Photogrammetric methods of 3D-models generation

Victor Adrov
Managing Director
Racurs, Russia

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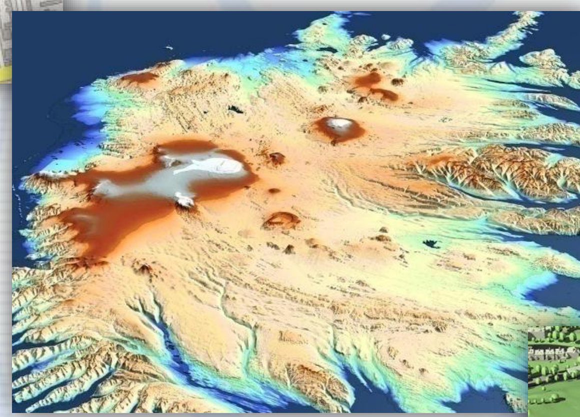
We live in three dimensions

2-dimensional representation

2.5-dimensional representation



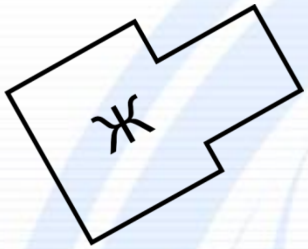
3-dimensional representation

3D topographic models:

- Geometric quality and accuracy of data
- Plausibility
- Completeness
- Up-to-date data
- Accurate photorealism
- Rich, real-time, comprehensive visibility
- Advanced analysis

Better representation of the reality

From 2D to 3D representation



From object geometric description to virtual reality

Building

Legal aspects

3D volume geometry

Facades

Relations

Behaviour

Topology

Property

3D model usage and creation challenges

The lack of standards and regulatory documents

- No strict definition and common understanding of the term "topographic 3D model".
- No stated requirements for the model contents.
- No stated requirements for the mathematical description of the models.
- No stated numerical and quality requirements for the output products.
- No stated requirements for the model generalization.
- No standard output data formats …

End-user problems

- Nowadays fewer and fewer end-users can read conventional 2D maps.
- Common lack of understanding how and why to use topographic 3D models.
- User inflexibility and unwillingness to adopt new conventions of data representation.
- No user-friendly software to handle 3D data.

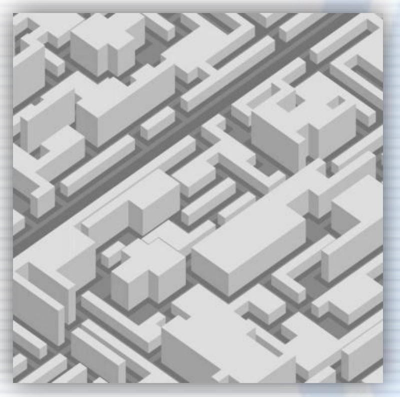
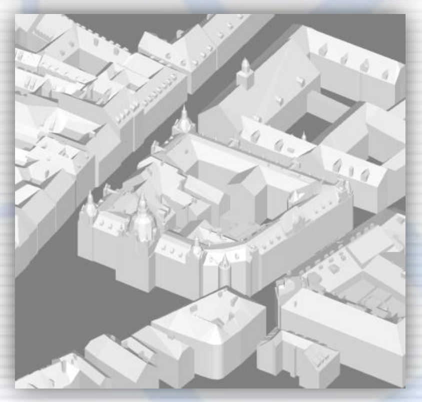
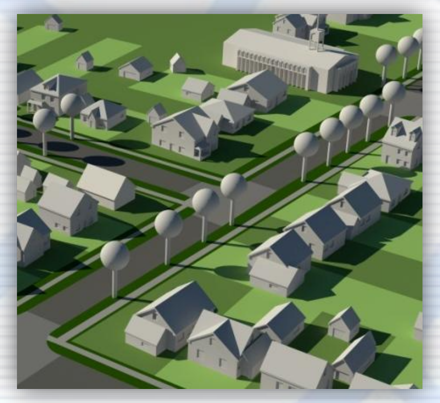
Computational problems

- Growing volumes of stored data.
- High performance requirements for the computational nodes.
- The lack of analytic and visualization mass-data tools.

Labor intensity

3D topographic models types

Levels of details

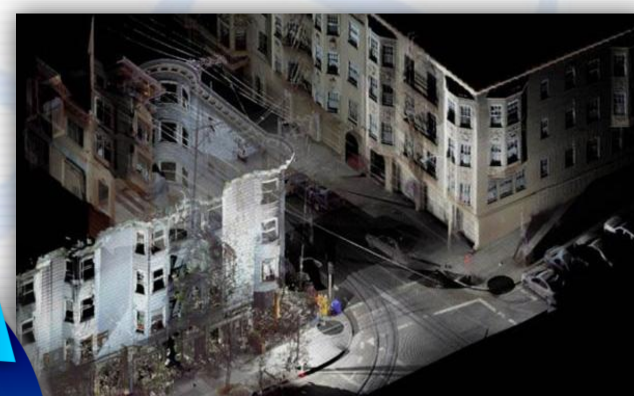
LOD 1	LOD 2	LOD 3
		
Buildings represented by block models	**Building models with standard roof structures**	**Detailed (architectural) building models**

Technologies

3D topographic models

2D to 3D Model Extrusion
LOD 1

Laser Scanning
LOD 1-4

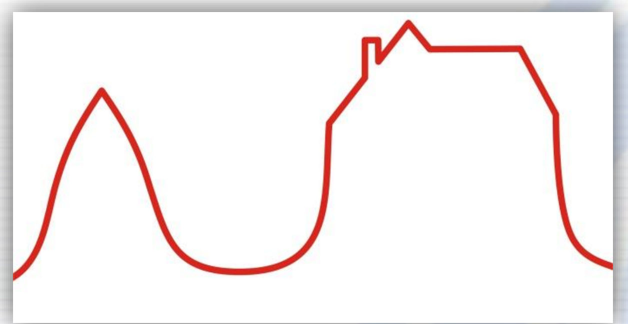


Photogrammetric technologies
LOD 1-4

Architectural 3D modelling
LOD 1-4

3D topographic models types

Continuous surface models (point clouds, dDSM)



Object-oriented (“separated”) models (DTM / DSM + vector objects)

Generation technology

- Full automation
- Semi-automatic or manual, including vectorization of point clouds

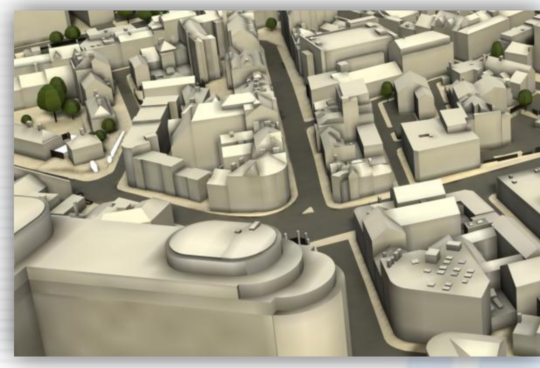
Application areas

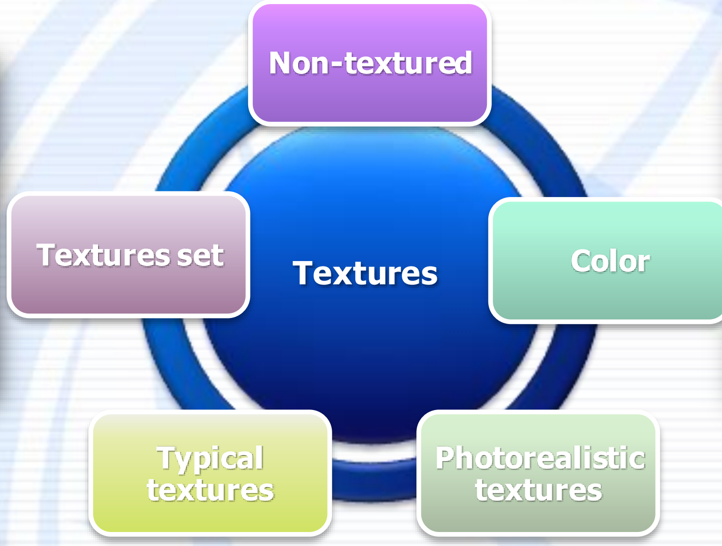
- Telecommunication engineering
- Natural disasters
- Landscape visualization
- Military operations planning
- Education

