



Introduction to GIS

9th Annual Crime Mapping Conference
Pittsburgh, Pennsylvania
March 28 -31, 2007

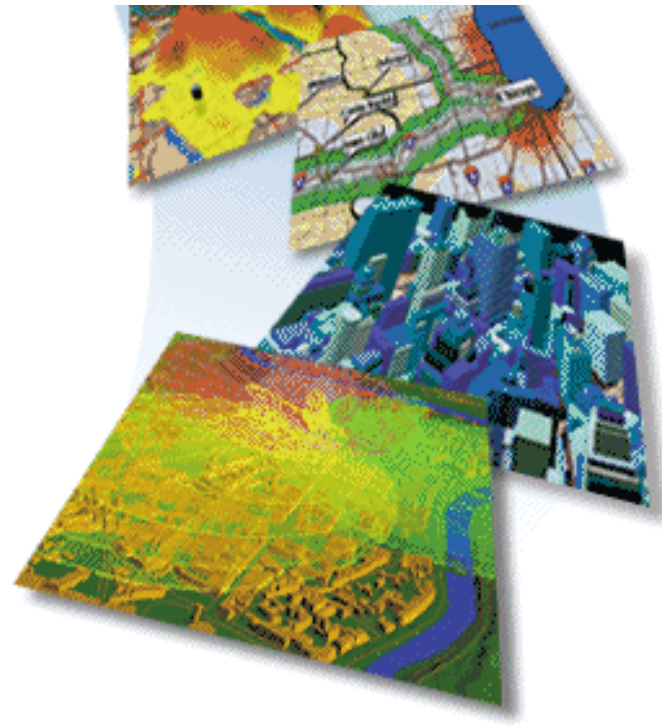
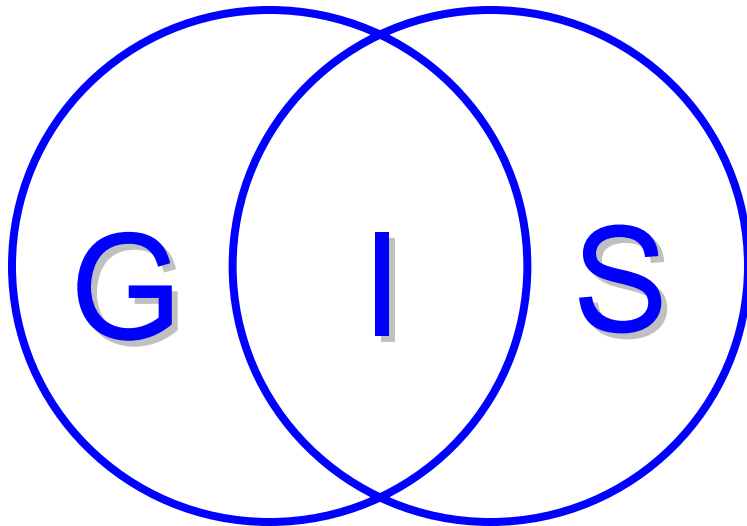
Timothy J Dolney
Department of Geography
Kent State University
Kent, Ohio 44242-0001
Email: tdolney@kent.edu
Internet: <http://tdigs.geog.kent.edu>

What is a GIS?

- GIS = GI U IS

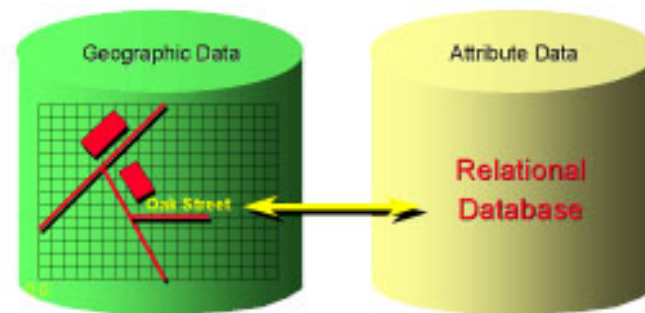
GI = Geographically referenced information

IS = Information system



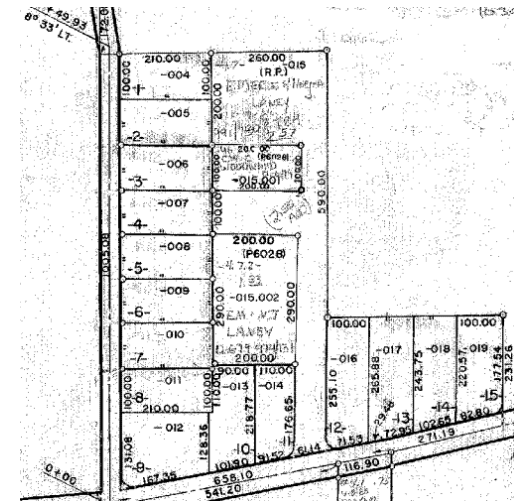
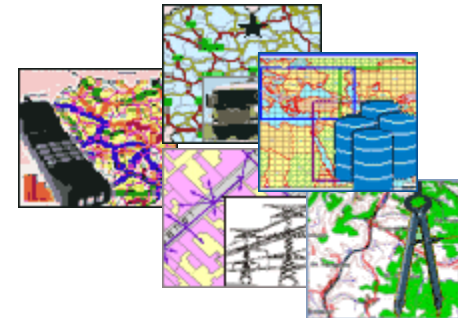
Components of a GIS

- People
- Procedures / Method
- Hardware
- Software
- Data



Data Capture

- Databases
- Digitizing paper maps
- Digitizing scanned images
- Global positioning systems
- Internet sources
 - digital data clearinghouses





explorer

Help

1 Where would you like to explore?

Search for place name (e.g., Cairo):



Or draw a search area :



2 What would you like to discover?

Select one or more of the following to narrow your search:

Choose content type:

Choose content theme:

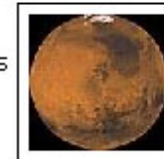
Optional Keyword (e.g., river):

SEARCH

Share geographic data and services through a global network of publishers.

What's New

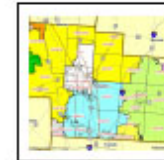
Map of Mars—Explore cliff walls and escarpments of craters, mesas, and troughs on the surface of Mars.



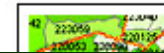
Globe at Night—Learn about a global campaign to observe and record the magnitude of visible stars to measure light pollution in a given location.



Delaware Appraisal Land Information System (DALIS) Project—Investigate more than 48 layers of detailed land data including orthophotos, roads, contours, parcels and utilities for Delaware County, Ohio.



Belarus Map Set—View postal maps of



THE PREMIER ONLINE RESOURCE FOR GIS AND GEOSPATIAL DATA

[National Elevation Dataset - Nationwide Bundle - Click here](#)

GISDataDepot.com -- *THE* leading provider of On-Line GIS Data.

Welcome to the Data Catalog > [Terms & Conditions](#) > [About Data Formats](#)

[GISDataDepot "Premium" Download Pipe!](#) - In order to access and download data GISDataDepot users are required to have a GeoCommunity account. Many data types of data (DEM, NWI, DLG, LU/LC, and TIGER) are available for free download (Green icon). Most other data products (DRG, DOQ, DOQQ, FEMA) will require account holders to purchase data "blocks" for a nominal fee using their account.

TOPICS

- Download Data
- Accounts
- USGS DRGs
- USGS DEMs
- USGS DOQQs
- FEMA Flood Data
- VMAP
- NWI
- Gazetteer
- Census/TIGER
- Index Grids
- About Data
- Contact

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[AirPhotoUSA® Offers New Higher-Resolution Aerials for East Coast Metropolitan Areas](#)

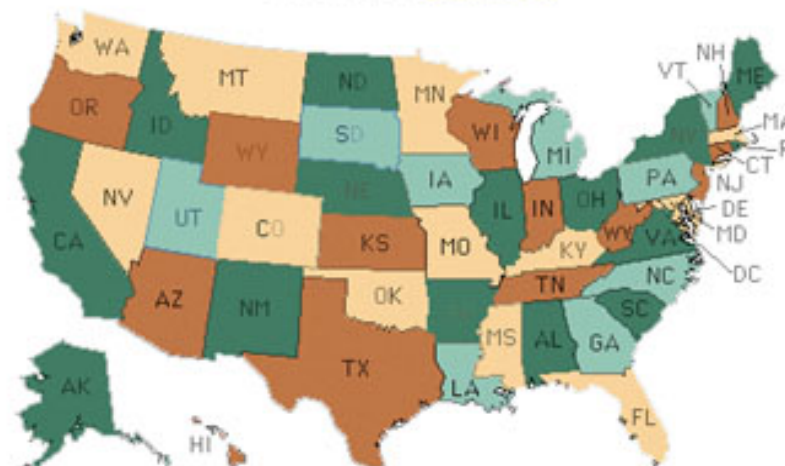
Data - Country Index

A	B	C	D	E	F	G	H	I	J	K	L
M	N	O	P	Q	R	S	T	U	V	W	X-Z

Please select the first letter of the country desired.

USA Data - Please Click on a State to access data...

Puerto Rico [Click Here](#)



<http://data.geocomm.com>

▶ **Agriculture:** Agriculture Census 2002 - Crops, Expenses, Farmland...

▶ **Biology:** Bat Ranges, Butterflies, Forests, Invasive Species, Land Cover...

▶ **Boundaries:** Congressional Districts, Counties, Federal lands, States...

▶ **Climate:** Precipitation, Hazard Events, Hurricanes, Sea Temperature...

▼ **Environment:** Air Releases, Hazardous Waste, Toxics Release...

EPA Envirofacts Data - Air Releases

[View map layer description](#)

[View sample layer in Map Maker](#)

EPA Envirofacts Data - Hazardous Waste Handlers

[View map layer description](#)

[View sample layer in Map Maker](#)

EPA Envirofacts Data - Superfund National Priorities List Sites

[View map layer description](#)

[View sample layer in Map Maker](#)

EPA Envirofacts Data - Toxics Release Inventory

[View map layer description](#)

[View sample layer in Map Maker](#)

EPA Envirofacts Data - Water Discharge Permits

[View map layer description](#)

[View sample layer in Map Maker](#)

▶ **Geology:** Earthquakes, Landslides, Shaded Relief, Volcanoes...

▶ **History:** Presidential General Election 2000 County and State Results.

▶ **Map Reference:** Cities and Towns, Urban Areas...

▶ **People:** Census, Crimes, Energy Consumption, Mortality...

▶ **Transportation:** Airports, Parkways and Scenic Rivers, Railroads, Roads...

▶ **Water:** Aquifers, Dams, Watersheds, Streams and Waterbodies...

<http://nationalatlas.gov/atlasftp.html>





Zoom

Query

Tools

Downloads

Documents

Scale Information

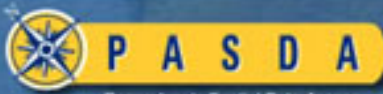
Scale ~ 1:159,172,400

Layers

Display Download

- ▶ Places (Names)
- ▶ Layer Extent
- ▶ Structures
- ▶ Transportation
- ▶ Boundaries
- ▼ Hydrography
 - National Atlas Sea Surf Temperatures Jan-Mar
 - National Atlas Sea Surf Temperatures April-June
 - National Atlas Sea Surf Temperatures July-Sept
 - National Atlas Sea Surf Temperatures Oct-Dec
 - National Atlas Ground Water Climate Response Network
 - National Atlas Dam
 - National Atlas Alluvial and Glacial

*U.S. Department of the Interior | U.S. Geological Survey | USGS for Earth Resources Observation and Science (EROS)
URL: /Website/Seamless/ | Last Update: Dec 23, 2004 || Maintainer: [Comments and Suggestions](#) | [Disclaimer](#)*



Pennsylvania Spatial Data Access

Data Access Wizard

The Pennsylvania Geospatial Data Clearinghouse

[Help](#)

[Shortcuts](#) →

[Aerial Photography](#)

[Topographic Maps](#)

[State-wide Data](#)

[Browse FTP](#)

[Online Maps & Services](#)

[Help](#)

[Home](#)

The Data Access Wizard combines a powerful search engine with web-based geoprocessing capabilities to provide users with improved access to PASDA's GIS data.

Find Data

[View Your Data Cart](#)

Search using one of the following options:

Search by Keyword(s): AND OR

Search by Theme:

Search by Data Provider:

Search by County:

Browse MapServices:

Browse All Data:

<http://www.pasda.psu.edu/>

P A S D A

PENNSYLVANIA SPATIAL DATA ACCESS

The Pennsylvania Geospatial Data Clearinghouse

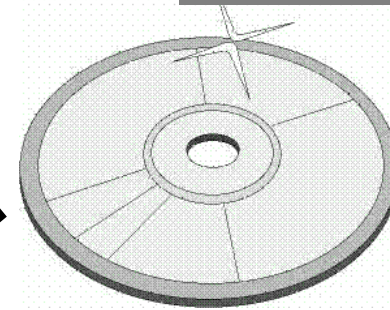
UNIVERSITY

Capturing data

Hardcopy maps

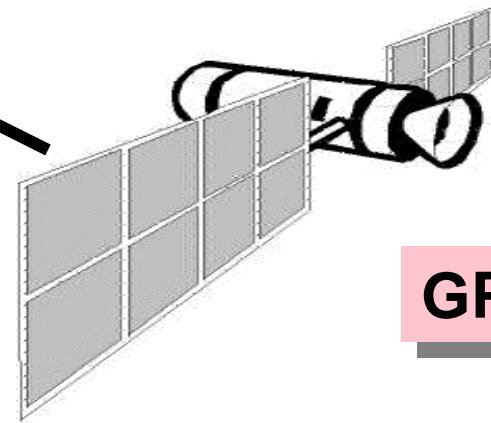


Digital data



Coordinates

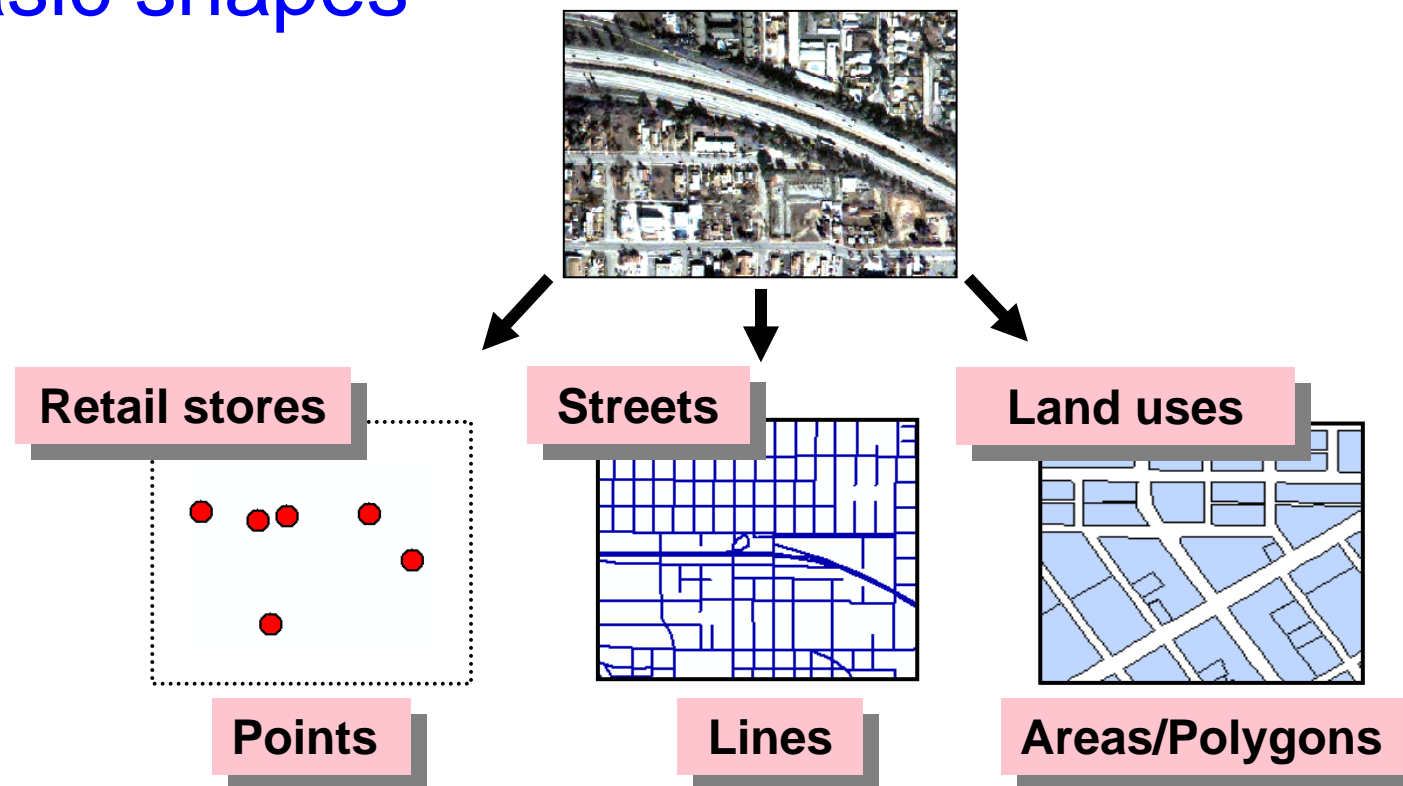
480585.5, 3769234.6
483194.1, 3768432.3
485285.8, 3768391.2
484327.4, 3768565.9
483874.7, 3769823.0



