TOWARDS 3D CITY MODEL FOR BRUNEI – A CONCEPTUAL PROPOSAL

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Introduction

- Why 3D City Model?
- 3D City Model Applications
- FIG's Vision of Cadastre 2.0
- 3D Modelling – Basic concepts
- Smart Cities
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  - LiDAR Sensor Data
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Why 3D City Model?

- Three Dimensional Digital Representations of the Earth's surface and objects in an urban area
- Growing needs and rapidly expanding in many fields
- Easier understanding of spatial properties

- Over the last number of years there has been a rapidly increasing interest in 3D geospatial data
- New techniques have been developed for capturing 3D data – photogrammetry, lidar data now fairly common and relatively cheap to capture
- New methods for visualising this data – tools such as Google Earth
- Market research has shown that there is a need for 3D data and organisations / businesses need to access this data
- However, they also wish to receive this data in a format that is an international standard. Up until now there has not been an internationally recognised standard for 3D geosopatial data – NB have been many different types of formats – shape, dgn etc

3D City Model Applications

Navigation

Tourism

Telecommunication

Disaster Management

Urban Planning

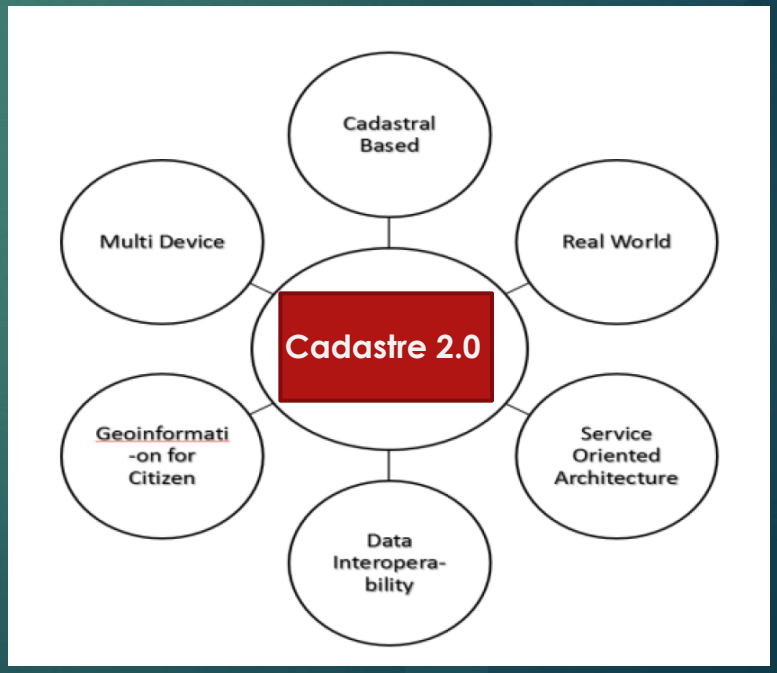
Navigation systems: 3D navigation maps have become omnipresent both in automotive and pedestrian navigation systems, which include 3D city models, in particular, terrain models and 3D building models, to enhance the visual depiction and to simplify the recognition of locations.
Urban Planning: To set up, analyze, and disseminate urban planning concepts and projects, 3D city models serve as communication and participation medium. 3D city models provide means for project communication, better acceptance of development projects through visualization, and therefore avoid monetary loss through project delays; they also help to prevent planning errors.
Disaster Management: For emergency, risk, and disaster management systems, 3D city models provide the computational framework. In particular, they serve to simulate fire, floodings, and explosions For example, analyzing effects of explosion in urban areas at high precision to support prediction of effects for the structural integrity and soundness of the urban infrastructure and safety preparations of rescue forces.

- Tourism: Interactive, realistic 3D maps in detailed accuracy - informative, better navigation.
- an innovative alternative to topographic maps. Created using aerial images, flawlessly work landscapes into lifelike scenes, rendering our maps convincingly realistic. On top of that, you can rely on finding all the most important map information in its correct geographic location.
- Realistic, 3D maps make searching for recreational and tourist information a fun online experience.

FIG's Vision of Cadaster 2.0

- Cadastre 2.0. Such a system will be:

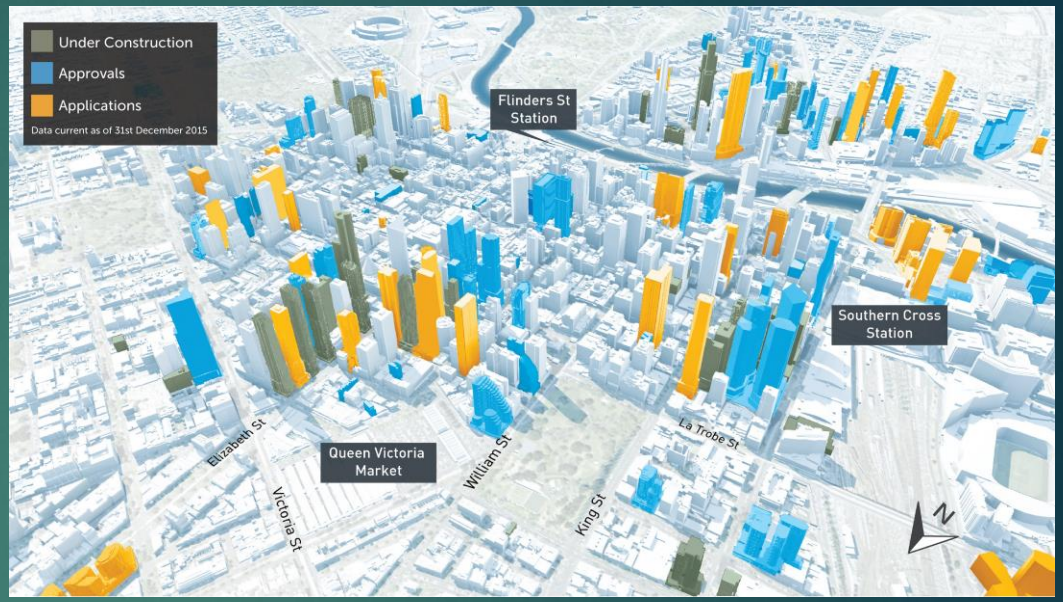
……. truly 3-D, better reflecting the real world of overlapping rights, the registration of utilities or multi-level properties;

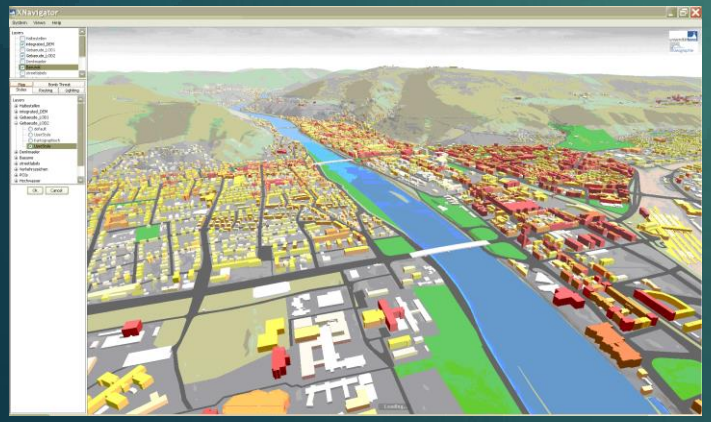


- ‘multi-purpose’, meeting a wide range of needs beyond simply recording land ownership or defining parcels for taxation;
- consistent with the LADM standards
- truly 3-D, better reflecting the real world of overlapping rights, the registration of utilities or multi-level properties

3D Modelling – Basic Concepts

- 3D Modelling in several domains / industries
  - Graphic Visualisation
  - GIS
  - BIM





- 3D modelling is a very broad sweeping phrase – it encompasses many different fields, some of which include :
- Graphic Visualization – everythings is centred around producing impressive graphics, can be static or video. No geospatial info
- CAD/BIM – centred on the AEC industries, very CAD dominated. BIM is more of a philosophy in ways of working, aims to help management and organisation of construction projects.
- GIS, more large scale, geosopatial references, can be used for visualisation, Hopefully to be used more as a tool for analysis of 3D data for specific applications

Smart Cities

1. Smart Transportation System
2. Utility Services Monitoring Devices
3. Parking Apps
4. Structures Monitoring Sensors
5. Self-Driving Vehicles
6. Utility Management
7. Street Lighting Maintenance
8. Fire Sensors
9. Power Management
10. Public Transit management
11. Freight and Logistic Services
12. Security Sensors
13. Law Enforcement
14. Public Engagement

Smart City

Smart Transportation System: Smart transportation system use sensors to detect congestion and bottleneck in traffic patterns, The also rely on cameras to enforce speed and traffic offences. In doing so, they gather real time information that can be use to make mobility networks safer and more efficient

Utility Services Monitoring Devices: Monitoring devices can detect leaks as well as changes in water pressure to determine whether water infrastructure is working properly

Parking Apps: Parking Apps coordinate with smart parking meters to inform drivers of where there is parking availability

Structure Monitoring Sensors: Sensors monitor the structural soundness of bridges and inform city engineers of any issues.

