Virtual reality, 2D and 3D geo-visualizations in web platforms

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3D Representation

- 3D analysis enables users to create, analyze, and display surface data;
- 3D is important in many applications in planning and landscaping, for example, road, canal, dam, and building construction, and simulation of air and water pollution;
- The new dimension that GIS has added to the 3D analysis is the ability to store information (database) about 3D objects, which is missing in Computer Aided Design (CAD).

Importance of 3D in planning

- GIS is found to be of a paramount importance in planning because it gives the global view (overlay of different layers/themes).
- However, producing maps of good quality sometimes may not convince the public to agree to certain planning projects.
- Thereby, some supporting visualization weapons are necessary such as aerial photographs, satellite imagery, 3D,video clips, and good simulation in virtual environment.

Use of 3D for landscaping

- Landscape goal include vegetation texture, spatial arrangement of stand types, location of specific treatment areas, visual quality, sun and light source conditions, atmospheric conditions, sky conditions.
- Data required for landscaping include topography; ground surface characteristics; tree size, and predominant species. All these data can be integrated in GIS
- Full featured GIS software, like ArcGIS, supports capabilities to enhance image rendering, such as atmospheric effects including sky, fog and haze.
- Recent additions also support the generation of map animations and virtual reality generation using standard MPEG encoding formats.
- However, GIS and CAD software typically does not have 3-D object rendering capabilities.

Spatial dimension of the site

The site , where ever it is located, is at the intersection of several flow systems that occupy different levels above and below the surface. These levels are:

- The upper tier (Air flow at low levels 25-50 ft is low). Factory chimneys must be at high level
- The middle tier (Landscape, runoff, wetlands, etc.). Most activities occur in this tier
- The lower tier (Soil, bedrock, groundwater). It is important to know the location of the site with respect to the soil and bedrock (building foundation, fault zones, earthquake) and w.r.t. aquifers (recharge and discharge zones)

Sources of environmental data for site planning

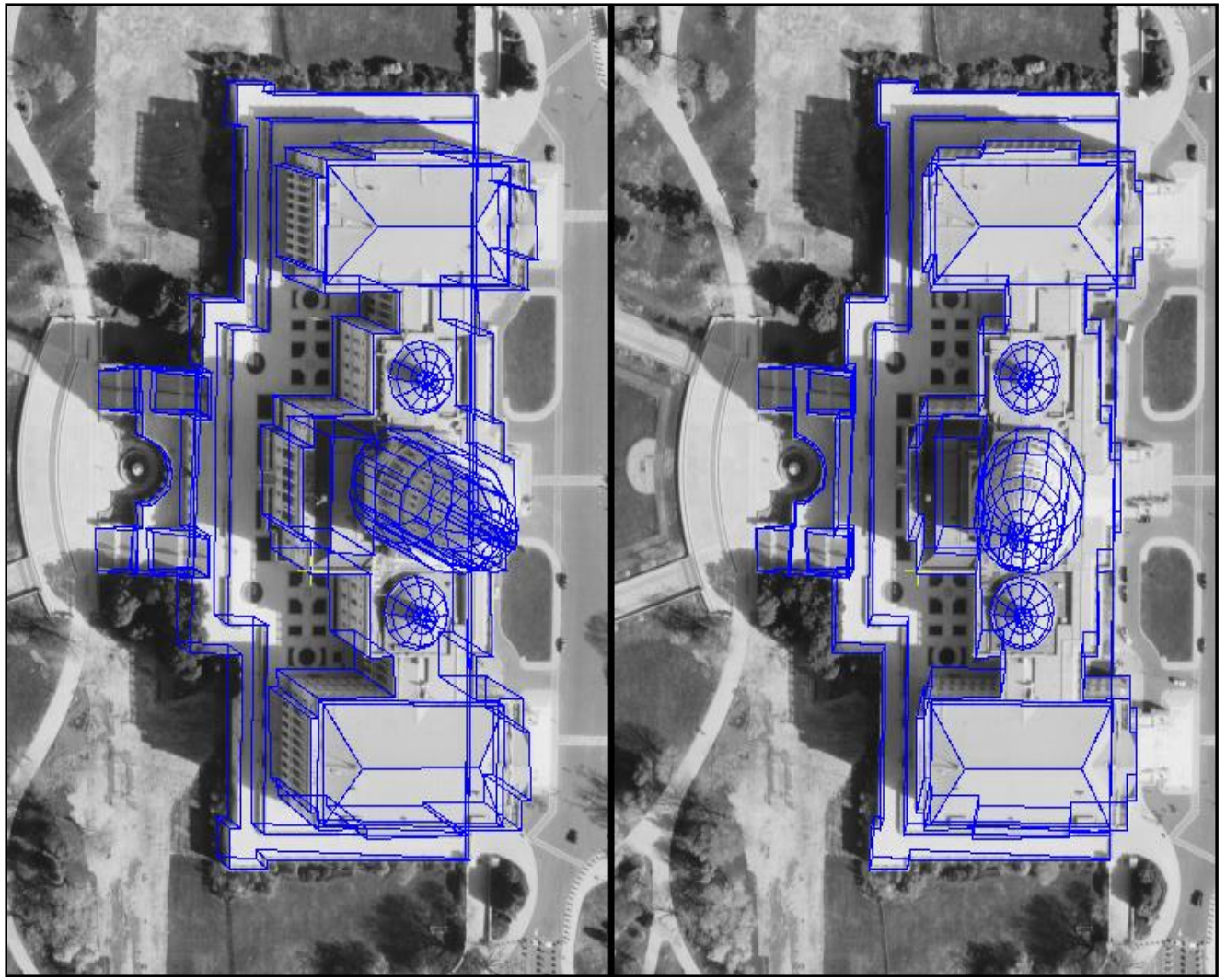
- Field investigation & Space based Earth Observations
- Secondary sources:
  - Topographic contour maps (SOI)
  - Soil map (NBSSLUP)
  - Aerial photographs (NRSC and SOI)
  - Special sources e.g. from maps or reports produced by municipalities

