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How emerging digital tools, data and computational power is reshaping the way we plan our built environment.

Daniel Osborne

Model: GPT-4

Can you tell me how emerging digital tools, data and computational power is reshaping the way we plan our built environment?

Emerging digital tools, data, and computational power are significantly reshaping the way we plan our built environment. Some of the key ways in which this transformation is taking place include:

1. Digital Twin Technology: Digital twins are virtual replicas of physical assets or systems, which enable us to monitor, analyze, and optimize the performance of the built environment. Planners and architects can use digital twins to simulate different scenarios, optimize resource usage, and improve the sustainability of urban environments.
2. Big Data and Analytics: Planners now have access to vast amounts of data from various sources such as sensors, social media, and satellite imagery. This data can be analyzed to identify patterns, trends, and opportunities, leading to more informed decisions on urban development, transportation, and infrastructure planning.
3. Computational Design: This approach combines computer algorithms and human creativity to generate innovative, sustainable, and efficient design solutions for the built environment. It allows architects and engineers to explore a wider range of possibilities and optimize designs based on specific criteria, such as energy efficiency or structural performance.
4. Building Information Modeling (BIM): BIM is a digital representation of the physical and functional characteristics of a building. It enables stakeholders to collaborate and share information throughout the entire building lifecycle, from design and construction to operation and maintenance. BIM helps streamline the planning process, reduce errors, and improve overall project efficiency.
5. Artificial Intelligence (AI) and Machine Learning (ML): AI and ML technologies are being used to analyze large datasets, p [illegible] timize design and planning processes. They are also being applied to automate routine tasks, enabling professionals

Regenerate response

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Applying machine learning to reveal land use data and enable more informed planning decisions

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The sheer level of impact human beings are having on our environment demands analysis tools equal to the task.

Deforestation, flood risk, overdevelopment, loss of biodiversity – these problems grow unnoticed, threatening the planet’s future and our own.

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Process

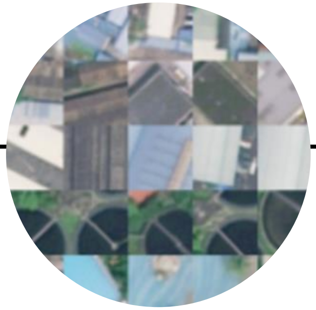
Embedding a data-driven approach

Satellite and Aerial Images

Terrain easily digests a variety of imagery from open source to commercially available, with the ability to analysis multiple resolutions at multiple scales.

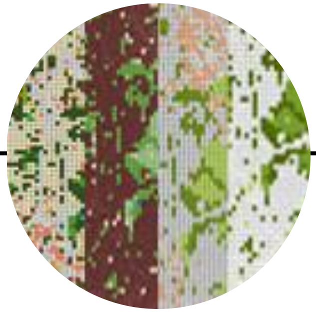
Artificial Intelligence

Through powerful deep learning artificial intelligence and cloud computing, we can either use Terrain's pre-existing models or create brand new ones to produce base maps for the use case required.



Land Use Identification and Analysis

Terrain infers the typologies of the land based on area coverage, location and predicted accuracy. Land use typologies can be further refined through parametric-based 'ground truthing.'



Domain Solutions and Interventions

The data output is available in a variety of formats, including imagery, tabular and GIS, and enables the development of domain solutions and interventions to meet client requirements.

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Benefits of this approach

~ 80% quicker than a traditional approach*

Greater efficiency:

Compared with a ‘manual’ approach to analysing land types

Analyses 20,000 m^2 of land per second

Speed of processing:

16 Olympic-sized swimming pools’ worth of land data analysed every second

High degree of accuracy with initial analysis

Enabling faster decisions:

Quicker turnaround times, leading to more informed, faster decision-making

Case Study: Shanghai, China

Mitigating flood risks at city-scale

Arup was selected by the Shanghai Water Authority to provide a stormwater masterplan for the city.

We used Terrain to map land use types and provide a forward-thinking solution: to introduce a wide range of substantial blue and green infrastructure measures – natural and semi-natural landscape elements within the city – in combination with optimising its necessary grey infrastructure measures.

