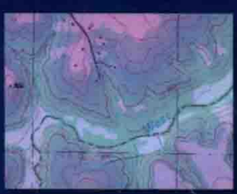
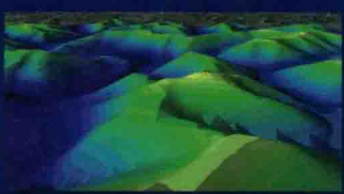
introduction to 3D data

MODELING WITH ArcGIS® 3D ANALYST™ AND GOOGLE EARTH™


K. HEATHER KENNEDY

Introduction to 3D Data

Modeling with ArcGIS® 3D Analyst™ and Google Earth™

K. Heather Kennedy

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Introduction to 3D Data

Preface

Introduction to 3D Data teaches GIS specialists, analysts, and technicians how to use ESRI's ArcGIS 3D Analyst to model and analyze three-dimensional geographical surfaces, create 3D data, and produce displays ranging from topographically realistic maps to 3D scenes and spherical earthlike views. The book is organized into 10 chapters, each focusing on one data type or software interface (ArcCatalog, ArcScene, ArcGlobe, or Google Earth). There are 39 step-by-step project exercises, with plain-language discussions throughout of pertinent data structures and software mechanics. My goal was to create a friendly, engaging atmosphere that strikes a balance between reference-like tutorials that just tell you what to do but not why, and academic tomes that celebrate theory without suggesting any real-world application. After going through these exercises, you will know exactly what 3D Analyst can do, and you will remember the situations in which you applied particular techniques and created particular types of data.

Some readers will recognize material from my previous book, *Data in Three Dimensions: A Guide to ArcGIS 3D Analyst* (Onword Press, 2004), which covered 3D Analyst for ArcGIS 8.*x*. *Introduction to 3D Data* is updated and expanded for ArcGIS 9.3 and covers new data formats, such as Terrains, multipatch features, and KML. Google Earth is also addressed, but 3D Analyst remains the focus since its strength is GIS data creation and analysis, while Google Earth is mostly for display.

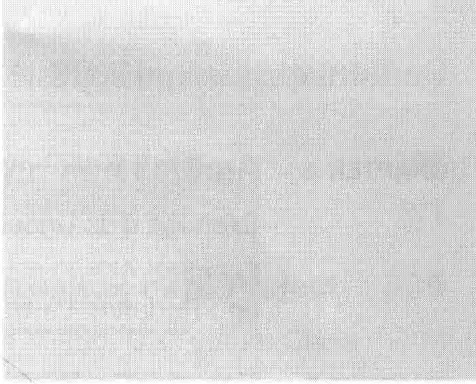
You will need to have ArcView installed to do the exercises in this book, and you will need a concurrent 3D Analyst license. Most of the exercises can be done using version 9.1 or 9.2, but some require 9.3. You will also need to have Google Earth installed.

The sample data on the support website at www.wiley.com/college/kennedy is only for tutorial use. The data has been altered and so is not reliable for purposes other than illustrative or educational. The datasets are not to be sold, copied (except for personal use), or distributed.

Acknowledgments

For providing the datasets used in this book, I'd like to thank Kent Anness and Rusty Anderson at Kentucky WRIS GIS, Ryan Freedman at Lakes Environmental Software and WebGIS.com, Jason Stoker at EROS, the North Carolina Floodplain Mapping Program via the USGS "CLICK" website, John Kelly at the SLO Datafinder, and Carol Schuldt of the Kennedy Library at Cal Poly, San Luis Obispo. I'd also like to thank Jim Harper, Dan Magers, Nancy Cintron, and Jeri Freedman of John Wiley & Sons, Josh Lazarus, and Lynda Gregory. I'd like to thank my husband, Tom McMurdo, for his never-ending support and for doing my chores while I wrote nights and weekends. Finally, I'd like to thank my dad, Michael Kennedy, author of many GIS books, including *Introducing Geographic Information Systems with ArcGIS*, Second Edition (Wiley & Sons, 2009) for his encouragement and support, and for his infectious enthusiasm that makes GIS fun.

