CHAPTER 4 RASTER DATA MODEL

4.1 Elements of the Raster Data Model
4.1.1 Cell Value
4.1.2 Cell Size
Box 4.1 Rules in Determining a Categorical Cell Value
4.1.3 Raster Bands
4.1.4 Spatial Reference
4.2 Types of Raster Data
4.2.1 Satellite Imagery
4.2.2 USGS Digital Elevation Models (DEMs)
Box 4.2 No-Data Slivers in 7.5-minute DEM
4.2.3 Non–USGS DEMs
4.2.4 Global DEMs
4.2.5 Digital Orthophotos
4.2.6 Bi-Level Scanned Files
4.2.7 Digital Raster Graphics (DRGs)
4.2.8 Graphic Files
4.2.9 GIS Software-Specific Raster Data

4.3 Raster Data Structure
4.3.1 Cell-by-Cell Encoding
4.3.2 Run Length Encoding
4.3.3 Quad Tree
4.3.4 Header File
Box 4.3 A Header File Example
4.4 Raster Data Compression
Box 4.4 A Simple Wavelet Example: The Haar Wavelet
4.5 Data Conversion and Integration
4.5.1 Rasterization
4.5.2 Vectorization
4.5.3 Integration of Raster and Vector Data
Box 4.5 Linking Vector Data with Images
Box 4.6 Digital Earth
Key Concepts and Terms
Review Questions
Applications: Raster Data Model
Task 1: View USGS DEM Data
Task 2: View a Satellite Image in ArcMap
Task 3: Convert Vector Data to Raster Data
Challenge Question
References

Raster Data Model

- A raster represents a continuous surface, but for data storage and analysis, a raster is divided into rows, columns, and cells.
- Raster data represent points by single cells, lines by sequences of neighboring cells, and areas by collections of contiguous cells.

Figure 4.1
A continuous elevation raster with darker shades for higher elevations.

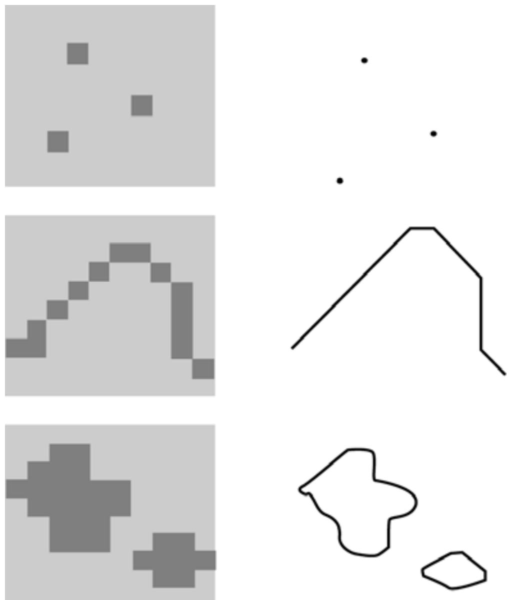


Figure 4.2
Representation of point, line, and area features: raster format on the left and vector format on the right.

Elements of Raster Data Model

1. Cell value. Each cell in a raster carries a value, which represents the characteristic of a spatial phenomenon at the location denoted by its row and column. The cell value can be integer or floating-point.
2. Cell size. The cell size determines the resolution of the raster data model.
3. Raster bands. A raster may have a single band or multiple bands.
4. Spatial reference. Raster data must have the spatial reference information so that they can align spatially with other data sets in a GIS.

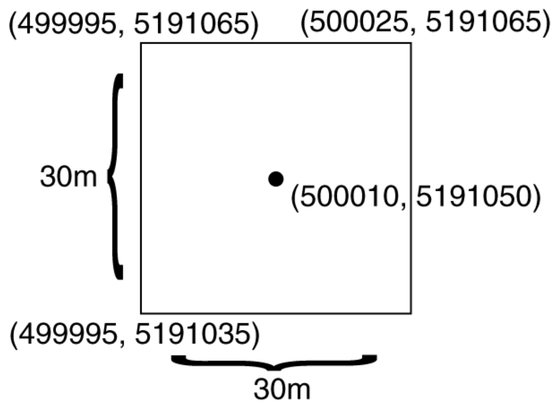


Figure 4.3
UTM coordinates for the extent and the center of a 30-meter cell.

