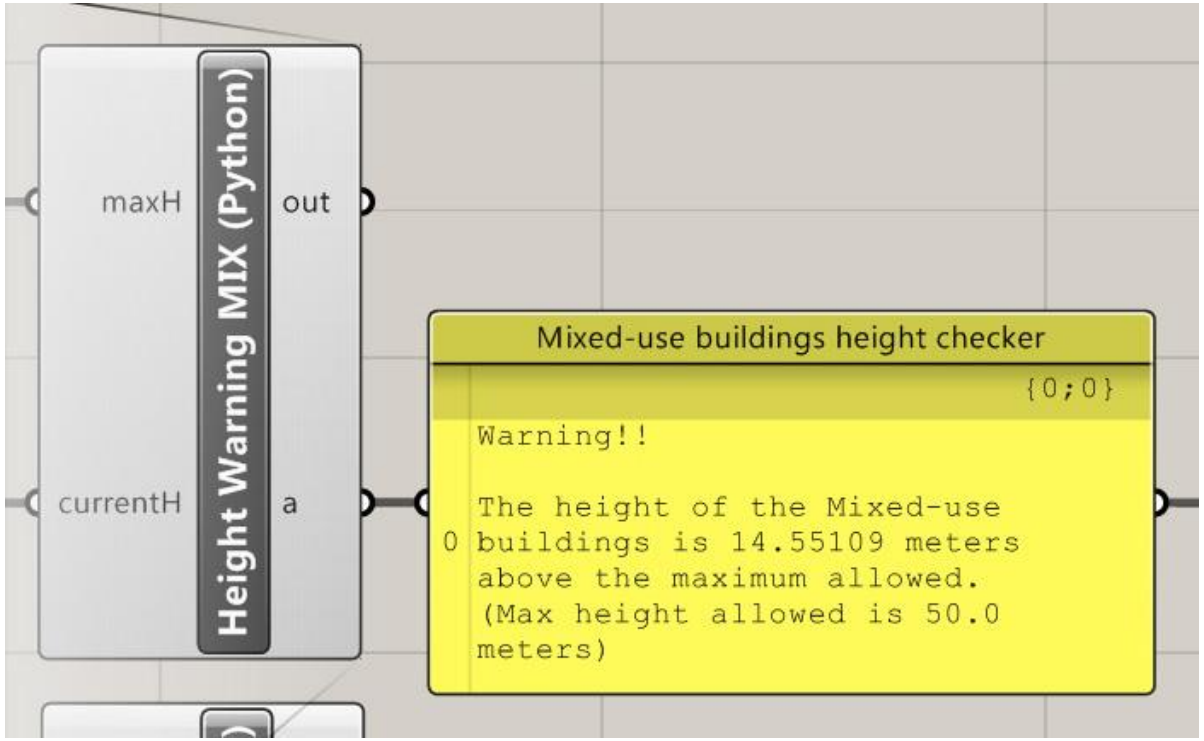
Step 3 – Schematic representation of the six open space classes

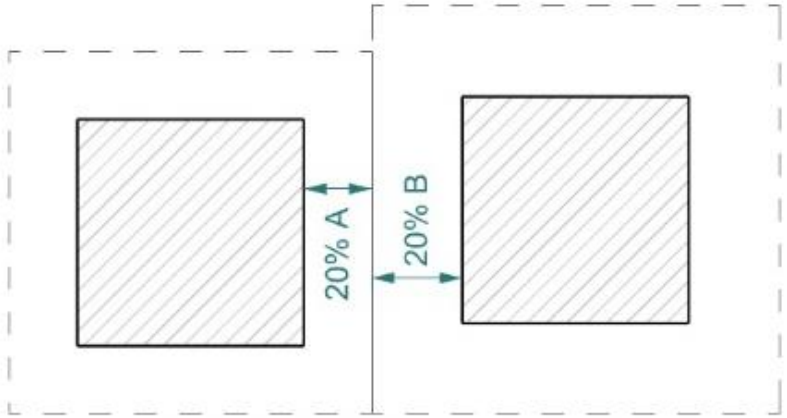


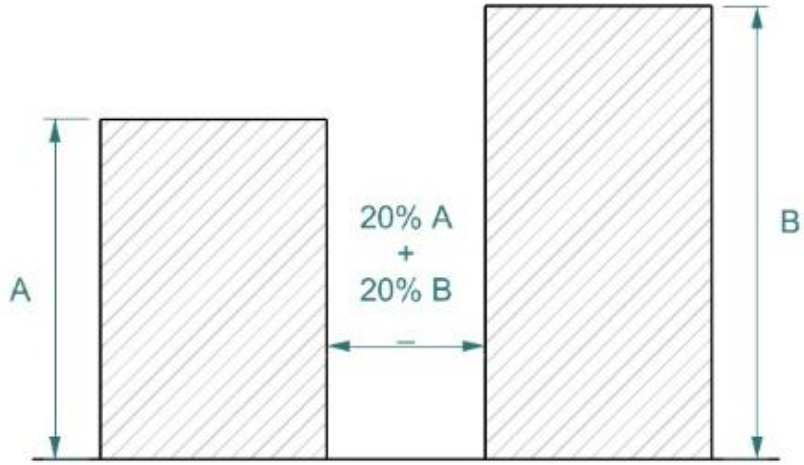
Step 3 – Example of urban/architectonic constraints