3D from aerial photographs and satellite images

- The use of digital photogrammetry has made a big jump in the history of 3D from aerial photograph. This jump has opened new frontier for integration of satellite imagery that has stereo-scopic nature such as CartoSat

- The advantage of digital photogrammetry can be seen in reduction of cost, minimization of time, and improvement of accuracy of 3D data derived from aerial photograph.

Extraction of Building Infrastructure Using Soft-Copy Photogrammetric Techniques



Urban Infrastructure of Rosslyn, Virginia Derived Using Soft-Copy Photogrammetric Techniques

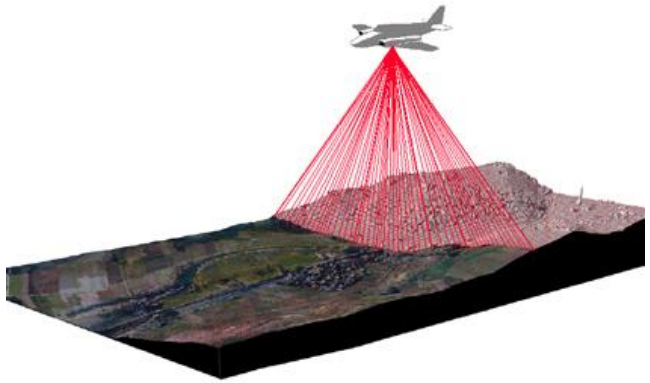
3D from Surveying and GPS

- Ground control survey (geodetic network)
- Utility location survey
- Topographic survey
- Drainage survey