Self-Driving Vehicles: Self-driving cars shuttle people in an out of the city, providing rides for others and making deliveries while their owners are occupied with work or other activities

Smart City

- **Utility Management**: Sensors detect the amount of garbage in recepticals around the city so that sanitation workers can be maximize efficiently in their routes.
- **Street Light Maintenance**: LED lights are weather adaptive and communications are automatically sent to the authority when bulbs need to be changed
- **Fire Sensors**: Sensors monitor conditions in public area and detect fires in building and initiate call to the fire department in an emergency
- **Power Management**: Power plants can be monitored for safety and city officials can be informed of any influx in radiation levels
- **Public Transit Management**: Public transit and city fleet vehicles communicate with their home agency when it is time for maintenance or replacement.

Smart City

- **Freight and Logistic Services**: Platooning trucks carry freight efficiently from the port to their final destination. Smart inventory systems inform operators about when freight is moved between different locations
- **Security Sensors**: Cameras ensure security by monitoring activity in areas that are not frequented by police, Areas that area not open to public access can be monitored to keep unauthorized personnel out
- **Law Enforcement**: Police can wear body cameras that capture footage of interactions between themselves and city residents to ensure safety for both parties
- **Public Engagement**: Cities can build in smartphone and wearable detection sensors so that people can be an active part of the internet ecosystem, communicating with the city, and with each other.

Data Sources – Multiview Oblique Aerial Images

- Provide geospatial data acquisition services and data processing for 800 Sq km proposed area which covers Bandar Seri Begawan and 7 other towns in Brunei (Kuala Belait, Seria, Tutong, Banga, Muara Town, Sukang and Panaga)
- Proposed MVO Camera

Data Sources – Multiview Oblique Aerial Images

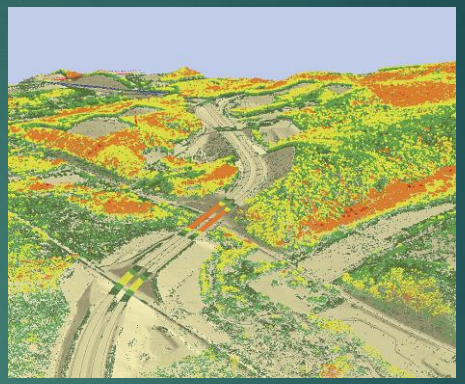
- Deliverables
  - Oblique Image Frames includes the Nadir
  - Precise Exterior Orientation (Triangulated Images)
  - Orthophoto
  - SGM LAS File for Point Clouds
  - RAW DATA and Processed Images

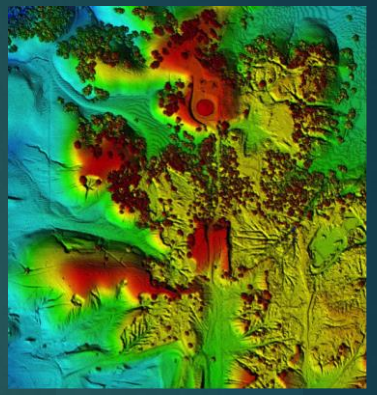
Data Sources – LiDAR Sensor Data

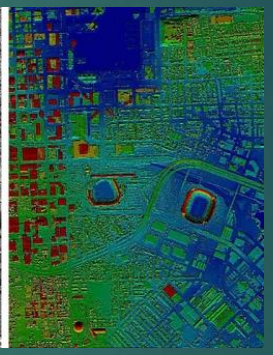
- Provide geospatial data acquisition services and data processing for 800 Sq km proposed area which covers Bandar Seri Begawan and 7 other towns in Brunei (Kuala Belait, Seria, Tutong, Banga, Muara Town, Sukang and Panaga)
- Proposed LiDAR Sensor

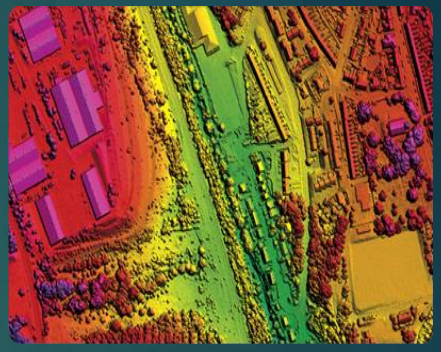
Data Sources – LiDAR Sensor Data

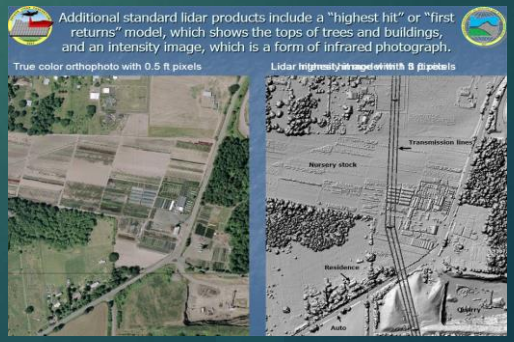
- Deliverables
  - Raw point cloud
  - LiDAR ground and non ground strikes
  - DTM and DSM
  - Contours
  - Colour intensity image
  - Orthophoto











Data Sources – Mobile Laser Scanning Data

- Provide geospatial data acquisition services and data processing for 2500 km proposed area which covers Bandar Seri Begawan and 7 other towns in Brunei (Kuala Belait, Seria, Tutong, Banga, Muara Town, Sukang and Panaga)

- Proposed Mobile Laser Scanner

Data Sources – Mobile Laser Scanning Data

- Deliverables
  - RGB-colour coded laser strikes
  - Raw data consists of left and right laser data
  - Raw panoramic images

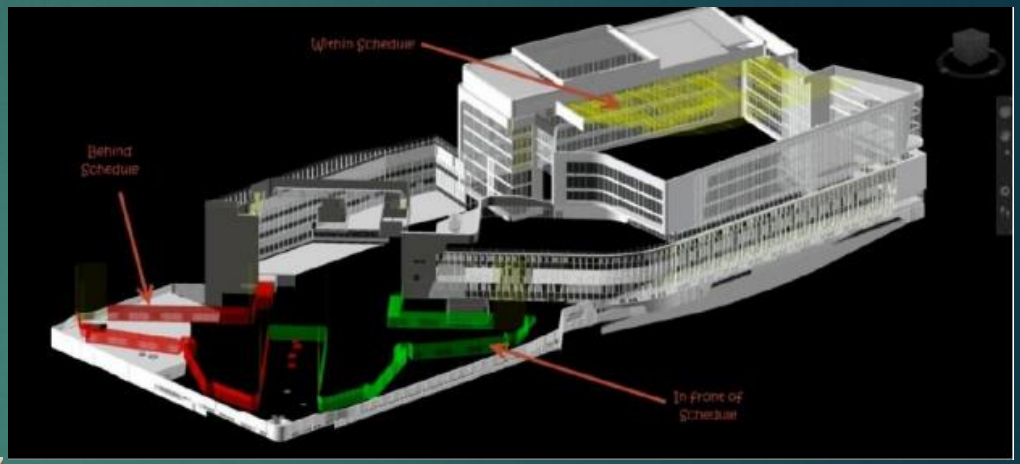
Data Sources – Terrestrial Laser Scanning Data

