Methods and Tools for Urban Design

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Context

Issue

Case Study

Stage 1
Data Collection

Stage 2
Data Synthesis

Stage 3
Data Mining

Parametric CAD
to GIS

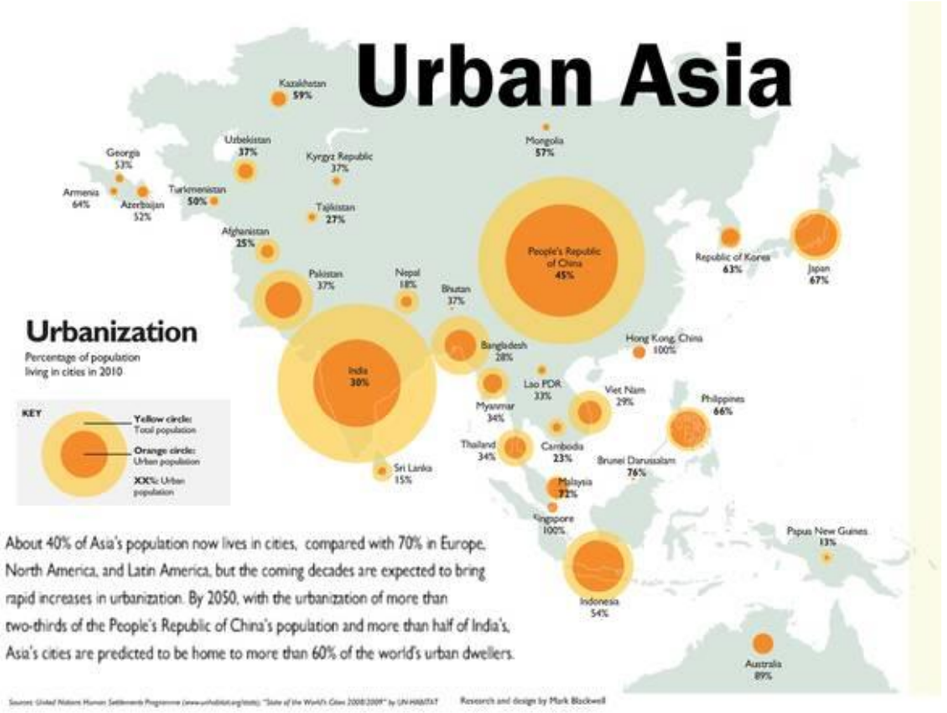
Parametric CAD
to Game Engines

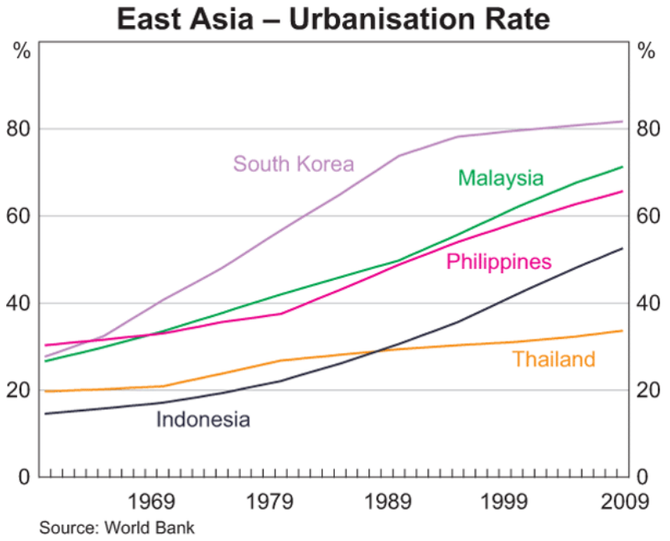
Future work

Conclusions

Accelerated Urbanization in Aisa

- Urban population is lower than Europe
- But the rate of urbanization is much higher
- This results in an accelerated urbanization process
  - For example:
    Delhi Mumbai Industrial Corridor

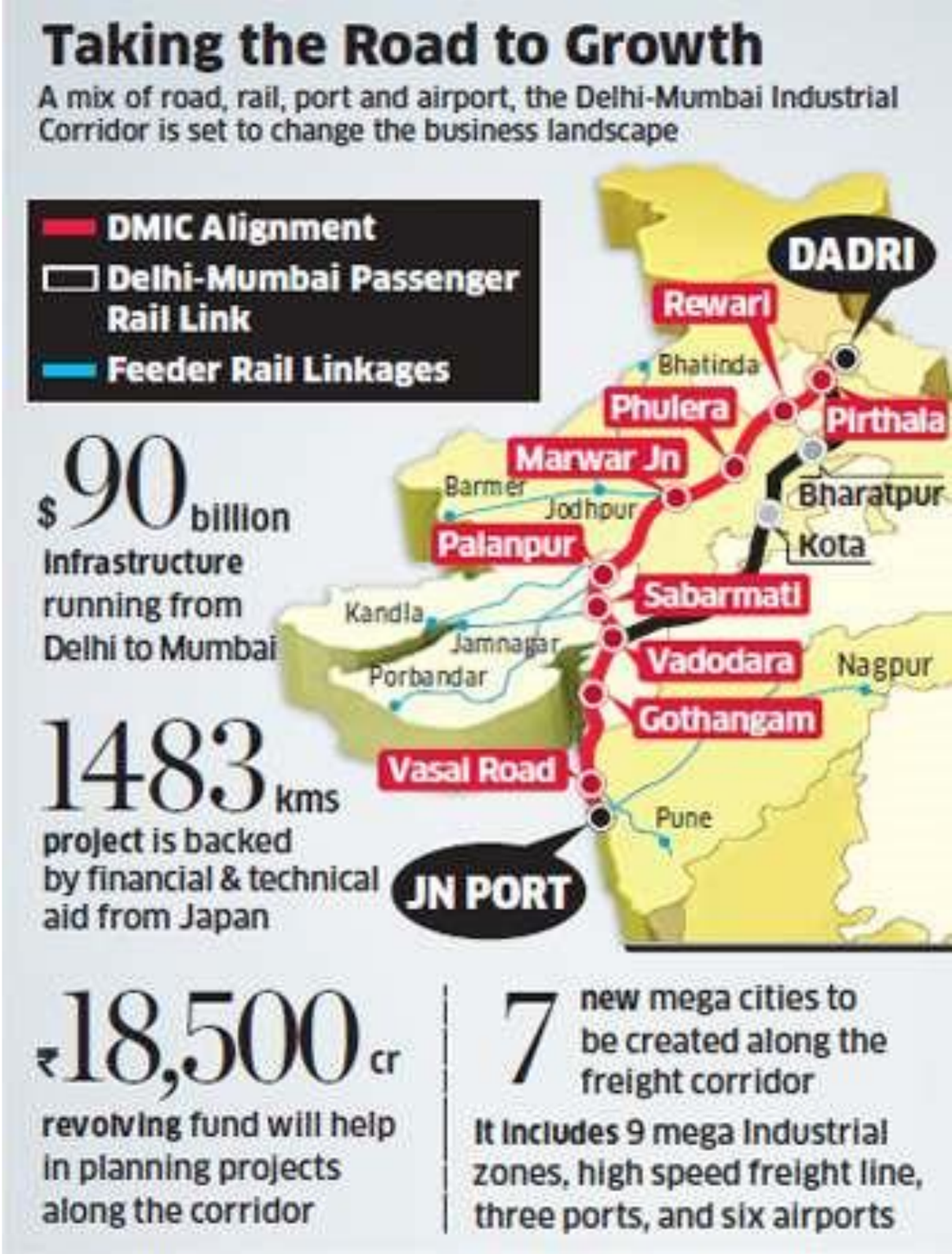




http://www.resilience.org/stories/2010-05-10/asias-epic-urban-sagas#
http://www.rba.gov.au/publications/bulletin/2011/dec/4.html

Delhi Mumbai Industrial Corridor

- Mega project between the political capital and the business capital of India
- Includes building new ‘mega cities’ from scratch
- E.g. Gujarat International Finance Tec-City



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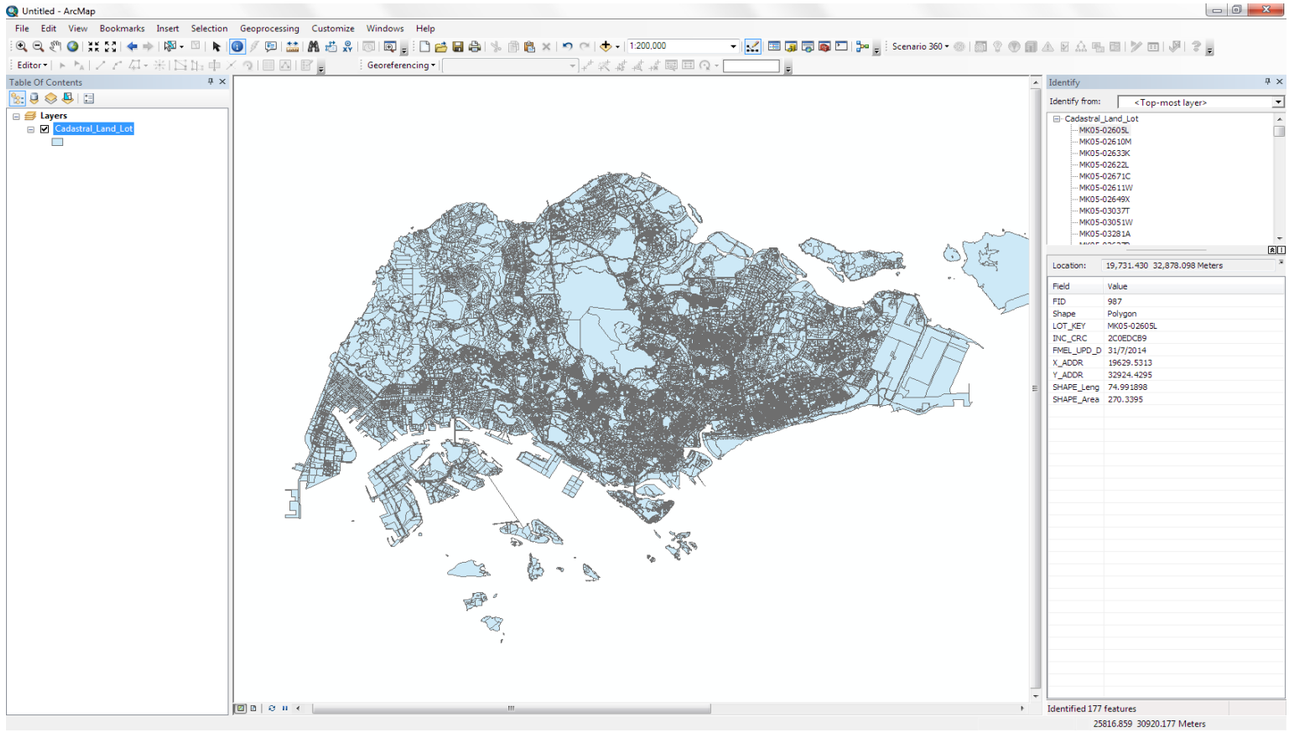
Planning Support Systems

- A collective term for a wide variety of tools (Harris, 1989)
- The tools emerged in the 1980s
- Initially focused on municipal information systems and land use-transportation models
- By the 1990s, cheap PCs and GIS based planning systems



The Challenge in Practice

- Dynamic processes
- Collaborative work
- Time constraints
- Skill constraints
- Tools constraints

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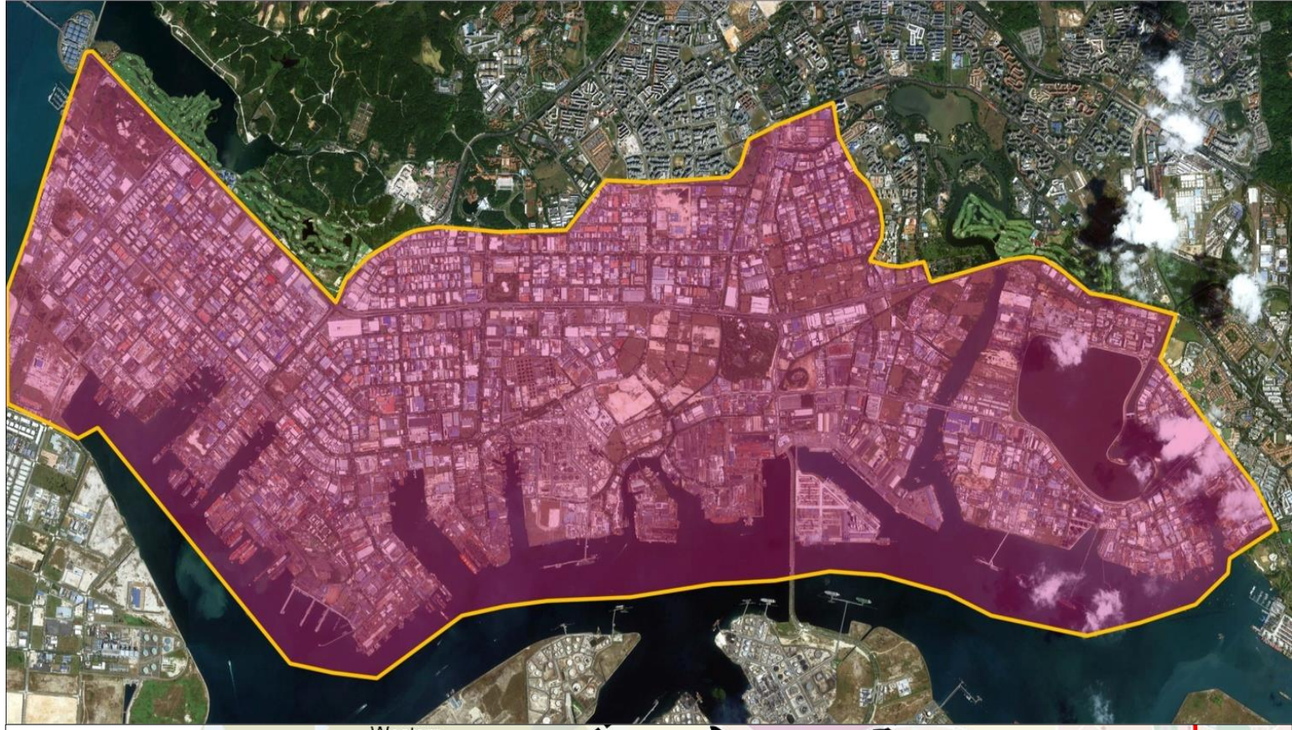
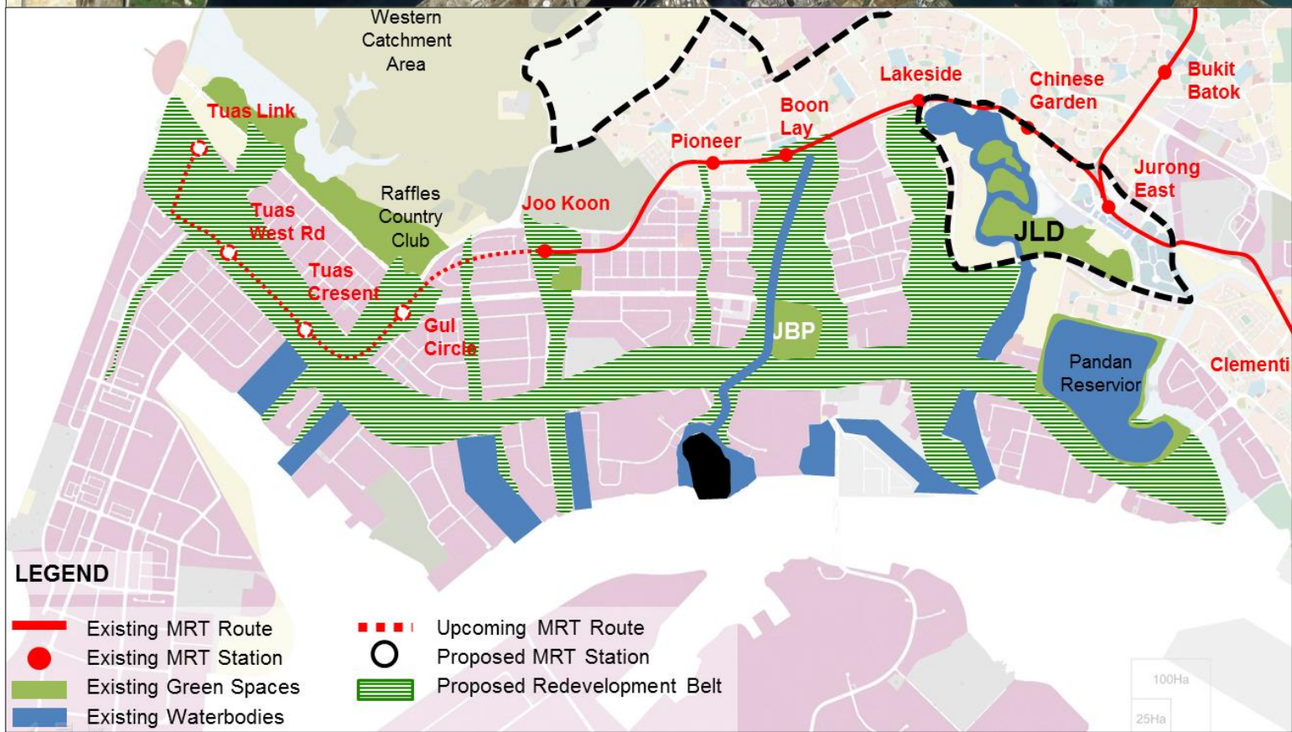
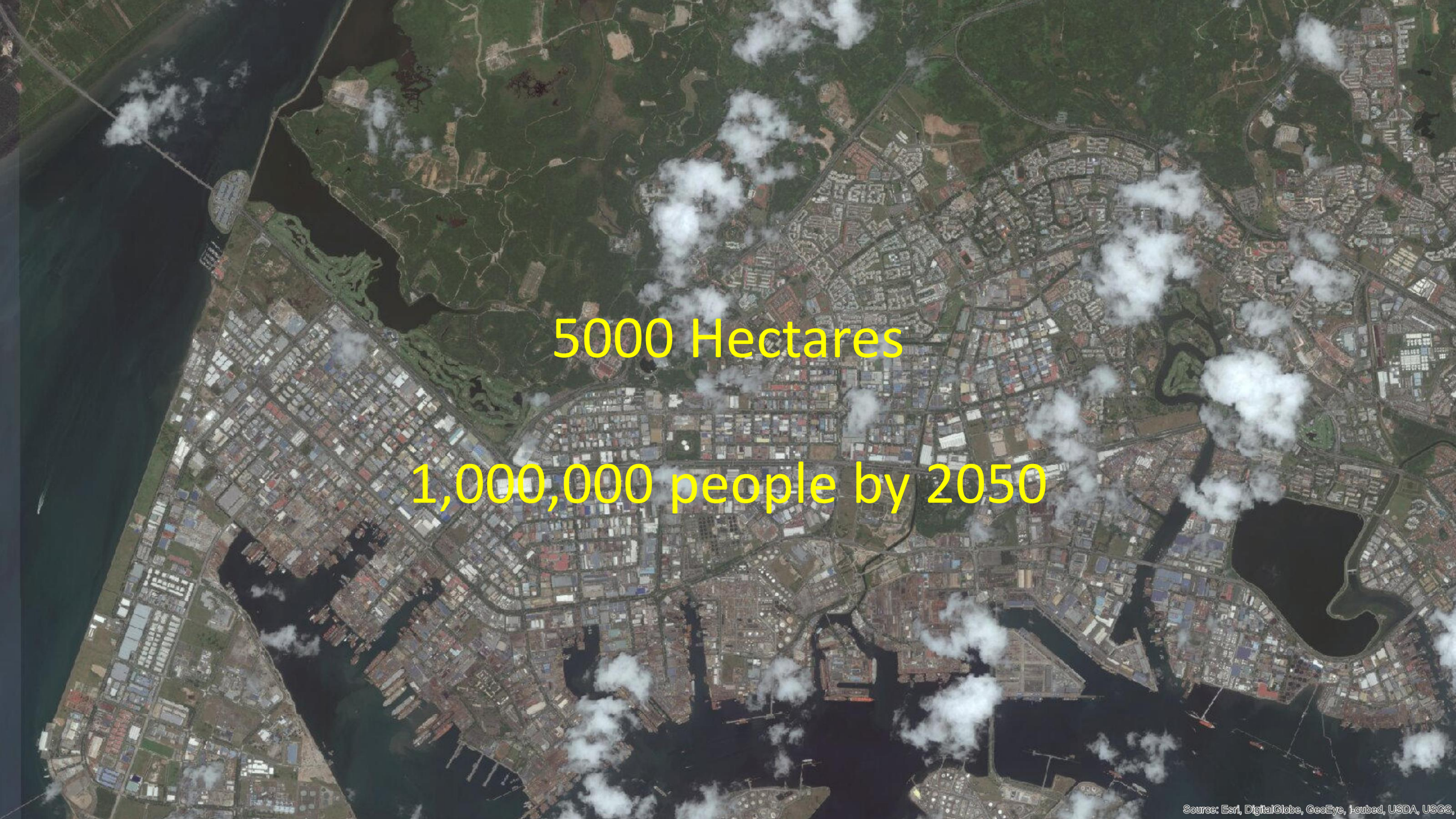
- International Forum on Urbanism (IFoU)
- 2015 winters school in Singapore
- Topic
  - In collaboration with Jurong Town Council (JTC)
  - Transform Jurong West area into an Industrial City

- http://ifou2015.sg





The transformation of the Jurong West area from an almost mono-functional, segregated and fragmented, highly polluted industrial area into a major catchment area for future population growth that integrates clean(ed) industrial plants with green lungs, attractive housing and vibrant urbanity for one million people.


5000 Hectares
1,000,000 people by 2050
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS,

Team 9

- IFoU studio

Jaume Pla
Goh Jia Li
Geraldine De Neuville
Ravish Kumar
Delon Leonard
Made Perwira
Tanzir Taher
Marco Berger
Josef Odvarka
Xiameng Jia
Meng Jing
Peter Lie
Fei Bo
Zhao Danyu
Jasmin Mok

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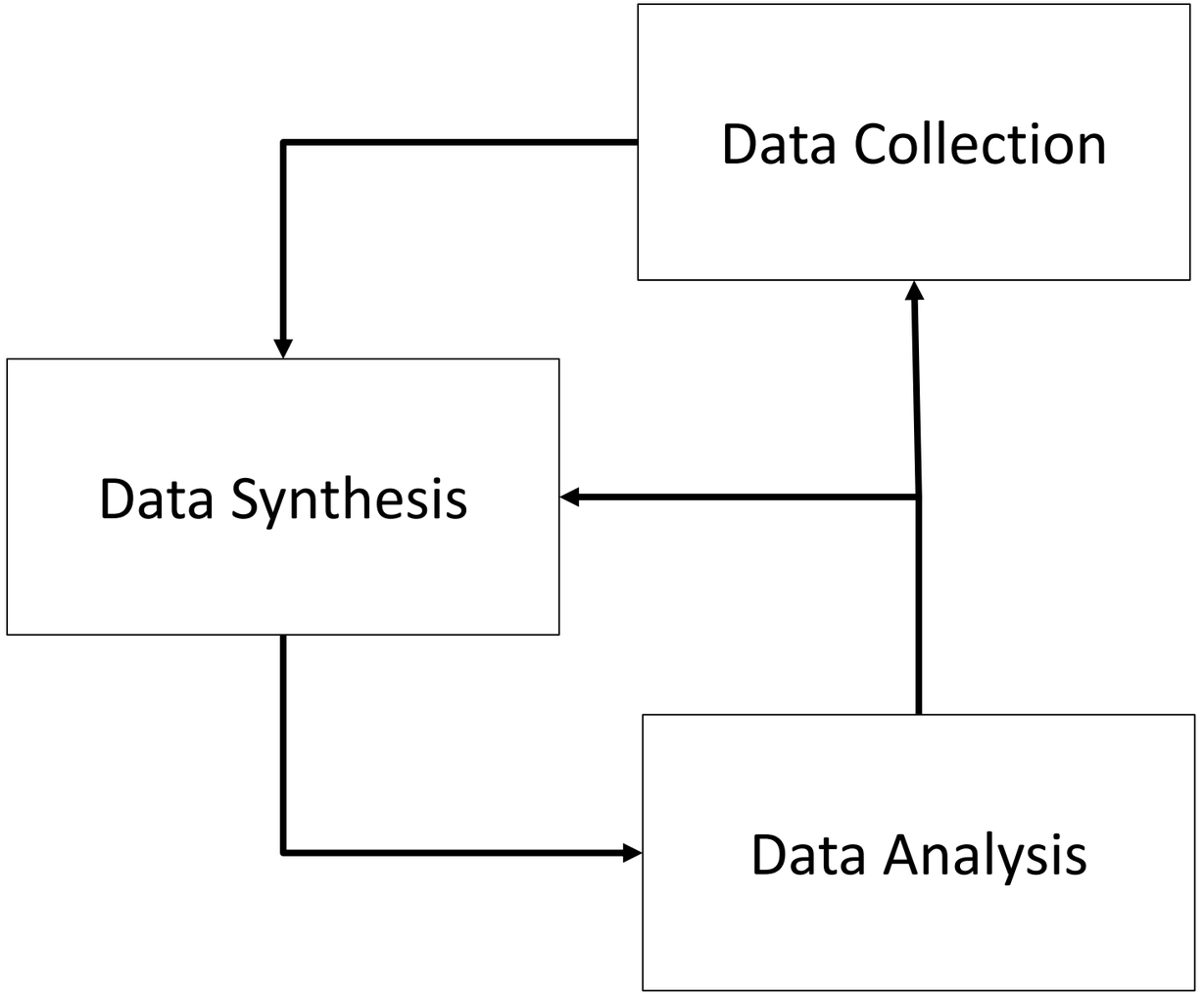
Quantification?