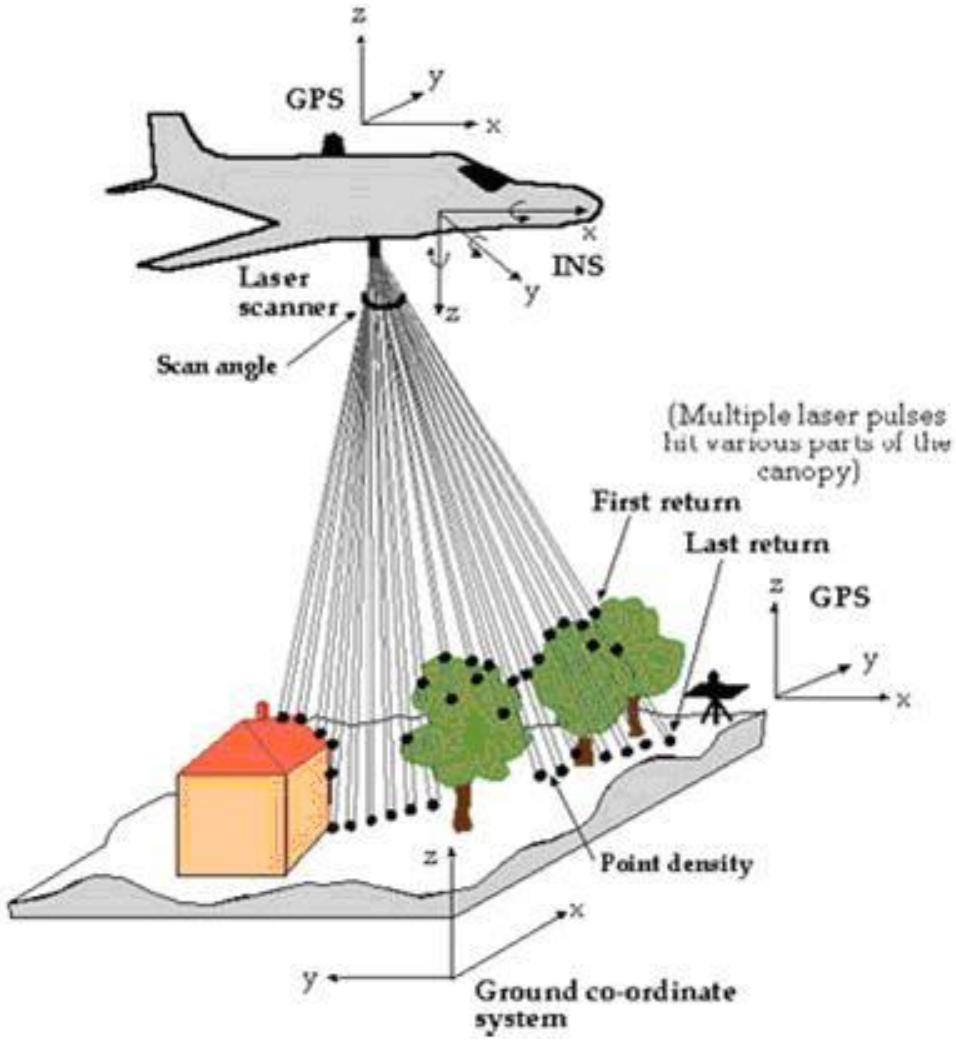
3D from LIDAR?

- LIDAR (Laser Imaging detection and ranging) is the technology of using pulses of laser (light) striking the surfaces of the earth and measuring the time of pulse return.

- LIDAR acquisition system includes:
  - LIDAR sensor
  - Digital camera
  - GPS
  - IMU (Inertial Measurement Unit)