Heights warning

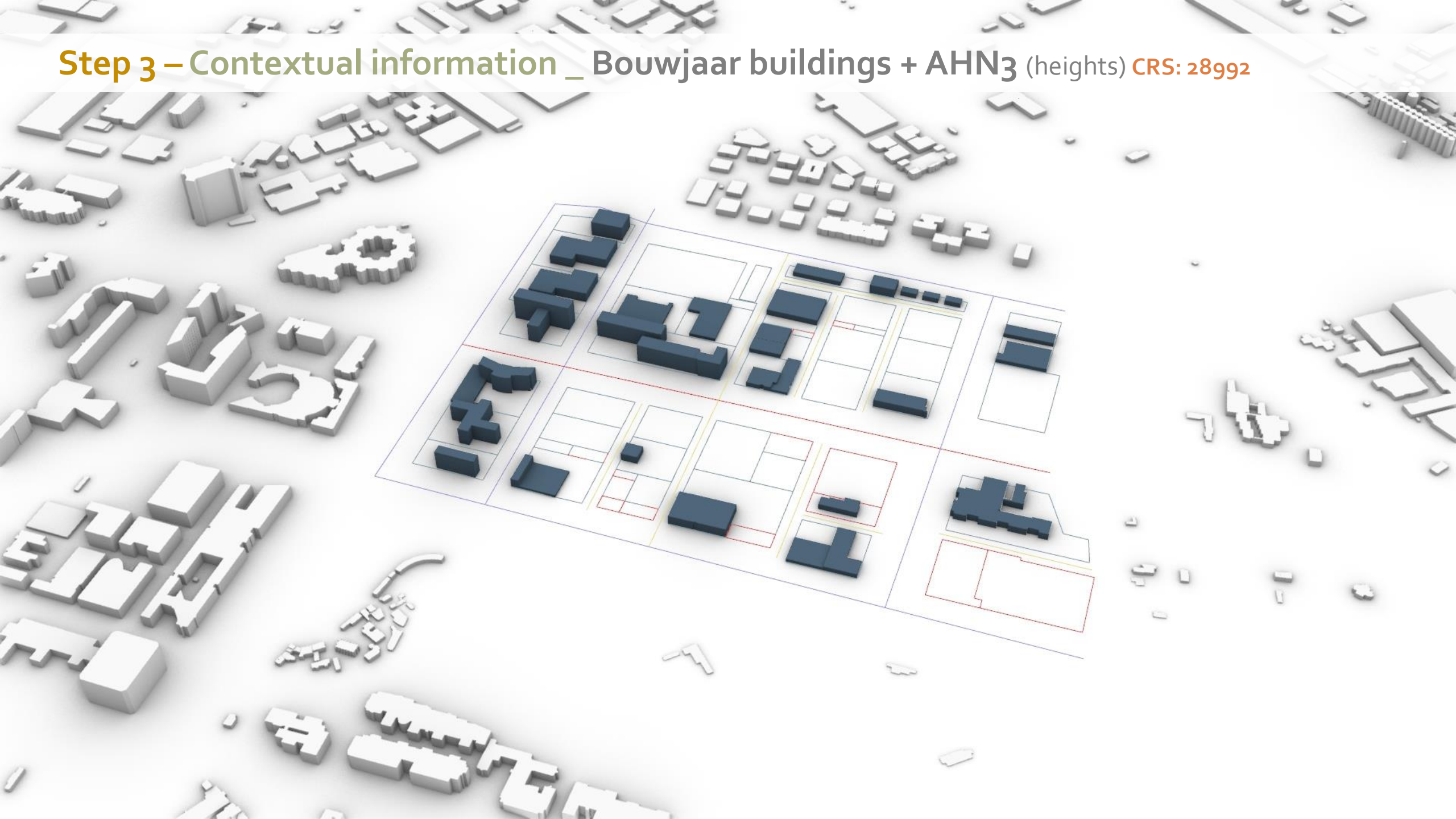






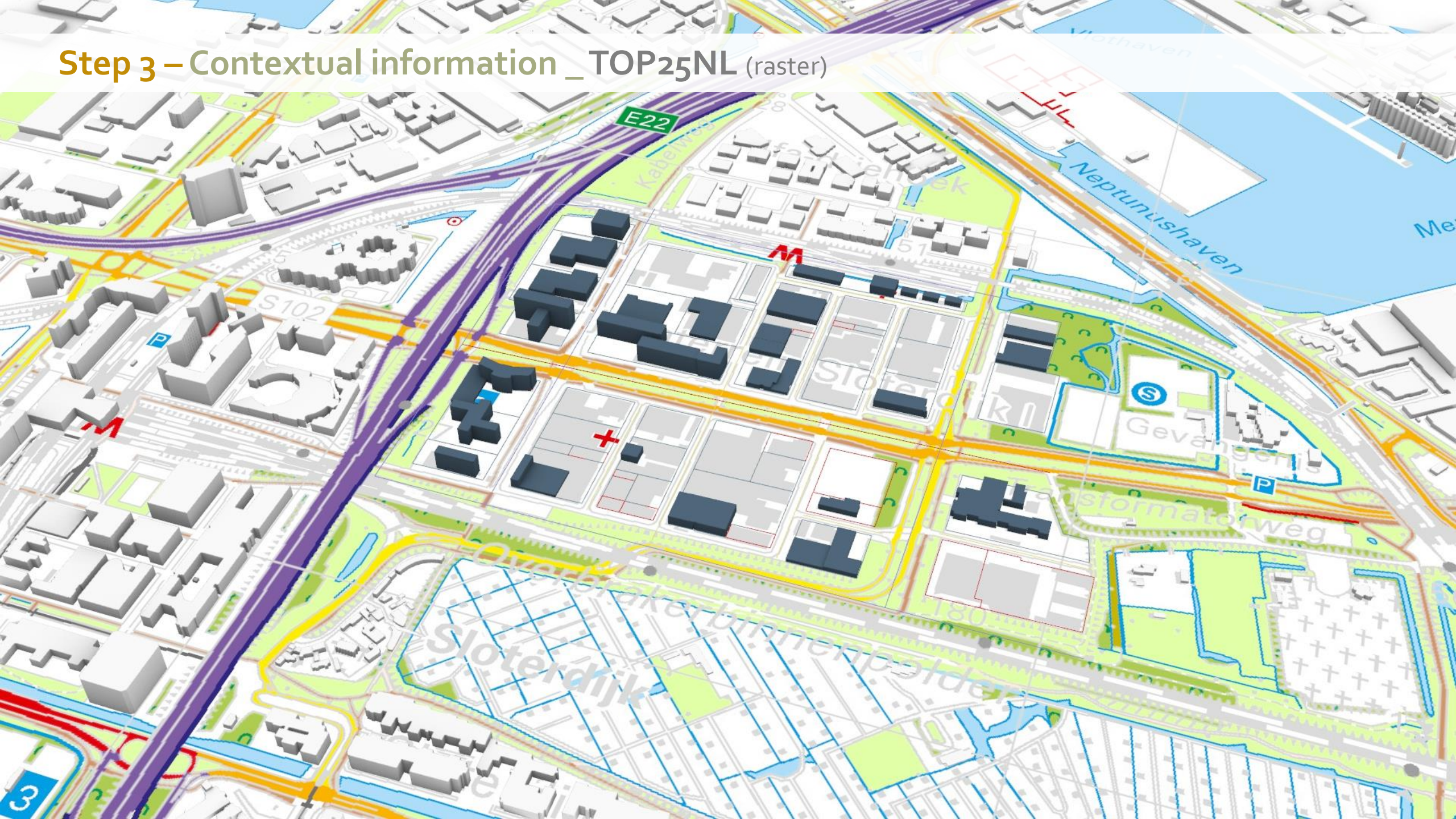
Rule: Space between buildings

Step 3 – Contextual information _ Bouwjaar buildings + AHN3 (heights) CRS: 28992



Step 3 – Contextual information _ Public transportation network (Tram- en metronet + GVB)

Step 3 – Contextual information _ TOP25NL (raster)