- 3D GIS + databases
- city and road planning
- Territory management
- Municipal improvements and landscaping

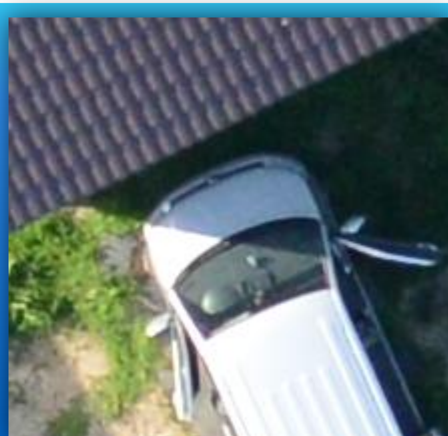
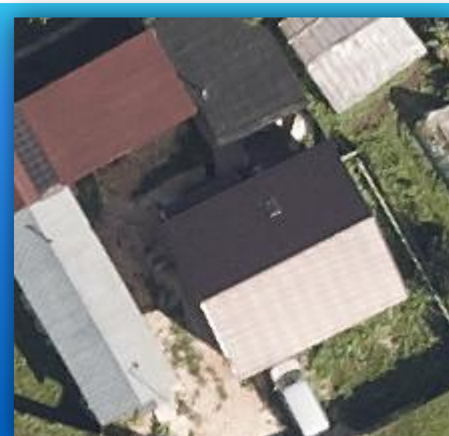
3D topographic models

Textured and non-textured models





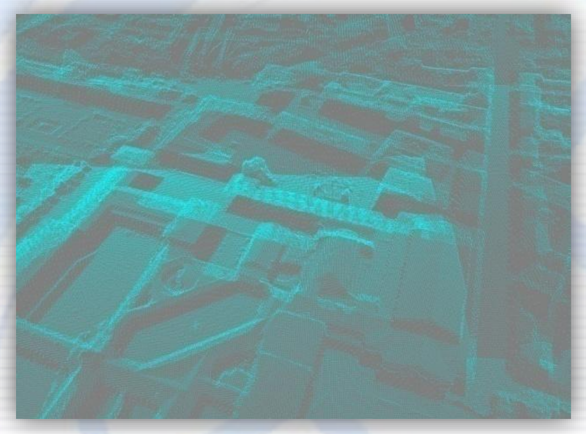
Source remote sensing data for 3D topographic modeling

	UAV images	Aerial photos	Satellite scanner images
Images to a 1:1 scale			
Accuracy	RMSE ~ 5 cm	RMSE ~ 5-50 cm	RMSE ~> 50 cm

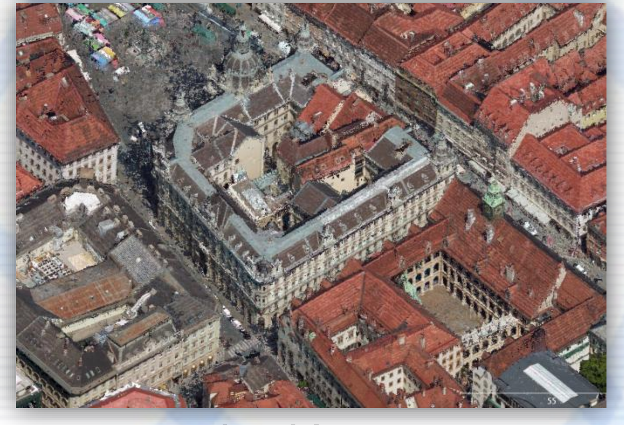
Photogrammetric technologies (DPW PHOTOMOD)

Dense Digital Surface Models (SGM)

