Geographical Information System (GIS)

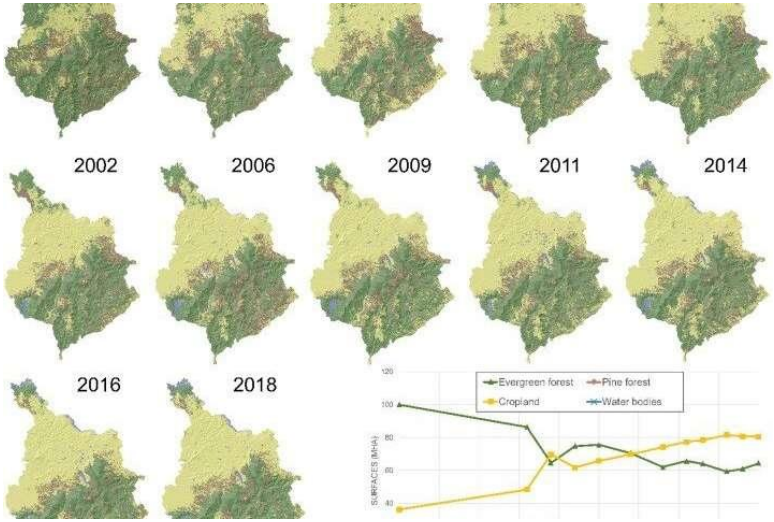
Dr. Tarendra Lakhankar

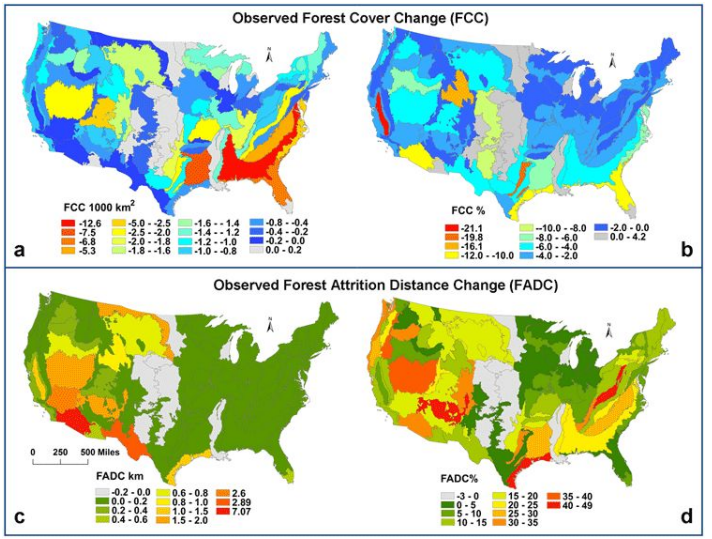
Why make maps?

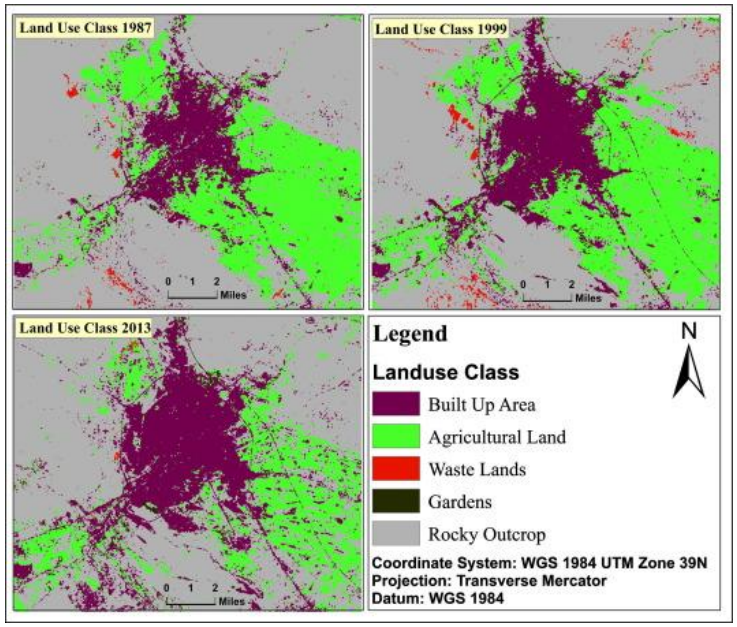
Maps as story tellers and can used as problem solvers.

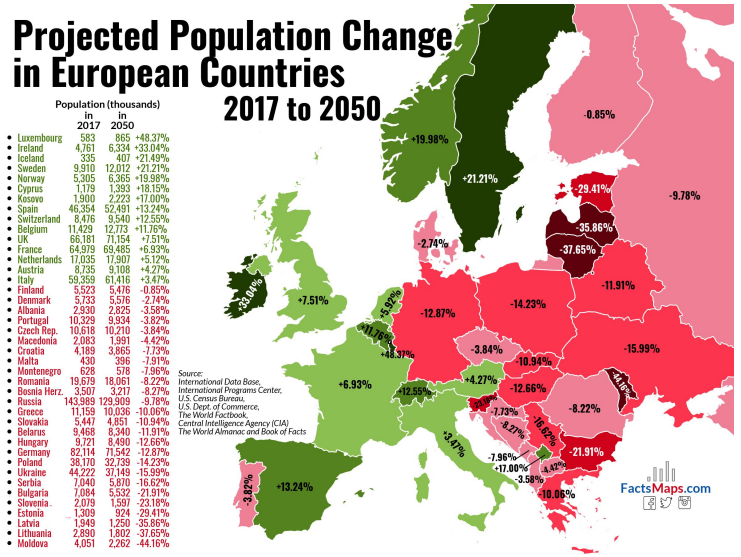
- To represent a larger area than we can see
- To show a phenomenon or process we can’t see with our eyes
- To present information concisely
- To show spatial relationships