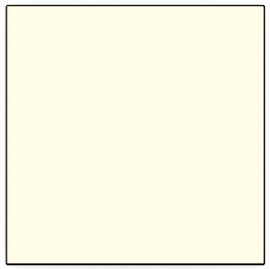
Step 3 – Contextual information _ Non-residential functions 1.5 km (Functiekaart)

3 step – Demo

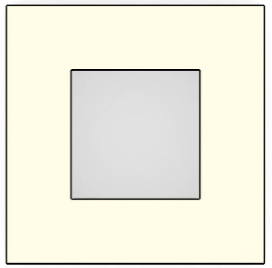
https://www.youtube.com/watch?v=cPYT5_cFIgw

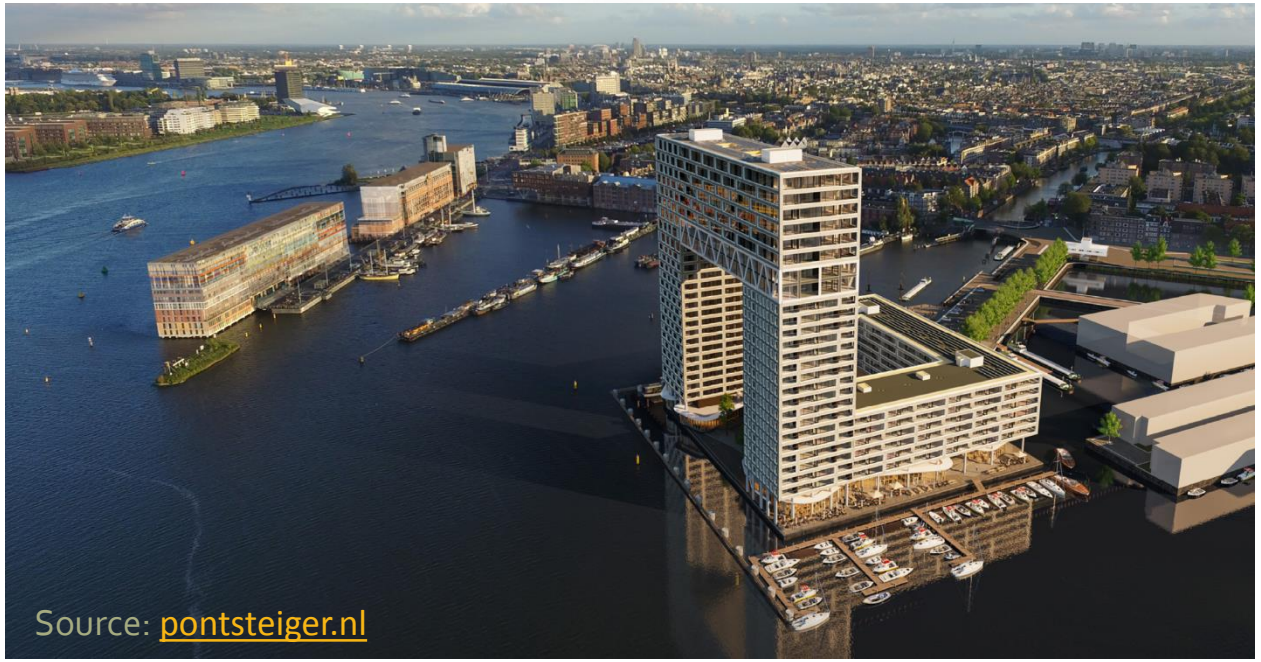
3 step – Further considerations

Solid buildings



Courtyard buildings (blocks)