Digital surface model

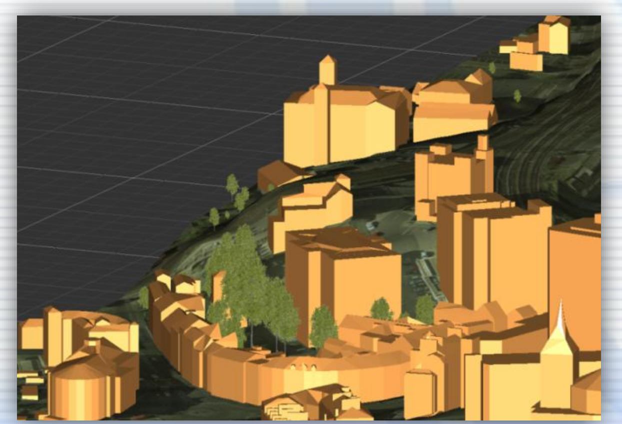


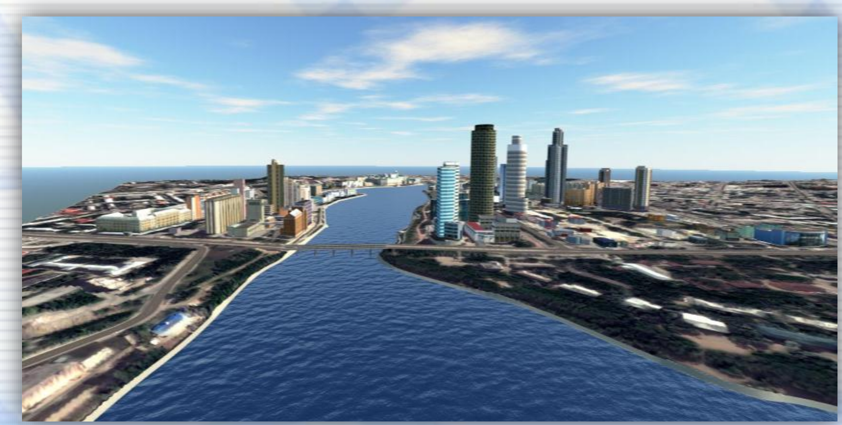
3D points cloud



3D textured model

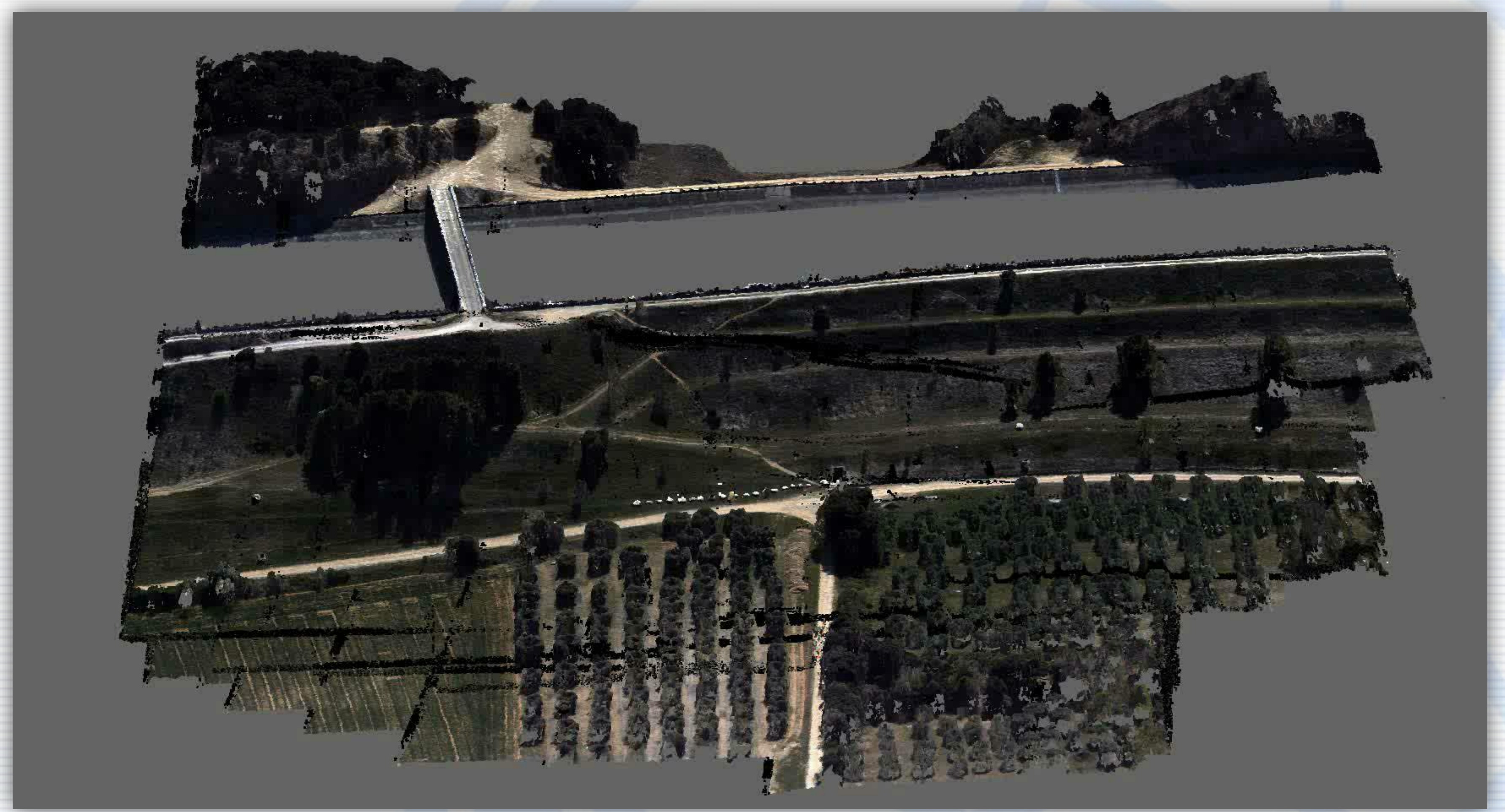
Vector object-oriented models





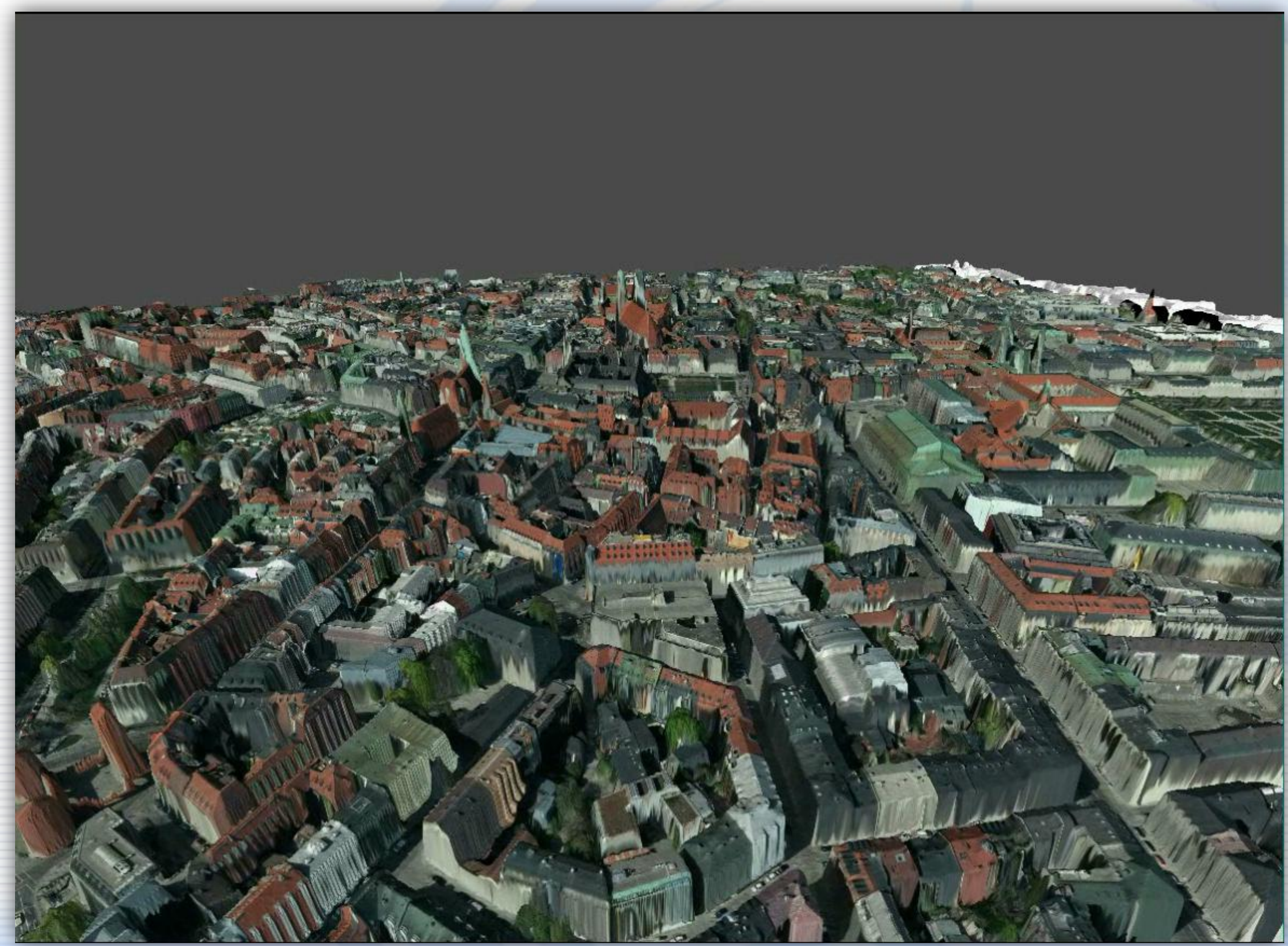
3D model (SGM)

UAV. Camera Delairtech. Ground sample distance (GSD) and DEM cell size - 5 cm. Horizon, France