- In general, there was a lack of quantified evidence

- Problems with working at large scale
  - Quantifying floor areas
  - Quantifying densities
  - Quantifying travel distances
  - Quantifying …



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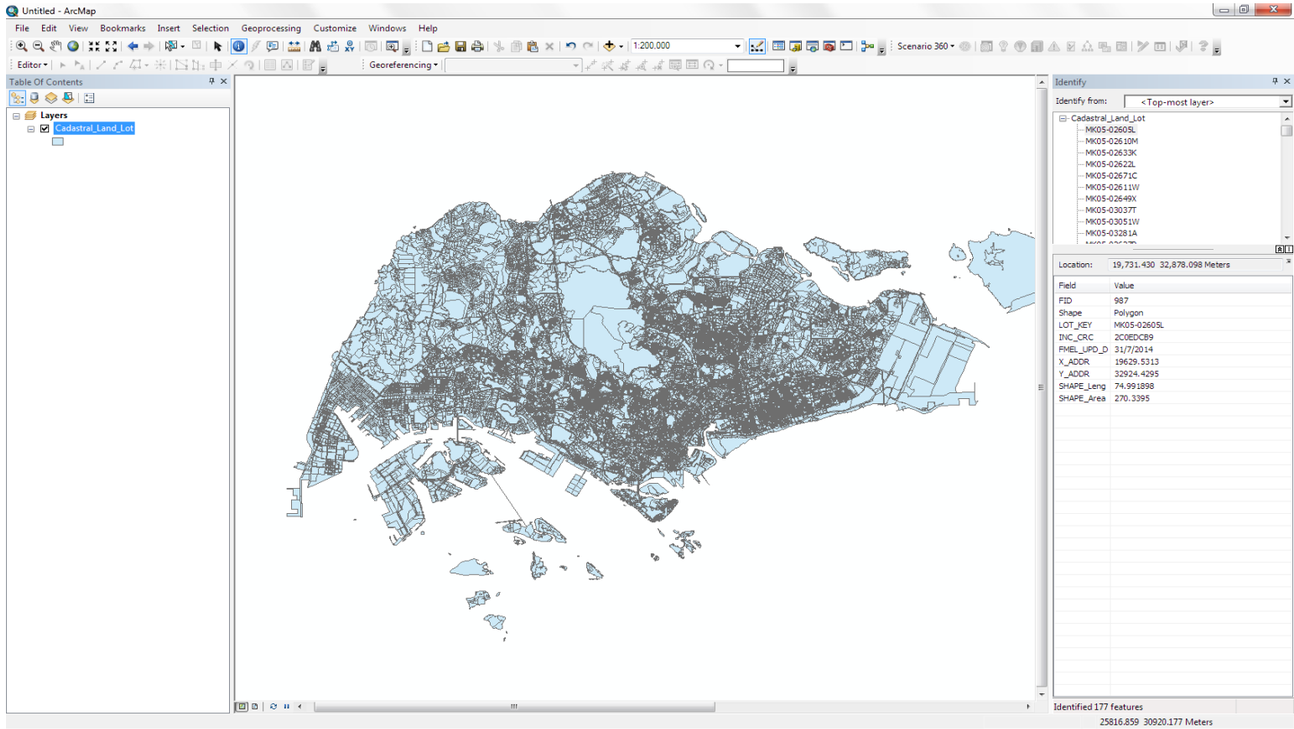
Data Collection Methods

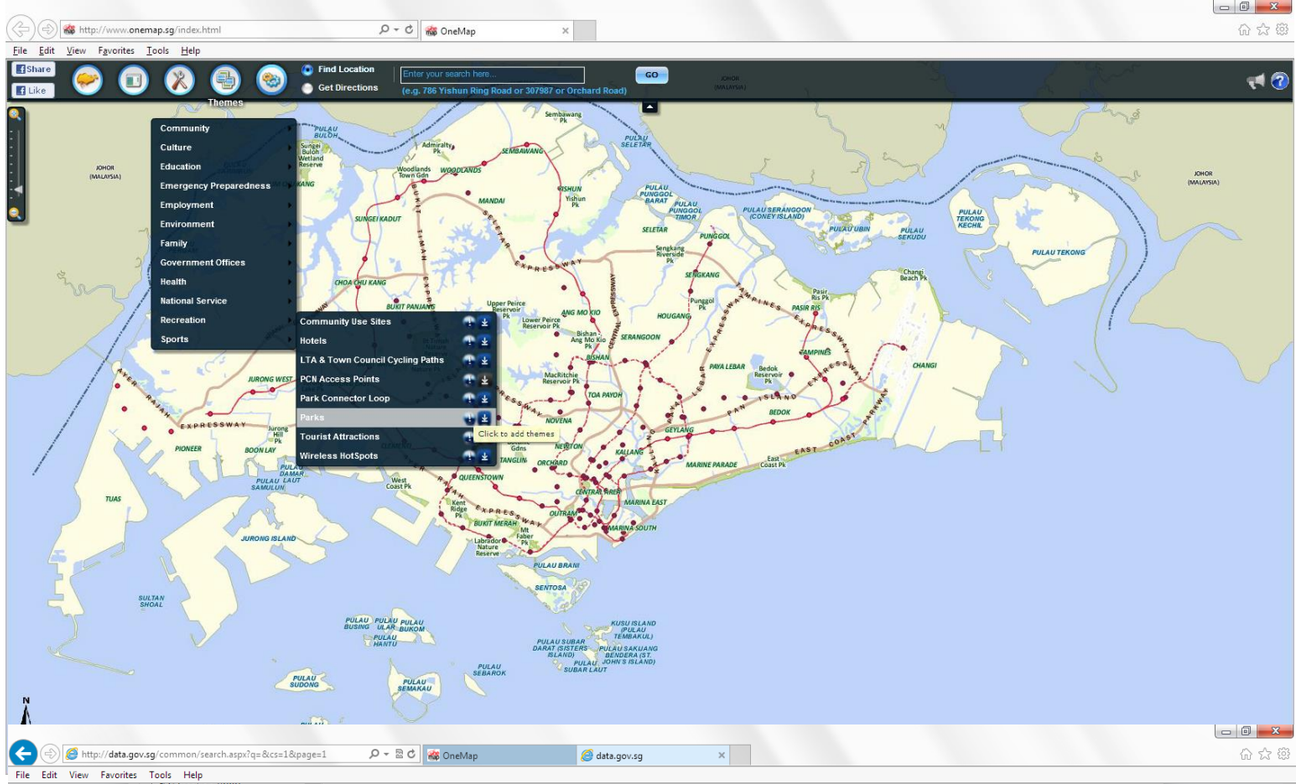
- Downloading
- Tracing
- Web scraping

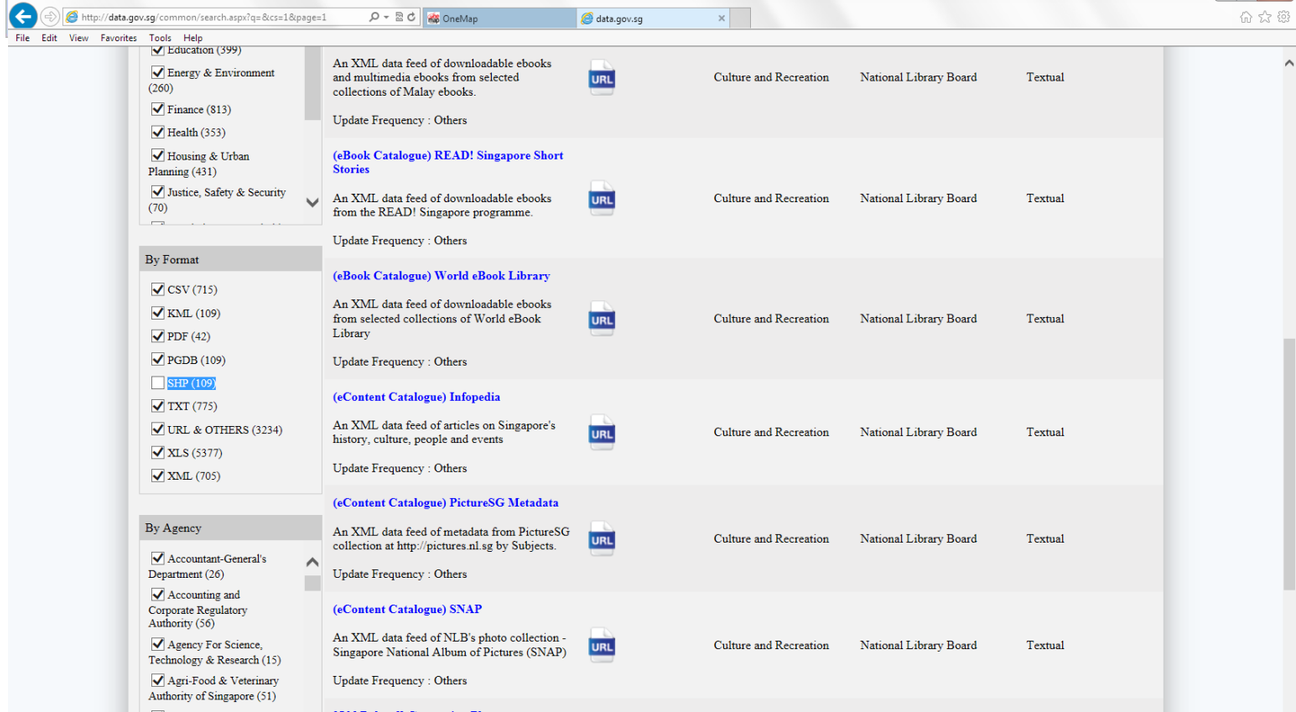


Downloading

- Government data portal
- 8600 datasets (textual and spatial) from 60 government ministries and agencies

data.gov.sg
discovering data, inspiring ideas

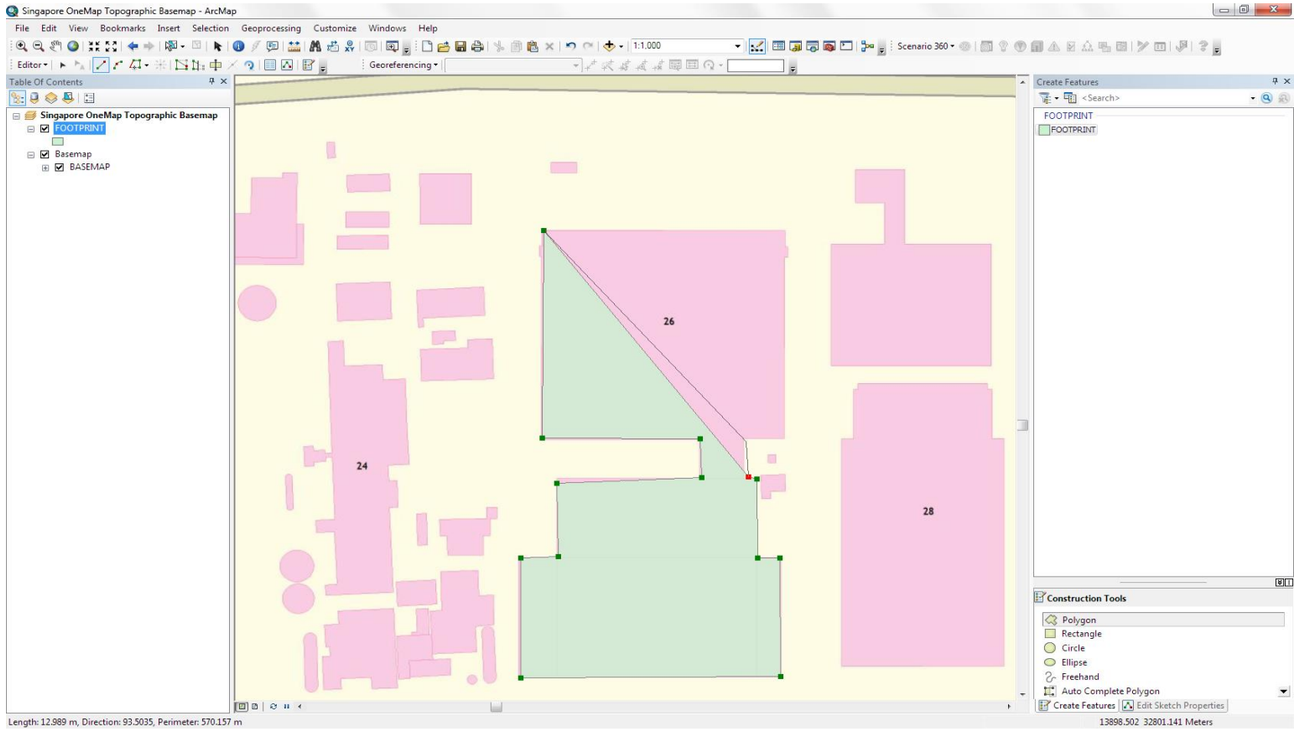




Tracing

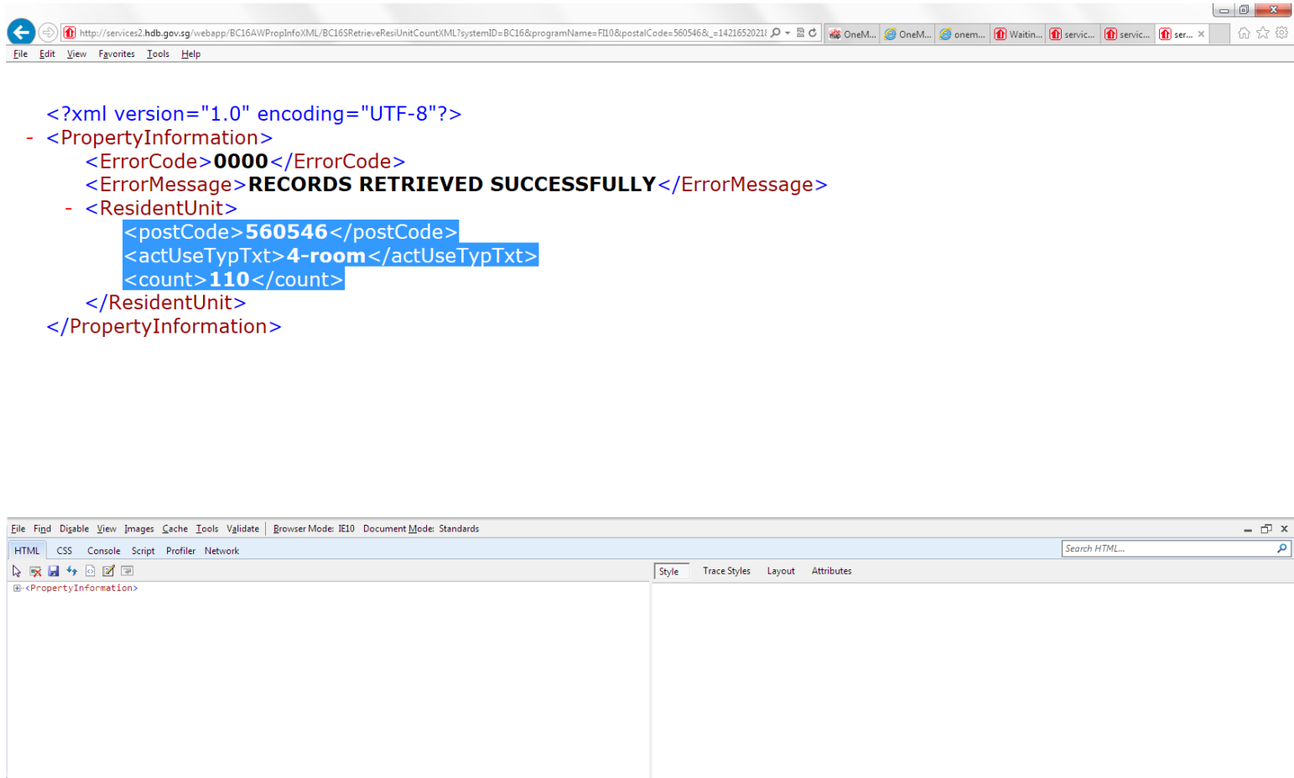
- Maps from OpenStreetMap had to be corrected

- Only method was to trace the images from data.gov.sg



Web Scraping

- A technique of extracting information from websites programmatically.
- Used to collect data
  - public housing types
  - business listings



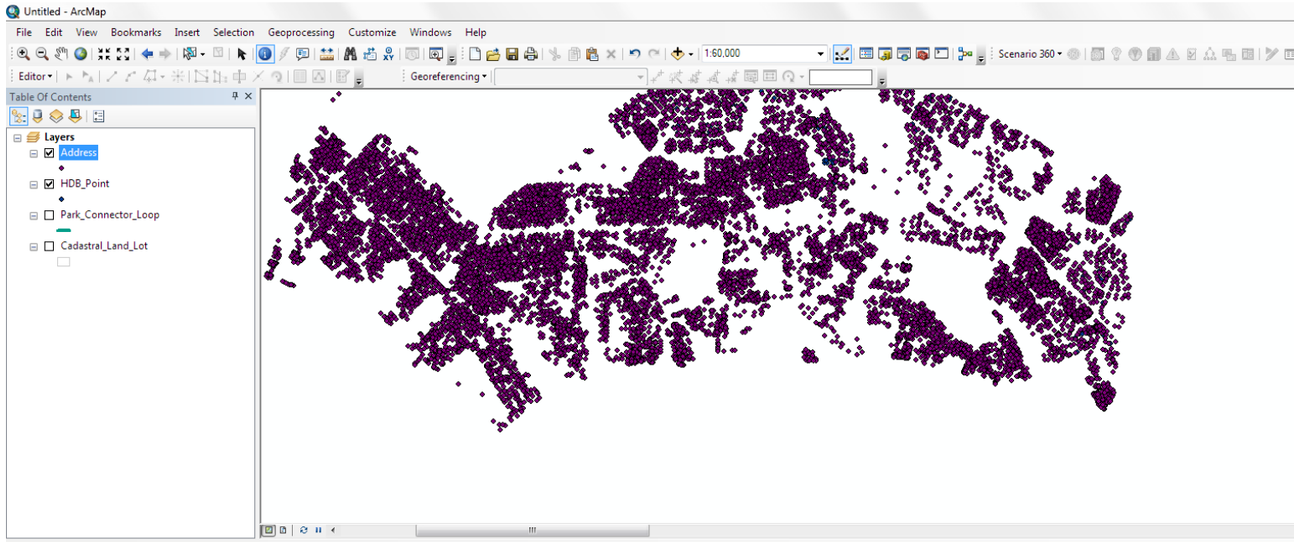
http://services2.hdb.gov.sg/webapp/BC16AWPropInfoXML/BC16SRetrieveResiUnitCountXML?systemID=BC16&programName=FI10&postalCode=560546
http://search.insing.com/singapore/browse/art-galleries

Web Scraping

Housing Type Data

postal	1_room	2_room	3_room	4_room	5
530005	0	0	126	0	
531001	0	0	178	0	
531002	0	0	161	0	
531003	0	0	117	0	
531004	0	0	128	0	
531006	0	0	0	88	
531007	0	0	0	88	
531008	0	154	0	0	
550101	0	0	0	144	
550102	0	0	16	8	
550103	0	0	0	144	
550104	0	0	16	8	
550105	0	0	120	0	
550106	0	0	130	0	

Geospatial Address Point Data

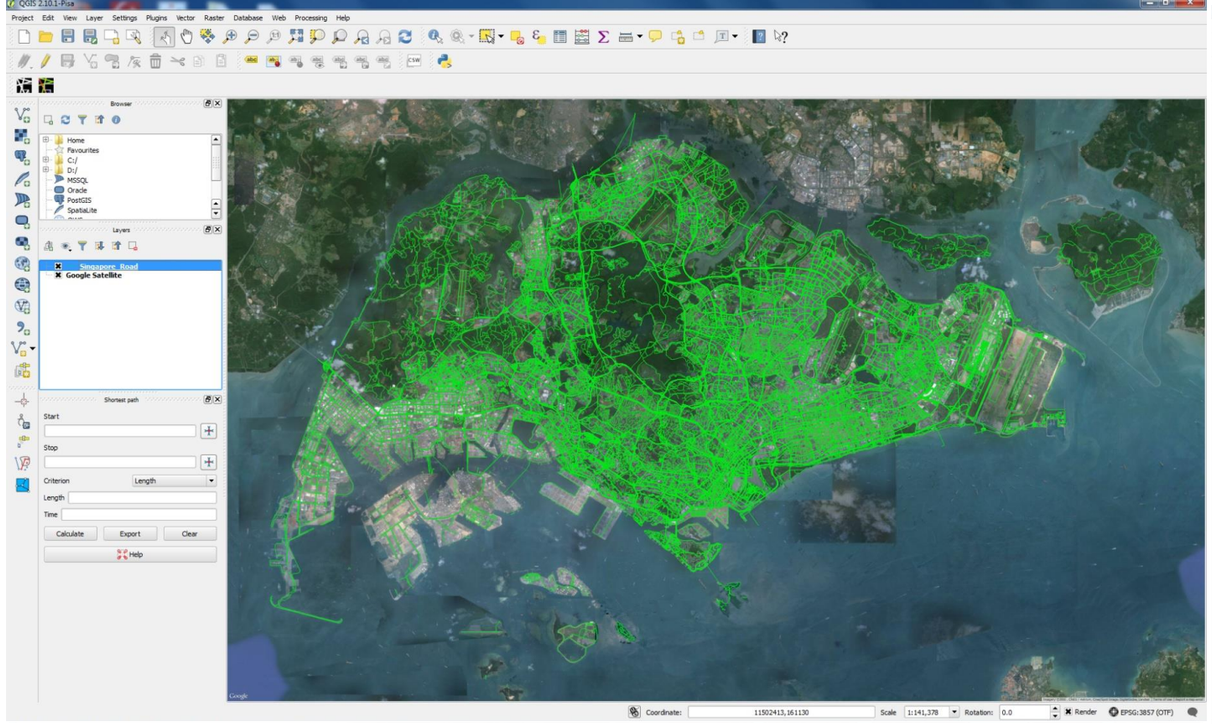


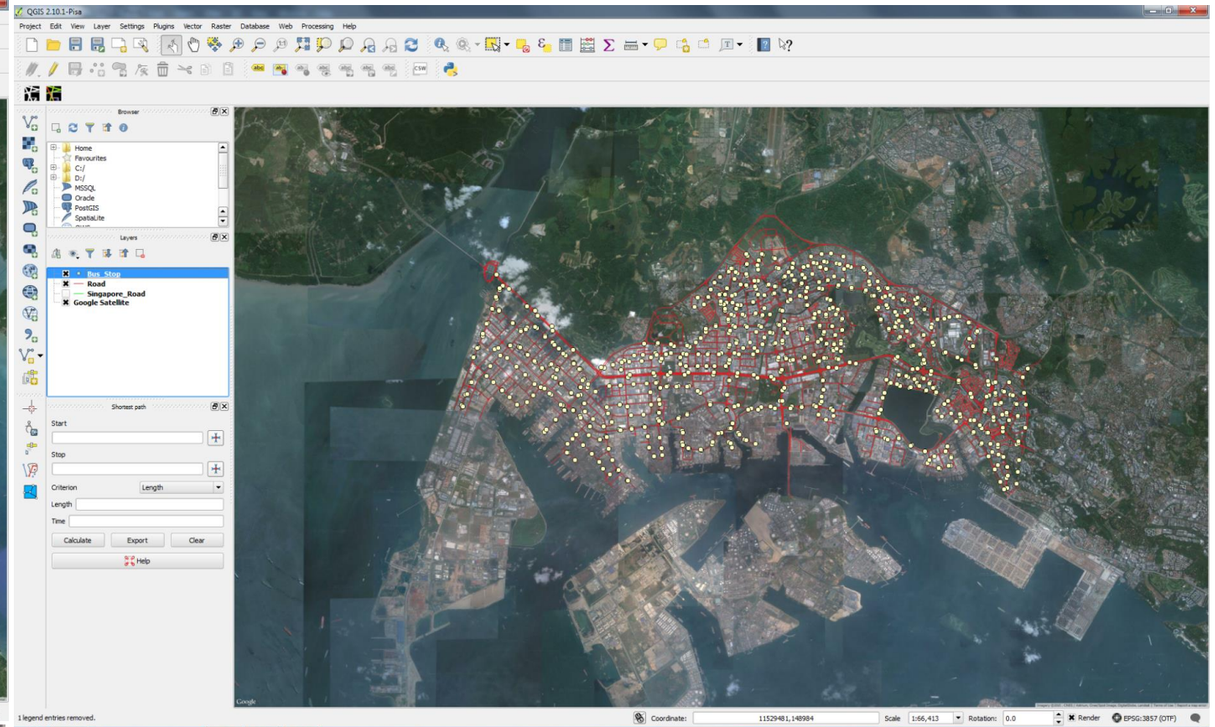
Table

Address

FID	BUILDING_N	HOUSE_BLK_	ROAD_NAME	POSTAL_COD
0	ASIA PACIFIC BREWERIES	459	JALAN AHMAD IBRAHIM	639934
1		87	SUNSET WAY	597108
2		8	SUNSET CLOSE	597523
3		35	BOON LAY AVENUE	649962
4		35	BOON LAY AVENUE	649962
5		9	TANJONG PENJURU CRESCENT	608972
6		11	SUNVIEW WAY	627540

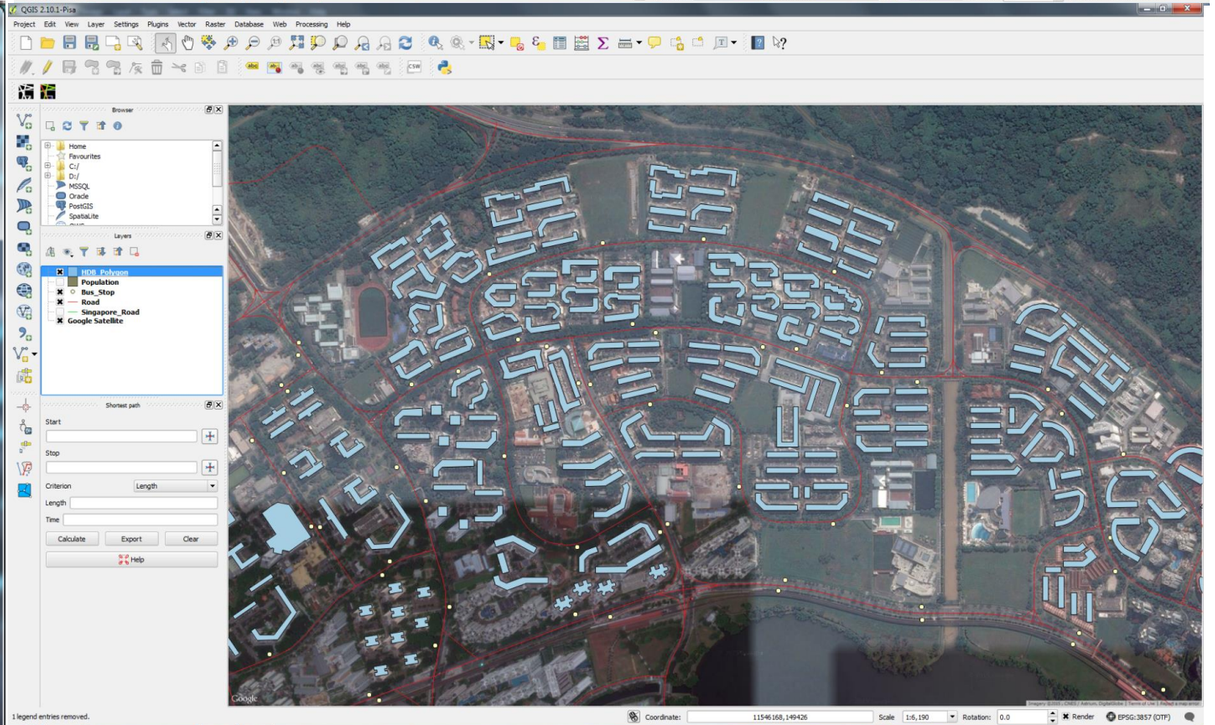
Join by Postal





Attribute table - HDB_Polygon :: Features total: 1087, filtered: 1087, selected: 0

	building_n	house_blk_	data_type_	bldg_type_	road_name	Sum_1_room	Sum_2_room	Sum_3_room
0	HDB-CLEMENTI	602	extg	H	CLEMENTI WEST ...	0.00000000000	0.00000000000	190.00000000000
1	HDB-CLEMENTI	724	extg	H	CLEMENTI WEST ...	0.00000000000	0.00000000000	0.00000000000
2	HDB-TEBAN GAR...	44	extg	H	TEBAN GARDENS...	0.00000000000	0.00000000000	66.00000000000
3	HDB-JURONG EAST	30	extg	H	TEBAN GARDENS...	0.00000000000	0.00000000000	0.00000000000
4	HDB-CLEMENTI	729	extg	H	CLEMENTI WEST ...	0.00000000000	0.00000000000	144.00000000000
5	HDB-CLEMENTI	114	extg	H	CLEMENTI STREE...	0.00000000000	0.00000000000	0.00000000000
6	HDB-JURONG WE...	539	extg	H	JURONG WEST A...	0.00000000000	0.00000000000	0.00000000000
7	HDB-JURONG EAST	263	extg	H	JURONG EAST S...	0.00000000000	0.00000000000	0.00000000000
8	HDB-JURONG EAST	325	extg	H	JURONG EAST S...	0.00000000000	0.00000000000	0.00000000000
9	HDB-TEBAN GAR...	34	extg	H	TEBAN GARDENS...	0.00000000000	0.00000000000	100.00000000000
10	HDB-CLEMENTI	426	extg	H	CLEMENTI AVEN...	0.00000000000	0.00000000000	126.00000000000
11	NULL	501	extg	H	WEST COAST DR...	0.00000000000	0.00000000000	6.00000000000
12	HDB-JURONG WE...	836	extg	H	JURONG WEST S...	0.00000000000	0.00000000000	0.00000000000
13	HDB-JURONG WE...	656B	extg	H	JURONG WEST S...	0.00000000000	0.00000000000	0.00000000000
14	NULL	502	extg	H	JURONG WEST A...	0.00000000000	0.00000000000	24.00000000000