640km^2

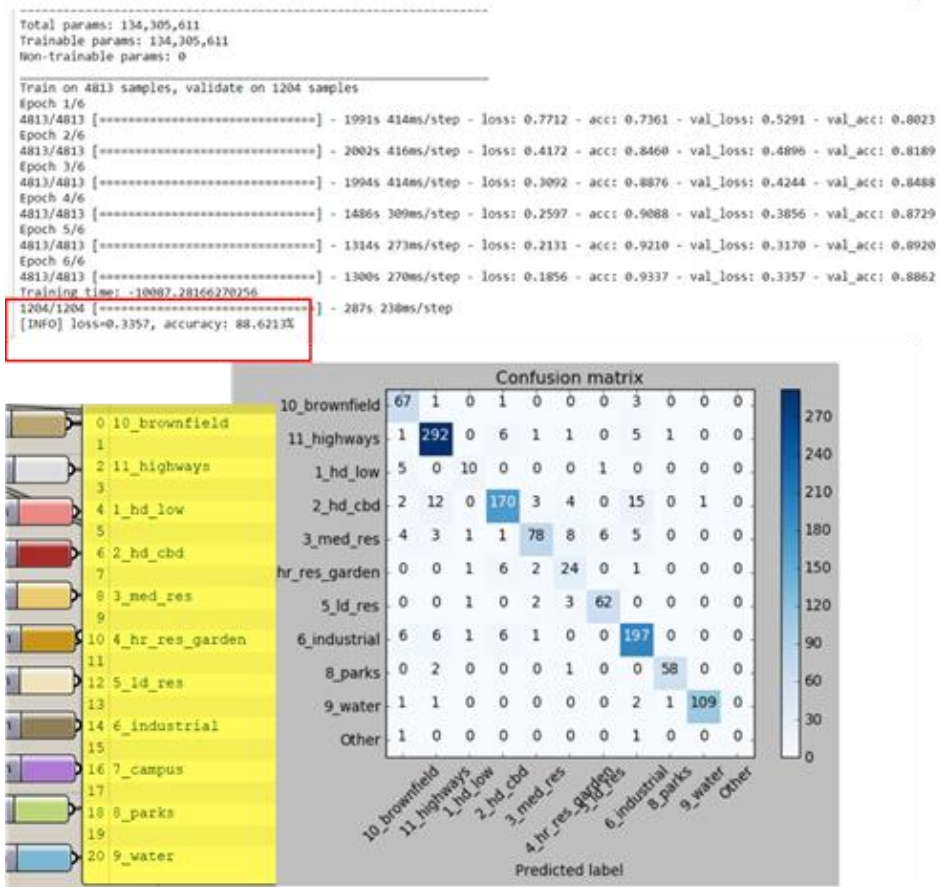
Site area analysed

>34m m^3

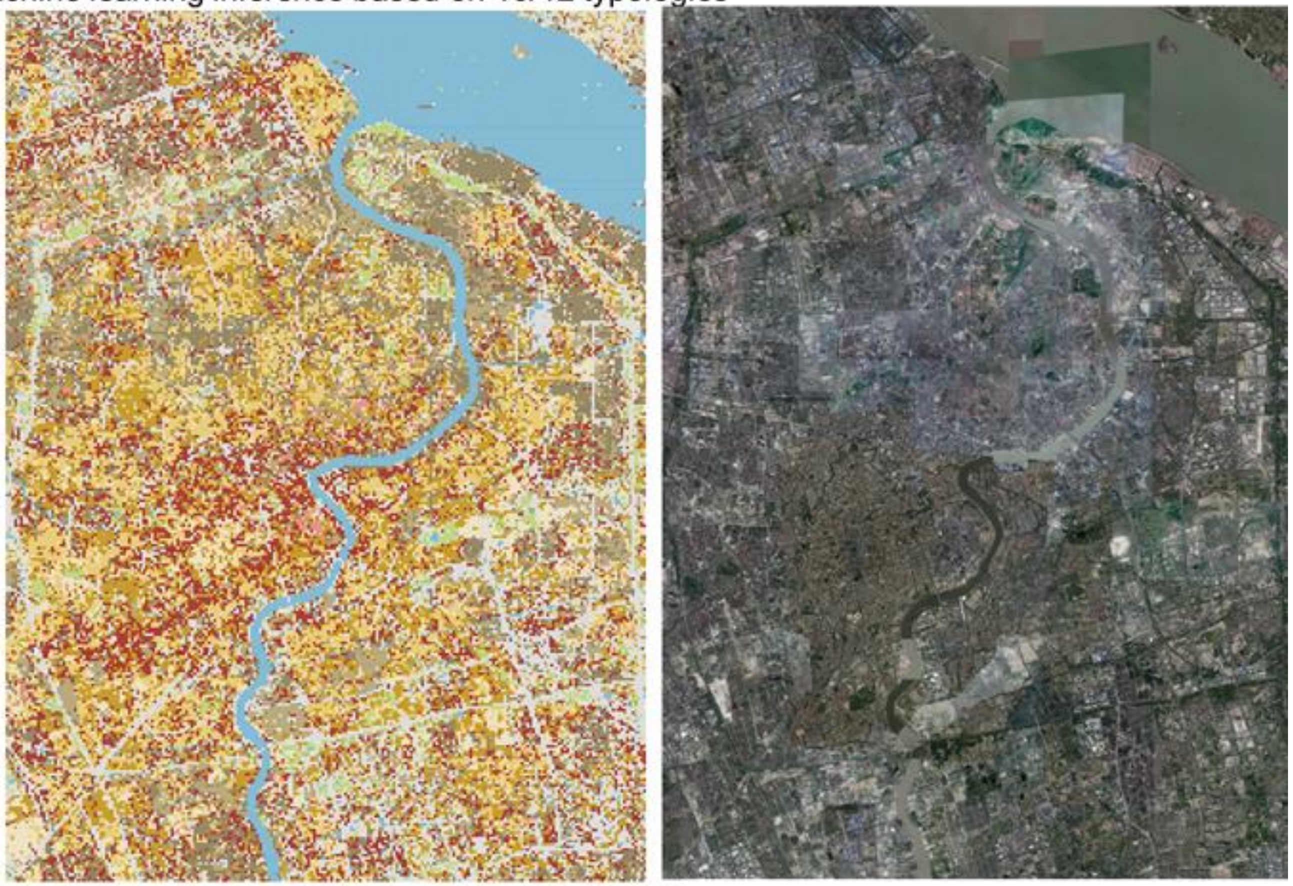
Stormwater capacity planned

Analysis: City Characterisation

Use of machine learning to inform the analysis.



Machine learning inference based on 10/12 typologies



Masterplan interventions

Case study: Mansfield, UK

Unlocking the potential for nature-based solutions

Arup supported Severn Trent Water by reviewing, developing and costing a range of nature-based solutions for the Town of Mansfield. Using Terrain we assessed 14 land use classes and their potential to accommodate nature-based solutions.

14

land typologies identified for the wider Mansfield area (107 Km2)

£75.7m

funding secured to deliver blue-green infrastructure across Mansfield.

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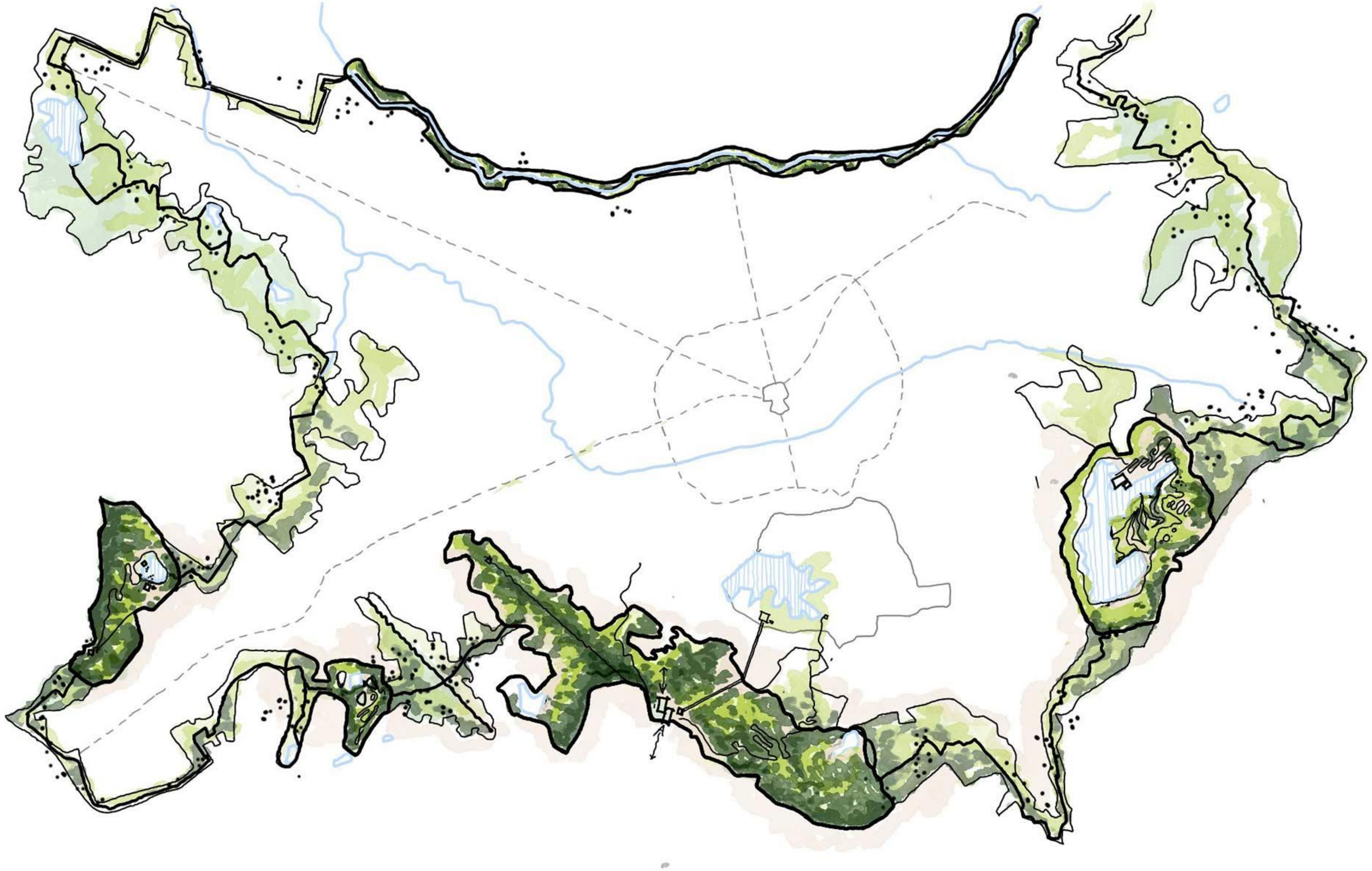
Tirana, Albania