- Provide geospatial data acquisition services and data processing for 12 buildings in the proposed area which covers Bandar Seri Begawan and 7 other towns in Brunei (Kuala Belait, Seria, Tutong, Banga, Muara Town, Sukang and Panaga)

- Proposed Terrestrial Laser Scanner

Data Sources – Terrestrial Laser Scanning Data

- Deliverables
  - BIM
  - LoD4 for Buildings



Terrestrial Laser Scanning Data

Scan to BIM process comprises of 4 stages

- •Field work involve scanning the subject matter(inside and outside the building, inclusive of Color photo where necessary)
- •Registration involve combining all the scan position into a single working file, sometime two (the data could be massive of hundred of GB, as you could imagine the point cloud is collected at above 300k – 1 Million point per second)
- •Modeling involved in identifying the shape and identity of the collected and interpret into useful Architectural and building elements
- •BIM process is to enhance the 3D geometry with intelligent using commercial off the shelf software

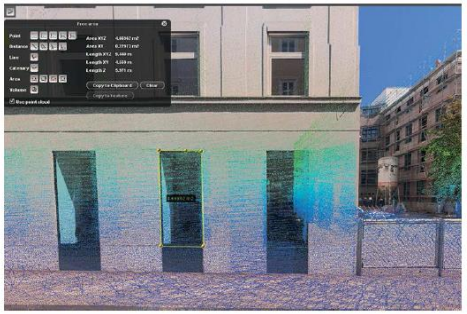
Data Sources – Panoramic Street View

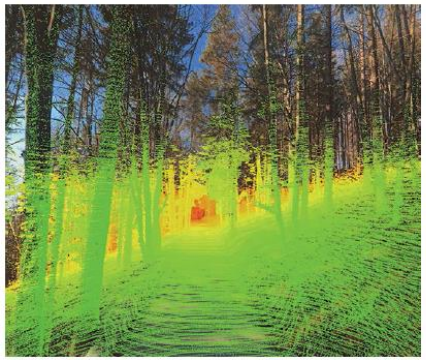
- Provide geospatial data acquisition services and data processing for 2500 km in the proposed area which covers Bandar Seri Begawan and 7 other towns in Brunei (Kuala Belait, Seria, Tutong, Banga, Muara Town, Sukang and Panaga)

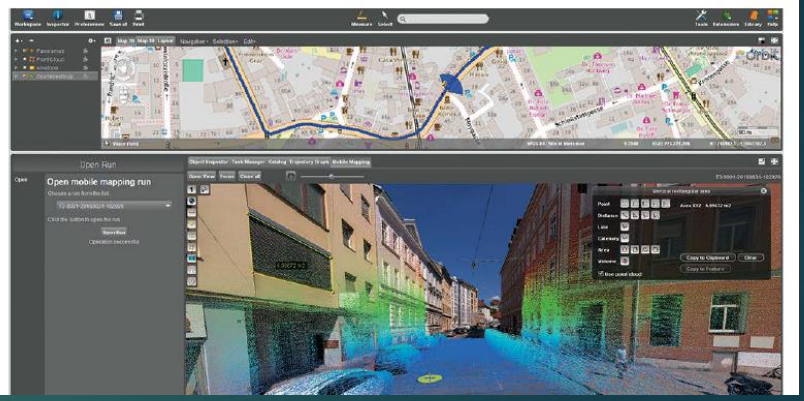
- Proposed Panoramic Street View 360 Degree Camera

Data Sources – Panoramic Street View Data

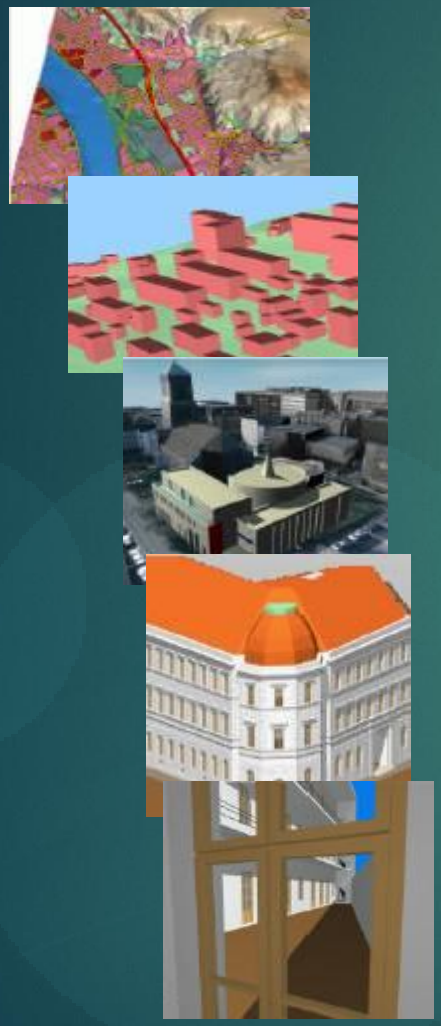
- Deliverables
  - Panoramic Images store in cube projection
  - Panoramic images to be converted into multi-resolution tiled pyramids in JPEG format







5 Level of Details (LoDs)

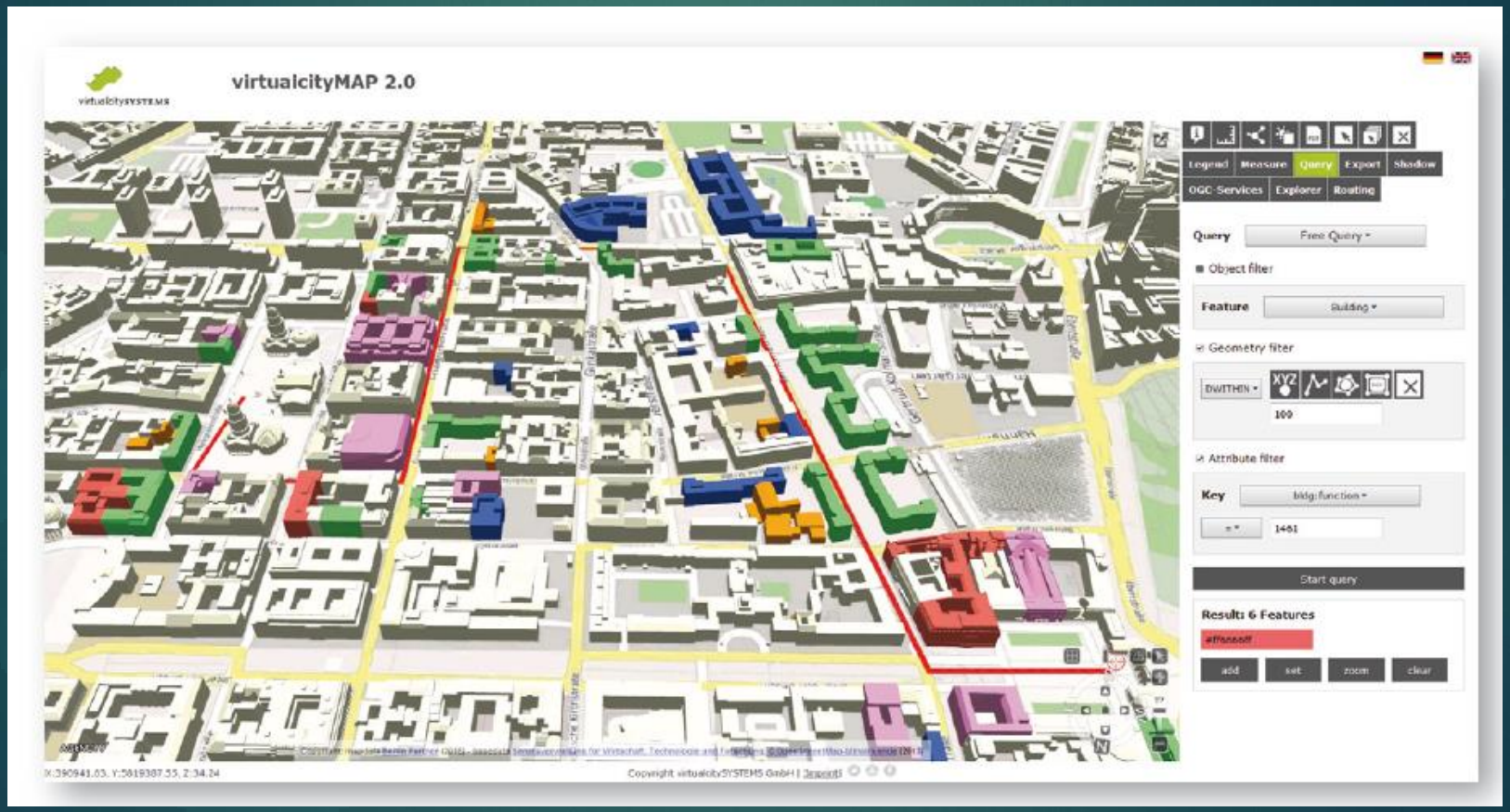


- **LOD 0 — Regional Model**
  2.5D Digital Terrain Model
- **LOD 1 — City model**
  block model, no roof structures
- **LOD 2 — City model**
  roof structures, optional textures
- **LOD 3 — Site model**
  detailed architectural model
- **LOD 4 — Interior model**
  Walkable interior spaces

