LECTURE 4-A
GIS DATA

CEEN 4800/6965 - Special Topics
Geographic Information Systems and Hydrologic & Hydraulic Modeling
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OUTLINE

- GIS Movie No. 4
- Data types
  - Mapping data
  - Applications data
- Public domain data
- Commercial data
- ArcGIS exercises
  - Section 3: Displaying Data

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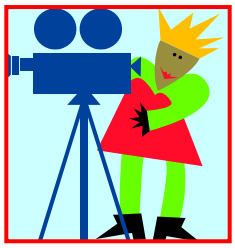
GIS MOVIE NO. 5

- GIS Primer: What you need to know about data
  - data types
  - map projections
- 3:40 minutes



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IMPORTANCE

- Data is the most important component of a GIS. Without data, you simply have a computer program; not a GIS.
- You should be aware of the intended use and accuracy of your GIS data.
- Data quality and accuracy should be evaluated in the context of the GIS application in which the data will be used.
- GIS data examples:
  - Water and sewer system drawings
  - Attribute data
  - GPS data
  - Aerial photographs
  - Satellite imagery
  - Contour maps
  - Parcel maps
  - Customer billing records

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DATA FORMATS

- According to some estimates there are over 80 GIS data formats.
- Too many data formats are not good.

Vector	Raster
Automated Mapping System (AMS)	Arc Digitized Raster Graphics (ADRG)
Coverage	Band Interleaved by Line (ESRI BIL)
Computer Graphics Metafile (CGM)	Band Interleaved by Pixel (ESRI BIP)
Digital Feature Analysis Data (DFAD)	Band SeQuential (ESRI BSQ)
Encapsulated PostScript (EPS)	Windows Bitmap (BMP)
Native MicroStation Drawing File (DGN)	Device Independent Bitmap Format (DIB)
Dual Independent Map Encoding (DIME)	Compressed ARC Digitized Raster Graphics (CADRG)
Digital Line Graph (DLG)	Controlled Image Base (CIB)
Drawing Exchange Format (DXF)	Digital Terrain Elevation Model (DTED Levels 1 and 2)
AutoCAD Drawing (DWG)	ER Mapper (Basic Image Format)
MapBase File (ETAK)	Graphics Interchange File (GIF)
ESRI GeoDatabase	ERDAS Imagine
Land Use and land Cover Data (GIRAS)	ERDAS 7.5 GIS
Interactive Graphic Design Software (IGDS)	ESRI GRID File Format (GRID)
Initial Graphics Exchange Standard (IGES)	JPEG File Interchange Format (JFIF)
Map Information Assembly Display System (MIADS)	Multiresolution Seamless Image Database (MrSID)
MOSS Export File	Spatial Database Engine Raster File Format (ArcSDE Raster)
TIGER/Line file	Tag Image File Format (TIFF and GeoTIFF)
Spatial Data Transfer Standard (SDTS)	
Topological Vector Profile (TVP)	
ArcView GIS Native Format (Shapefile)	
Vector Product Format (VPF)	

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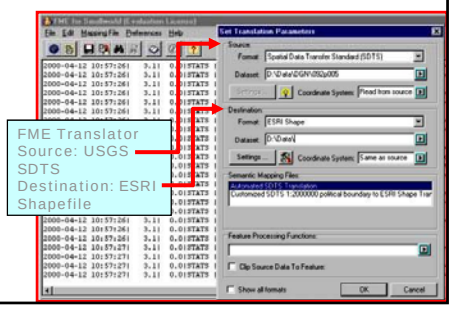
DATA CONVERSION

- Different GIS data are available in different formats, projections, and scales.
- Converting from one format of data to another is cumbersome, time-consuming, and error-prone.
- Open GIS Consortium (OGC) (www.opengis.org) is working hard to standardize data formats

Sample GIS Data Conversion Web sites

- GeoCommunity: software.geocomm.com/translators/
- GIS Tools: www.gistools.com
- Safe Software Inc.: www.safe.com
  - Feature Manipulation Engine (FME) suite
  - ArcGIS Data Interoperability Extension
- Hitachi Software: www.anygis.com



TYPES OF DATA

- **Mapping Data: Necessary assets data for making GIS maps**
  - **Water, Wastewater, Stormwater**
    - **Example: manhole layer**
  - **A pre-requisite for most applications**
- **Applications Data: Optional data for developing applications**
  - **Planning**
  - **Modeling**
  - **Work order management**
  - **Example: manhole inspections**
  - **Needed when applications are developed**

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WATER SYSTEM FEATURES

Feature Types	
Line	**Point**
Water main	Manhole
Service main	Vault
Raw water intake	Backflow preventor
Fire line	Flow meter
Hydrant line	Leaks
Casing	Pump station
Service line	Reservoir

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WATER SYSTEM ASSETS

- Pipes
- Valves
- Hydrants
- Storage facilities:
  - Tanks
  - Reservoirs
- Supply sources:
  - rivers, lakes
  - groundwater (wells)
- Intakes
- Treatment plants
- Pumping stations
- Motors
- Wells
- Services
- Meters
- Pressure zones

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WATER SYSTEM: PIPES DATA

- Source ID
- Street address
- Upstream (from) ID
- Downstream (to) ID
- Diameter
- Length
- Upstream invert elev.
- Downstream invert elev.
- Depth
- Date installed
- Pipe gage
- Friction factor
- Corrosion factor
- Material
- Joint
- Frost depth
- Valve shutoff
- Critical service & hydrant cross-referencing