Orbital Forest

Exploiting land use data to design greener cities

The forest is a proposed ring around the urban perimeter of the city with a mix of forests, shrubland, agricultural land and recreational areas



27

land typologies identified.

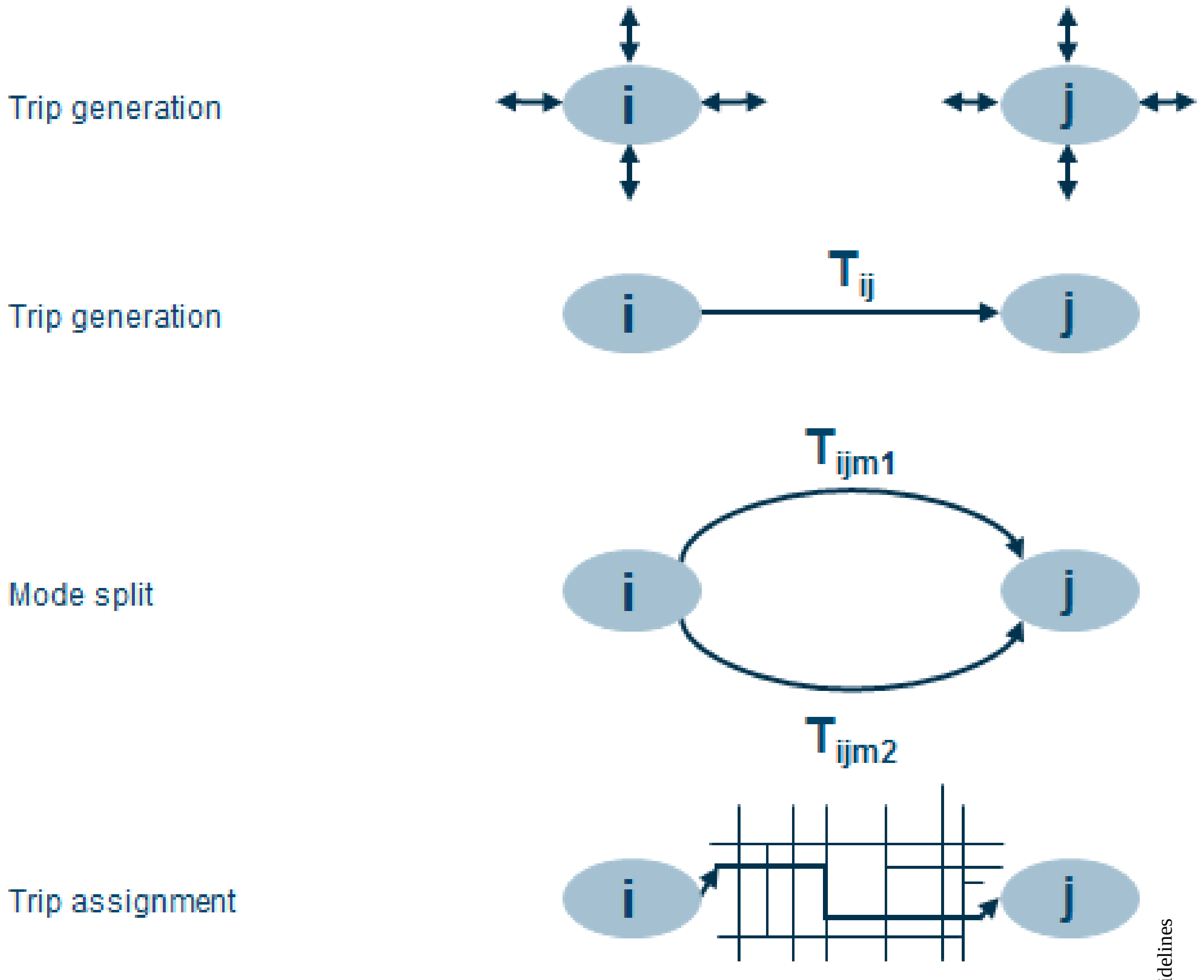
Leveraging massive compute resources o simulate daily life at a city scale

The traditional transport modelling approach

For simplicity, classical strategic transport models do not model people, they model trips.

However, this abstracts away much of the realities of city life. At an individual level, travel plans are complex and dynamic, just as cities are massively complex systems.

By modelling aggregated travel demands, rather than people, we miss much of the underlying drivers behind travel decisions.