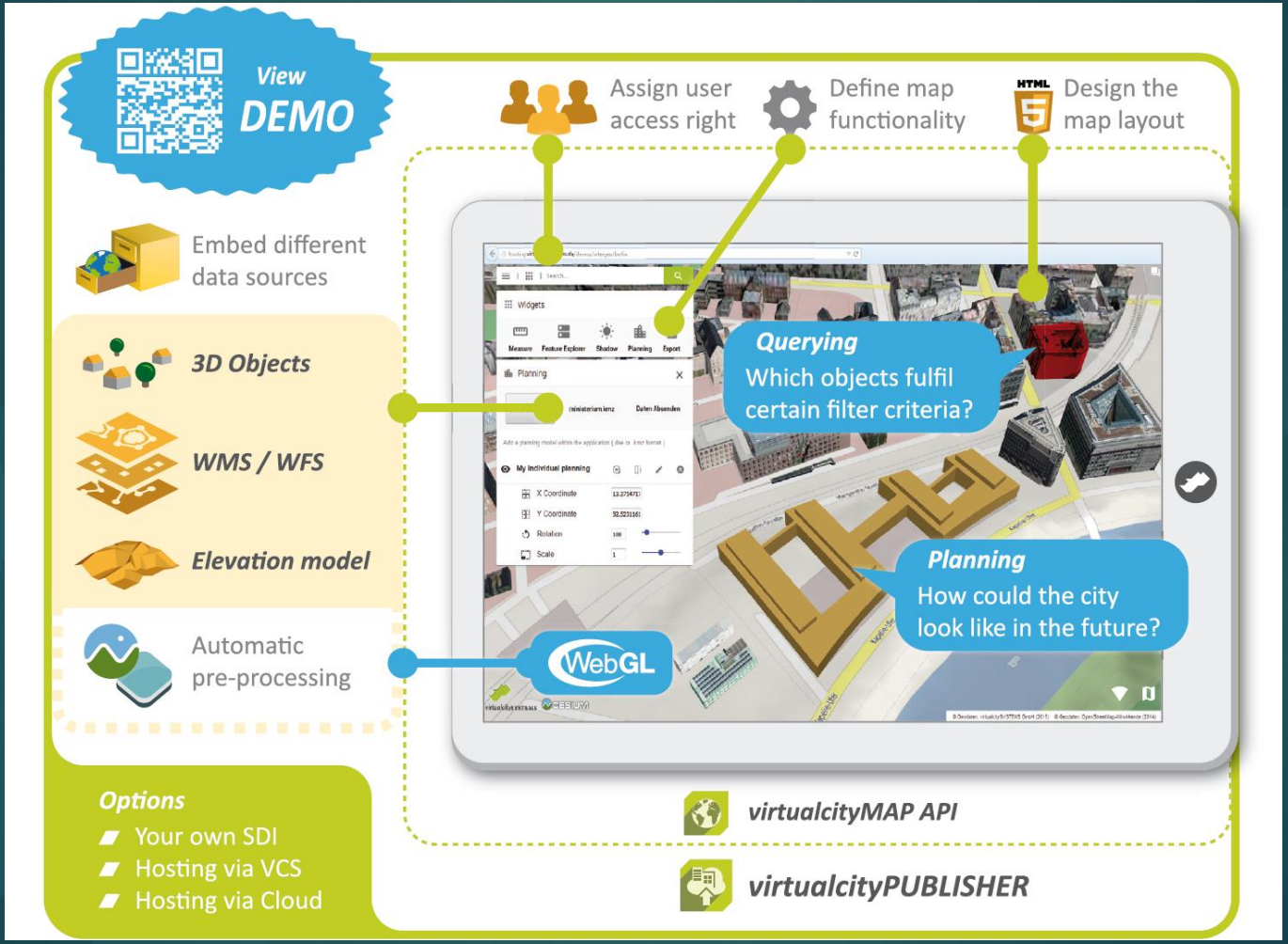
Web Portal

- Create, configure and distribute Brunei own Smart City Applications
- Client-based 3D rendering
- Data visualisations, query and mapping
- Web-based authoring tool for 3D maps
- Producing streamable layers, adding map features and managing user roles

VirtualCity Publisher

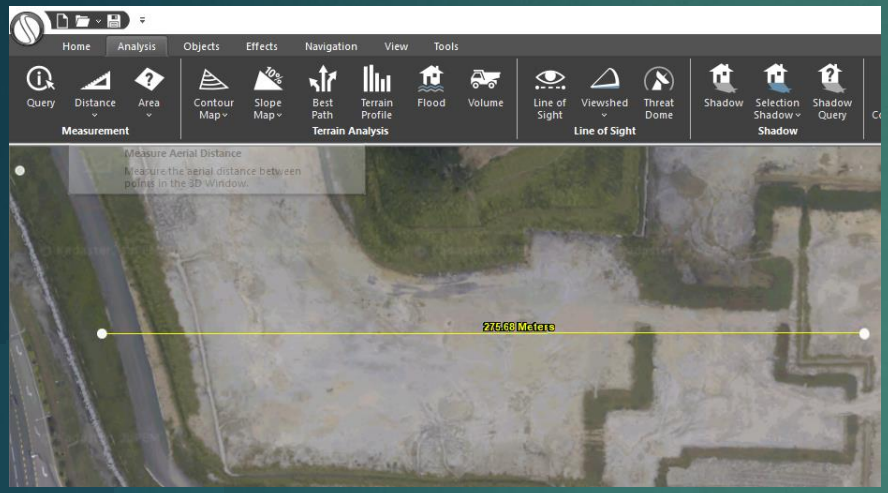


VirtualCity Publisher



MEASUREMENT FUNCTIONS

Horizontal Distance Measurement



This function horizontal distance means the distance between two points or “flat".
The horizontal distance tool allows to measure the horizontal distance, elevation difference and slope betw een two or more points.

Aerial Distance Measurement

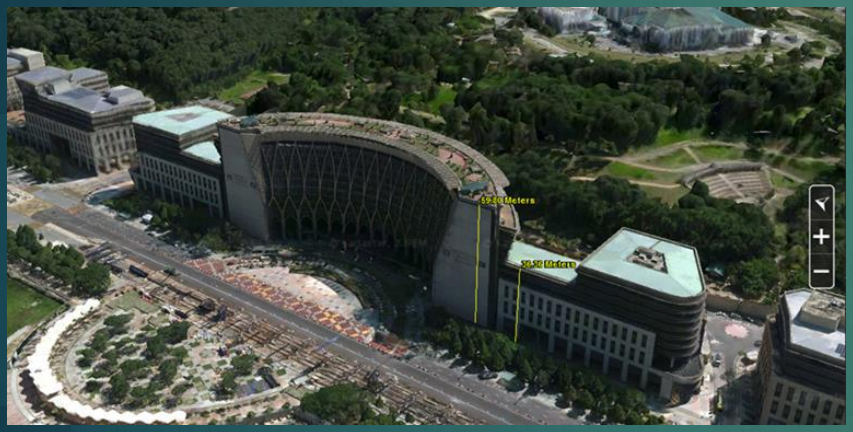
The aerial distance tool allows to measur e the aerial distance, elevation difference and slope between two or more points. These aerial distance is the actual distance between the points.