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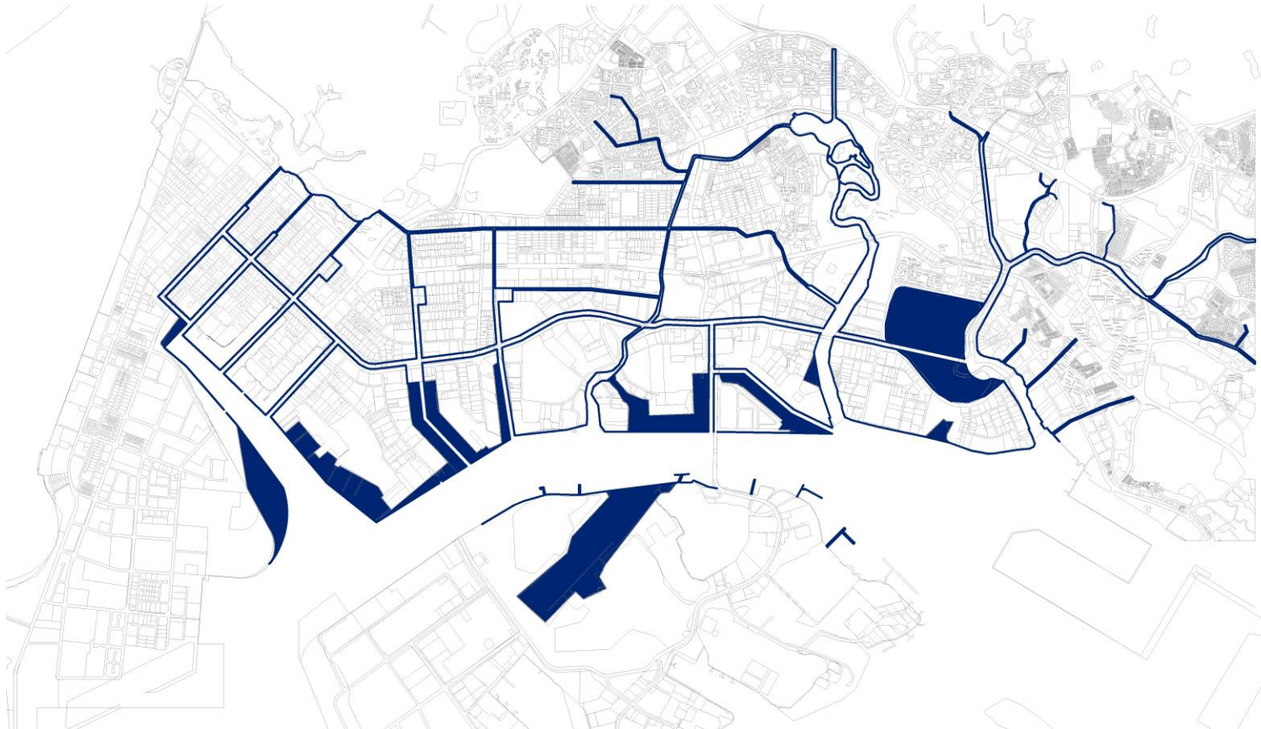
Synthesis tools

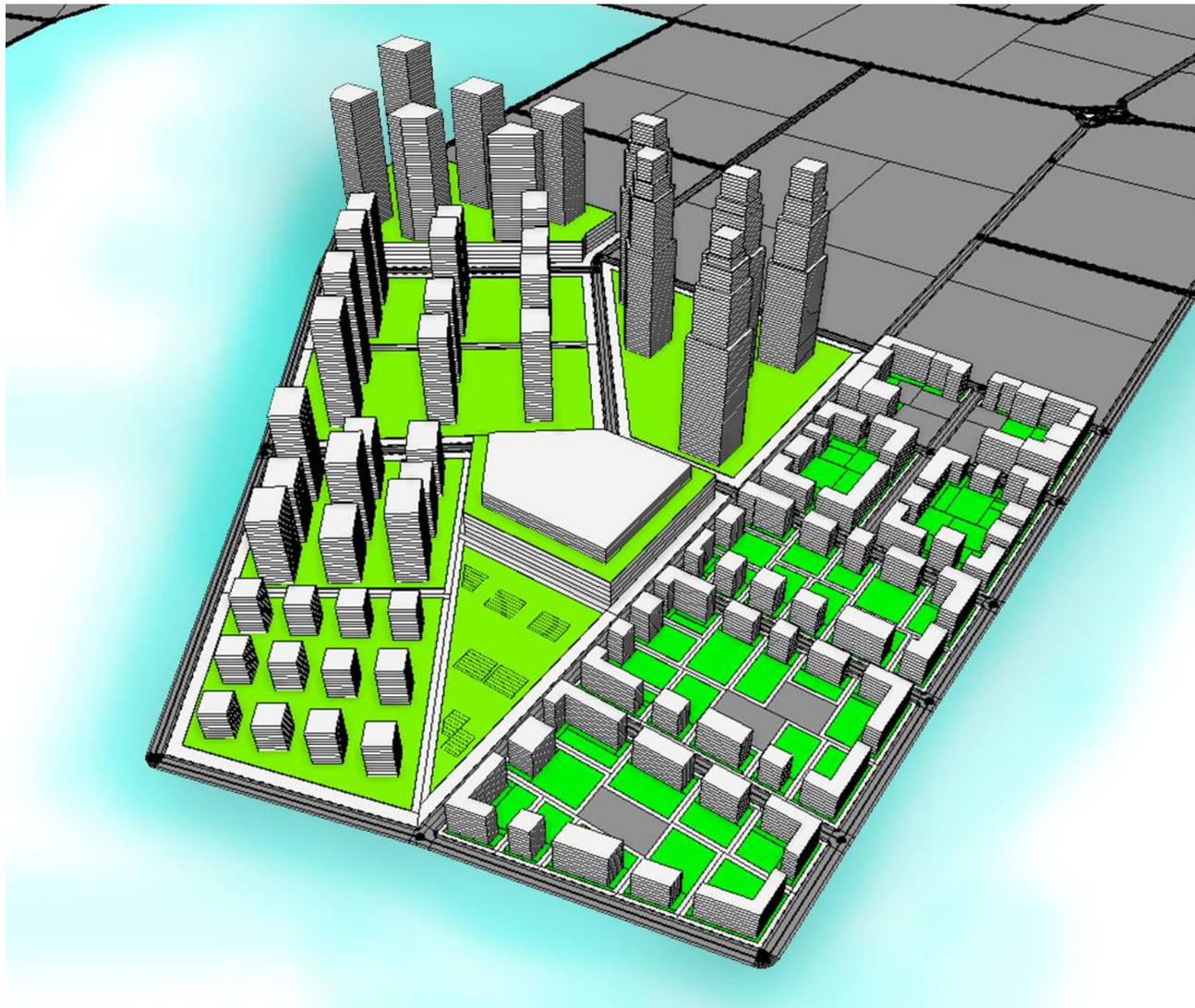
- Tools are needed to generate large-scale 3D models
  - Generation process needs to be highly automated
  - Designers need to be able to define
    - Typologies
    - Urban variation



Experiments with Esri CityEngine

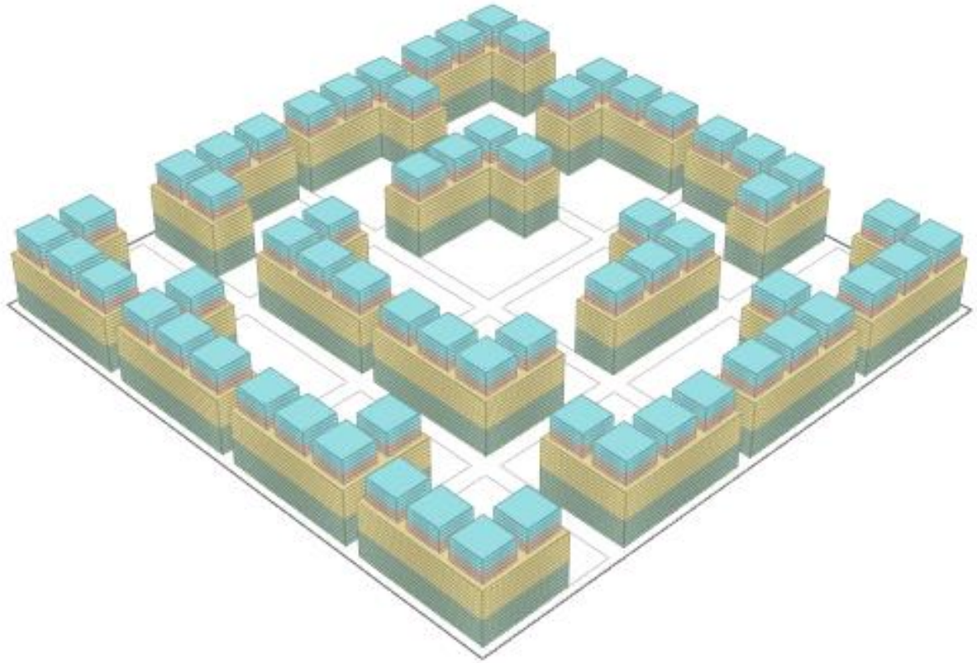
- Very good at making models for visualization

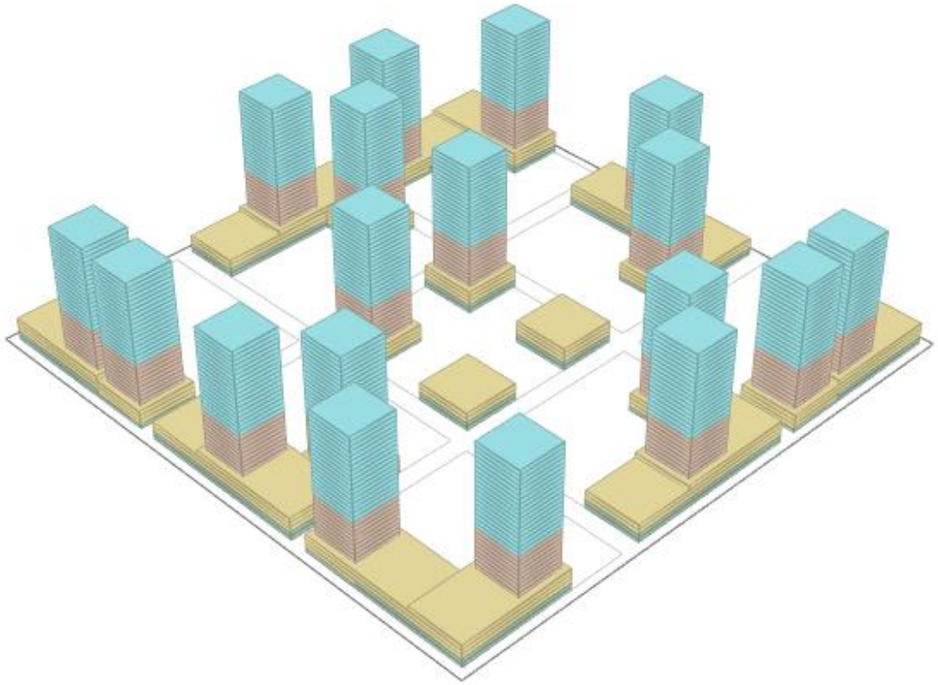
- But level of automation is limited

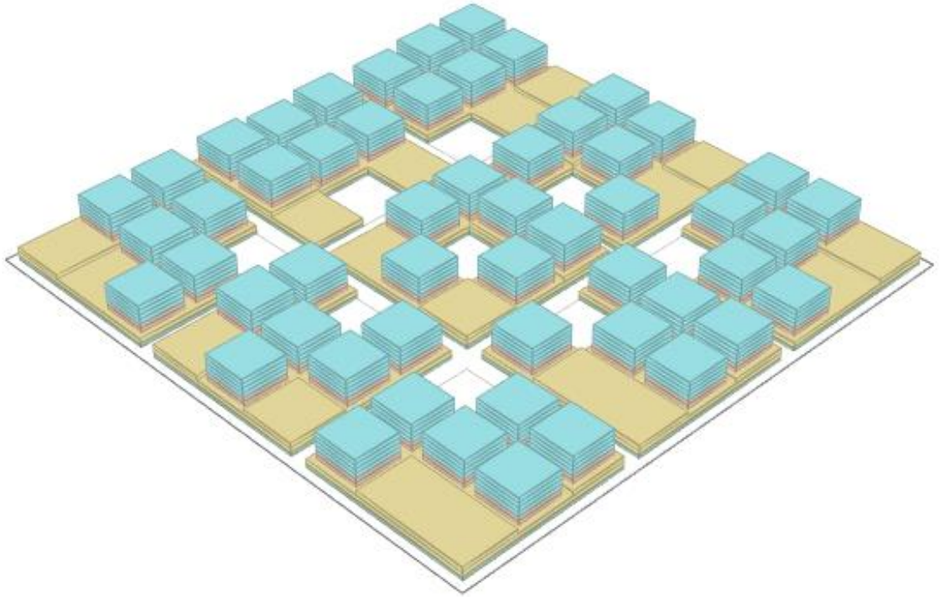


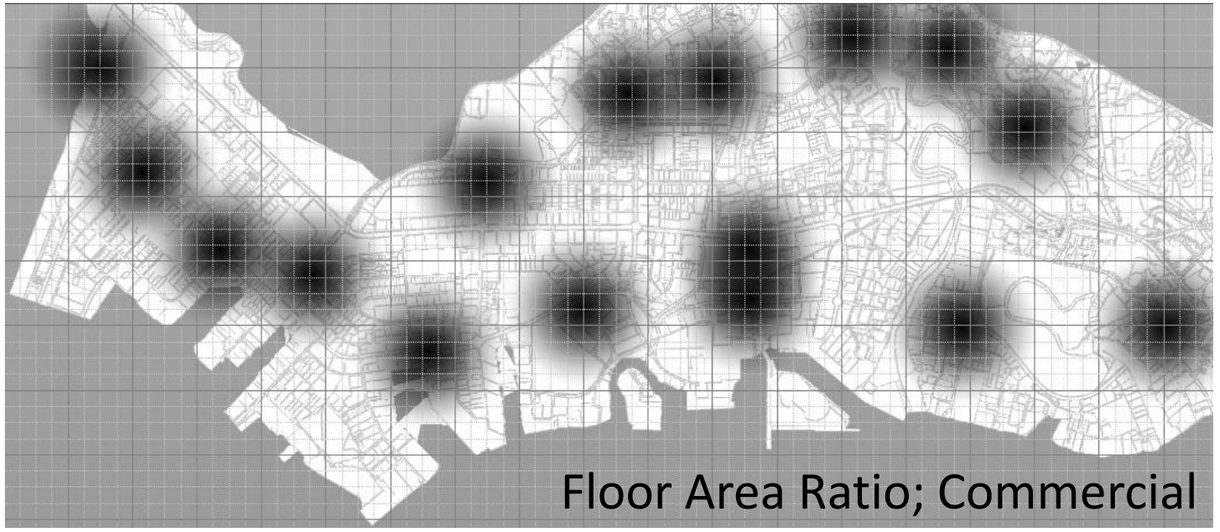
Experiments with Sidefx Houdin

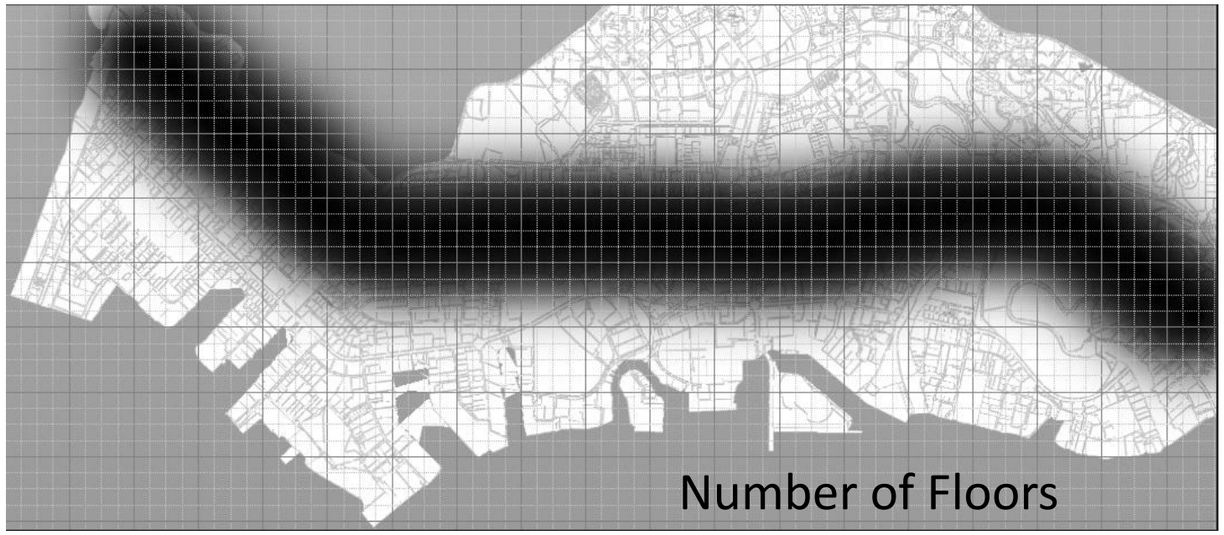
- Parameters
  - Floor Area Ratio
  - Number of floors
  - Site coverage
  - Function

