UNIVERSITY OF TWENTE.

3D UNDERGROUND MODELLING

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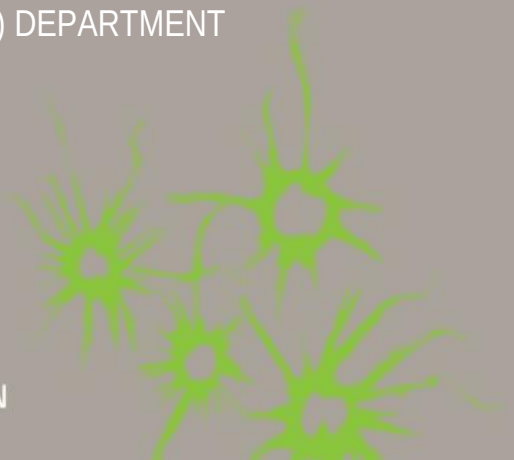
UNIVERSITY OF TWENTE

ITC FACULTY - DEPARTMENT OF URBAN AND REGIONAL PLANNING

AND GEO-INFORMATION MANAGEMENT (PGM) DEPARTMENT

ENSCHEDE, THE NETHERLANDS



ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

CONTENT

- Who we are / research focus

- Recent 3D modelling underground research

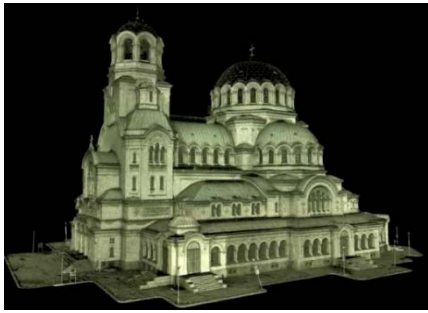
MILA KOEVA BACKGROUND

- MSc. degrees in Engineering (Geodesy) (UACG)
- PhD “3D modelling in architectural photogrammetry” (UACG)

http: //regtour.lovech.bg/

- ITC- EOS-Lecturer in Photogrammetry and RS
- ITC- PGM-Assistant Professor in

  3D Land Information



RESEARCH

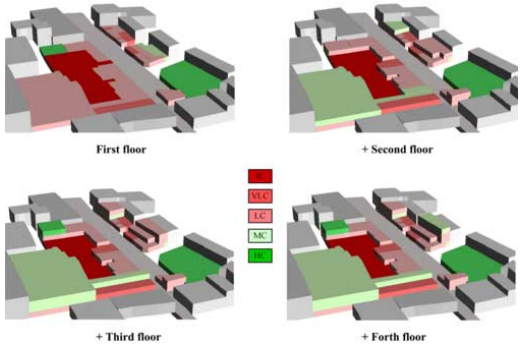
Research papers related with 3D:

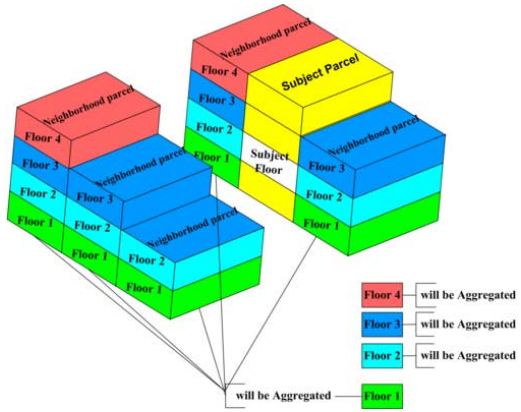
- **3D modelling and interactive web-based visualization** of cultural heritage objects (XXIII ISPRS Congress ISPRS)
- Integrating **spherical panoramas** and maps for visualization of cultural heritage objects using virtual reality technology. In: Sensors
- Investigation of **3D modelling techniques**.(GIM)
- Challenges for updating **3D cadastral objects** using LiDAR and image-based point clouds (FIG)
- Public participation using **3D city models**: e-participation opportunities in Kenya.(GIM)
- A global perspective on **3D cadastral development** (ISCAS)
- Transit-oriented development (TOD) assessment using **3D visualisation and modelling** (13 th Unrban planning conference)

- **3D modeling of underground space for urban planning and management – providing basic planning insight**

RICHARD SLIUZAS BACKGROUND

- MSc. ITC, Urban Surveys and Human Settlement Anslysis
- PhD UU Geographical Sciences – Informal settlement development and planning, Dar es Salaam, Tanzania





- ITC- PGM- Associate Professor Urban Planning – modelling (informal) urban development, planning, vulnerability and risk reduction, risk perception and public policy, resettlement policy.