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WATER SYSTEM: VALVES DATA

- Device ID
- Status
- Direction to open
- Number of turns
- Manufacturer
- Size
- High/low pressures
- Operator depth
- Water main and valve cross-referencing

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WATER SYSTEM APPLICATIONS DATA

- Attribute data required for hydraulic modeling (e.g., node demands and elevations)
- Field Inspections
  - Water quality tests
  - Hydrant testing
  - Pressure tests
  - Flow tests
- Preventive Maintenance
  - Valve exercising
  - Flushing
  - Leak survey
- Monitored constituents

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DATA SOURCES

1. Mapping Data

- **Always need custom data created by data conversion**
  - **Scanning, and/or**
  - **Digitization**
- **GPS**

2. Applications Data

- **Might need custom data created by data conversion**
- **Obtain public domain data**
- **Purchase commercial data from data vendors**

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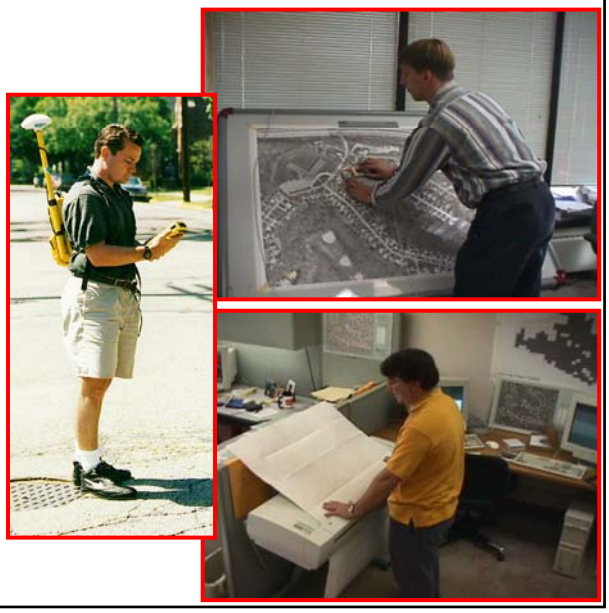
DATA CONVERSION / COLLECTION

- Data conversion
  - Digitization
  - Scanning
- Data collection
  - Global Positioning System (GPS)
    - Details in a separate lecture



PUBLIC DOMAIN DATA

- Non-proprietary data developed by government agencies for public use
- Generally free when available online or for the cost of media
- The most common public domain data sources:
  - USGS / EPA
    - Low resolution B&W aerial photographs
    - Topographic maps
    - Digital elevation models (DEMs)
    - Watershed boundaries
    - Rivers and streams
    - Land use / land cover
  - Census Bureau
    - Demographics
    - Vector land base (roads, streams, etc.)
  - NRCS
    - Digital soil maps
  - FEMA
    - Digital flood plain maps

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PUBLIC DOMAIN DATA WEBSITES

Organization	*Data*	*Web Site*
USGS	**Digital Orthophoto Quadrangles (DOQ)**	***seamless.usgs.gov gisdata.usgs.net edc.usgs.gov/geodata/***
	Digital Raster Graphics (DRG)	
	Digital Elevation Model (DEM)	
	National Elevation Dataset (NED)	
USGS/EPA	**National Land Cover Database (NLCD)**	***seamless.usgs.gov nhdgeo.usgs.govindex_java.html***
	National Hydrography Dataset (NHD)	
U.S. Census Bureau	**TIGER/Line data for census blocks and geographic features**	***www.census.gov/geo/www/tiger/index.html***
FEMA	**DFIRM**	***www.fema.gov/MSC/index.htm***
	Digital Q3 flood data	
NRCS	**Soil Survey Geographic (SSURGO) soils data**	***www.ncgc.nrcs.usda.gov/products/datasets/statsgo/***
	State Soil Geographic (STATSGO) soils data	***www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/***

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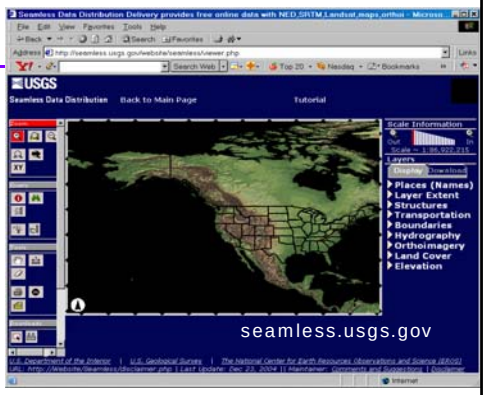
USGS GIS DATA



- Older tiled data sets retired June 30, 2005 :
  - Digital Elevation Models (DEM)
  - Digital Line Graphs (DLG)
- New seamless data formats
  - Older data sets replaced by:
    - National Elevation Data Set (NED),
    - National Atlas Data Set, and
    - National Hydrography Dataset (NHD)
- Web sites:
  - seamless.usgs.gov
  - gisdata.usgs.net (use this URL for Web service link from within GIS)
  - edc.usgs.gov/geodata/
  - National Atlas: www.nationalatlas.gov
  - National Map: nationalmap.gov
    - Fast map viewer interface
    - Only map making; no data downloads
    - Scale too small for our GIS applications

