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City below the City – Urban Planning of the Future

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Hypothesis

- We need to plan the space in our cities more carefully than ever
- A growing demand on housing, office space, infrastructure and open space is competing for the subsurface and urban surface areas
- To gain better (Geo) insight a coordinated planning approach incorporating the subsurface is required
- This requires a shift from thinking in area to thinking in volume

Contents

- Challenges our Cities are facing
- The need to visualize the subsurface
- Data Data Data
- New planning methodology
- Work in progress
- Conclusions

USE OF UNDERGROUND SPACE

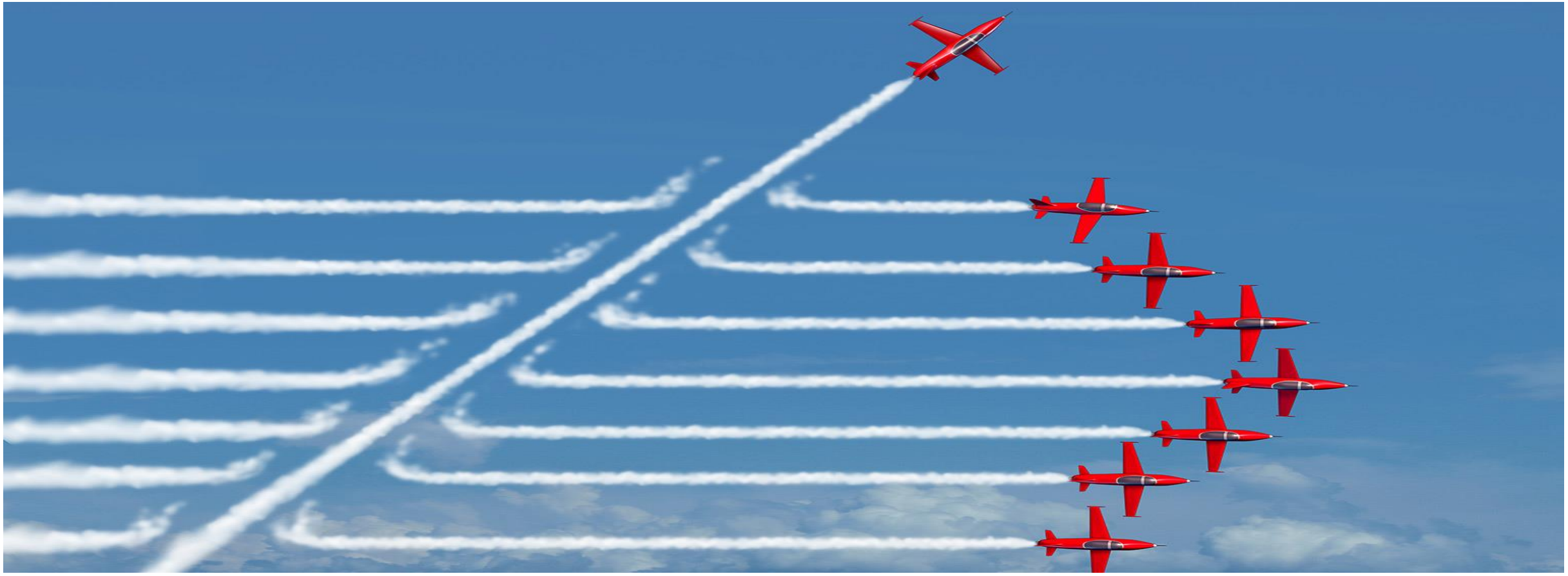
Contemporary and future infrastructures require space

- We are rapidly running out of surface space
- We need to keep our cities liveable
- We cannot use every last bit of public space for new infrastructures
- Underground space use offers a lot of advantages

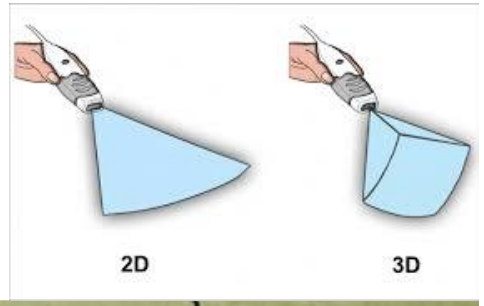
USE OF UNDERGROUND SPACE: ADVANTAGES

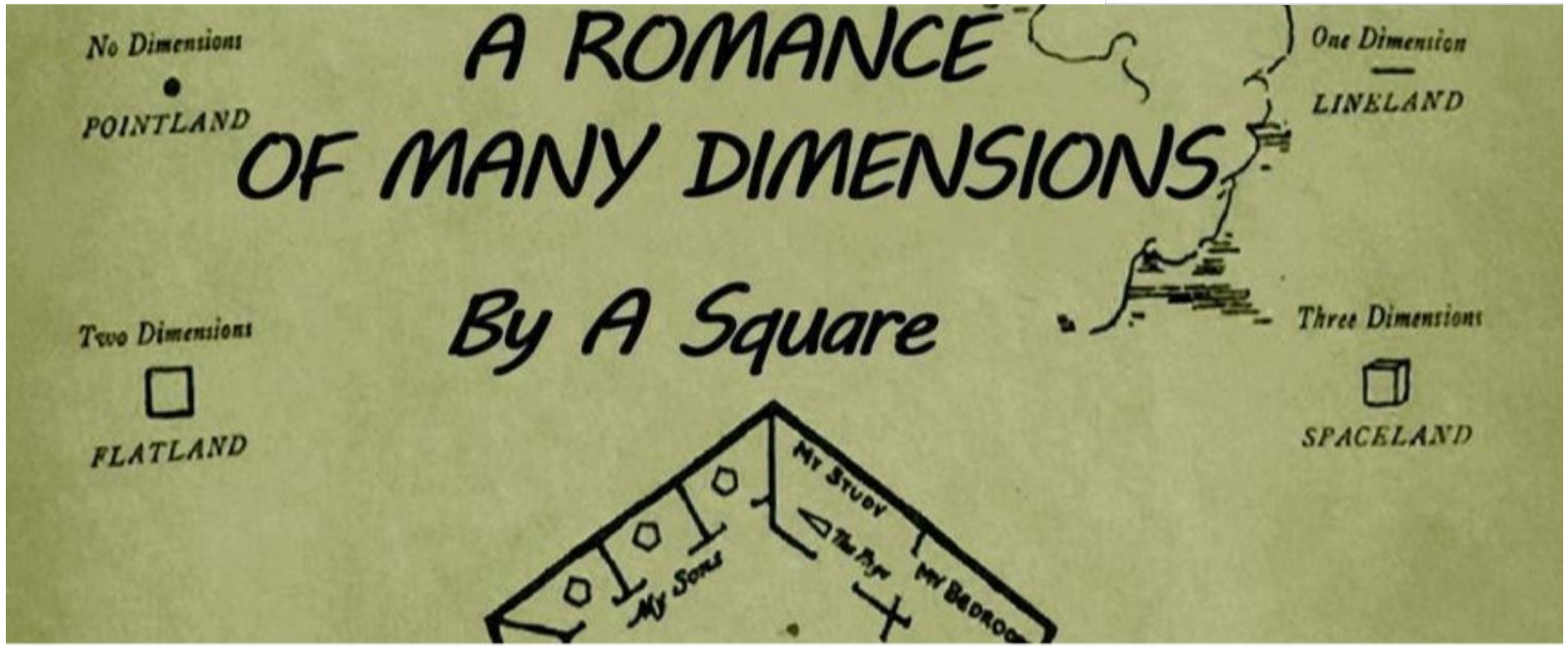
- Easier to create unhindered and direct connections
- No surface impact on communities
- No environmental impact on the surface
- Rapid development of new layer of supplemental infrastructure
- Allowing new combinations that serve the modern needs of the city