URBAN PLANNING AND 3D GIS

UNISDR – Urban Planning Advisory Group

AESOP – Resilience and Risks Mitigation Strategies

Above ground:

- Compact city development: high density, mixed uses, externalities and risk management. (MILU Project, Istanbul, Tehran, Dar es Salaam)

Underground:

- Critical infrastructures and risk reduction – planning, design and construction, multi-functional use in hazardous situations CHARIM.NET
- Sub-surface characteristics > land use and construction impacts
  – Rotterdam, Manila and Jakarta

TITLE

3D modeling of underground space for urban planning and management – providing basic planning insight

Maryam Ghodsvali

GENERAL OBJECTIVE

To develop an integrated 3D model of subsurface/surface conditions and their interactions to support communication and knowledge exchange between planners and subsurface specialists.

3D modeling of underground space for urban planning and management – providing basic planning insight

Figure 5: Foundation Types in Bloemhof
Source: Municipality of Rotterdam, July 2017

Figure 6: Groundwater level in Bloemhof
Source: Municipality of Rotterdam, July 2017

Figure 7: A cracked building in Bloemhof
Source: Private photo by the author, 20 July 2017

Figure 8: A collapsed building in Bloemhof
Source: Private photo by the author, 20 July 2017

ITC

DONE; Overview

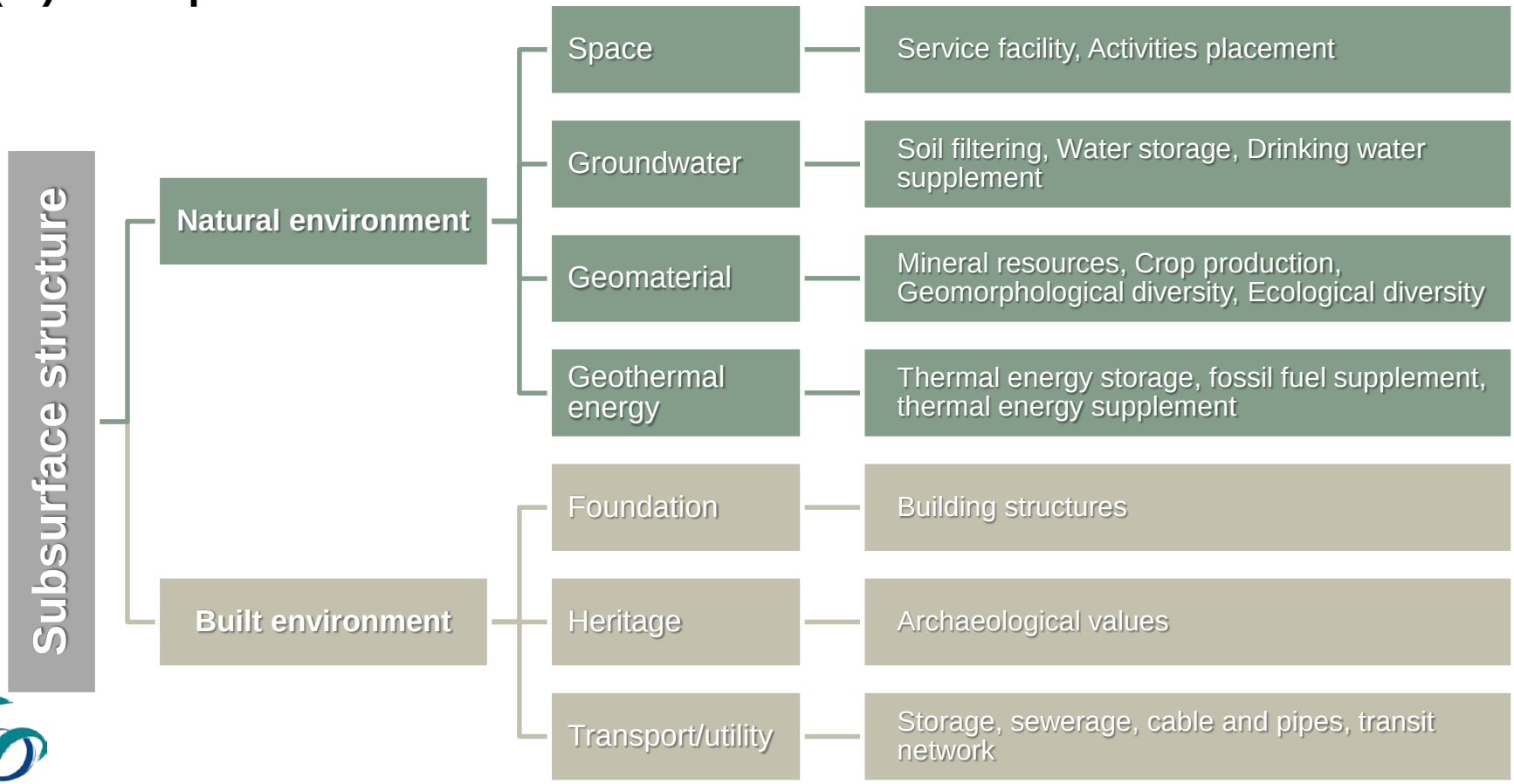
Concept	Sub-objective	Question
Awareness	Surface/subsurface interactions	Characterising subsurface components
		Understanding surface/subsurface connections
Connection	Demand-driven knowledge exchange	Identifying specialised urban need information
		Relating corresponding information
		Exploring quality specifications for data
Interaction	Information transformation	Harmonising/categorising information regarding urban needs
		Assessing the effectiveness of transformed data
Integration	Integrated 3D modeling	Exploring the existing 3D modeling methods
		Designating an integrated 3D modeling method
	Model validation	Evaluating model effectiveness
		Validating the model
		Maintenance procedure