GPS

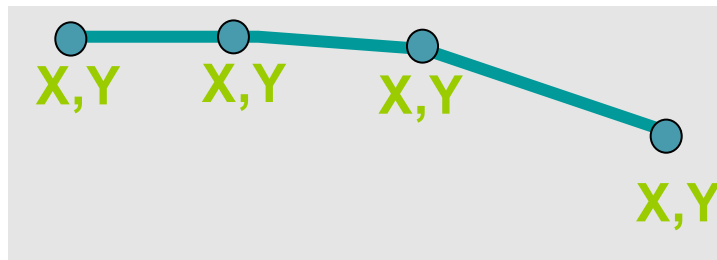
Representing features in vector data

- Real-world entities are abstracted into three basic shapes

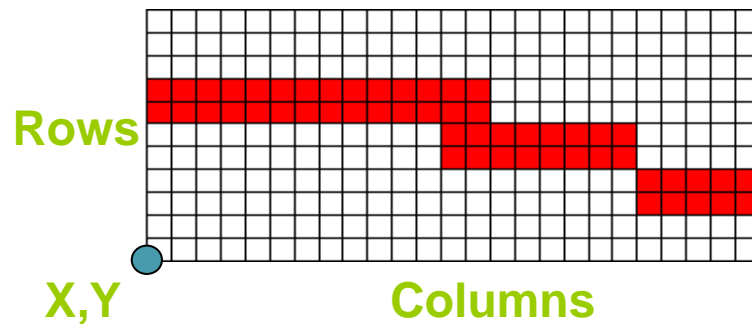


Storing data

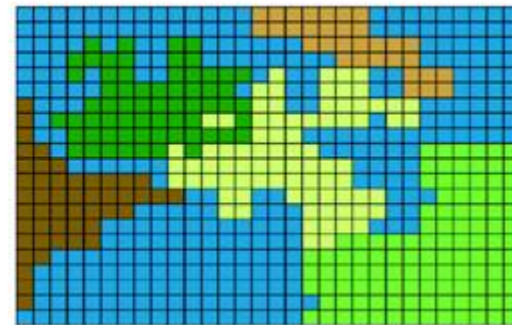
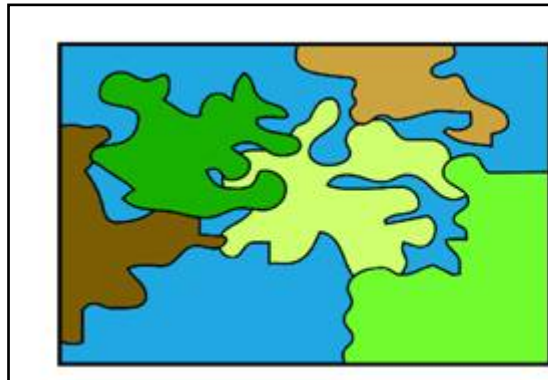
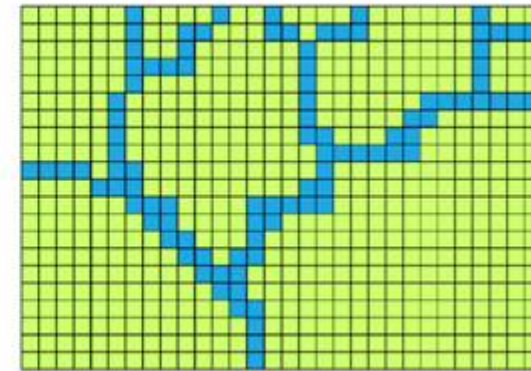
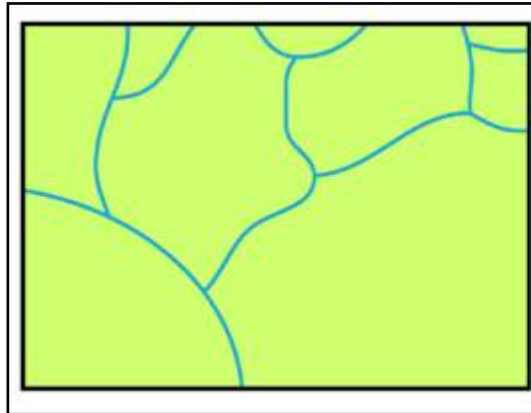
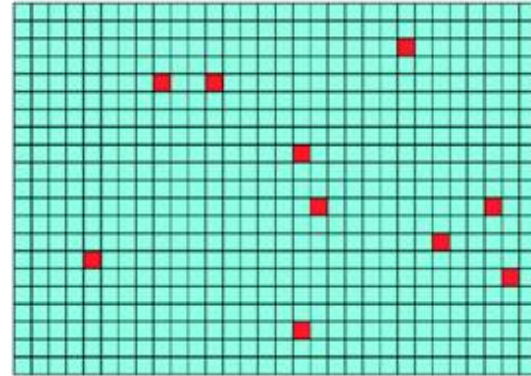
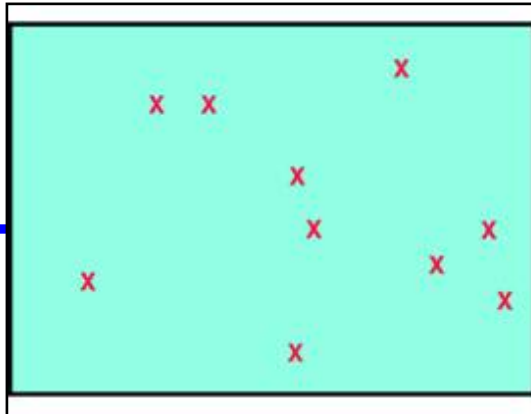
- Vector formats
 - Discrete representations of reality



- Raster formats
 - Use square cells to model reality



Reality
(A highway)

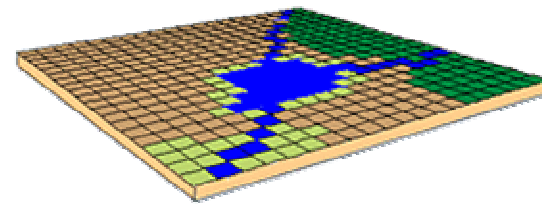


Vector

Raster

Attribute Data

- Attribute or descriptive data
 - Statistical information
 - Numerical information
 - Characteristic information
- Linked to geographic objects
- Most important in GIS
- Operations
 - Joining,
 - Relating,
 - Querying



ROW	COL	LU_CODE	LU_CODE	LAND_COVER	NAME	CELLS
1	1	2	1	forest	Sherwood Forest	100
1	2	2	2	grassland	Marshall Field	150
1	3	2	100	lake	Blue Lake	75
1	4	2	3	marsh	Okeefenokee Swamp	55
...			101	river	Suwanee River	20
1	19	101				

Untitled - ArcMap - ArcEditor

File Edit View Insert Selection Tools Window Help

1:2,759,8

Editor Task: Create New Feature

Layers

- counties polygon

Attributes of counties polygon

NAME	STATE_FIPS	CNTY_FIPS	FIPS	POP1990	POP90_SQMI	HOUSEHOLDS	MALES
Mifflin	42	087	42087	46197	111.86	17697	22131
Lehigh	42	077	42077	291130	836.58	112887	139940
Huntingdon	42	061	42061	44164	50.36	15527	22849
Blair	42	013	42013	130542	247.71	50332	61526
Cambria	42	021	42021	163029	235.93	62004	78112
Berks	42	011	42011	336523	390.85	127649	162646
Juniata	42	067	42067	20625	52.61	7598	10146
Allegheny	42	003	42003	1336449	1838.31	541261	626732
Westmoreland	42	129	42129	370321	358.49	144080	177143
Dauphin	42	043	42043	237813	450.4	95264	113672
Bucks	42	017	42017	541174	887.17	190507	266445
Perry	42	099	42099	41172	73.92	14949	20488
Lebanon	42	075	42075	113744	313.34	42688	55512

Record: 1 Show: All Selected Records (1 out of 67 Selected.) Options

Display Source Selection

Drawing Arial 10 B I U

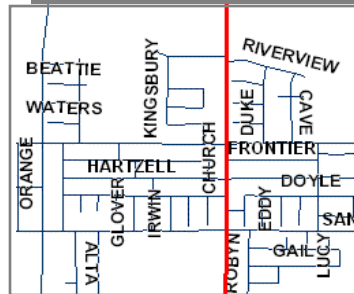
-22420.54 21836.52 Meters

Components of geographic data

- Three general components to geographic information



Geometry



Attributes

STR_NAME	STR_TYPE
> CONE CAMP	RD
CHURCH	ST
OPAL	RD
CHURCH	ST
DISHONG	ST
STATE 30	HWY
STATE 30	HWY
STATE 30	HWY
STATE 30	HWY
OPAL	AV
OPAL	AV

Behavior

Rules
Streets and
highways may
not intersect

- Each feature corresponds to a record in the attribute table

GIS functions

Assemble

Store

Analyze

Manipulate

Display

Output

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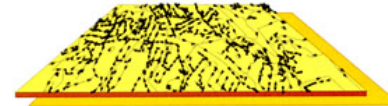


Terrain Models



Network

- Street center lines
- Drainage network



Utilities

- Sanitary sewer lines
- Water lines
- Telephone
- Gas/electric



Lots/Ownership

- Lot lines
- Property lines



Zones/Districts

- Comprehensive plan
- Municipal zoning
- Voting precincts
- School districts
- Census tracts/blocks



Base Mapping

- Road pavement
- Buildings/structures
- Fences/parking lots
- Drainage
- Wooded areas
- Spot elevation
- Contour lines
- Recreational facilities

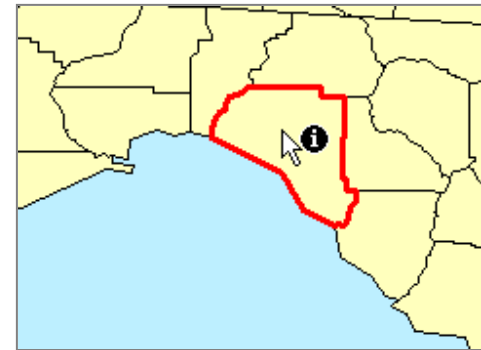
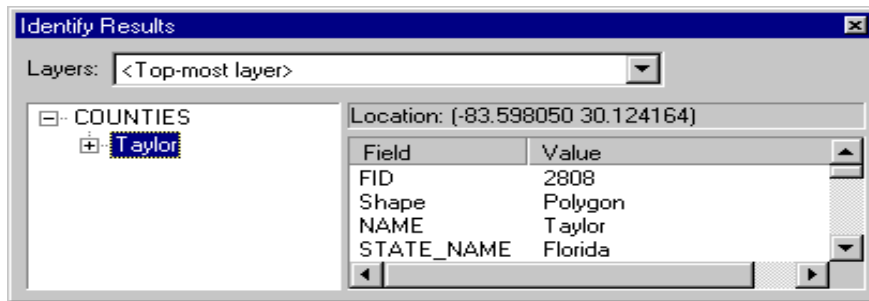
Using spatial relationships

- The relative position of features determines relationships



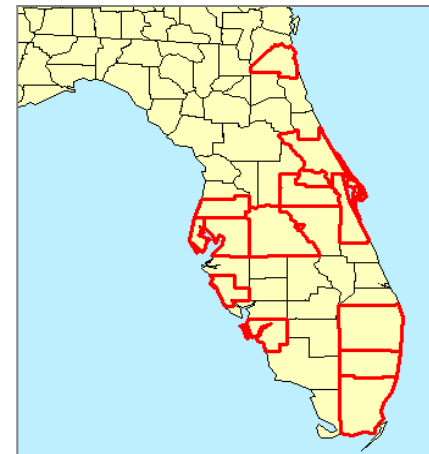
Query

- Identifying specific features



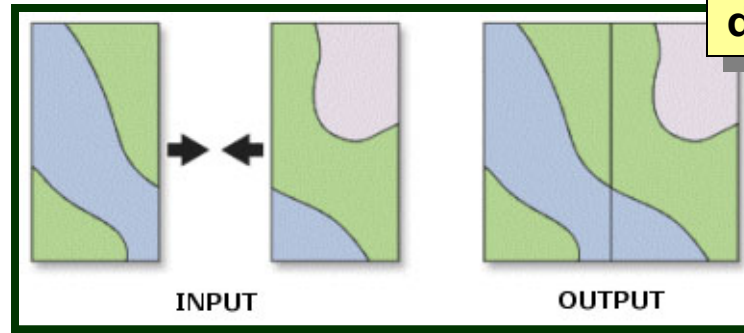
- Identifying features based on conditions