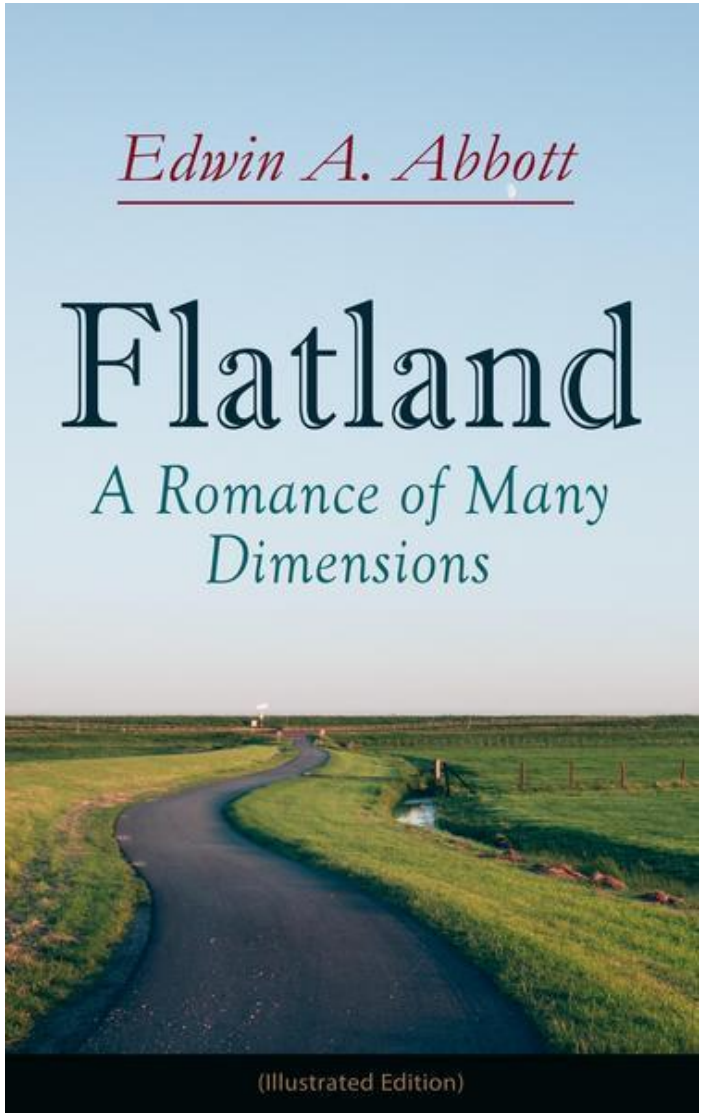
Urban underground future



Flatland
A Romance of Many Dimensions (by a Square)
Edwin A. Abbott

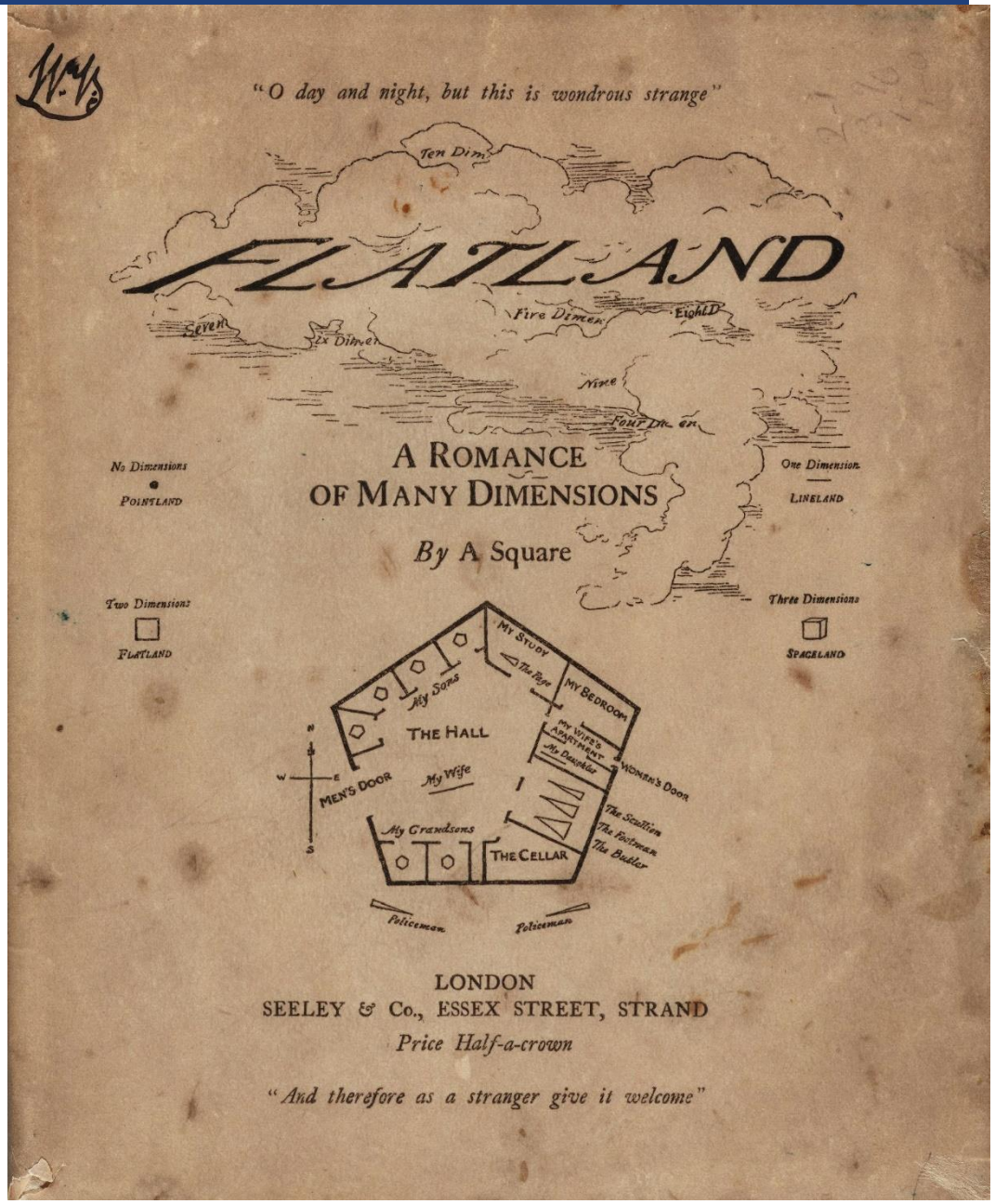






Volumetric Planning of the Subsurface

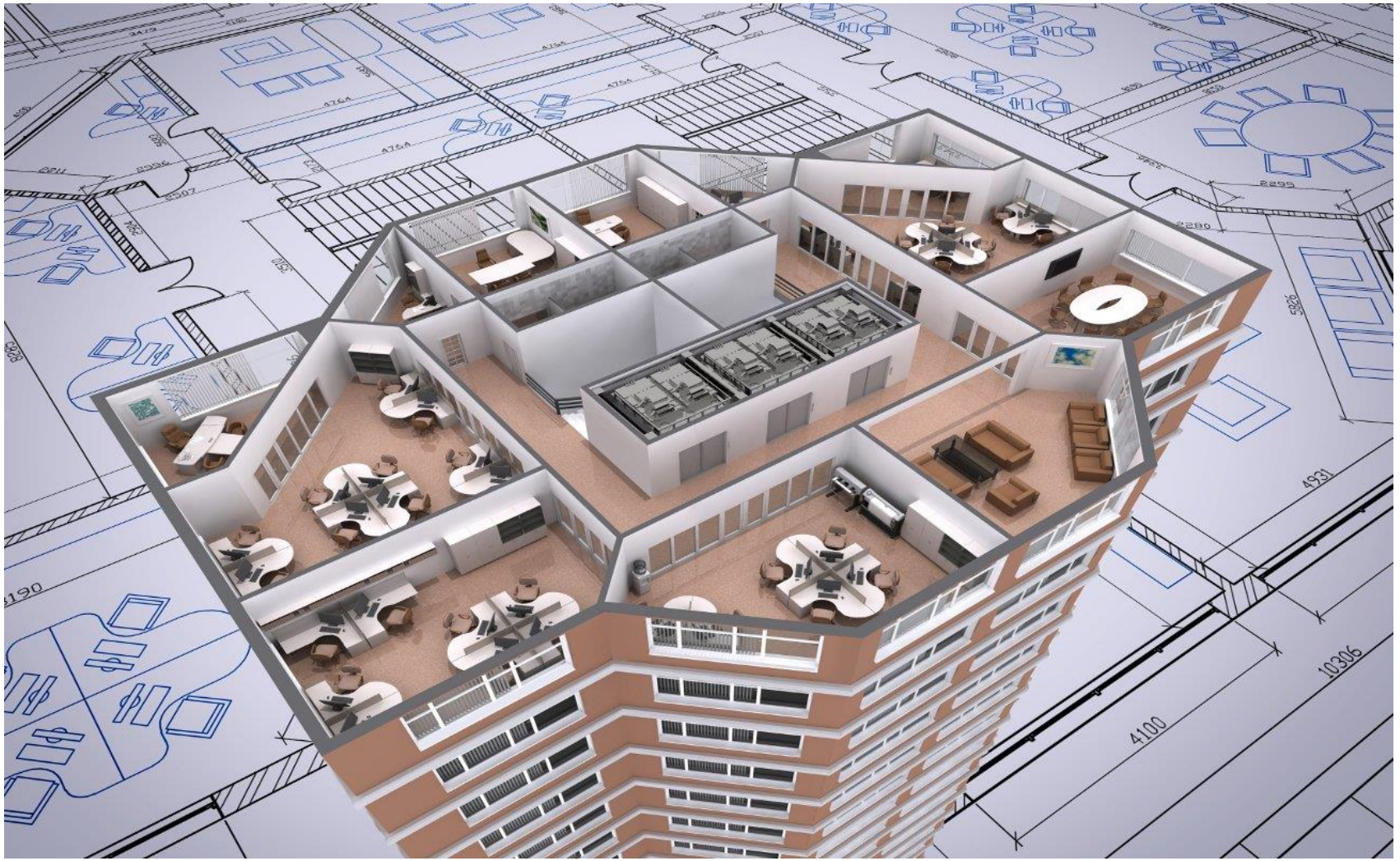
- Our high-density cities grow upward and downward, a flatland approach only considering the horizontal no longer suffices
- Architects/Engineers/Geographers move towards volumetric approach to have better differentiation between height and depth
- Underground space planning calls for a volumetric approach which includes thinking in layers
- Move from Flatland to Spaceland



From : "Multi-Dimensional Planning Approach (MDPA) - Towards a New Rationale to Planning And Visualising Underground Spaces as Part of the Urban Metabolism" (in press)
Han Admiraal, Antonia Cornaro

Volumetric Planning of the Subsurface

3D visualisation as opposed to the traditional 2D approach of the urban fabric is needed