DONE; First sub-objective Surface/subsurface interactions

Research questions:

1. *What are the types and characteristics of subsurface structures (i.e. natural and artificial)?*

Characteristics of subsurface structure and its contribution to urban (re)development.



DONE; Second sub-objective Demand-driven knowledge exchange

Research questions:

1. *What types of surface/subsurface information are required for urban planners and subsurface specialists to develop an integrated (re)development plan?*

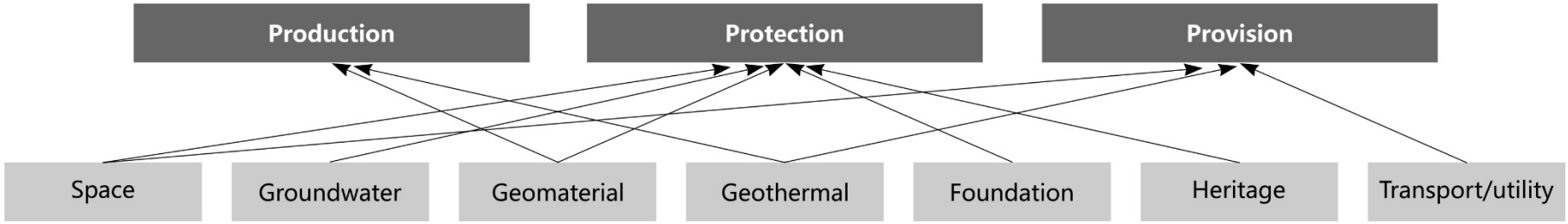
5 expert interviews

Primary theme	*Sub-theme*	*Weight*	
Geological structure	Condition of soil layers	12.8%	**25.6%**
	Soil quality	5.1%	
	Soil penetration	7.7%	
Heavy construction development	Foundation	7.7%	**18.0%**
	Building density	10.3%	
Greenery	Green spaces	12.8%	**12.8%**
Hydrological challenges	Water infiltration	12.8%	**43.6%**
	Surface water flooding	***20.5%***	
	Groundwater discharge	10.3%	

DONE; Second sub-objective Demand-driven knowledge exchange

Research questions:

2. *How to relate corresponding surface and subsurface information?*



Subsurface solution

Protection; supply inventory

Provision; demand targeting

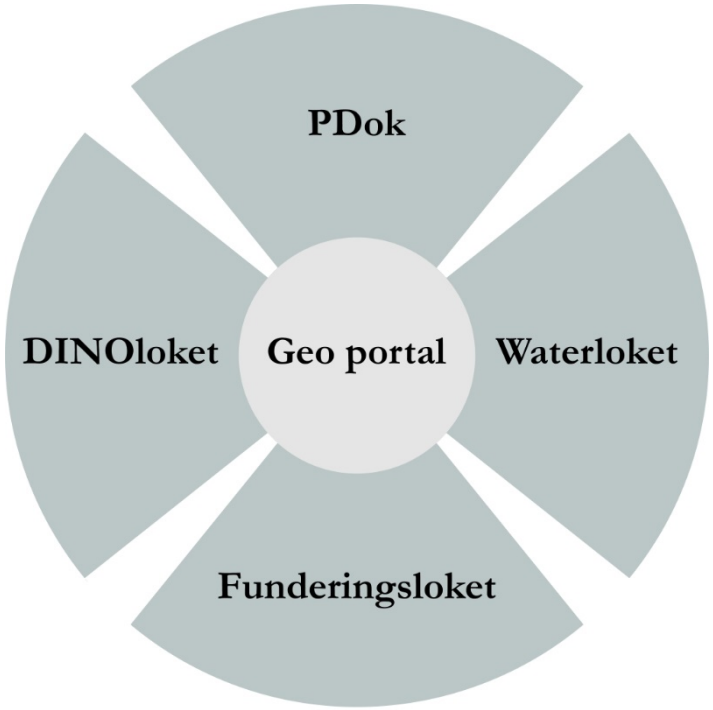
Environmental issue, with social and economic impacts

Urban problem

DONE; Second sub-objective Demand-driven knowledge exchange

Research questions:

3. *What are the quality specifications for required data?*



Data consistency across time ← Date of production

Data collection method → **Measurement certainty**

Data interpretation ← Producer of data; specialisation

DONE; Third sub-objective Information transformation

Research questions:

1. *How to harmonise and categorise surface/subsurface data across urban need aspects?*

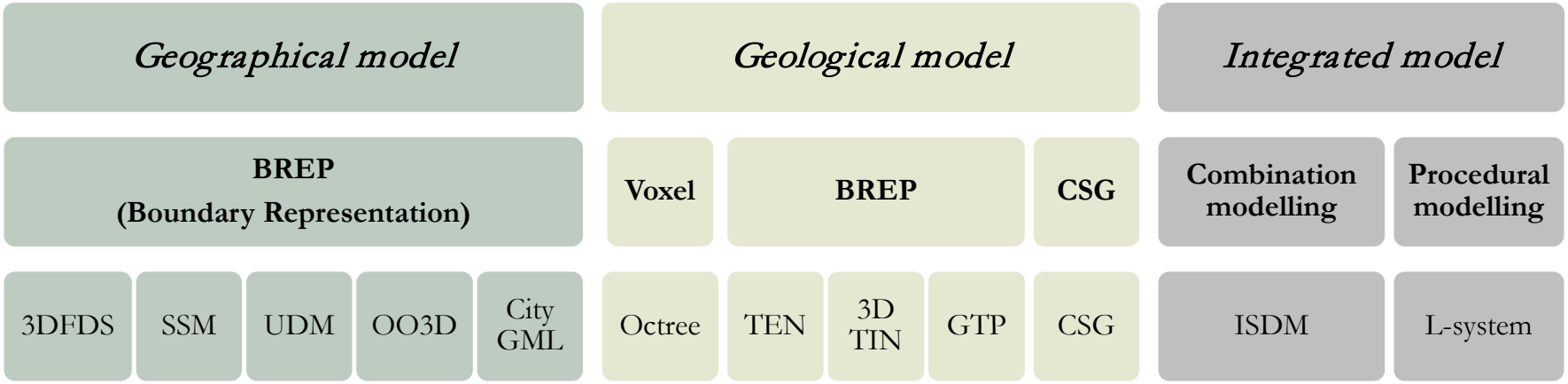
Data harmonisation

Unit	Spatial unit of data	Generation of square-based tessellation
Scale	Range of values	Data normalisation; linear and decay
Projection	Coordinate system	The Netherlands local projection; RD_new
Format	Type of data	Assigning values to square-based grids

DONE; Fourth sub-objective Integrated 3D modelling

Research questions:

1. *What are the existing methods to develop a 3D surface/subsurface model?*



Geographical (surface structure) and geological (subsurface structure) – are the main types of 3D modelling

DONE; Fourth sub-objective Integrated 3D modelling

Research questions:

2. *What is the most suitable method to have high interoperability level among data?*