Florida counties with a population greater than 300,000



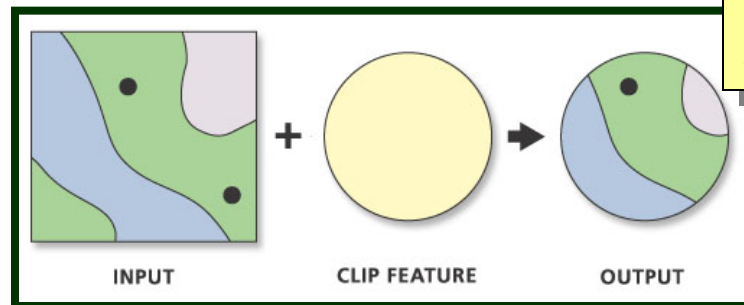
Data Management

Append

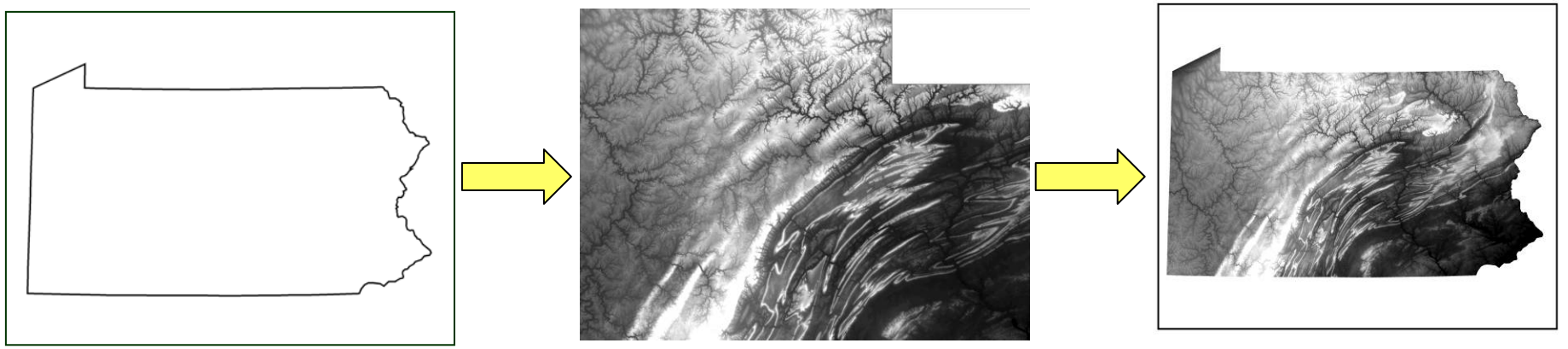
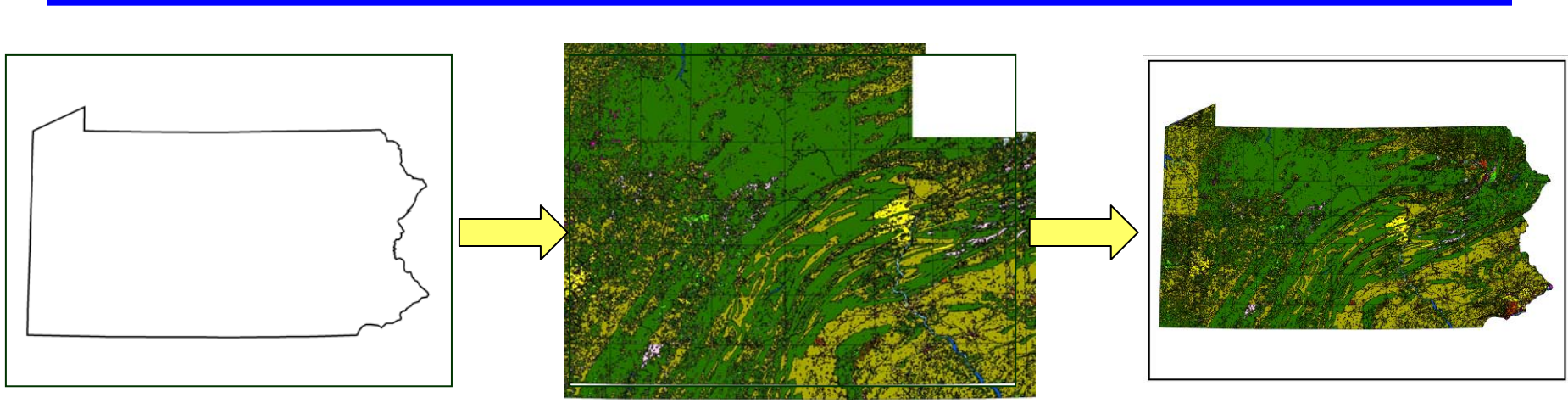


Merge two or more data layers.

Clip

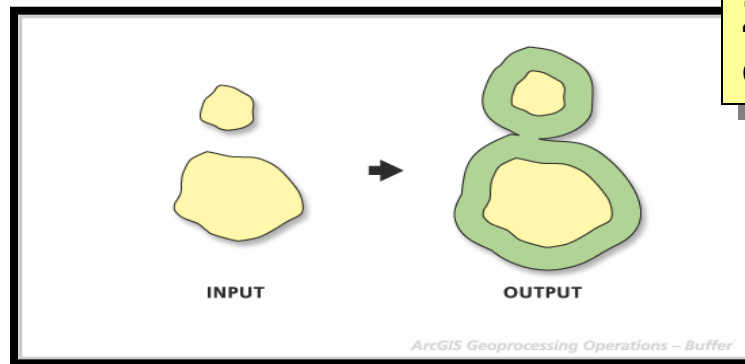


Extract parts of a feature

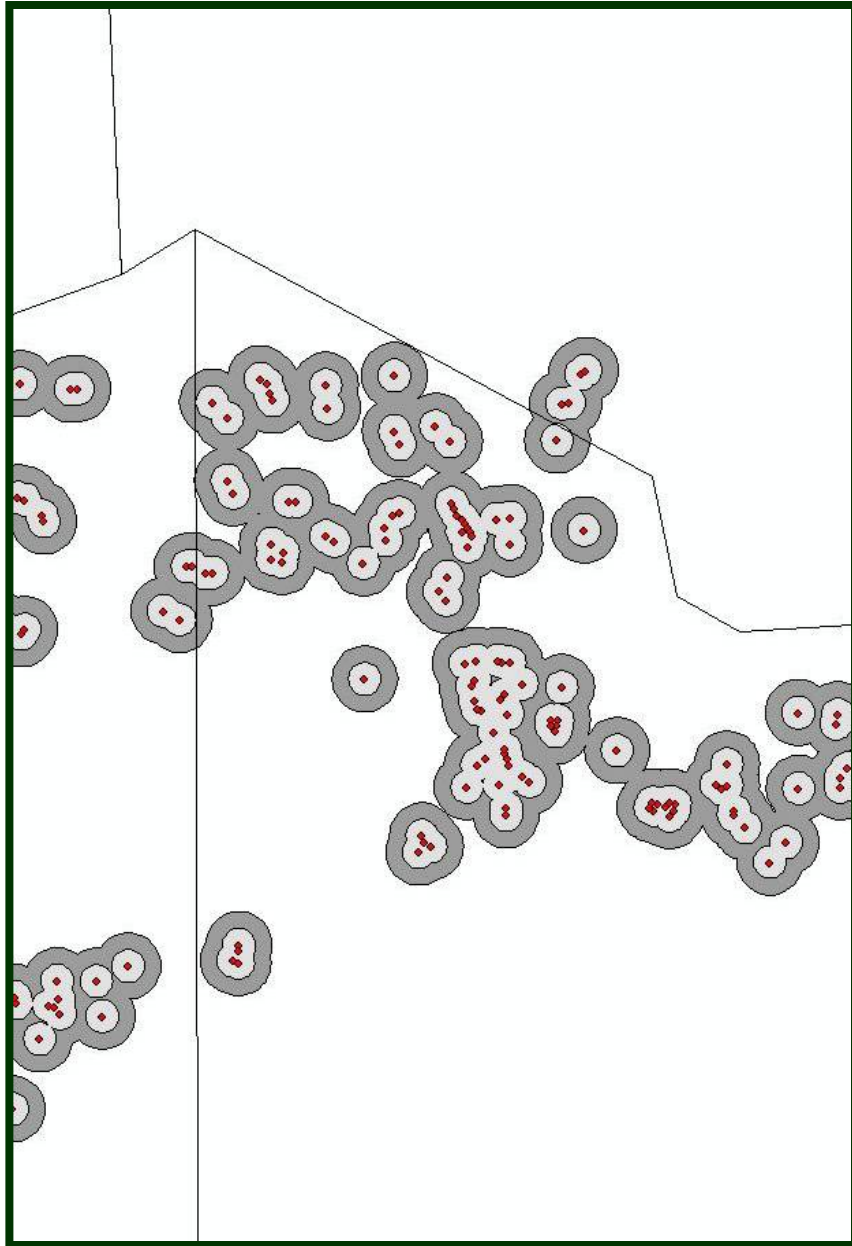


Data Management

Buffering

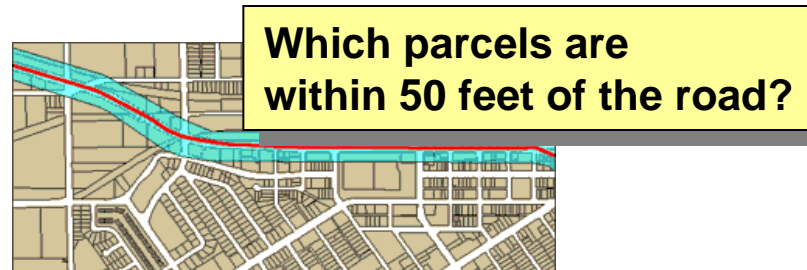


Zone of specified distance.

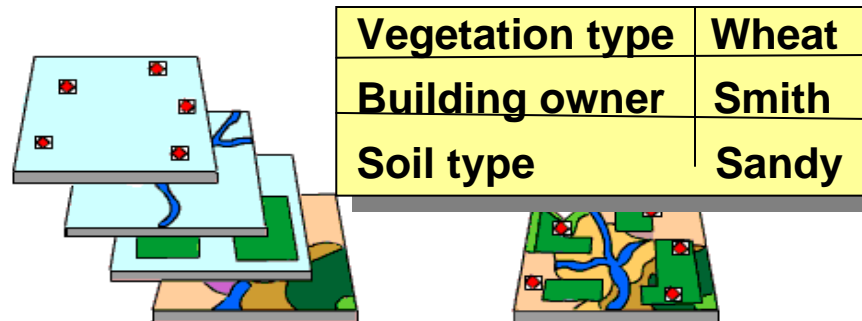


Analysis

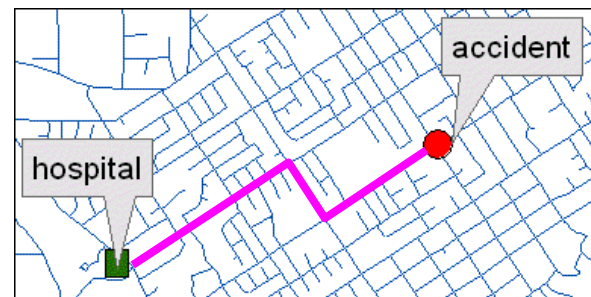
Proximity



Overlay



Network



Display

jellystone.mxd - ArcMap - ArcView

File Edit View Insert Selection Tools Window Help

1:1,500,000 41%

Yellowstone Park Vegetation Study Area

Vegetation Classifications

- Alpine tundra
- Big Sagebrush
- Douglas-fir
- Hot springs vegetation
- Idaho Fescue
- Sedge bogs
- Subalpine Fir
- Tule
- Tufted Hairgrass
- Wetlands
- Wetlands
- Whitebark Pine
- Willow

Vegetation Type Report
Yellowstone Study Area

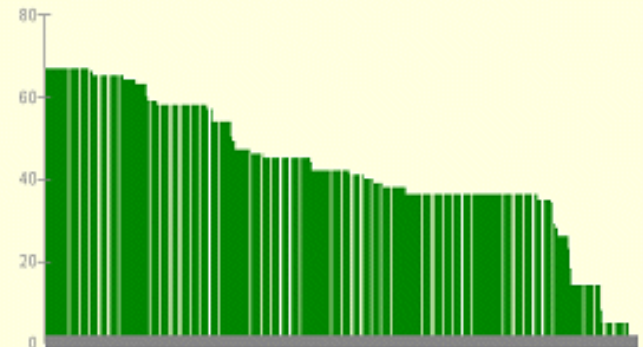
FID	VEGCODE	VEGTYPE	PRIMARY TYPE	VEGNAME1
2	ABLA/VASC-VASC	forest	Subalpine Fir	Subalpine Fir/Conifer Whortleberry-Grouse Whortleberry Phase
3	ABLA/CARU	forest	Subalpine Fir	Subalpine Fir/Pinegrass
4	ARTR/TEID	non-forest	Big Sagebrush	Big Sagebrush/Idaho Fescue
5	ABLA/VASC-VASC	forest	Subalpine Fir	Subalpine Fir/Conifer Whortleberry-Grouse Whortleberry Phase
6	DBCE/CAREX spp.	non-forest	Tufted Hairgrass	Tufted Hairgrass/Sedge
7	sedgebogs	non-forest	Sedge bogs	Sedge bogs
8	Wet forests	forest	Wet forests	Wet forests

16.66 0.79 Inches

Maps

Graphs

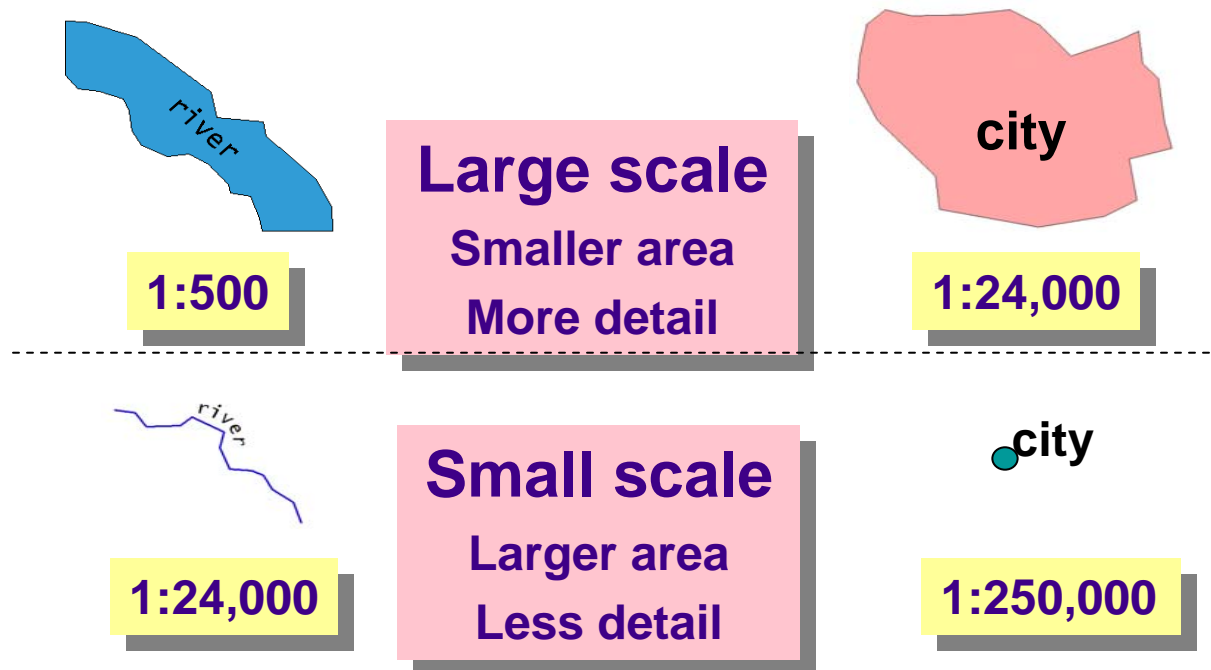
Graph of vegetation polygon



Reports

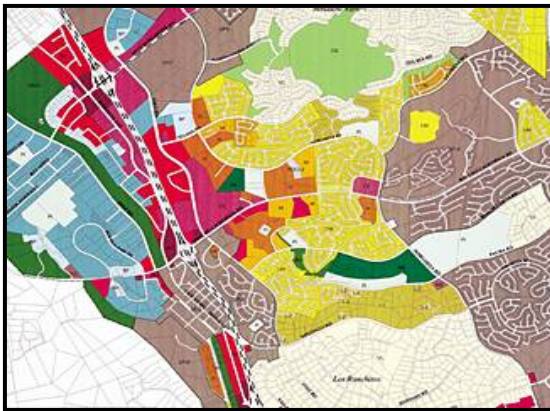
Map scale

- Map scale determines the size and shape of features

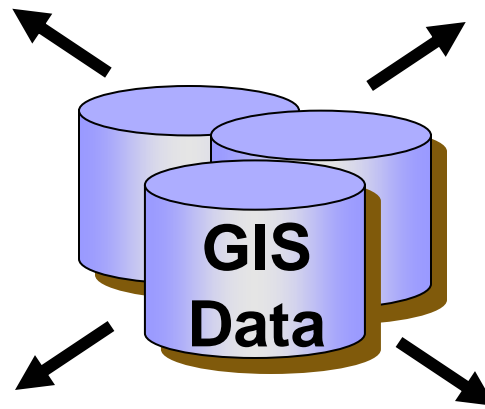
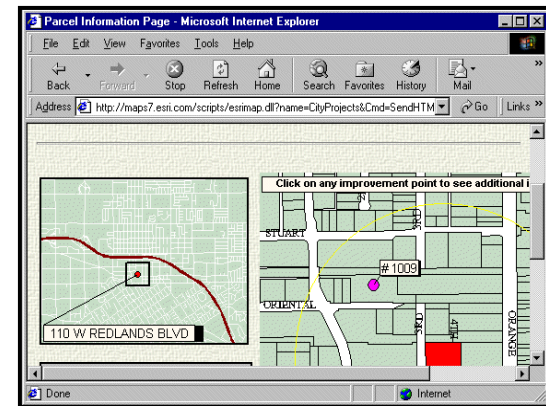


