Power of the ArcGlobe to Explore a City on the Real World: Trabzon, Turkey

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Abstract
3D GIS provide users to create a realistic perspective image that drapes over a surface. ArcGIS 3D Analyst, allows us to visualize global perspective, large sets of 3D geographic data, and it provides the capability to seamlessly interact with any GI as data layers on 3D globe. Using the ability of ArcGIS with ArcGlobe, a 3D digital view of Trabzon city in Turkey has been successfully created on the Globe. Required large scale data including a high resolution satellite image were extracted from the current set of geographically referenced dataset of an urban GIS. In this paper, how a 3D city modeling environment can be explored on the real world with the power of ArcGlobe is acknowledged.

1. INTRODUCTION

Until now, GIS remain one of the exciting tools to manipulate geospatial data. Systems offered by various vendors are growing in terms of functionalities and all of these systems are basically two-dimensional based and at the most just able to manipulate another data layer like contours or heights to the existing datasets or layers. GIS users are getting more complex datasets and need to manipulate these datasets and generate information as we perceived in the real world, i.e. in 3D environment. This environment provides much better understanding of the geospatial pattern and phenomena, either in small or large scale areas.

3D GIS methods for display and analysis of multiple and complex datasets have been developed and used in many spatially based planning projects. These techniques demonstrably improve the presentation and understanding of site conditions to allow engineers, scientists, and the public to better understand geography, and other environmental issues. The primary advantage of these new techniques over traditional methods is that multiple datasets with different features can now readily be integrated and visualized, quantitatively evaluated, and presented together while original data integrity is maintained. However, the aim of this paper is to examine the current ArcGIS Globe extension efforts towards realizing a 3D city modeling environment on the real world with the case study of Trabzon city in Turkey.

2. BACKGROUND

Study Area: City of Trabzon, Turkey

Turkey is located at a point where the three continents making up the old world. Geographically, the country is located in the northern half of the hemisphere, at a longitude of 36 degrees N to 42 degrees N and latitude of 26 degrees E to 45 degrees E (Figure 1a). The actual area of Turkey inclusive of its lakes is 814,578 square kilometers, of which 790,200 are located in Asia and 24,378 in Europe. Turkey has a population 67.8 million (as of 2002 data). 66% of them live in cities and towns. Istanbul, the most crowded city of Turkey, has 15% of the total population of the country. In terms of population, Turkey is the second largest country in Europe.

Trabzon is located in North East part of Turkey and having coast to the Black Sea (Figure 1b). There are 17 counties and 537 villages in the province. The total area of the province is 4.664 km2, with its population is 975.137, downtown's population is about 250.000 (with respect to 2000 year data). City of Trabzon, historically and socio-culturally being the most important centre of Eastern Black Sea Region, has a history of approximately 5000 years. Because of its important location on the historic Silk Road between Europe and Asia, the city hosted many civilizations throughout history. So, the city has gained a rich cultural heritage, enriched by many ancient tales and local folk songs. It has a great developing potential with its university, modern harbor, free trade zones and tourism values.

Figure 1. Location of Trabzon, Turkey

3D with ArcGIS

Until lately, 3D global data visualization has not been a practical application because data sets of any magnitude would quickly overcome the memory and graphics resources of 3D applications in most desktop computers. ArcGIS 3D Analyst 9 ArcGlobe bypasses these limitations by varying dynamic data access and tiling to produce many different levels of detail as the users interact in real-time with large volume of data.

ArcGIS 3D allows user to effectively visualize and analyze surface data. Using ArcGIS 3D tools, a surface can be viewed from multiple viewpoints, query a surface, determine what is visible from a chosen location on a surface, create a realistic perspective image that drapes raster and vector data over a surface, and record or perform three-dimensional navigation.

The ArcGlobe application in ArcGIS 3D Analyst allows user to manage and visualize, from a local or global perspective, extremely large sets of three-dimensional geographic data. ArcGlobe also provides the capability to seamlessly interact with any geographic information as data layers on a three-dimensional globe. ArcGIS 3D Analyst mainly provides the below tasks to users.

- View data from a global to local perspective.
- Create 3D views directly using GIS data.
- Do spatial analysis in two or three dimensions.
- Analyze 3D data using cut/fill, line-of-sight, and terrain modeling.
- Visualize modeling or analysis results in 3D.
- Export visualizations into videos.