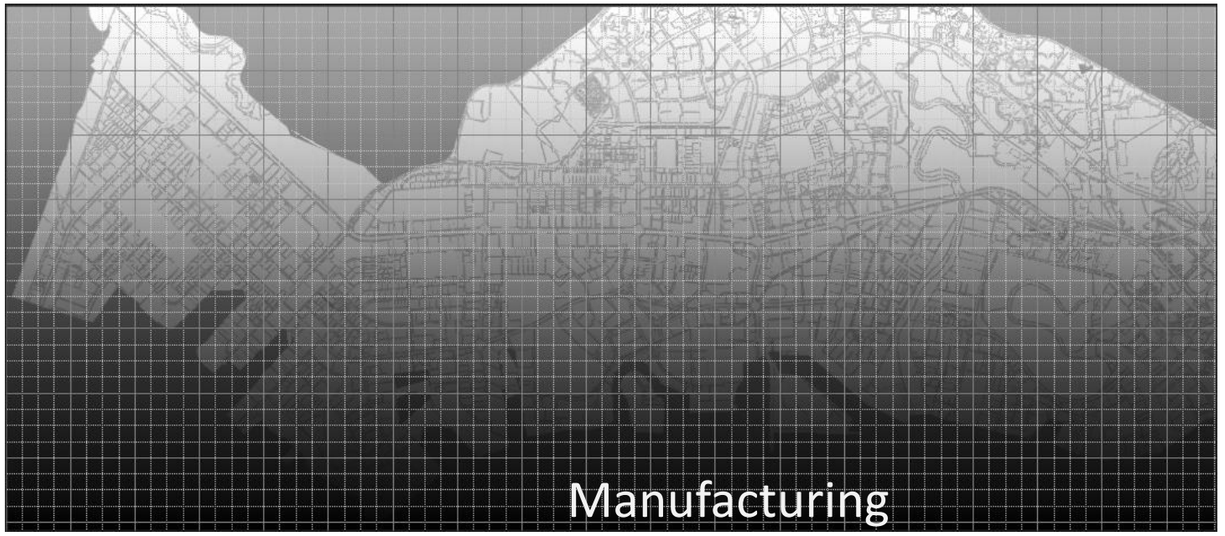


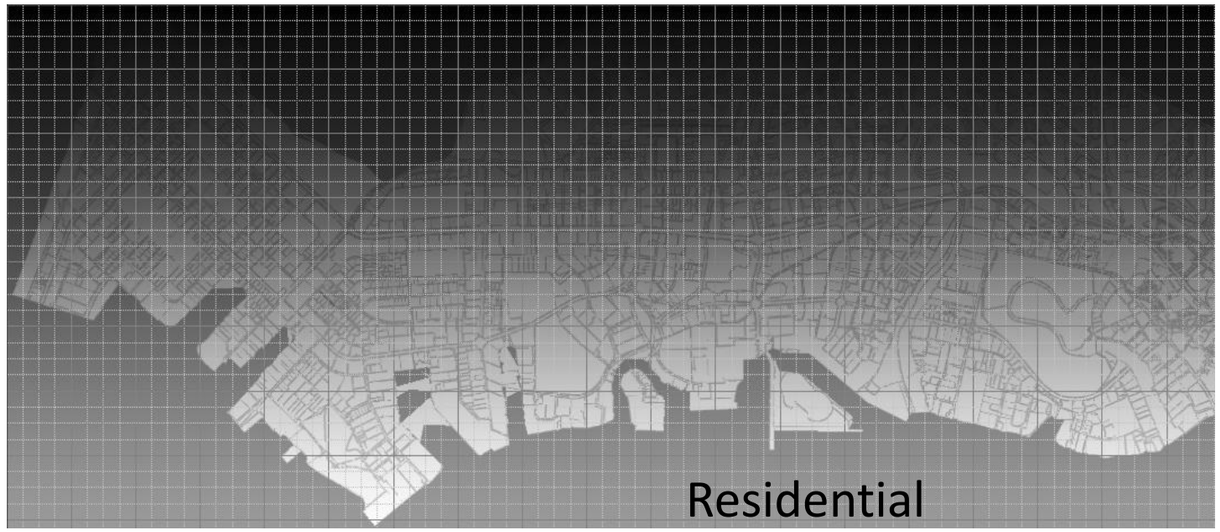


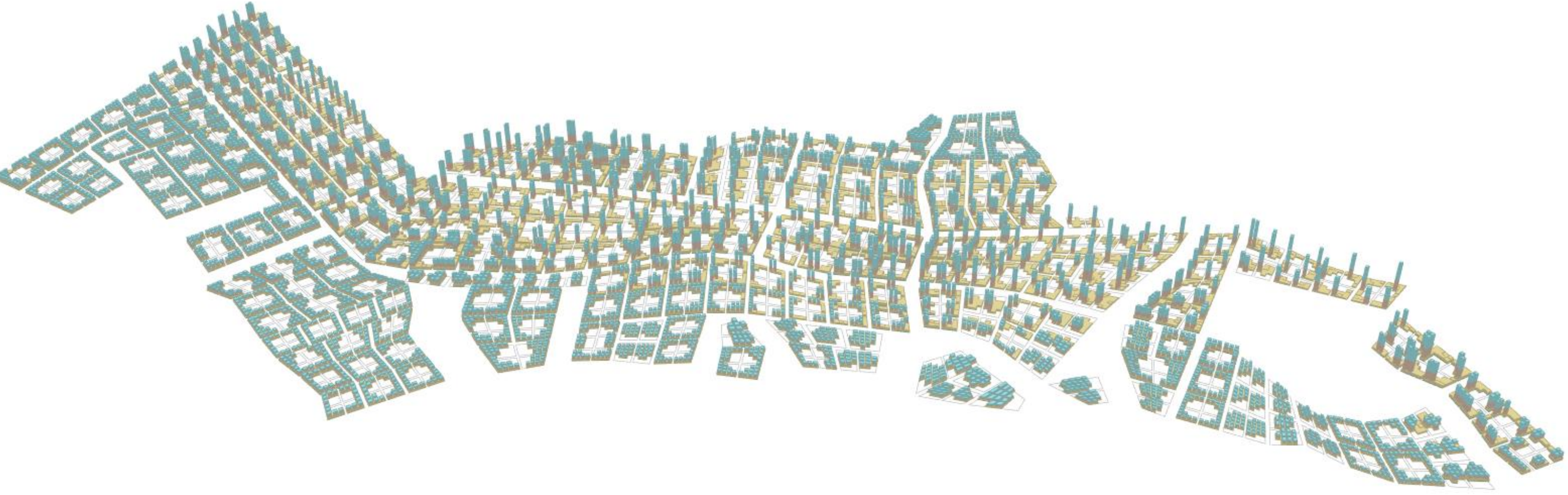



Floor Area Ratio; Commercial


Number of Floors

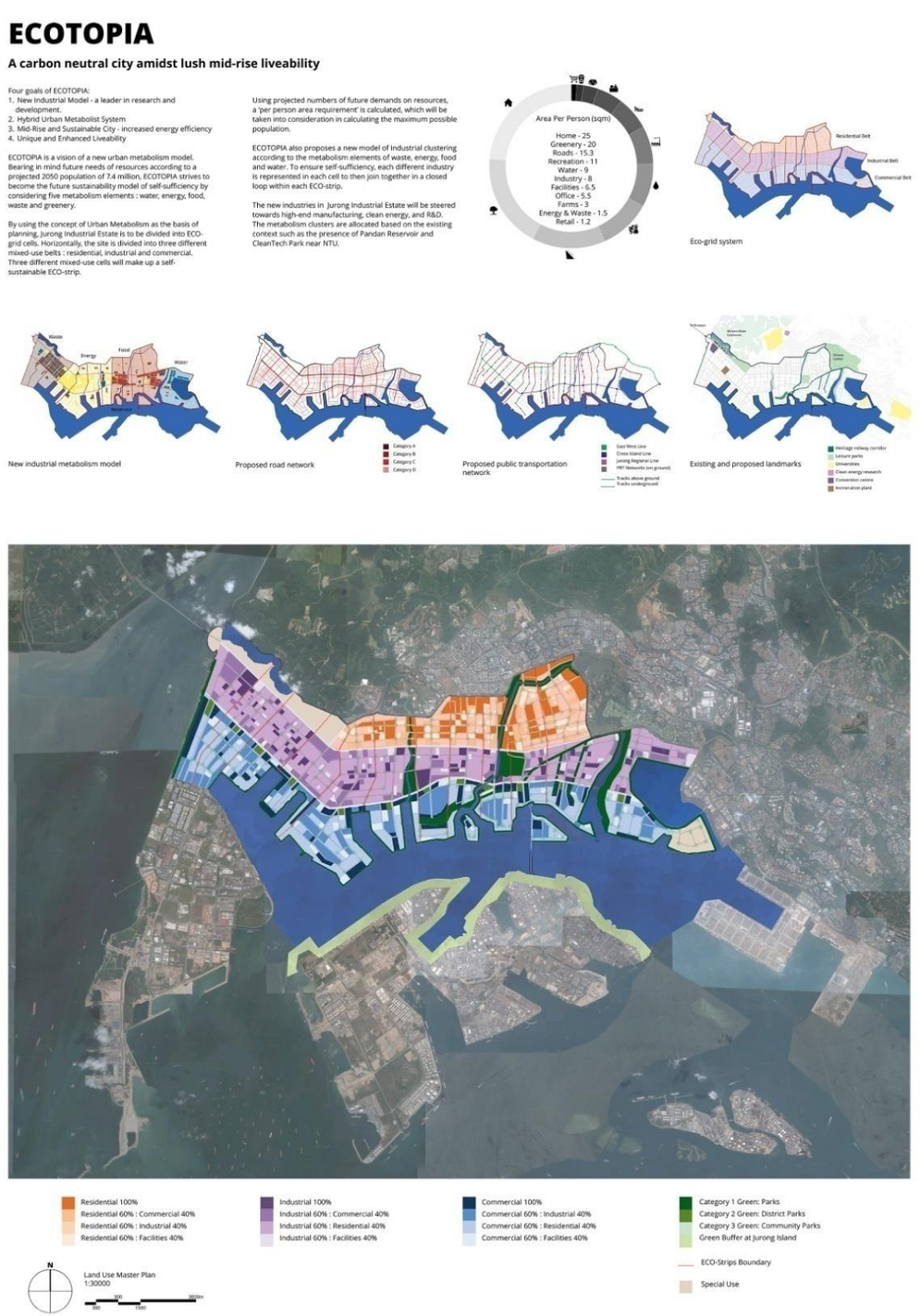

Manufacturing


Residential



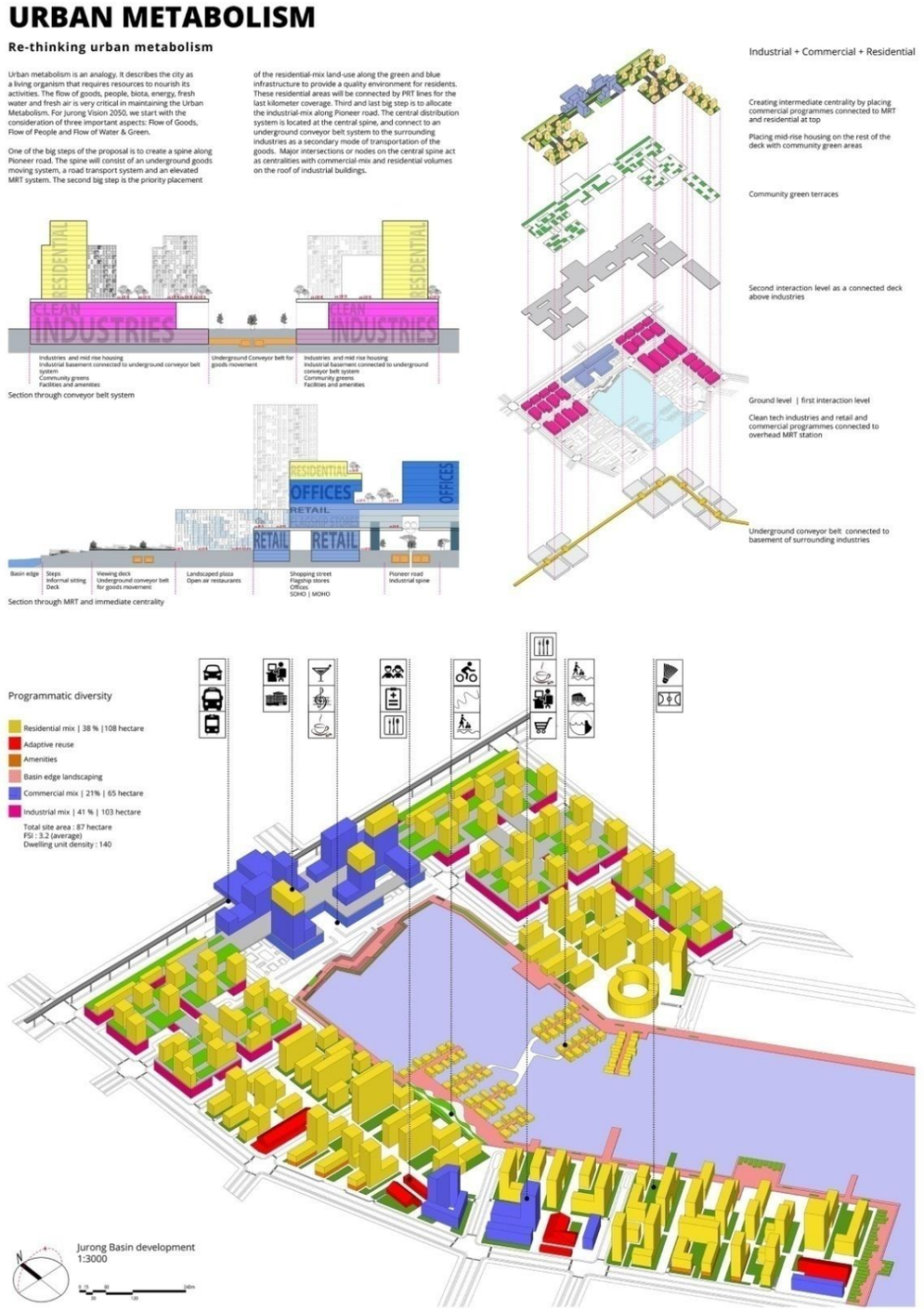
Project 1: Ecotopia

- Credits
  - Andrea Meinarti Rachmat, Tey Hui Ping Serene, Delon Leonard, Wu Xin Peng, Loh Sze Sian
  - Urban Planning Studio, 2014-15
  - Master of Urban Planning
  - Tutor : Prof Oscar Carracedo



Project 1: Urban Metabolism

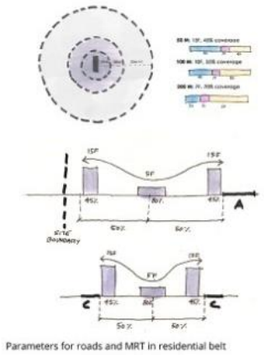
- Credits
  - **Ravish Kumar**,
    Tulika Agrawal, Yuting Liu
  - Urban Design Studio 2
    2014-15
  - Master of Arts (Urban Design)
  - Tutor : Prof Jurgen Rosemann,
    Prof Low Boon Liang



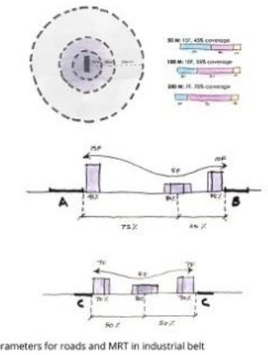
Rule-base urban design

- Students defined sets of rules that controlled the urban fabric

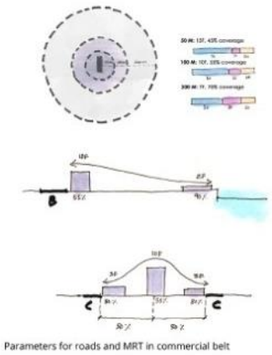
- Rules were based on distances to certain elements
  - Train stations
  - Expressways
  - Waterfront
  - Canals
  - Parks



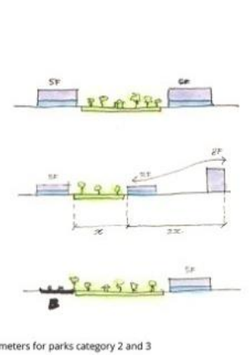
Parameters for roads and MRT in residential belt



Parameters for roads and MRT in industrial belt



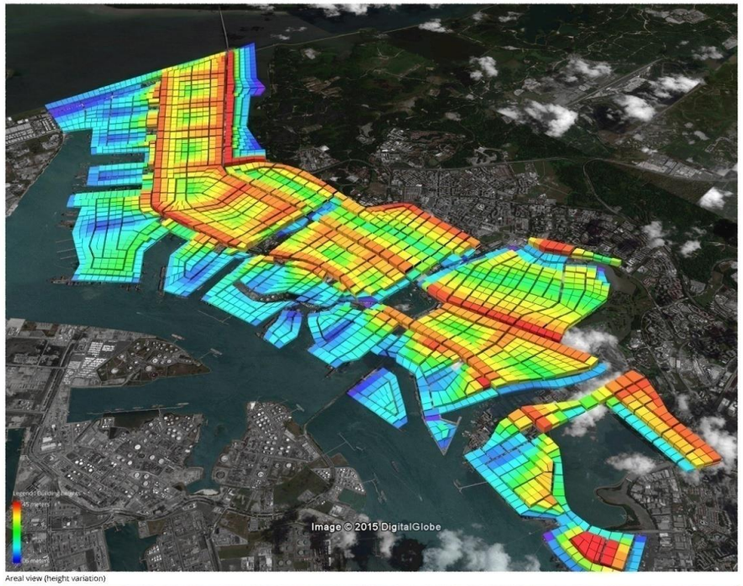
Parameters for roads and MRT in commercial belt



Parameters for parks category 2 and 3

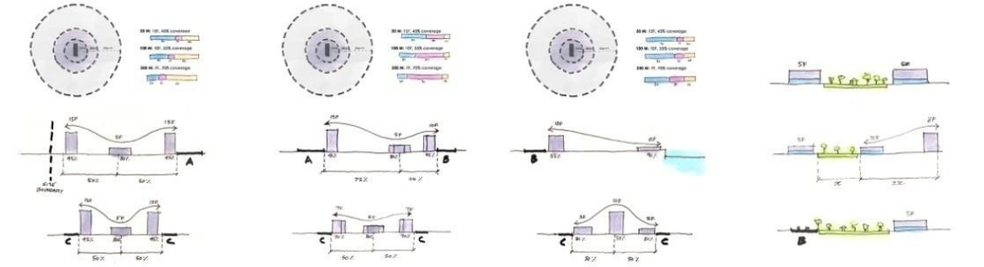
Project 1: Ecotopia
Version 2

Waste flow (centralised biomass energy plant) | Energy flow (centralised clean energy plants) | Food flow (new age industrial farming) | Water flow (new reservoir supply)



Areal view (height variation)

Street view



Parameters for roads and MRT in residential belt | Parameters for roads and MRT in industrial belt | Parameters for roads and MRT in commercial belt | Parameters for parks category 2 and 3

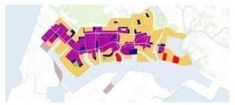
Harbor view

Areal view

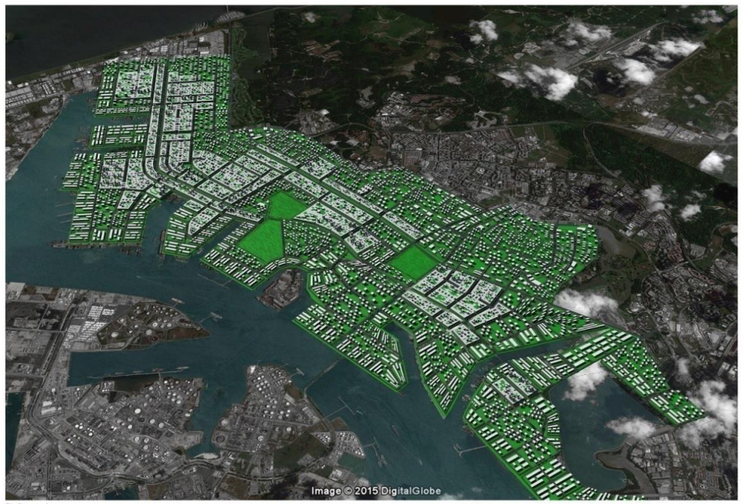
Project 2: Urban Metabolism Version 2

Creating an industrial spine : Primary goods mover system
Pioneer Road as the central spine for Jurong Estate and developing an underground goods mover system along it.

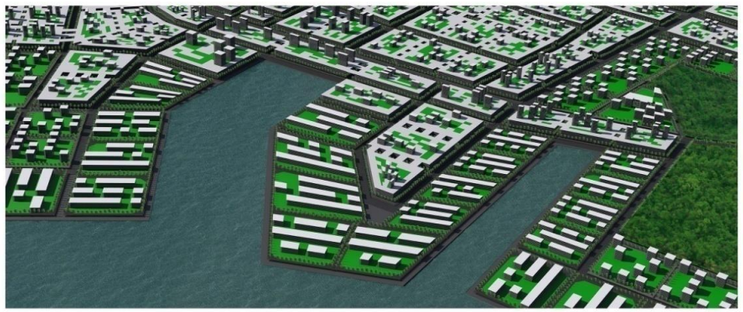
Industrial mix land-use along the spine : Secondary distribution of goods
Utilizing the infrastructure in the best possible way by having industrial land-use on both sides. Conveyor belt system to distribute the packaged goods from the central distribution system to the basements of the industries.



Residential mix land-use facing blue and green areas
Giving importance to the view for residents. Identifying sites for adaptive reuse of existing industrial infrastructure and turning them to industrial heritage sites.



Bird's-eye view

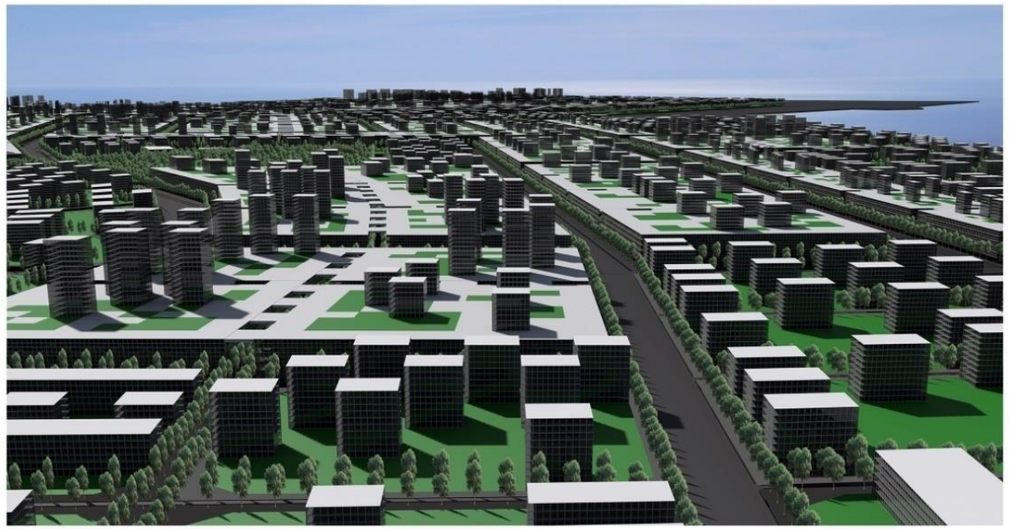


Harbor view (waterfront housing)

Existing and proposed extensions in 2030 for MRT lines : East-West Line and Jurong Regional Line
Proposal to extend the Jurong Regional Line until Jurong Island and also shift the security checkpoint. Petroleum production will decrease so that land can be utilized for clean industries and hence more need for public transport.

Proposed extension of MRT lines for 2050
This area currently lacks public transport connectivity. Extension of the (red) North-South Line from Jurong East interchange until Tuas.

Last Kilometer through PRT lines
100% of the area covered by public transport in 2050



Street view (Industrial + Commercial + Residential)

Areal view

Context

Issue

Case Study

Stage 1
Data Collection

Stage 2
Data Synthesis

Stage 3
Data Mining

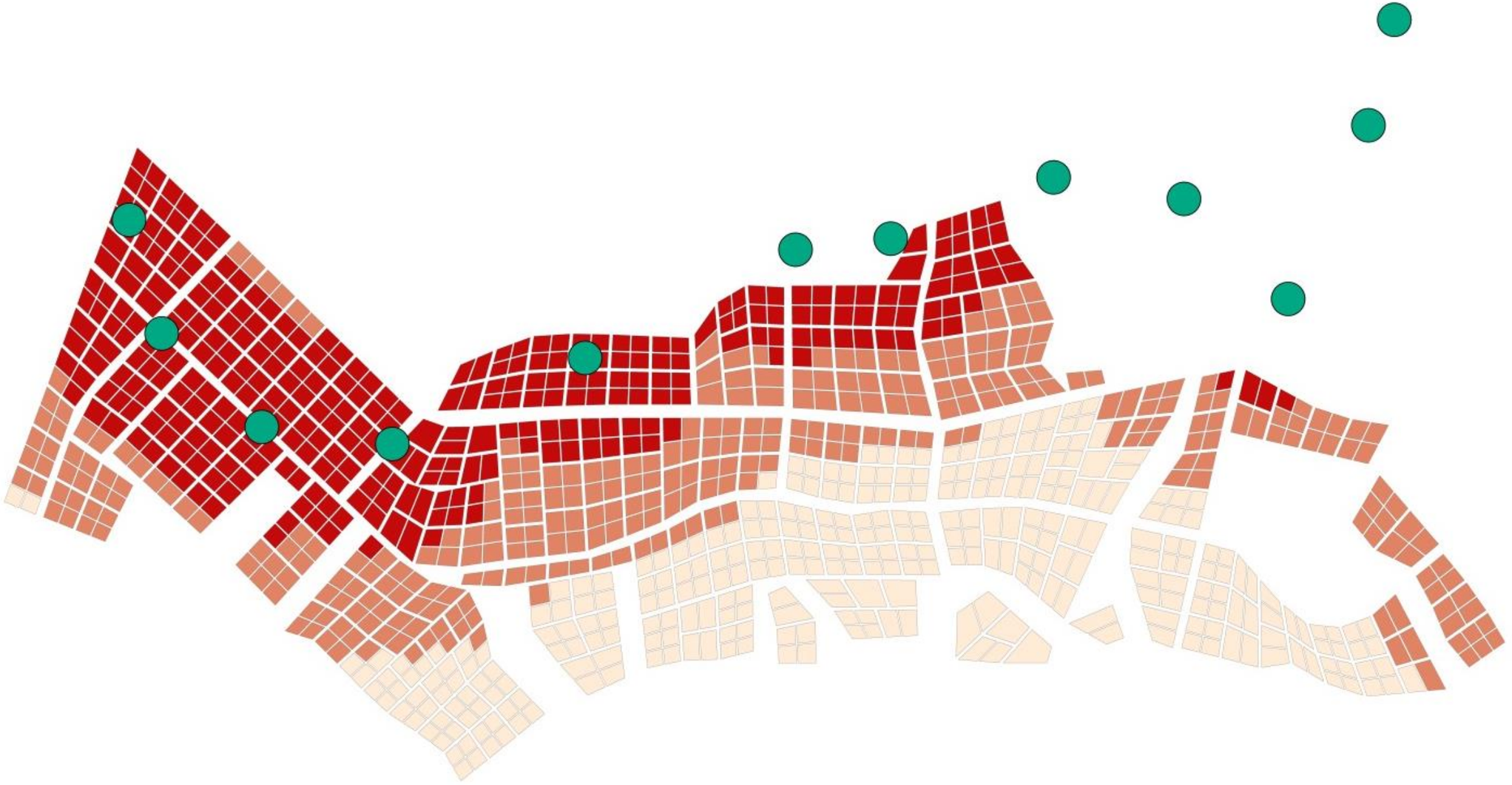
Parametric CAD
to GIS

Parametric CAD
to Game Engines

Future work

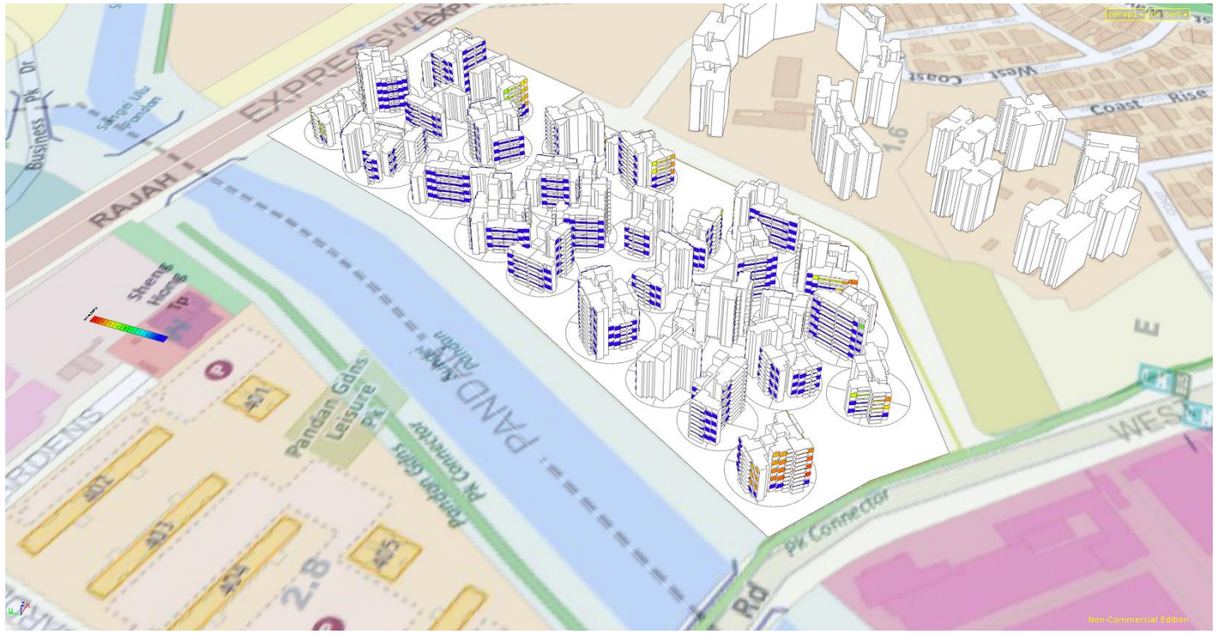
Conclusions

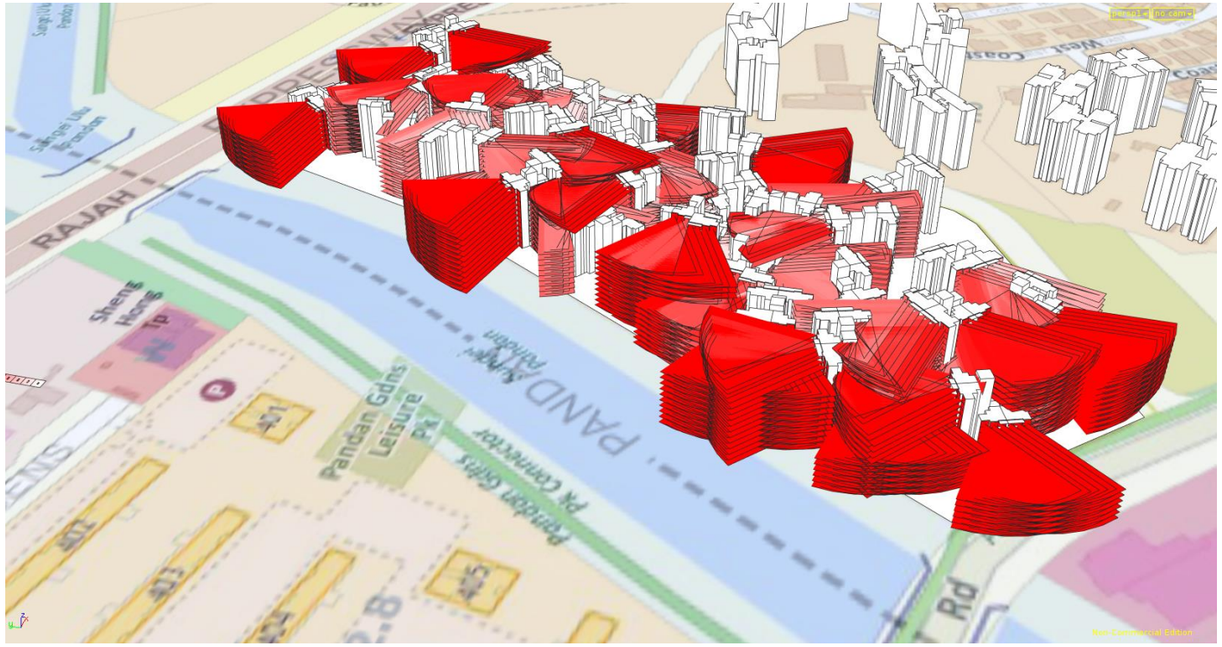
2D Data mining

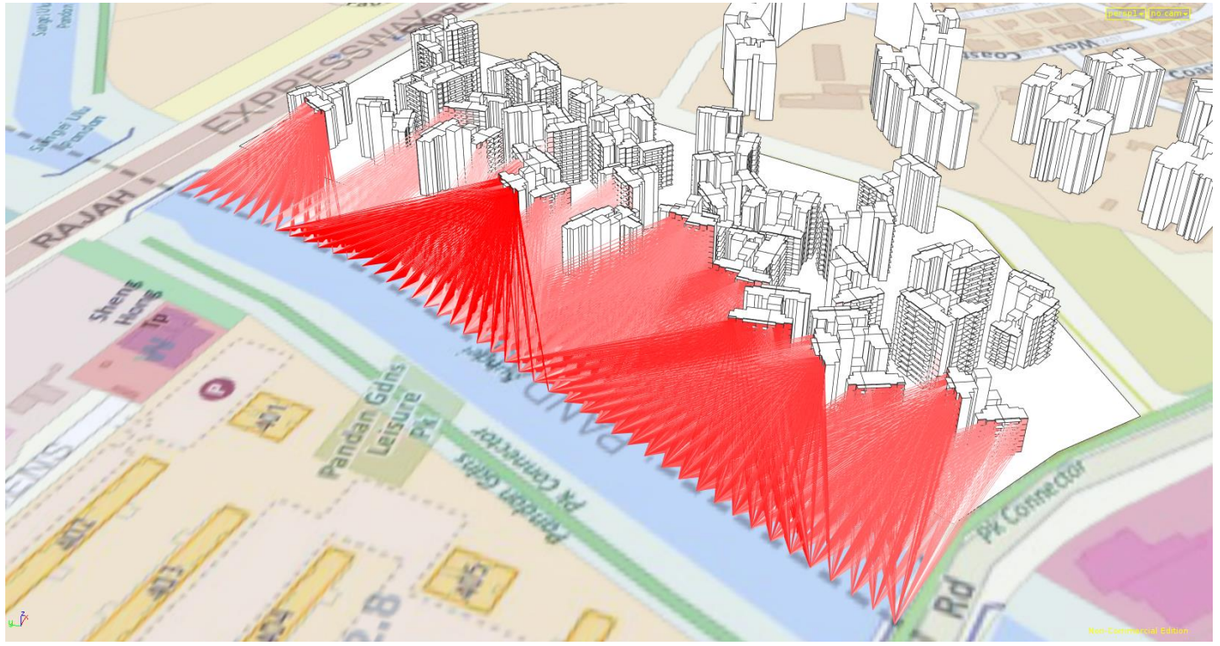


3D Data mining

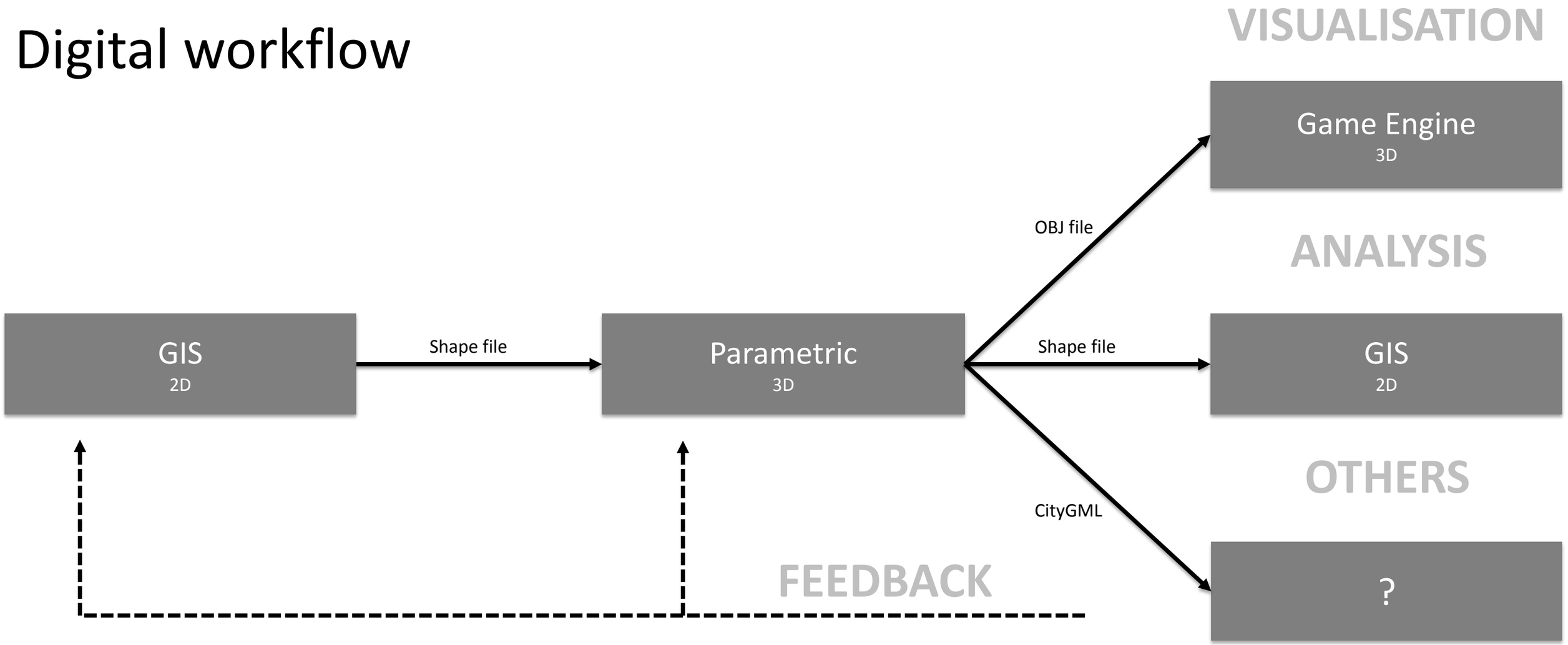
- Solar radiation
- Scenic views
- Unobstructed views