Output

Paper map



Internet



Image



Florida.jpg

Document

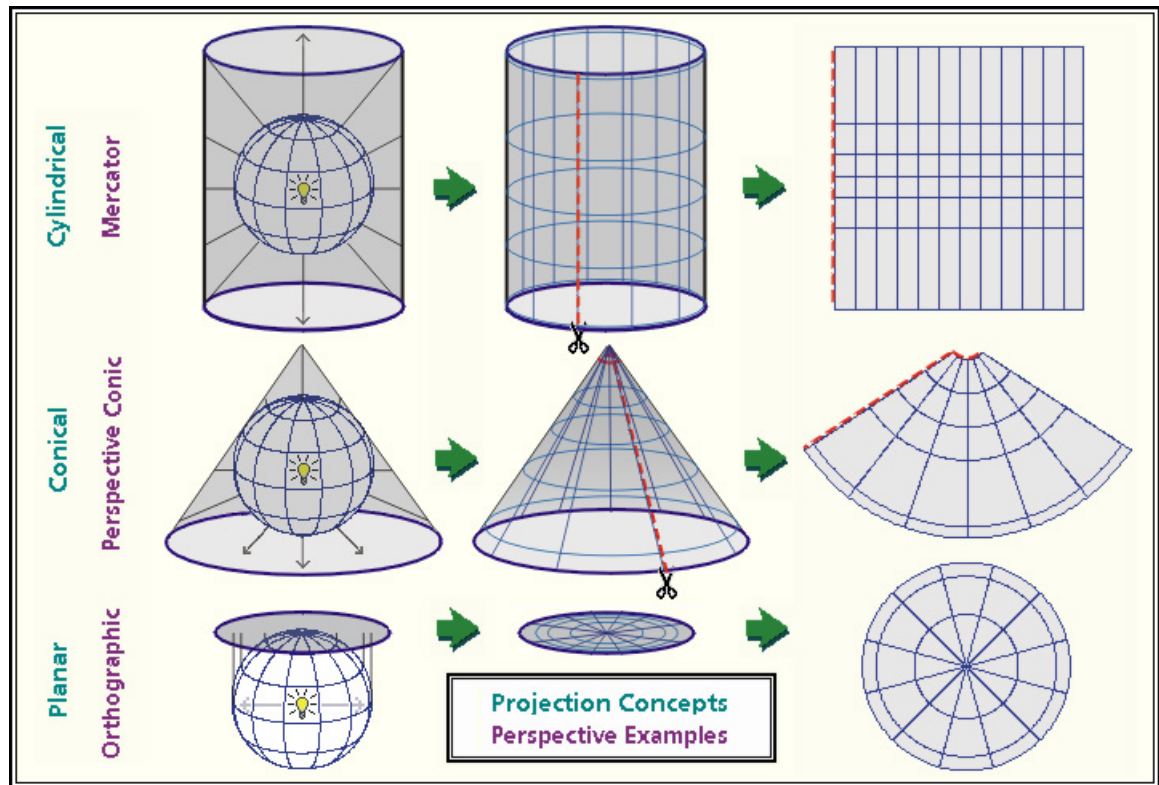


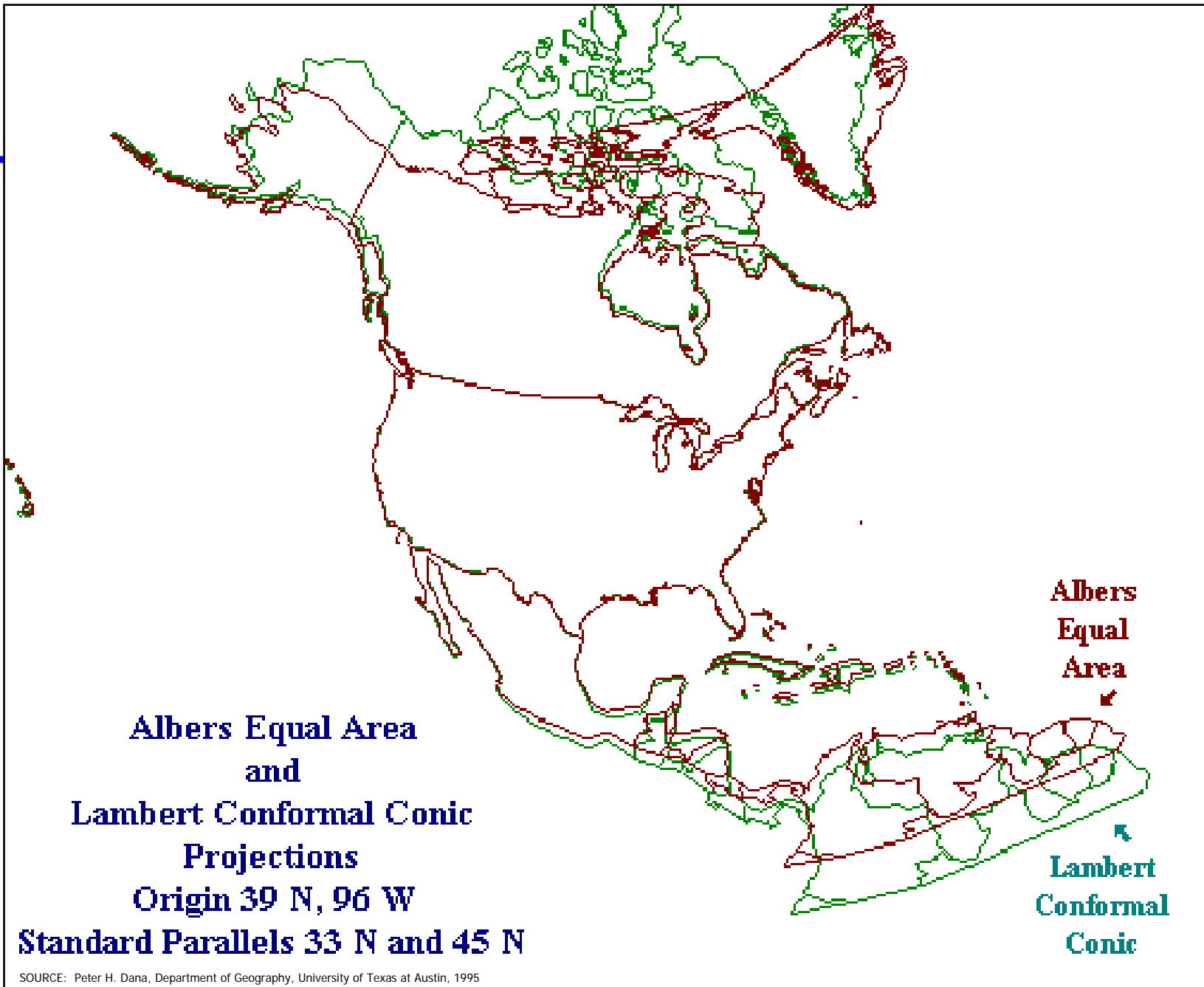
Florida.mxd

Projection and Rectification

- 3D globe to 2D maps/displays

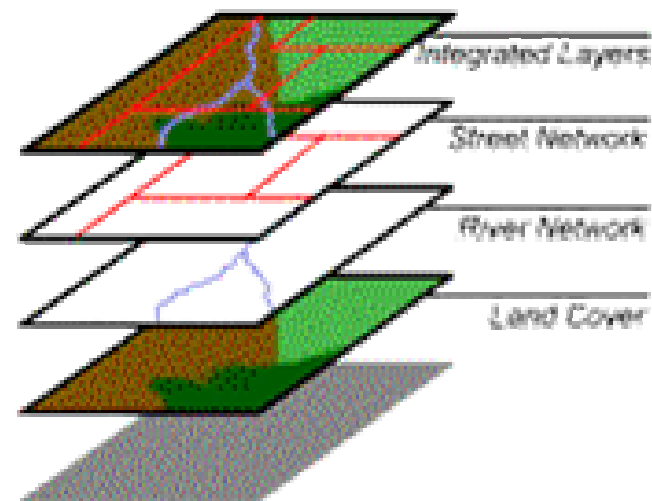
- Shape
- Area
- Direction
- Distance





Data Modeling

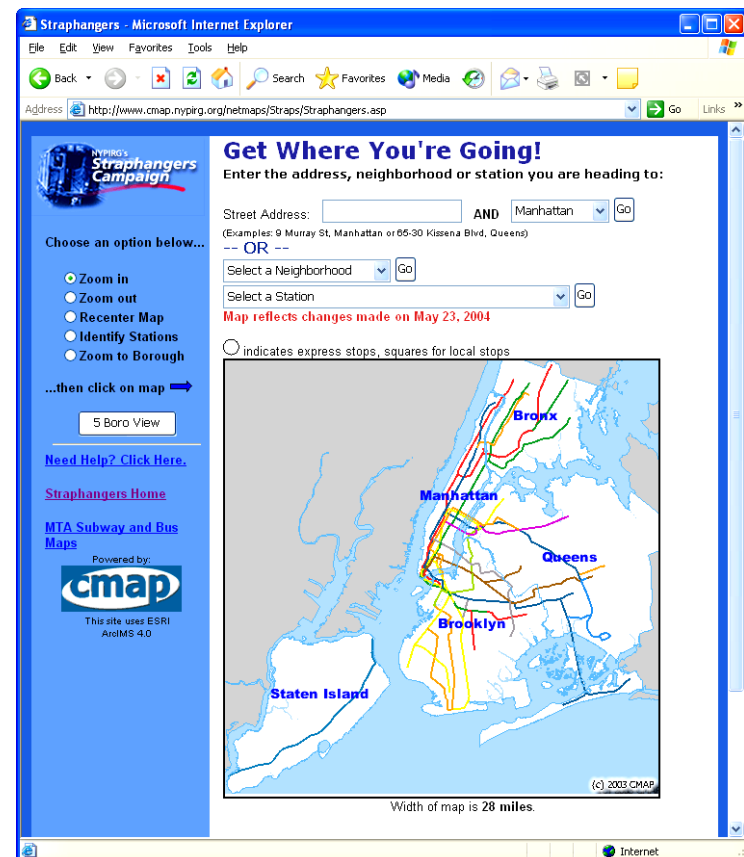
- The process of abstraction from the real world for the purpose of representation and analysis in a GIS.
- Field view
- Object view
- Attribute data



GIS Applications

New York's Subway

- Network and stations
- Status and statistics
- Queries



<http://www.cmap.nypirg.org/netmaps/Straps/view.asp>

GIS Applications

US Dept of Housing and Urban Development

- Interactive mapping service
- Community development
- Housing program
- Environmental data



<http://egis.hud.gov/egis/>

GIS Applications

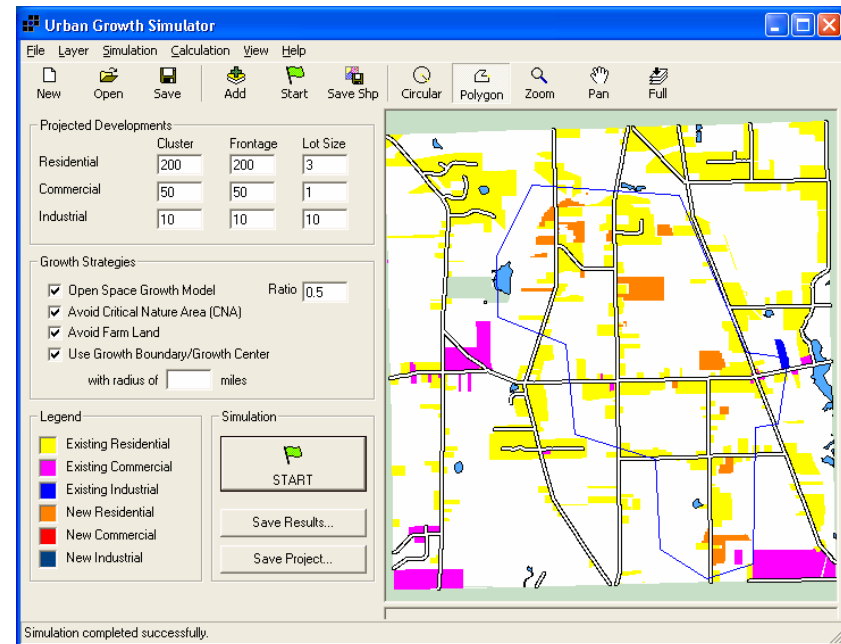
Urban Growth Simulator

- Growth scenarios
- Growth management
- Environmental impacts

Nutrient Loading

Nutrient Loading by Development and Hydrosoil Group

Development	Hydrosoil Group	A	B	C	D	
RESIDENTIAL	cultivated	N	0.00-0.00	0.43-1.73	1.92-7.66	0.49-2.44
		P	0.00-0.00	0.06-0.25	0.28-1.10	0.07-0.35
	pasture/range	N	0.00-0.00	0.43-1.51	1.92-6.70	0.83-2.20
		P	0.00-0.00	0.06-0.22	0.28-0.96	0.12-0.32
	woodland	N	0.00-0.00	0.22-1.08	0.96-4.79	0.49-1.47
		P	0.00-0.00	0.03-0.16	0.14-0.69	0.07-0.21
COMMERCIAL	cultivated	N	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
		P	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
	pasture/range	N	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
		P	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
	woodland	N	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
		P	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00

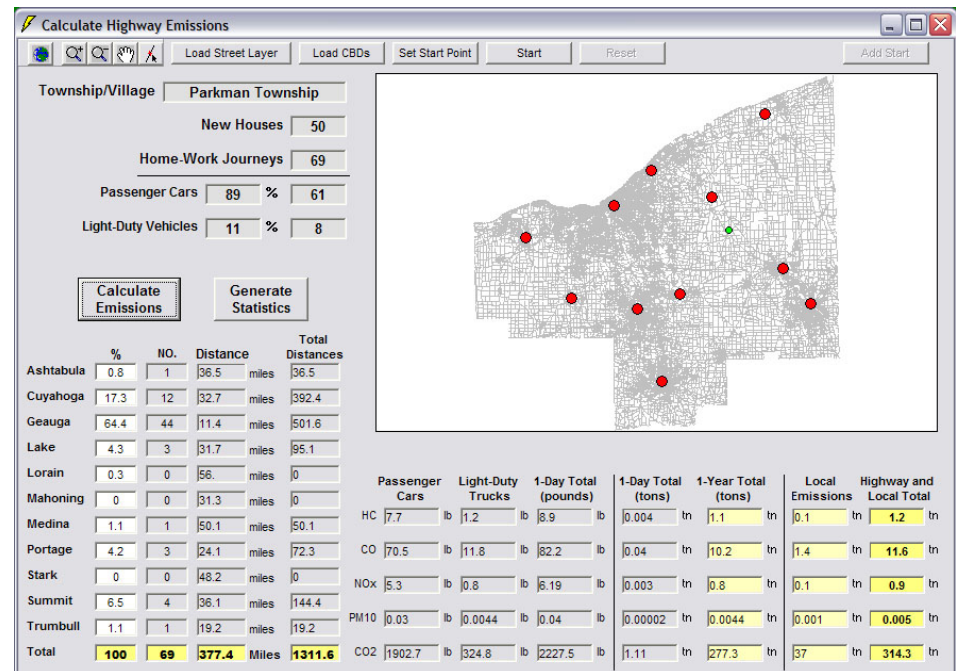
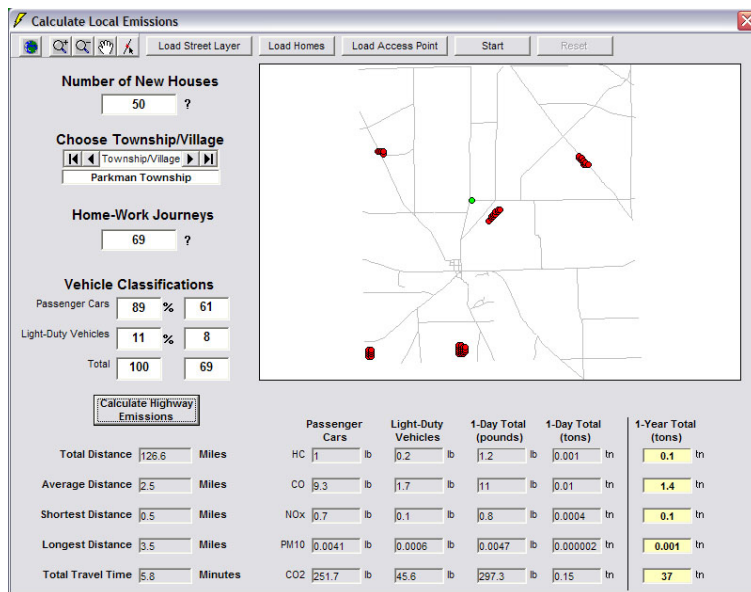