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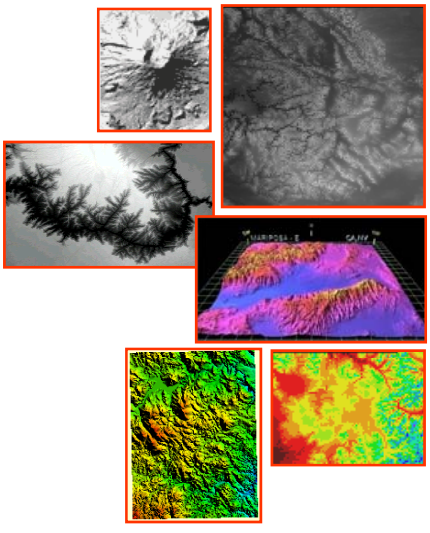
USGS DEM DATA

- Digital representation of cartographic information in raster format
- A grid of elevation points defined by X,Y,Z coordinates



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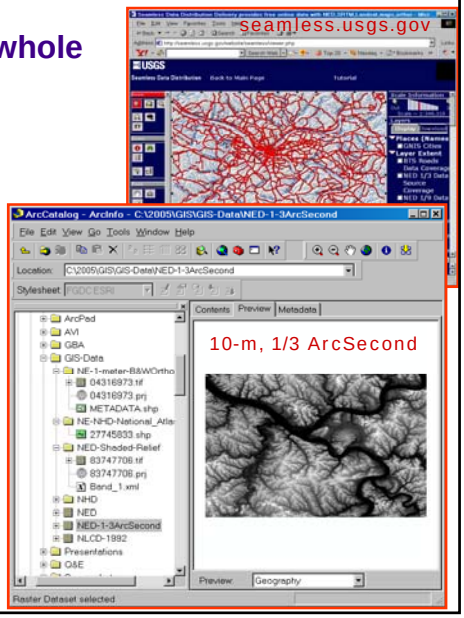
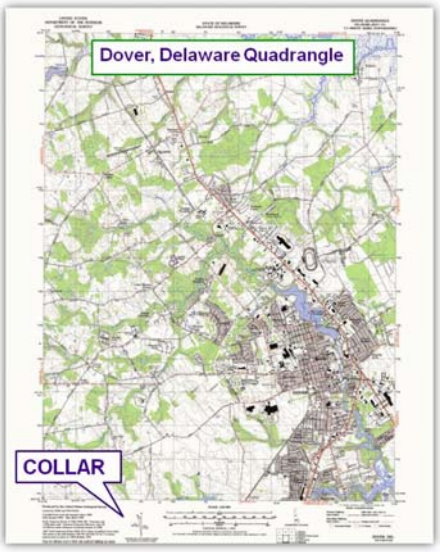
NATIONAL ELEVATION DATASET (NED)

- Seamless raster data for the whole country
- Drag a rectangle to define download region
- Formats: ESRI GRID, Floating Point, and BILS
- Scale: 1:24,000
- Resolution: 3-30 meters
- Free download from seamless.usgs.gov



USGS DIGITAL RASTER GRAPHIC (DRG)

- A raster image of a scanned 7.5 minute USGS topographic map in UTM map projection system.
- Can be used as a background raster layer (base map) in GIS.
- Web: topomaps.usgs.gov/drg/



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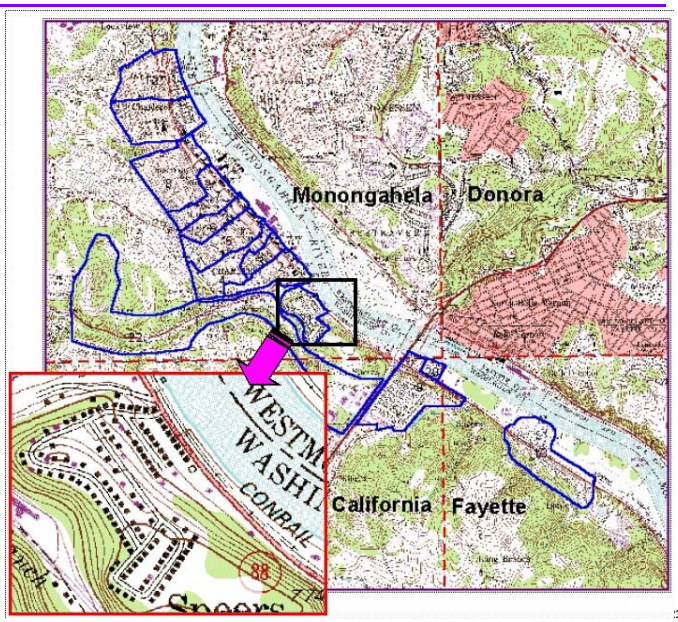
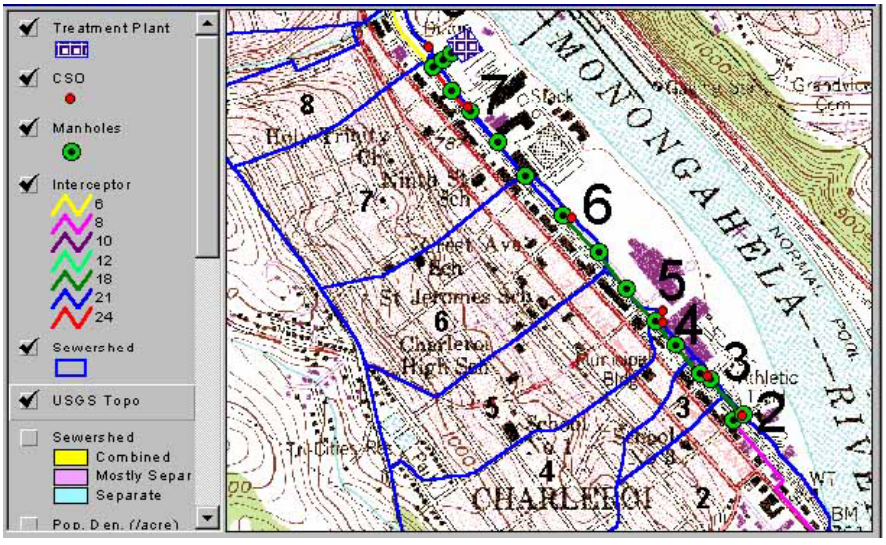
DRG EXAMPLE