Digital workflow

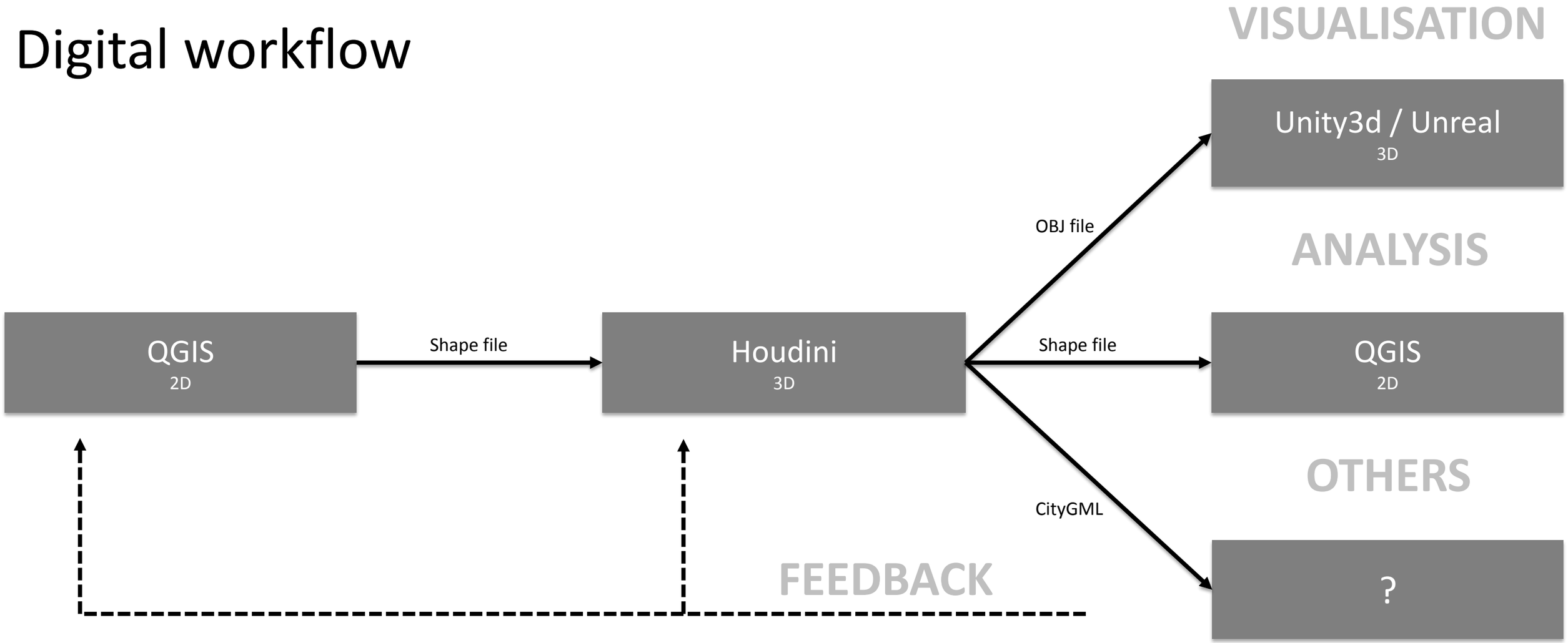


Data Collection

Data Synthesis

Data Mining

Digital workflow



Data Collection

Data Synthesis

Data Mining

GIS-based data mining

ANALYSIS

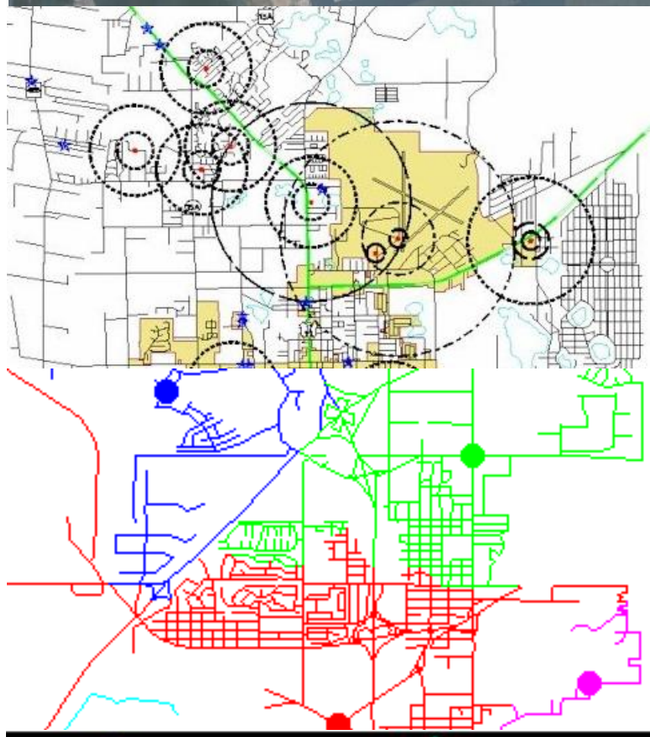
QGIS
2D

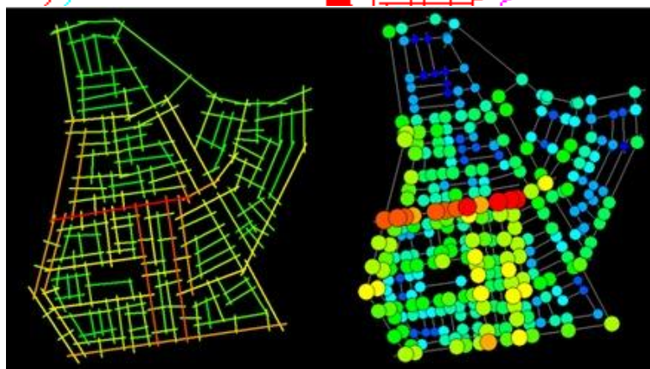
Colour Maps

Buffer Analysis

Network Analysis

Space Syntax





Context

Issue

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Parametric CAD to GIS

Parametric CAD to Game Engines

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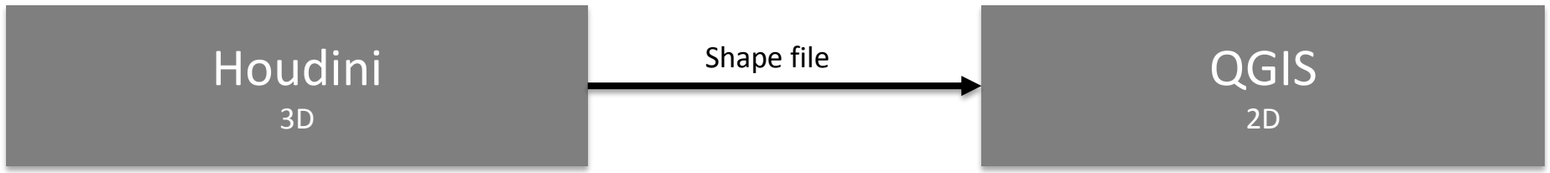
From 3D CAD to 2D GIS

- A GIS shape file is exported

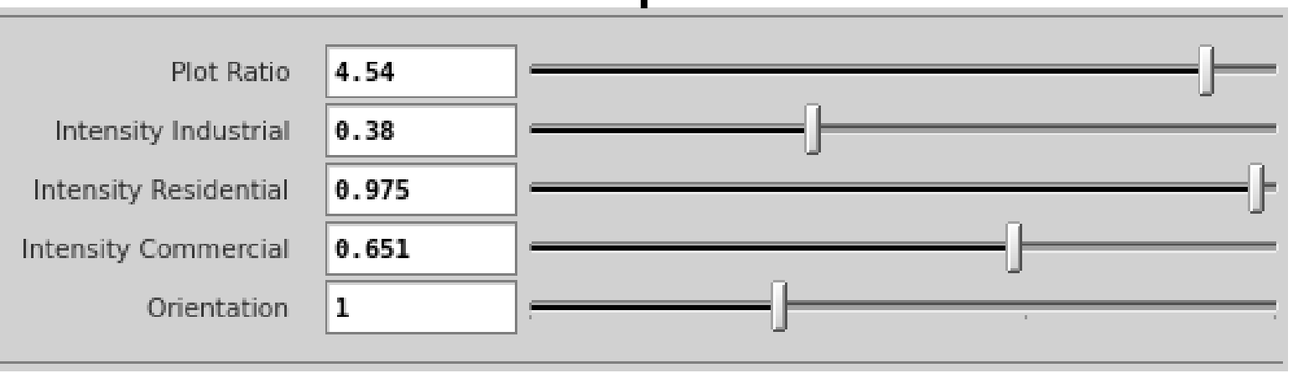
- Data from the 3D model needs to be transferred to the 2D model

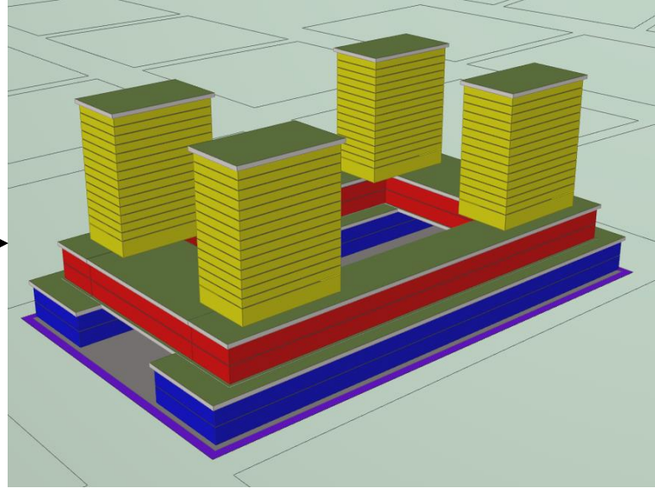


- This data can then be analyzed using existing GIS based tools

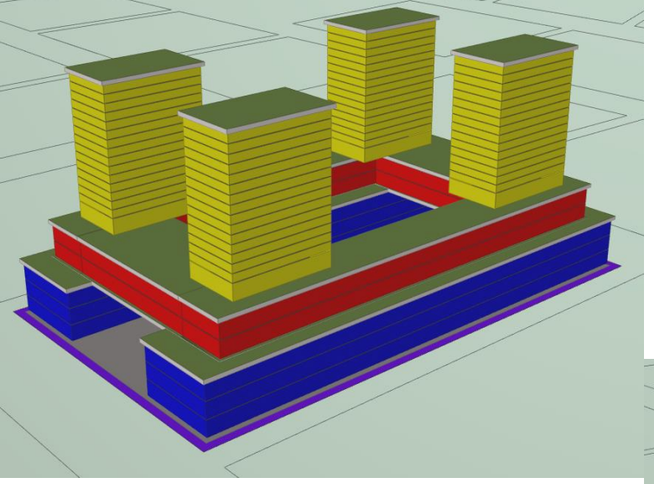
Parametric model

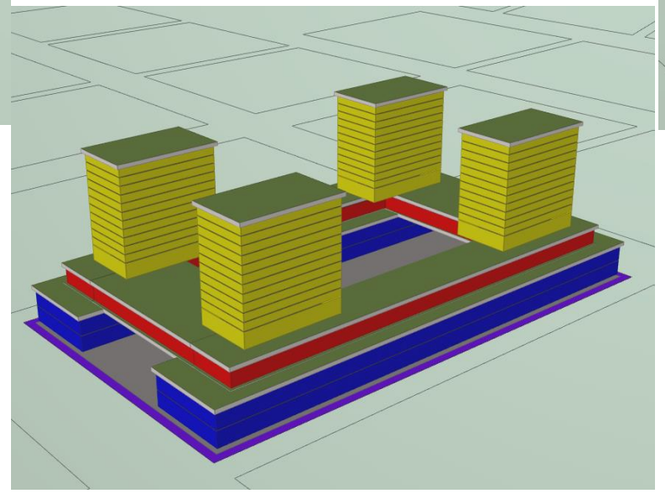
Parameters

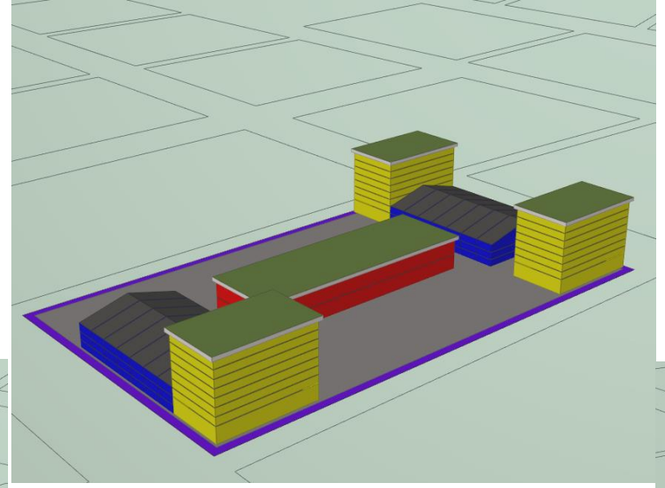


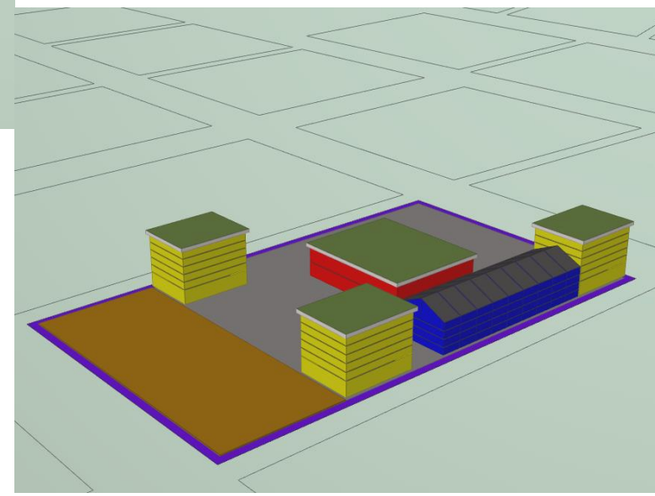


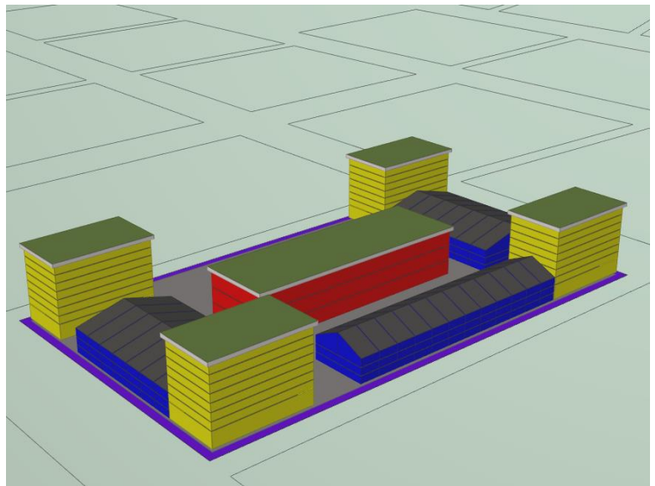
- Parameters are guides
- The model tries to satisfy the parameters
- ‘Intensity’ parameters are relative to one another

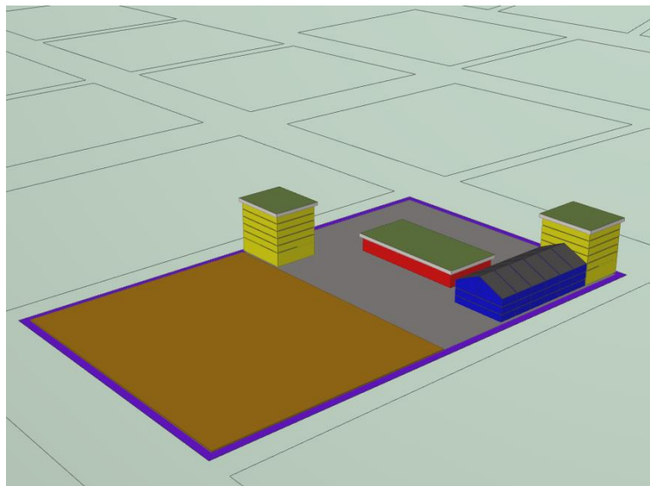




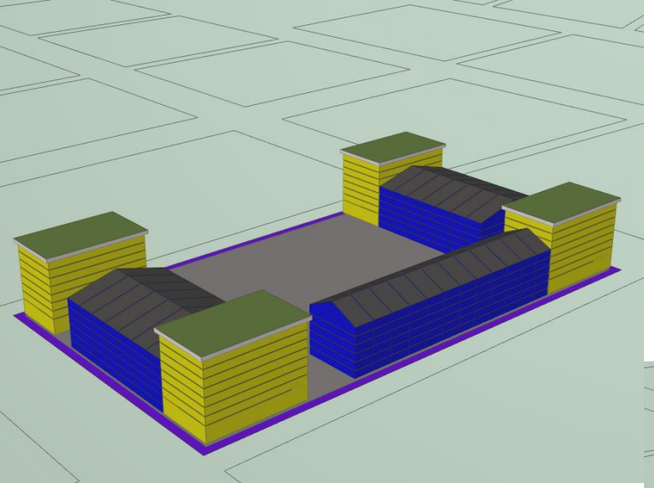


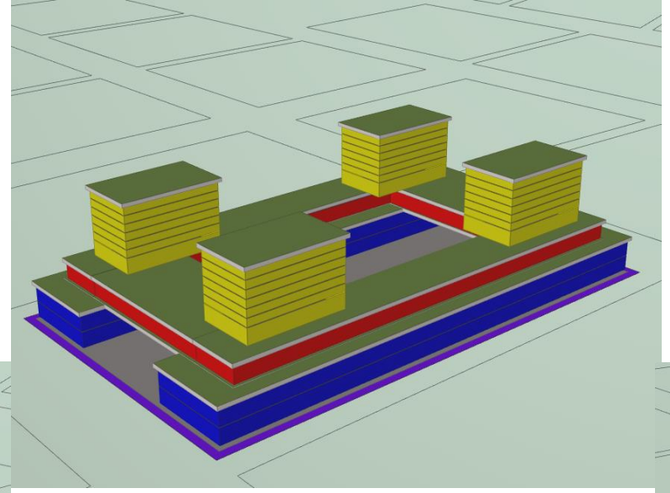


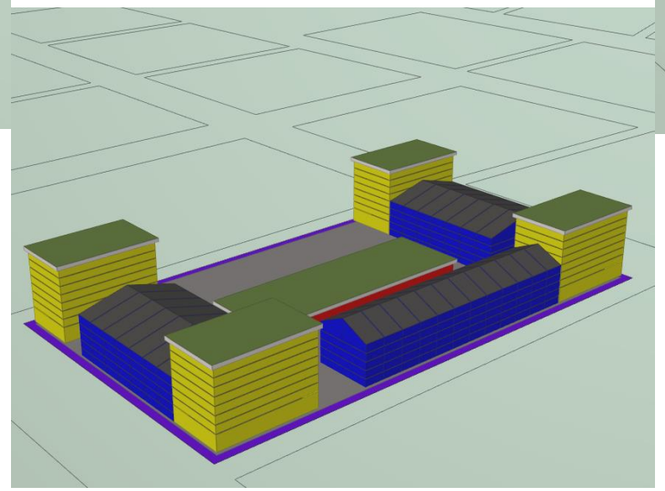


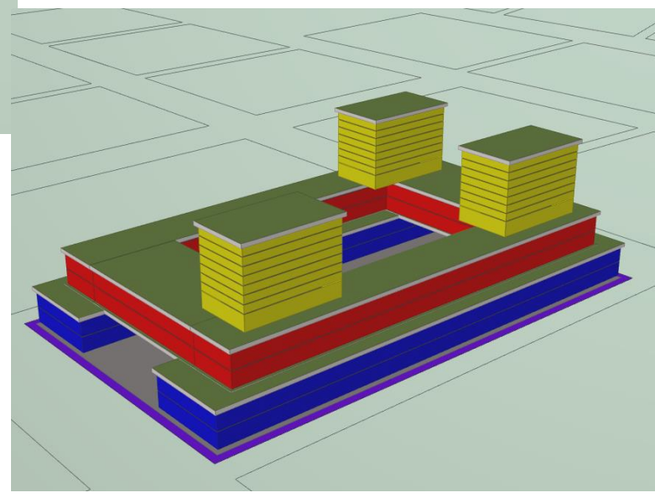


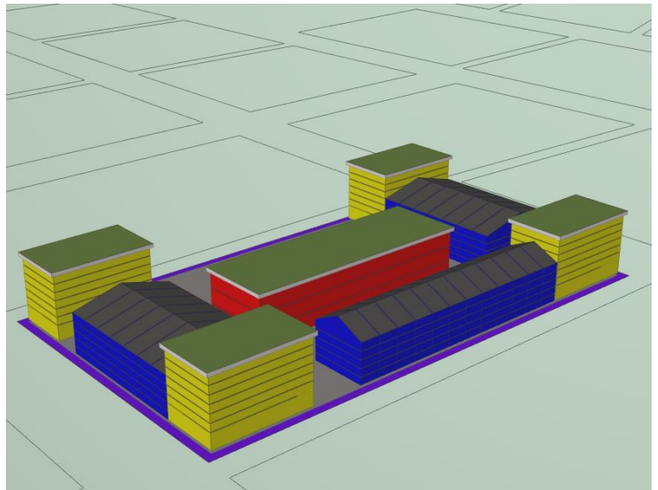
- Reducing plot ratio
- Constant intensities

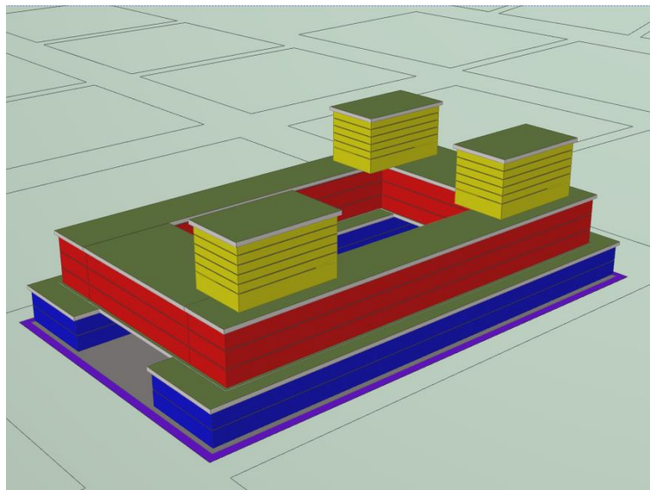








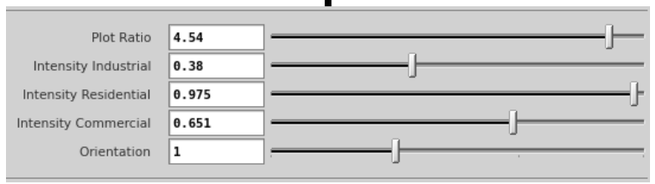


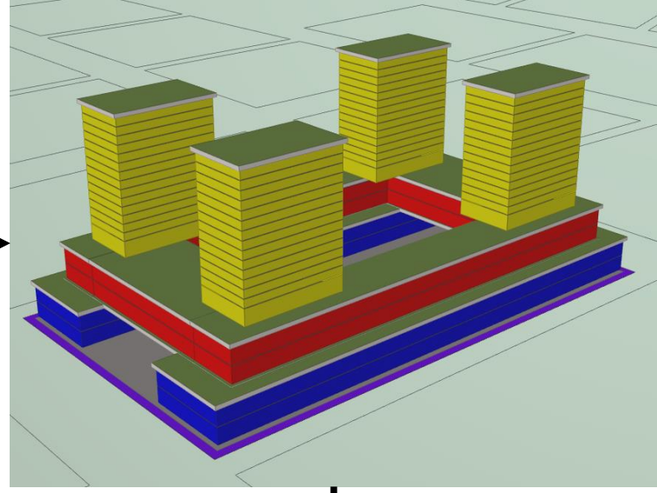


- Constant plot ratio
- Increasing industrial intensity (red)