Introduction to 3D Data



Contents

CHAPTER **1**

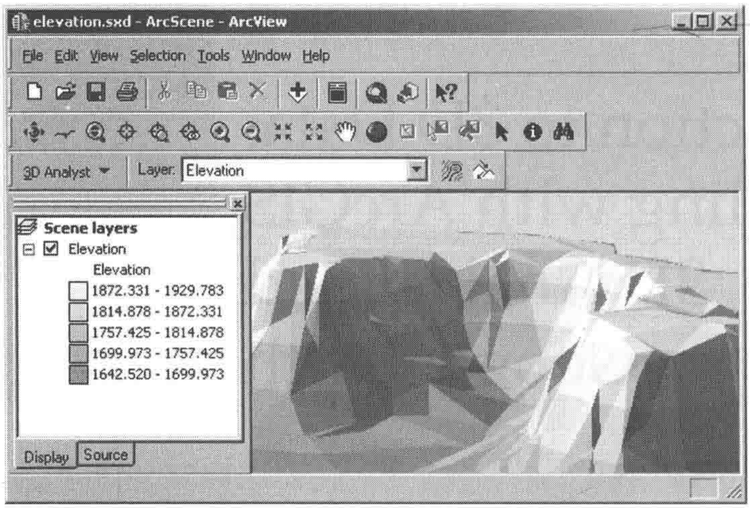
Introduction to 3D Data: Modeling with ArcGIS 3D Analyst and Google Earth

Introduction to 3D Data is a self-study tutorial workbook that teaches you how to create data and maps with ESRI's 3D Analyst software, and to integrate them with Google Earth.

The datasets for all of the exercises in the book are provided online at www.wiley.com/college/kennedy. You must already have ArcGIS 3D Analyst installed to use this tutorial, as the book does not come with any trial software. Most of the 3D Analyst exercises can be done with versions 9.1 or 9.2 of ArcView, ArcEditor, or ArcInfo; some exercises require 9.3. Google Earth is free.

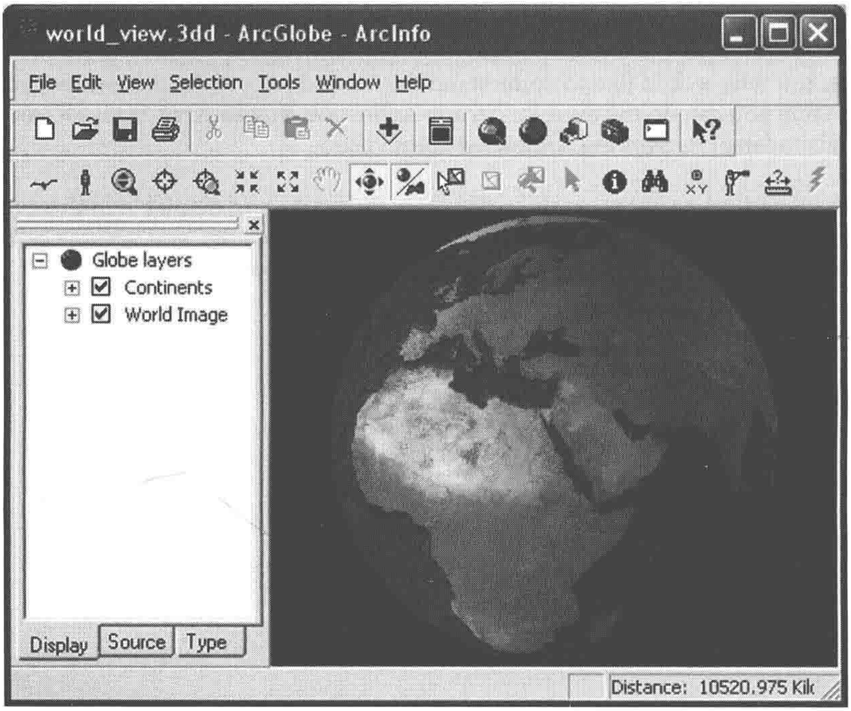
This book is designed for people who are already familiar with ESRI products, particularly ArcMap and ArcCatalog, but who would like to understand the ins and outs of the three-dimensional modeling environment. While you can do the exercises in any order, you should work through early chapters first, since instructions in later chapters are somewhat abbreviated.

3D Analyst is designed primarily to create surface elevation data and display it in three dimensions. It provides additional analysis functions such as viewshed, surface area, and volume calculation. Its original interface, ArcScene, presents data in three-dimensional space.