Mosaic of four quads

Charleroi, PA

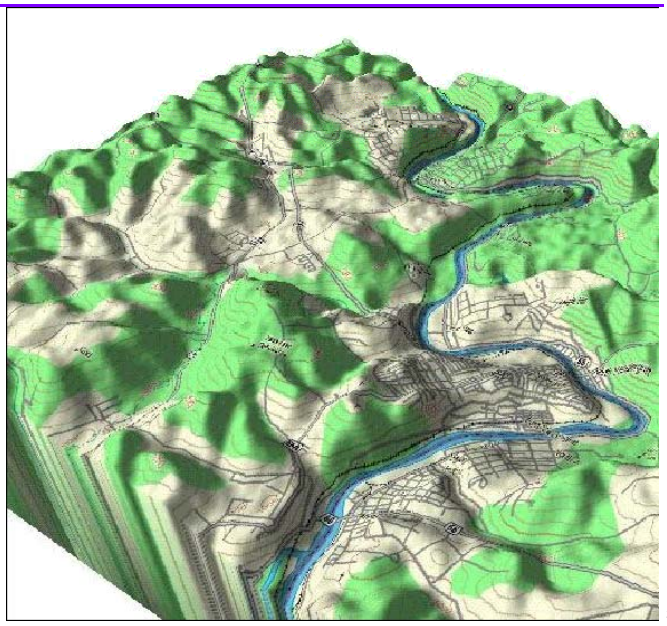


DRG APPLICATION



INTEGRATE DRGs and DEMs

- DRGs can be merged with DEMs to produce a hybrid digital file (3D draping).
- Example: A DRG Draped Over a DEM Showing Kiskiminetas River, Pennsylvania (Created using TopoUSA from DeLorme Inc.)



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AERIAL PHOTOGRAPH VS. ORTHOPHOTO

1. A conventional perspective aerial photograph contains image displacements caused by the tilting of the camera and terrain relief (topography). It does not have a uniform scale. You cannot measure distances on an aerial photograph like you can on a map. It is not a map.
2. The effects of tilt and relief are removed from the aerial photograph by the rectification process to create an orthophoto.
3. An orthophoto is a uniform-scale photograph. It is a photographic map.
4. Since an orthophoto has a uniform scale, it is possible to measure directly on it like other maps.
5. An orthophoto may serve as a base map onto which other map information may be overlaid.

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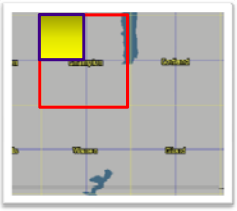
DOQ AND DOQQ DATA

- DOQ = Digital Orthophoto Quad
  - Cover a 7.5' (1:24,000) USGS quad
  - Based on 1:80,000 NHAP aerial photos, alt. 40,000 ft
  - 2m resolution, 40 ft accuracy
  - 5 MB JPEG-compressed, $35.5 per county CD
- DOQ_Q = Digital Orthophoto Quarter Quad
  - Cover a quarter of USGS quad (3.75' @ 1:12,000)
  - Based on 1:40,000 NAPP aerial photos (90's), alt. 20,000 ft
  - UTM Projection, NAD83 Datum
  - 1m resolution, 33.3 ft accuracy
  - 40-50 MB uncompressed, $60 per file on CD



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DOQ_Q APPLICATION

USGS DOQ_Q Image as a Basemap for Sanitary Sewers and Manholes

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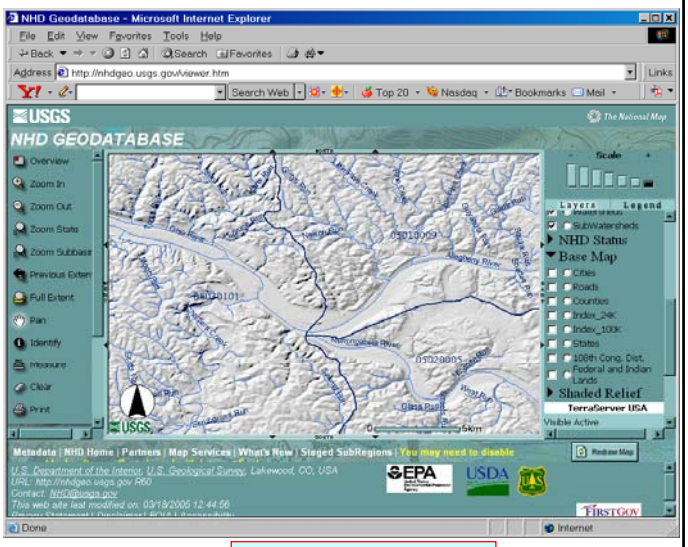
NATIONAL HYDROGRAPHY DATASET (NHD) USGS + EPA JOINT DATA