Show what we can't see

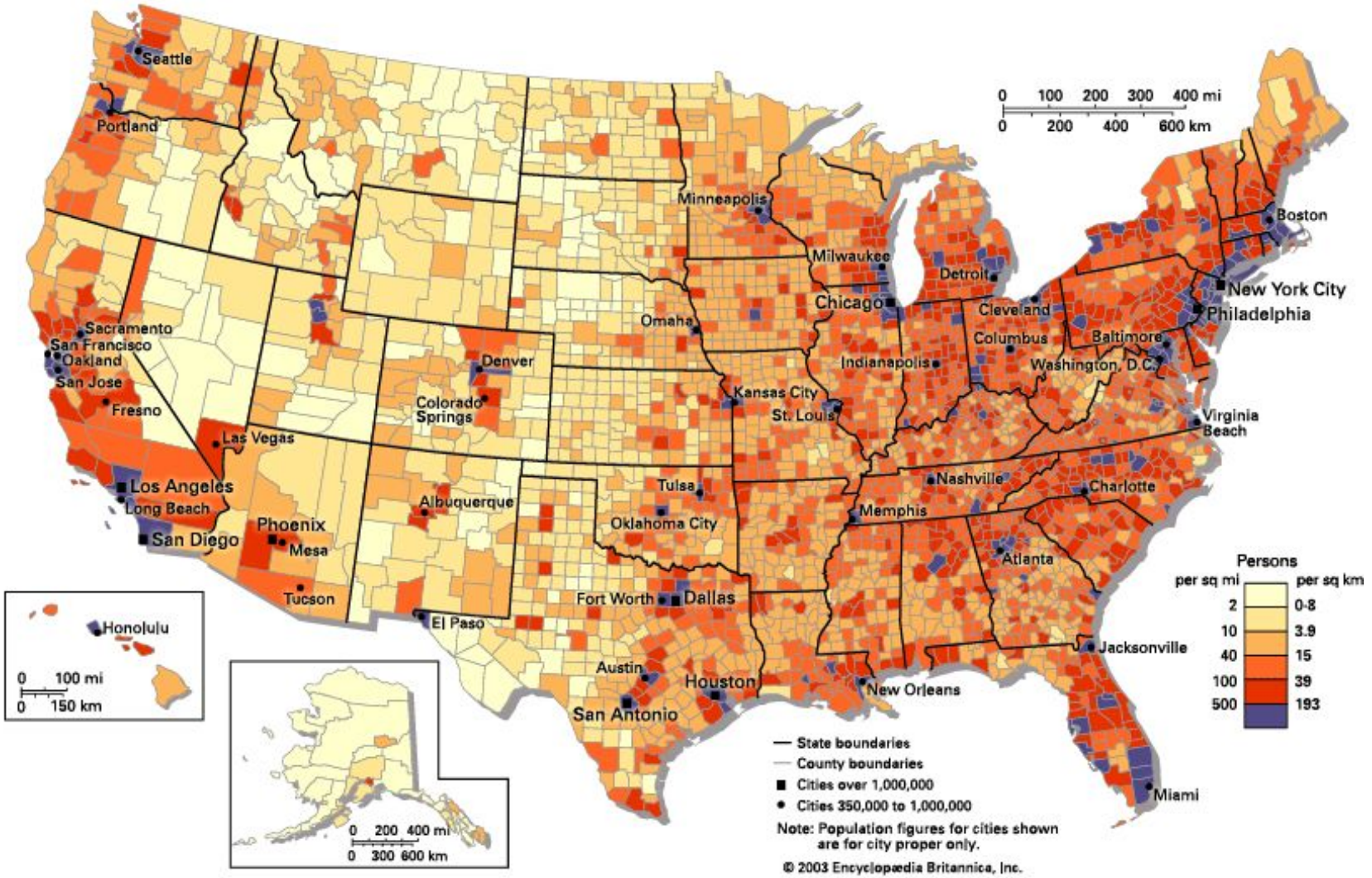




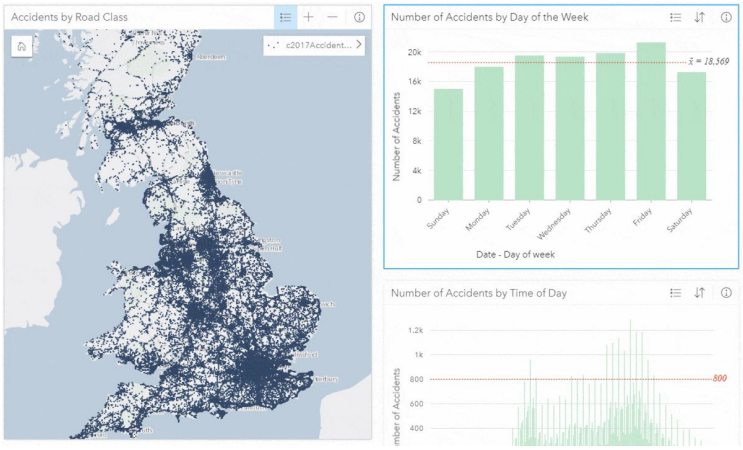


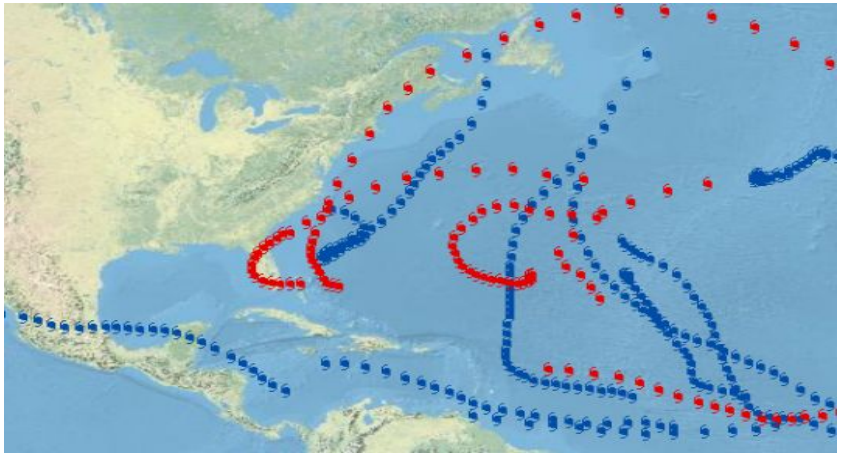


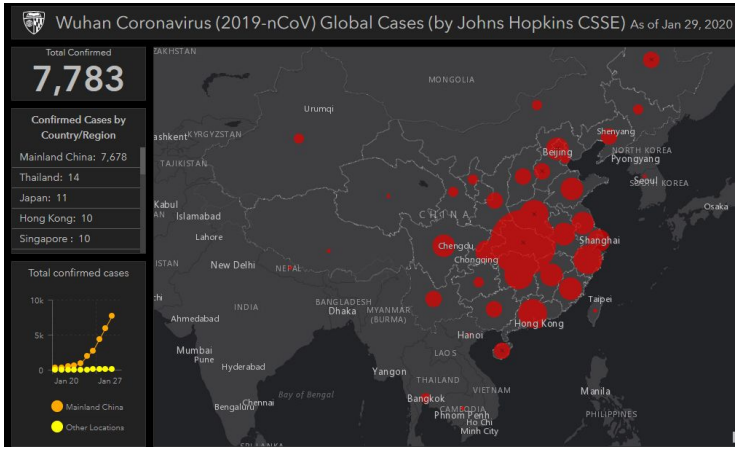
Present info concisely

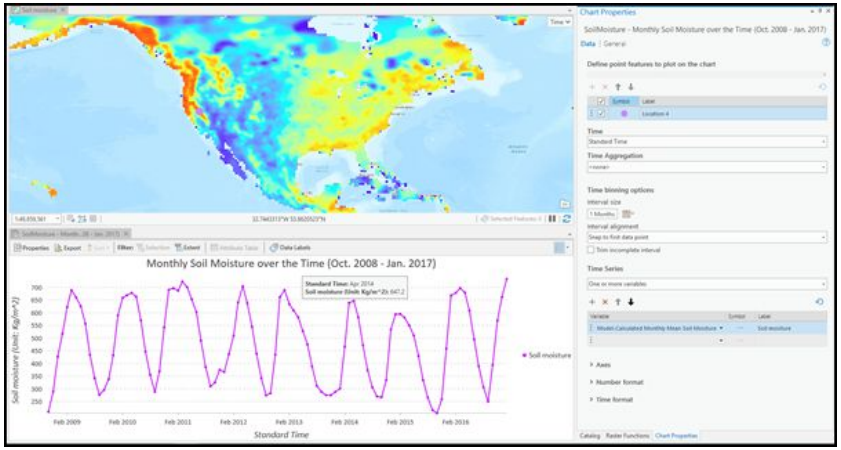


Show spatial-temporal relationships





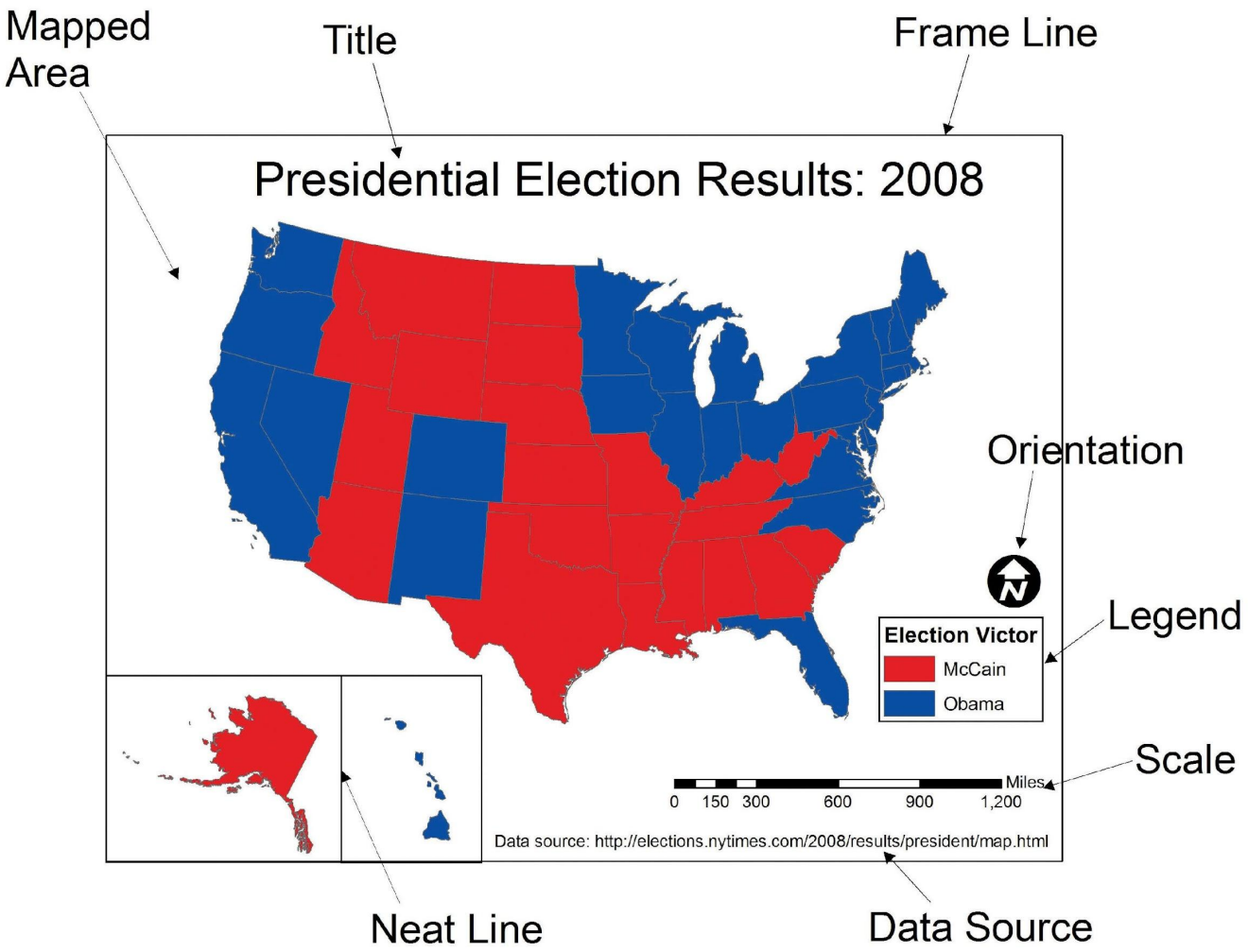




How do we read maps?

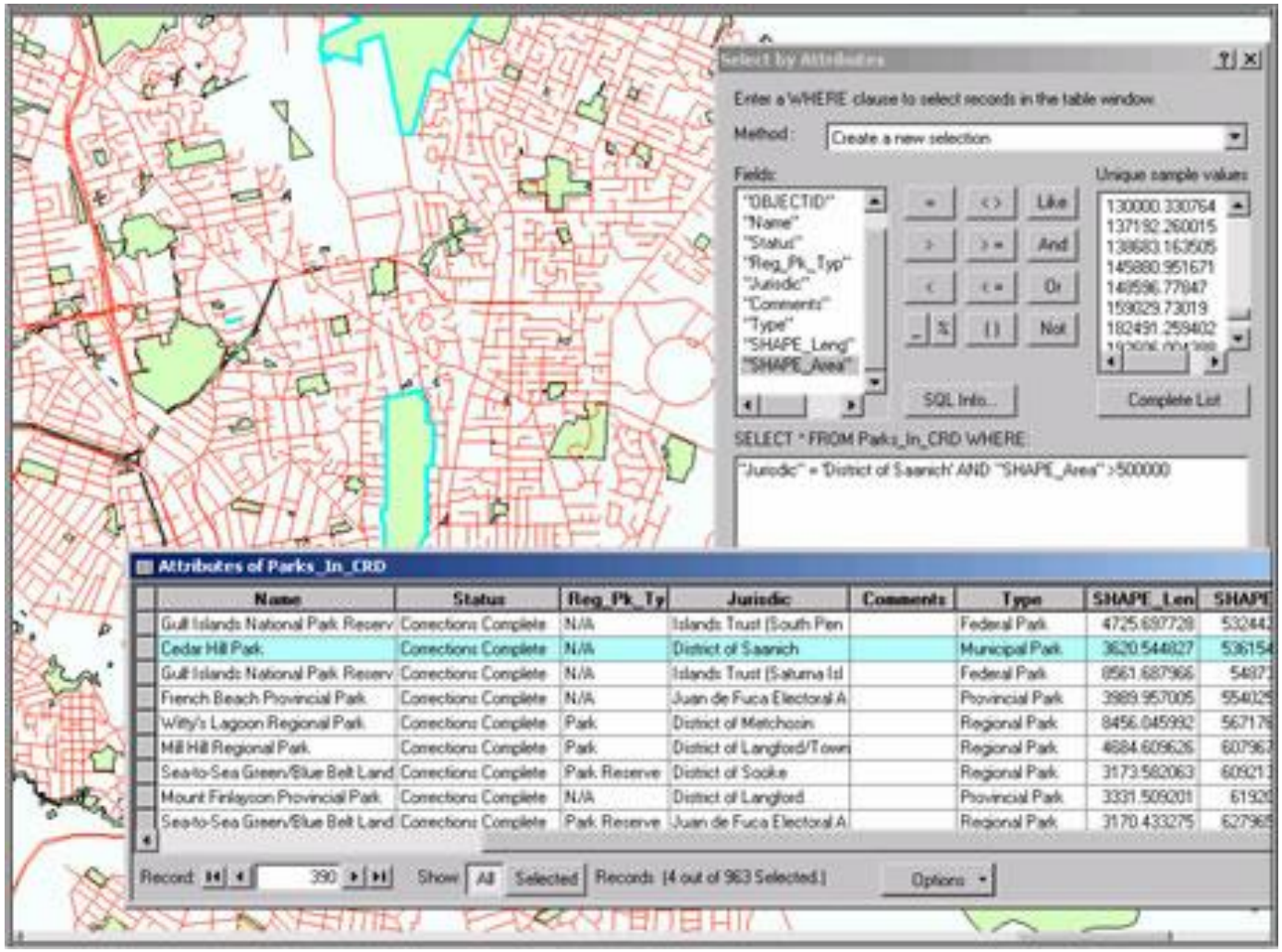
- Maps are selective views of reality
- Size of the map relative to reality (scale)
- What's on the map (symbolization)
- Shape of the map (projection)
- Checking map orientation (North Arrow)

Common Map Elements



What is a GIS?

- A GIS is a computer system that allows you to map, model, query, and analyze large quantities of data within a single database according to their location.



Geographic primitive

$$G = f(x, y, z, t, F)$$

x, y = Spatial data
z = Elevation data
t = time data
F = Attribute data

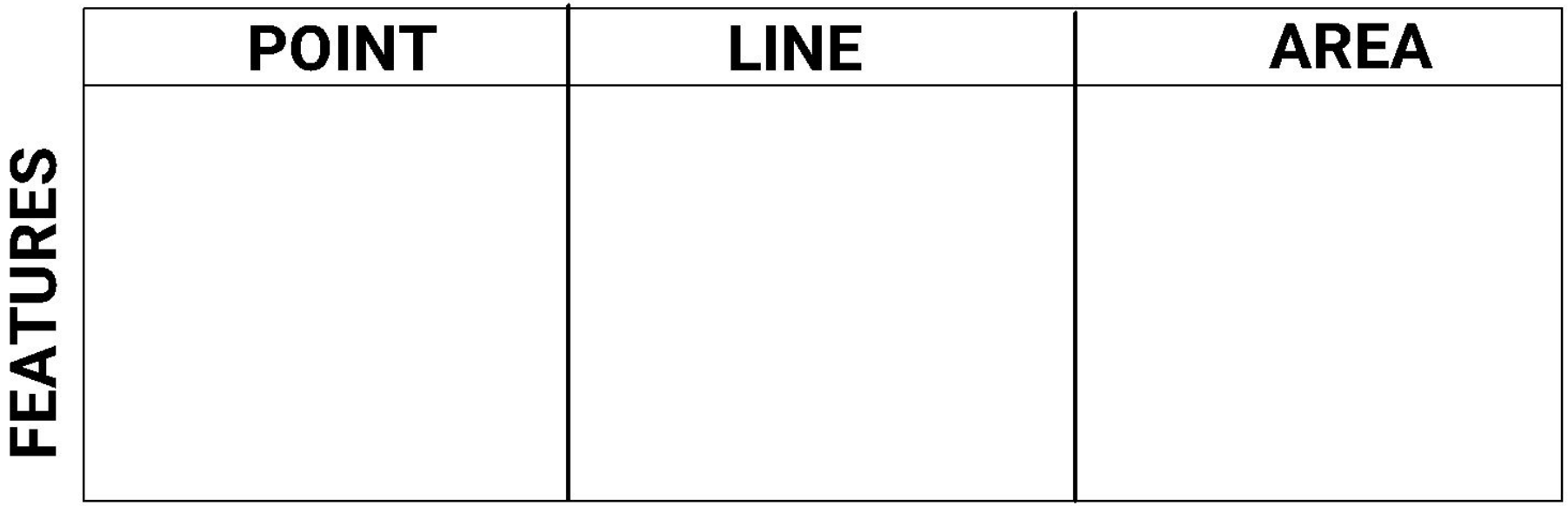
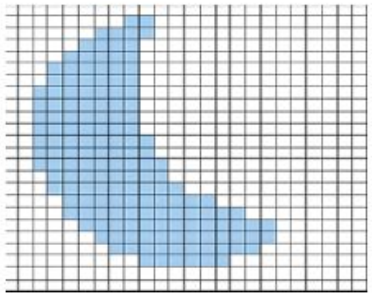
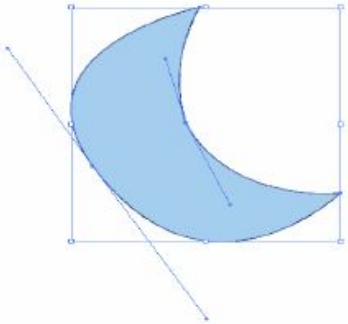


Figure 1.2The Feature Model: Examples of a point feature (38 foot elevation bench mark), ture (road, contours) and area features (reservoir, vegetation).