ArcScene models data in three-dimensional space

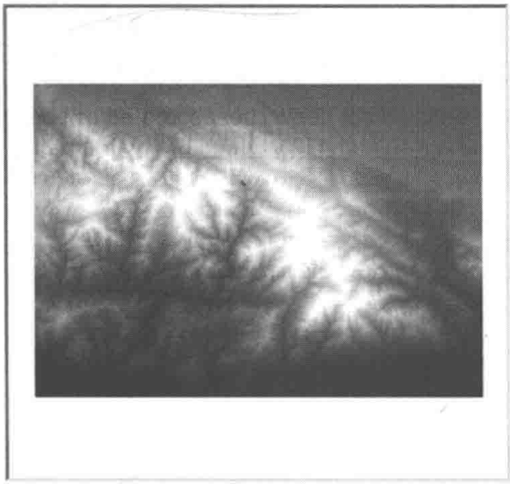
In version 9.0 ESRI added ArcGlobe to the package, which allows you to view large datasets in a global format.



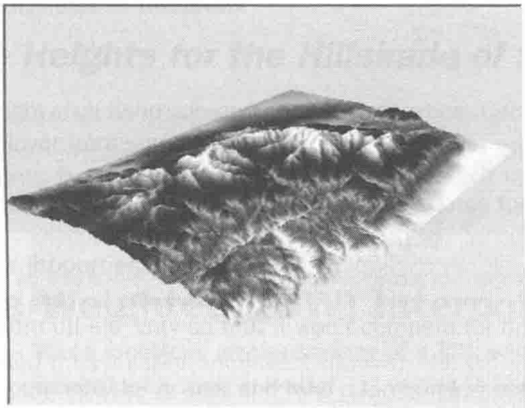
ArcGlobe models data on the earth

Increasingly, however, GIS users and the general public expect to be able to view maps interactively, on the web, for free. This is thanks largely to Google Earth, which has revolutionized the way we view spatial information. ArcGIS 3D Analyst has the power to create and analyze geographic data, but Google Earth has the speed and intuitive interface that makes it a staple for displaying maps and sharing spatial information.

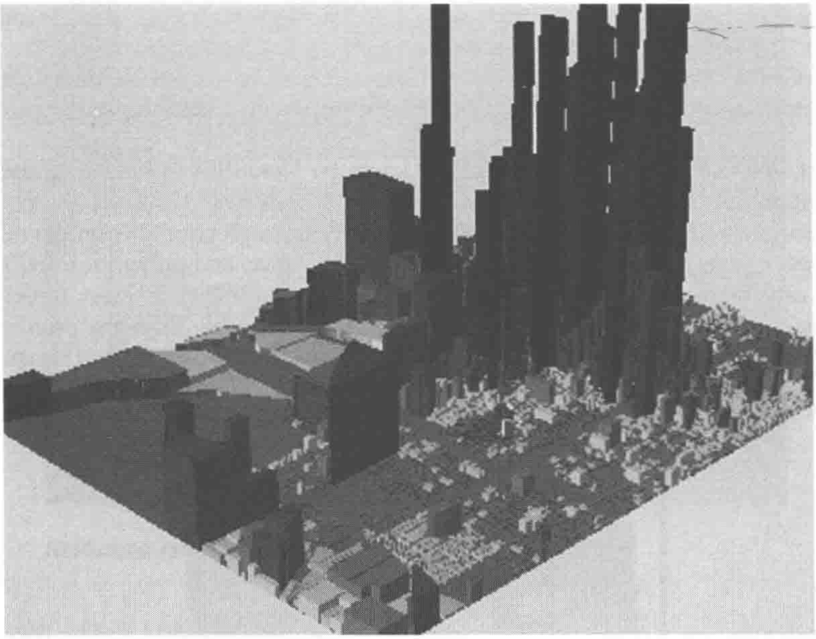
With 3D Analyst, you can create TIN (Triangulated Irregular Network) and raster surface models from any vector elevation data such as contour lines, GPS points, or survey points. In ArcScene and ArcGlobe, you can drape images and vector features over surfaces, fly through your GIS data in 3D perspective, and make movies of your flights. You can extrude 2D points, lines, and polygons into lines, walls, and solids, and you can create multipatch "true 3D" features. You can calculate slope, aspect, hillshade, volume, and surface area; create contour lines, and determine visibility from any point on a surface. You can also determine lines of sight, create profile graphs of a surface, and digitize 3D features and graphics.