- Rivers, streams, creeks
- Scale = 1:100,000
- Highly attributed and very accurate



Streams on NED Shaded Relief

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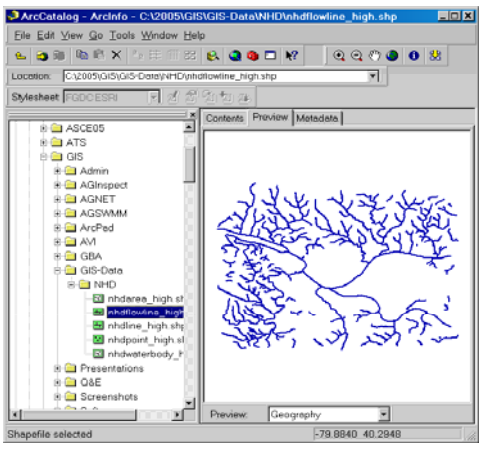
NATIONAL HYDROGRAPHY DATASET (NHD)

- Free downloaded from: nhdgeo.usgs.gov
- Instant download of streams shapefile (less than 1 minute)
- Other raster layers (DOQ, DRG, etc.) are not downloaded.
- Downloaded shapefile in ArcCatalog



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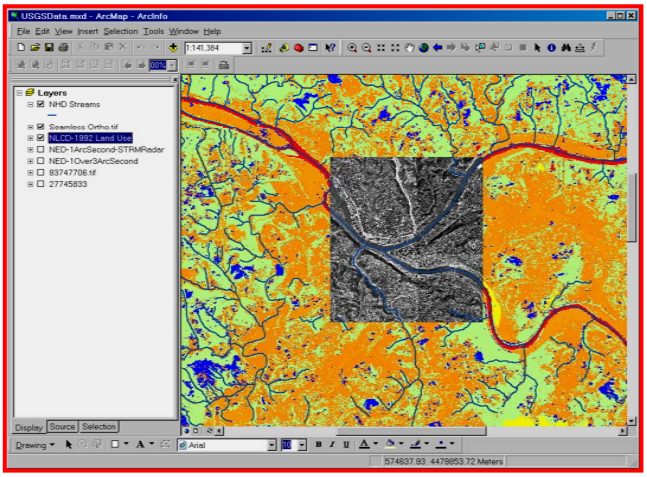
NATIONAL LAND COVER DATABASE (NLCD)
USGS + EPA JOINT DATA

- Land use data
- The first seamless national coverage
- Based on 30-meter Landsat Thematic Mapper satellite imagery
- Resolution = 30 m
- Free download from seamless.usgs.gov



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CENSUS BUREAU'S TIGER DATA

- TIGER® = Topologically Integrated Geographic Encoding and Referencing
- The system and digital database developed at the Census Bureau to support its mapping needs for the Decennial Census and other Bureau programs
- Coordinates: Decimal degrees (projected data is available from other data vendors)
- Latest Data: Census 2000 in shapefile format. (1990 data was in a proprietary format that needed translation to a GIS-ready format).

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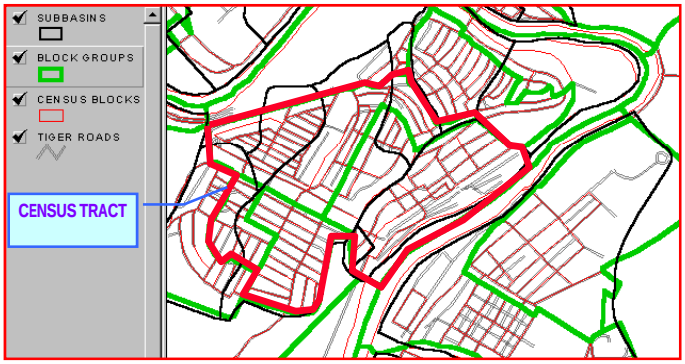
TIGER/LINE FILE

- Census:
  - Tracts (Largest), Block Groups, Census Blocks
  - Attributes: population, houses, income, housing value, ethnicity, etc.
- Geography:
  - Roads
  - Railroads
  - Streams
  - Political boundaries



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TIGER DATA AVAILABILITY

- Scale = 1:100,000
  - Not suitable for high-precision measurement applications such as engineering or property transfers
- Availability:
  - Free downloads from USBC, NRCS, and ESRI Geography Network
  - USBC CDs: $1,500 for 6 CDs (all States) or $250/CD (~8 states)
  - Free TIGER/Line 2000 Shapefiles at ESRI Census Watch www.esri.com/censuswatch
  - Commercial vendors (Wessex, ADC, etc.)
    - Enhanced data at higher cost
    - Double-line roads
    - GIS-ready (shapefiles)
    - Projected