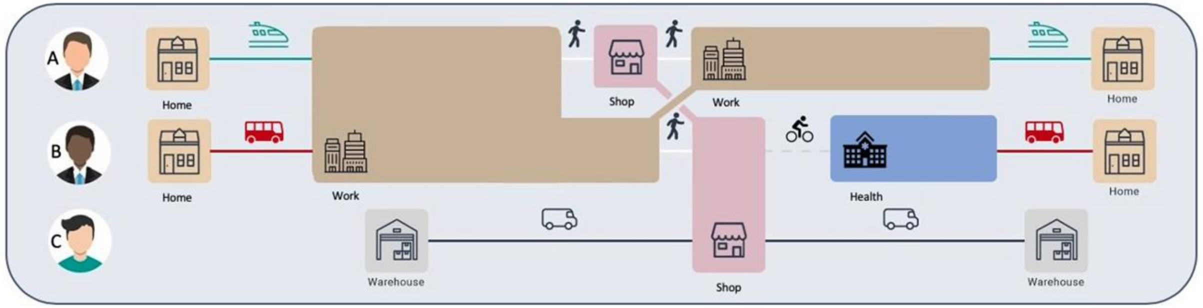


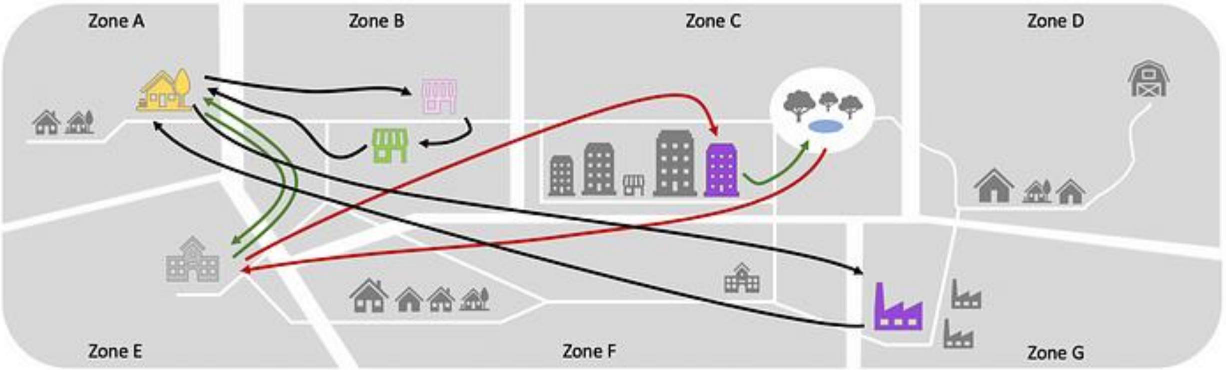
Source: ATAP Guidelines

The agent based approach

Agent based models put people back at the heart of transport planning, simulating the travel needs of the individual.

Unlike the classical approach, ABMs model the ‘why’ as well as the ‘what’, gaining insights into complex behaviours. This allows us to better understand shifts in travel behaviour, establishing a truer perspective on the impacts of policy decisions, city planning and new transport schemes enabling more fair, equitable and sustainable decisions and investments for our society’s future.



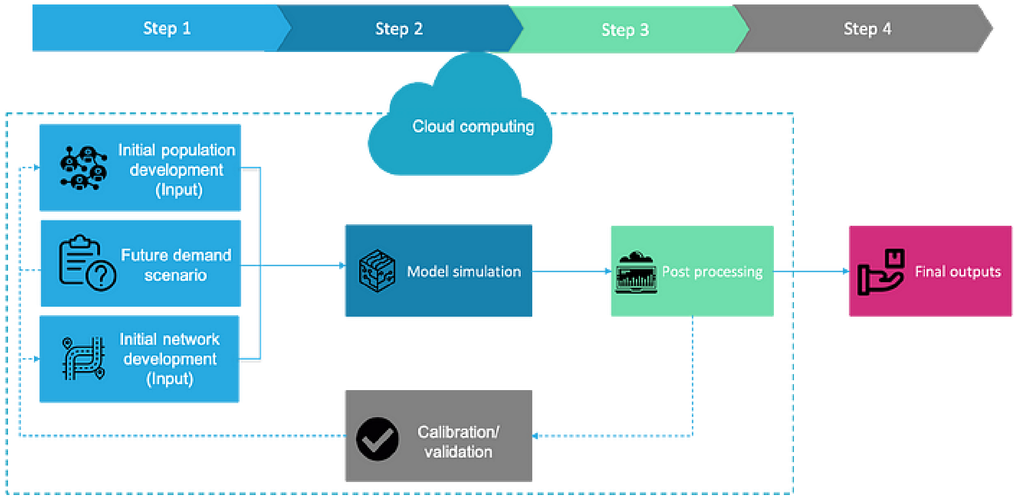


Better decision making enabled by cloud computing

Simulating the travel behaviour of millions of individuals across a city is exceptionally compute intensive.

With inexpensive access to previously unattainable compute resources available via commercial cloud services, this level of simulation is now practical, allowing planners to better evaluate the impacts of:

- Road pricing policies
- Emissions reduction
- Land use policy change
- Etc…

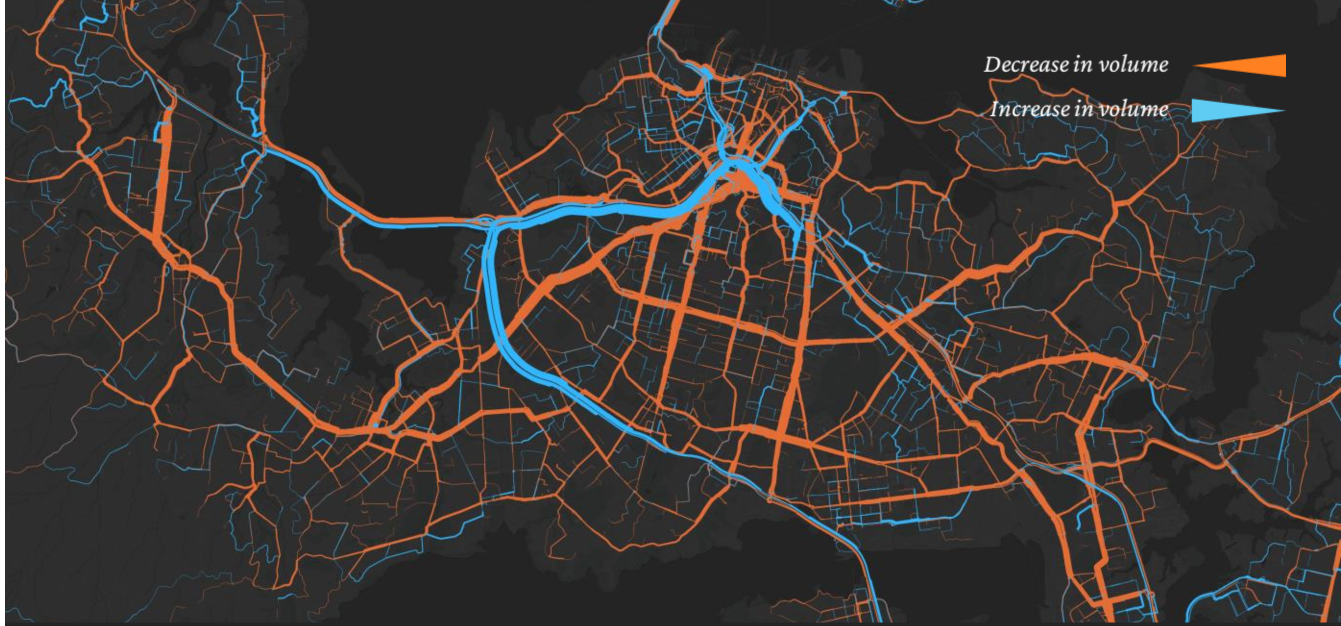


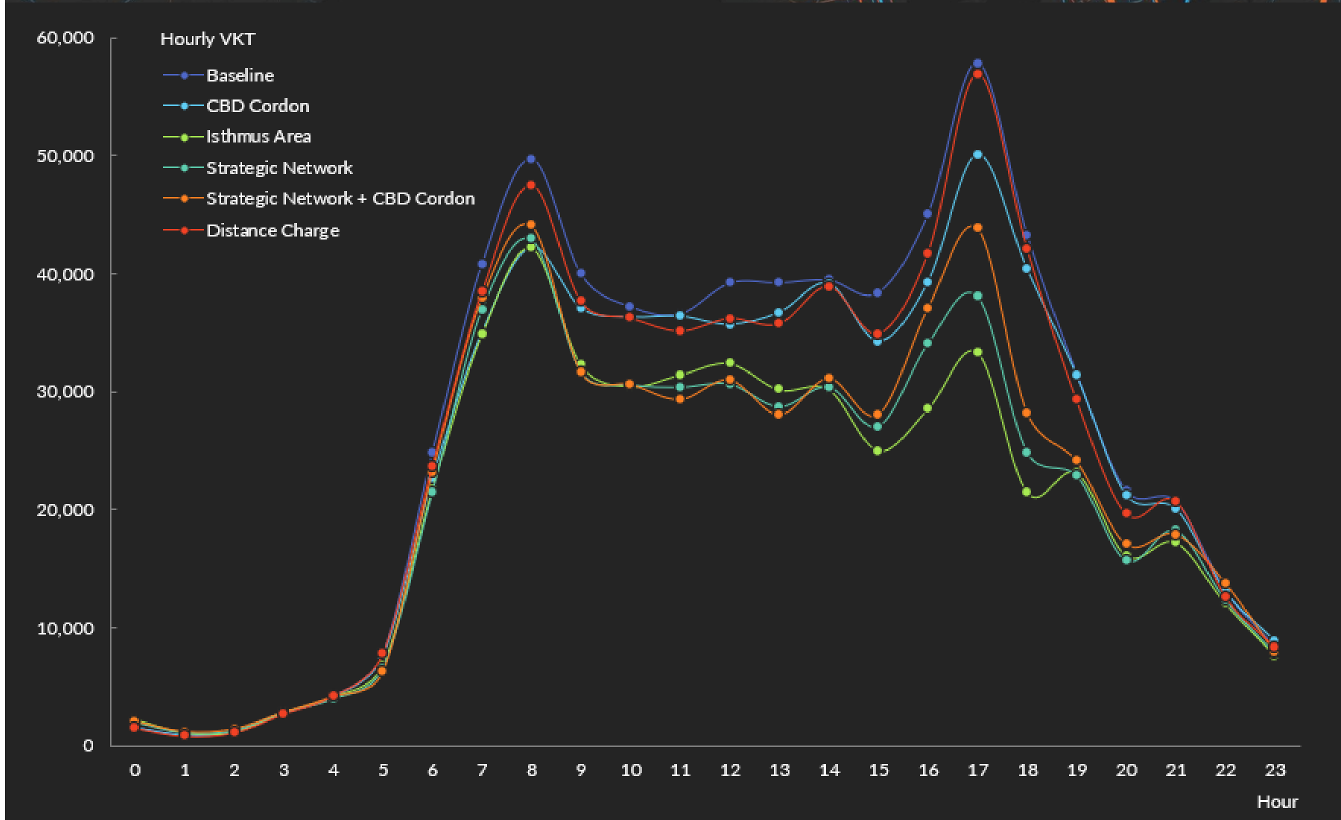
Case Study: Confidential city

Modelling road pricing at city scale

Arup has been developing an activity based travel model covering an entire country.

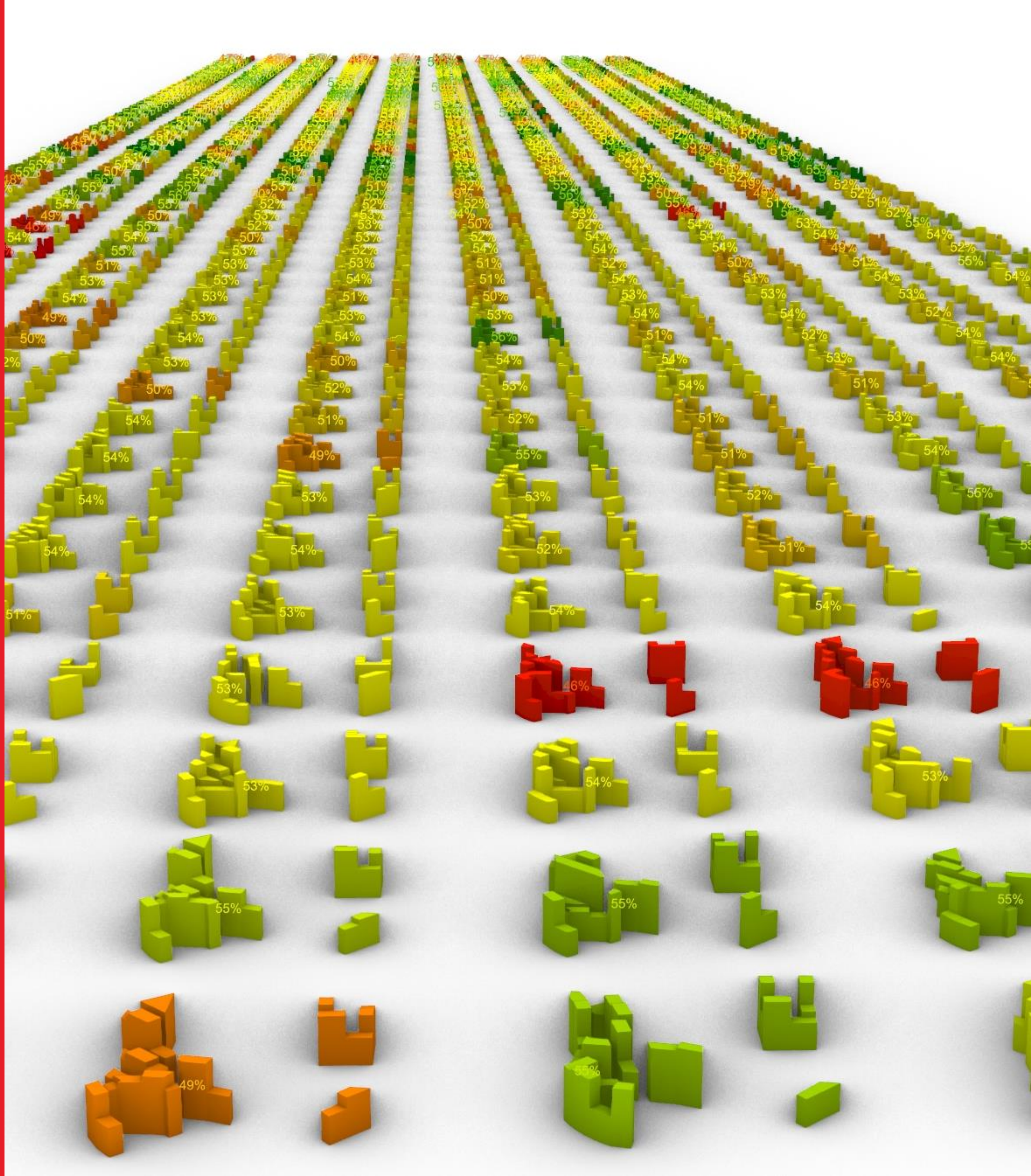
We used the ABM to test the hour by hour impact of a range of road pricing strategies on traffic volumes, mode share and on individuals in terms of social impacts and equity.