An elevation raster in ArcMap

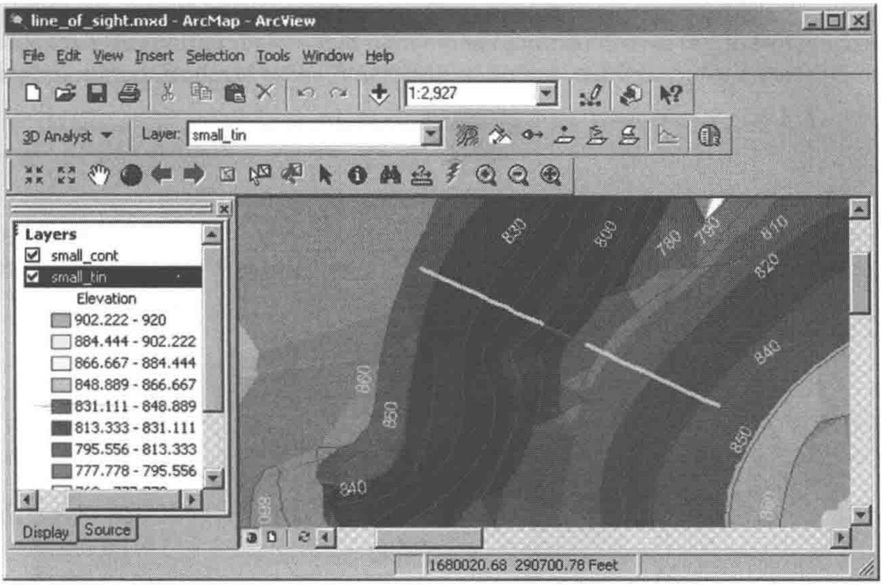


The same elevation raster in ArcScene



Parcels colored and extruded by land value

A TIN created from contour lines with faces symbolized by slope

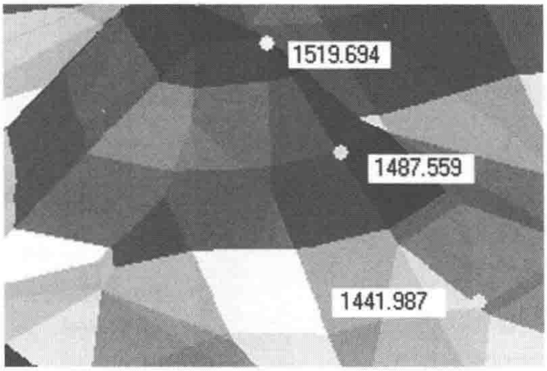


A line of sight drawn in ArcMap

3D Data Overview

X, Y, and Z Values

All geographical data contains horizontal x,y coordinate values. To work in three dimensions, you need data that contains z values as well. For each x,y location stored in a 3D dataset, a z value is stored that represents an attribute other than that location's horizontal position. In a terrain model, the z value represents elevation, or height about sea level.



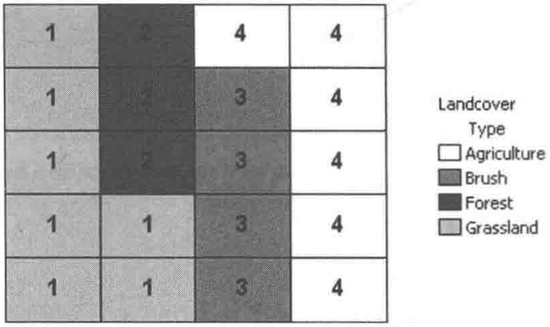
Three locations on the surface of a TIN, each labeled with their elevation (z) values in feet

3D Analyst works primarily with raster, TIN, and 3D vector feature data. Rasters and TINs are used to model surfaces, not just of terrain but of any phenomenon that varies continuously across an area, such as precipitation, chemical concentration, pollution dispersion, noise levels, population distribution, or soil pH.