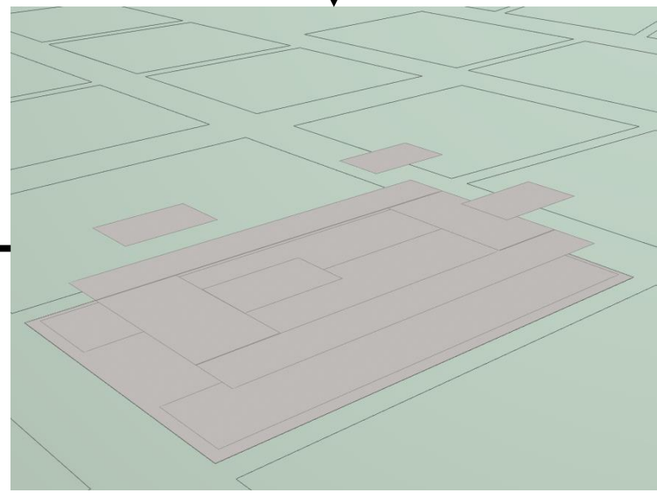
Data extraction from parametric model

Parameters





3D to 2D



Data

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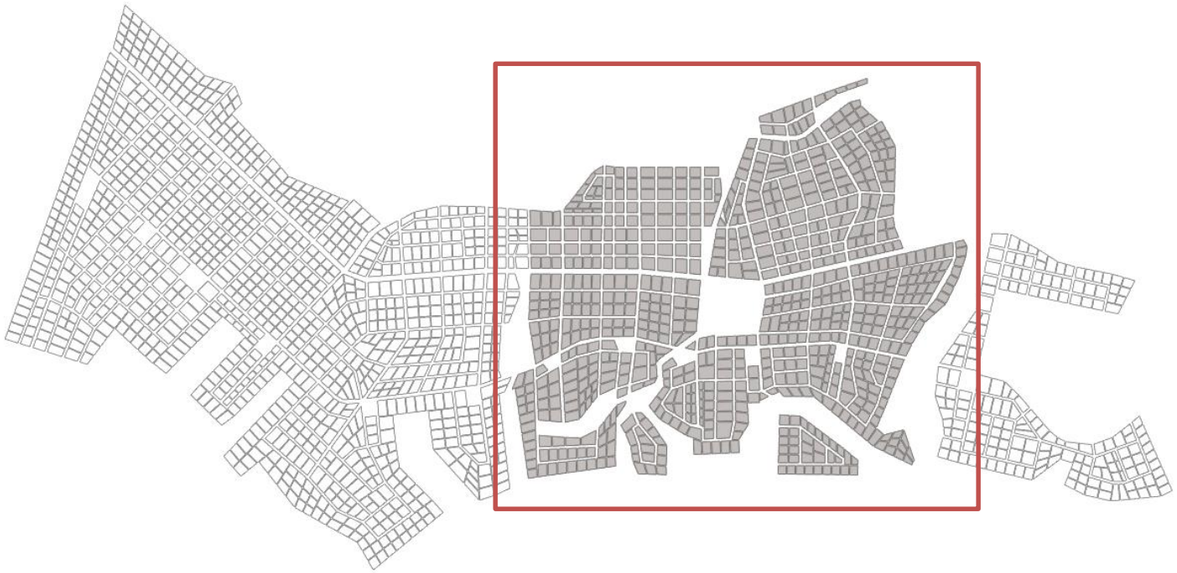
1	3242.89	14.7	20.7	6485.78	2.0	industrial	437	1	1830
2	3274.03	14.7	20.7	6548.05	2.0	industrial	437	1	1830
3	1987.65	14.7	20.7	3975.31	2.0	industrial	437	1	1830
4	1992.81	14.7	20.7	3985.63	2.0	industrial	437	1	1830
5	841.404	34.4	73.4	11779.6	14.0	residential	437	1	1830
6	849.516	34.4	73.4	11893.2	14.0	residential	437	1	1830
7	847.341	34.4	73.4	11862.8	14.0	residential	437	1	1830
8	839.228	34.4	73.4	11749.2	14.0	residential	437	1	1830
9	5953.04	1.0	7.0	11906.1	2.0	commercial	437	1	1830
10	6003.56	1.0	7.0	12007.1	2.0	commercial	437	1	1830

GIS
Shape File

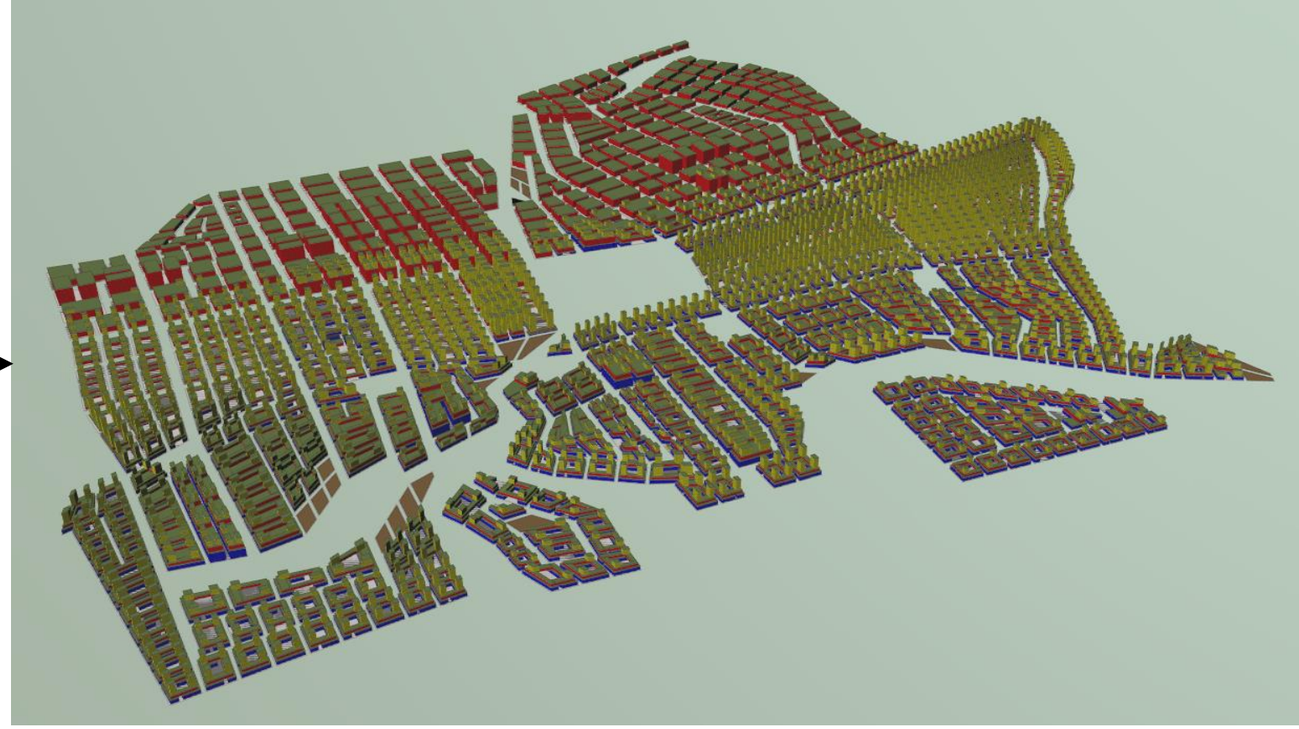
Design decision support

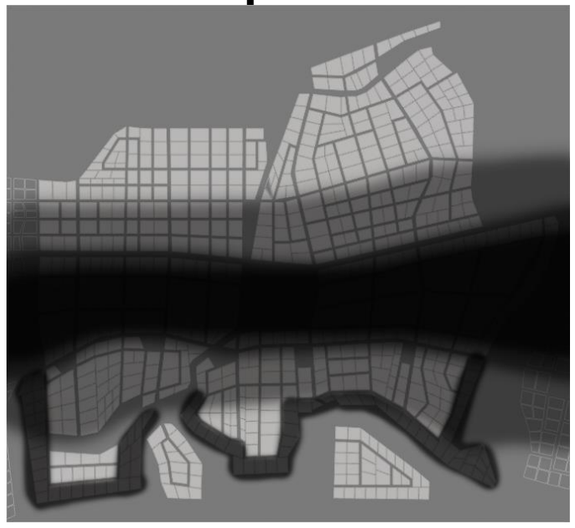
- Workflow

1. Create parameter fields
    - 4 image maps for each option
2. Generate 3D CAD model
    - Full CAD model
    - Simplified GIS model
3. Analyze results in GIS
    - Quantitative design data
    - Buffer analysis