Raster vs Vector

Raster and Vector Graphics

Raster	Vector
	
Made up of a ***grid*** of pixels	Geometric shapes and lines that are defined ***mathematically***
Resolution dependent	Resolution ***independent***
When scaled, visual quality and sharpness is degraded	When scaled, visual quality and sharpness is ***unaffected***
File size is relatively ***large***	File size is relatively ***small***
File Formats: ***GIF, TIF, BMP, PSD***	File Formats: ***EPS, WMF, AI***
Pixel-oriented	***Object*** -oriented

Zoom raster vs Vector image

100% (900 x 983 dpi)

200%

500%

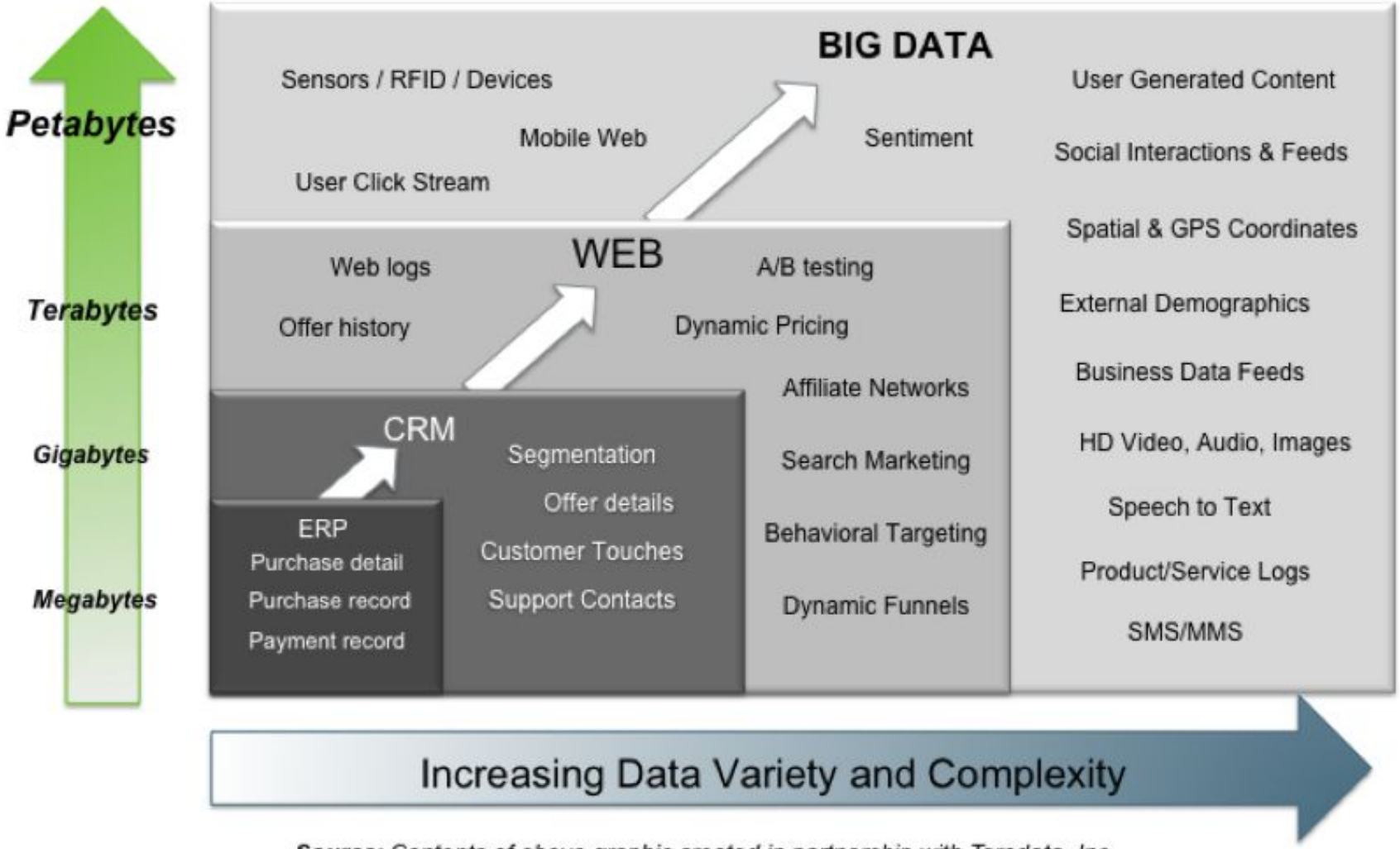
100%

200%

500%

Data…. Big Data?

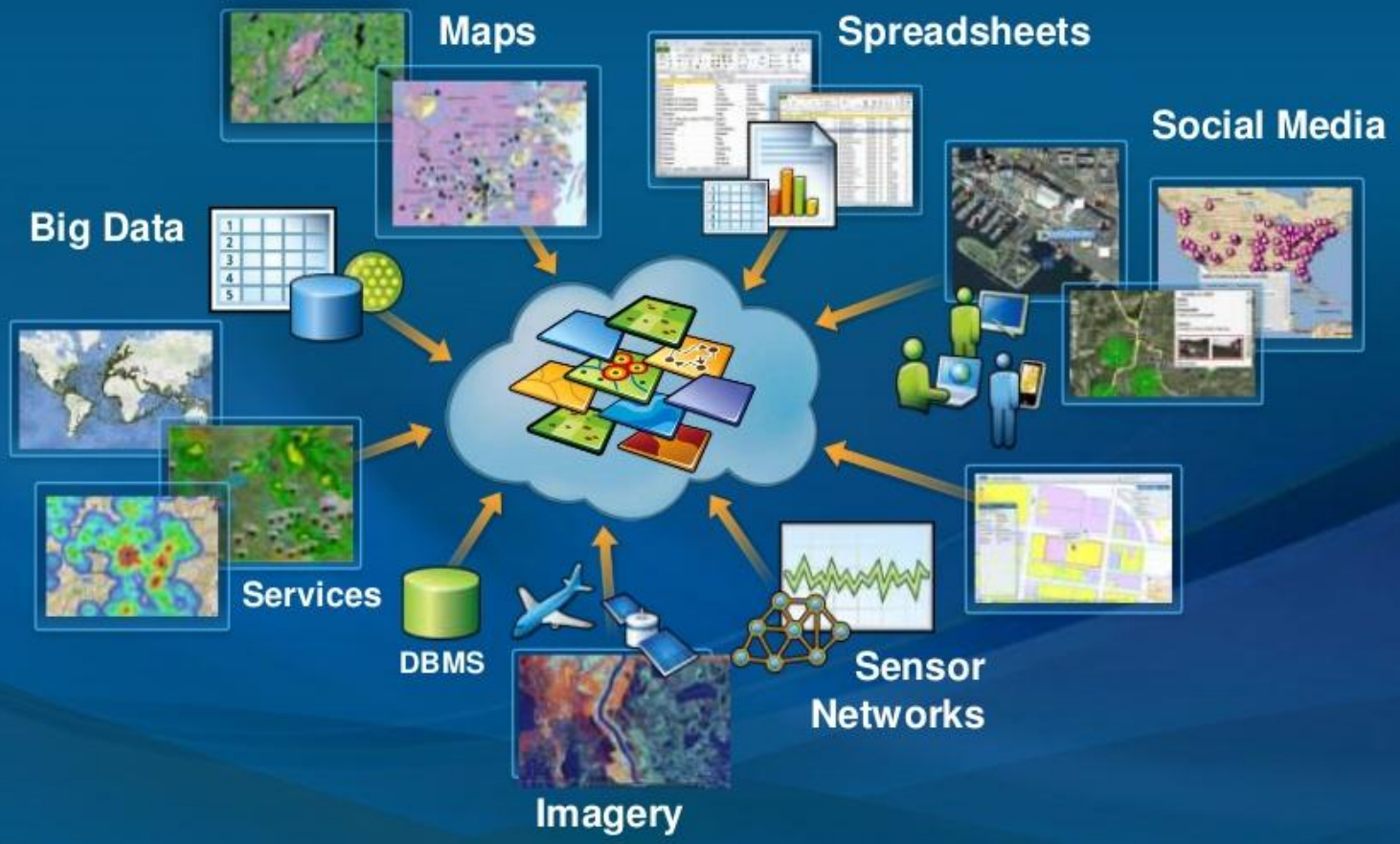
Big Data = Transactions + Interactions + Observations



***Source**: Contents of above graphic created in partnership with Teradata, Inc.*

ArcGIS online integrates geospatial information

Leveraging the cloud and standards



Authoritative content

- Basemaps
- Reference layers
- Demographic
- Templates

The foundation and building blocks for making maps and apps

Source: ESRI

What is GIS?

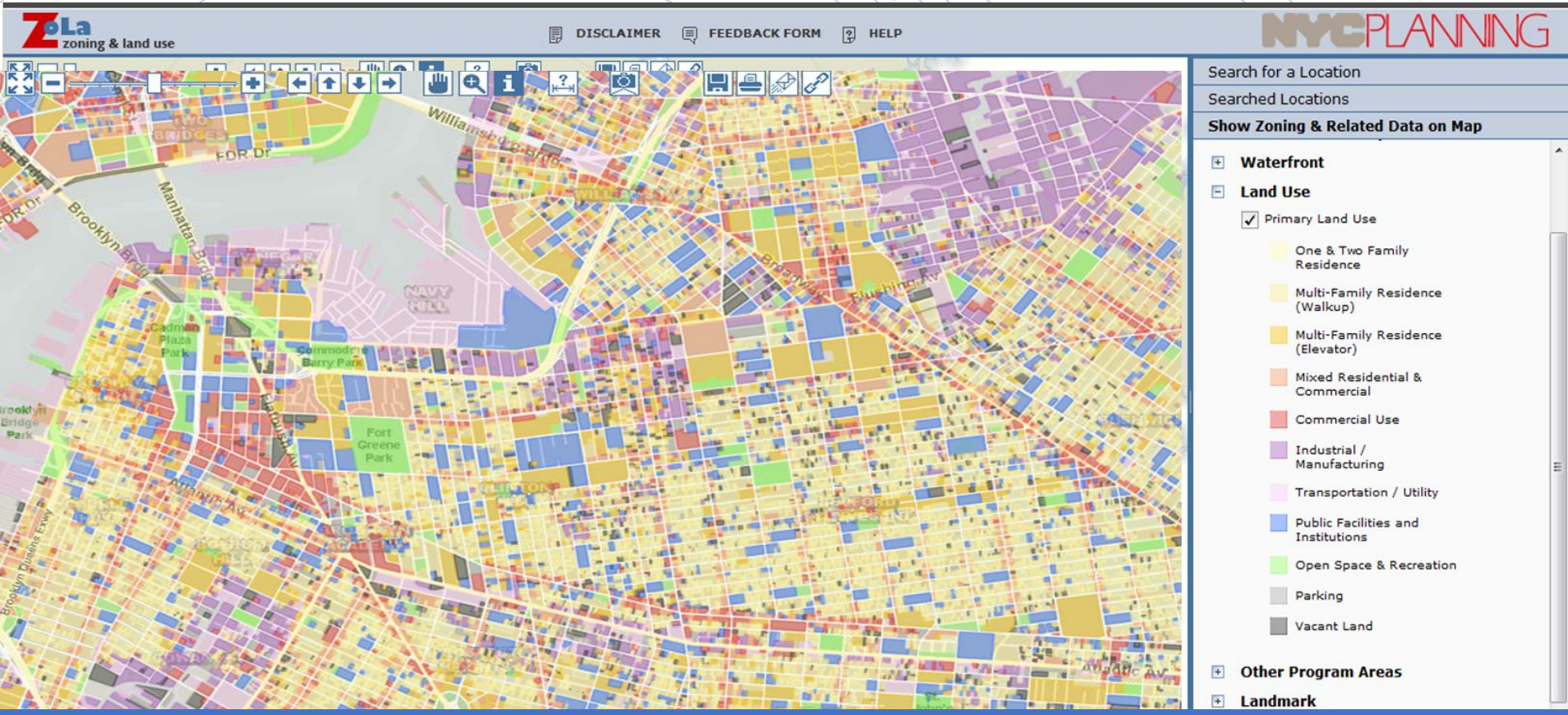
It's **Geographic Information System**

So, GIS deals with any data with geographical coordinates?

Examples of Applied GIS

- **Urban Planning, Management & Policy**
  - Zoning, subdivision planning
  - Land acquisition
  - Economic development
  - Code enforcement
  - Housing renovation programs
  - Emergency response
  - Crime analysis
  - Tax assessment
- **Environmental Sciences**
  - Monitoring environmental risk
  - Modeling stormwater runoff
  - Management of watersheds, floodplains, wetlands, forests, aquifers
  - Environmental Impact Analysis
  - Hazardous or toxic facility siting
  - Groundwater modeling and contamination tracking
- **Political Science**
  - Redistricting
  - Analysis of election results
  - Predictive modeling
- **Civil Engineering/Utility**
  - Locating underground facilities
  - Designing alignment for freeways, transit
  - Coordination of infrastructure maintenance
- **Business**
  - Demographic Analysis
  - Market Penetration/ Share Analysis
  - Site Selection
- **Education Administration**
  - Attendance Area Maintenance
  - Enrollment Projections
  - School Bus Routing
- **Real Estate**
  - Neighborhood land prices
  - Traffic Impact Analysis
  - Determination of Highest and Best Use
- **Health Care**
  - Epidemiology
  - Needs Analysis
  - Service Inventory


