# *INTERVISIBILITY, LBS, SUNLIGHT/SHADOW ANALYSIS, AIR AND NOISE POLLUTION*

# Applying 3D City Models

Planning, designing and managing the urban environment require appropriate decision-making. Here the availability and use of three-dimensional (3D) geo-information in the form of 3D city models is crucial. The authors give examples of how 3D city models can be used for applications including determination of intervisibility between objects, Location Based Services (LBS), sunlight/shadow analysis, and air and noise pollution.

Three-dimensional city models include Digital Elevation Models (DEM) of ground surface and 3D models (geometry and attributes) of buildings and other objects. Applications such as analysis of sunlight and shadow of buildings in densely populated areas require, in addition to 3D city models, appropriate mathematical methods, usually in addition to other types of information. Such mathematical methods include geo-statistical analysis, time-series analysis and analysis of moving platforms (dynamic analysis). The focus here is on examples of the use of 3D city models, without comprehensive treatment of the mathematical methods used to compute the results.

Wireless Communication
Intervisibility means that one object is visible from the other, and vice versa. Intervisibility is widely used in urban planning, for example for determining the locations of telecommunication antennas and analysis of sunlight and shadow of buildings. To compute whether an antenna can receive signals from a receiver in a certain position the following information has to be known: height of receiver, antenna and objects obstructing the line of sight between antenna and receiver, and elevations of their base at ground level. All this information can be extracted from 3D city models.

Location-based Services
Intervisibility is also important for establishing location-based services in a town. A typical example of LBS would be a base-station broadcasting information picked up by a moving platform, such as a truck. In this case the Electro- Magnetic (EM) signal transmitted by the base-station should reach every street of the town. Buildings and other obstacles will obstruct the propagation of EM signal by reflection, absorption, refraction or penetration. So the establishment of LBS requires analysis of how EM signals interact with objects present in the town. Also, the strength of an EM signal weakens with increasing distance from the base-station, so factors to be used in the analysis include:

- distance between base-station and moving platform
- antenna height of base-station and height of moving antenna
- heights of buildings and other obstructing objects
- distances between buildings in the street and the moving platform.

Air Pollution
Air pollution is affected by the following factors:

- source of pollution: in cities mainly industry (usually point pollution), traffic/transportation (usually linear pollution), and living stove (usually plane pollution)
- gravity causing polluting dust to nestle easily on objects between atmosphere and ground
- height of gas layer beneath which pollution concentrates.

Calculation of the pollution index of an area requires knowledge, in addition to how much pollution emitted by individual sources, of height of objects between gas layer and the ground. This information can be extracted from 3D city models.

Noise Pollution
Noise affects the health of human beings and is becoming a major source of environmental pollution. In modern cities noise comes mainly from traffic/transportation, industry and public activity. It spreads in certain directions and is emitted at a certain strength that weakens with increasing distance from the source. The presence of obstacles also influences direction and strength of noise at a certain location. Measurement of sound intensity at a certain location, the noise pollution index, is determined by many factors, including terrain relief,

presence of sound walls, vegetation and buildings and their surface structure, and the height of bridges, streets and railways. Terrain relief will be evident in the 3D city-model in the form of a DEM, along with heights of obstacles and the height of bridges, streets and railways. Measures should be taken if the noise pollution index exceeds a given index.

Sunlight and Shadow

The presence of sunlight has a great effect on human wellbeing. The number of daily sunlight hours depends upon length of day as related to position on earth and season, terrain relief, and position, height, size and shape of buildings and other objects that generate shadow. Planning location, size and shape of residential buildings, office buildings and recreational facilities therefore greatly relies on analysis of the daylight hours of sunlight and shadow. More specifically, sunlight analysis facilitates determination of the distance between two buildings, facing direction of buildings, layout orientation, width of streets and distri- bution of blocks. Analysis of sunlight and shadow requires display of various shadows, calculation of sunlight time and computation of sunlight interval: the time between sunrise and sunset without shadow. Computation of the area covered by a shadow is done by projecting the 3D building surfaces onto a 2D plane on the ground along the direction of a ray of sunlight. Figure 3 visualises the result of computing the extent of shadow created by a building. The extent of the shadows of surrounding buildings can be superimposed on the designed building to determine sunlight hours and sunlight interval.

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Further Reading

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