Digital master planning through computational design

Case studies from Battersea, London & Smakkelaarspark, Utrecht



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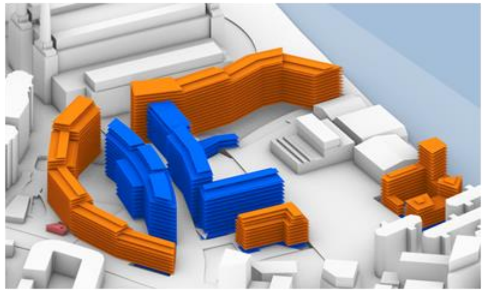
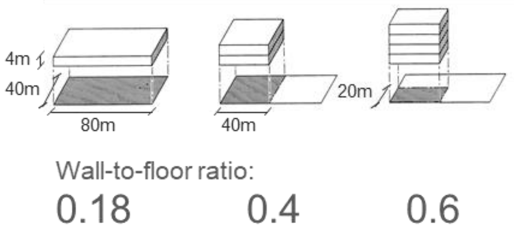
Assessment

Design assessment parameters

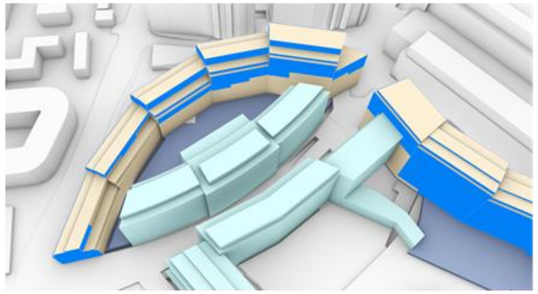
1. Total GEA
Gross external area



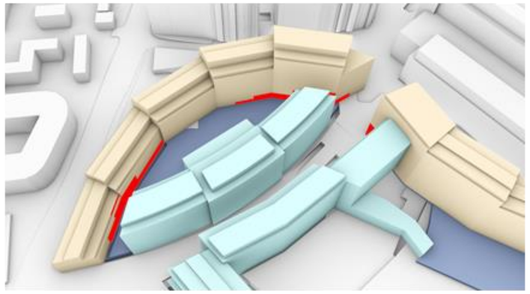
2. Wall-to-floor ratio (WFR)
Façade area / GEA



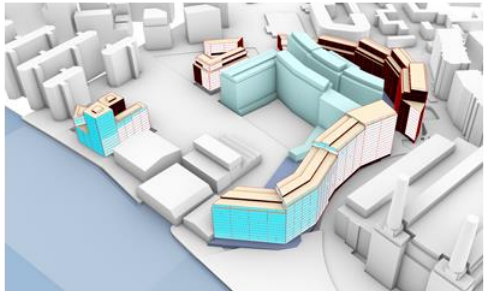
3. Good VSC
Percentage of residential façade with a Vertical Sky Component about 27%



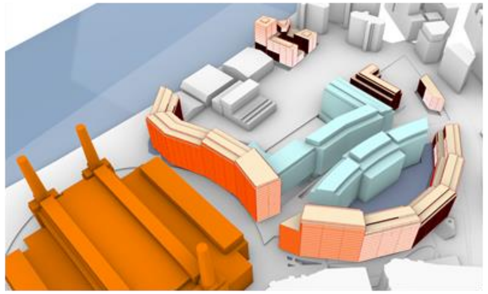
4. Non-acceptable VSC
Percentage of residential façade with a Vertical Sky Component below 15%



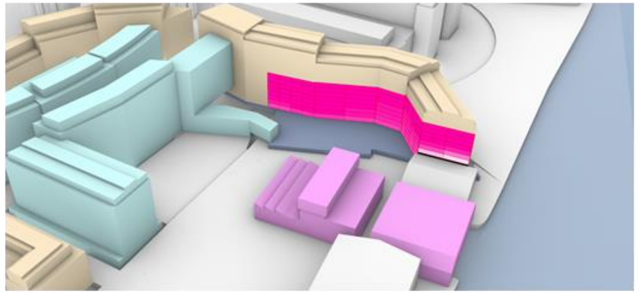
5. River views
Residential façade area (sqm.) with river views