Flatland

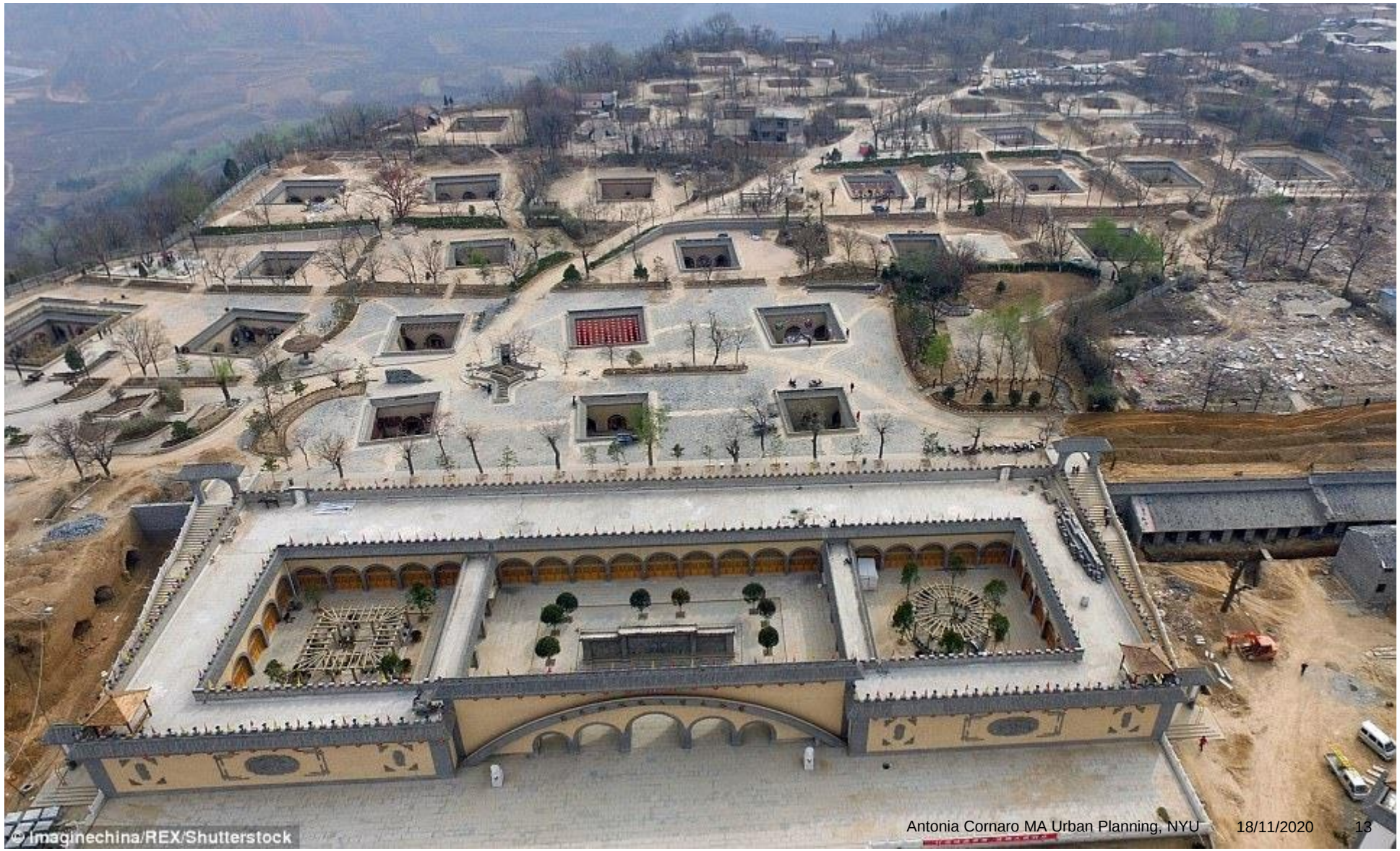
- Abbott (1884) in his novel ‘Flatland’ describes what it would be like to live in a 2D world.
- The existing paradigm, which consists of extending surface planning practice downwards, isn’t working. The overarching reason for this is that underground space planning calls for a volumetric approach which includes thinking in layers.
- The world he describes is a far cry from how we observe our physical world. In the same way we propose that planning of the subsurface is radically different from how we have been planning our cities up to now.
- To adequately plan underground space, a first step is to move from Flatland to Spaceland from a 2D area-oriented approach, to a 3D volumetric oriented approach.

The role of geology

Surface: buildings are surrounded by air

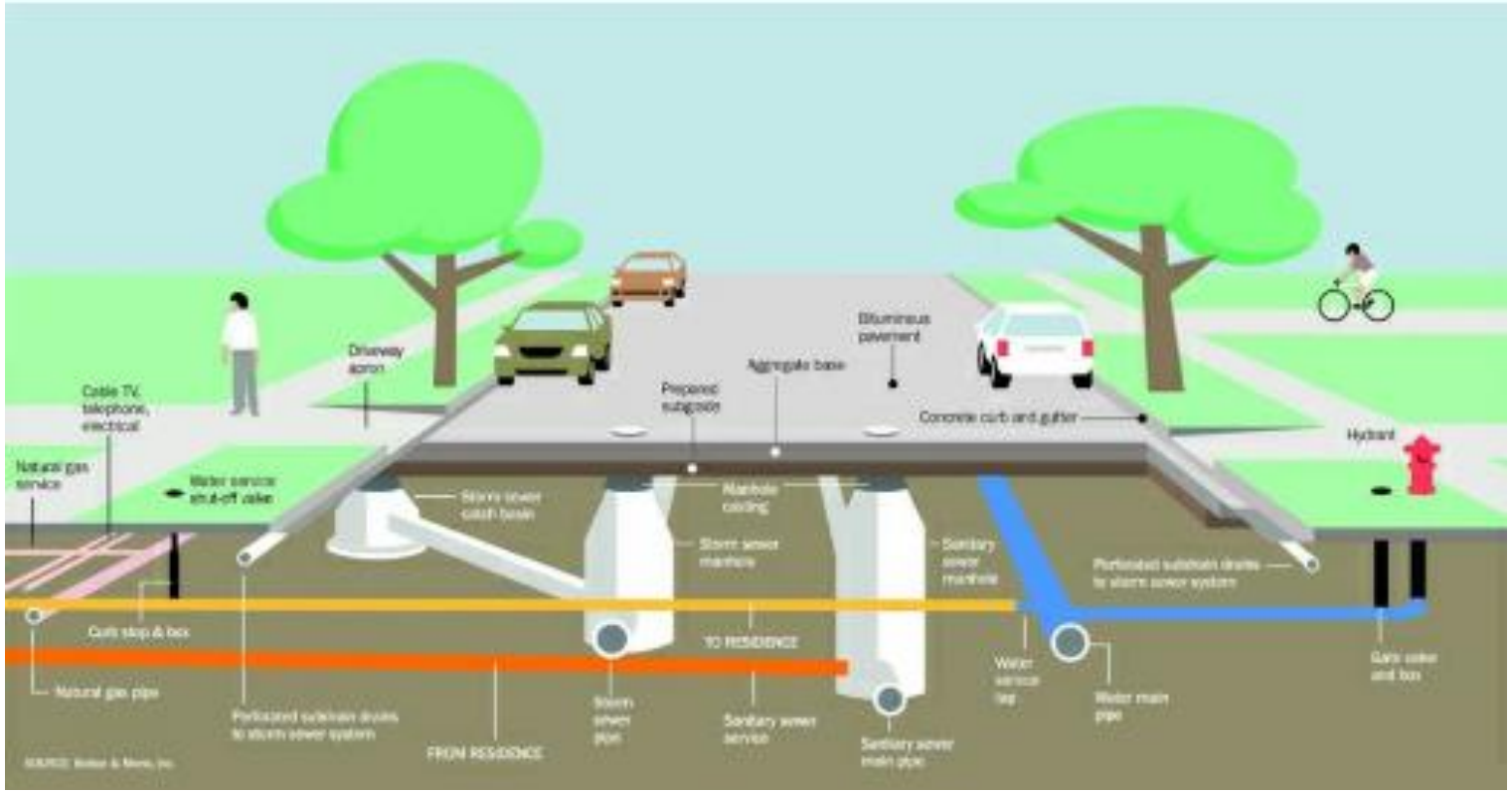
Below the surface: buildings are contained inside the earth – they become part of the subterranean.

Planning approach: Geology is single most important factor.



Volumetric Planning of the Subsurface

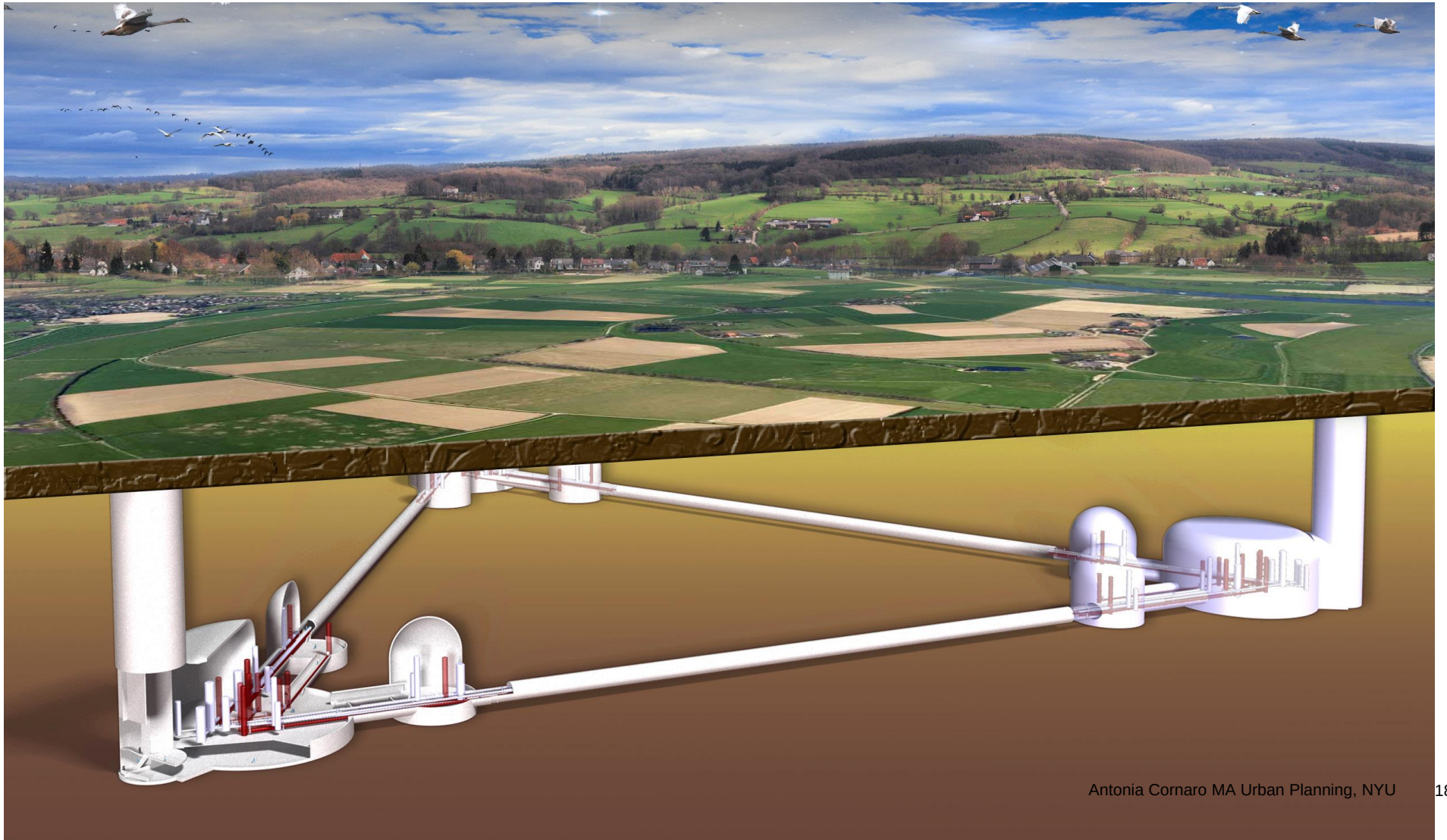
- A multi-dimensional approach, which includes geology and time as parameters, must be used to fully understand the opportunities and challenges the subsurface brings to cities.
- This approach is necessary to allow development of underground spaces and to assess the role of the subsurface in urban resilience.