Rasters

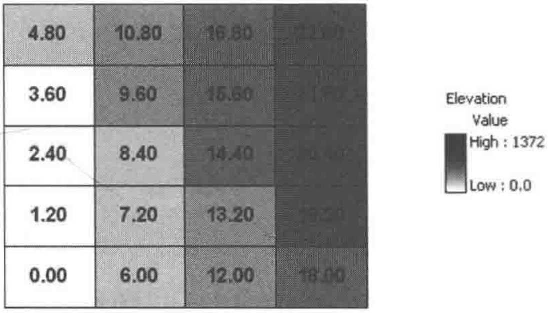
A raster represents a surface as a rectangular grid of evenly spaced square cells. Each cell is the same size and has a unique row and column address. A cell can represent a square kilometer, a square meter, or a square centimeter. The smaller the cells, the more detailed the raster, and the larger the file space taken up by the grid.

Since the grid is uniform, its horizontal (x,y) coordinates don't need to be stored in each cell. Instead they are calculated from the x,y location of the lower-left cell in the grid. Each cell does, however, hold its own z value that represents a quantity or a category of phenomena such as elevation, crop yield, or reflected light.



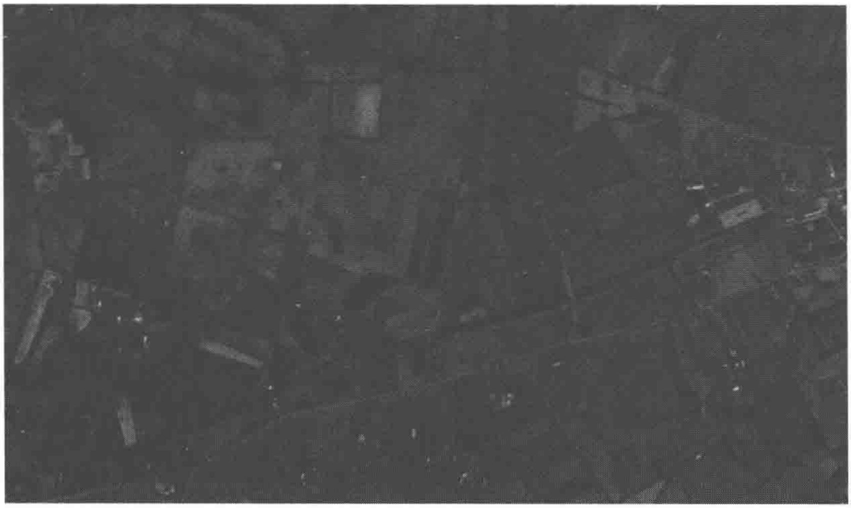
Cells in a landuse grid. All cells with the same value are symbolized by the same color

While landuse could also be represented by discrete vector polygons, vector data cannot represent values that change gradually, or continuously, over an area.



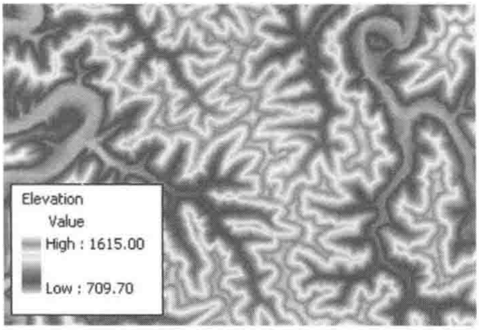
Cell in a continuous grid, symbolized by value range

Raster data is often divided into two categories: image and thematic. In an image, the surface phenomenon is the reflection or emission of light, or some other band in the electromagnetic spectrum, and can be measured by camera or satellite.



An aerial photograph. Cells in this raster represent light reflected from the earth's surface

When a phenomenon such as light is measured by a camera or a satellite, each cell's value represents the light and color at that point on the surface. A thematic raster, however, represents a category or quantity of a phenomenon such as elevation, pollution, population, rainfall, or noise. Since readings cannot be taken at every location, samples are taken instead, and a surface model is made. The model approximates the surface by interpolating the values between the sample points.



A thematic raster of elevation values. A few of the cells represent samples actually taken, but most of the values have been interpolated

3D Analyst uses the z value stored in each cell to display the raster in 3D. Elevation values are commonly shown, but any numeric cell value can be illustrated in three dimensions. Even though images and many