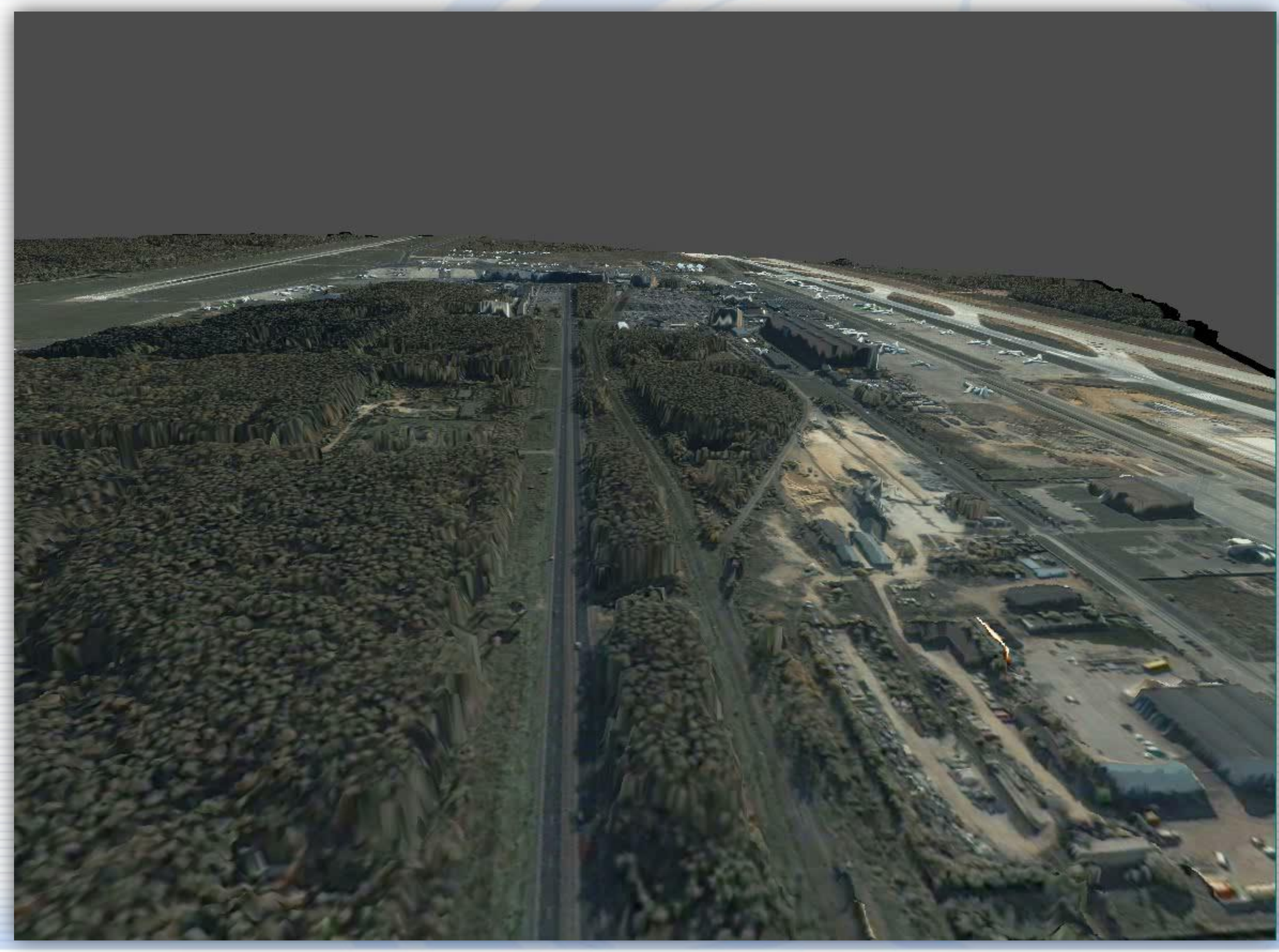
3D model (SGM)

Aerophoto camera DMC. Ground sample distance (GSD) and DEM cell size - 10 cm. Munich, Germany



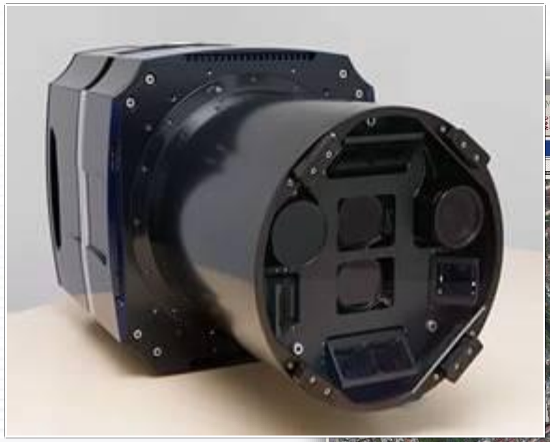
3D model (SGM)

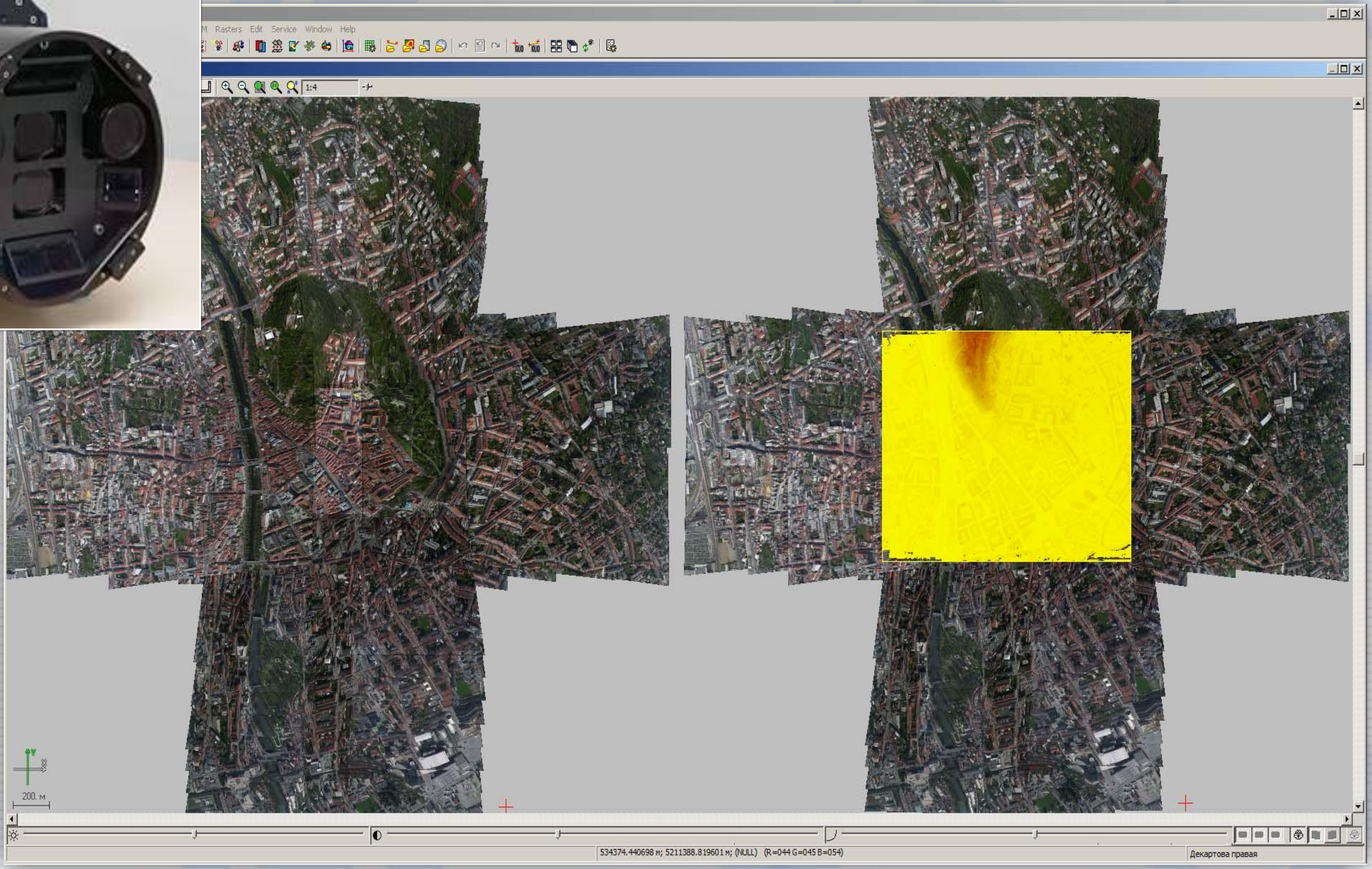
Satellite sensor Ikonos. GSD and DEM cell size – 1 m. Airport Domodedovo, Moscow, Russia



Oblique aerial cameras systems data processing

Aerial camera UltraCam Osprey Prime II. Ground sample distance (GSD) and DEM cell size – 7,1 cm