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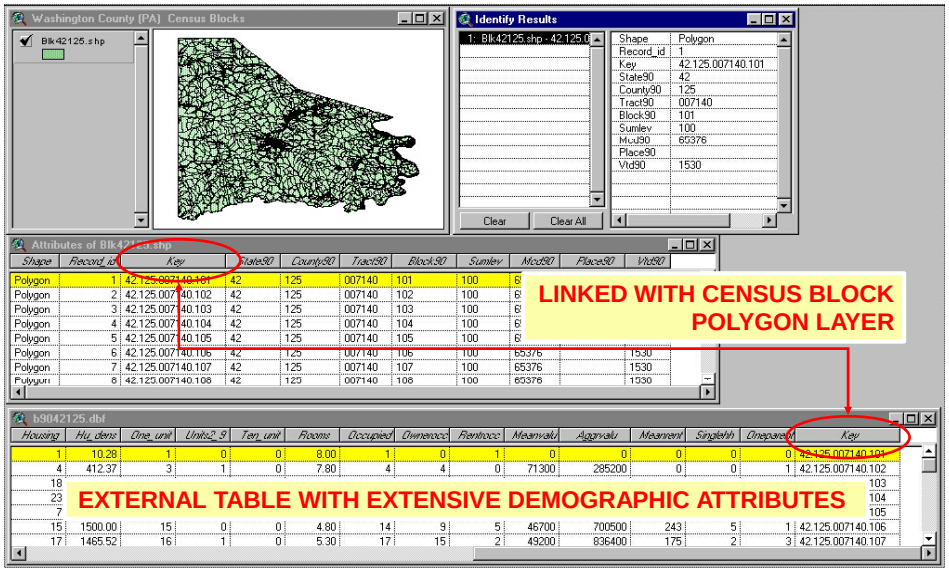
TIGER DATA APPLICATIONS



TIGER Census Block Data for Washington County, Pennsylvania, Imported in ArcView GIS

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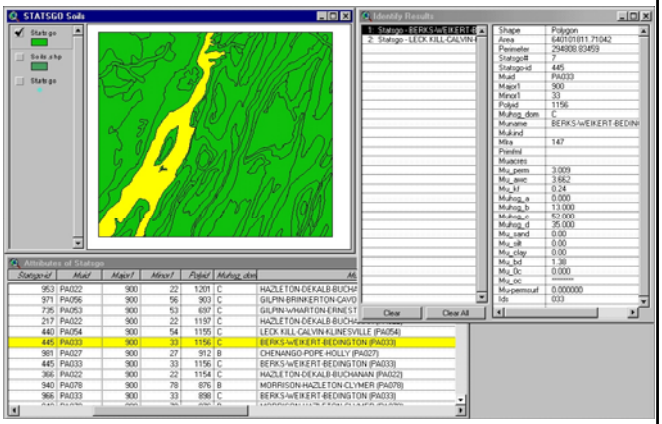
NRCS SOILS DATA

1. **STATSGO: Soil Association Maps (1:25k)**
2. **SSURGO: More detailed (1:12k) (Use this)**

- **Highly attributed**
- **Have Hydrologic Soil Groups to estimate SCS Runoff Curve Numbers**



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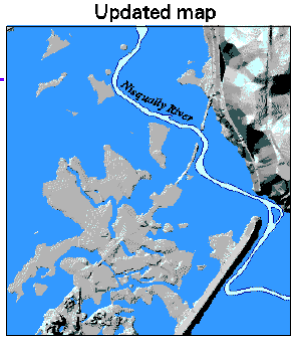
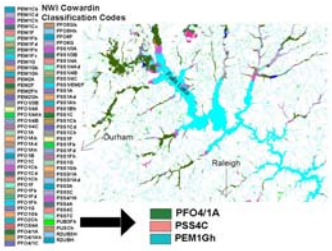
MORE DATA

- **FEMA flood data**
  - DFIRM (digital FIRM)
    - 1:24K countywide coverages
  - Digital Q3 Flood Data
    - Vector format
    - 100 and 500 year flood plain boundaries
  - FEMA orders ($50/CD): www.msc.fema.gov/q3flooda.shtml
  - Free downloads from other sites (e.g., NRCS)
- **National Wetlands Inventory (NWI)**
  - US Fish & Wildlife Service
  - 1:24k 7.5-minute quads
  - Seamless or quad downloads in shapefile format
  - As of Feb. 2006, 90% of the states completed
  - Web: wetlands.fws.gov

Updated map





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GIS DATA CLEARINGHOUSES

National Geospatial Data Clearinghouse	www.fgdc.gov/data/data.html
FGDC Clearinghouse Gateway	fgdclearhs.er.usgs.gov/
Geography Network	www.geographynetwork.com
Geography Network list of clearinghouses	www.geographynetwork.com/data/clearinghouses.cfm
GIS Data Depot	www.gisdatadepot.com
GISLinx (categorized GIS links)	www.gislinx.com
Directions Magazine Data Center	www.directionsmag.com/datacenter
Spatial Hydrology	www.spatialhydrology.com
US EPA Region 5, Office of Information Services	www.epa.gov/reg5ogis/gisurls3.htm

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STATE GIS DATA GATEWAYS

California –City & County of San Diego	www.sangis.org
Delaware DataMIL	datamil.delaware.gov
Georgia Spatial Data Infrastructure	gis.state.ga.us
Indiana GIS Atlas (ArcIMS site for the whole state)	http://129.79.145.5/arcims/statewide/viewer.htm
Iowa Department of Natural Resources Geographic Information System (NRGIS)	www.igsb.uiowa.edu/nrgis/gishome.htm
Louisiana Statewide GIS Atlas	atlas.lsu.edu
Massachusetts GIS	www.mass.gov/mgis/massgis.htm
New Jersey Spatial Data Clearinghouse from Office of GIS (NJOGIS)	njgeodata.state.nj.us
New Mexico Division of Government Research	www.unm.edu/~dgrint/dgr.html
New York State GIS Clearinghouse	www.nysgis.state.ny.us/index.html
Pennsylvania Mapping and Geographic Information Consortium (PaMAGIC)	www.pamagic.org
Texas Natural Resources Information System	www.tnris.state.tx.us
Virginia Geographic Information Network	www.vgin.vipnet.org
State of Ohio	gis1.oit.ohio.gov/geodatadownload/data.aspx gis1.oit.ohio.gov/geodatadownload/osip.aspx
Mahoning County, Ohio	http://gis.mahoningcountyoh.gov/