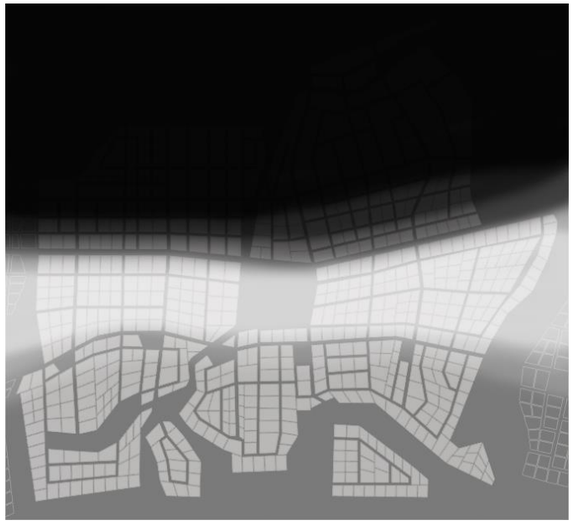
Option 1 – Parameter fields



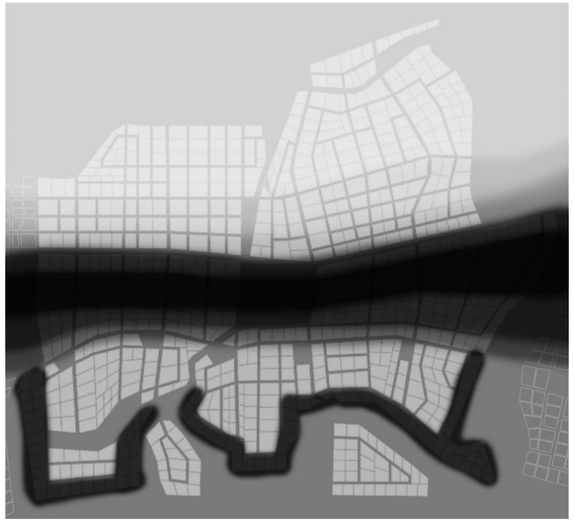


Plot ratio

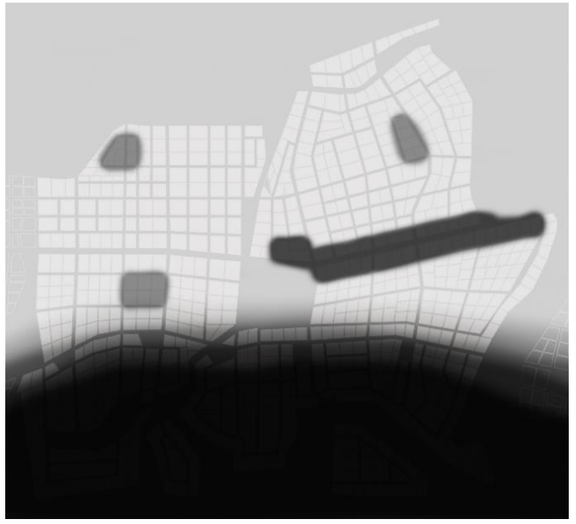
Industrial



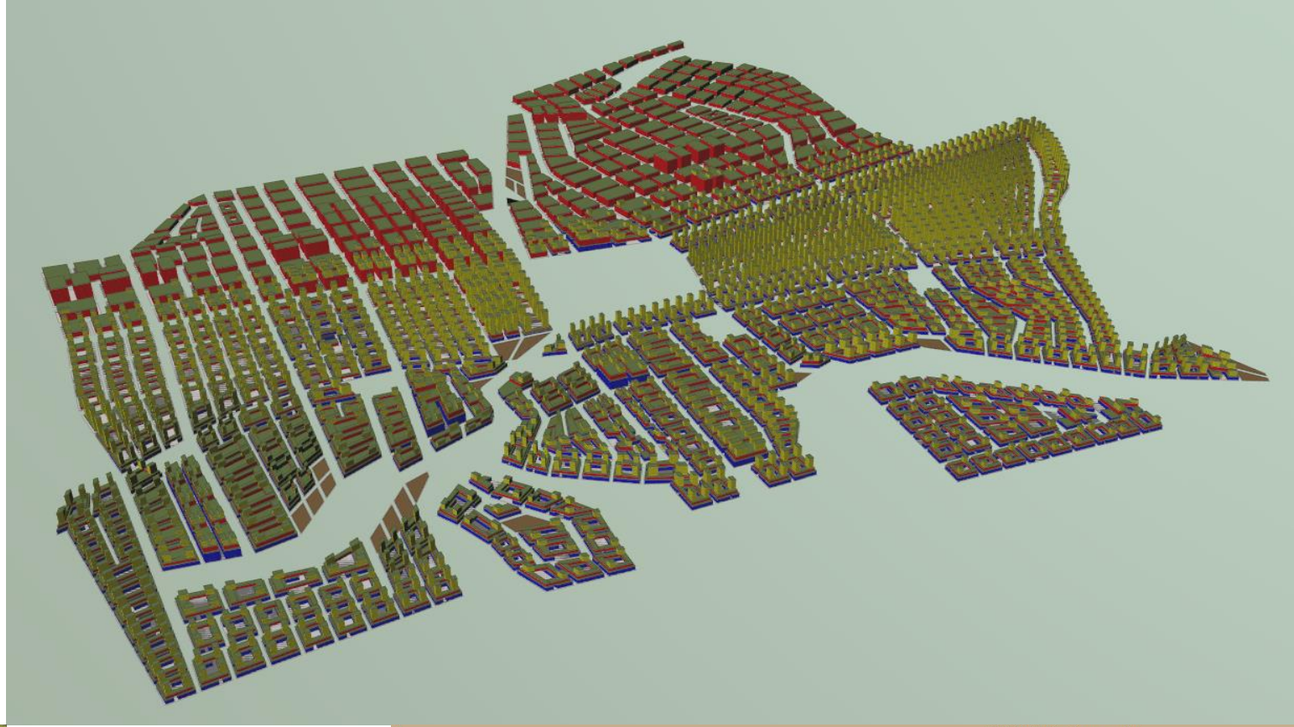
Residential

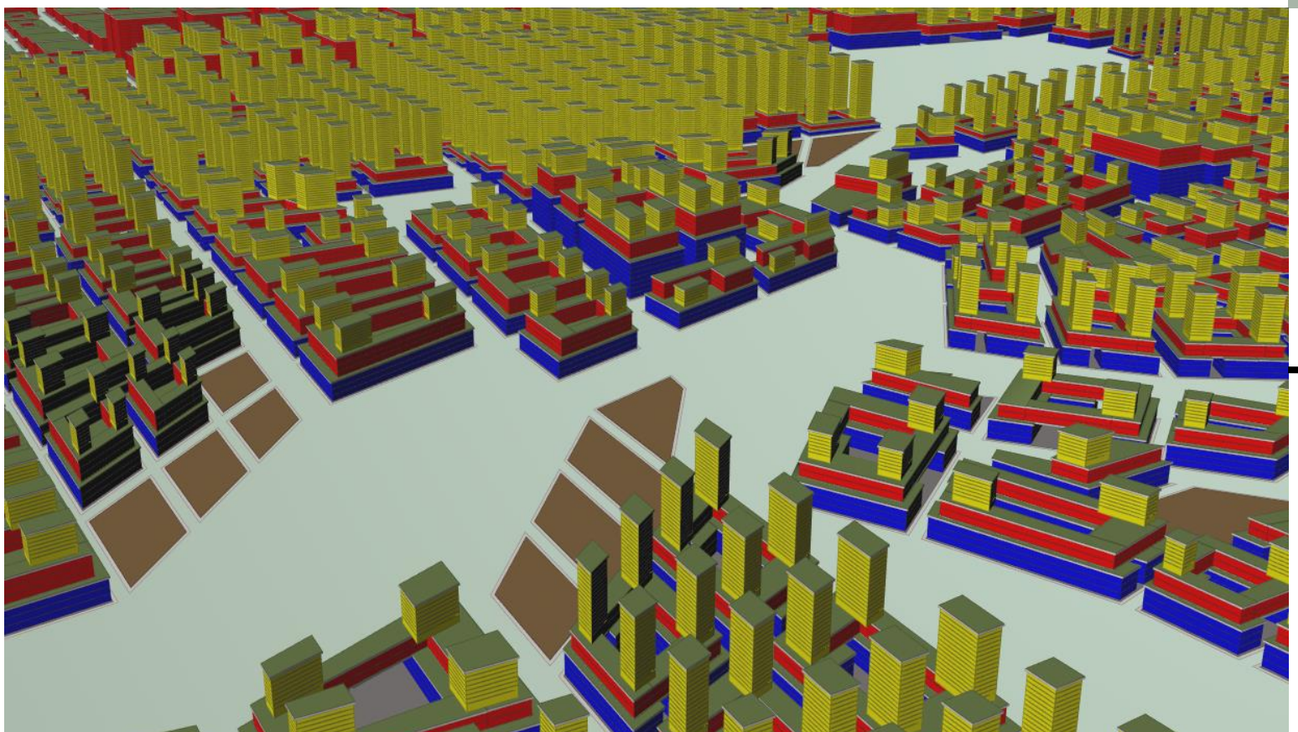


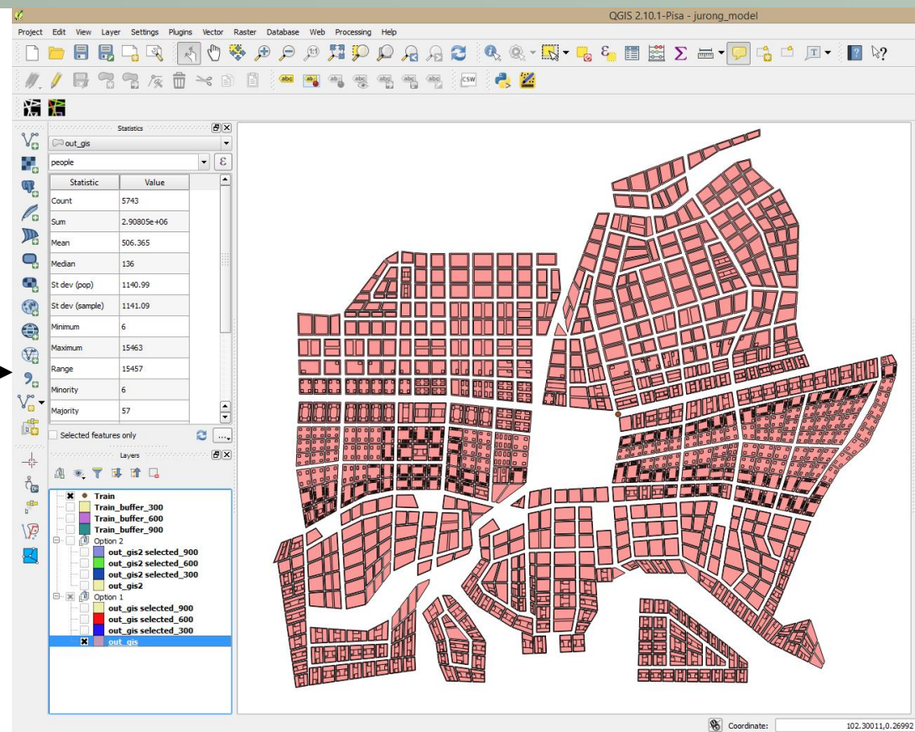
Commercial



Option 1 – 3D CAD model

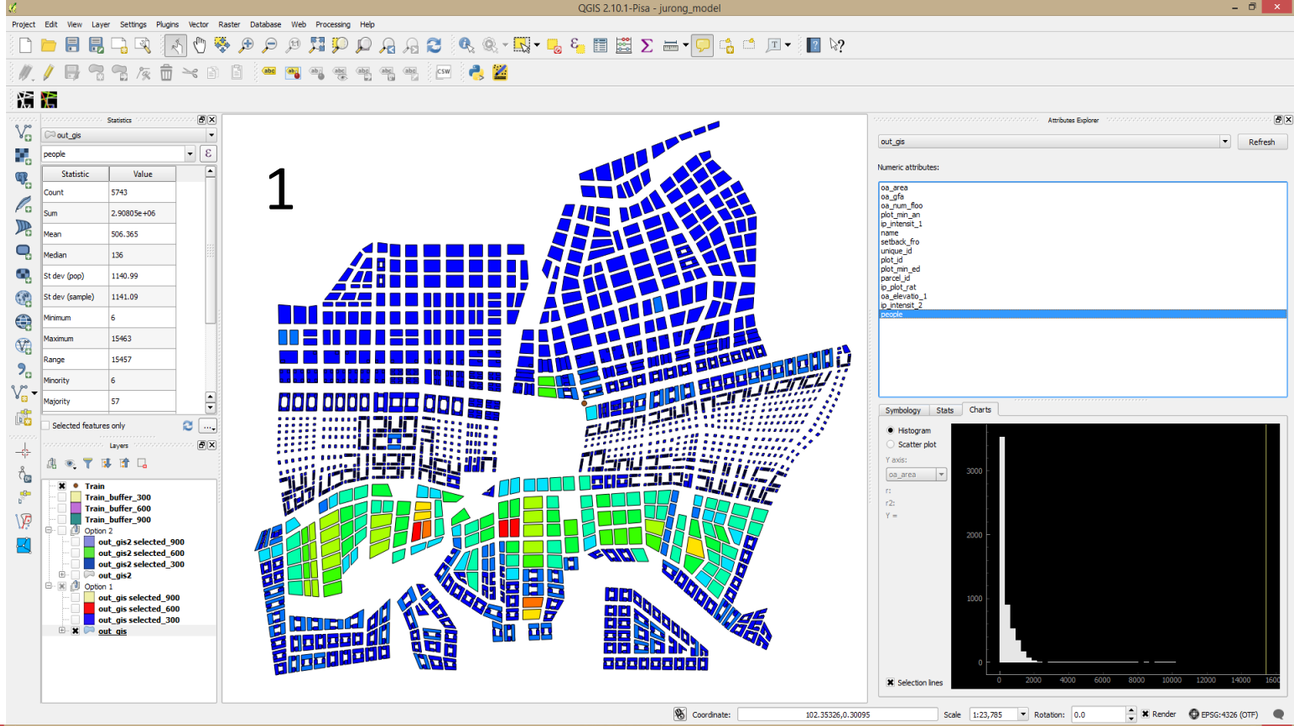


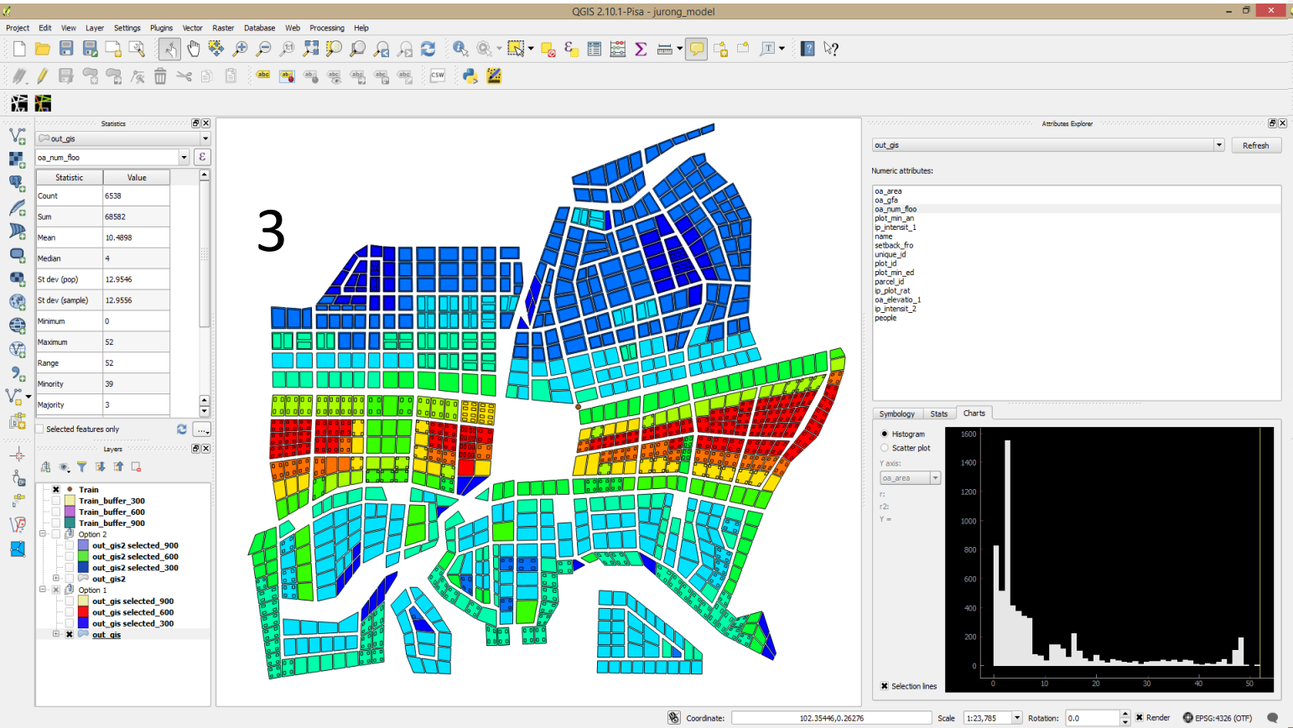


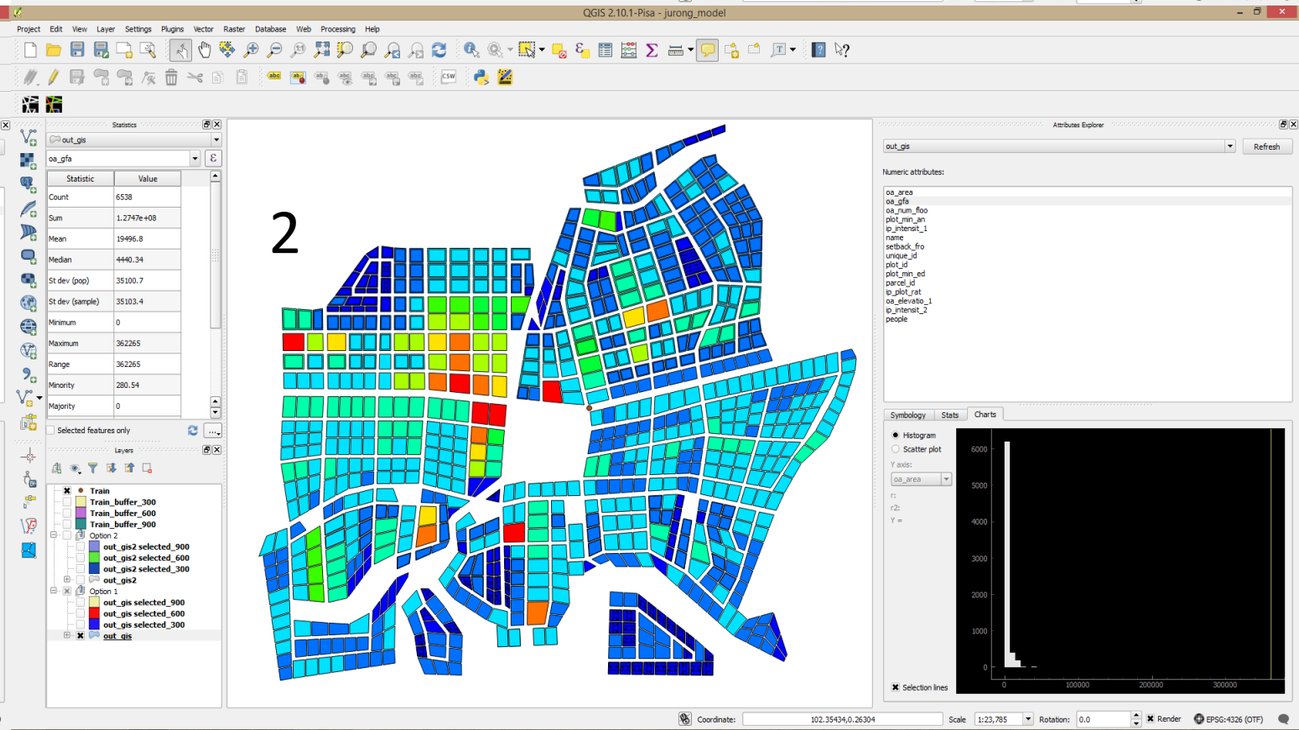


Option 1 – Data Analysis

1. People density
2. GFA
3. Building height

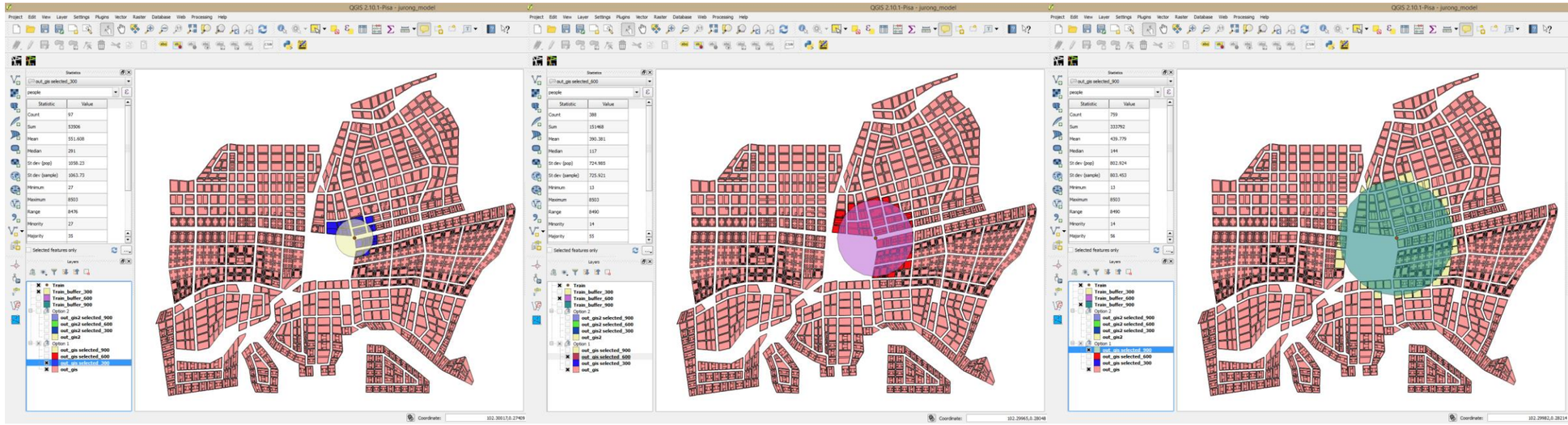




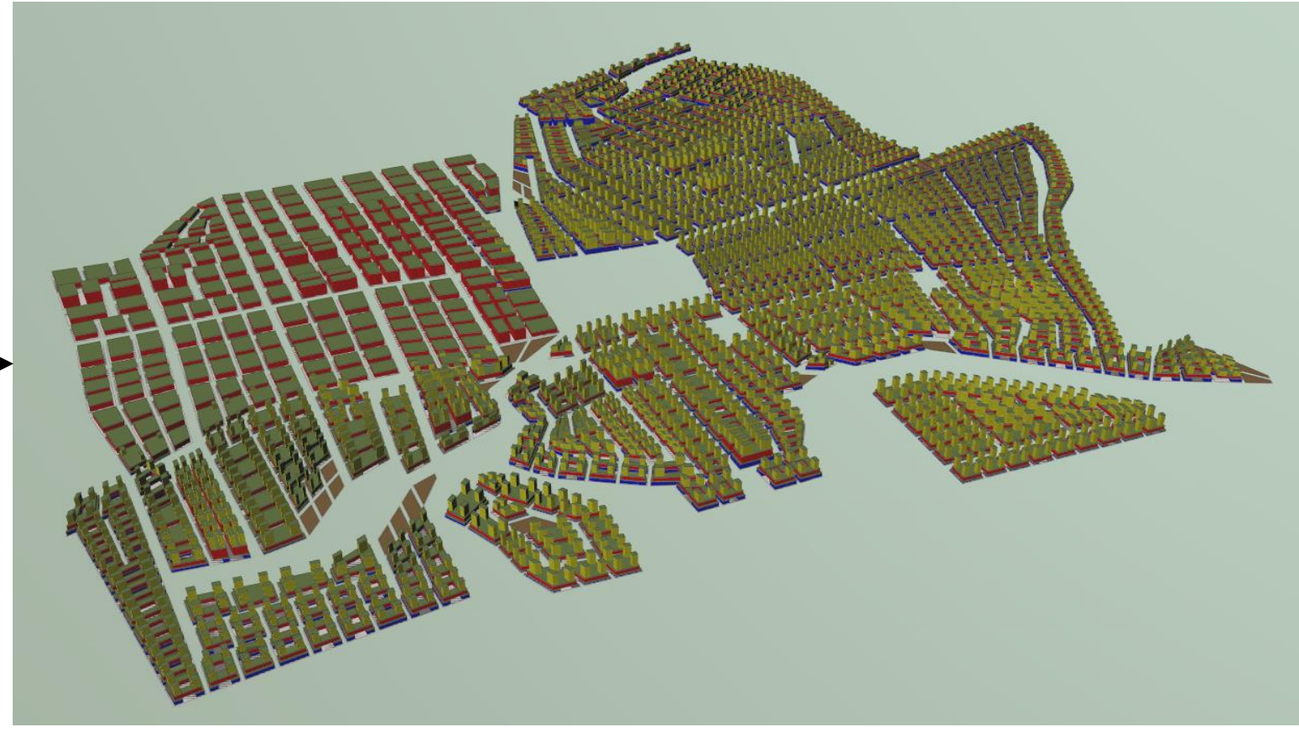


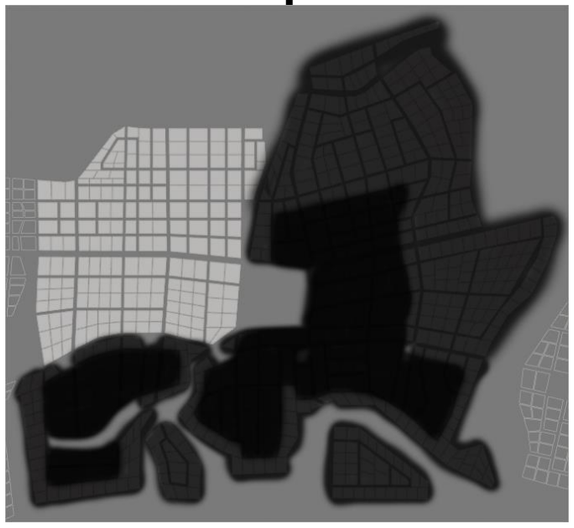
Option 1 – Buffer Analysis

- Total (residents): 910,000
- 300m buffer: 1% of residents
- 600m buffer: 6% of residents
- 900m buffer: 14% of residents



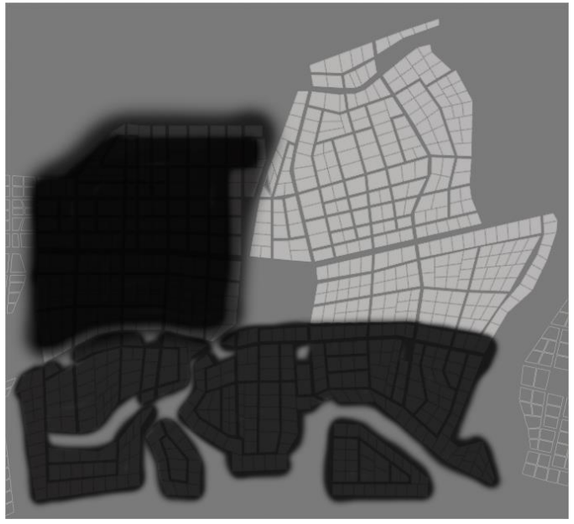
Option 2 – Parameter fields



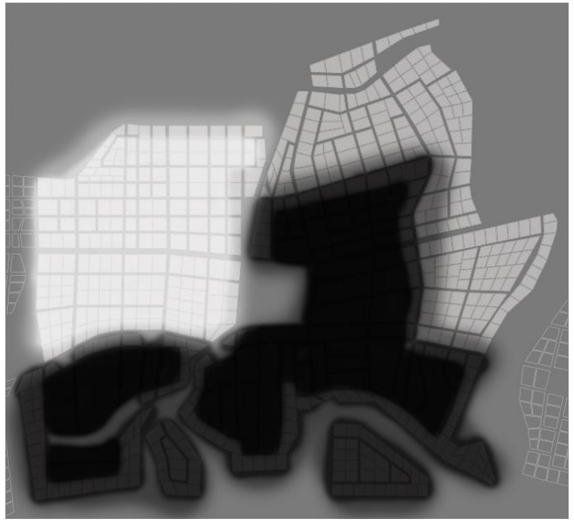


Plot ratio

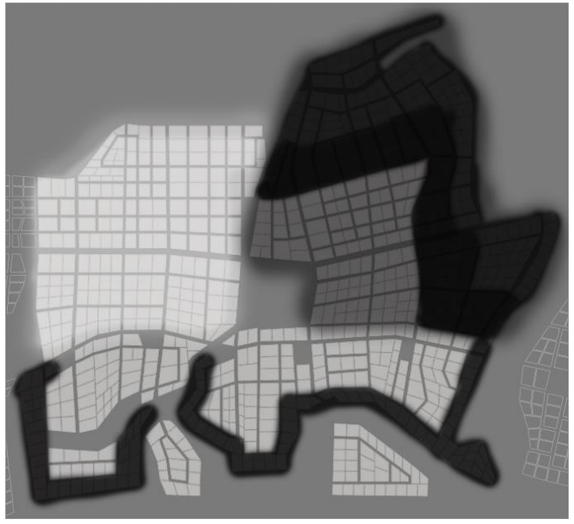
Industrial



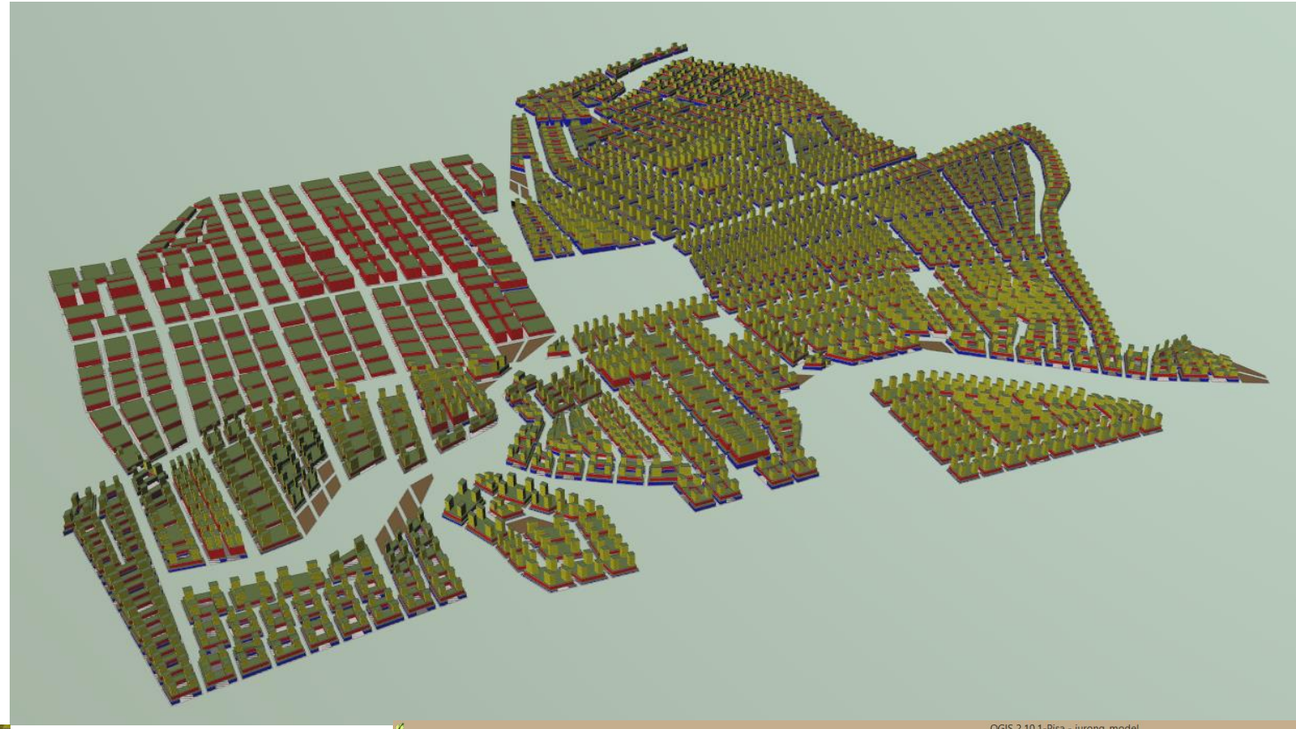
Residential

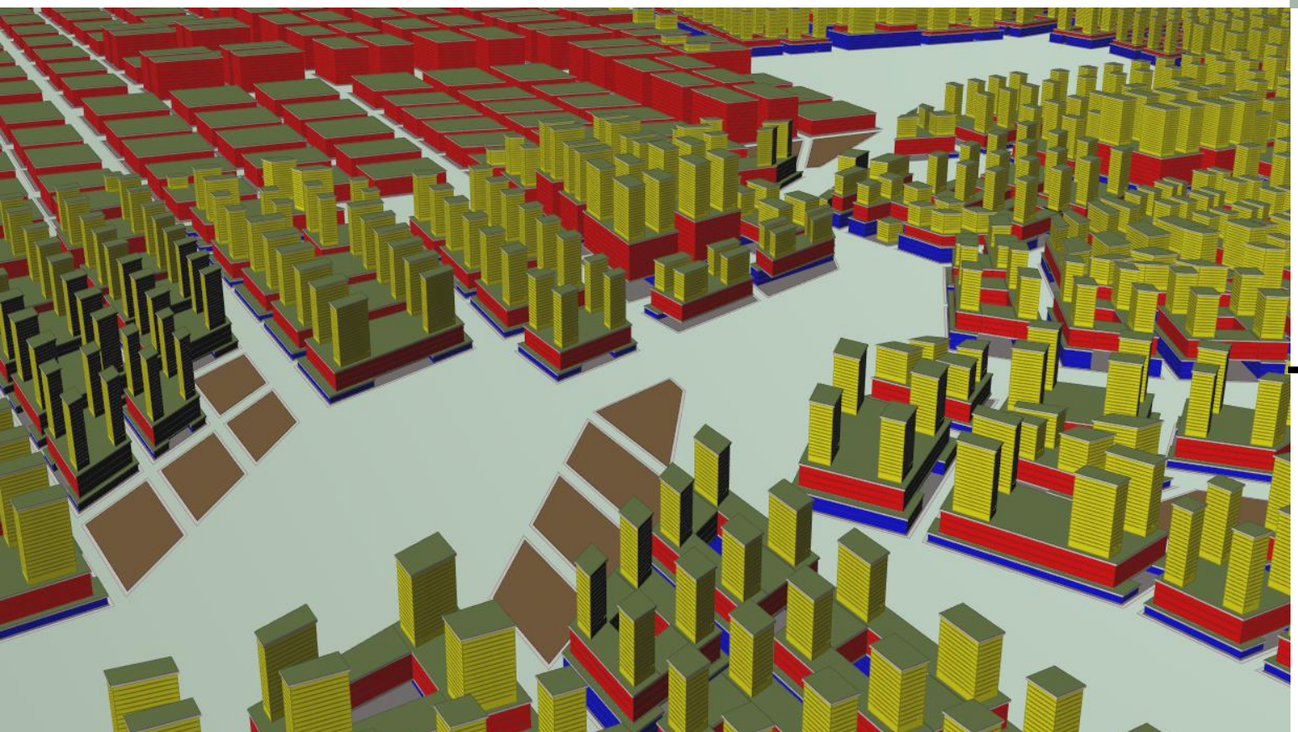


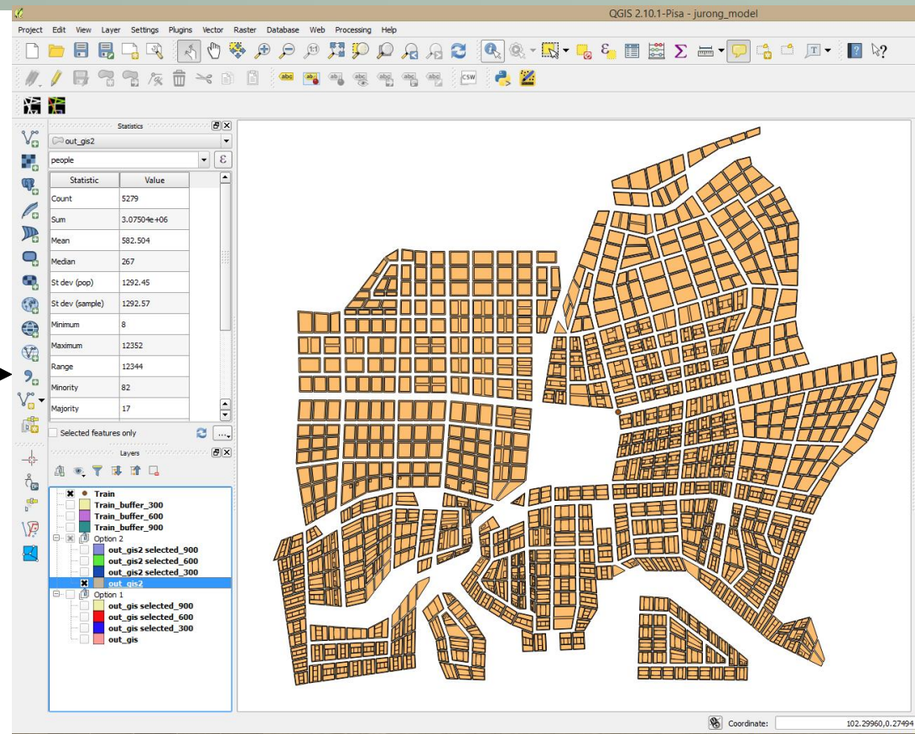
Commercial



Option 2 – 3D CAD model

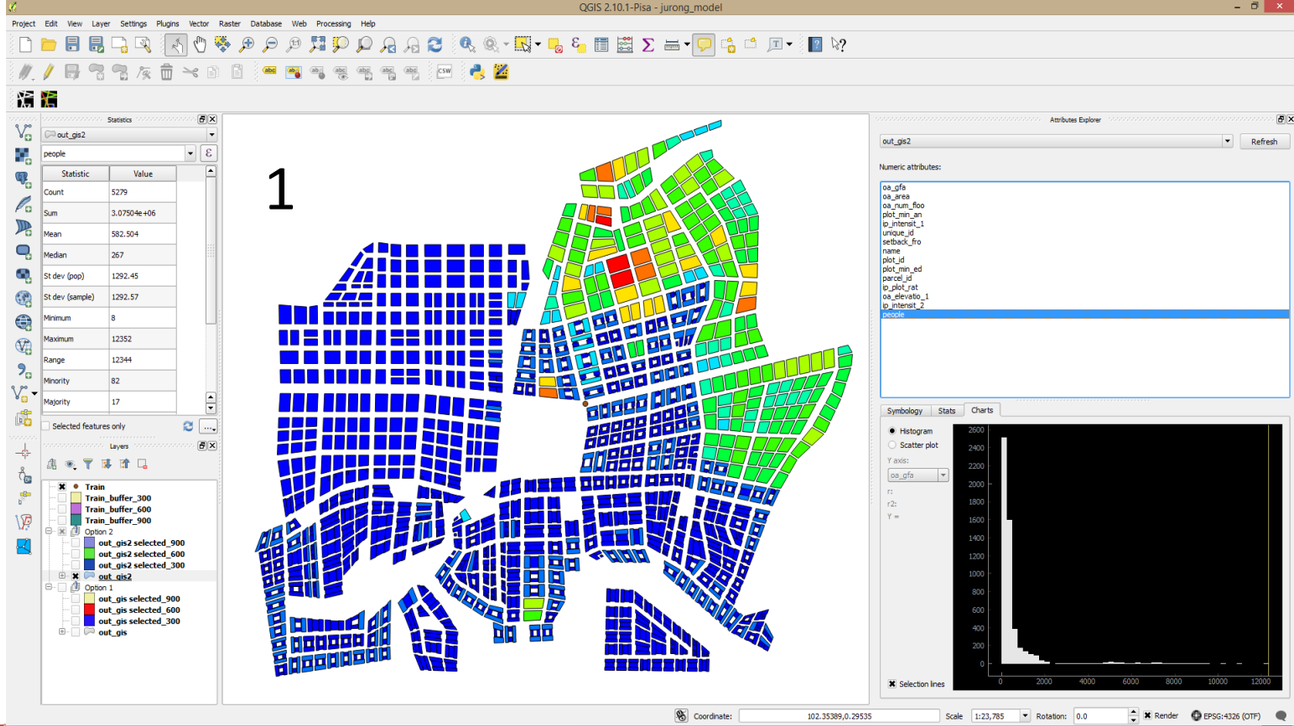


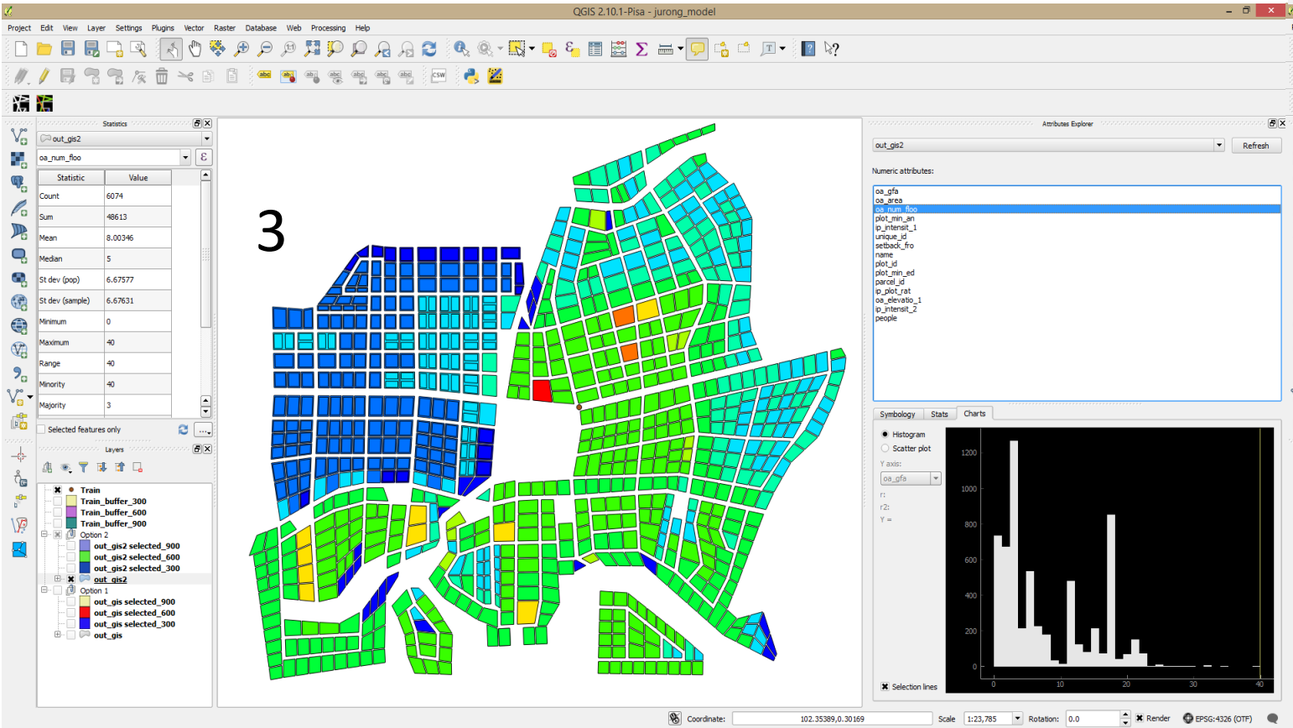


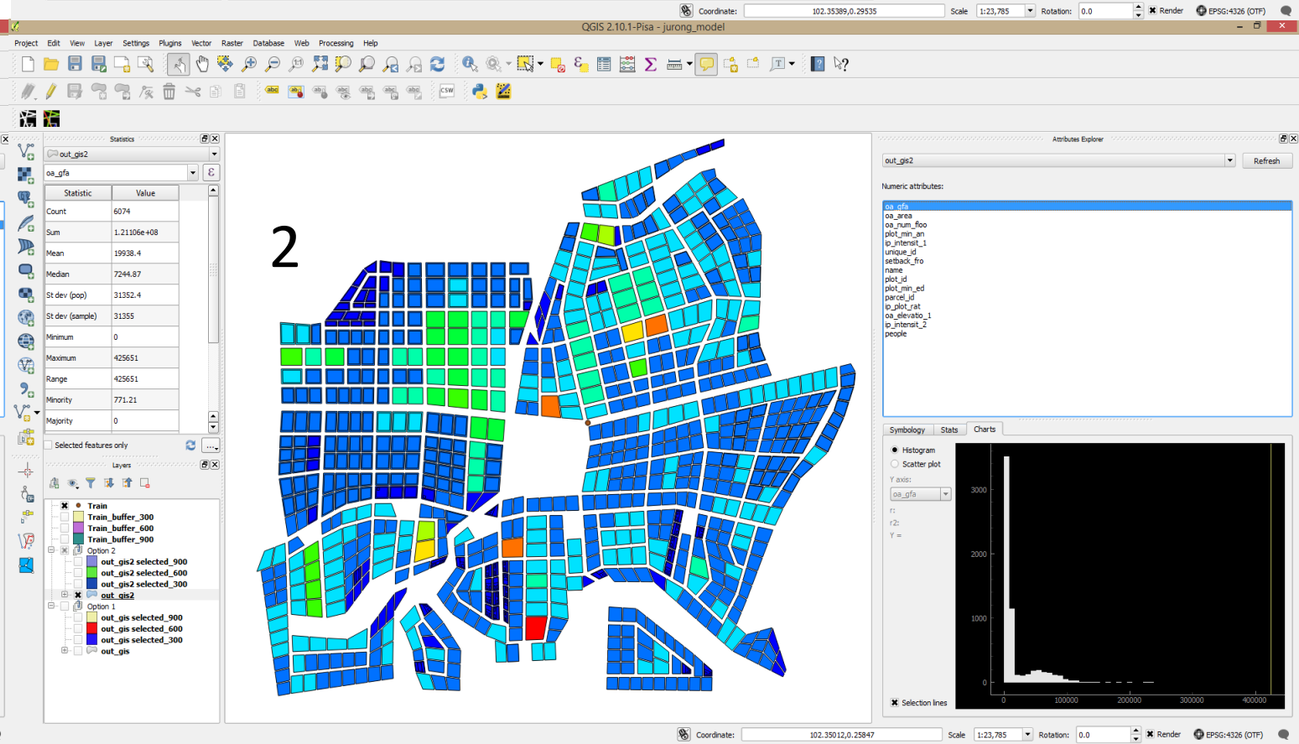


Option 2 – Data Analysis

1. People density
2. GFA
3. Building height

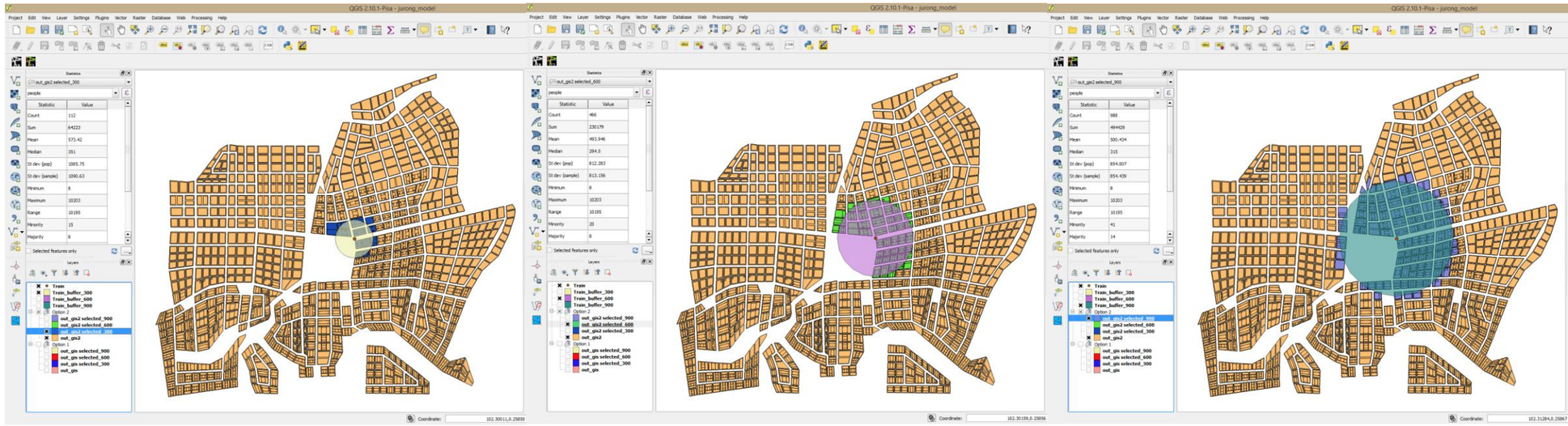






Option 2 – Buffer Analysis

- Total (residents): 650,000
- 300m buffer: 2% of residents
- 600m buffer : 9% of residents
- 900m buffer : 20% of residents