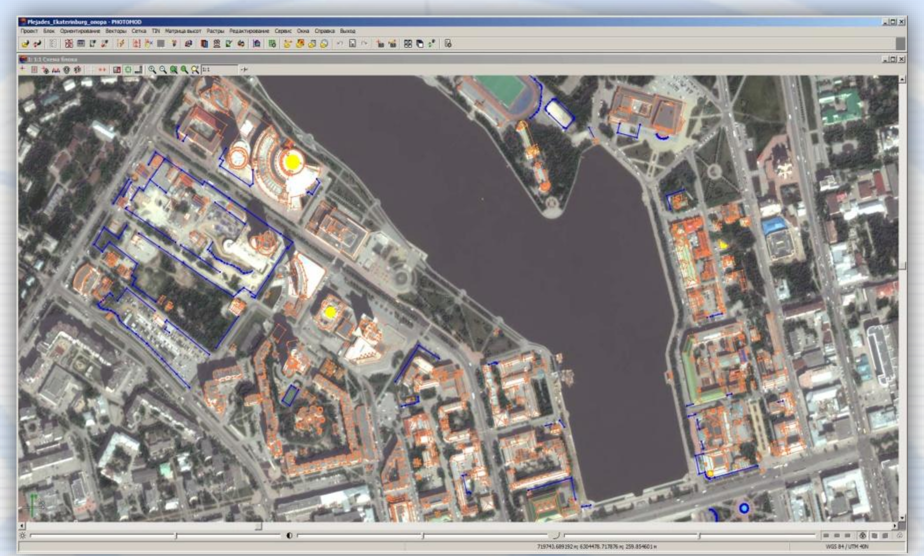


Oblique aerial cameras systems data processing

Aerial camera UltraCam Osprey Prime II. Ground sample distance (GSD) and DEM cell size – 7,1 cm. Graz, Austria

Vector 3D model creation

- Automatic blocks of images orientation
- Automatic DTM creation
- Automatic orthophoto creation
- Semi-automatic stereovectorization
- Automatic buildings 3D-models generation by closed polygons set
- Manual and semi-automatic object texturing

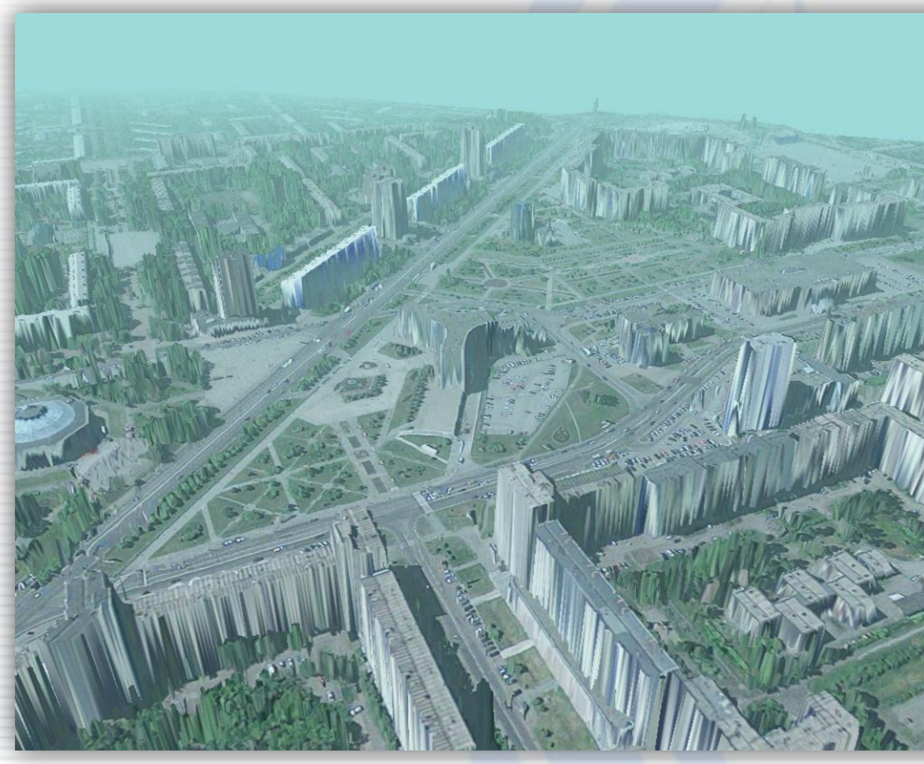


Vector 3D model

Satellite sensor Pleiades, Ground sample distance (GSD) – 0.5 m at nadir, Ekaterinburg, Russia

Proc and cons of two types of 3D photogrammetric models

Satellite sensor GeoEye, Ground sample distance (GSD) – 0.5 m at nadir, Novokuznetsk, Russia



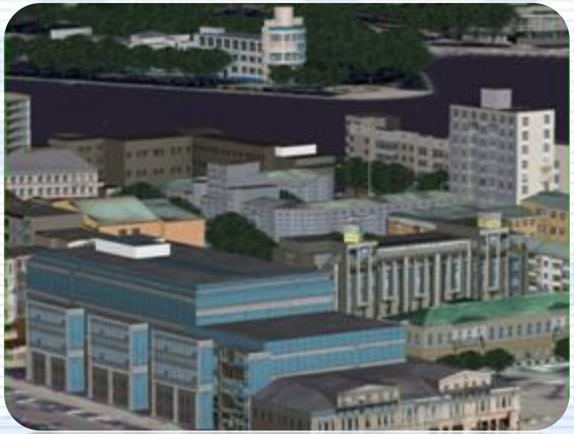
Pros and cons of two photogrammetric methods of 3D modeling

Dense DSM

Pros	• Full automation
Cons	• Worse accuracy • No way to attach database (no vector objects) • More powerful hardware requirements