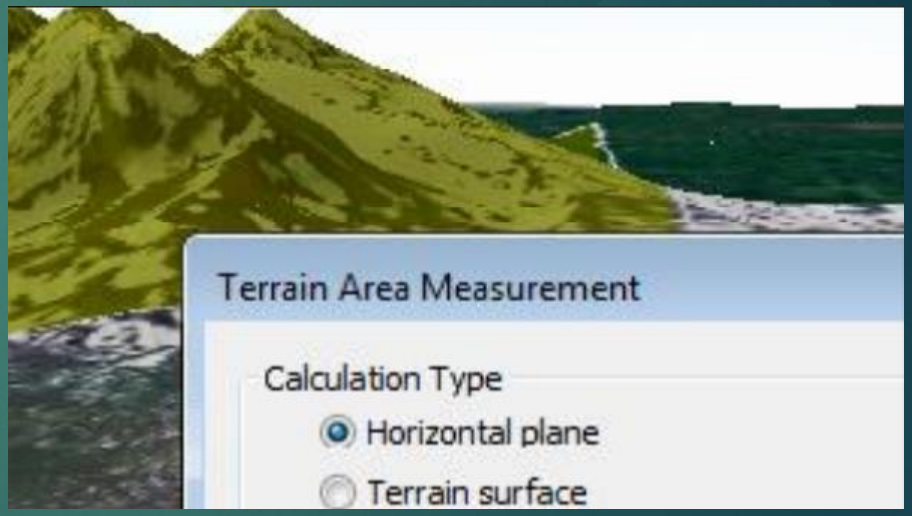
MEASUREMENT FUNCTIONS

Terrain Area Measurement

The terrain area tool allows to define an area of terrain and obtain its exact measurements. The area measured is the horizontal projection of the area that have outlined. Using the terrain area tool, user can measure the following for a defined area on the terrain consist of:

- Area of the horizontal plane (2D measurement) - The area measured is the horizontal projection of the area you have outlined
- Surface area (3D measurement) - The area measured takes into terrain surface



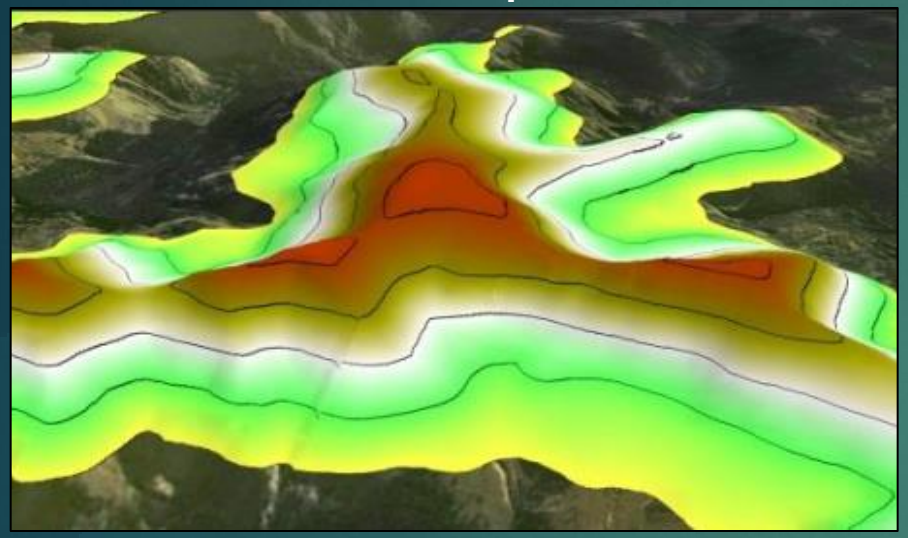


Vertical Distance Measurement

The vertical distance tool allow to measure the vertical difference between two points by selecting the first point and dragging the ruler up to desired position. This function of vertical distance means the distance perpendicular to the ground on earth surface

TERRAIN ANALYSIS FUNCTIONS

Contour Map



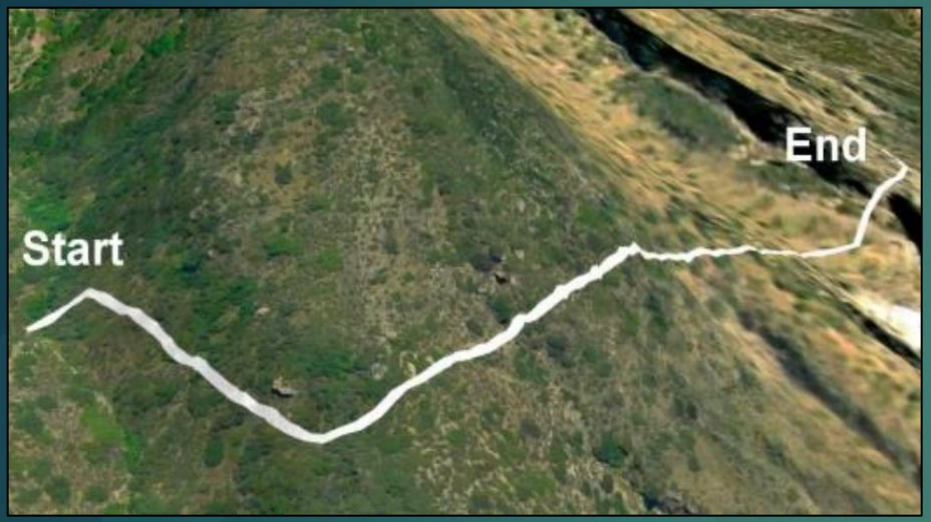
The contour map tool creates a contour map on the terrain. This function allow user to creates a topographic map that portrays differences in terrain elevation with contour lines and contour interval or by coloring terrain

Slope Map

This function allow user create a slope map on the terrain that can show the terrain colored according to degree of slope, and arrows display the direction of the slope. The contour color is default color, but the arrows of the contour color can be applied to a specified rectangular area or to the entire terrain.

TERRAIN ANALYSIS FUNCTIONS

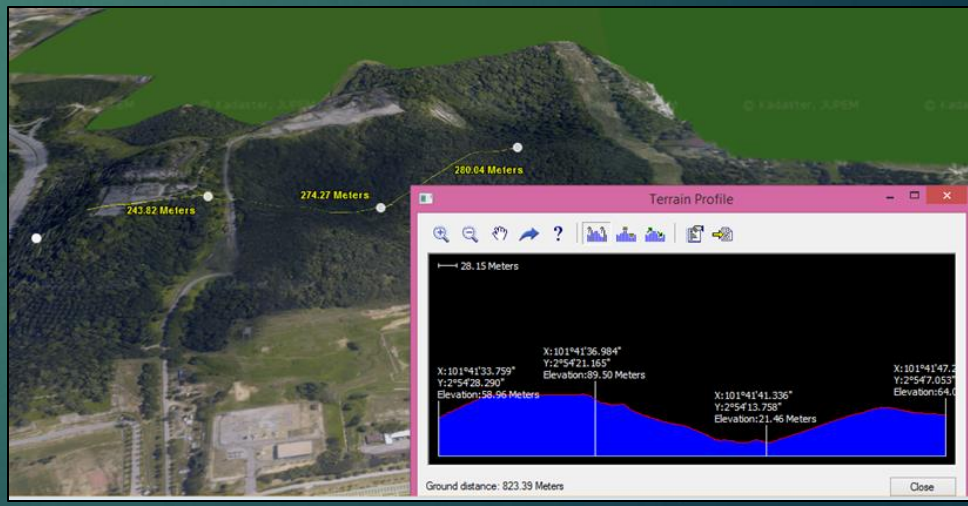
Best Path



The best path tool calculates the best p ath between two locations on the terrai n without exceeding definable climb and descent slope limits.