Volumetric Planning of the Subsurface

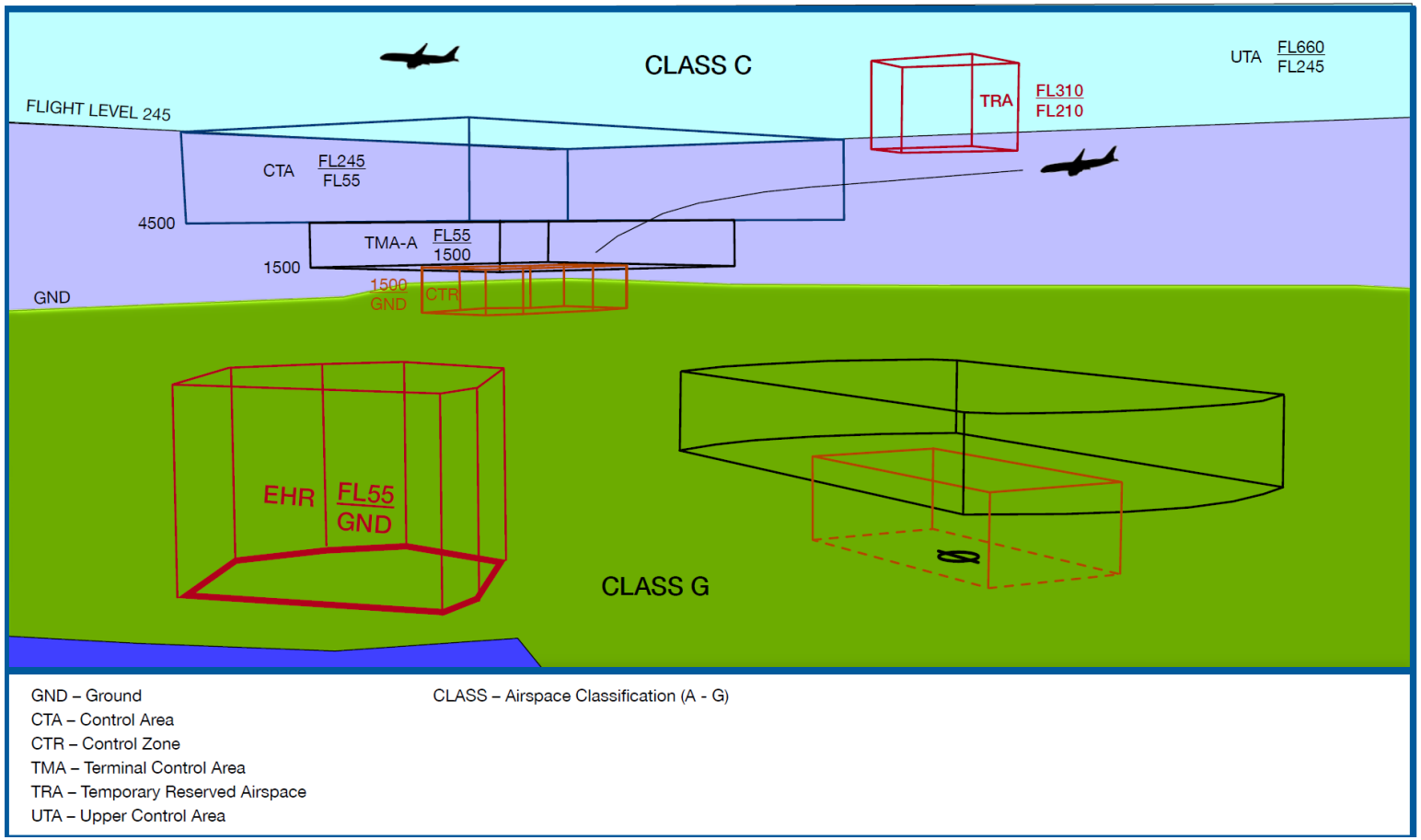
Instruments to visualise and analyse 3D: BIM and GIS

Technology to visualize underground space is widely available



Planning of air space
Planning of underground space

- New paradigm needed for planning of underground space
- Could AIR SPACE serve as a basis for a new methodology for underground space planning?



The need for data- Planning of Underground Space

- Data on geology and soil composition necessary to plan and construct underground
- Cultural heritage archives, archaeology
- Existing or future planned projects in the subsurface
- Data needs to be acquired, stored digitally and made available by combining it in 3D models to support urban planning

Chaos in the Swiss subsurface

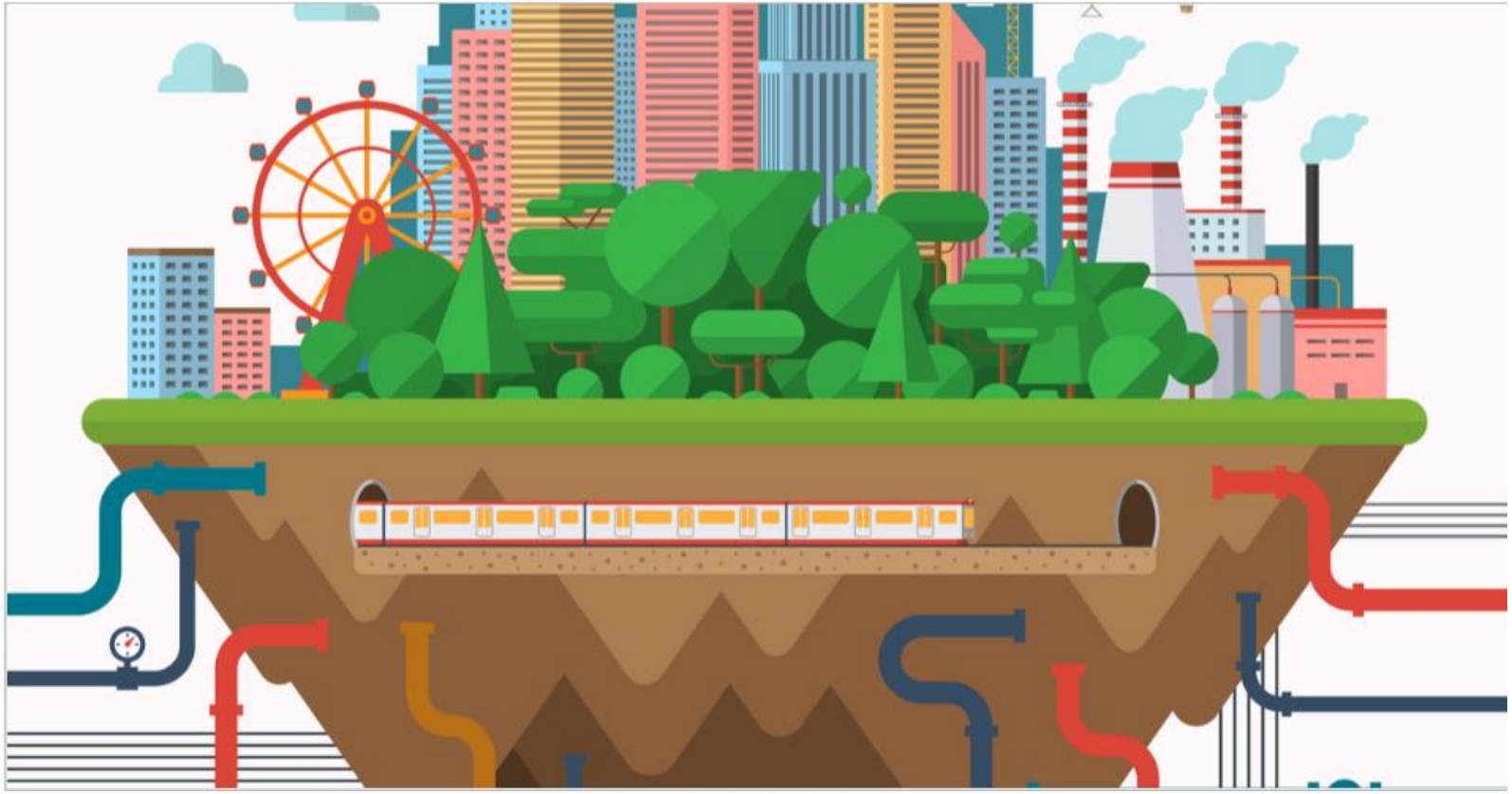
« Im Schweizer Untergrund herrscht das Chaos

Der Bund plant eine verlässliche Dokumentation über Leitungen im Boden. Experten finden, dass das bitter nötig sei. »

- The Swiss government is planning a reliable documentation of pipes and cables in the underground
- 550’000 km network
- Swiss topo: “It is time to produce knowledge”

(Tagblatt 15.7.2019)