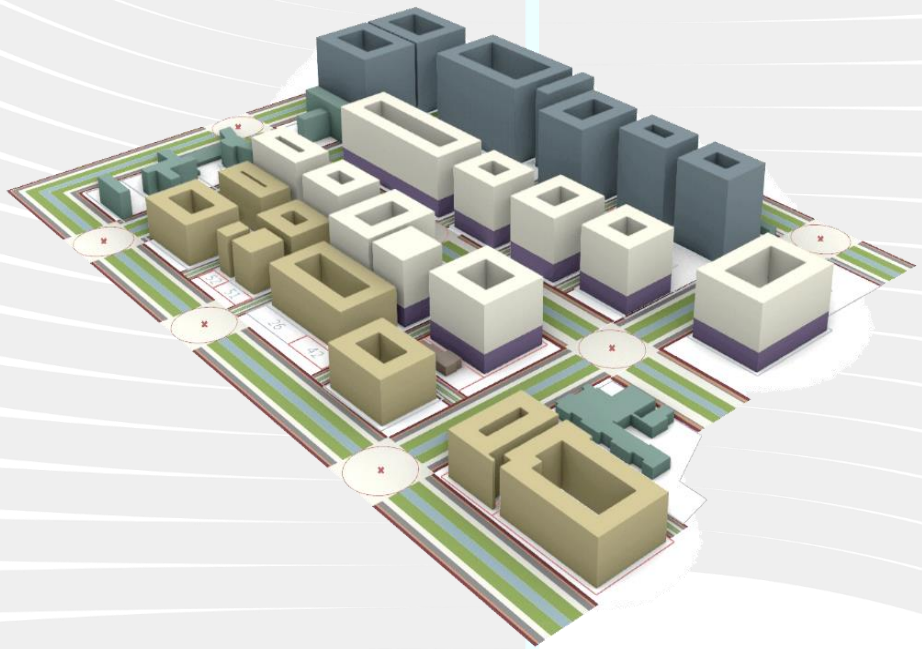


Source: pontsteiger.nl

Source: Bing maps

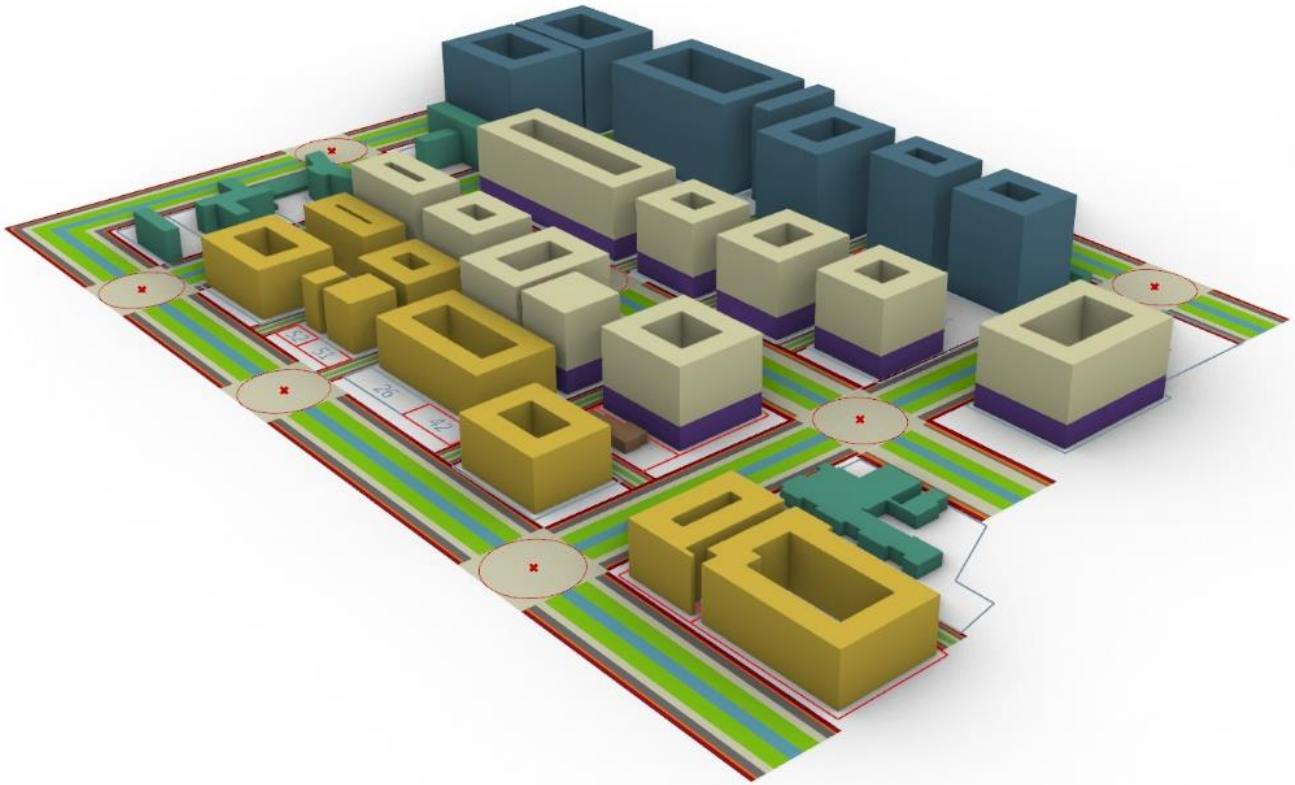
3 step – Output: Reports with model information (logs)

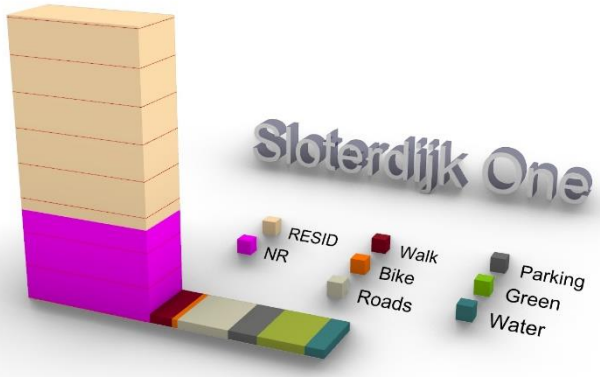
- Residential building shape
- Offset from street RESID
- Building depth RESID
- Level height RESID
- Mixed-use building shape
- Offset from street Mixed-use
- Building depth Mixed-use
- Level height NR in Mixed-use
- Number of NR levels in Mixed-use
- Level height RESID in Mixed-use
- NR building shape
- Offset from street NR
- Building depth NR
- Level height in NR buildings
- Number of levels in NR
- Existing buildings RESID
- Existing buildings NR
- All plots avaolable
- Number of new houses
- Average house size in m3
- % of RESID to Mixed-use buildings