Urban planning and
management

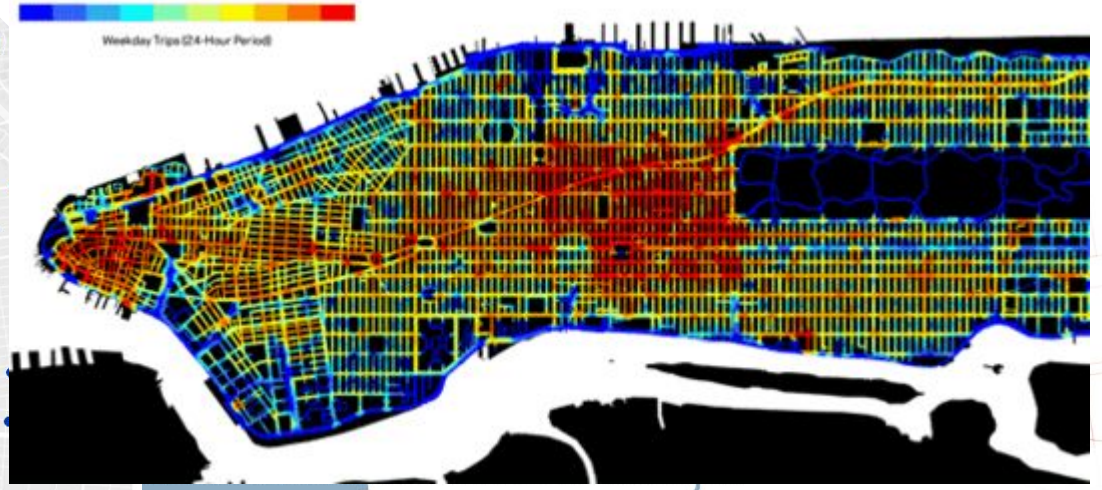


Land-use data

http://maps.nyc.gov/doitt/nycitymap/

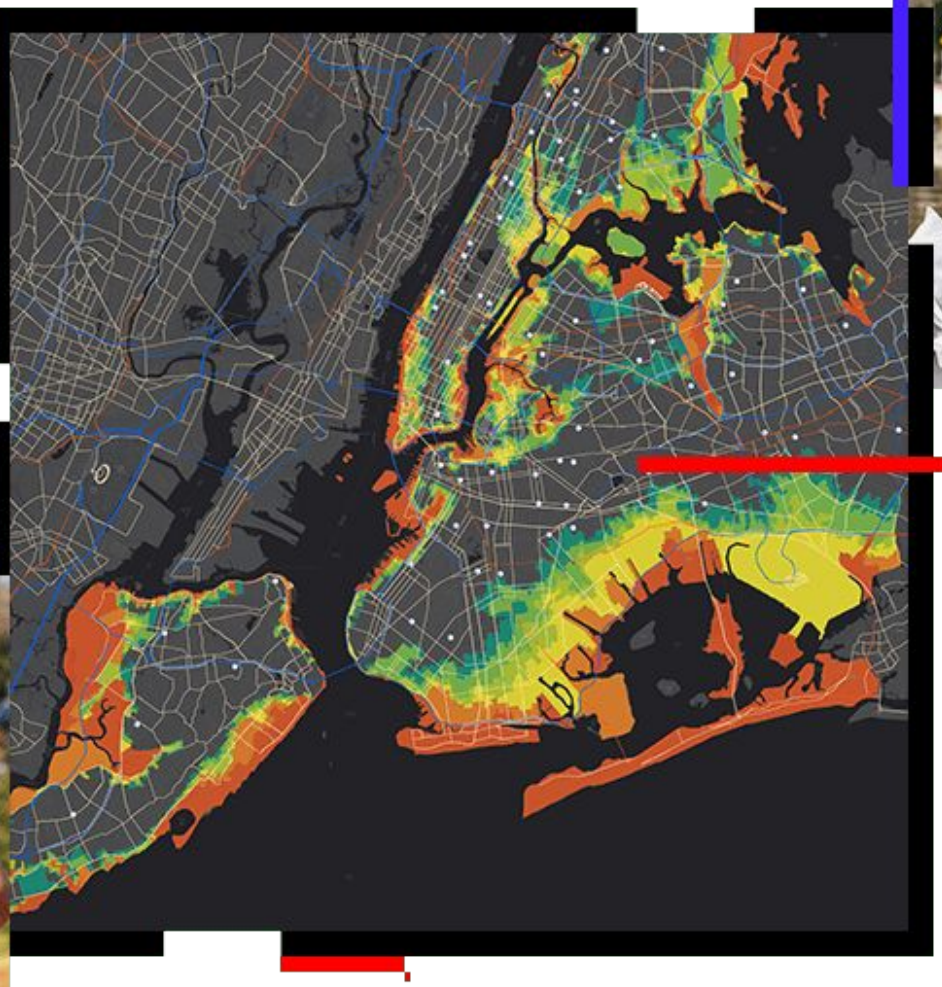
5.5 Million Journeys at NYC Bike Share

Based on origin-destination data released by NYC Bike Share for journeys between July 2013 and February 2014. Idealised route assumed, using OpenStreetMap data.

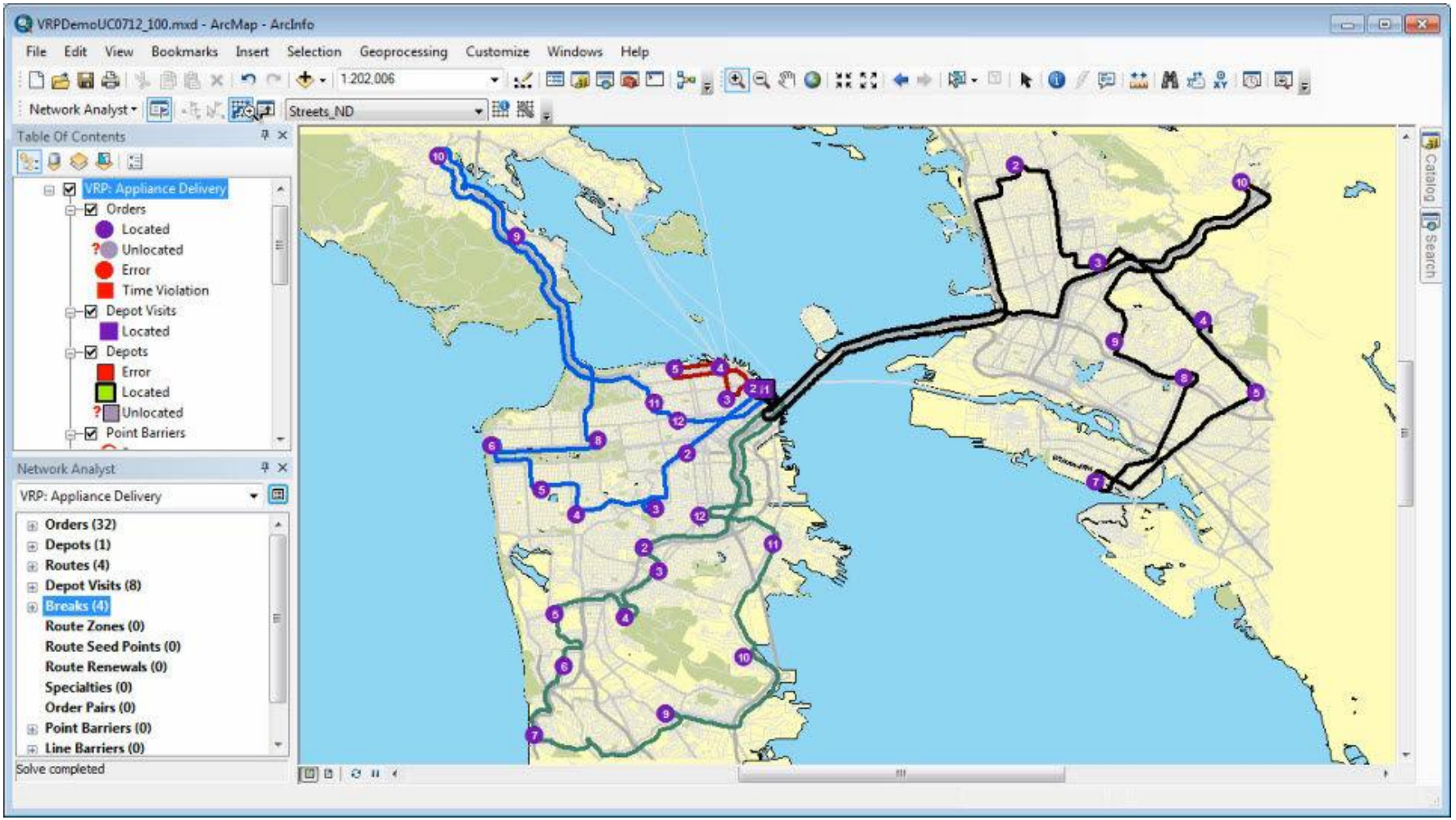



DisasterLAN Incident Management Mapping System - Windows Internet Explorer
http://gis.disasterlan.org/DisasterLan/viewer.aspx
DISASTER LAN
Incident Management Mapping System
Zoom To Region
Address Search
Coord. Search
Zoom In
Zoom Out
Full Extent
Pan
Measure
Identify
Select by Box
Buffer Feature
Buffer Point
Clear Selection
Markup Map
Erase Markup
ALOHA Plume
Retrieve Data
Erase Plume
Track Assets
Print
View Layers
View Legend
Refresh Map
Map Layers
Auto Vehicle Locator
Shelters
Pharmacies
Schools
Day Care Centers
Fire Hydrants
Parcels
Erie County Ortho Imagery
Airports
Runways (Regional)
Airports (Regional)
Airports (Local)
Landing Fields (Detailed)
Background
National Forests (Reg-Local)
US Background (National and State)
US Background (Regional)
US Background (Local)
Canada and Mexico Background
Ocean Background
Cities (Points)
Large Cities (National)
Major Cities (State)
City (Areas)
Urban Outlines (State)
Urban Outlines (Regional)
Municipal Boundaries
Places (Outline)
Urban Areas (State)
Field EOC
Triage
Chlorine Gas Release
0 0.1039 Miles
Current Map Mode: Markup Map
Done
Internet
100%

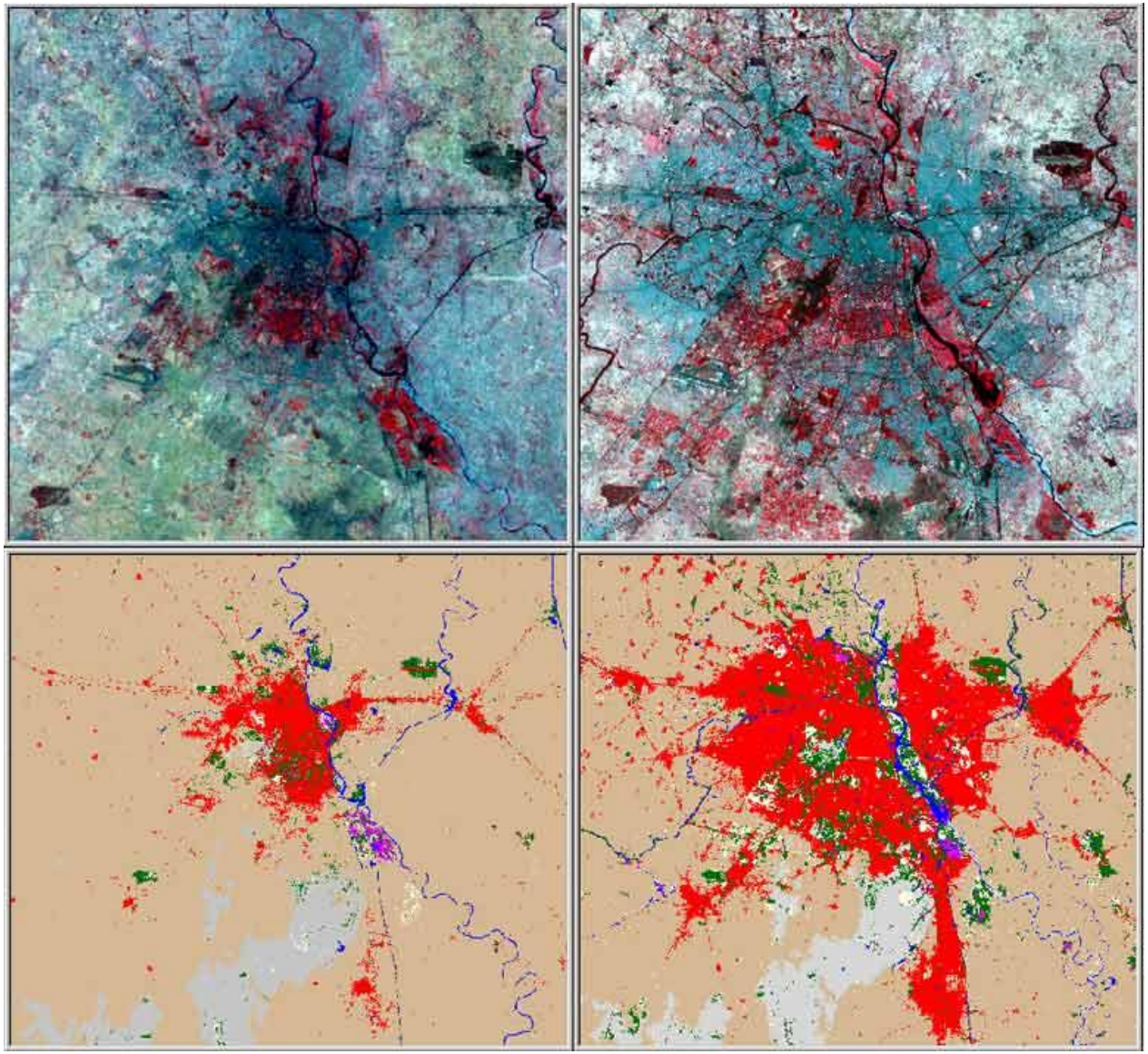
Emergency Management



Road Network Analysis (Appliance Delivery)