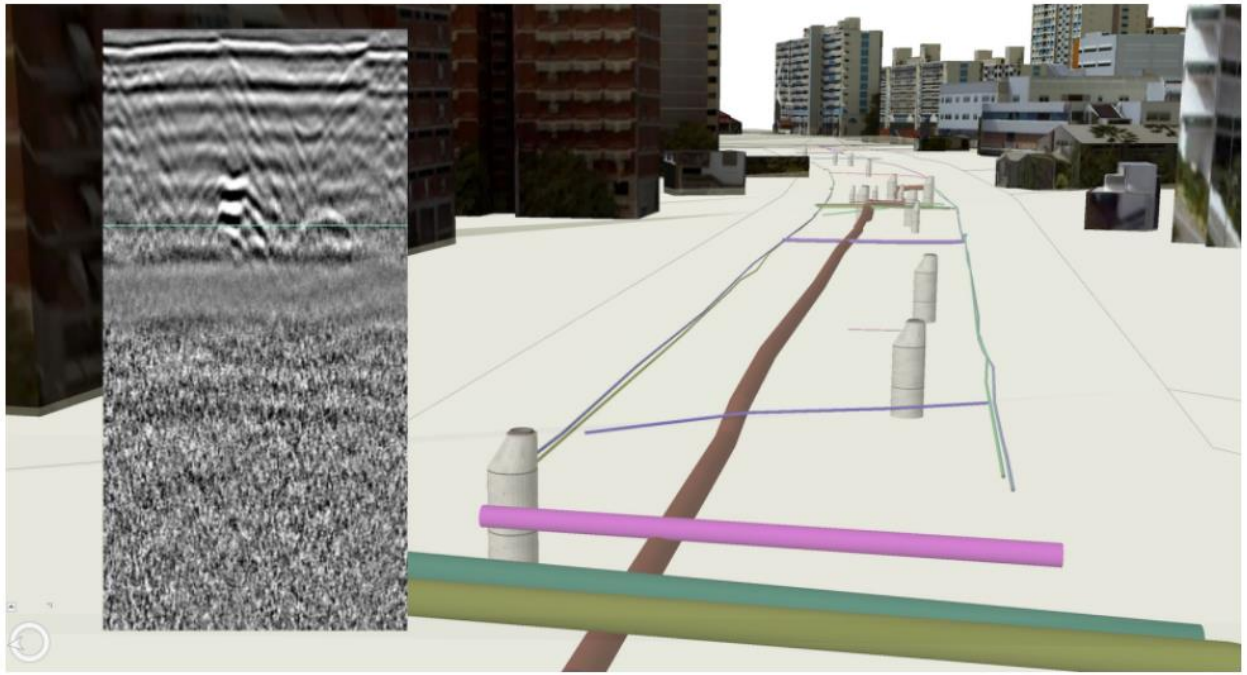
National Underground Assets Register Pilots (NUAR)- what exactly is beneath the ground?



- The Geospatial Commission launched the **National Underground Assets Register** Pilots, to make it easier to find out what exactly is beneath the ground.
- Did you know... that there are 1.5 million kilometres of underground services in the UK all working hard to keep our country supplied with water, gas and electricity?!
- All assets are run by different companies/owners

Singapore-ETH Centre - Digital Underground

DIGITAL UNDERGROUND

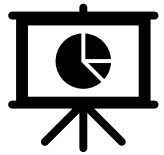


- Reliable information of the underground is essential for the planning, administration and development of underground space.
- The Digital Underground project is a collaboration between Singapore Land Authority and the Singapore-ETH Centre.
- It is aimed at establishing an accurate, current, and complete map of subsurface utilities in Singapore.

The need for data

Acquisition of data

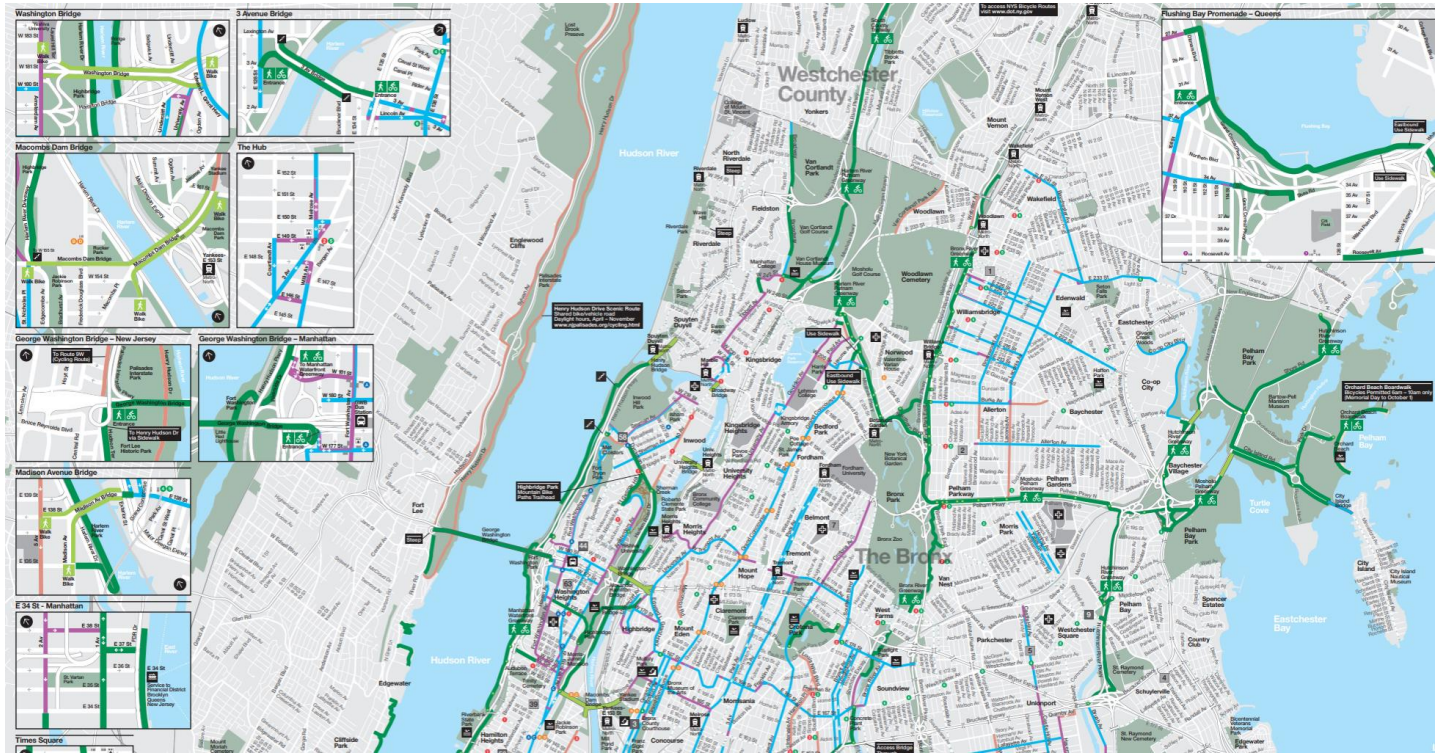
- Collaboration between public and private sectors- British Geological Survey and Glasgow city council
  → ASK Accessing Subsurface Knowledge
- Present all available and future data in urban 3D models
- Knowledge of the subsurface is key to deliver successful construction and regeneration projects
- Poor understanding of subsurface is considered key cause of project delay as well as overspending.



(book chapter 5.4)

Acquisition of data

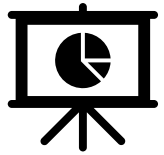
- Lacking knowledge of the ground conditions are main reason for time and cost delays
- Due to a lack of regulations for private developers, geologists struggle to develop these models
- No standard format
- High cost
- Lack of harmonisation and information obstacles to creating 3D models
- The devil is in the detail: Increase of data that needs to be stored and processes needed



The need for data

Urban planners' needs

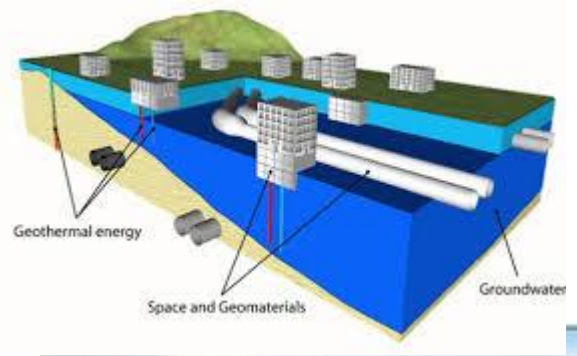
- Current concepts are driven by the needs of geologists and engineers
- Urban planners need access to information without the need of specific expertise in underground construction
- Simple user-friendly models

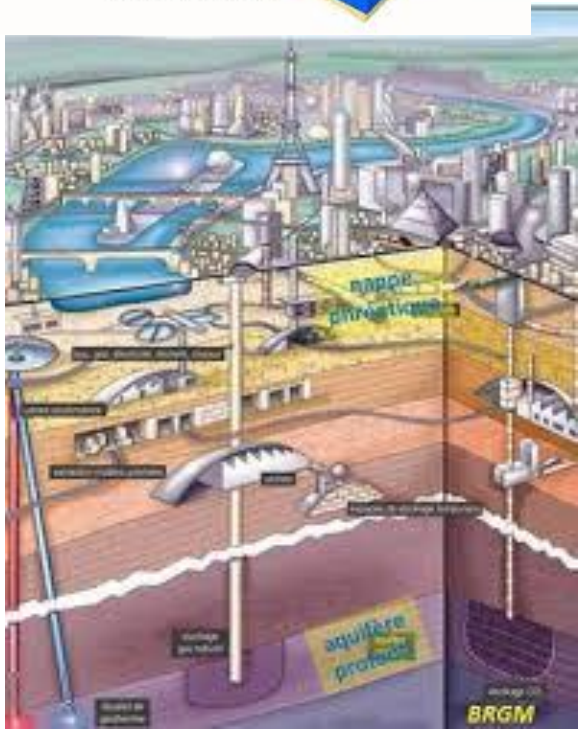


The need for data

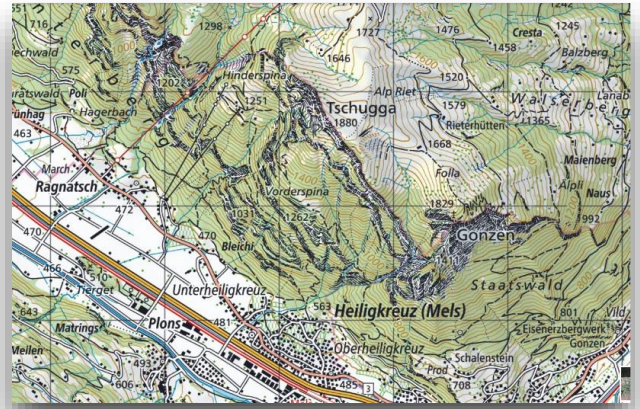
The Deep City Project

- At Ecole Polytechnique Fédérale of Lausanne EPFL: combines all information within the "Deep City Project"
- Decision framework based on the “resources to need" paradigm
- The Deep City project considers resource potentials prior to specific urban projects or plans.
- Mapping is central to the project and has been explored in several cities around the world.
- Uses available data, transforms it into maps, illustrating city wide opportunities
- Allows for an integrated method allowing surface and subsurface planning
- Considers the need for urban planners, engineers and geologists