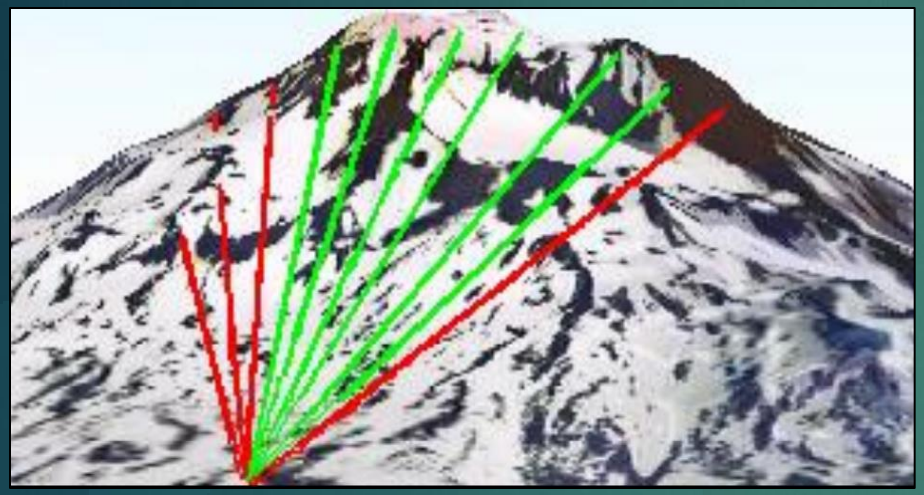
Terrain Profile

The terrain profile tool displays the terrain elevation profile along a defined path, and related information on this profile such as maximum and minimum elevation values and slope. The terrain profile can also compare between the base terrain and an elevation layer.



TERRAIN ANALYSIS FUNCTIONS

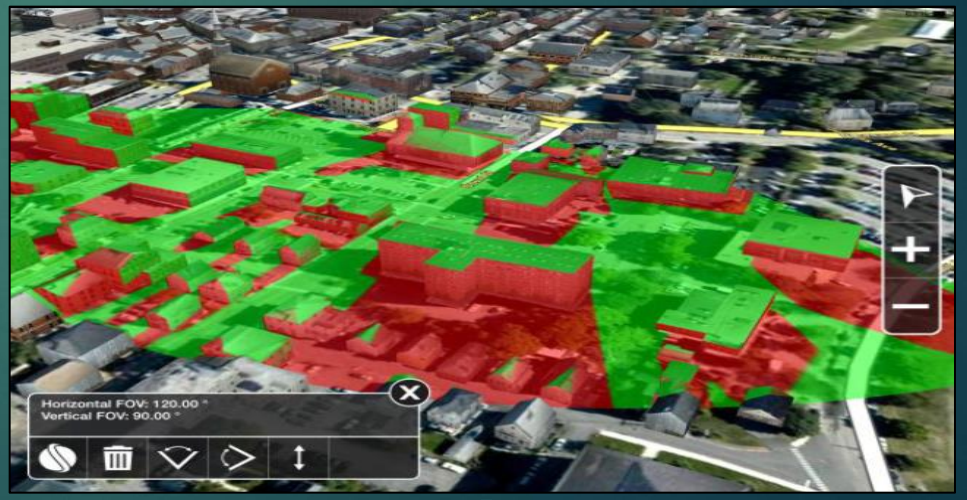
Line of Sight Analysis



Indicates whether specific locations in the 3D World can be seen (green line) from a selected position or not (red)

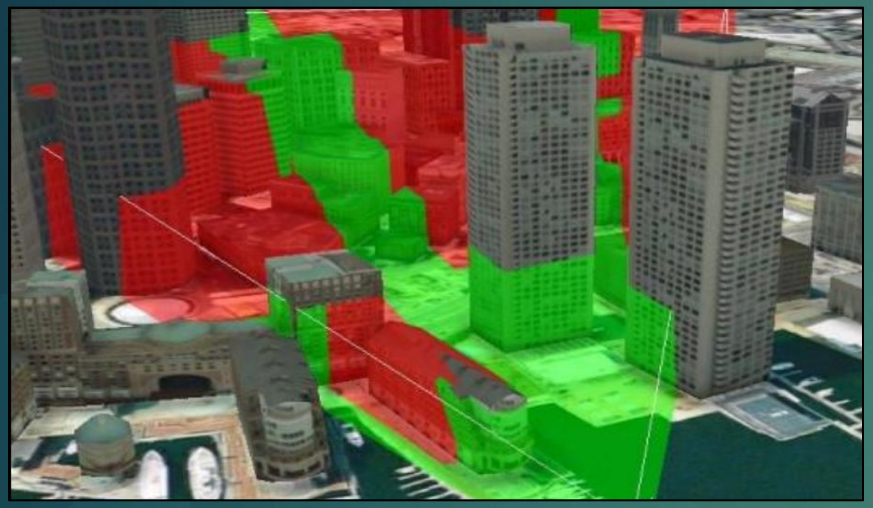
Viewshed Analysis

Indicates which areas on the entire selected terrain are visible from the viewpoint (colored in green), and which areas cannot be viewed (red). The Viewshed analysis tool provides with a graphical representation of the view from a ny defined viewpoint, along a line or a sector, to an end point.



TERRAIN ANALYSIS FUNCTIONS

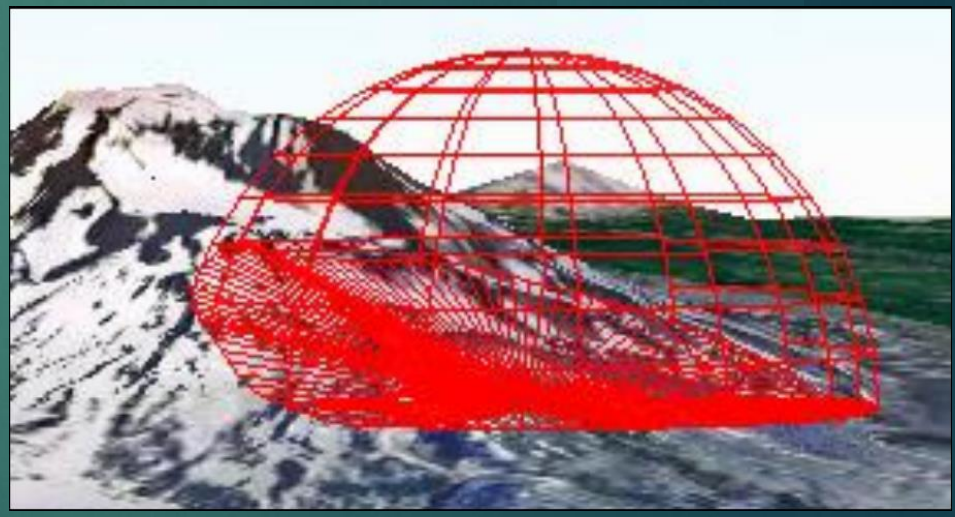
Dynamic 3D Viewshed



Create a graphical representation of the view from a moving object.

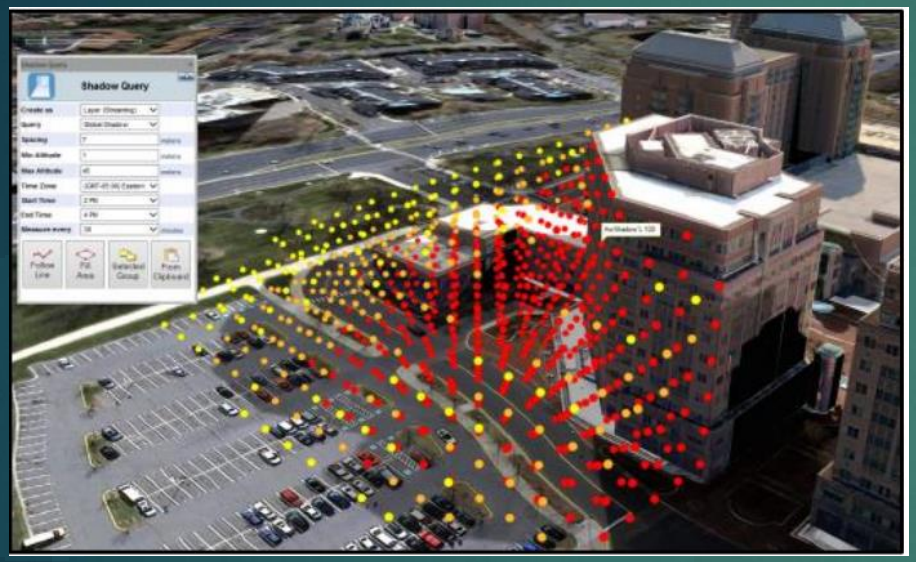
Treat Dome

Indicates the volume visible from a given point on the terrain. The tool creates a 3D shape that resembling the top half of a sphere that accurately describes the areas viewable from the defined point