LIDAR Data Acquisition



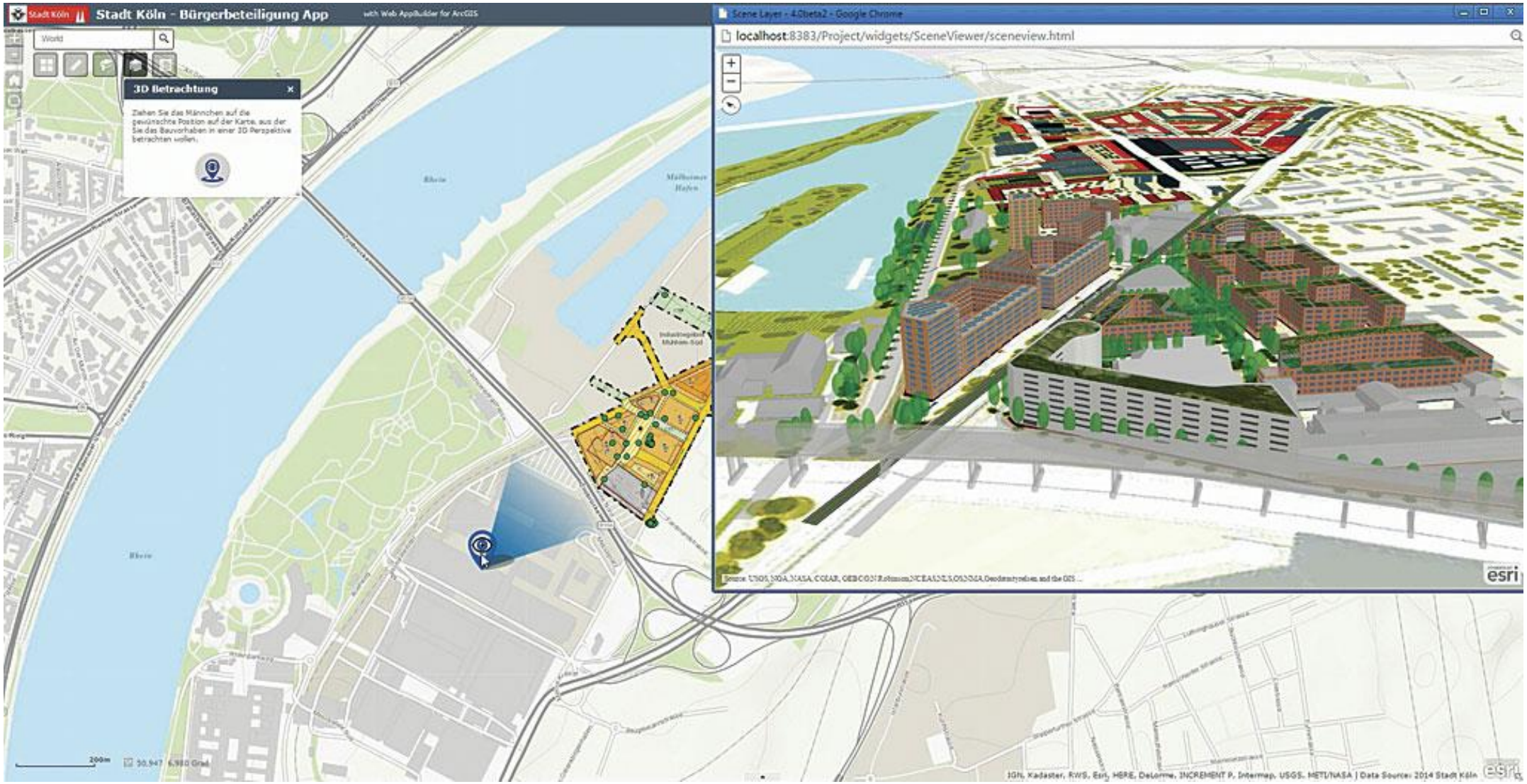
LIDAR Derived Products

- Digital surface model (DSM)
  - *Elevation model including vegetation, buildings and objects*
- Digital terrain model (DTM)
  - *Elevation model without buildings and vegetation*
- Digital elevation model (DEM)
- Triangulated Irregular Network (TIN)
- Contour lines
- Hillshades
- Volume calculations
- Data classes (post-filtering)
- Cross-section information
- Breaklines