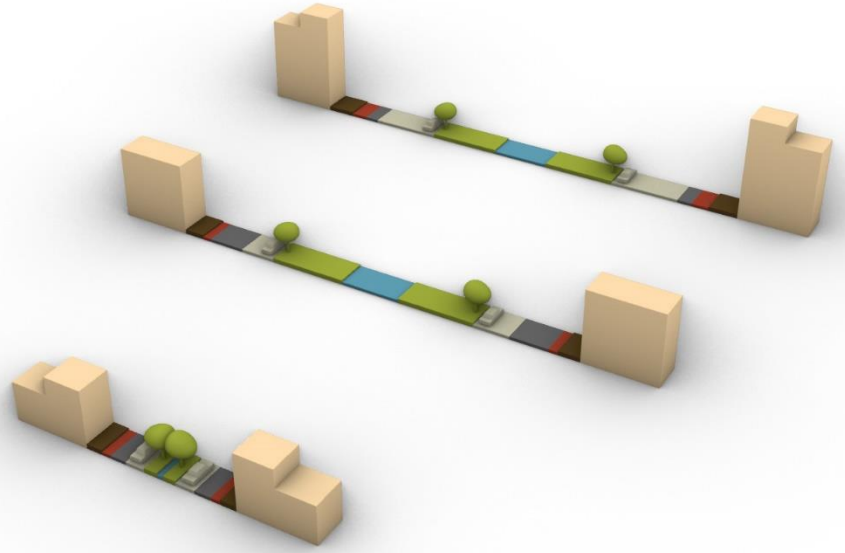


- GSI
- FSI
- TOT parcel surfaces (m2)
- TOT m2 construction
- TOT number of houses
- Height of new residential buildings
- Number of levels of new residential buildings
- Height of new Mixed-use buildings
- Number of levels of new Mixed-use buildings
- Height of new NR buildings
- Number of working places
- Amount of NR space per house (m3)
- Overall % of NR in the area
- % of NR in Mixed-use buildings
- % of NR in NR buildings
- % of NR in Existing buildings

3 step – Output: Screenshots from the 3D model







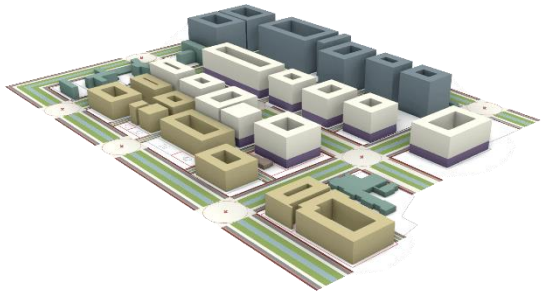
3 step – Output: Export 3D model + data (CityGML + Geo-globes visualization in collaboration with G.Agugiaro)

```
RESIDENTIAL OVERVIEW
O - Total number of houses: 11996.05 homes
      I - New houses: 11220.0 homes
            I - Houses in MIXED-USE buildings: 60.0 %
            O - Houses in RESID buildings: 40.0 %
      O - Existing houses: 776.05 homes
I - Average house size: 350.0 m3
```

Log (CSV)

+

Model (DWG)



CityGML

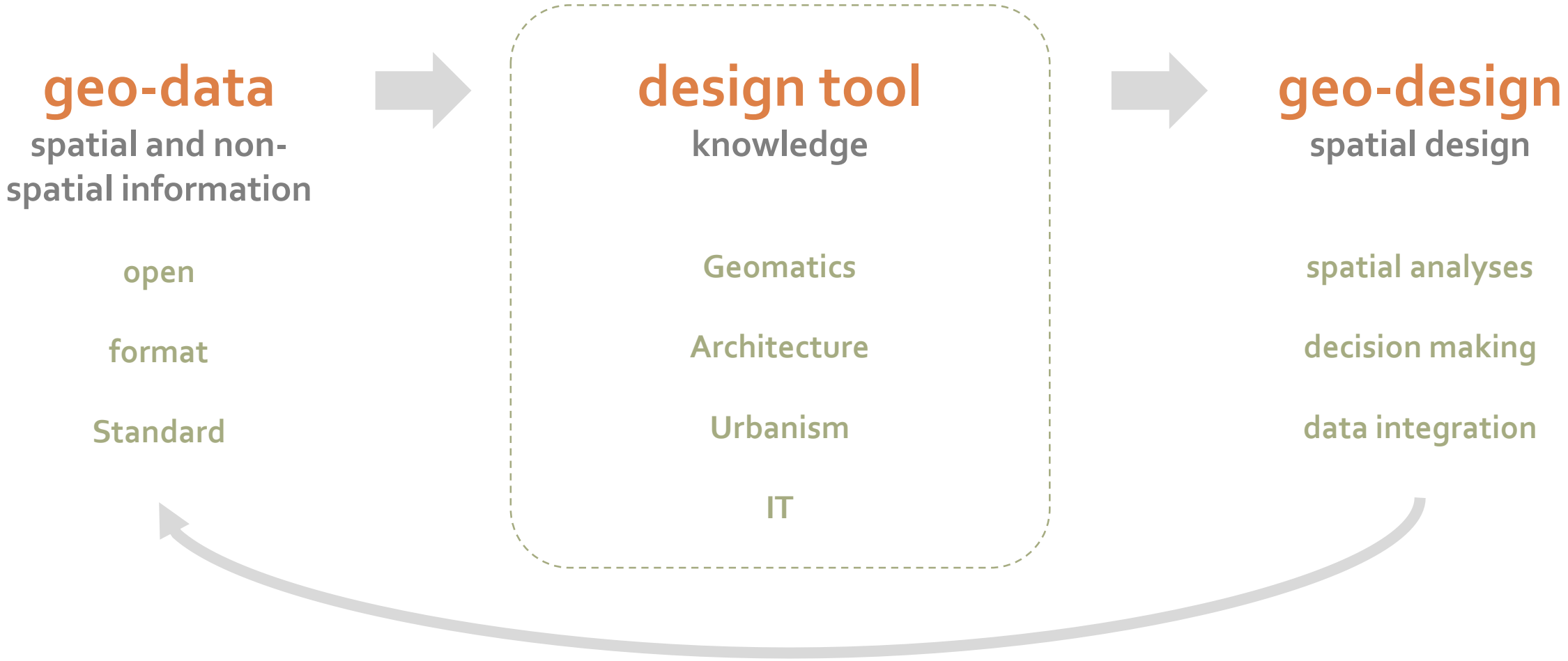
Open standardized data model
to store and share 3D city models