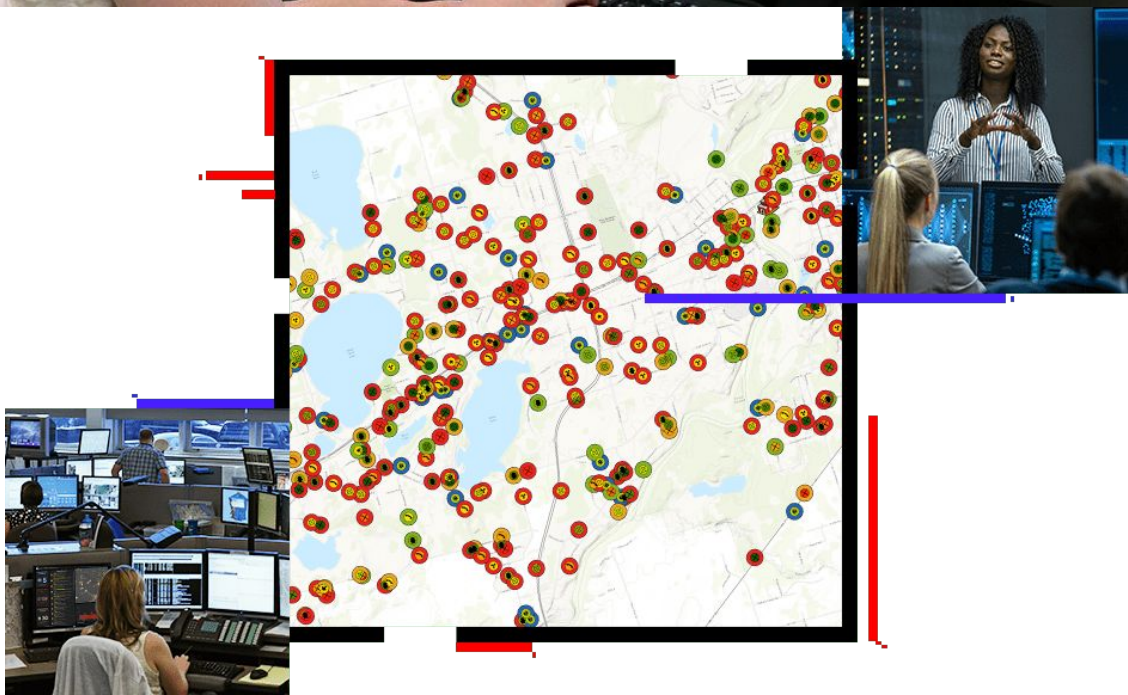


Mapping and Compare Urban Growth



911 - GIS Integration

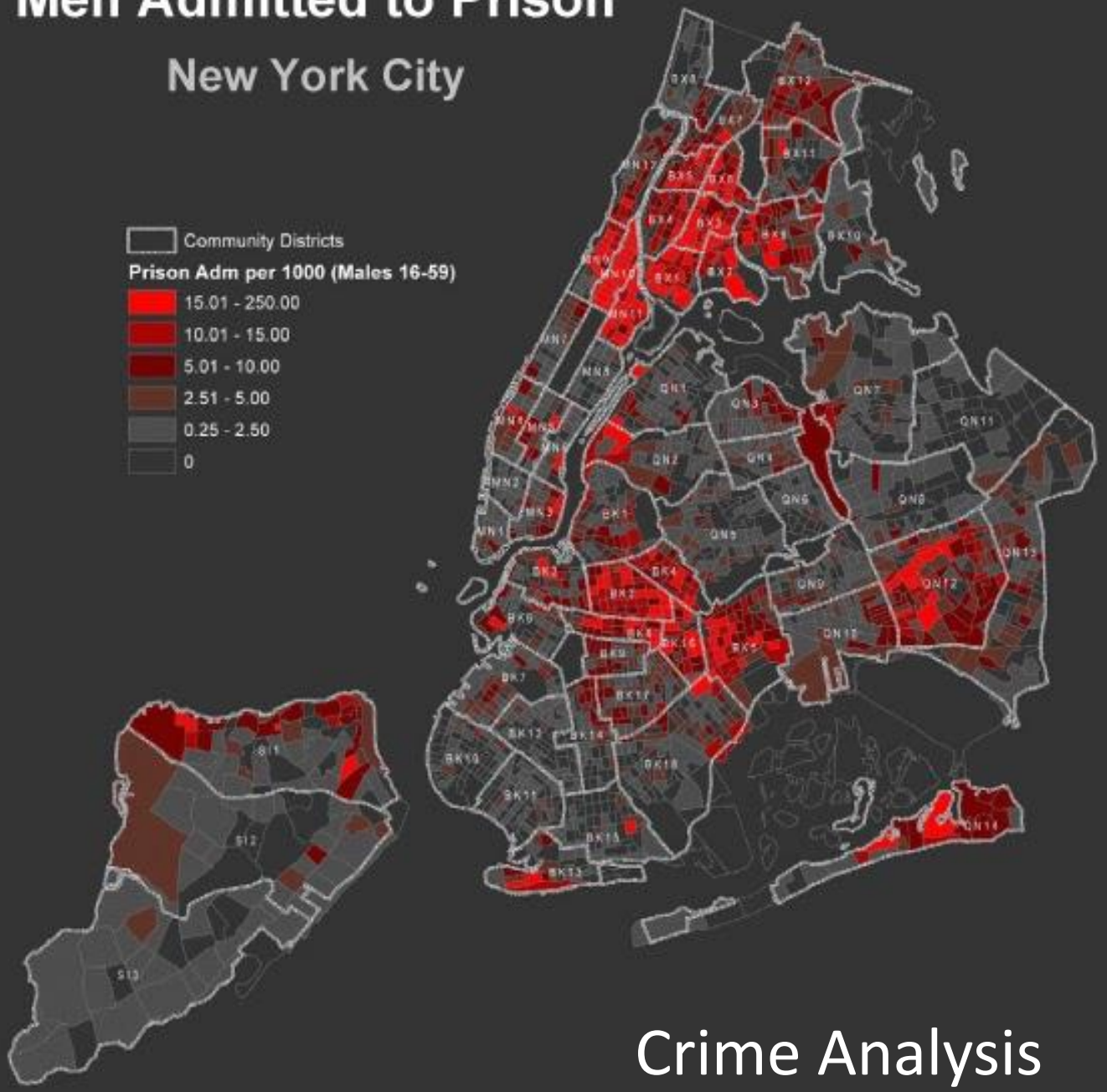
Computer-aided dispatch (CAD)



Men Admitted to Prison

New York City

Per 1000 Adult Males (16–59)



Admissions per 1000

Boro	CD	Count	Rate
MN	10	748	25.7
MN	11	671	19.8
BX	3	328	19.2
BX	2	226	17.4
BX	1	358	16.8
BX	5	531	14.7
BK	3	516	13.7
BK	16	274	13.7
BX	6	249	12.8
BK	8	289	12.1
MN	9	423	11.8
BX	4	396	10.6
BK	5	457	10.1

Crime Analysis

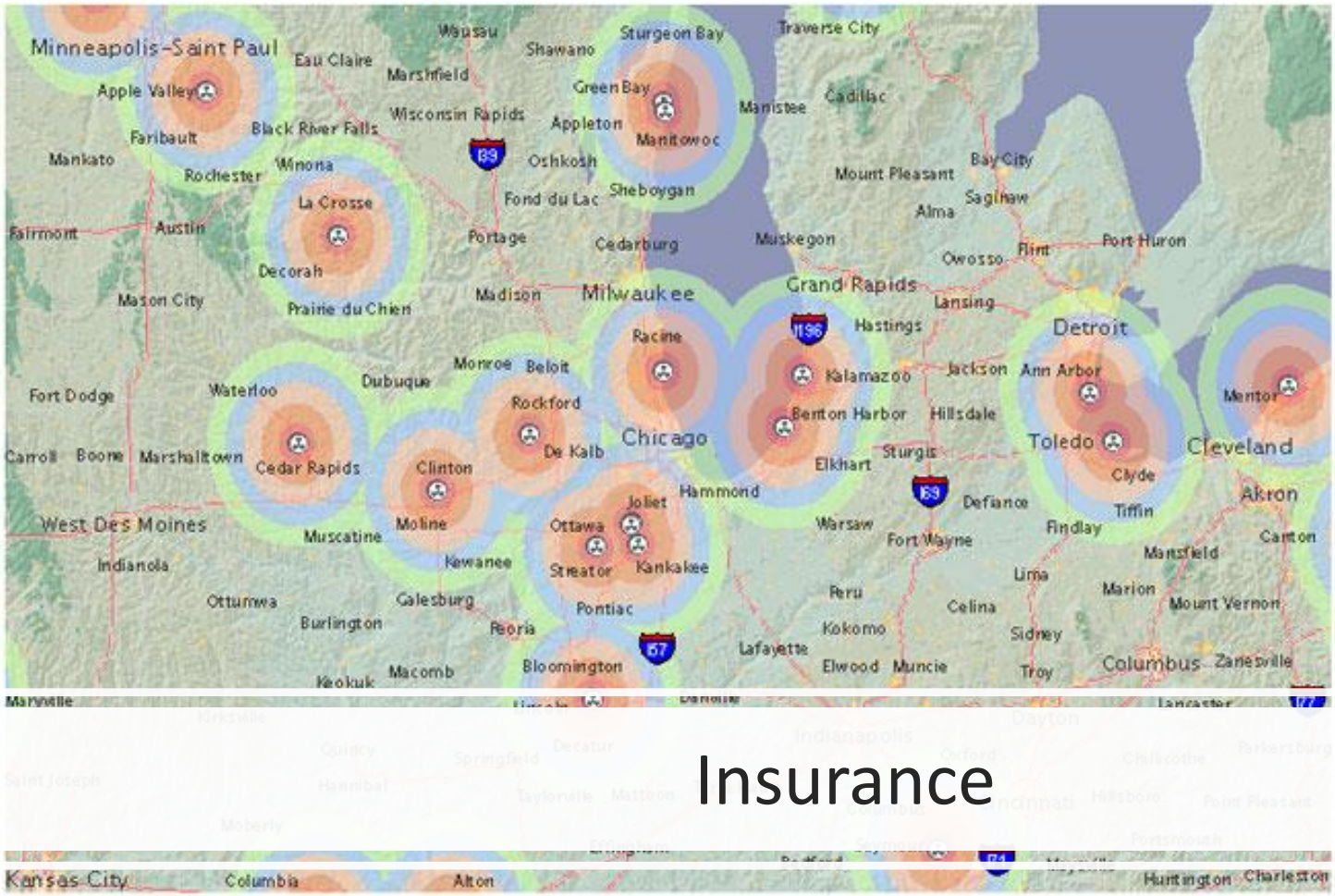
Environmental applications

Untitled - ArcMap - ArcInfo

File Edit View Insert Selection Tools Window Help

Insurance & ReInsurance Industry Geographic Information System

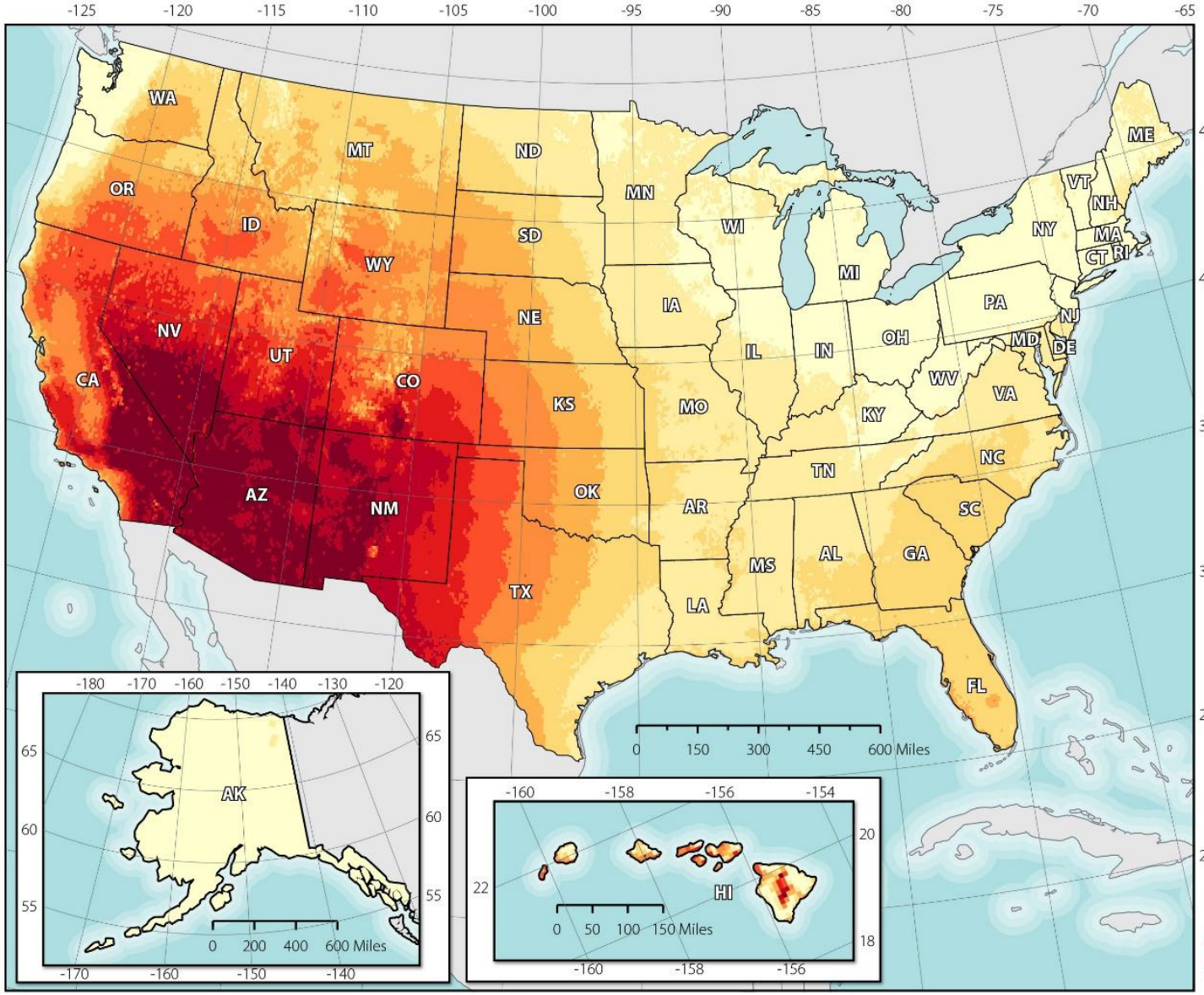
What is it ? A database driven map that can overlay hazard data with policy & exposure data to quantify risk