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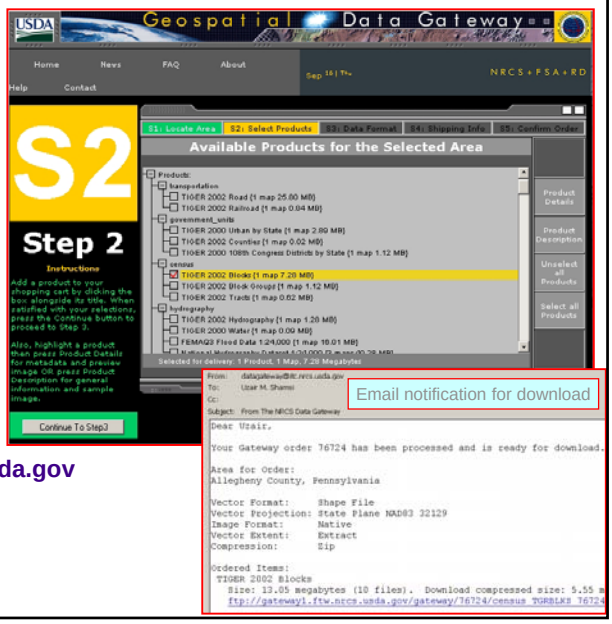
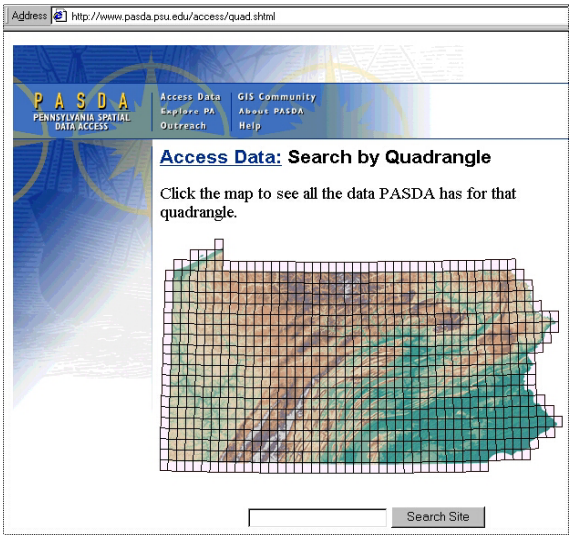
NRCS GEOSPATIAL DATA GATEWAY

- Seamless data download (free) for a county or user defined rectangular area
- Can specify projection
- Available data:
  - TIGER 2002
  - USGS DEMs
  - USGS DRGs
  - NRCS Soils
  - … and more
- Web: datagateway.nrcs.usda.gov



PENNSYLVANIA SPATIAL DATA ACCESS SYSTEM (PASDA)

- www.pasda.psu.edu
- Pennsylvania's official geospatial information clearinghouse
- Fee downloads of DRG, DEM, and DOQ data for Pennsylvania



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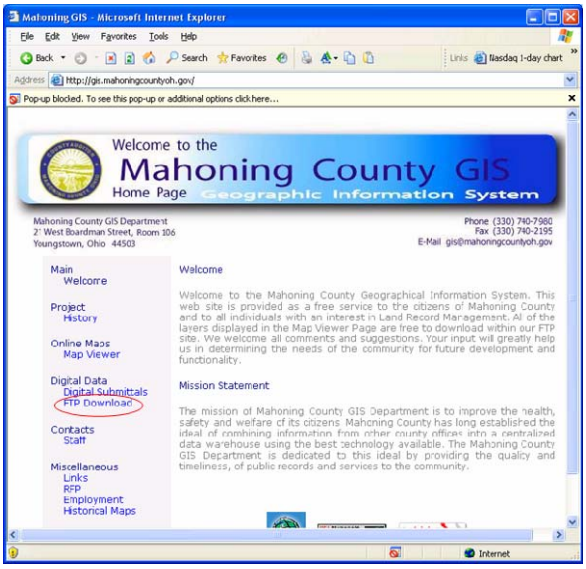
MAHONING COUNTY GIS DATA CLEARINGHOUSE

http://gis.mahoningcountyoh.gov/



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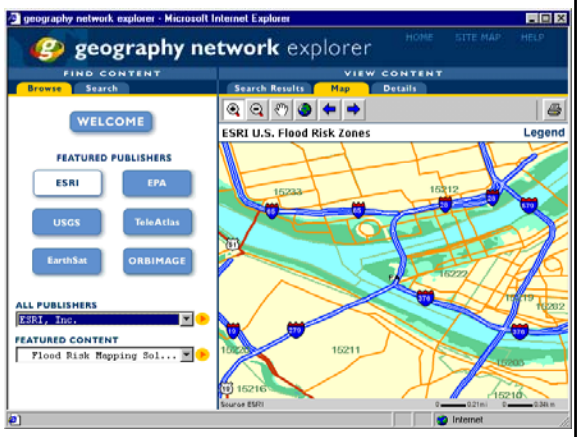
THE GEOGRAPHY NETWORK