6. BPS views
Residential façade area (sqm.) with views over BPS

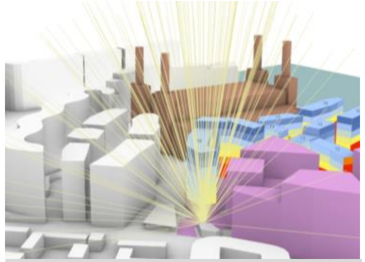


7. Negative views
Residential façade area (sqm.) with direct views (8 storey, with 70m) over waste transfer station

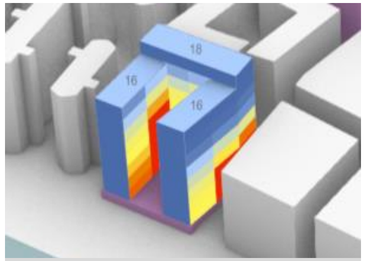


Optimisation

Extrusion Based Masterplan Optimisation



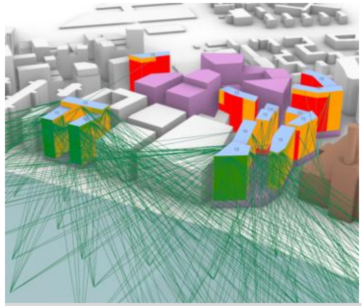
Unobstructed SkyDome % on Public Space



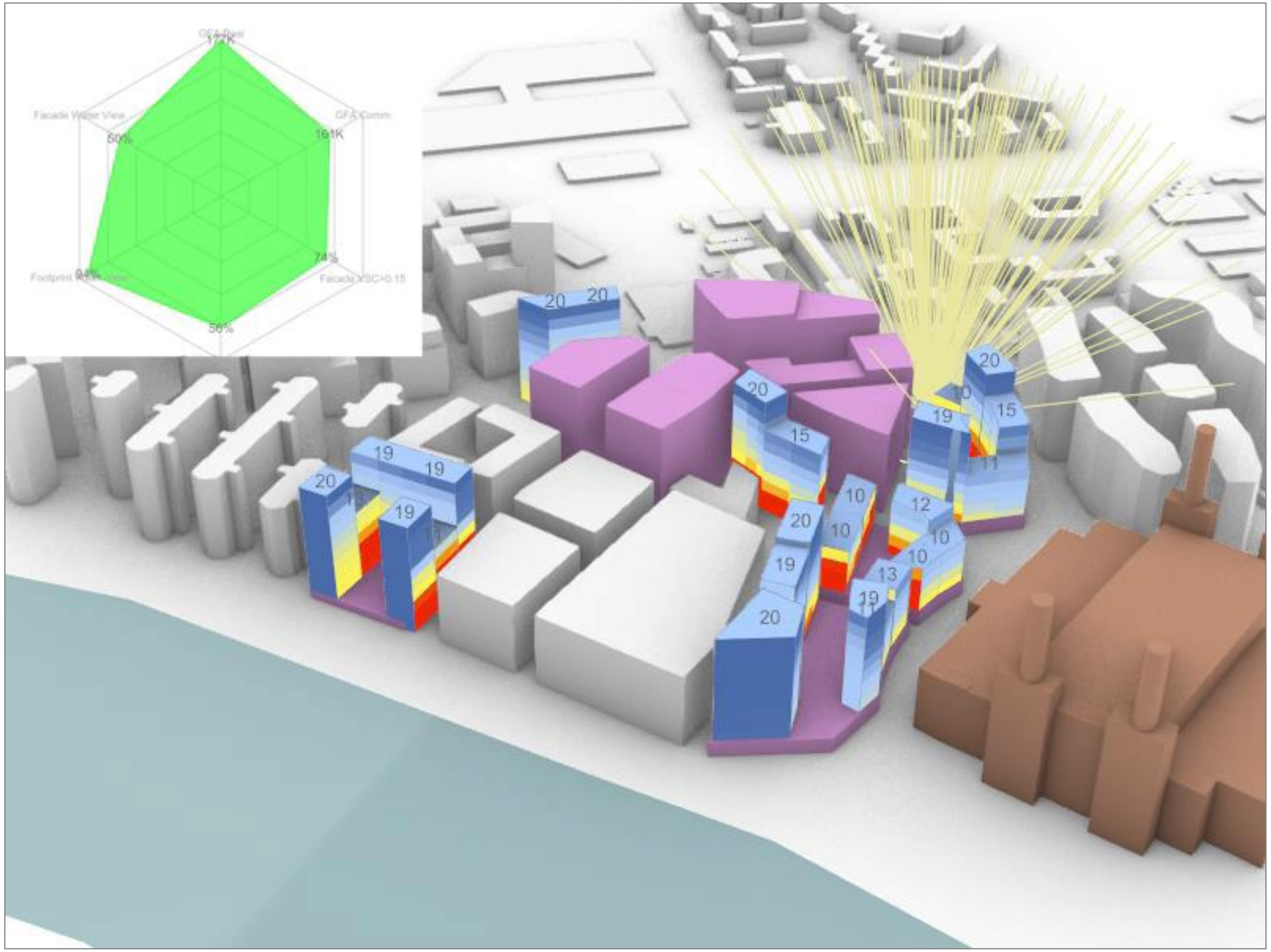
% of Façade with >0.15 VerticalSky Component

GFA Residential

GFA Office and Commercial



Percentage of Façade with Water View



Generative design

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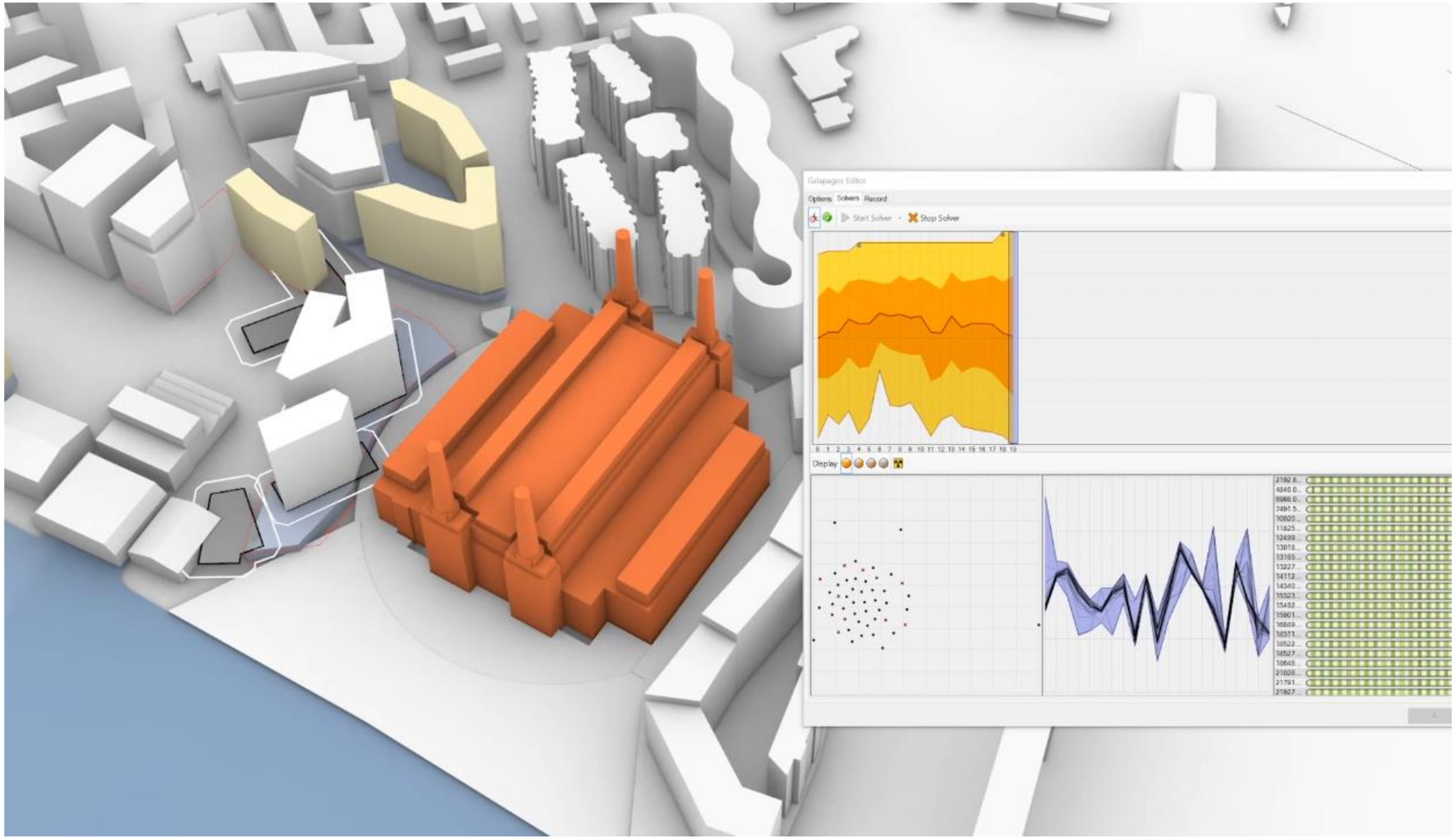
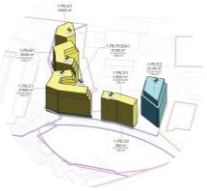
- Exploration of alternative design layouts by using generative algorithms
- Building typologies developed during the design stage have been used as inputs to run the algorithms
- Adoption of established design parameters to assess and compare design outcomes