Insurance

677.21 560.59 Points

Concentrating Solar Resource of the United States



kWh/m²/Day

- > 7.5
- 7.0 to 7.5
- 6.5 to 7.0
- 6.0 to 6.5
- 5.5 to 6.0
- 5.0 to 5.5
- 4.5 to 5.0
- 4.0 to 4.5
- < 4.0

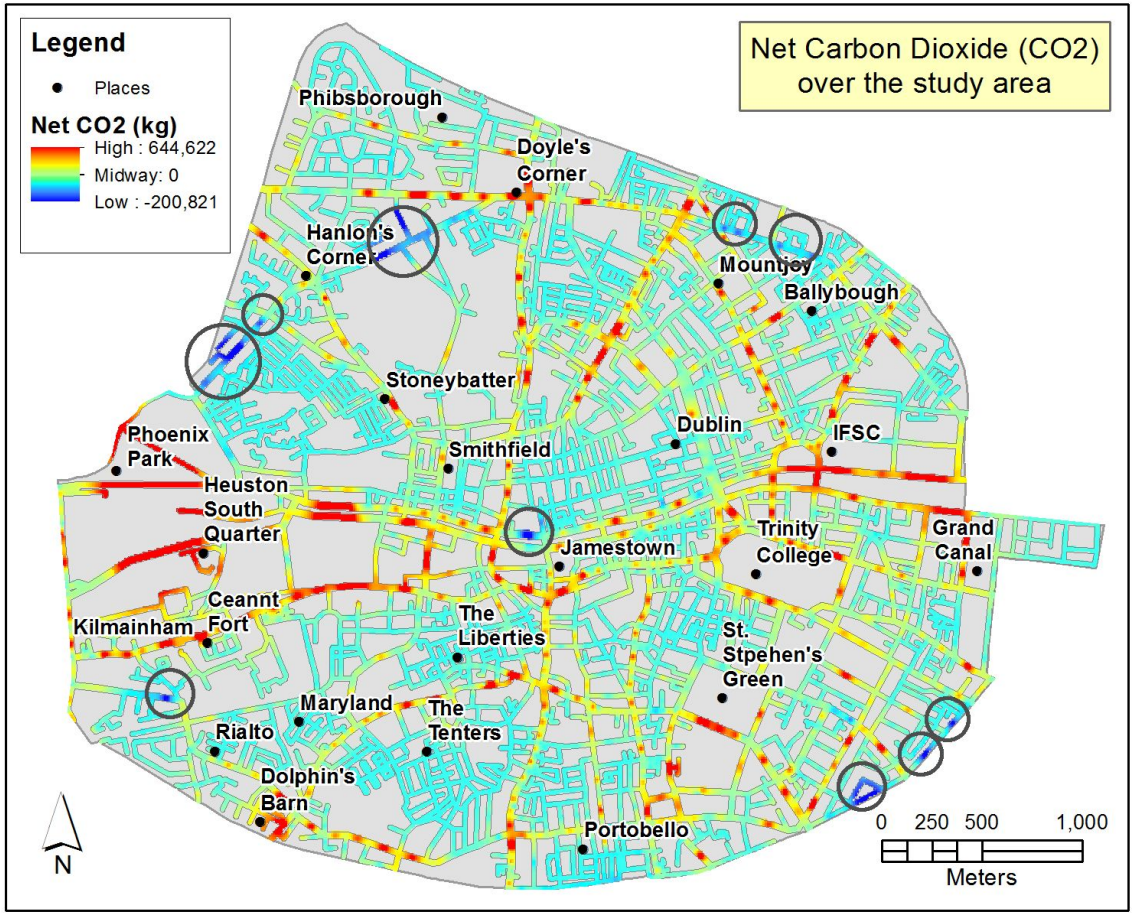
Annual average direct normal solar resource data are shown. The data for Hawaii and the 48 contiguous states are a 10km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2009.

The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2003).

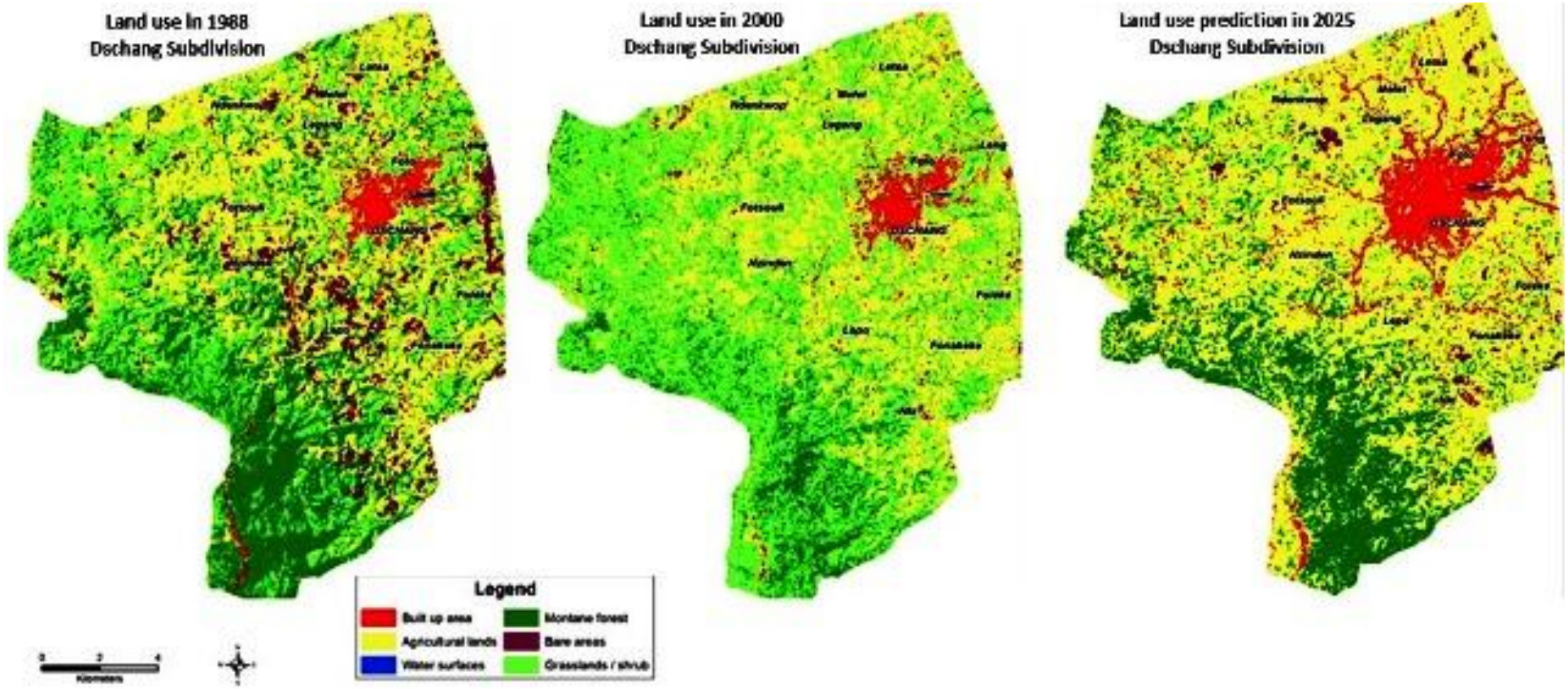
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.
Billy J. Roberts
19 September 2012

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

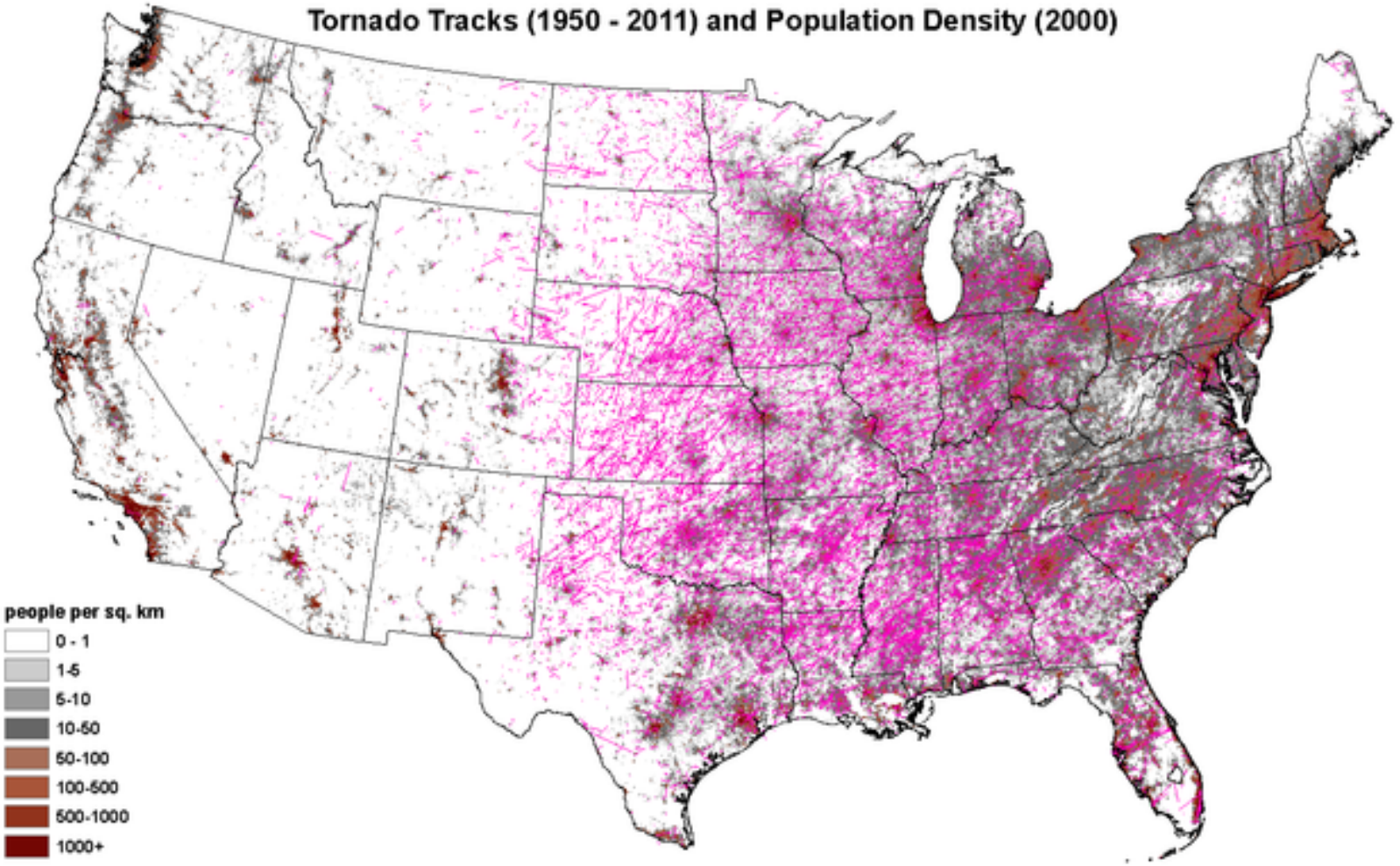
Environmental Analysis: CO2 and Traffic Congestion