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to GIS

**Parametric CAD
to Game Engines**

Future work

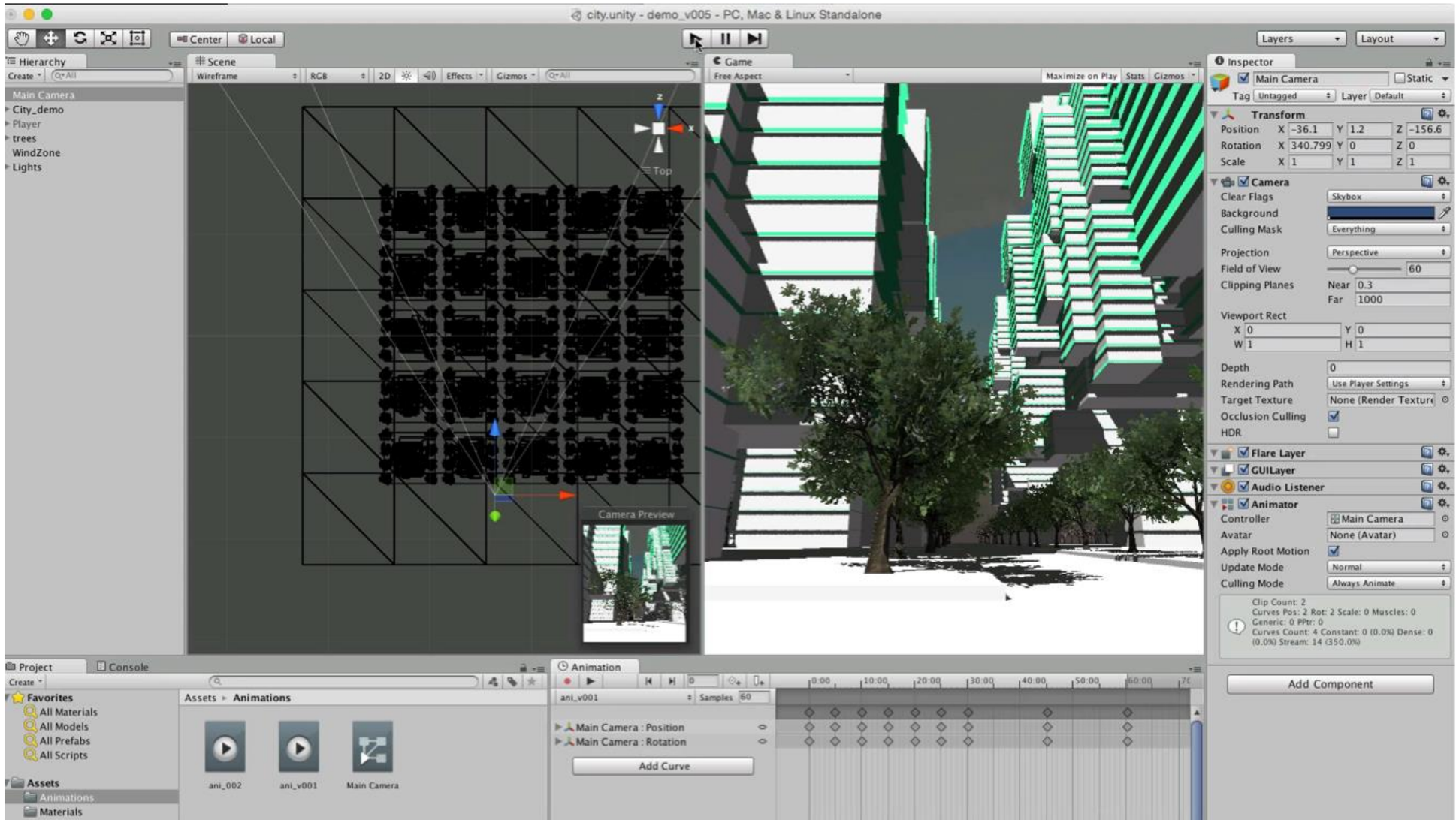
Conclusions

From 3D CAD to 3D Game Engine

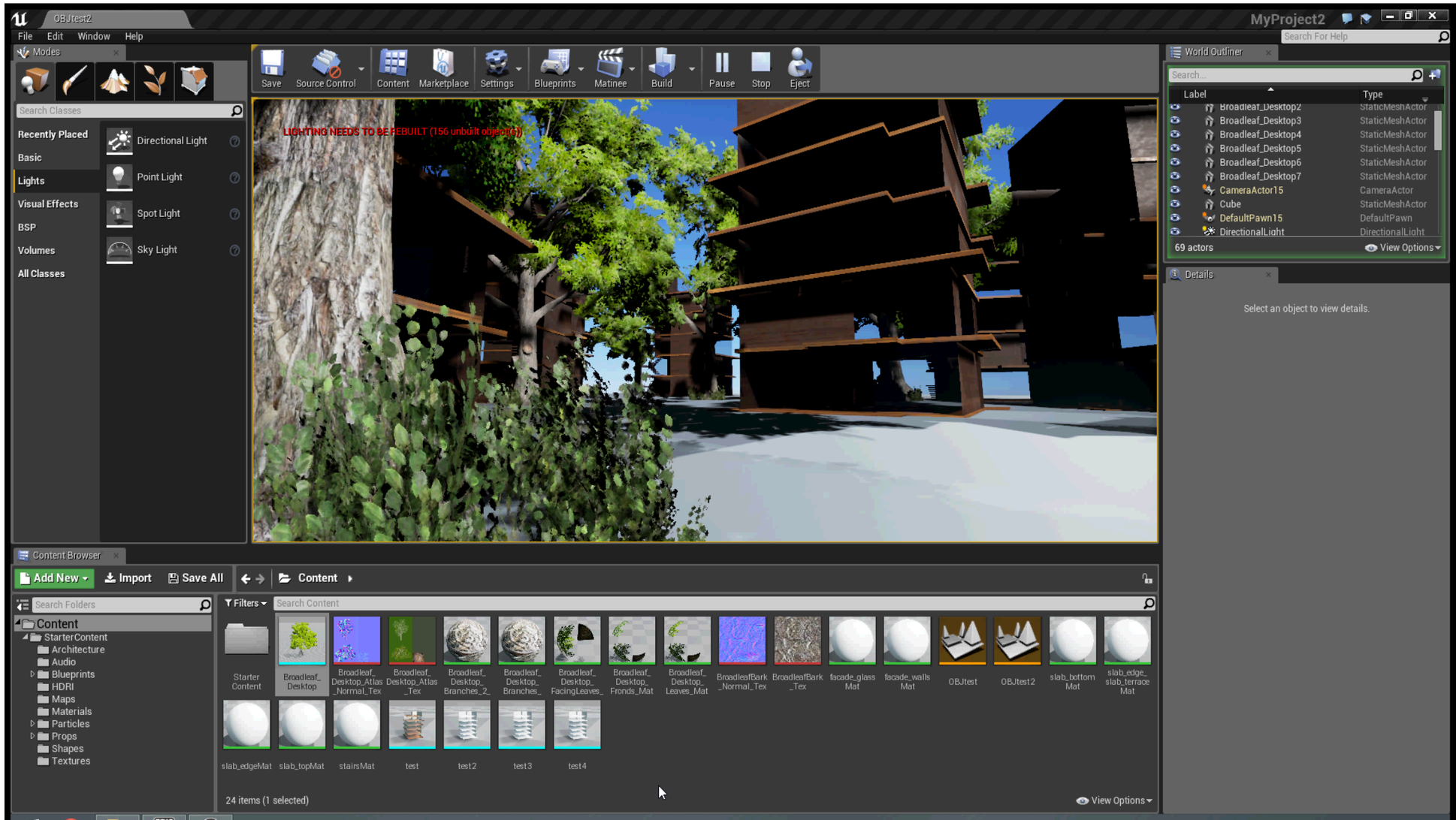
- Data from the 3D model is exported as an OBJ file

- The model can then be interactively explored with real-time effects
  - Rain
  - Wind
  - Noise

Visual analysis - Unity3D



Visual analysis - Unreal



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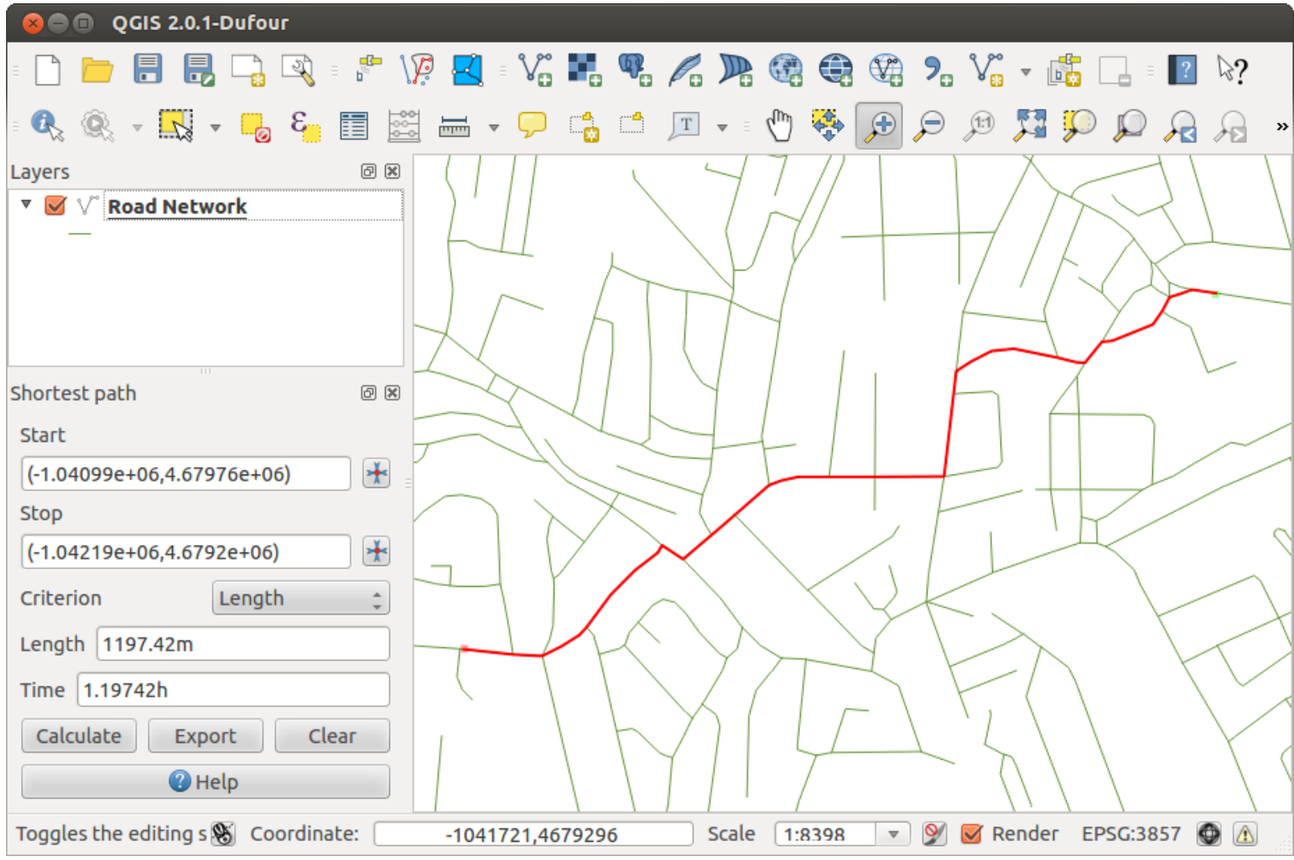
Conclusions

Network Analysis

- Network Analysis will allow a additional types of analysis
  - Isochrone analysis
  - Space Syntax analysis
  - Walkability analysis

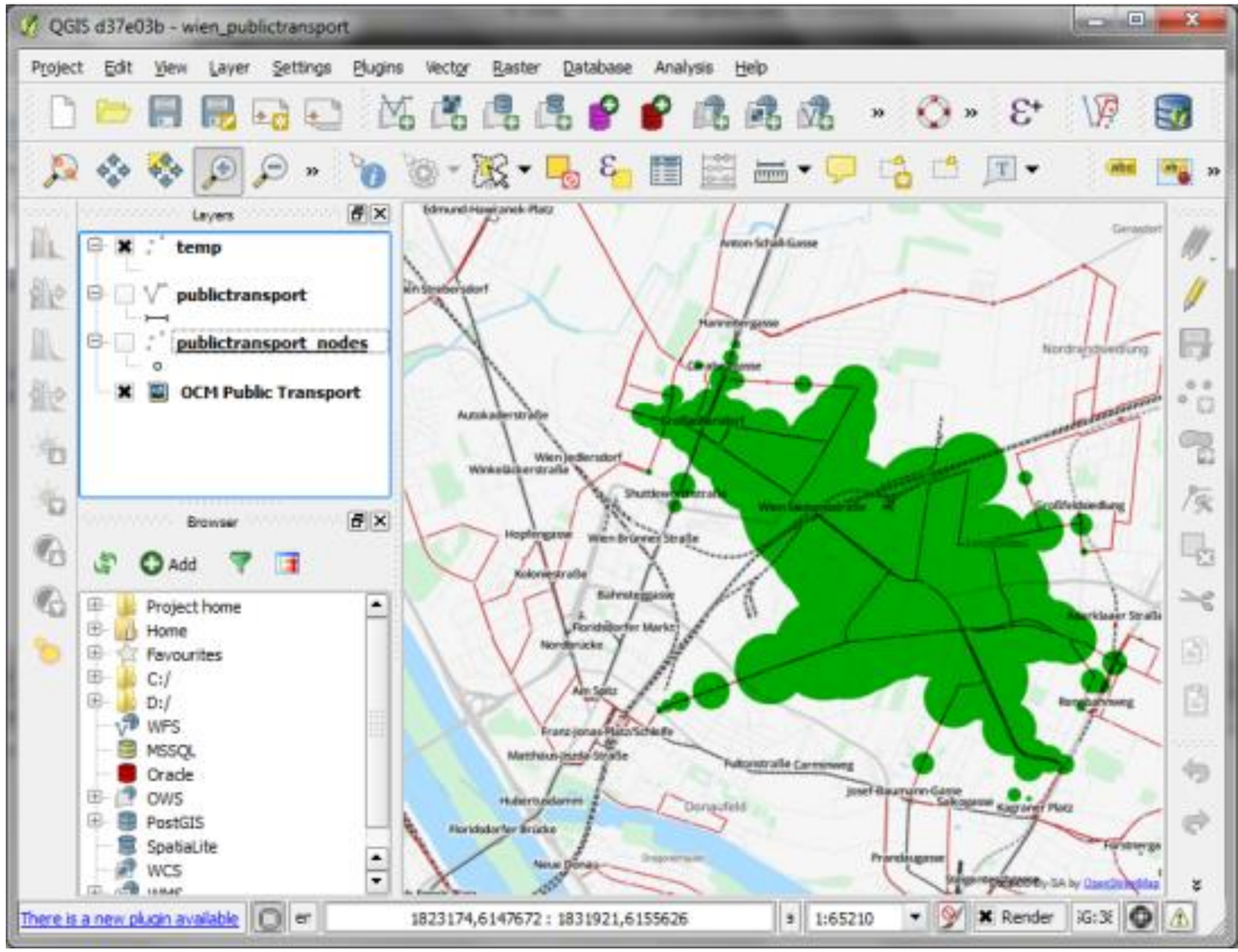
- Requires a well defined network of roads, transport links, and other pathways



Isochrone analysis

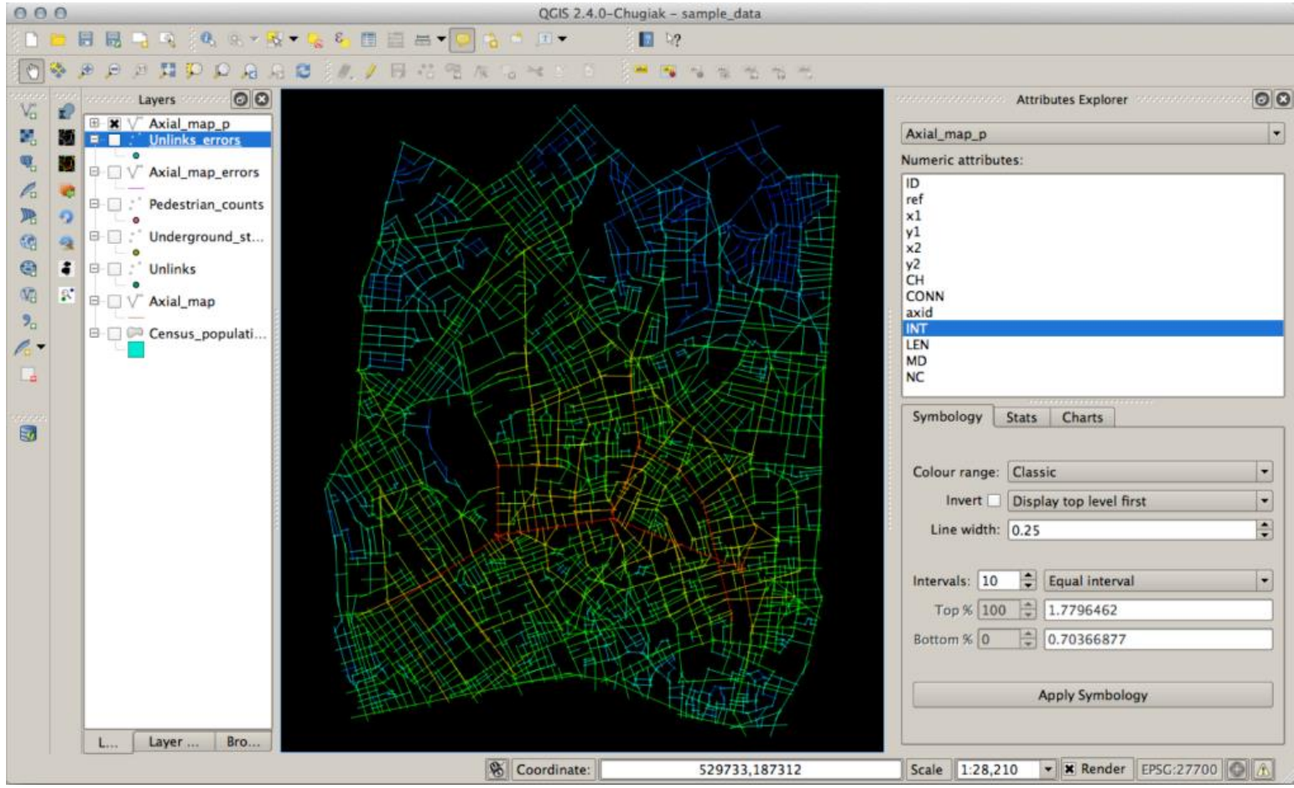
- A map connecting points of equal times

- Requires a connected network with travel speeds define for each link in the network



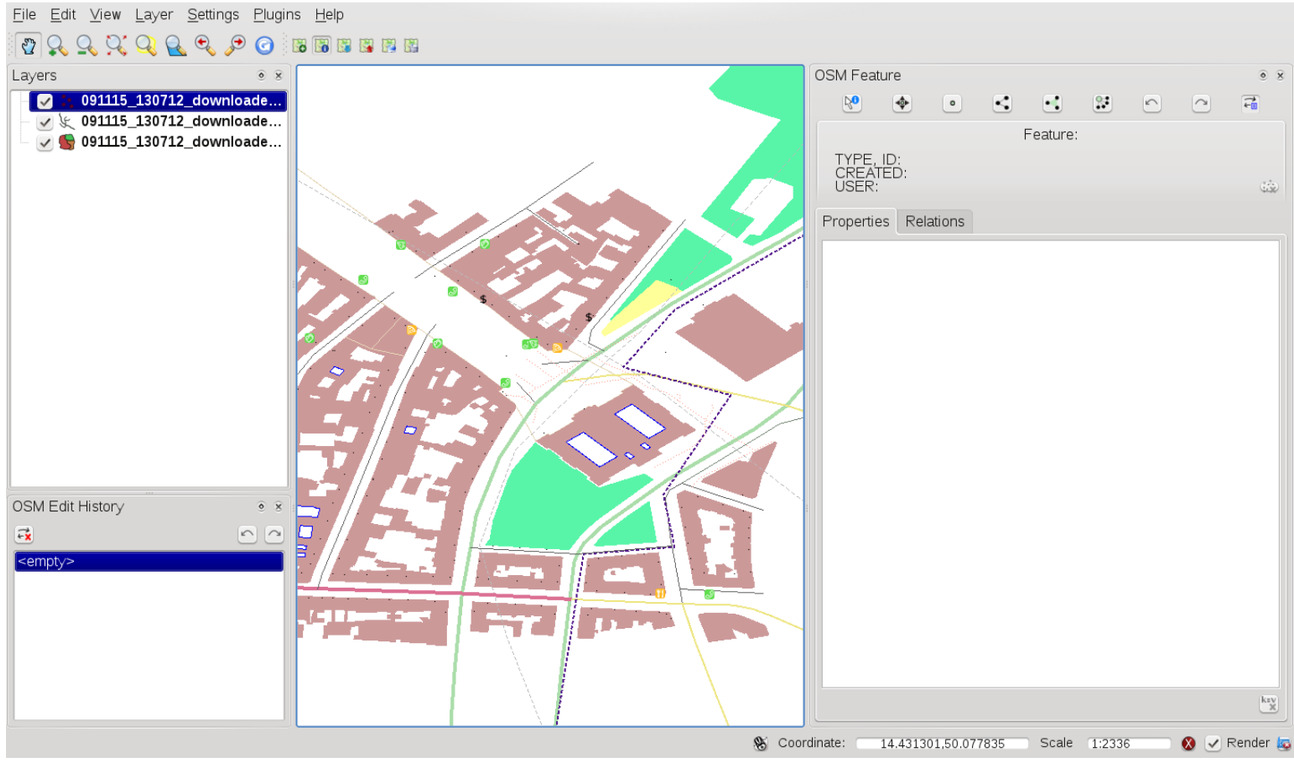
Space Syntax Analysis

- Various types of centrality analysis
- Requires an axial map of the street network
- SpaceSyntax plugin exists for QGIS



Walkability Analysis

- For example, WalkScore
- Requires location of amenities such as shops and schools to be define
- For existing neighborhoods, the data can be extracted from OpenStreetMap



Context

Issue

Case Study

Stage 1
Data Collection

Stage 2
Data Synthesis

Stage 3
Data Mining

Parametric CAD
to GIS

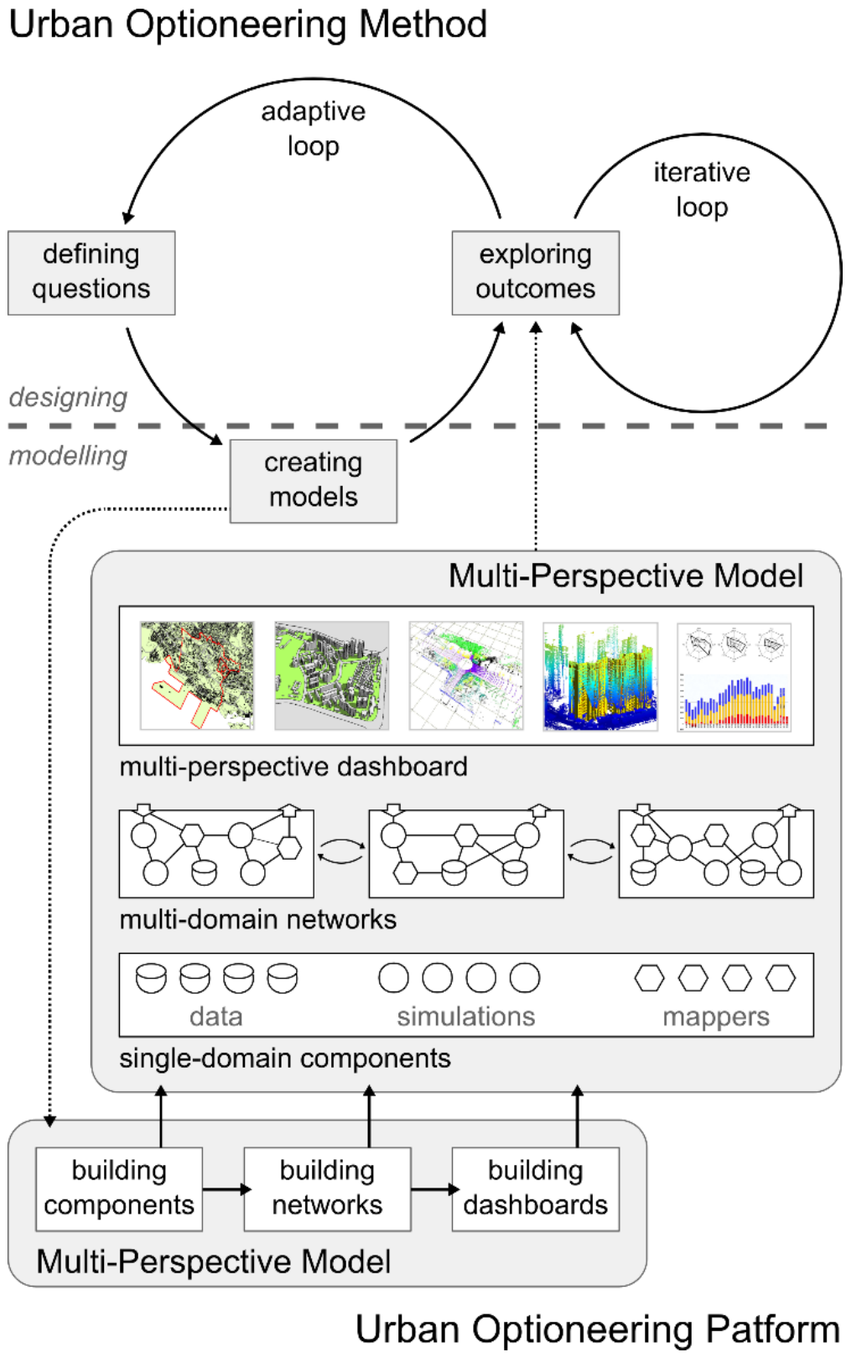
Parametric CAD
to Game Engines

Future work

Conclusions

Urban Optioneering Platform

- A future platform that integrates all these tools
  - Define ‘what-if’ questions
  - Build models
  - Explore models



Collaborators and credits

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The End.