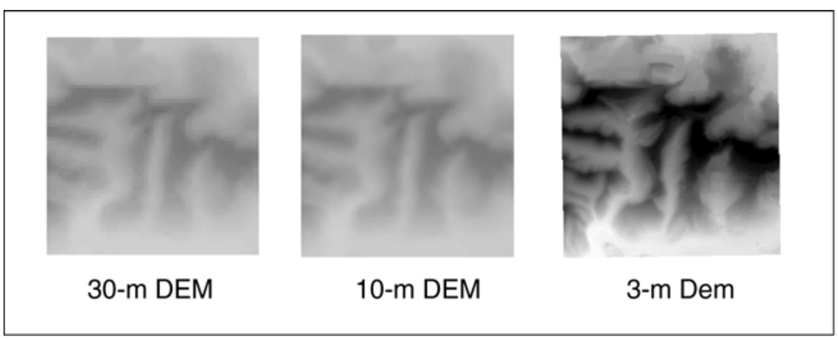


Figure 4.4
DEMs at three resolutions: 30 meters, 10 meters, and 3 meters. The 30-m and 10-m DEMs are USGS DEMs. The 3-m DEM is a derived product from LIDAR data.

Types of Raster Data

1. Satellite Imagery
2. Digital Elevation Models (DEMs)
3. Digital Orthophotos (DOQ)
4. Bi-Level Scanned Files
5. Digital Raster Graphics (DRGs)
6. Graphic Files
7. GIS Software-Specific Raster Data

Figure 4.5
USGS 1-meter black-and-white DOQ for Sun Valley, Idaho.

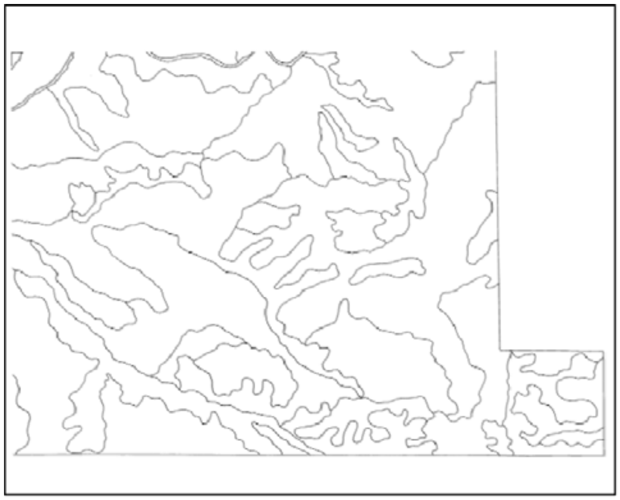


Figure 4.6
A bi-level scanned file showing soil lines.

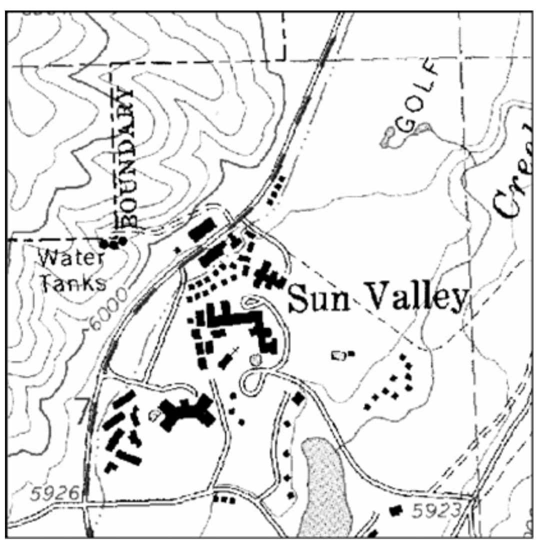
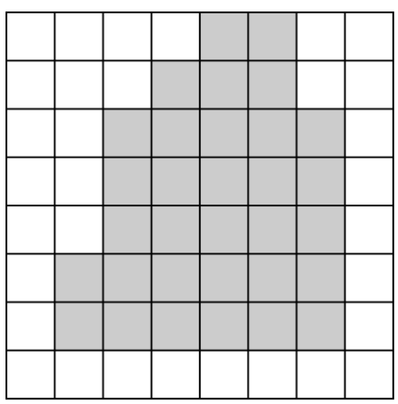


Figure 4.7
USGS DRG for Sun Valley, Idaho. This DRG is outdated compared to the DOQ in Figure 4.5.