<http://empact.geog.kent.edu/>

GIS Applications

VERTUS Model

- urban growth
- commuting patterns
- vehicle emissions

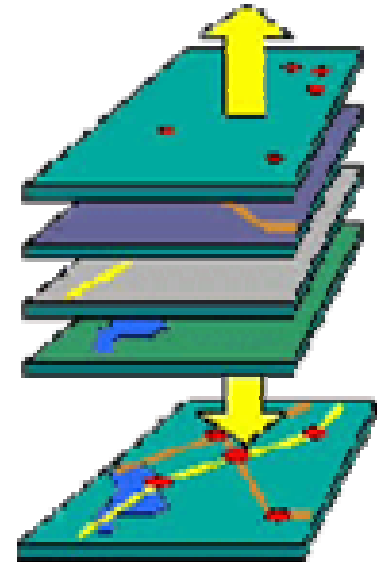


GIS Spatial Analysis

- What is at ...?
 - What is it ...?
 - What has changed since ...?
 - What spatial patterns exist?
 - What if ...?
-
- GIS uses geography, or space, as the common key element between data sets.
 - Information is linked only if it relates to the same geographic area.

Spatial Analysis

- Query georeferenced information
 - Location?
 - Proximity?
 - Adjacency?
 - Longevity?
 - Multiple criteria evaluation?
 - Clusters? Hot/cold spots?
- For example:
 - How many people live within one mile of a Superfund hazardous waste site in the United States?
 - How many counties does I-76 pass in Pennsylvania?
 - What are the neighboring land parcels of a parcel that is requesting change of use from residential to commercial?



Developing a GIS

- Objectives
- Feasibility studies
- Hardware – input, processing, output
- Software – basic and tailored applications
- Data – currency, accuracy, scale, versions
- Personnel – training, workload
- Procedures - In-house/out-source
- Pilot study

GIS Management

- Inter-unit collaboration and intra-unit operation
- Maintenance
 - Budget
 - short-term, long-term
 - Data
 - acquisition, updates, sharing, dissemination
 - Products
 - legal issues, cost/income

Demonstration: GIS Overview

A quick tour

- Data exploration
- Data manipulation
- Data display

Commercial GIS

- ESRI
 - ArcInfo, ArcView 3.x, ArcGIS, etc.
 - AML, Avenue, MapObjects, ArcGIS VBA
 - Internet Map Services
- Intergraph
 - GeoMedia suite, ImageStation, etc.
 - Internet Map Services
- MapInfo
 - MapInfo
 - MapBasics
- Others

Free GIS

- ArcVoyager Special Edition
 - <http://www.esri.com/industries/k-12/education/voyager.html>
- ArcExplorer
 - <http://www.esri.com/software/arcexplorer/index.html>
- DIVA-GIS
 - <http://www.diva-gis.org/>
- FlowMap
 - <http://flowmap.geog.uu.nl/>
- GMT-Generic Mapping Tools
 - <http://gmt.soest.hawaii.edu/>

Free GIS (cont'd)

- GRASS
 - <http://www.geog.uni-hannover.de/grass/index.php>
- SPRING
 - <http://www.dpi.inpe.br/spring/english/>
- TNT Lite
 - <http://www.microimages.com/tntlite/>
- uDig
 - <http://udig.refractions.net/confluence/display/UDIG/Home>

Studies of Crime

- Pre-1970: Sociology & Psychology (George 1978)
- Since 1970: Spatial Components
 - Geographic patterns and distributions
 - Contributing factors
 - Program controls and assessment
- Georges, D. E. (1978) The geography of crime and violence: A spatial and ecological perspective, Association of American Geographers: Resource Papers for College Geography, 78(1).
- Jerry Ratcliffe, GIS and Crime Mapping

Law Enforcement and GIS



GIS and Law Enforcement

- Same law enforcement tasks
 - + GIS = more timely
- Data Management
 - integration
 - analysis
 - allocate resources
 - policy implications



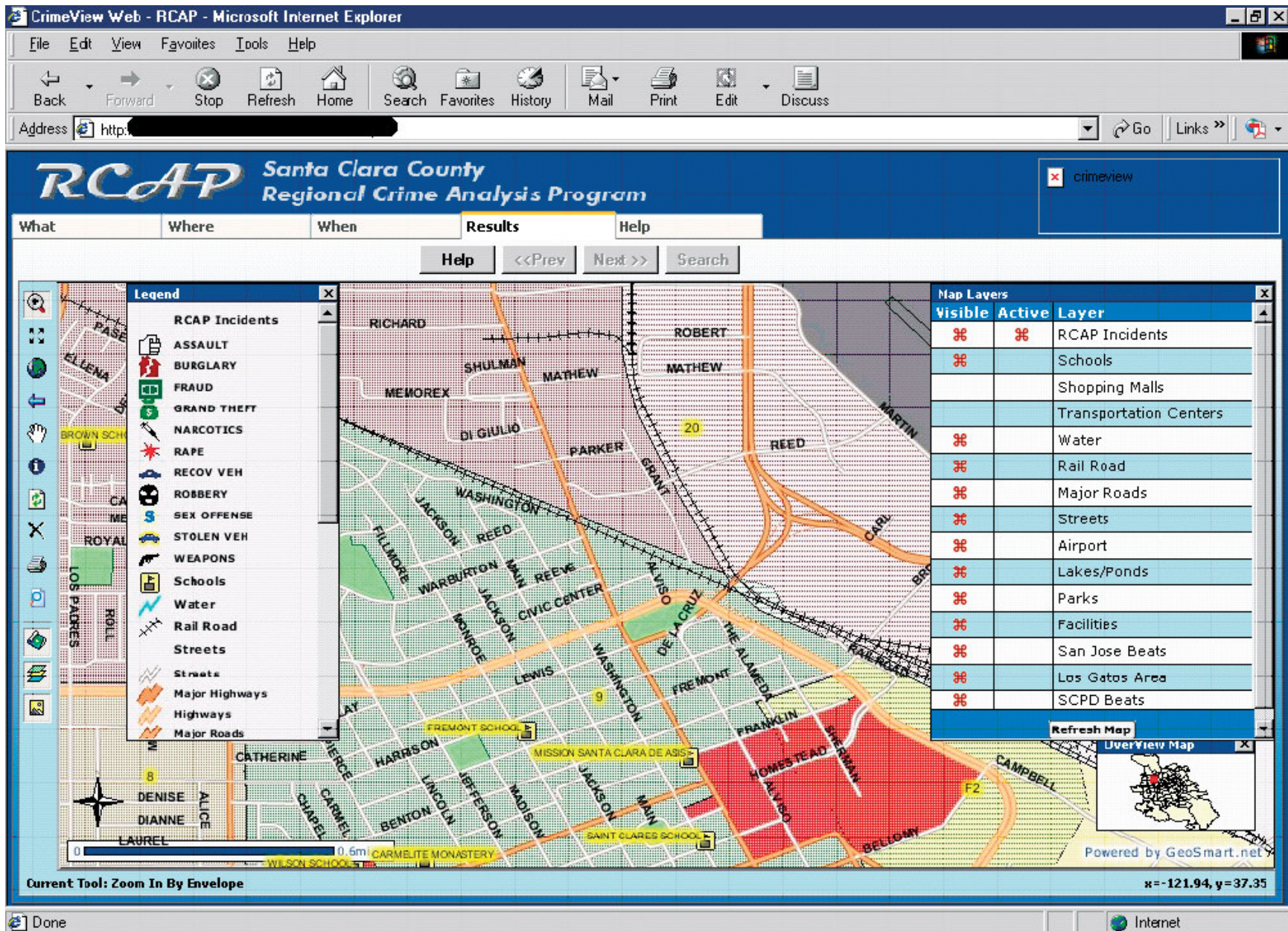
GIS and Law Enforcement

- Overlay multiple data-layers
 - integrate with databases
 - *i.e.* generate list of suspects
- Neighborhoods patrolled
 - understand demographics
- Megan's Law
 - identify & notify residents about sex offenders in their areas



Applications of GIS to Crime

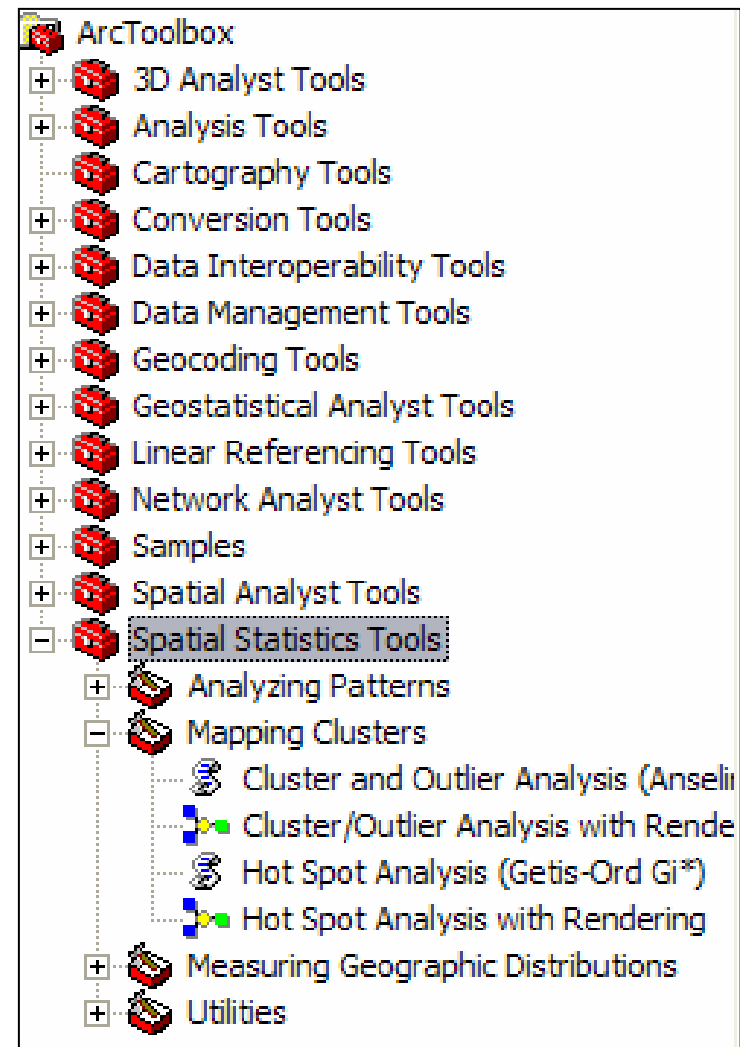
- Santa Clara County, CA
 - RCAP (Regional Crime Analysis Program)
 - interagency partnership
 - standardize, access, share
 - internet, database, GIS
- Identify and reduce crimes
 - crime data
 - incident type; geographic area
 - schools, parks



SOURCE: ArcNews

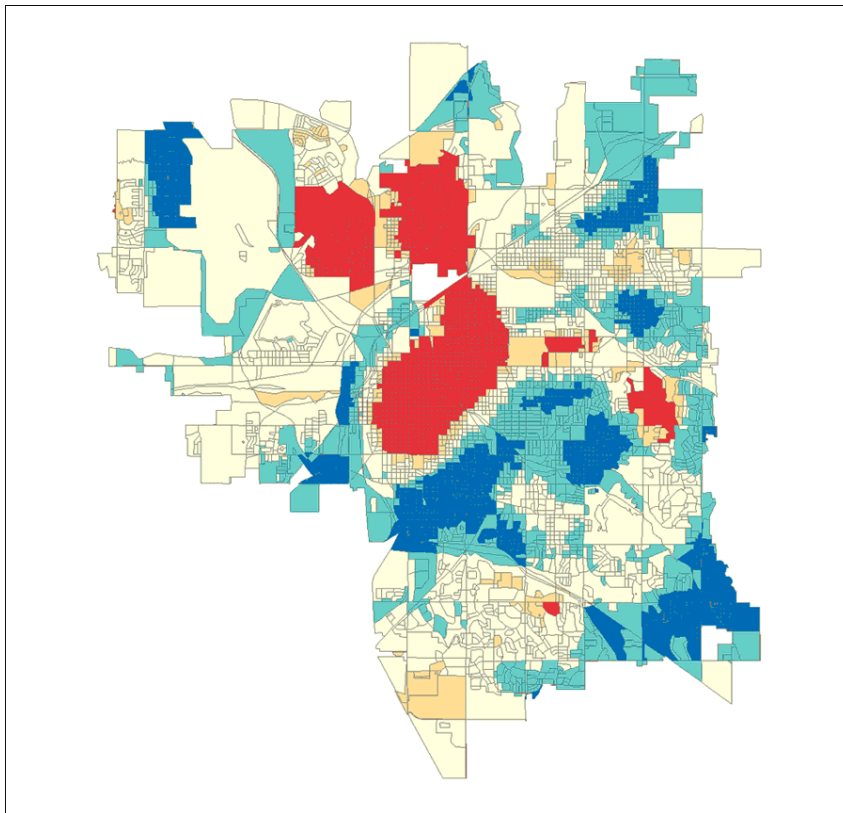
Where Crimes Occur

- Hot Spot Analysis
 - # crimes/census block
 - identify high crime intensity
 - hot spots
- Drawbacks
 - overall pattern
 - high crime where expected