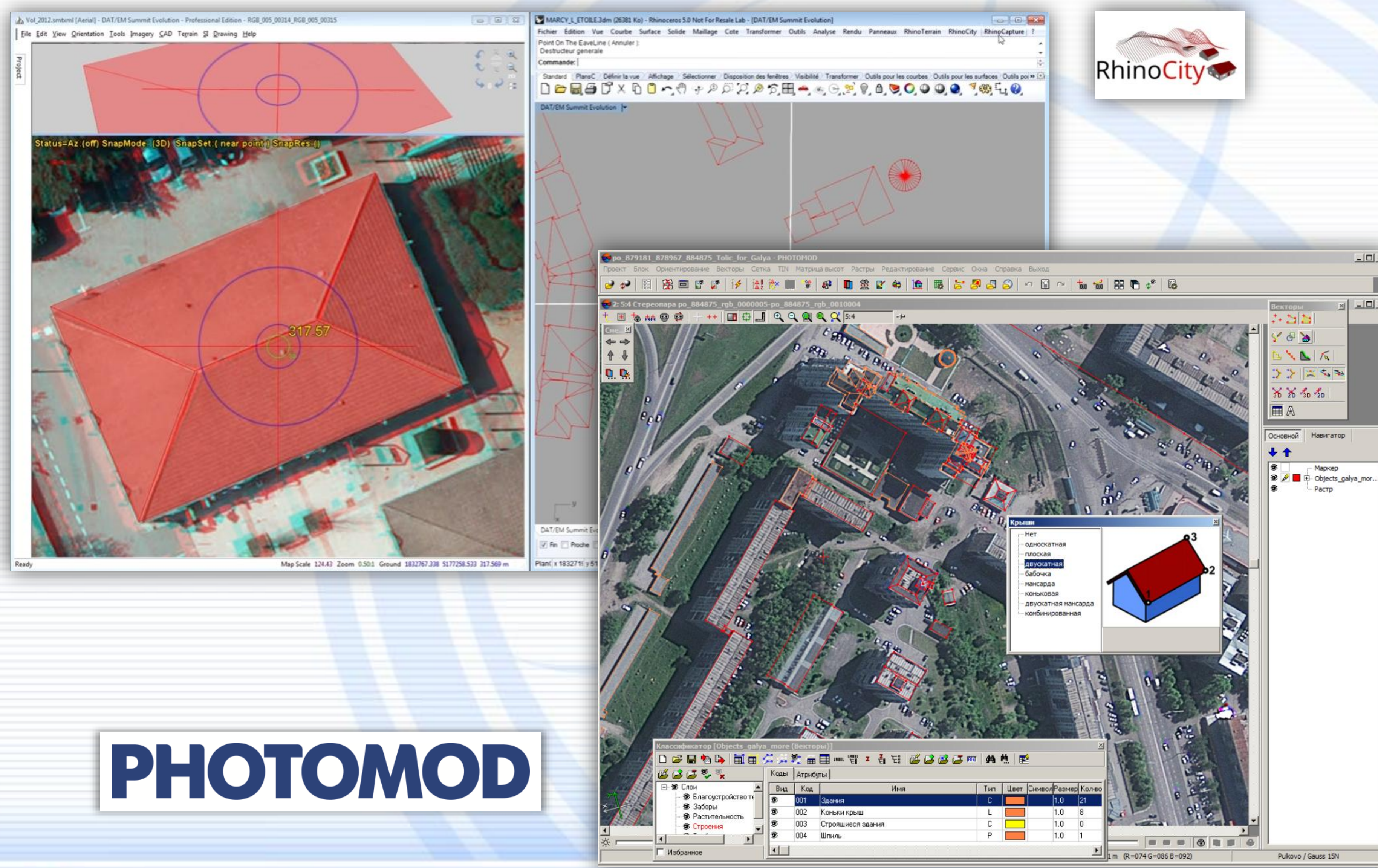
Vector model

Pros	• High accuracy • Ready for 3D GIS (ability to attach database to vector objects)
Cons	• A lot of manual work (vectorization and texturing) • No automatic facade texturing



Automation in vector 3D models generation

Automation in stereovectorization

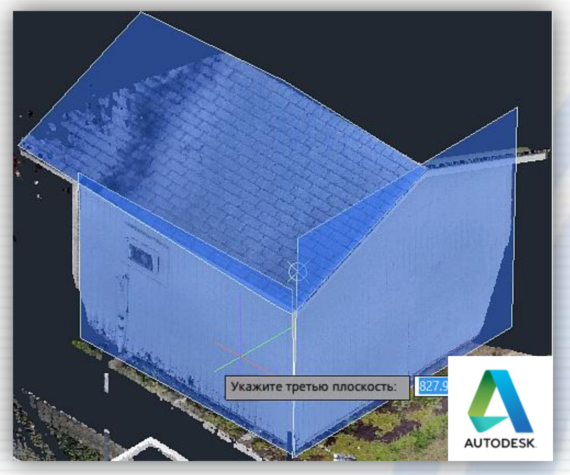


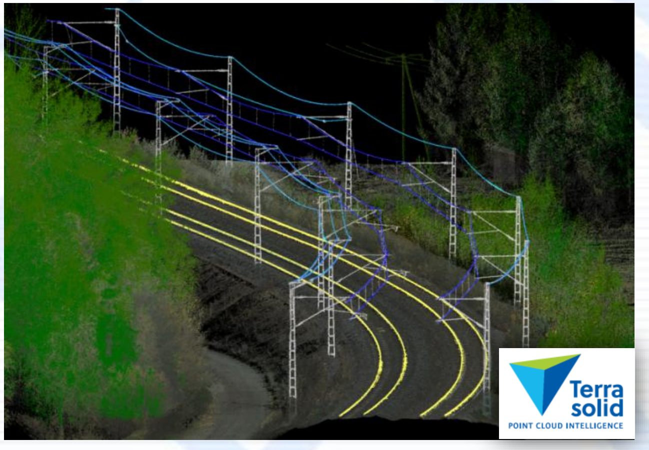
RhinoCity

PHOTOMOD

Automation in vector 3D models generation

Automation of point clouds vectorization





Automation of point clouds segmentation, building and line objects detecting. Auto texturing

PHOTOMOD

Advantages of 3D models generation using PHOTOMOD system

- **Integrated solutions: from remote sensing data processing till 3D-models generation**
- **Relevance and high geometry accuracy of 3D topographic models**
- **High level of automation of 3D-models generation**
- **Different types of models depending on customer requirements**
- **Special program for 3D-models visualization and analyze (3D-mod)**
- **Converting 3D data files to/from different formats**

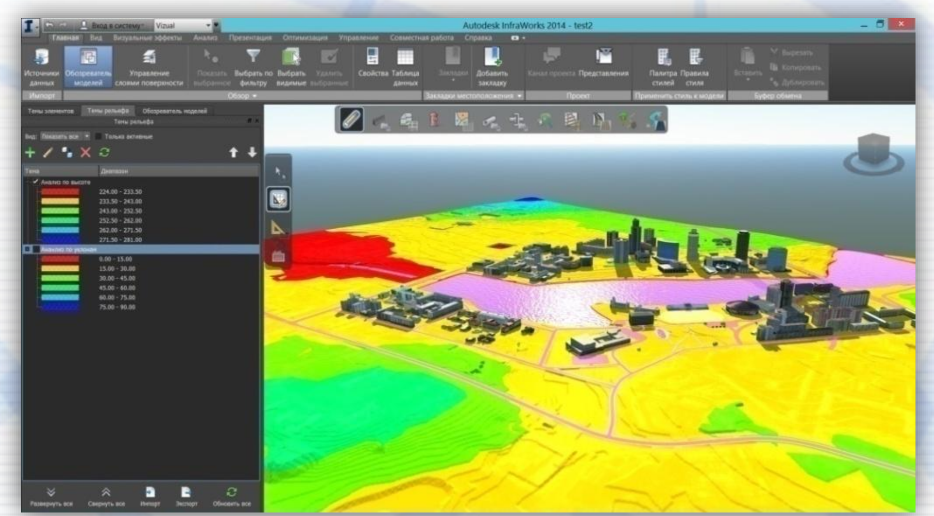
3D-GIS creation

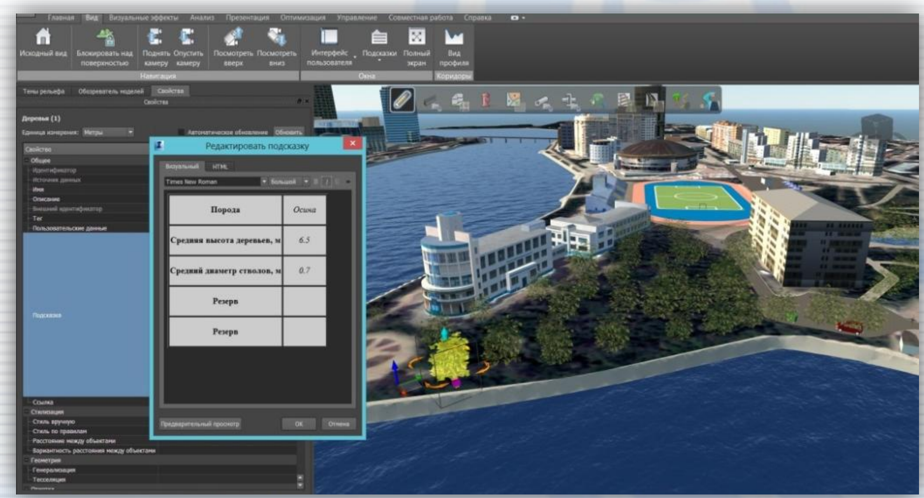
PHOTOMOD + AUTODESK INFRAWORKS

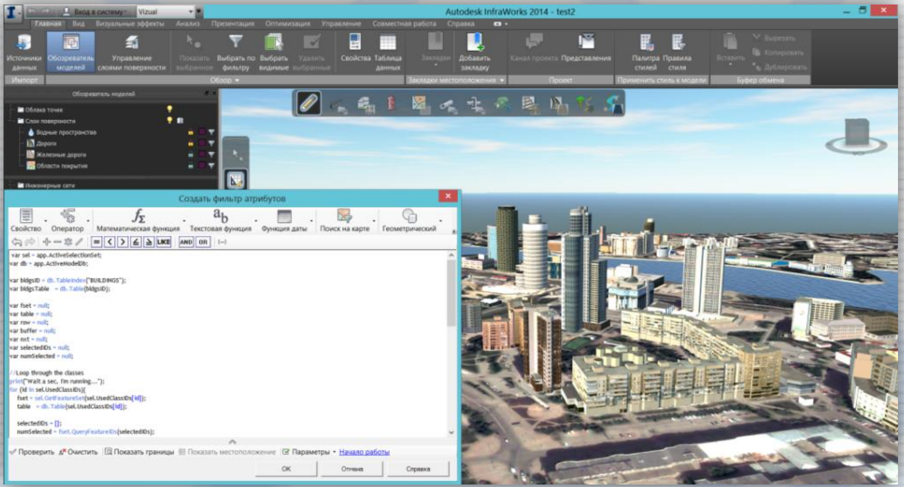
Opportunities of using 3D-GIS functions:

- Linking to a database
- Attributes associated with 3D objects
- Selecting objects with queries
- Spatial analysis

Etc



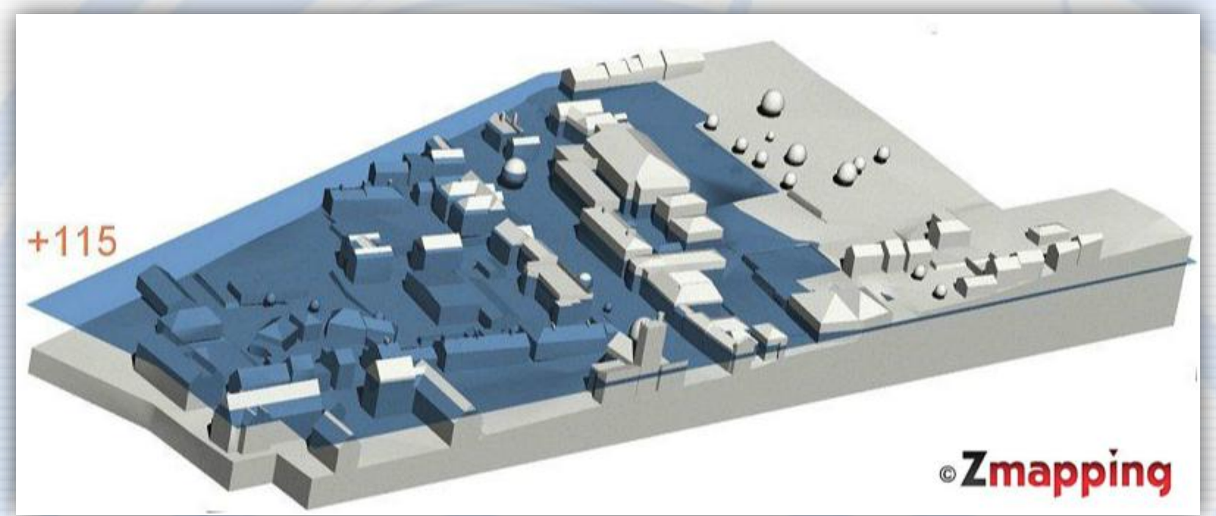


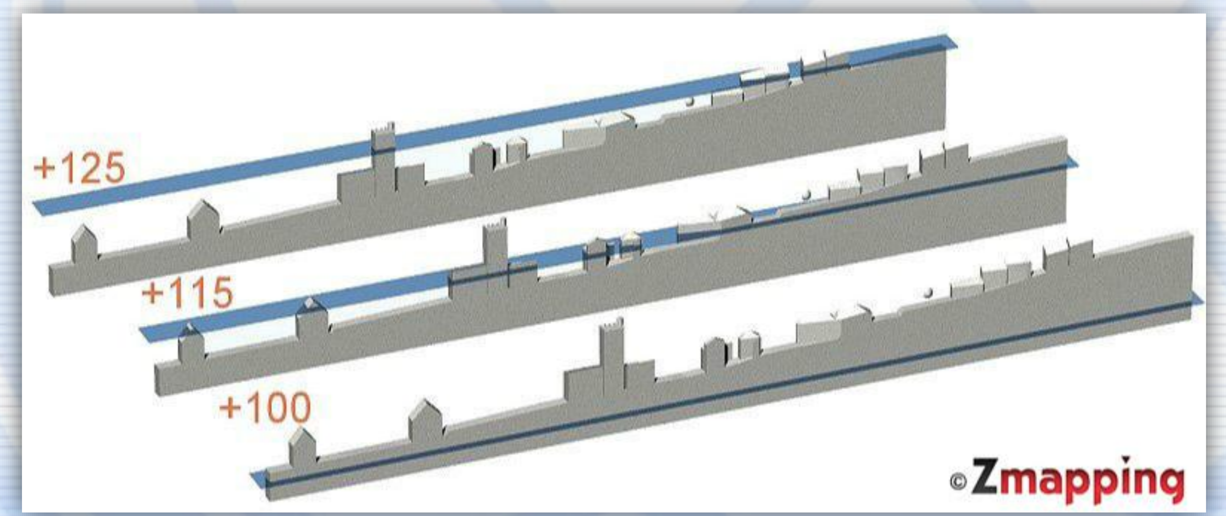


Application of 3D models

Height analysis

- Flood monitoring and forecasting
- Earthwork volume calculations
- Design of drainage systems

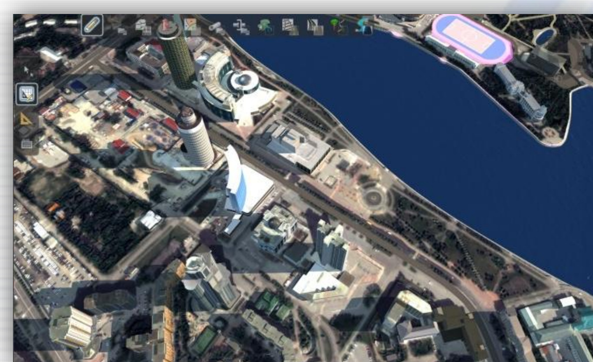




Application of 3D models

Sun and shadow studies

- July 13, 2014. 8-00 a.m.



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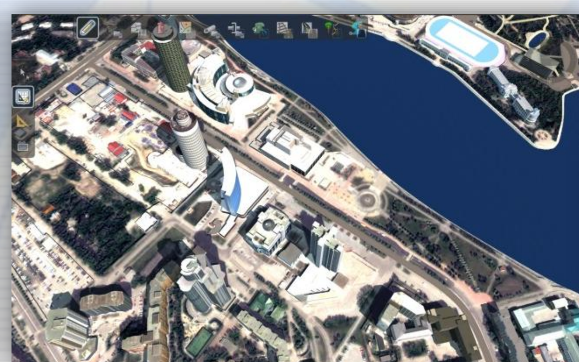

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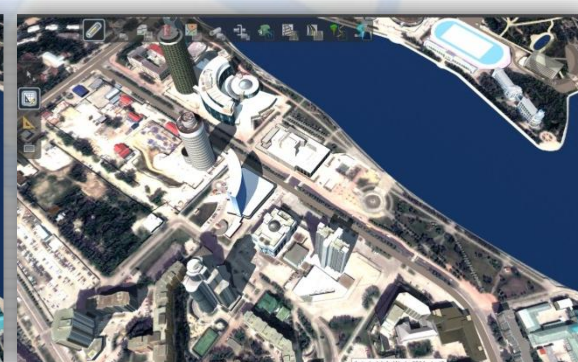