- **ESRI's free GIS data clearinghouse**
- **"If the Web is like the public library system, then the Geography Network is like a really nice librarian who keeps the library open 24 hours a day and makes it possible for everyone to find exactly what they need (Geospatial Solution, December 2000)."**

www.geographynetwork.com



Flood Risk Map for Pittsburgh (PA) Prepared Using Geography Network

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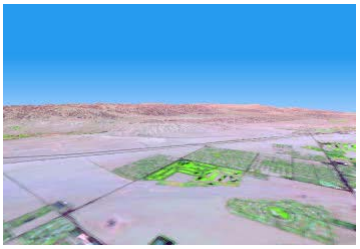
3D ANIMATION OF DRGs

- DOQ draped over DEM for Pittsburgh created using ERDAS Imagine 8.4 Virtual GIS animation

PITT DOQ Drape on DEM.AVI

- Satellite imagery draped over DEM: Fly over Palm Springs and San Jacinto mountains



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COMMERCIAL DATA VENDORS

Representative examples only; not a complete list:

American Digital Cartography ADC	www.adci.com
Sure Maps	www.suremaps.com
Map Mart	www.mapmart.com
LANDINFO	www.landinfo.com
ChartTiff	www.charttiff.com
ESRI Geography Network	www.geographynetwork.com
Maptech	www.maptech.com
TopoDepot	www.topodepot.com
Sanborn Map	www.sanbornmap.com
Micropath	www.micropath.com
Geowarehouse	www.geowarehouse.com
TopoZone	www.topozone.com
MapFactory	www.alphamap.com
LandView	landview.census.gov
USGS Earth Science Information Centers (ESIC)	geography.usgs.gov/esic/esic_index.html

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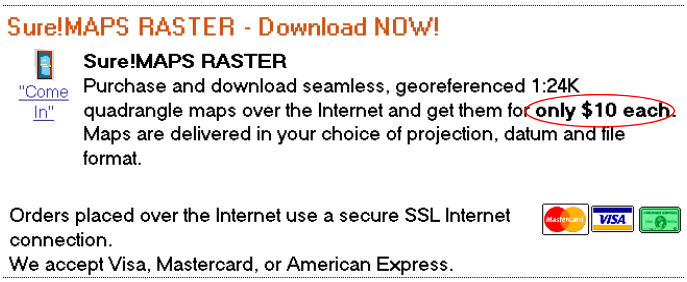
COMMERCIAL DATA CASE STUDY



1. **Sure!Maps RASTER from Titan Systems Corporation (*www.suremaps.com*)**
2. **$10 per USGS topo quad (DRG)**
3. **Drag a rectangle to select an area spanning partial or multiple quads and create a seamless (mosaicked) image. Price is based on the total quad area rather than the number of quads**
4. **Specify projection (UTM or SP), datum (NAD 27 or 83, WGS 72 or 84) units (meters or feet) and format (ESRI TFW, MapInfo Tab, or Autodesk GeoTiff).**

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ON-LINE ORDER AND DOWNLOAD

1. Drag a rectangle to define an area spanning several quads
2. Enter credit card info and get an E-mail notification of the download URL within 15 minutes (I got an E-mail in less than 1 min.)
3. Cost = $20.52 (June 2002)
4. Downloaded 4.6 MB Zip file (12.8 MB TIF file) in less than a minute on a T-1 line.

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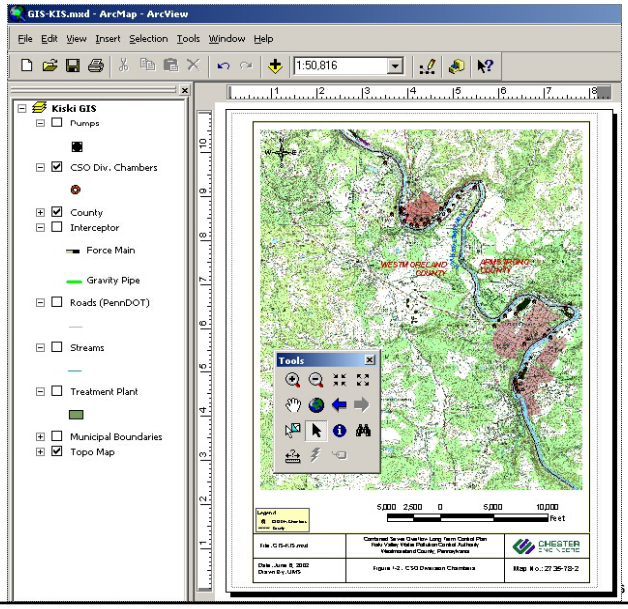
DOWNLOADED DATA ARE GIS-READY

Add DRG in ArcGIS



ArcGIS EXERCISE (Lab)

- Section 3: Displaying Data
  - Chapter 5: Symbolizing Features and Raters
    - Ex. 5a: Changing Symbology
    - Ex. 5b: Symbolizing Features by Categorical Attributes
  - Chapter 6: Classifying Features and Rasters
    - Ex. 6a: Classifying Features by Standard Methods
    - Ex. 6b: Classifying Features Manually
  - Chapter 7: Labeling Features
    - Ex. 7a: Using Dynamic Labels

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