Procedural modelling method; L-system

3 D M O D E L L I N G M E T H O D C O M P A R I S O N

Comparison Factor	Comparison Dimension	Comparison Indicator
Level of Detail	Attributes of objects	Level of detailed information
	Multi-value objects	Model base
	Storage capacity	Data size
Visual Efficiency	Simplicity of models concepts	Primitive objects/elements
	Adjacency of spatial objects	Geometry objects/elements
	Integration of separate models	Main using idea
Understandability Level	Complexity of spatial objects	Spatial structure
	Spatially assign of new information	Position query

TO DO; Fourth sub-objective Integrated 3D modelling

Research questions:

2. *What is the most suitable method to have high interoperability level among data?*

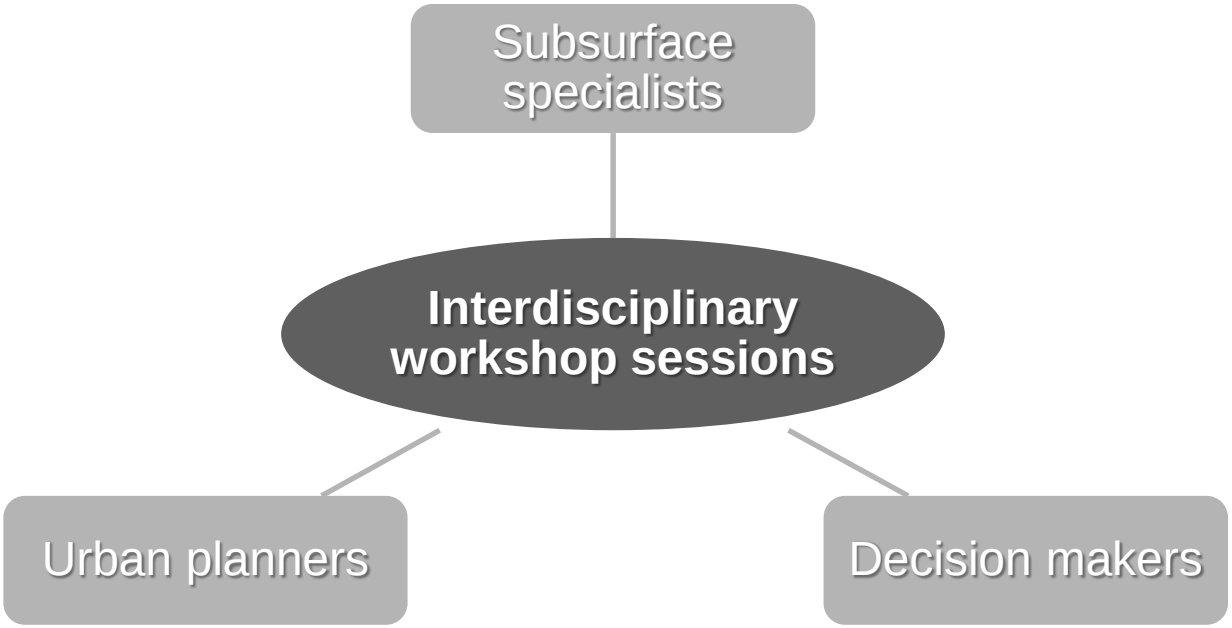
This study develops an integrated 3D model based on procedural L-system 3D modelling method using CGA (Comp. generated architecture) shape grammar.

Stage		ArcGIS Pro	CityEngine
Procedural geometry	2D to 3D procedural engine	Yes	Yes
	Interactive design tool (Dynamic reports, handles, local edits, etc.)	No	Yes
	Rule authoring	No	Yes
	Dynamic 3D streets and blocks	No	Yes
3D data types	BIM import	Partly	Partly
	Multi-patch editing	No	Yes
	3D export	No	Yes
3D visualisation	Scales	Global and local	Local
	Rendering	Streaming, adaptive	In-memory
	Animation	Yes	No
	Analysis	Yes	No

TO DO; Fifth sub-objective Model validation

Research questions:

1. *How does the model contribute to planners' and subsurface specialists' communications?*
2. *What are the strengths, weaknesses, opportunities, and threats of the model?*
3. *How to maintain the model?*



Participation of different countries

Organizer: the Municipality of Rotterdam

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THANK YOU FOR YOUR ATTENTION!