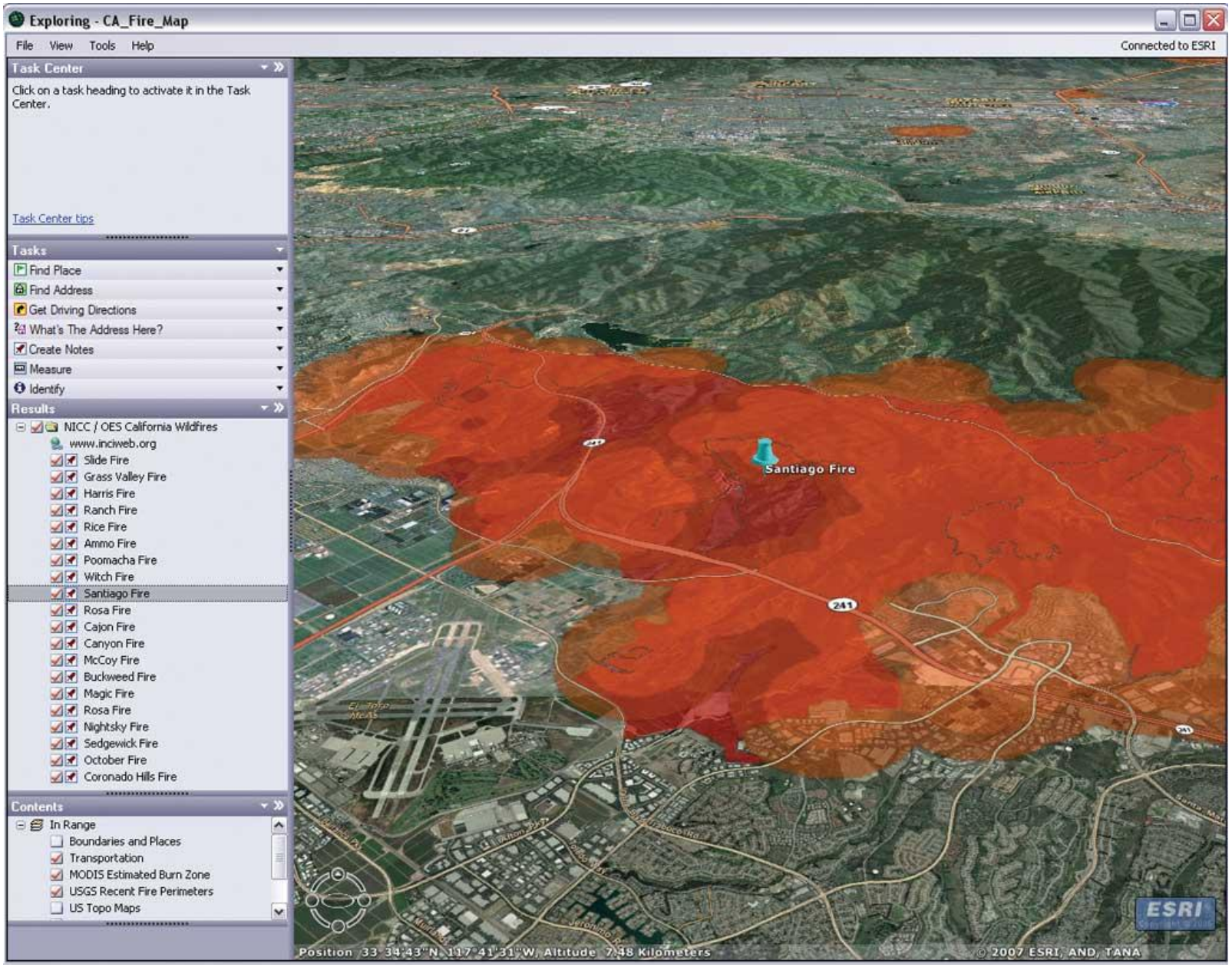
Biodiversity

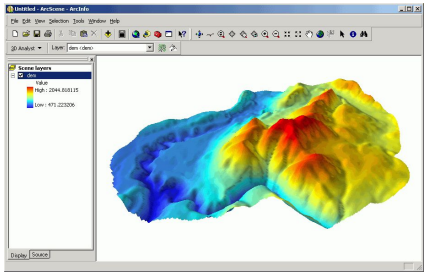


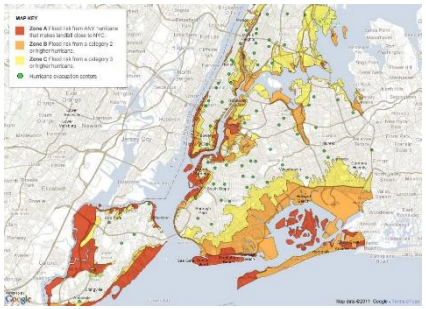
Tornado Tracking



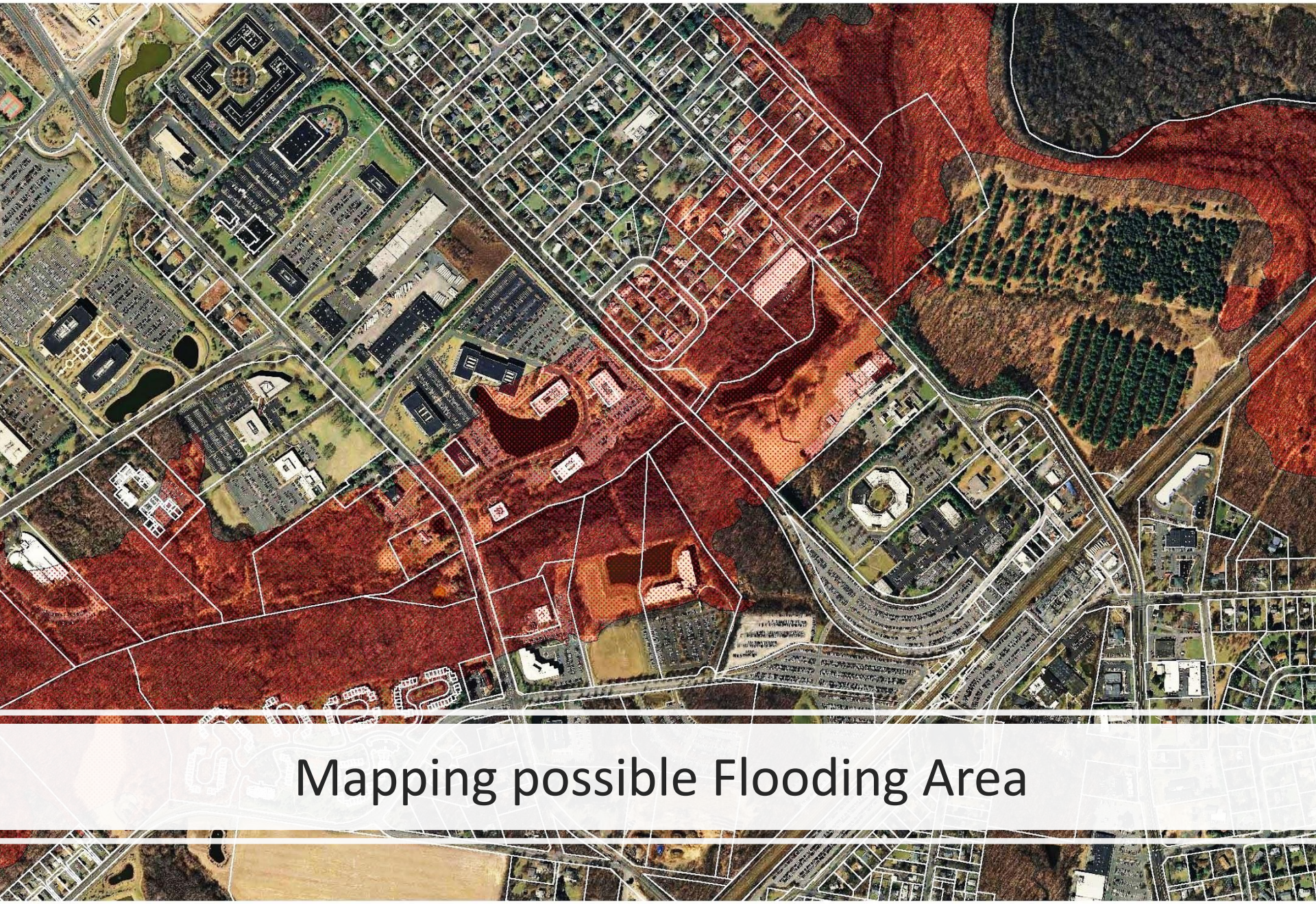
Forest Fire


Exploring - CA_Fire_Map
File
View
Tools
Help
Connected to ESRI
Task Center
Click on a task heading to activate it in the Task Center.
Task Center tips
Tasks
Find Place
Find Address
Get Driving Directions
What's The Address Here?
Create Notes
Measure
Identify
Results
NICC / OES California Wildfires
www.inciweb.org
Slide Fire
Grass Valley Fire
Harris Fire
Ranch Fire
Rice Fire
Ammo Fire
Poomacha Fire
Witch Fire
Santiago Fire
Rosa Fire
Cajon Fire
Canyon Fire
McCoy Fire
Buckweed Fire
Magic Fire
Rosa Fire
Nightsky Fire
Sedgewick Fire
October Fire
Coronado Hills Fire
Contents
In Range
Boundaries and Places
Transportation
MODIS Estimated Burn Zone
USGS Recent Fire Perimeters
US Topo Maps
Santiago Fire
241
Position 33 34 43 N 117 41 31 W Altitude 7.48 Kilometers
© 2007 ESRI, AND, TANA
ESRI