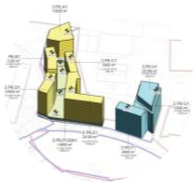


PH6 design options presented

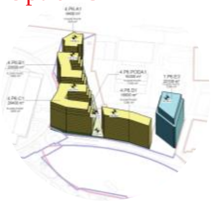
Option 1



Option 2



Option 3



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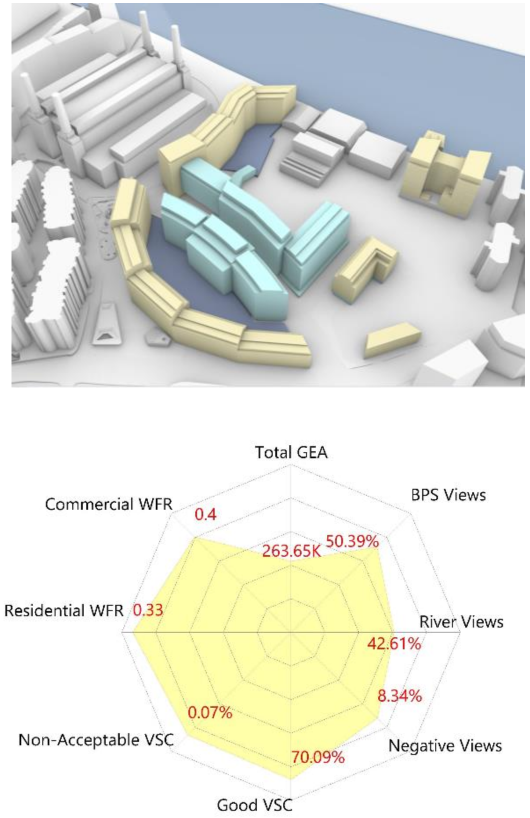
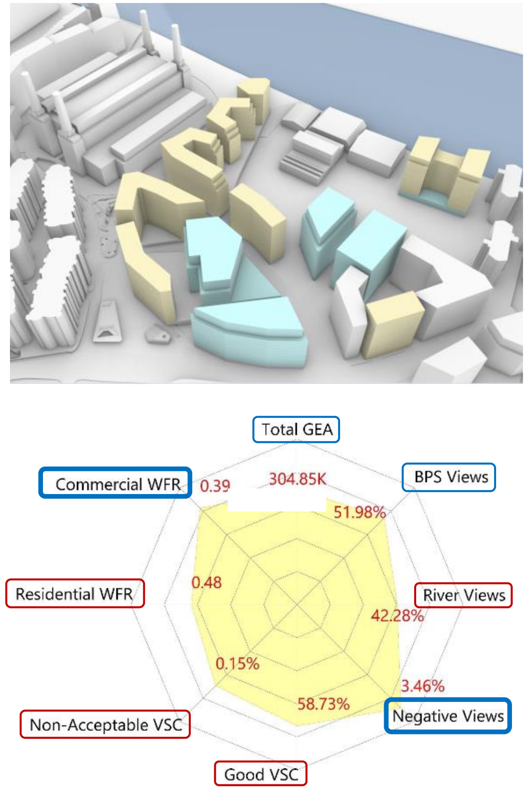
Assessment

Masterplan Design Options Assessment

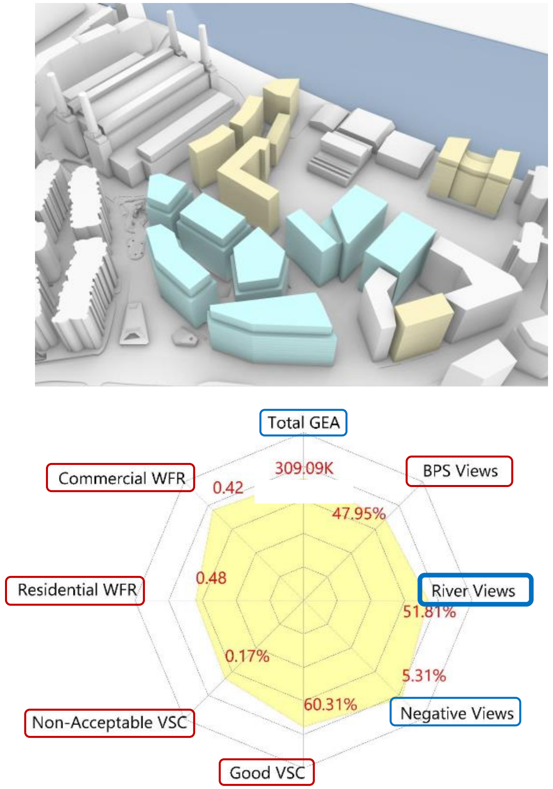
Consented Baseline Scheme



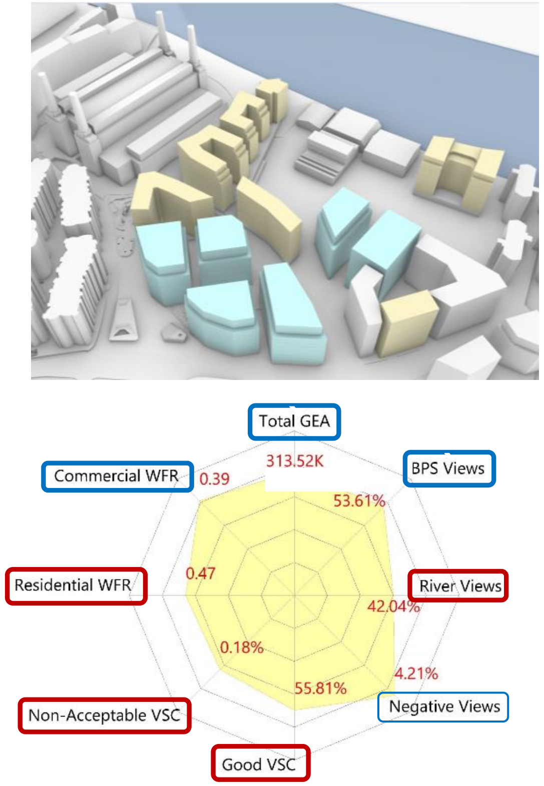
Arup – Option 1



Arup – Option 2



Arup – Option 3



[View on youtube]

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Benefits of this approach

Speed and efficiency

Automate tedious and repetitive tasks. Allow more time for design and collaboration with other teams / disciplines

Test 3D scenarios

Assess options during planning process against agreed parameter/metric

Facilitate approval process

Compare design scenarios with consented planning schemes and, existing site conditions

Identify priorities for the client

Testing many possibilities can help identify what's most important

Participatory design process

Improve community engagement through better evidence

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