TERRAIN ANALYSIS FUNCTIONS

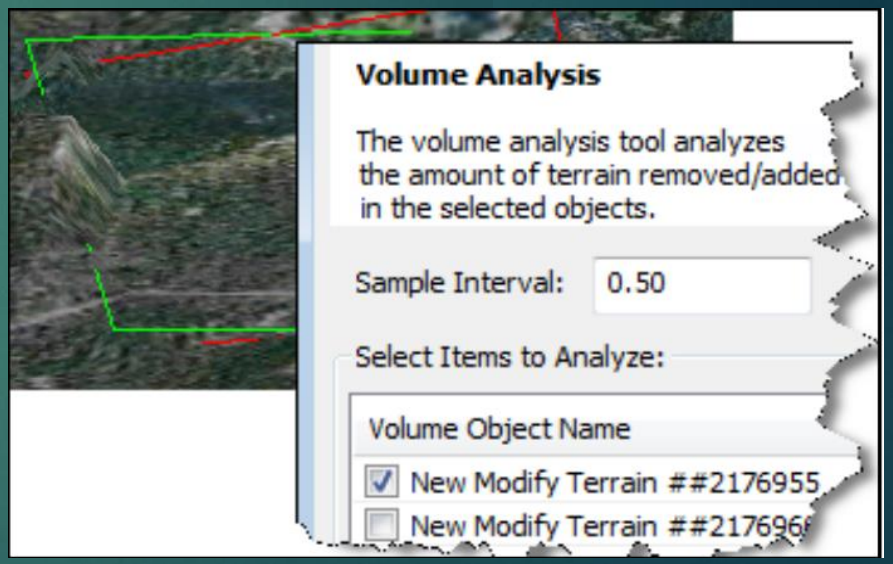
Shadow Query



This function can calculate and graphically represent overall shadow coverage or a particular object's shadow effect in a specified area.

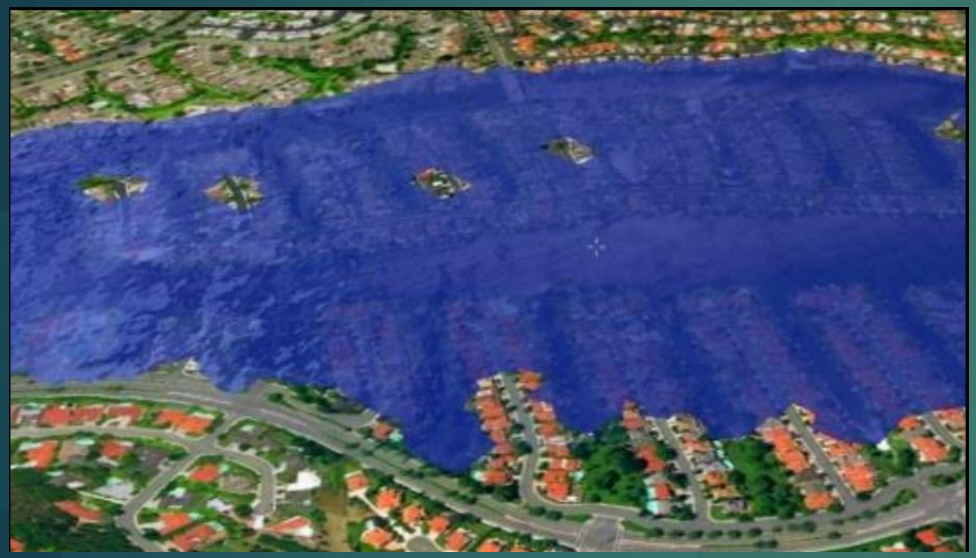
Volume Function

This function can analyze amount of terrain removed from or added to the terrain surface.



TERRAIN ANALYSIS FUNCTIONS

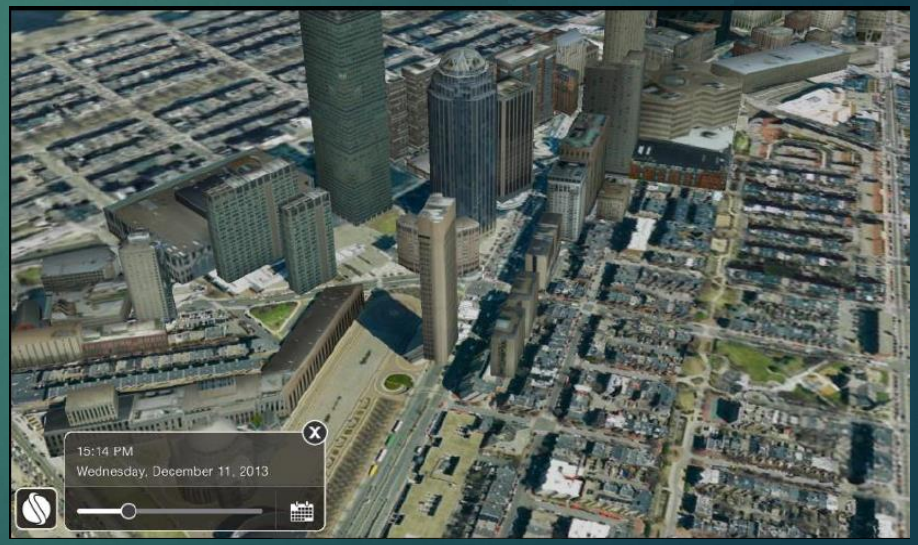
Flood Analysis



This function assesses the land area covered by water in different water flooding. The result of the flood analysis process is a set of polygons showing the flooded areas

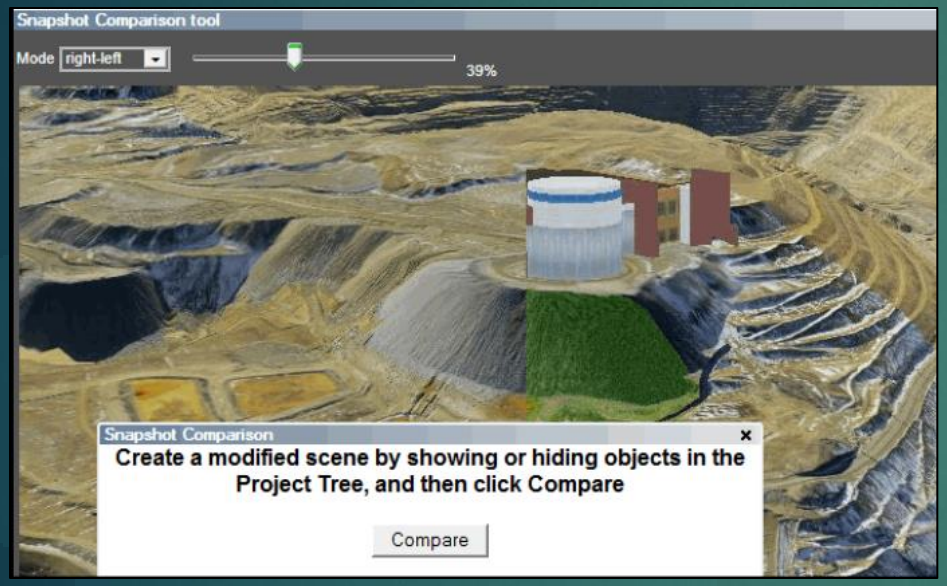
Shadow Analysis

Shadow analysis tool can display shadow for terrain and building. User can controlled date and time (Sun Position) to display the shadow.