CESIUMJS

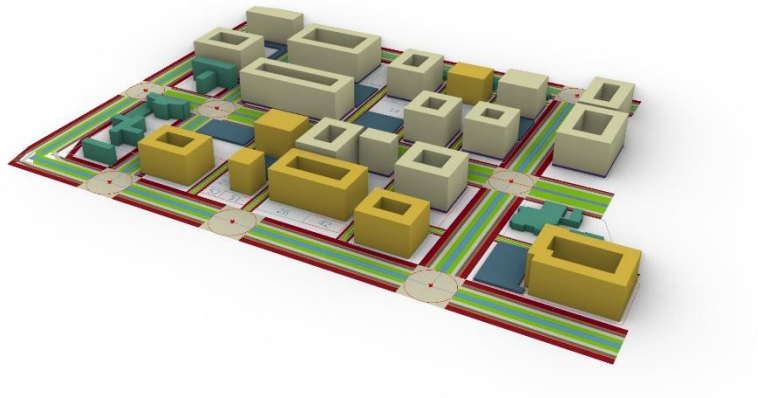
JavaScript library for 3D maps on the web

Cesium screenshot: G. Agugiaro

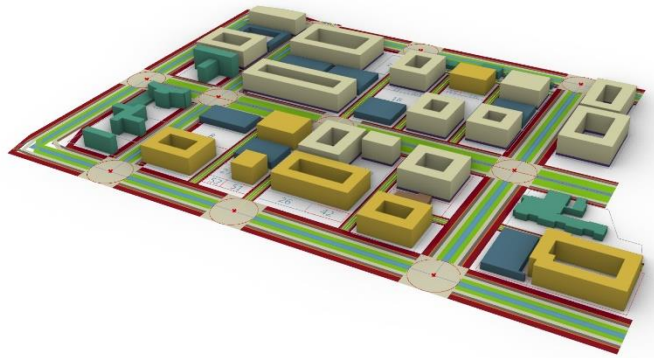
Overview of the project



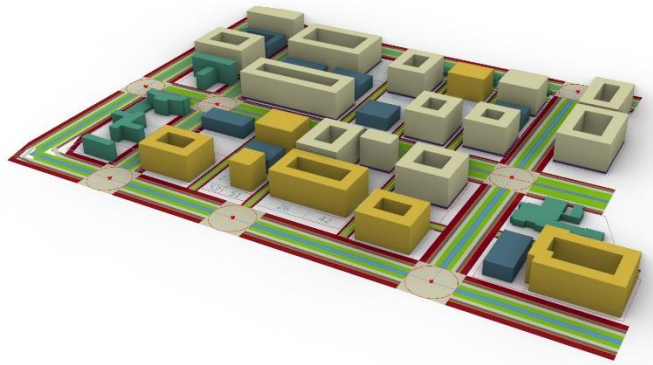
Java - 8	4,885 e	97 h/Ha	1996

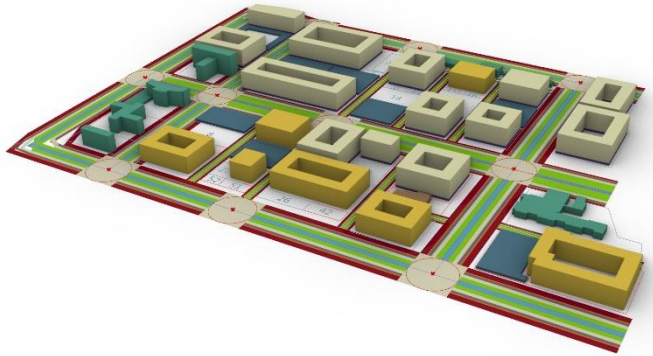


Herc - 7	6,207 e	221 h/Ha	1920

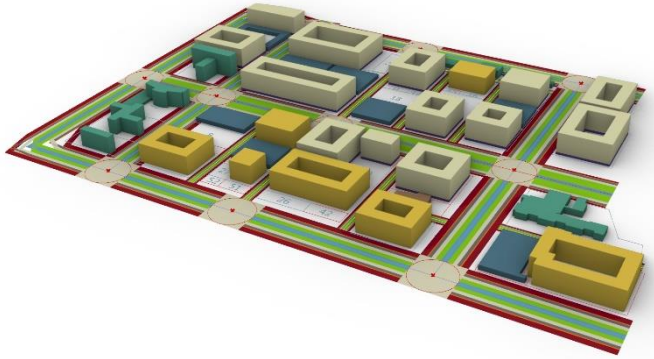


Elan - 9	6,738 e	151 h/Ha	1593

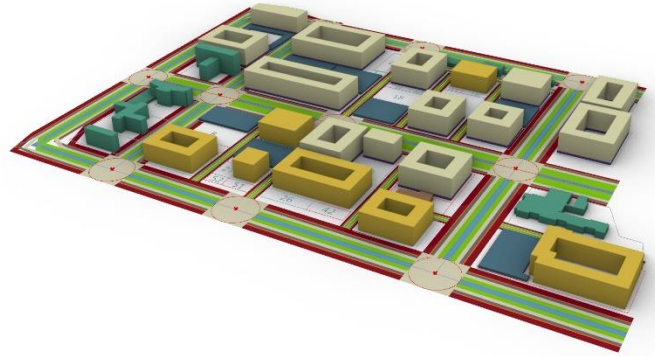




Orte - 4	5,442 e	203 h/Ha	1931

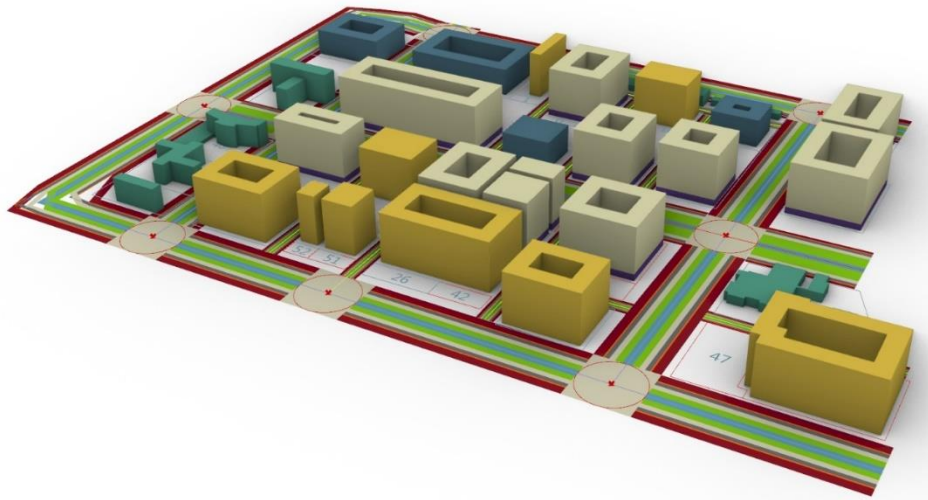


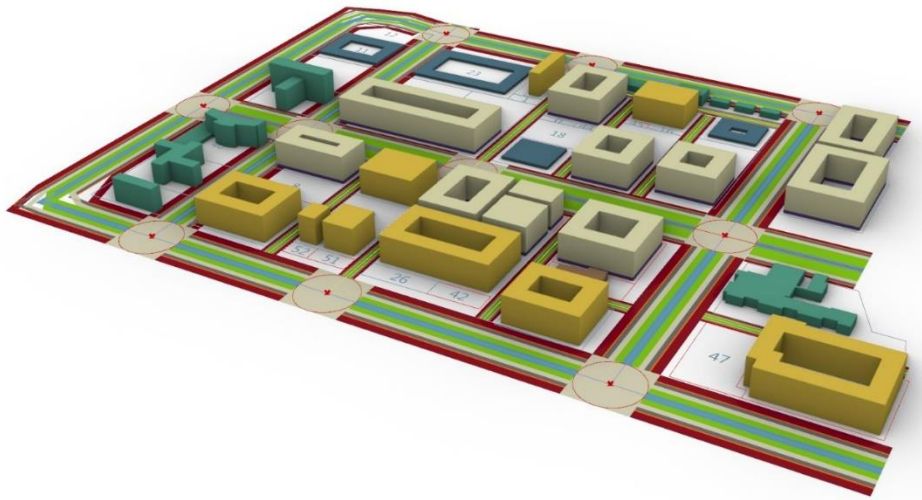
Loots - 7	6,422 e	214 h/Ha	1918



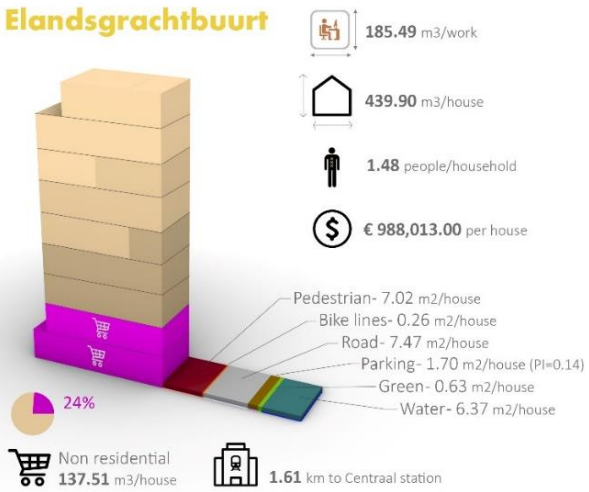
Fann - 4	6,151 e	235 h/Ha	1930

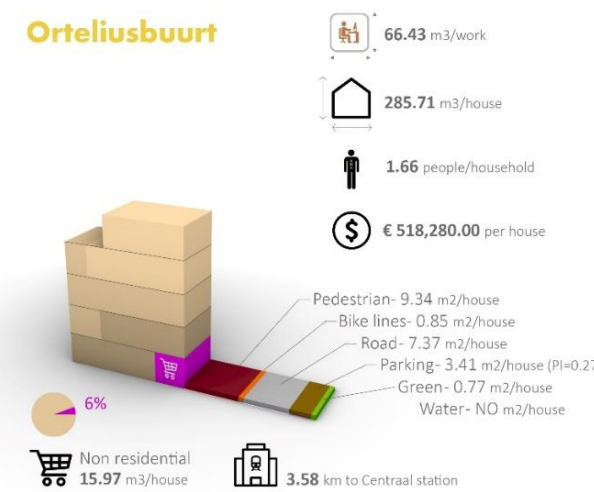
Comparison among scenarios – Goal: 11,220 households





11220 households	Java E.	Hercules	Elands.	Orteliusb.	Lootsb.	Fannius
Household size (m3)	515	290	440	285	310	300
Working space (m3)	95	145	185	65	125	110
Working places	8,692	7,785	7,524	12,703	7,930	11,250
FSI	5.8	3.8	5.51	3.57	3.92	3.79
m2 of construction	1,848,000	1,212,200	1,754,700	1,136,400	1,247,900	1,206,500
Storeys Residential	16	9	13	9	9	9
Storeys Mixed-Use	17	10	15	10	11	11
Storeys NR	1	3	6	1	2	1





Conclusions

- Analyze the **city of the present** through open **data** to create the **city of the future.**
- Inspiration from the Amsterdam Municipality goal: **reproduce** the existing **areas of 'success'** in expansion projects of the city (ring A10).
- Even if assumptions and simplifications were made in this thesis, the results shown the importance of considering the **size of the living spaces for future** development projects.
- Forgotten design proposals? The **exporting process** proposed in this thesis allows to make more **transparent** and **public** the design process and **store design as data** for possible future benefits.
- **GIS analysis** and parametric modelling of **cities** and **roads** together to have a complete overview of the design process.
- Expected uses of the 3D modelling tool for the design process:

Before - Help to **set the minimum parameters** for a new project.
During - **Review the guidelines** and check if the parameters are up to date.
After - **Adjust** parameters or **add new data** over time**.**