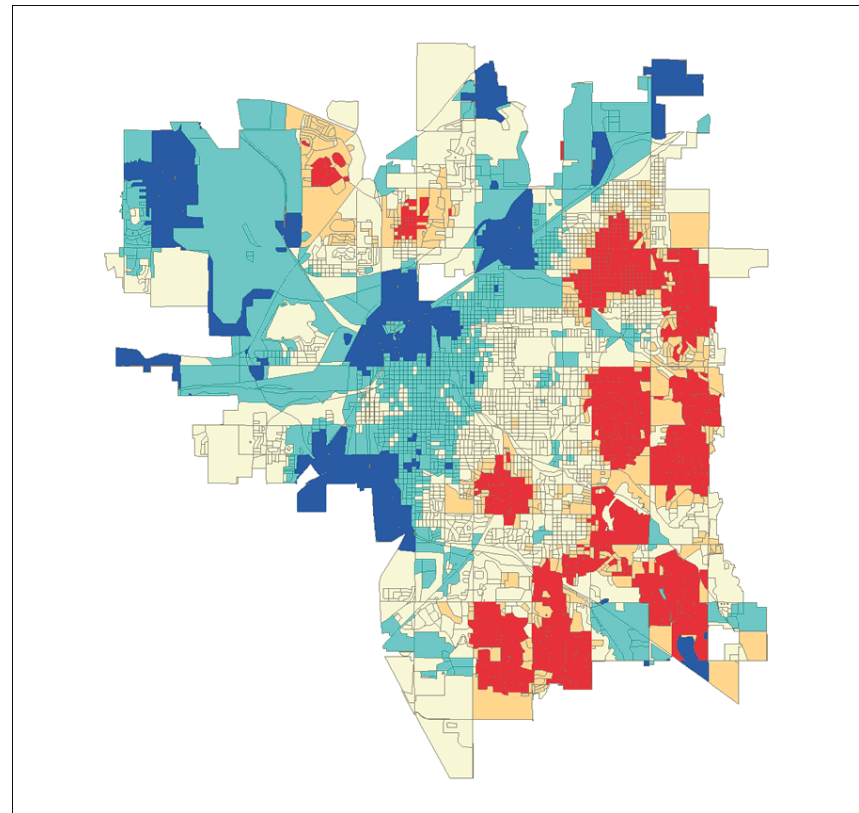


Red = Hot Spots (High Crime)

Blue = Cold Spots (Low Crime)



Not Normalized



Normalized

SOURCE: ArcNews

Risk Assessment

- Implement crime prevention programs
- Example: vandalism
 - divide vandalism by all crime
 - vandalism as proportion of all crime
 - hot spot analysis on normalized ratios
 - areas where vandalism represents a larger than expected proportion of all crime events
- Lincoln, NE
 - vandalism a suburban issue

Megan's Law

- Notification about sex-offenders
 - web-based GIS
- Query data in relation to
 - neighborhoods, schools, parks, residential areas
 - offender displayed according to seriousness
 - visit local police for further info

Riverside County Sheriff - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://216.57.210.151/riverside/jsp/index.jsp>


Google Search Web Search Site New! PageRank Page Info Up Highlight

Riverside County Sheriff's Department

Registered Sex Offender Map








hair and blue eyes, is believed to have abducted the boys in the Colu

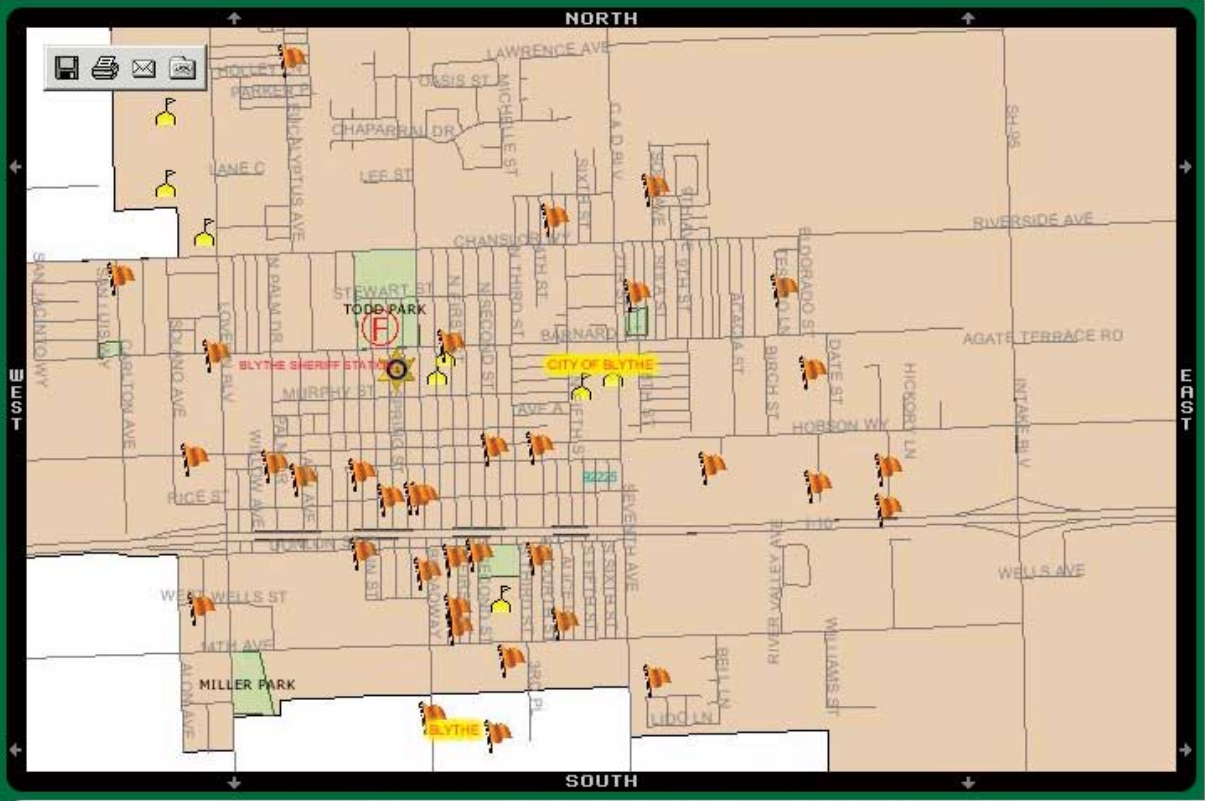
Search: School A STREET ELEMENTARY GO Other Sex Offender Sites



What is Megan's Law?
Office of the Attorney General
State of California

Legend

-  High Risk Sex Offender
-  Serious Sex Offender
-  Park
-  School
-  Sheriff's Station
-  Fire Station
-  Public Facility



NORTH

WEST EAST

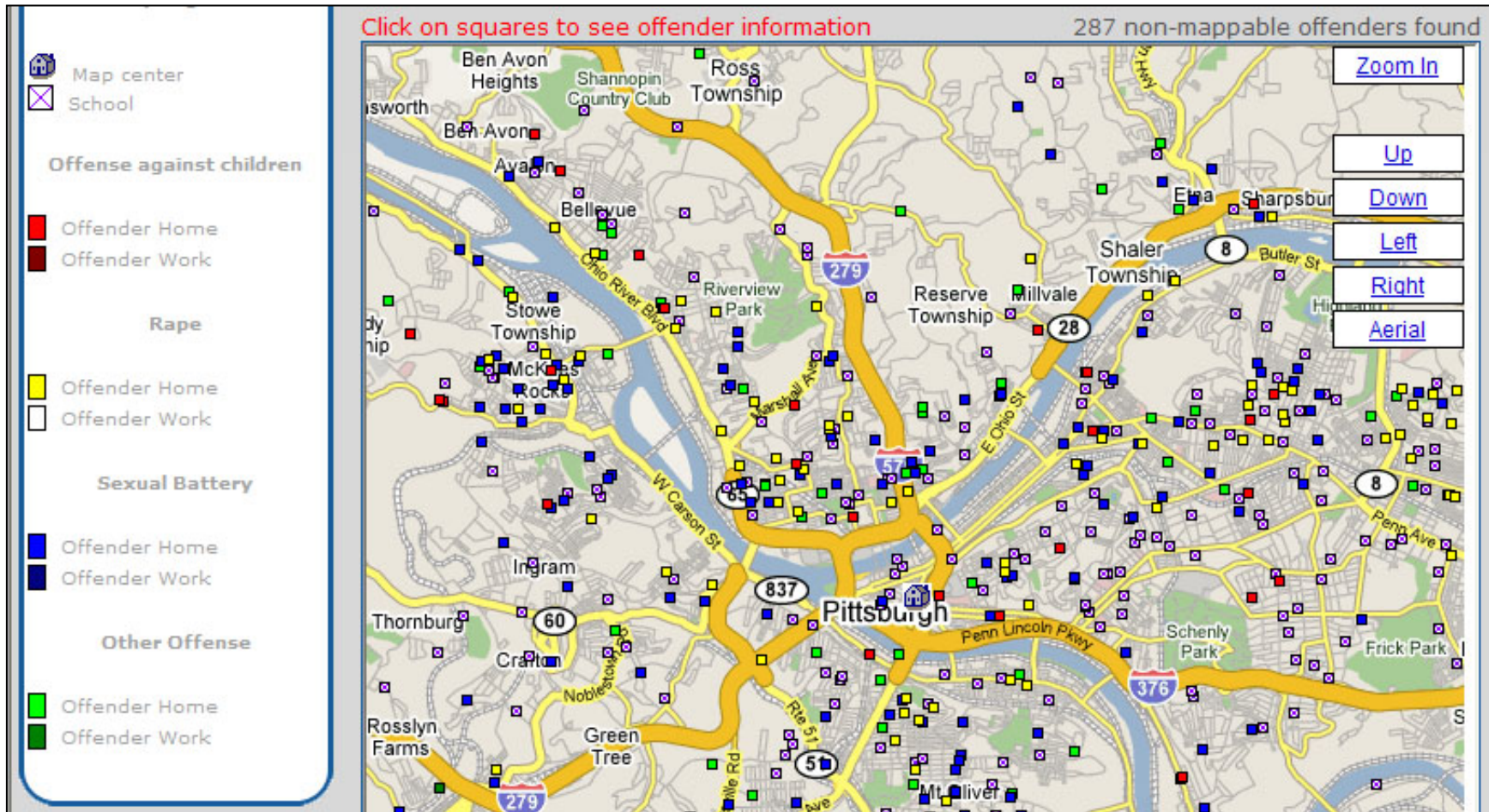
SOUTH

Identify Zoom In Zoom Out Show County Pan

Done Internet

SOURCE: ArcNews

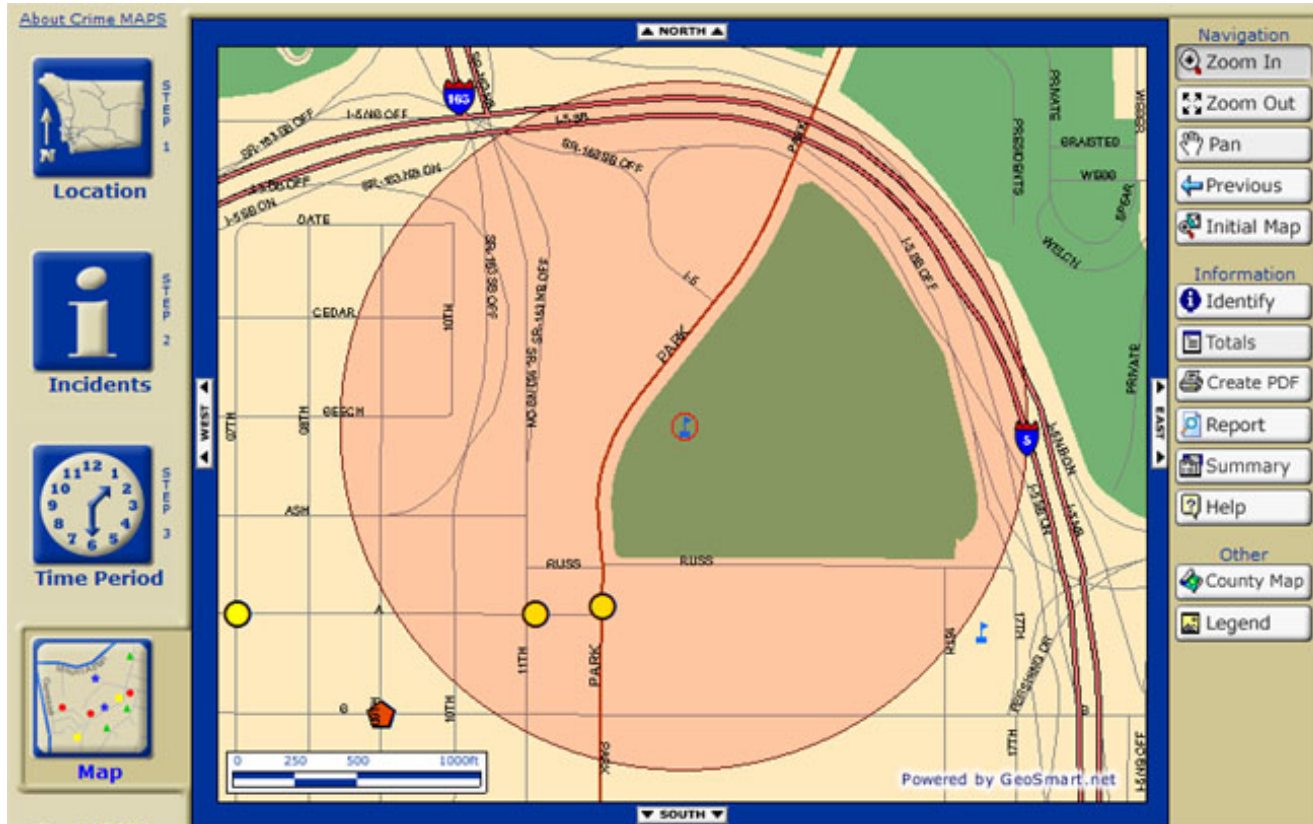
<http://www.familywatchdog.us/>



GIS Applications - Crime

Automated Regional Justice Info System

- San Diego Police Department



<http://mapping.arjis.org/>

GIS Applications - Crime

COMSTAT

- COMPuter or COMParative STATistics
- NYPD



NYC Crime									
Year	NYC Pop.	MURDER				RAPE			
		Number	Rate	Proj. Rate	Saved by Compstat	Number	Rate	Proj. Rate	Saved by Compstat
1,985	7,183,984	1,384	19			3,880	54		
1,986	7,179,609	1,582	22			3,536	49		
1,987	7,284,319	1,672	23			3,507	48		
1,988	7,346,352	1,896	26			3,412	46		
1,989	7,369,454	1,905	26			3,254	44		
1,990	7,322,564	2,245	31			3,126	43		
1,991	7,350,023	2,154	29			2,892	39		
1,992	7,375,097	1,995	27			2,815	38		
1,993	7,347,257	1,946	27	29	184	2,818	38	40	118
1,994	7,336,224	1,561	21	29	565	2,666	36	40	271
1,995	7,319,546	1,177	16	29	944	2,317	32	40	608
1,996	7,339,594	983	13	29	1,145	2,332	32	40	602
1,997	7,320,477	770	11	29	1,354	2,157	30	40	769
1,998	7,357,745	633	9	29	1,501	2,046	28	40	898
1,999	7,429,263	664	9	29	1,493	1,702	23	40	1,270
2,000	8,008,278	673	8	29	1,650	1,630	20	40	1,570
2,001	8,023,018	714	9	29	1,613	1,664	21	40	1,548
2,002	8,084,693	587	7	29	1,754	1,689	21	40	1,544
2,003	8,098,066	597	7	29	1,749	1,609	20	40	1,628
2,004	8,101,321	570	7	29	1,779	1,428	18	40	1,813
Total		15,732				12,638			