Raster Data Structure

1. Cell-by-Cell Encoding
2. Run Length Encoding
3. Quad Tree



Row 1: 0 0 0 0 1 1 0 0
Row 2: 0 0 0 1 1 1 0 0
Row 3: 0 0 1 1 1 1 1 0
Row 4: 0 0 1 1 1 1 1 0
Row 5: 0 0 1 1 1 1 1 0
Row 6: 0 1 1 1 1 1 1 0
Row 7: 0 1 1 1 1 1 1 0
Row 8: 0 0 0 0 0 0 0 0

Figure 4.8
The cell-by-cell data structure records each cell value by row and column.

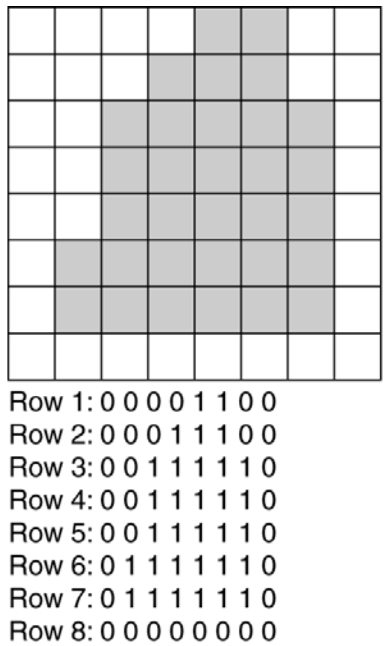


Figure 4.9
The run length encoding method records the cell values in runs. Row 1, for example, has two adjacent cells in columns 5 and 6 that are gray or have the value of 1. Row 1 is therefore encoded with one run, beginning in column 5 and ending in column 6. The same method is used to record other rows.

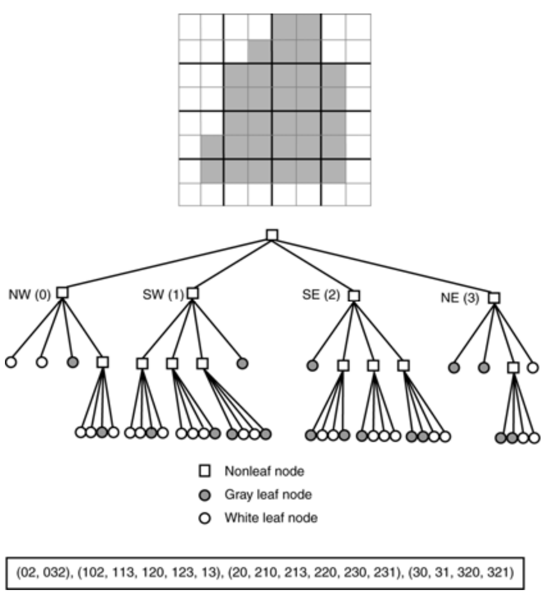


Figure 4.10
The regional quad tree method divides a raster into a hierarchy of quadrants. The division stops when a quadrant is made of cells of the same value (gray or white). A quadrant that cannot be subdivided is called a leaf node. In the diagram, the quadrants are indexed spatially: 0 for NW, 1 for SW, 2 for SE, and 3 for NE. Using the spatial indexing method and the hierarchical quad tree structure, the gray cells can be coded as 02, 032, and so on. See text for more explanation.

Raster Data Compression

- Data compression refers to the reduction of data volume.
- A variety of techniques are available for image compression. Compression techniques can be lossless or lossy.
- The wavelet transform, the latest technology for image compression, treats an image as a wave and progressively decomposes the wave into simpler wavelets.