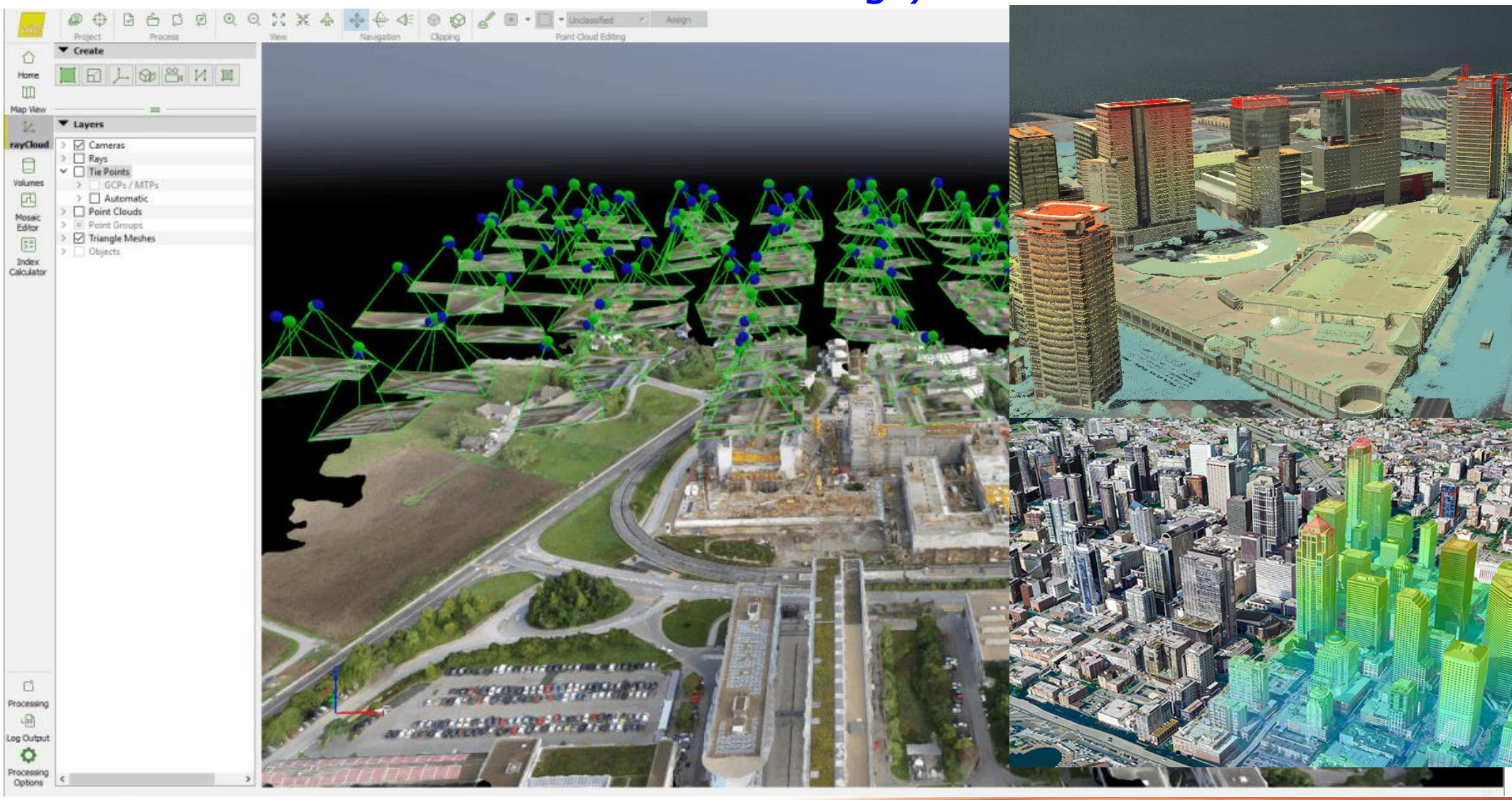
Case 1-
Urban Development/Planning

- Street-level development visualization
- Site & design review
- Neighborhood viewshed
- Feature extraction
  - Buildings
  - Planimetrics (ex. sidewalks)
- Infrastructure planning

Urban Development: 3-D Visualization



Calculation of volume data (elevation and volume of buildings)



"One image says thousands of words"


GarudaUAV

Example of 3D GIS software

- TerraExplorer
- Marbel
- AutoCad 3D : http://www.autodesk.com
- C Tech Development-EVS True 3D: http://www.cTech.com
- ESRI 3D Analyst (http://www.esri.com).
- GenaTIN (Genasys http://www.genasys.com)
- Vertical Mapper (MapInfo http://www.mapinfo.com)
- Imagine Virtual GIS (ERDAS http://www.erdas.com)
- Geovisual (EC joint Research Center, ISPRA, ITALY)
- 3-D city model (Flexiton)
- 3D Virtual White Board
- Microstation TriForma
- Landscape system (LMS)2
- Realax Terrain
- Power Scene (http://silvae.cfr.washington.edu/lms/lms.html) http://www.romt.com/Products/VISTA/index.html
- VistaPro3
- Visual Explorer (http://www.woolleysoft.co.uk)

Example of 3D software- Features

- Most of these software allow generation of 3D models, adding texture, draping images or other geographic features, fly-through, animation, rendering, making waves, designing sunset, and generation or exporting to Virtual Reality Modeling Language (VRML) and MPEG software for further animation and visual enhancement.

- Some of these software support stand level forest visualization and landscape rendering.

- The selection of a specific software is dependent on many factors such as cost, performance, ease-of-use, application domain, support to raster and vector data, and interoperability between platforms.