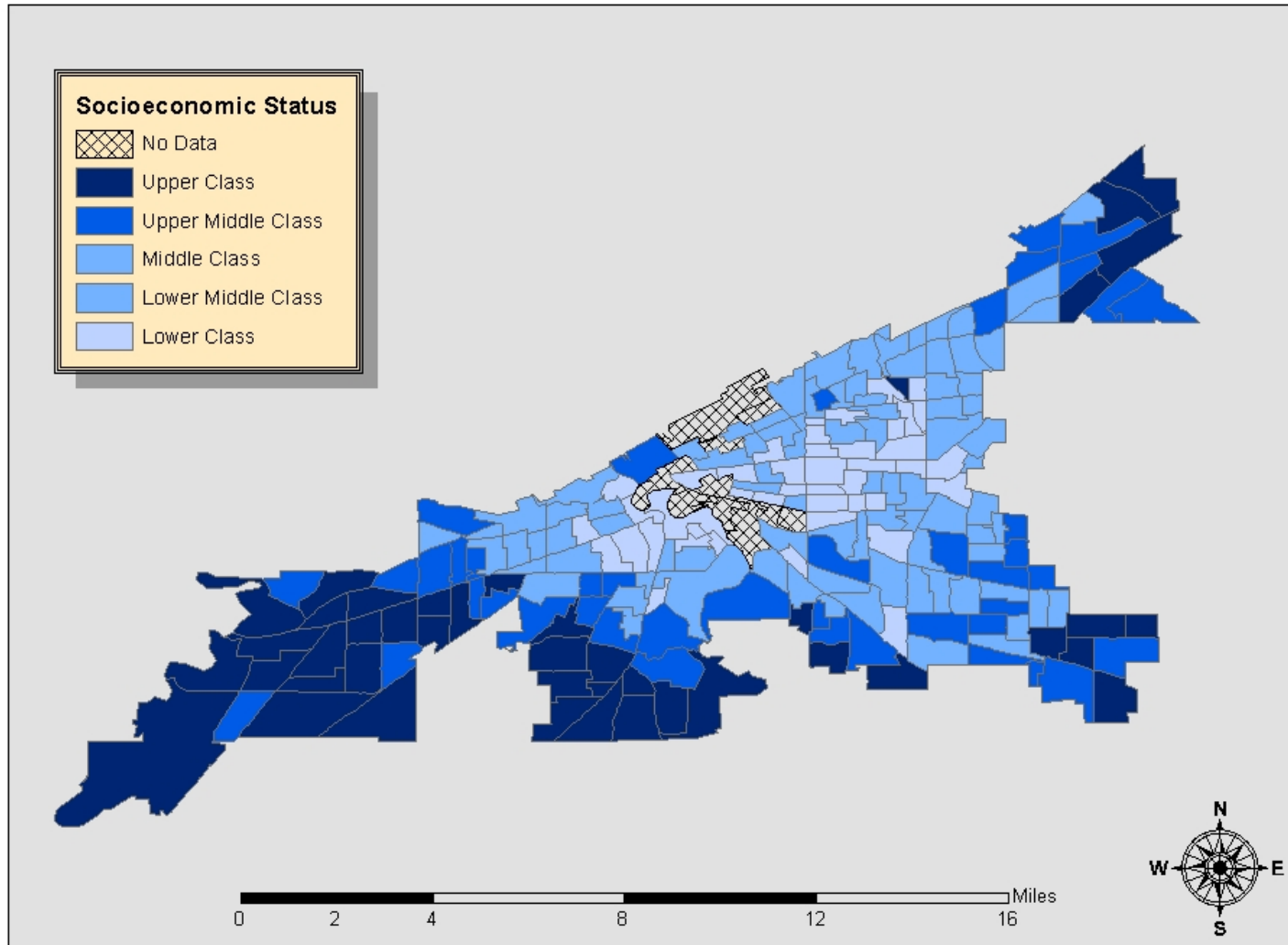


<http://www.nyc.gov/html/nypd/html/chfdept/compstat-process.html>

Geography of Crime

- To **describe** and **map** the **spatial distribution** of crime in greater **detail** and **meaning** than has been done before.
- To **relate** the spatial patterns of crime to the **environmental, social, historical, psychological** (cognitive), and economic variables.
- To **develop** associational and predictive **models** that explain crime manifestation in regard to locale.
- To **analyze** the dynamics of crime manifestation to **help** **crime control** and to **assess** better the effectiveness of **programs** they currently use.

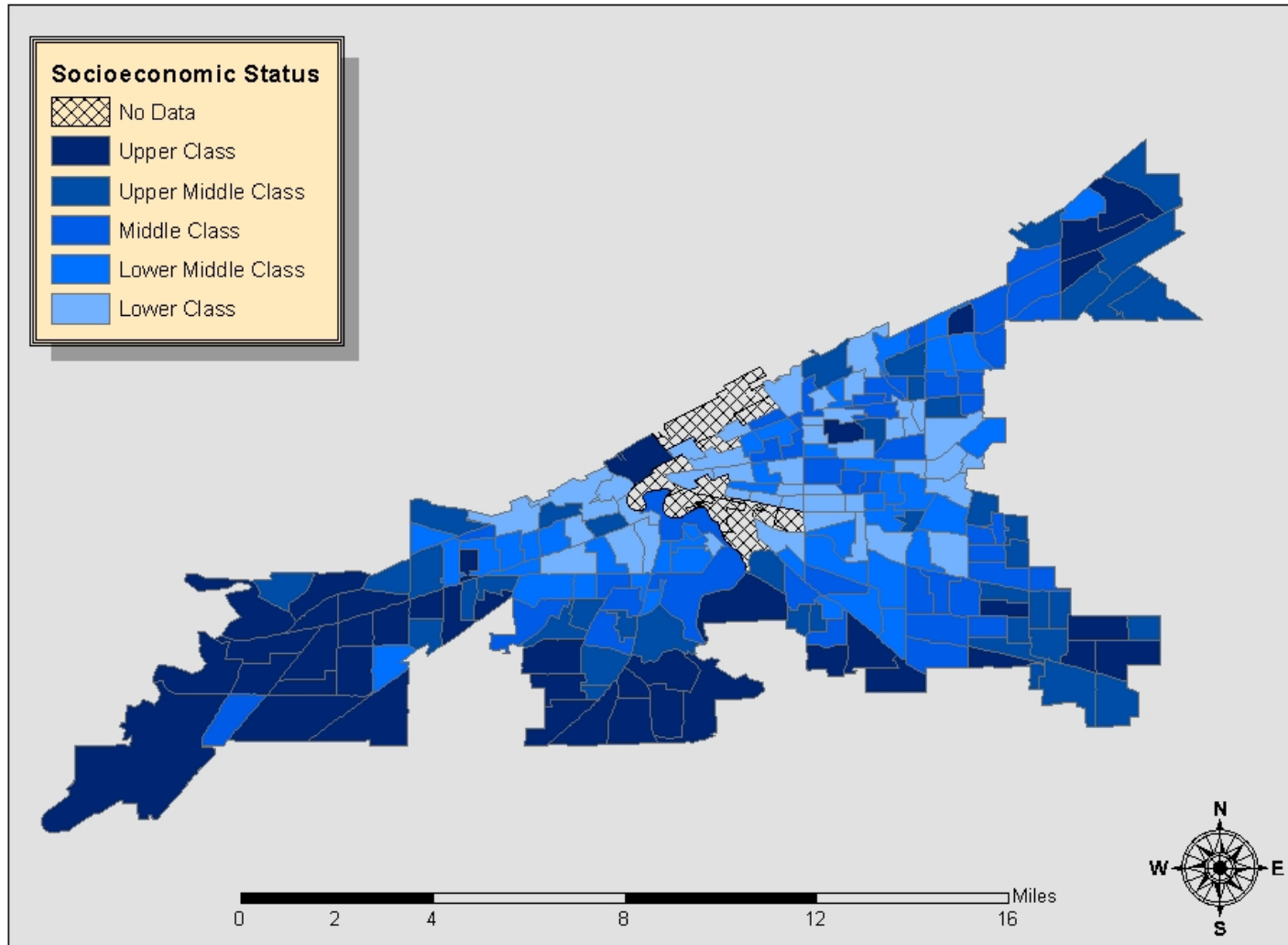
Cleveland, OH Socioeconomic Status by Census Tract, 1990