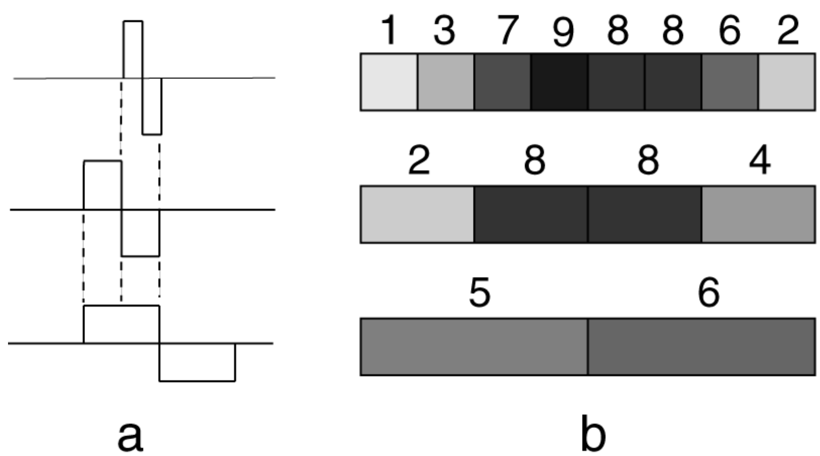


Figure 4.11
The Haar wavelet and the wavelet transform: (a) Three Haar wavelets at three scales (resolutions), (b) A simple example of the wavelet transform.

Data Conversion

The conversion of vector data to raster data is called *rasterization*, and the conversion of raster data to vector data is called *vectorization.*

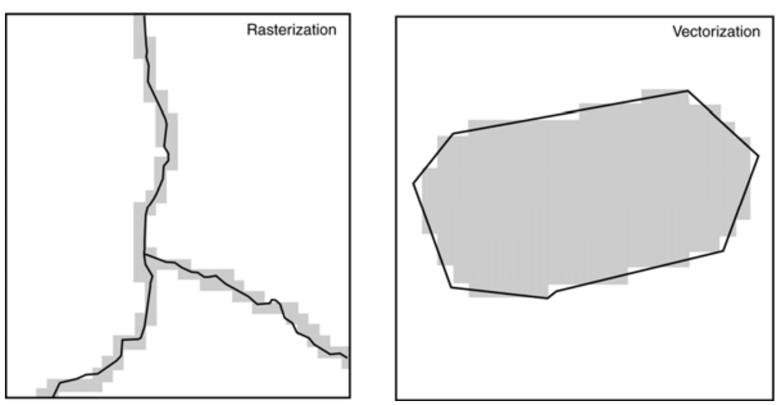


Figure 4.12
On the left is an example of conversion from vector to raster data, or rasterization. On the right is an example of conversion from raster to vector data, or vectorization.

Landsat 7
http://landsat.usgs.gov/
Terra / ASTER
http://terra.nasa.gov/About/
AVHRR
http://edc.usgs.gov/products/satellite/avhrr.html
SPOT
http://www.spot.com/
India’s space program
http://www.isro.org/
Japan’s space program
http://www.jaxa.jp/index_e.html
GeoEye
http://www.geoeye.com/
QuickBird
http://www.digitalglobe.com/
USGS National Center for Earth Resources Observation & Science
http://edcsns17.cr.usgs.gov/srtmdted2
Intermix Technologies
http://www.intermap.com/
USGS website for LIDAR
http://lidar.cr.usgs.gov/

SRTM DTED
http://edcsns17.cr.usgs.gov/srtmdted2
ETOPO5
http://www.ngdc.noaa.gov/mgg/global/etopo5.HTML
GTOPO30
http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html
GLOBE
http://www.ngdc.noaa.gov/mgg/topo/globe.html
Lizard Tech Inc.
http://www.lizardtech.com/
ERDAS
http://gis.leica-geosystems.com/
ER Mapper
http://www.ermapper.com/
Feature Analyst
http://www.featureanalyst.com
USGS: status graphics for DEMs, DRGs, and DOQs
http://statgraph.cr.usgs.gov/viewer.htm
Geospatial One-stop
http://www.geodata.gov/

Massachusetts GIS
http://www.state.ma.us/mgis/mrsid.htm
Digital Earth in China
http://www.digitalearth.net.cn