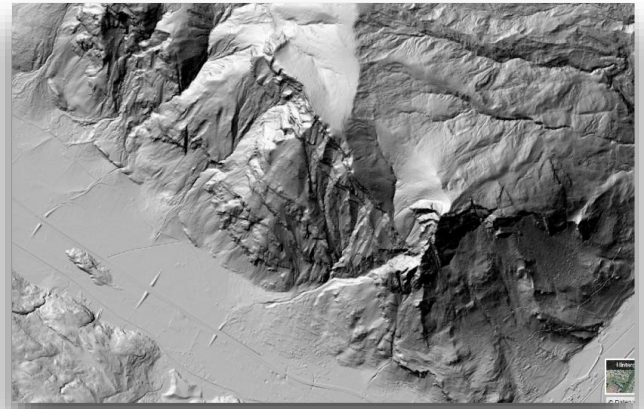




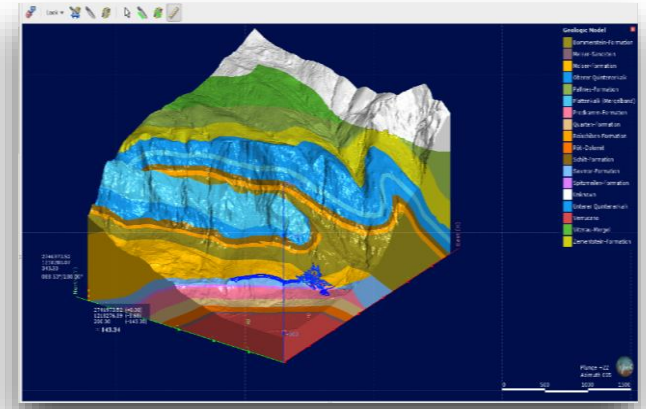
Use of various data sources



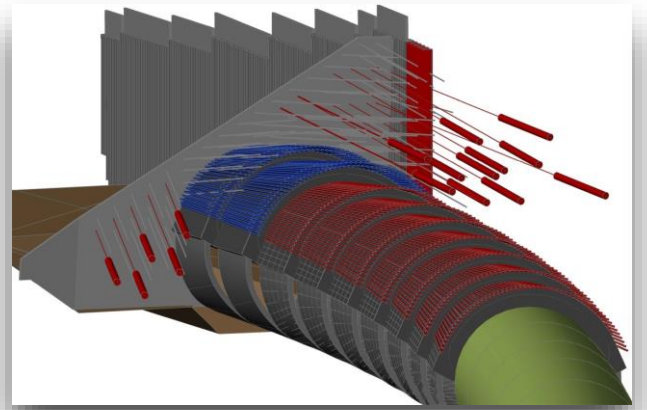
GIS



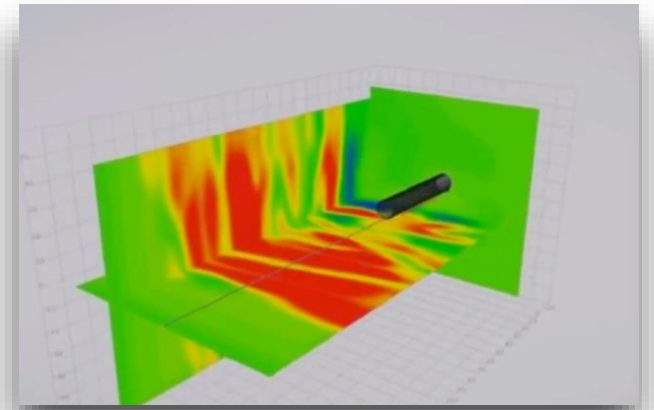
TOPOGRAPHY



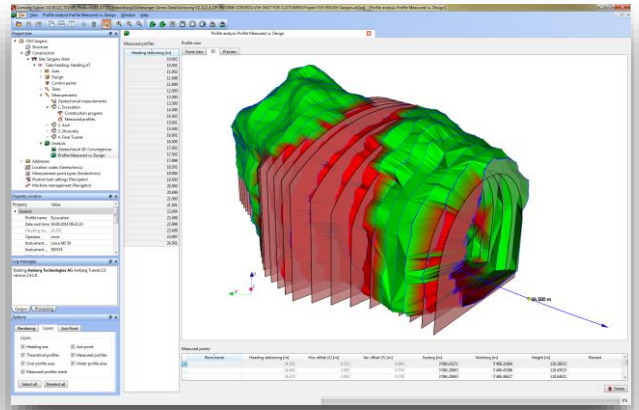
GEOLOGY



EXISTING MODELS

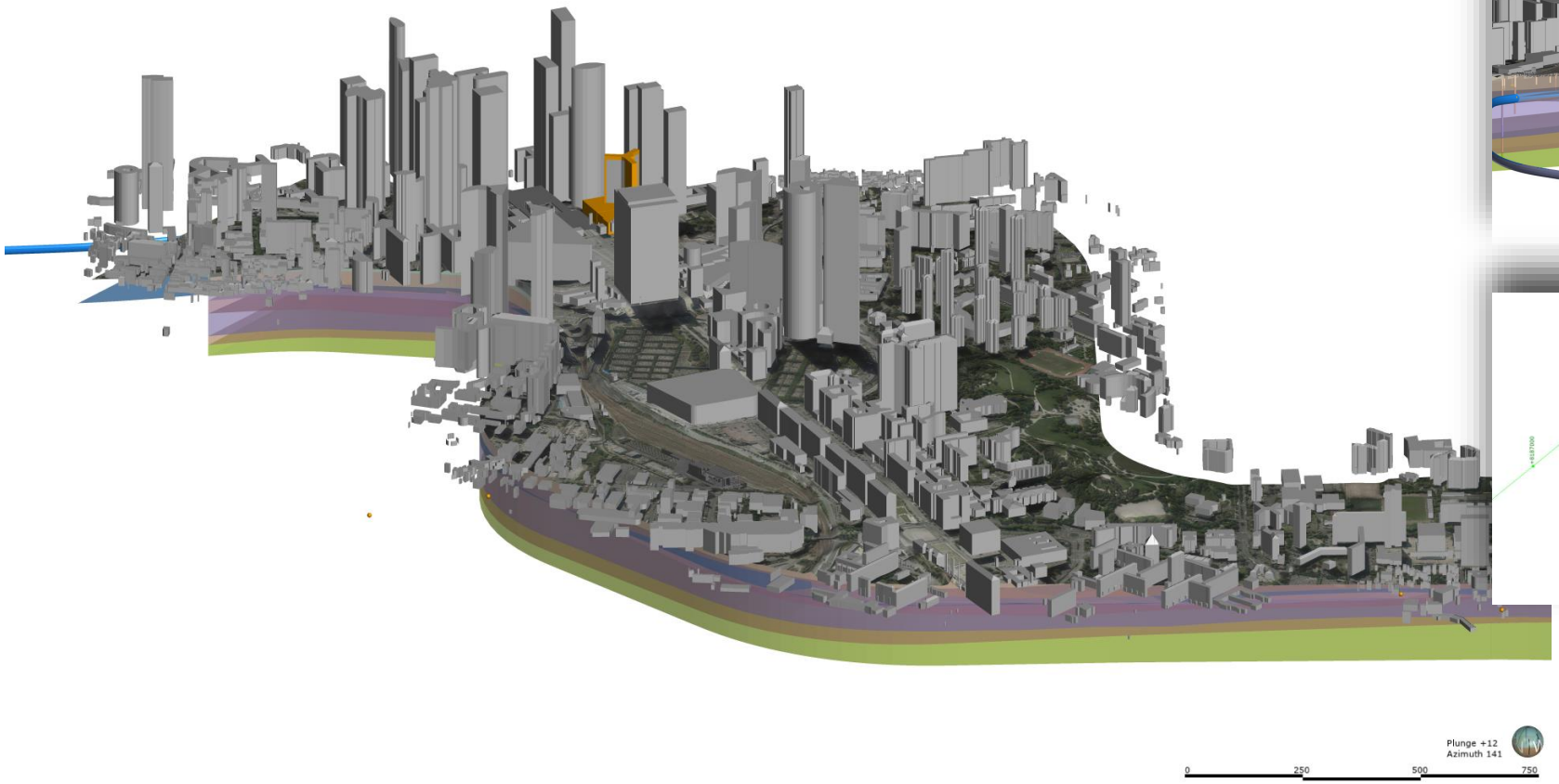


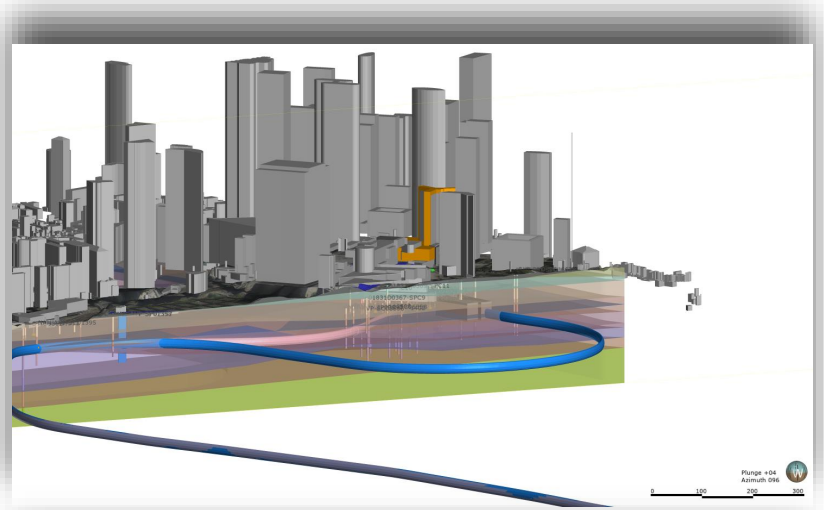
SEISMIC MODELS

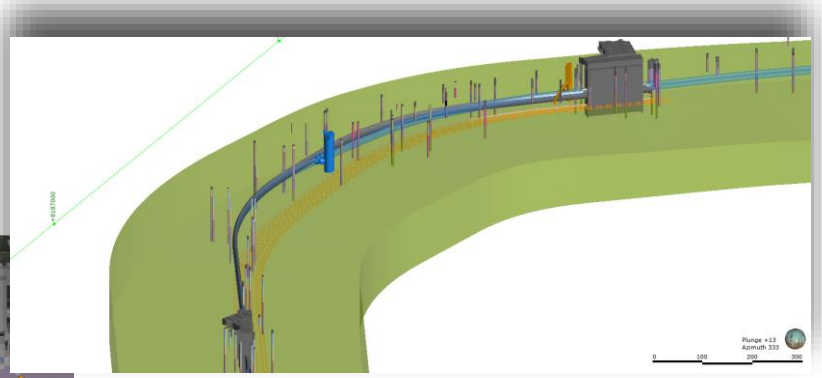


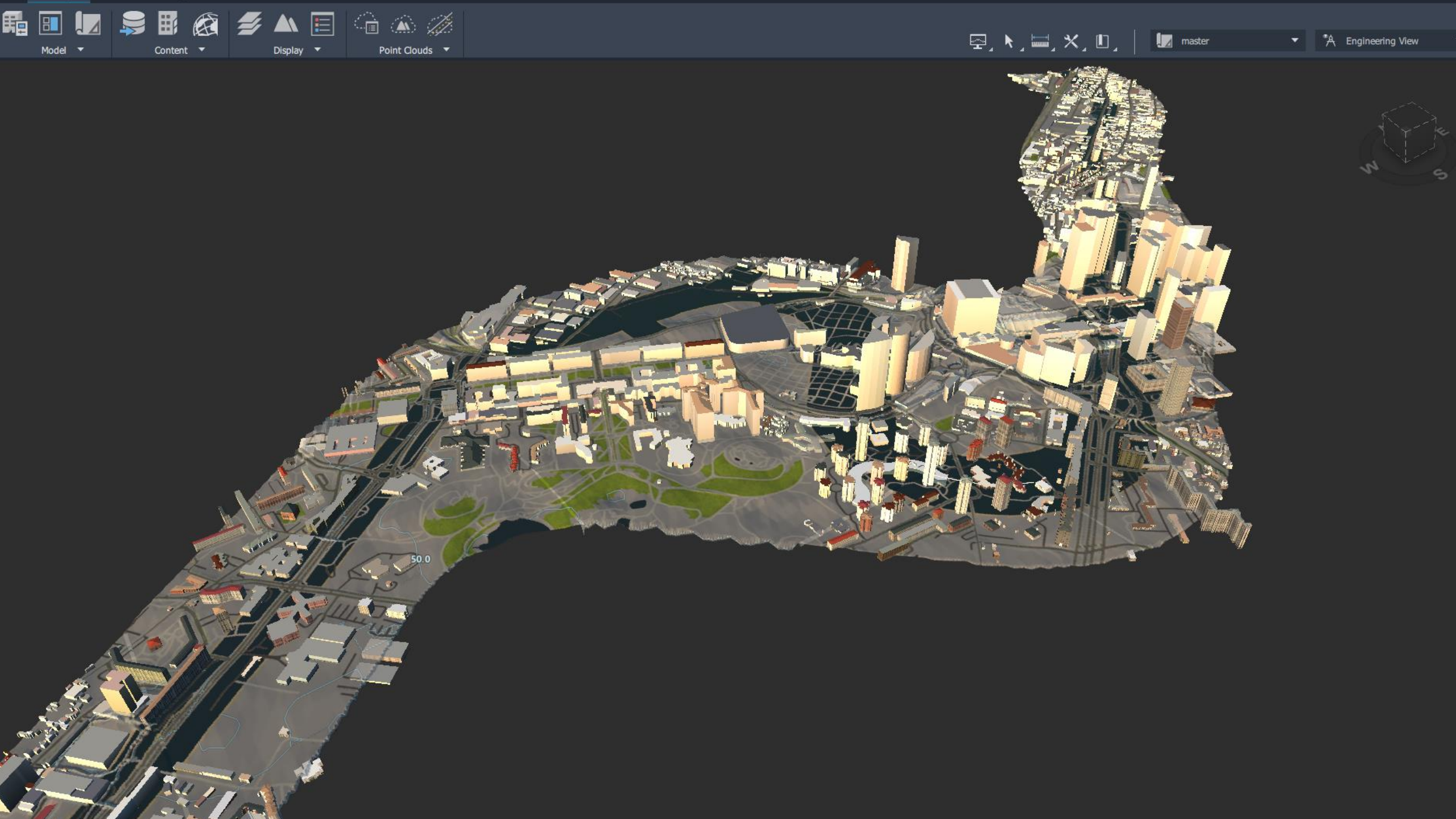
SCAN DATA

Multisource-insights

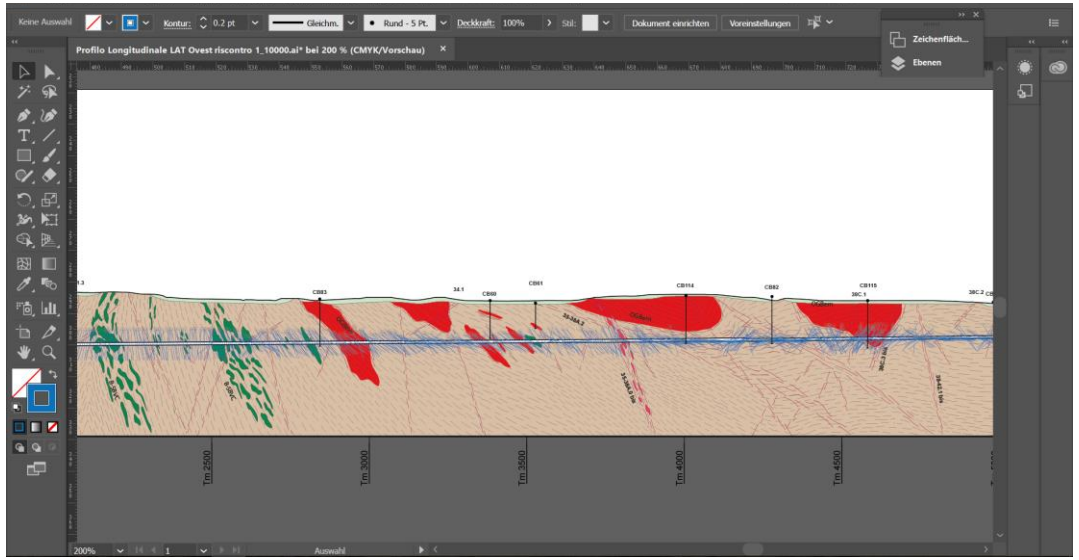


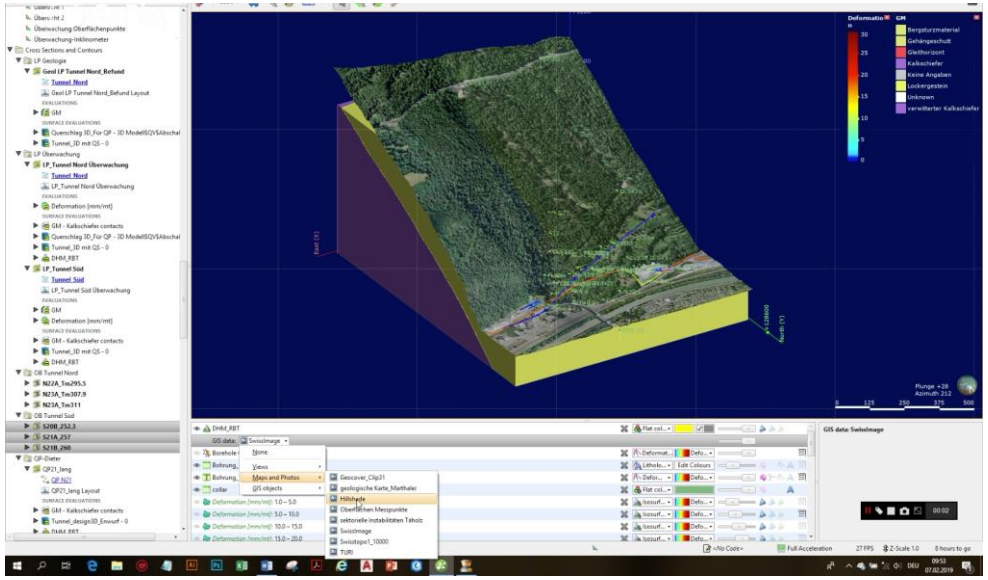





Model
Content
Display
Point Clouds
master
Engineering View
50.0

Geo-insights

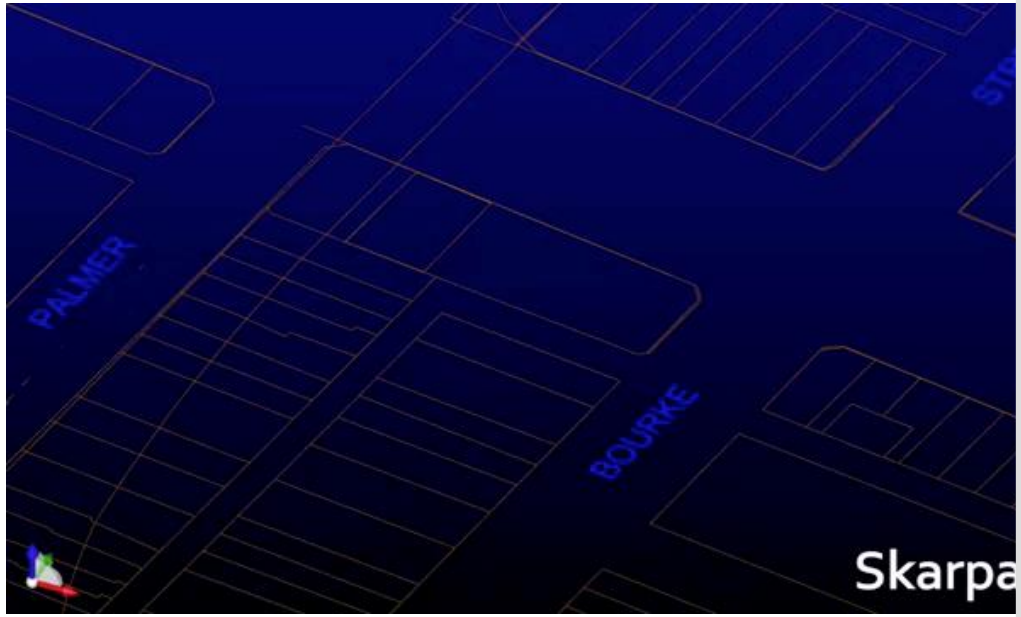


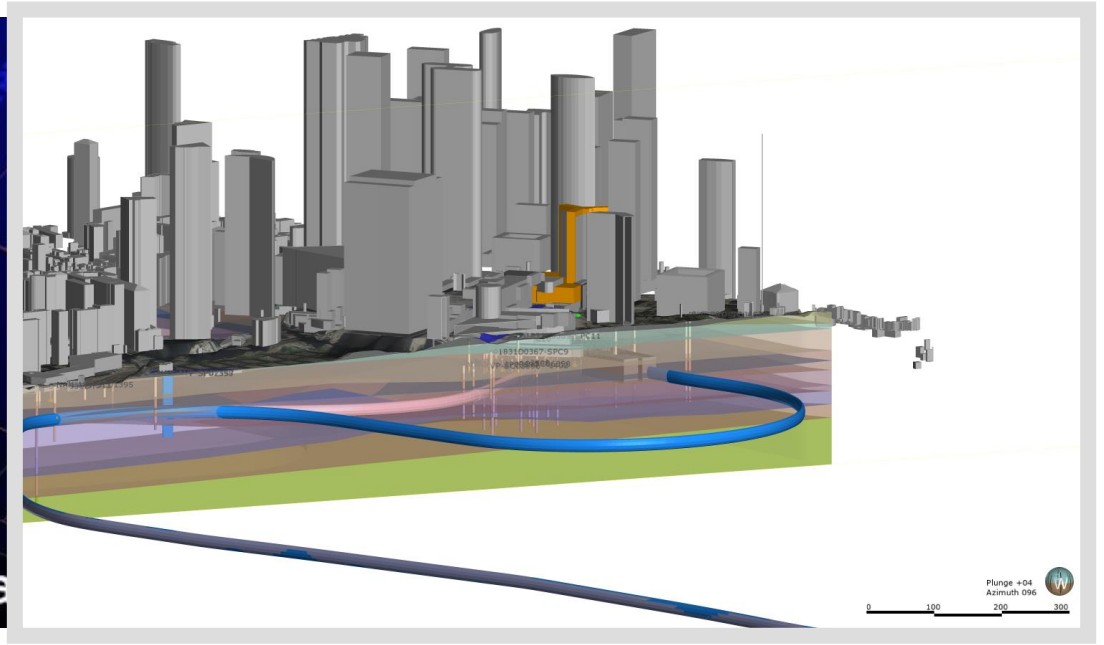


Ölberg Tunnel

Till now, geology was conveyed with explicit methods based on bore hole data and advance explorations as drawings. We are now creating models with much better predictive accuracy. All new findings are evaluated in real time and are immediately available to those involved as a model.