ArcGlobe is specially an easy-to-use 3D visualization application. Out of the box, image and terrain data is present and available for the entire globe. It is already available for the user to interact with. Adding data is straightforward since ArcGlobe supports all data formats supported by ArcGIS, including shapefiles, coverages, geodatabases, rasters, CAD, and much more. Once data is added, it is dynamically transformed to its appropriate location on the globe with the combination of both imagery and terrain.

3. DATA ACQUISITION

3D data in city are needed, because as compared with 2D data, 3D data can describe detail of city, which enables us conduct more accurate and detailed simulation or analysis on urban areas. Especially for planners and decision makers a virtually of real world with the surface details is very important. Besides, a 3D city overview is also very exciting and more valuable for city visitors as tourists. However, such data volumes are quite large in the number and size of elements. Because, a simple database query require a complex database search that returns hundreds, and even thousands of records. In addition, the vector or raster geometry being retrieved for display can be many megabytes and larger in size for each record. GIS data also has complex relationships and structures, such as networks, terrains, and topologies.

In order to organize local authorities' requests and planning expectations in a GIS context an urban information system has been established for Trabzon city by its own municipality. To do this, required data such as buildings, roads and streets, contours, zoning plans, land parcels, district borders etc digitized in 1:1000 map scales in vector format and all stored in the ArcGIS environment. In addition, a high resolution satellite image like Quick bird is also orthorectified with respect to control points and made available for the Trabzon GIS. All data put together within a geodatabase framework. The size of study area is totally 47.198.104 square meter with 33.619 land parcels polygons, 39 districts, 25.857 buildings and 596 km length streets (Figure 2).

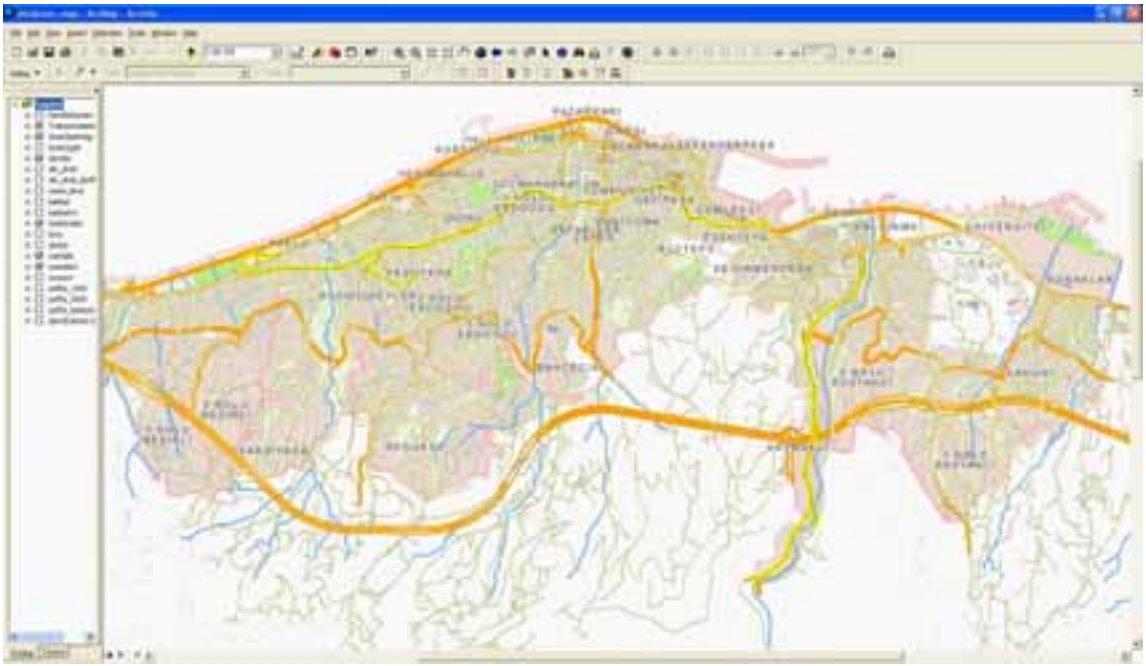

Figure 2. View of geographical data sets of Trabzon

Applications

First, data layers of downtown Trabzon as buildings, roads, districts, zoning blocks, land parcels, quick bird image have been uploaded from ArcMap to ArcGlobe environment. A high resolution image draped over surface. Using ArcGlobe main navigation tools, views from different directions over the city have been done (Figure 3). In this way, an

integration of high resolution image data and general surface data can give more detailed information about city's real world when zoomed in. Using vectorized building data with it's tabular data, all buildings can put on the real terrain data both for visualization and data query as well. Based on the building number of floors, entire buildings with their heights in the city can be viewed on the globe (Figure 4). This is especially gives very interactive good looking and valuable information on the building density of the city.