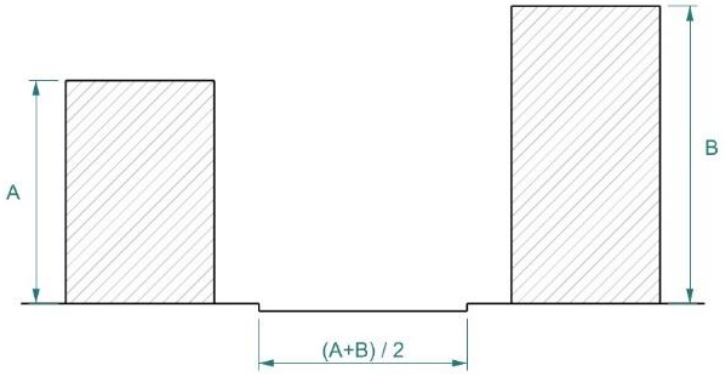
Future implementations

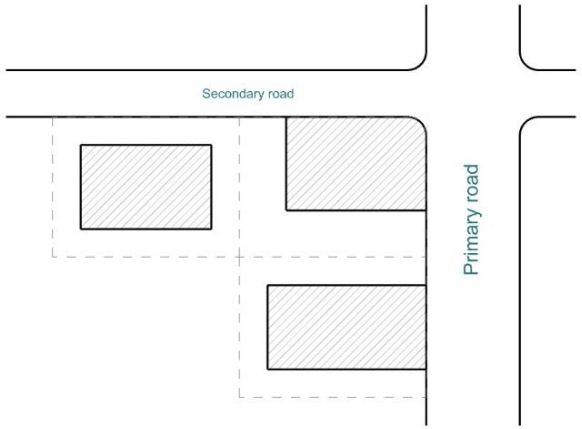
1. Calculate in an automated way the **size of the living space for Amsterdam** and the **NL** based on the proposed method.

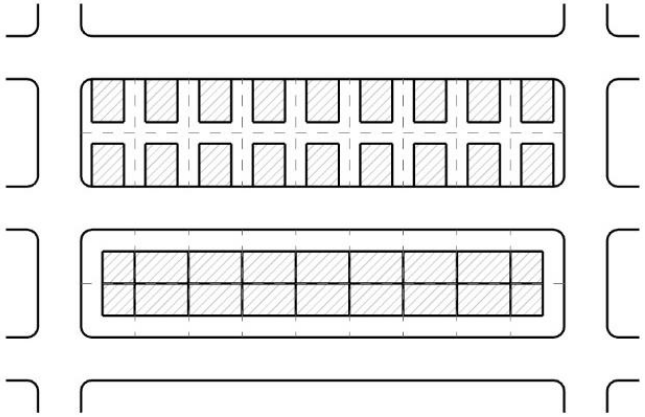
2. Beeing able to **compare** the scenarios **with other neighbourhoods** in the country and viceversa.

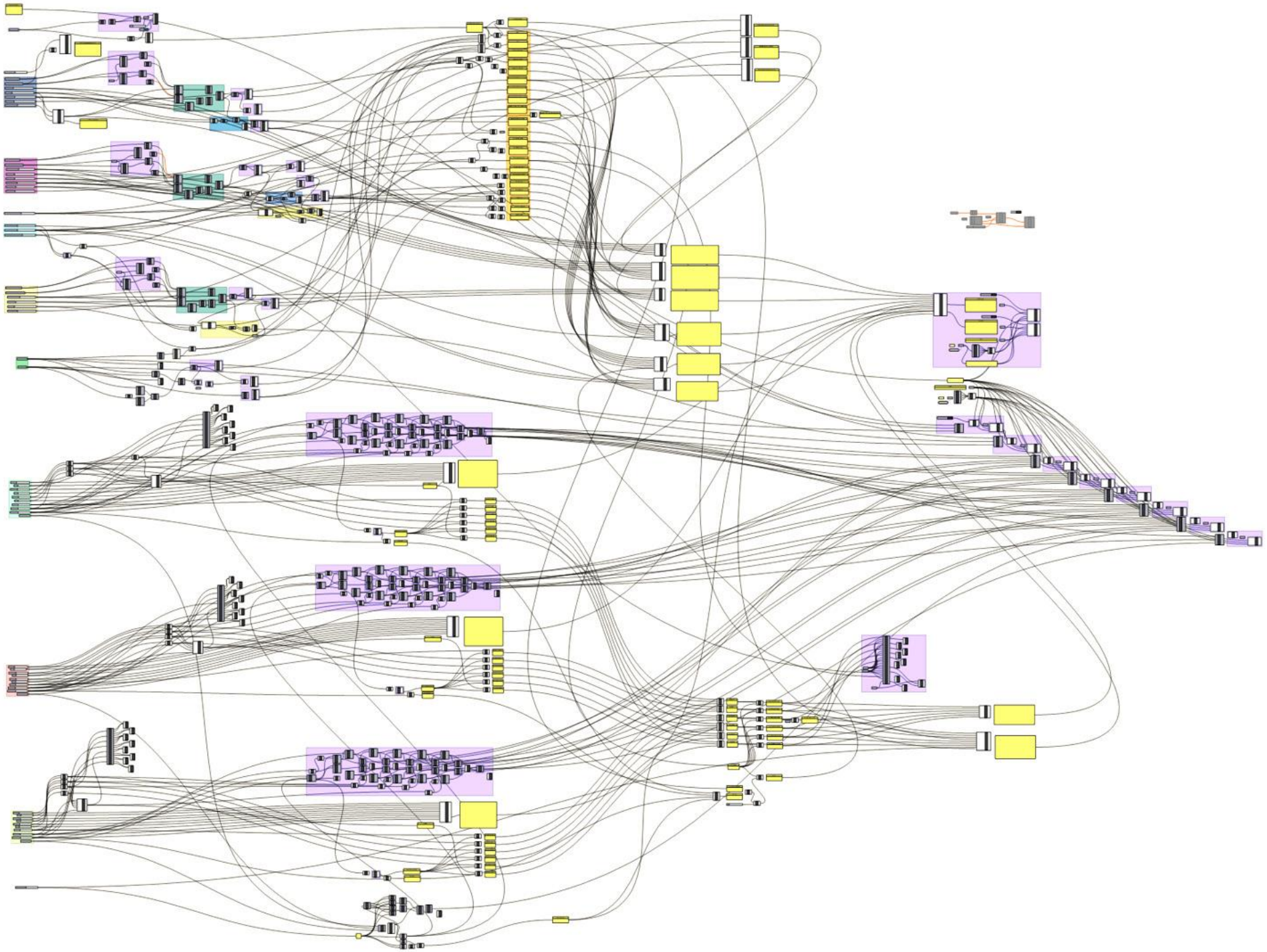
3. Implement the 3D modelling tool in an **open source software** (preferably web based).

4. Implement a **topology checker** to improve the **design possibilities** and calculate road widths based on building heights.









Thanks.