Beyond BIM: geology interdependent scheduling



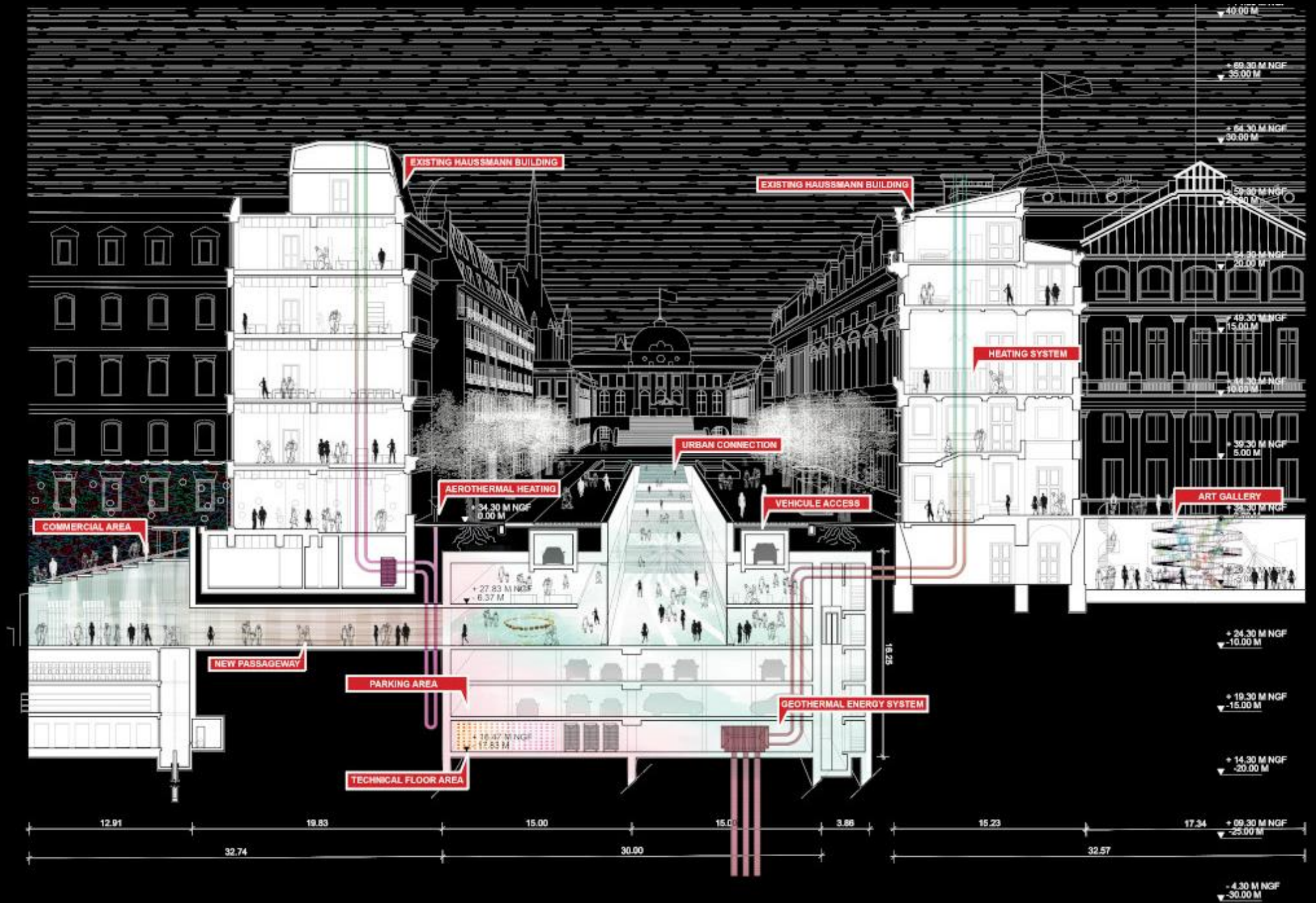


- The advance rate in tunnelling depends largely on the excavation method and the geology.
- The speed depends on both parameters and both influence each other.
- In heterogeneous environments, alternatives are difficult to assess.
- In our approach, geology impacts the time schedule and evaluates all available data.

Contemporary thinking on urban underground space - Future extensions of dense urban centres

- Densify the city without using up land
- "Open air Underground Space"
- Pedestrian passage close to surface with natural light
- Multiuse
  - Public Transport
  - Public Spaces
  - Shopping
  - Entertainment /art
  - Parking
  - Geothermal energy

Design by Dominique Perrault


EXISTING HAUSSMANN BUILDING
EXISTING HAUSSMANN BUILDING
HEATING SYSTEM
URBAN CONNECTION
AERODYNAMIC HEATING
+ 34.30 M NGF
0.00 M
VEHICULE ACCESS
ART GALLERY
COMMERCIAL AREA
+ 27.83 M NGF
- 6.37 M
NEW PASSAGEWAY
PARKING AREA
GEOTHERMAL ENERGY SYSTEM
TECHNICAL FLOOR AREA
16.25
+ 40.00 M
+ 69.30 M NGF
35.00 M
+ 64.30 M NGF
30.00 M
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32.57

IN CONCLUSION

- The future is out there, a large part of that future is still below the surface
- “Underground space offers as yet untapped potentials”
- Our job is to unveil what is hidden and visualise and map it
- Then using it for smart and sustainable city development by creating connectivity and combining uses
- Freeing up surface space to maintain the liveability of our cities
- Balancing urban development above, at and below the surface
- Visualising all that in 3D will make major steps in unveiling the City below the City and planning our cities in the future

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THANK YOU

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