Source: 1990 U.S. Bureau of the Census

Paul Butke 4/11/05

Cleveland, OH Socioeconomic Status by Census Tract, 2000

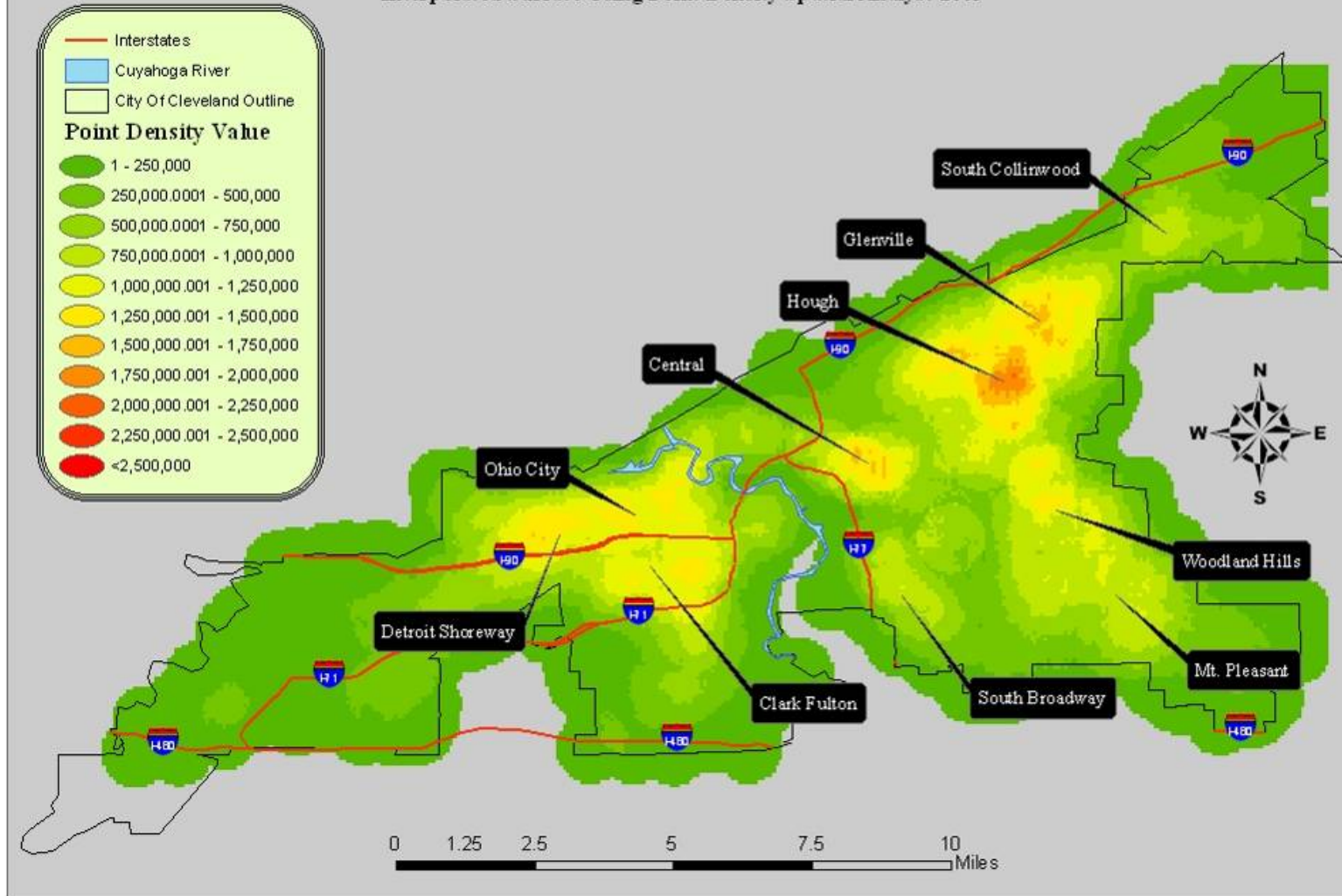


Source: 2000 U.S. Bureau of the Census

Paul Butke 4/11/05

Cleveland, OH Assaults By Census Block, 1990

Interpolated Surface Using Point Density Spatial Analyst Tool

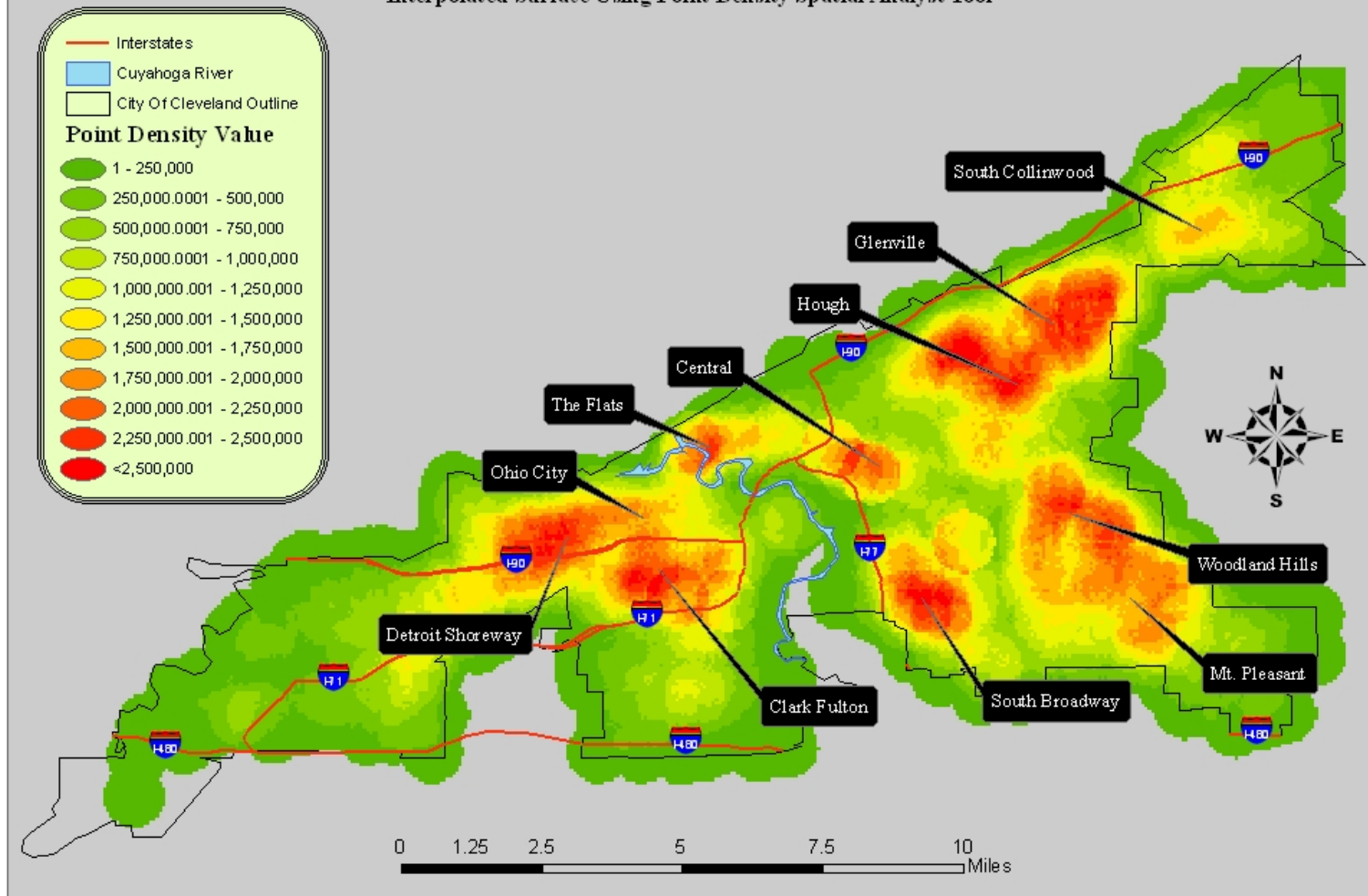


Data Source: Case Western Reserve's Center On Urban Poverty And Social Change

Paul Butke 4/19/05

Cleveland, OH Assaults By Census Block, 2000

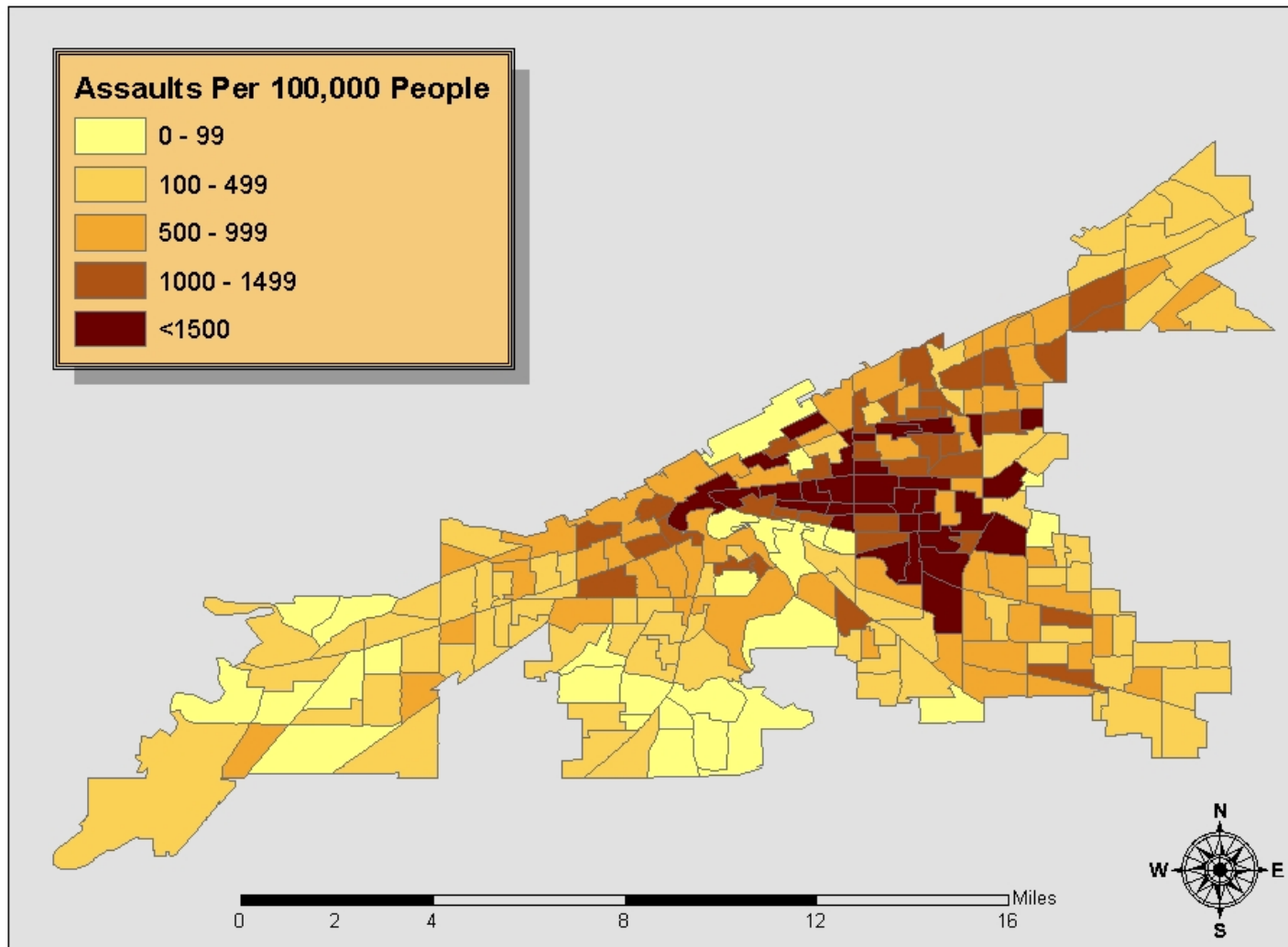
Interpolated Surface Using Point Density Spatial Analyst Tool



Data Source: Case Western Reserve's Center On Urban Poverty And Social Change

Paul Butke 4/19/05

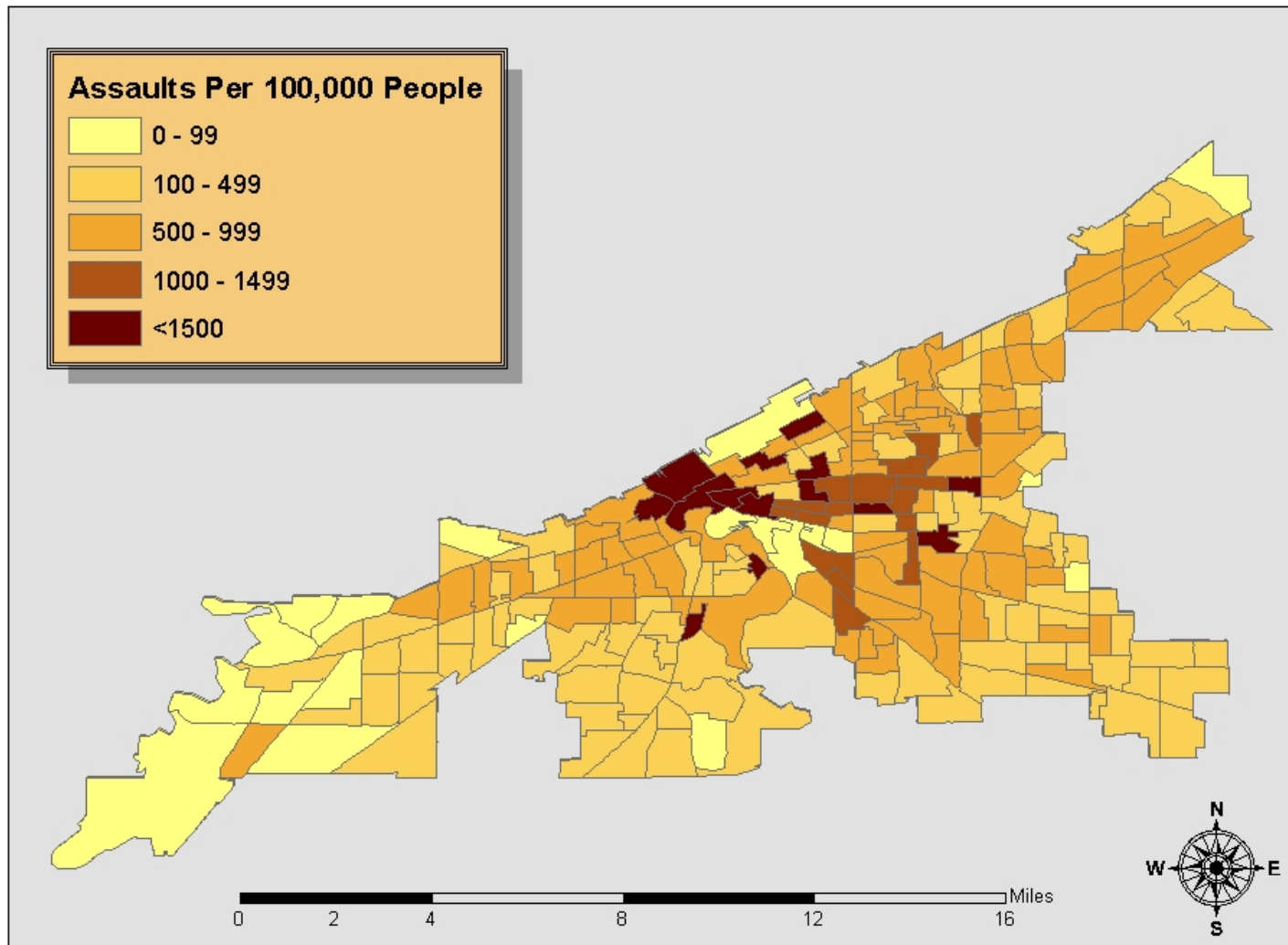
Cleveland, OH Assaults by Census Tract, 1990



Source: Case Western Reserve's Center For Urban Poverty And Social Change

Paul Butke 4/11/05

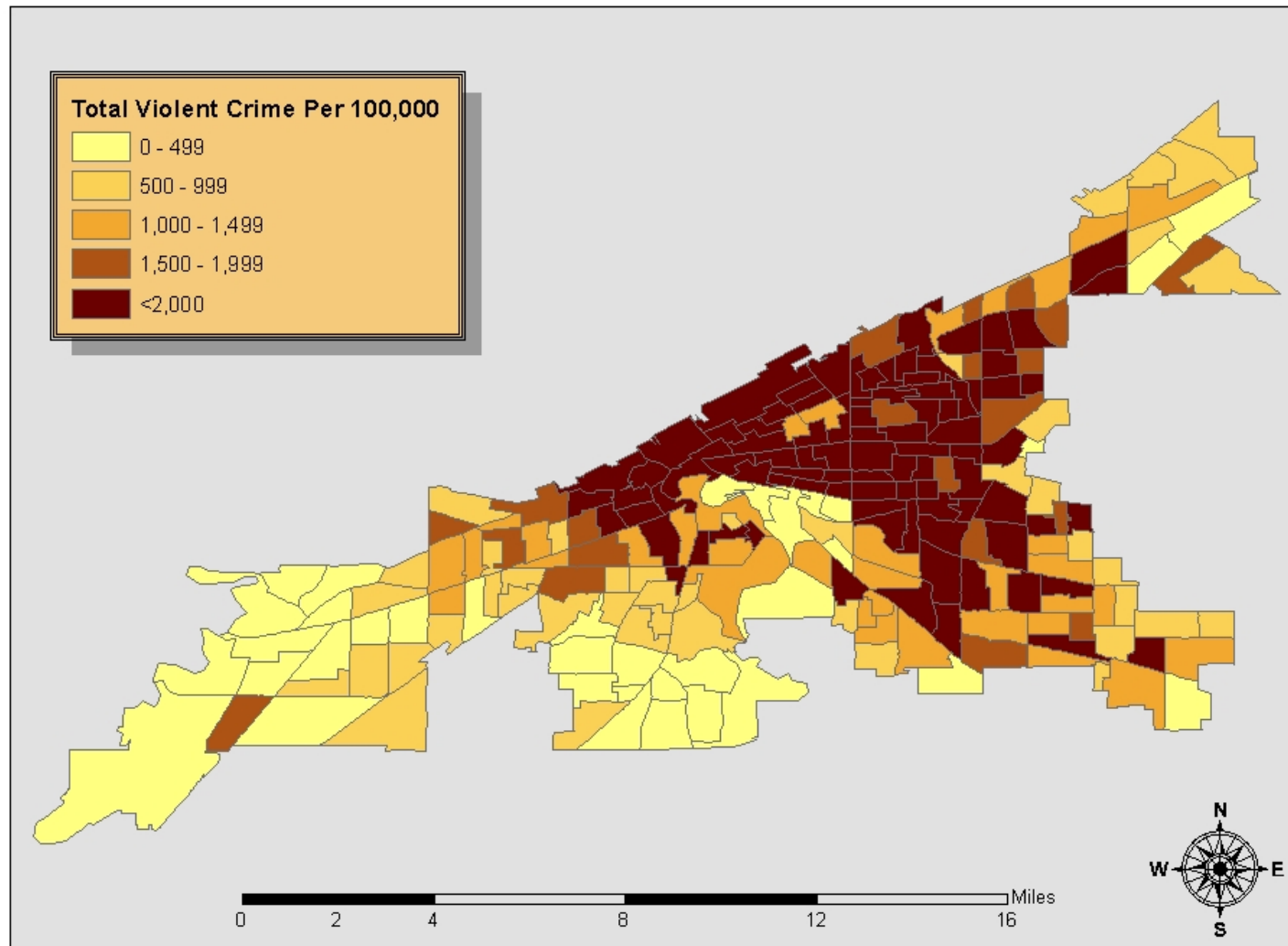
Cleveland, OH Assaults by Census Tract, 2000



Source: Case Western Reserve's Center For Urban Poverty And Social Change

Paul Butke 4/11/05

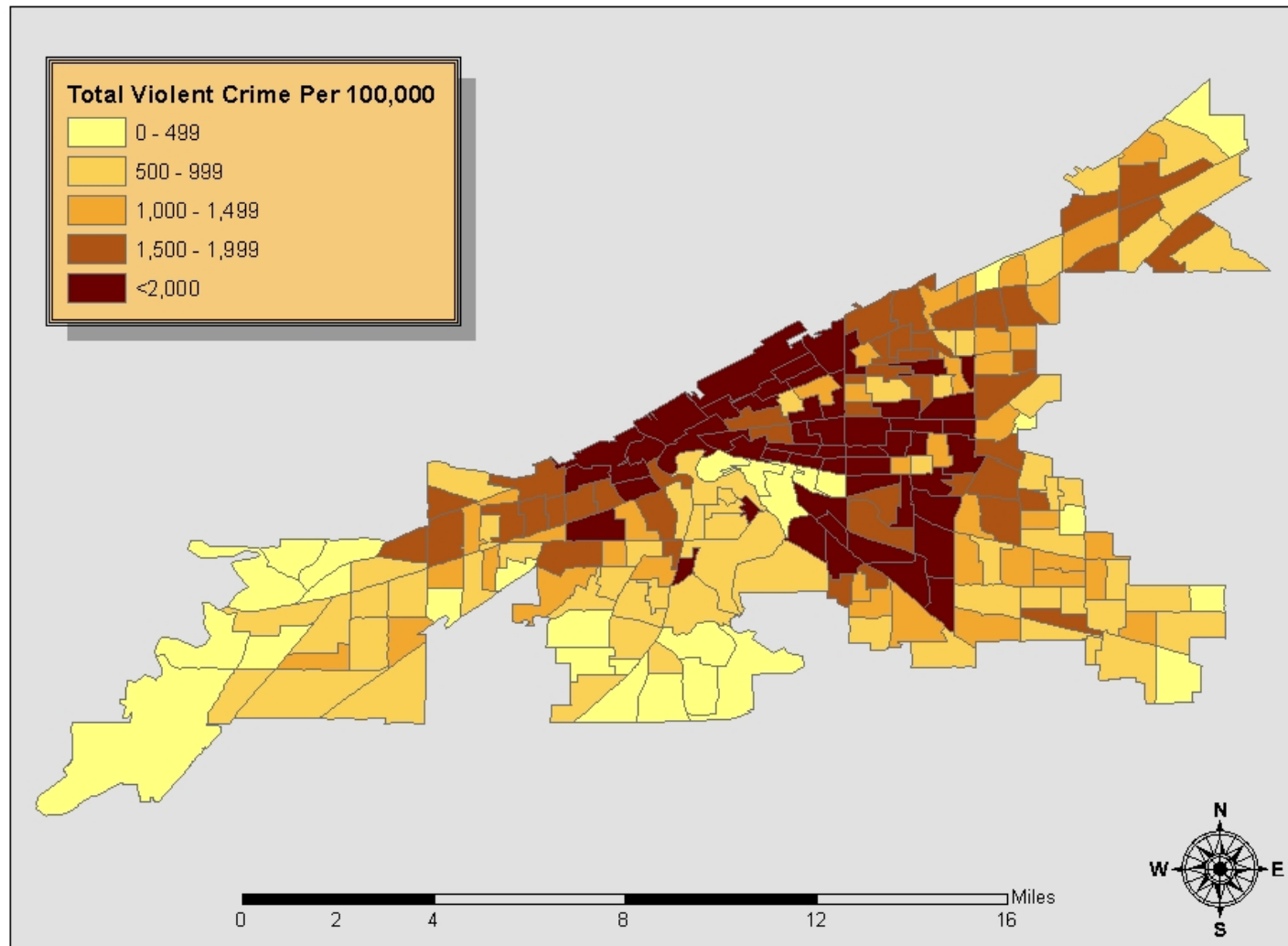
Cleveland, OH Total Violent Crime by Census Tract, 1990



Source: Case Western Reserve's Center of Urban Poverty And Social Change

Paul Butke 4/11/05

Cleveland, OH Total Violent Crime by Census Tract, 2000



Source: Case Western Reserve's Center of Urban Poverty And Social Change

Paul Butke 4/11/05