Using the other data sets draped on the globe also gives user unique way to view and analyze a large GIS datasets. Because spatially referenced data is placed on a 3D globe surface, displayed in its true geodetic location. Instantly, the globe can be manipulated, investigated and analyzed its data while viewing the city within it. At this point, ArcGlobe gives decision makers the power to tame voluminous data, and allows efficient display and query of raster data and is integrated to function with the ArcGIS geodatabase while providing support for analysis in the geoprocessing environment. Changes in surface detail are handled continuously and smoothly. Unlike other simulation applications that bring in higher surfaces abruptly causing visual "pop"-like anomalies, ArcGlobe gradually morphs the surfaces in resolution. This makes it easy to combine multiple resolutions of elevation models without sacrificing display quality or performance.

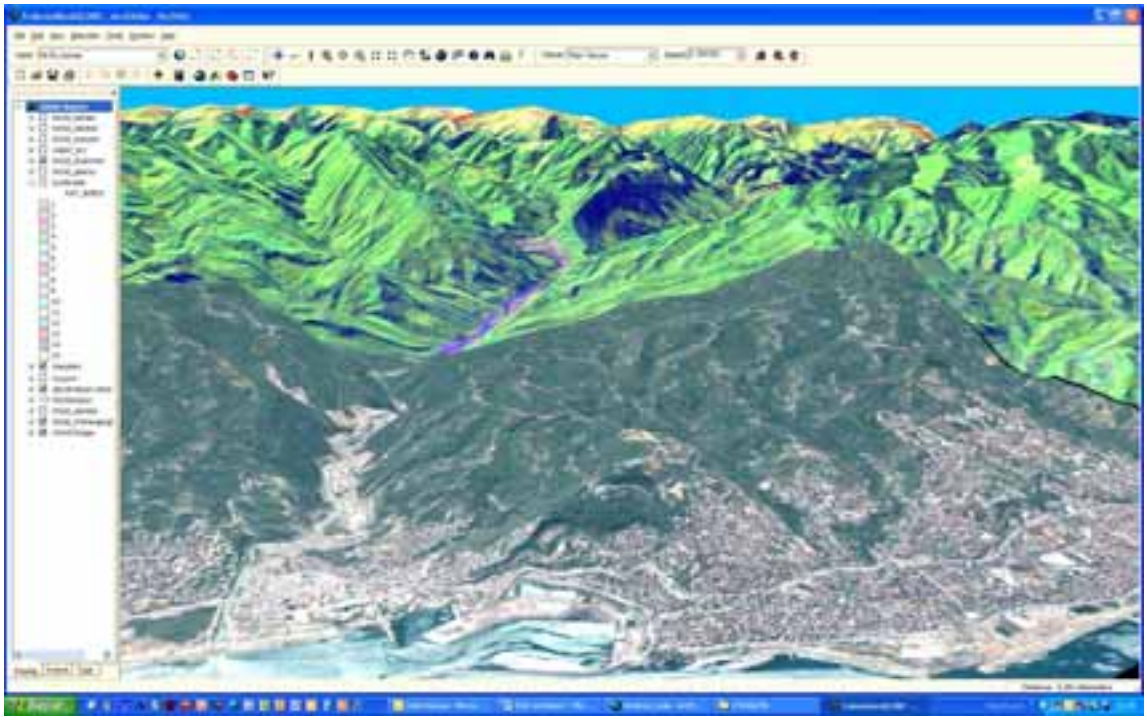

Figure 3. A view of Trabzon city with high Quick bird image which draped over the globe.

Figure 4. Building distribution in Trabzon downtown based on floor numbers.

CONCLUSION

ArcGlobe can handle extremely large amounts of data because it uses an intelligent scale dependent paging mechanism that works in conjunction with multiple levels of detail. The data is generalized when viewed from a distance while full detail is displayed as the observer zooms in. A 3D city model ordinary consists of a great amount of geometry data of buildings/structures and terrain models. When they should be transmitted through the internet, it becomes a critical requirement to reduce the data as well as to divide it into small data parts in order that they can be transmitted efficiently in the ordinary transmission environment. When a 3D city model is rendered in real time, those polygons of buildings/structures and terrains defined by 3D coordinates are displayed. Because the buildings' geometry data occupy the largest portion of the whole data, the reduction of their amount is most important. ArcGlobe utilizes a multithread approach to data and, therefore, preloads data based on the users actions, eliminating display "freezing" during redraws.

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