Challenges of integrating 3D

- Large file size especially with more colors and details
- Long Processing time e.g. for rendering
- The increase in the computer performance has made a tremendous impact on 3D modeling and visualization tools.
- The increase can be noticed in the CPU speed (3+ Ghz), Hard disk storage (80+ GB), Random Access Memory (2+ GB), video card, and monitor resolution and color (large screens for visualization).
- The end result is that generation of 3D model which may take overnight in the past can now be done within minutes and with high accuracy and vivid colors.
- Difficulty for online display (Bandwidth)
- Difficulty in import/export between different software

Virtual Reality

- The simple definition of Virtual Reality (VR) can be detected from virtual games which allow people to become visually and aurally immersed in a 3D computer generated environment that is inhabited by many virtual objects.
- As a user explores the virtual space, he/she encounters several species of computer generated animals, birds, and insects that move about independently, and interactively respond to the user's presence in various ways.
- The hardware configuration for games usually includes high performance, real-time computer, graphics platform, a head-coupled, stereoscopic color viewer, 3D localized sound cues linked to characters and events in the virtual space, and 3D high-definition television (HDTV) system.
- Existing VR interaction techniques include menus, postures, gestures, and wands.

Virtual Reality Modeling Language (VRML)

- **The Virtual Reality Modeling Language (VRML) is a standard language for describing interactive 3-D objects and worlds delivered across the Internet. The following software support VRML on the internet.**
  - CASUS Presenter (Fraunhofer Institute for Computer Graphics)
  - Community Place (Sony Corporation)
  - Cosmo Player (Silicon Graphics, Inc)
  - GLView 3.1 (Holger Grahn) http://home.snafu.de/hg/vrml/hg/index.html
  - Oz Virtual (Oz inc.)
  - Platinum WIRL (Platinum Technology)
  - WorldView (InterVista Software, Inc)
  - Lightwave 3D (http://www.clickgrafix.com)
  - http://www2.iicm.edu/vrweb VRWeb site
- MPEG-1 players: Tucows ,The Berkeley Player , Net Toob Multimedia Player

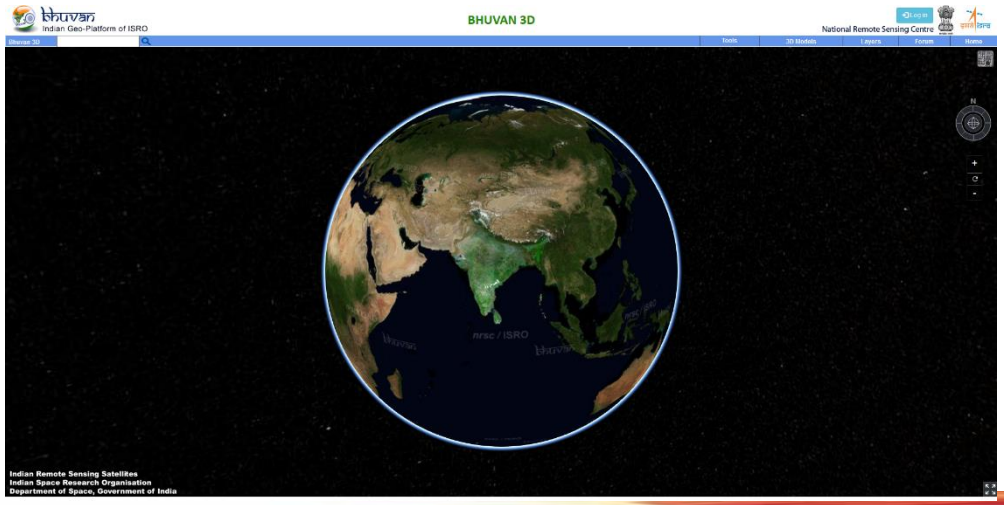
- A new way of visualization through the internet is known as **Web3d/WebGL**. It describes any programming or descriptive language that can be used to deliver interactive 3D objects and worlds across the internet. This includes open languages such as VRML, Java3D, X3D, and any proprietary languages that have been developed for the same purpose (http://www.web3d.org/vrml/vrml.htm).

WebGL

- WebGL (Web Graphics Library) is a JavaScript API for rendering interactive 3D and 2D graphics within any compatible web browser without the use of plug-ins. WebGL does so by introducing an API that closely conforms to OpenGL ES 2.0 that can be used in HTML5 elements;

- Supported by all the standard web browser;

- GIS 3 data visualization is very effective in webGL environment



Benefits of 3D and Virtual reality for Planning

- Photo-realistic presentation with possibilities for navigation through the 3D city model (fly through) and animate on-screen designs while directly linking sound and video to the display of geo-spatial information
- Abilities to create, store, design, analyze, and query city objects
- Virtual reality interface that supports visualization, manipulation and editing of standard GIS data in a VR environment

Demonstration