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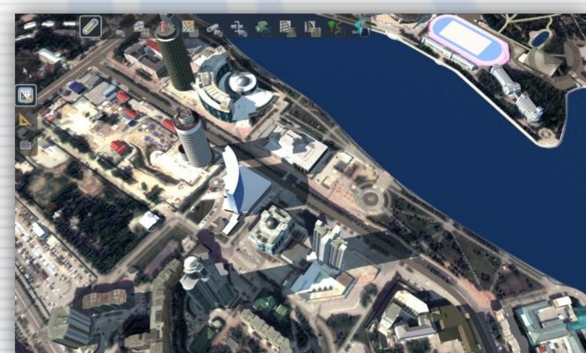

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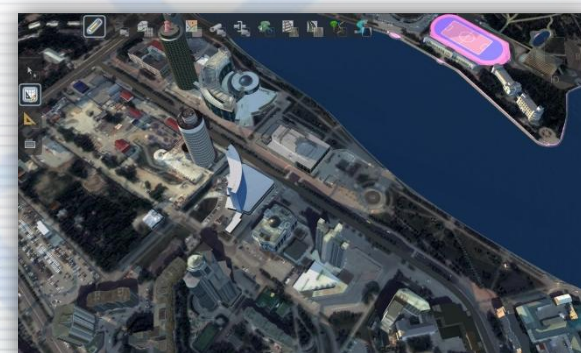
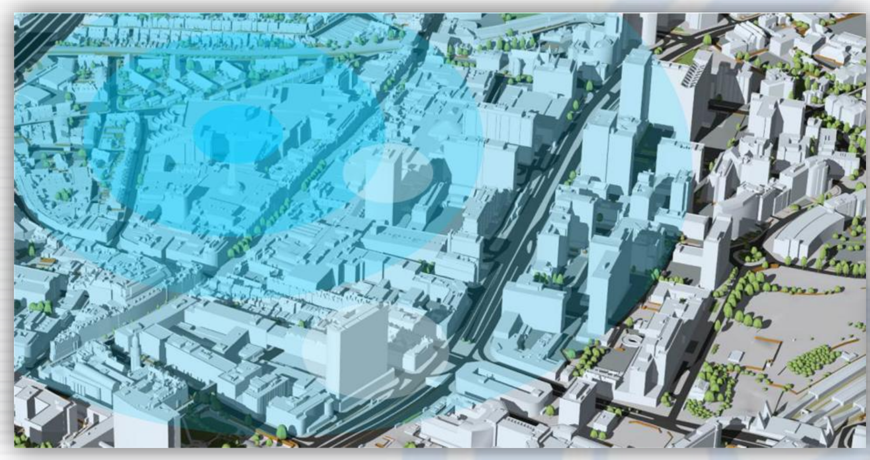
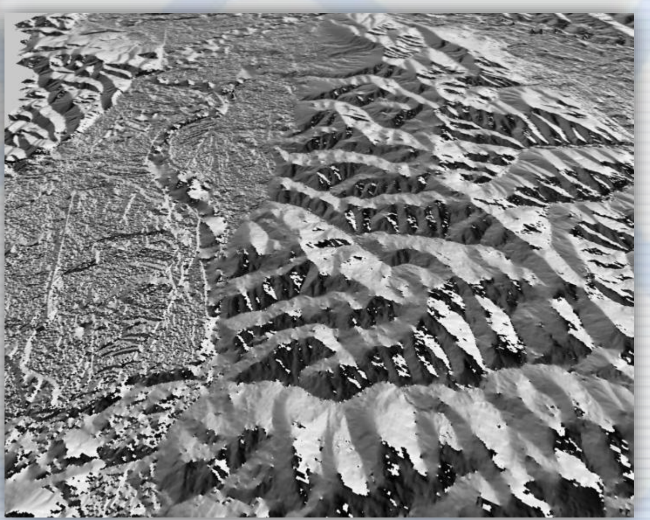
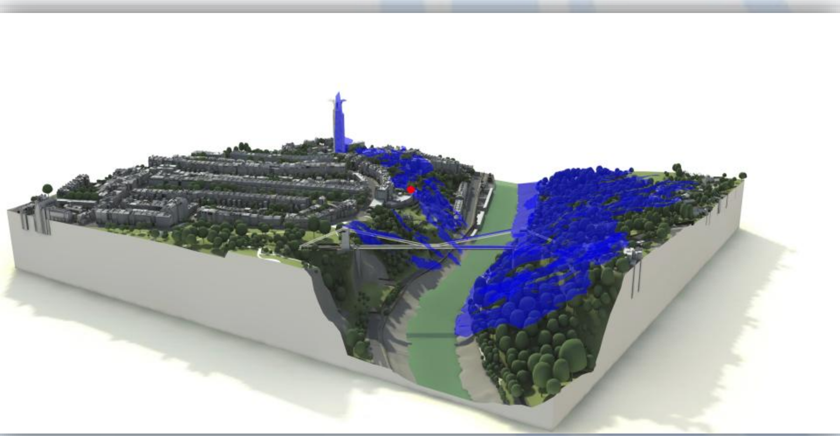


Application of 3D models

Telecommunication

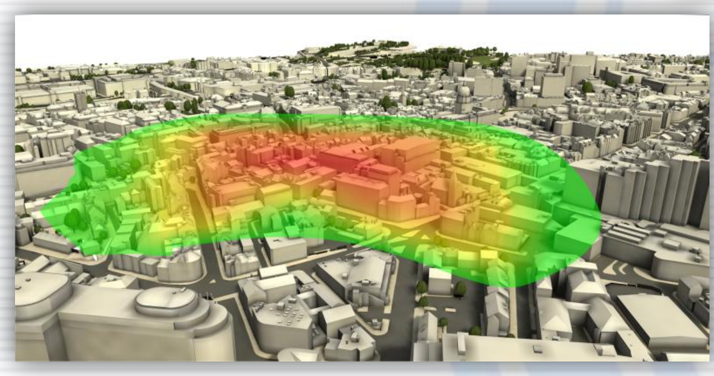


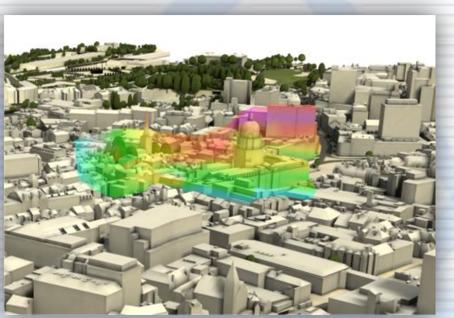




Application of 3D models

Emergency planning



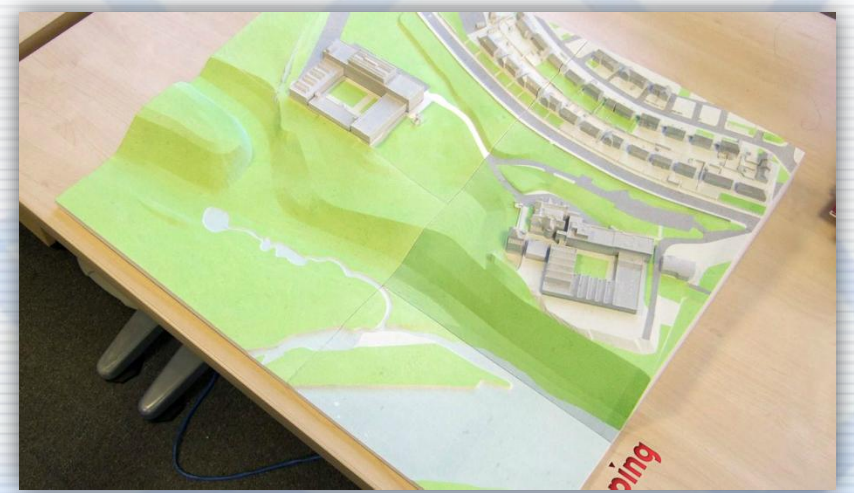


Application of 3D models

Planning. Public consultation

Application of 3D models

Rapid prototype models



Thank you for the attention!