COMPARISON TOOLS

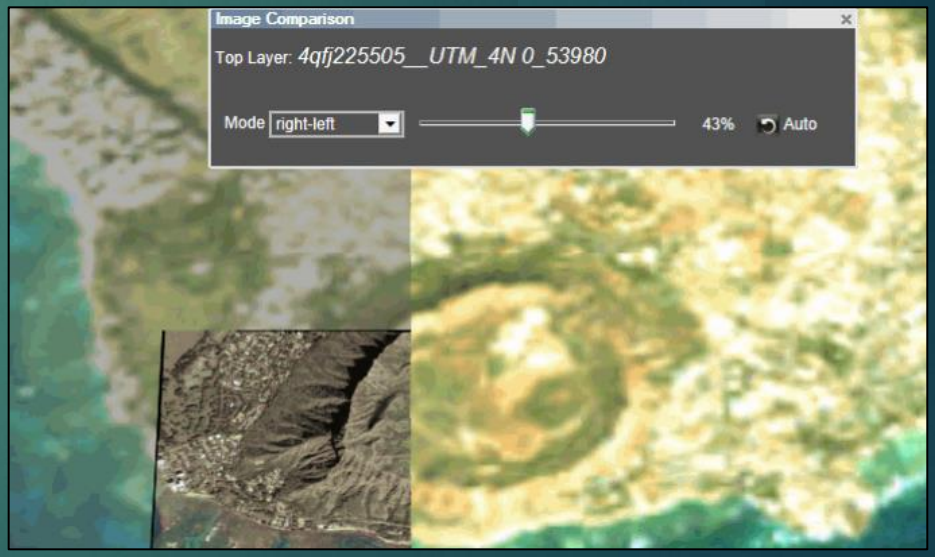
Snapshot Comparison



This function can create and compare snapshots showing different versions of the area in view in the 3D Window by showing or hiding objects in the Project Tree

Imagery Comparison

This function can compare two (2) imagery layers or an imagery layer to the base terrain by dynamically clipping or modifying transparency of an overlaying layer.



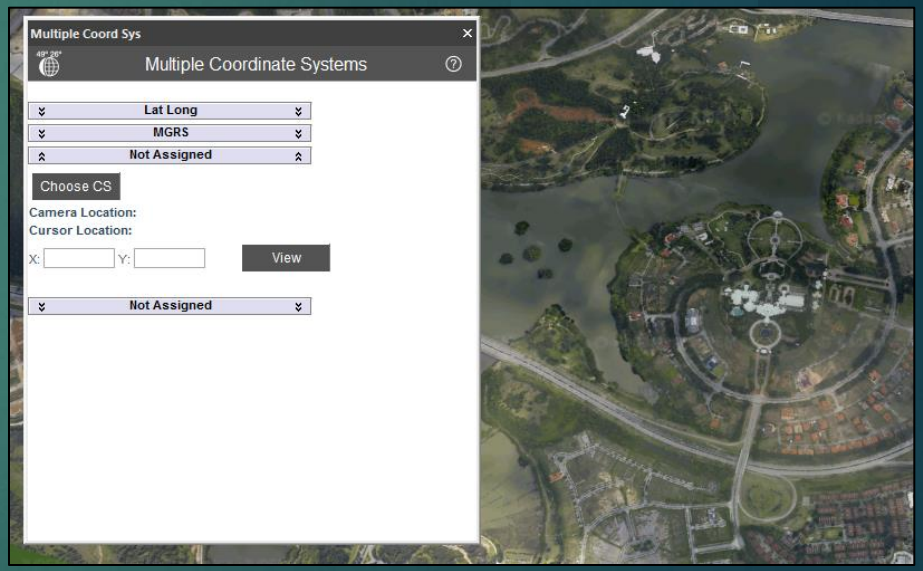
NAVIGATION

Look Around

The look around tool serves as a virtual stationary observation deck, enabling to analyze the view from a specific position. Using the controls, easily adjust your direction and tilt and zoom in and out.

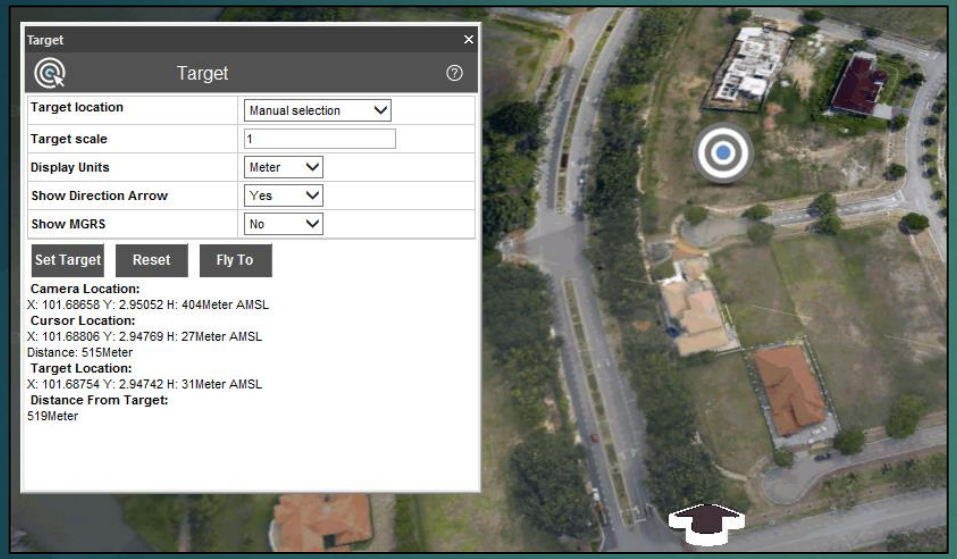
Multiple Coordinate System

The multiple coordinate systems tool projects the current camera/cursor coordinates to a user-selectable coordinate system.



NAVIGATION

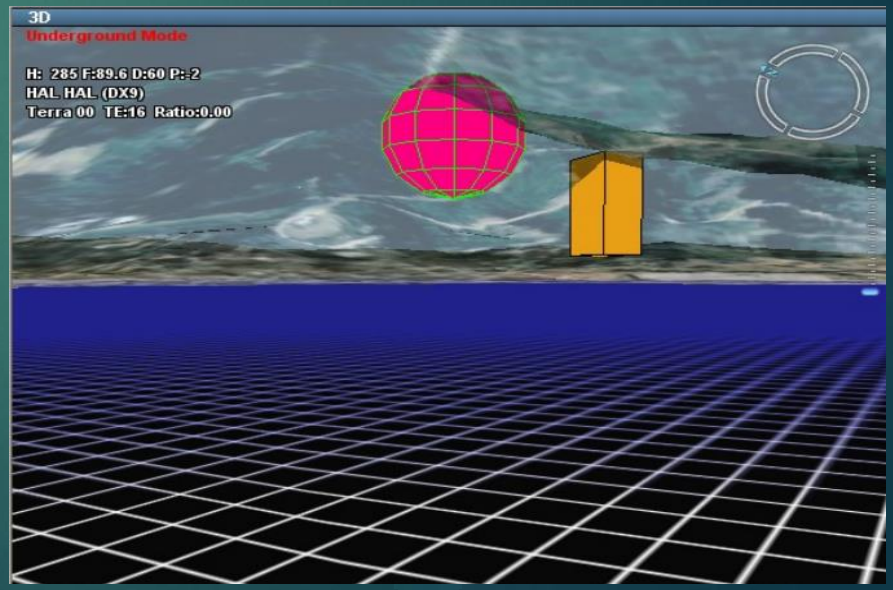
Target



This function tool continuously tracks the distance and direction to a specific target.

Underground Mode

The underground navigation mode allows user to explore the subsurface of the terrain. User can navigate under the terrain's surface and through buildings. A subsurface grid navigation aid appears when navigate below the terrain, and allowing to navigate the same way as above ground..



Conclusions

- The City Model of Brunei proposed in this paper is in line with FIG's vision of Cadastre 2.0 to produce a multi-purpose cadastral system for the future, with the prime objective of providing a solid cadastral-based spatial analysis platform which support services towards smart cities enablement in Brunei.
- The 3D City Model shall also provide an exhaustive geospatial database or information that allows the development of smart cities in a sustainable manner.
- Smart cities will be more than just a trend in the future; it can become an indispensable system to drive economic growth by harnessing the 3D information that will eventually lead to a better tomorrow.