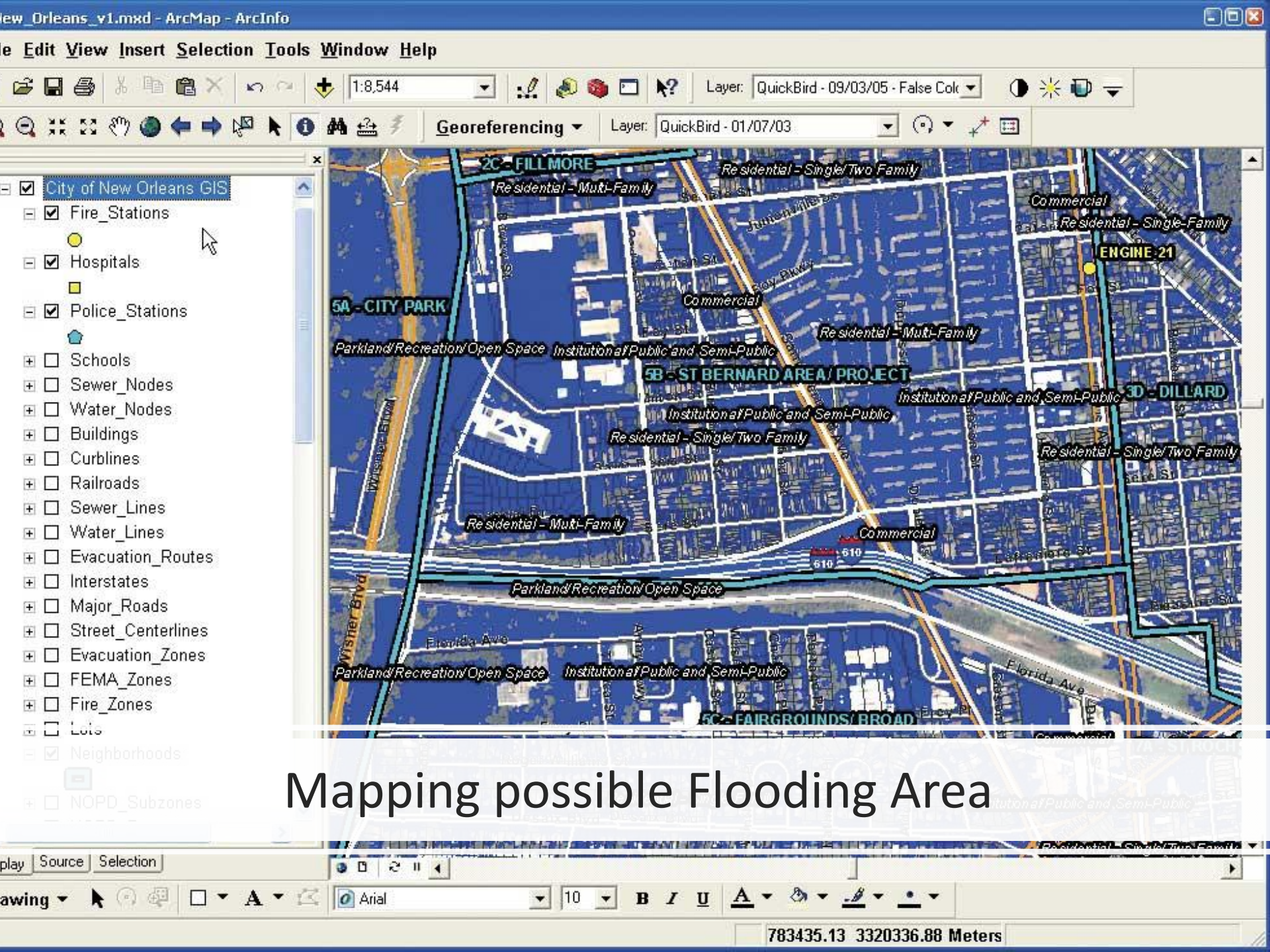




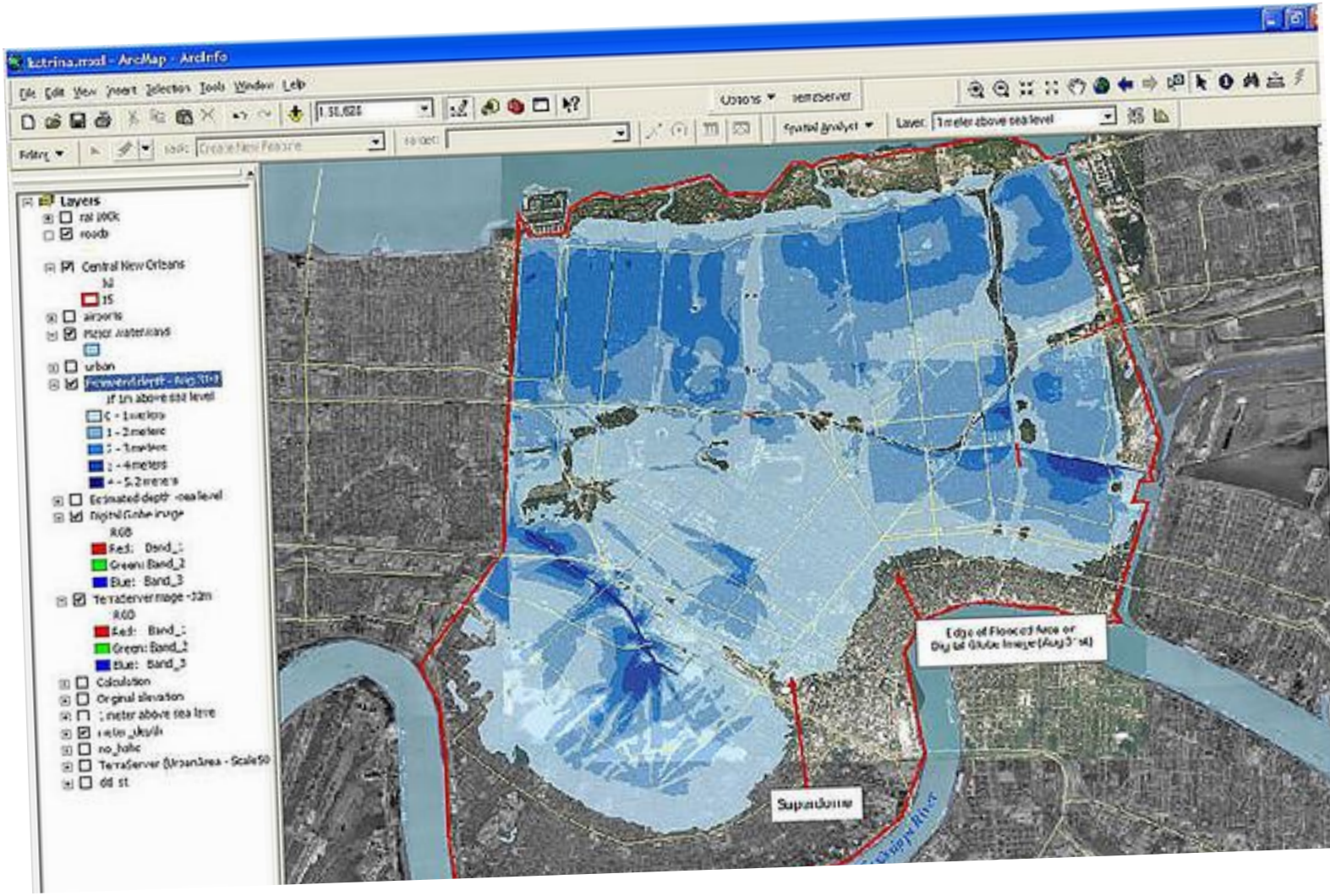
Mapping possible Flooding Area 3D

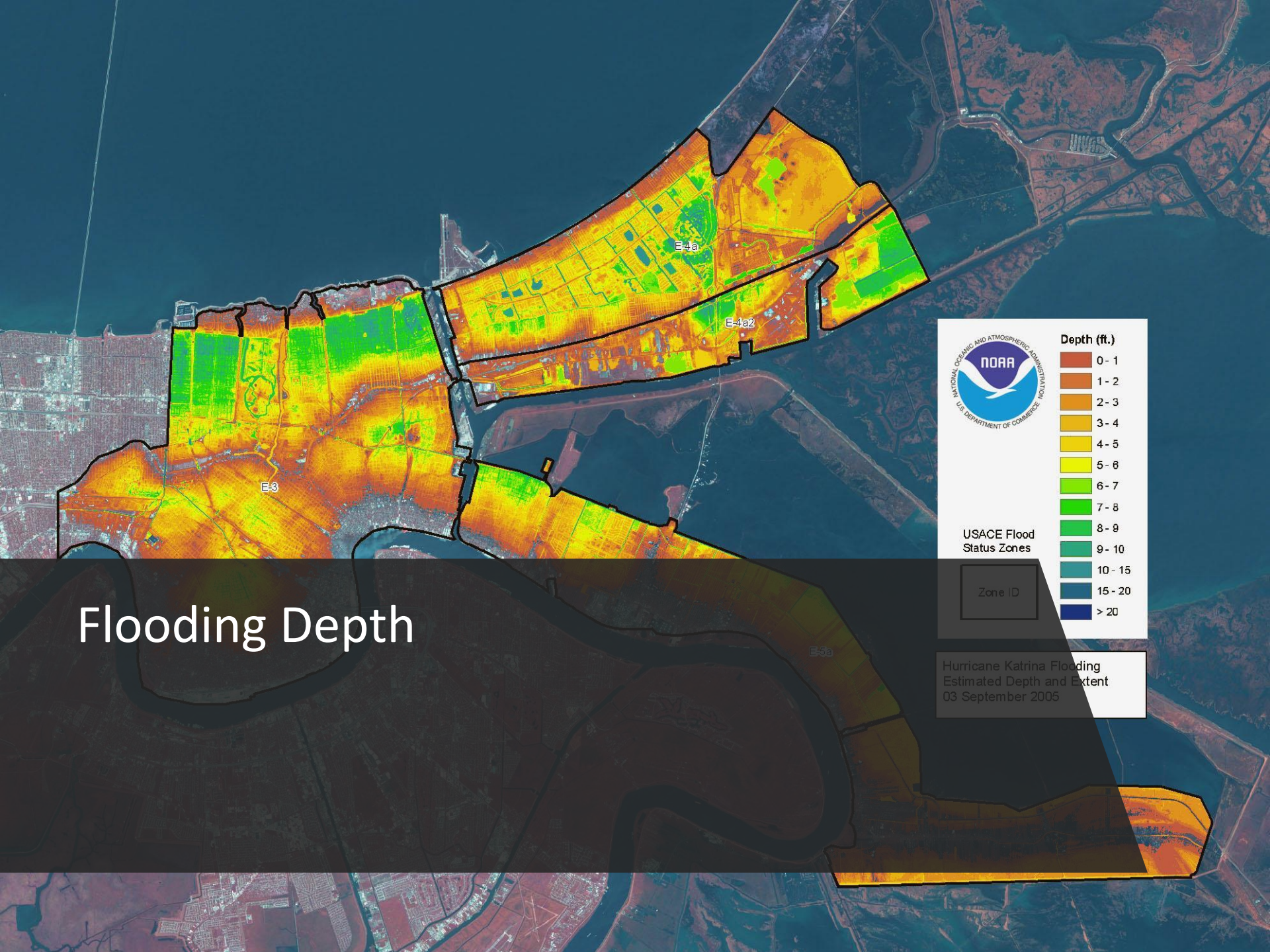


Mapping possible Flooding Area

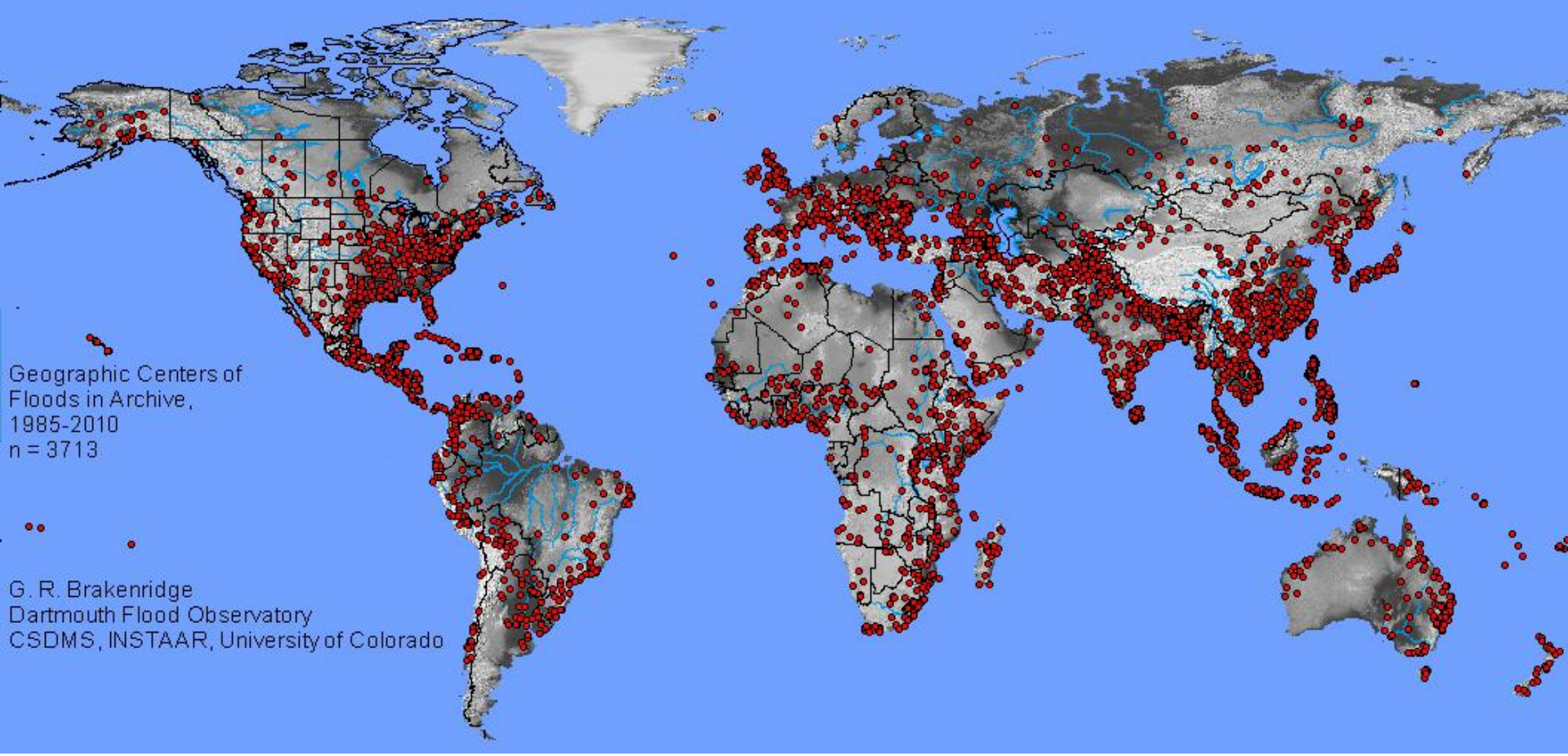


Mapping possible Flooding Area


Katrina.mxd - ArcMap - ArcInfo
Layers
roads
Central New Orleans
airports
major waterways
urban
meter above sea level
Digital Globe image
Terraserver image
Calculation
Original elevation
Edge of Flooded Area on
Digital Globe Image (Aug 31st)
Superdome

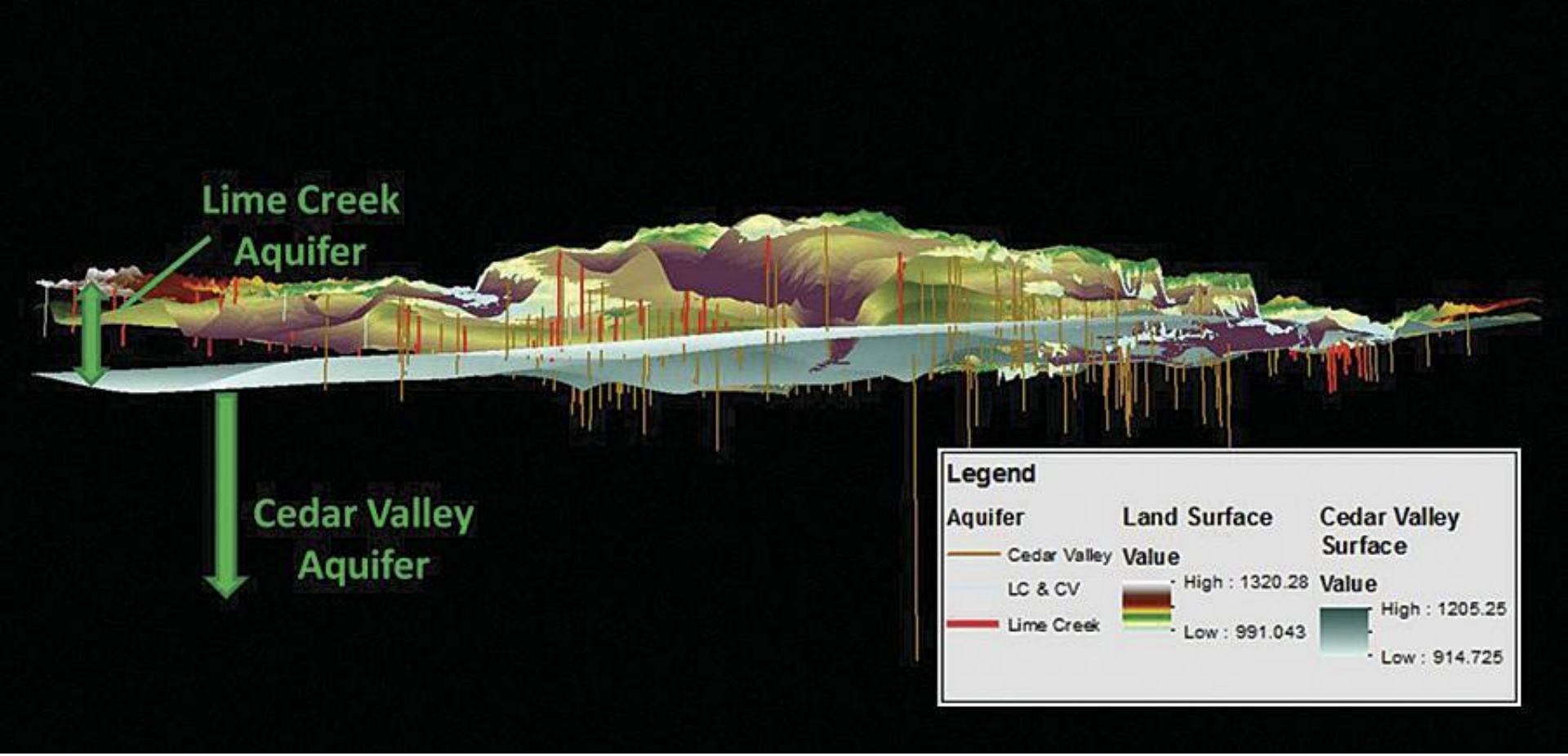


Flooding Depth

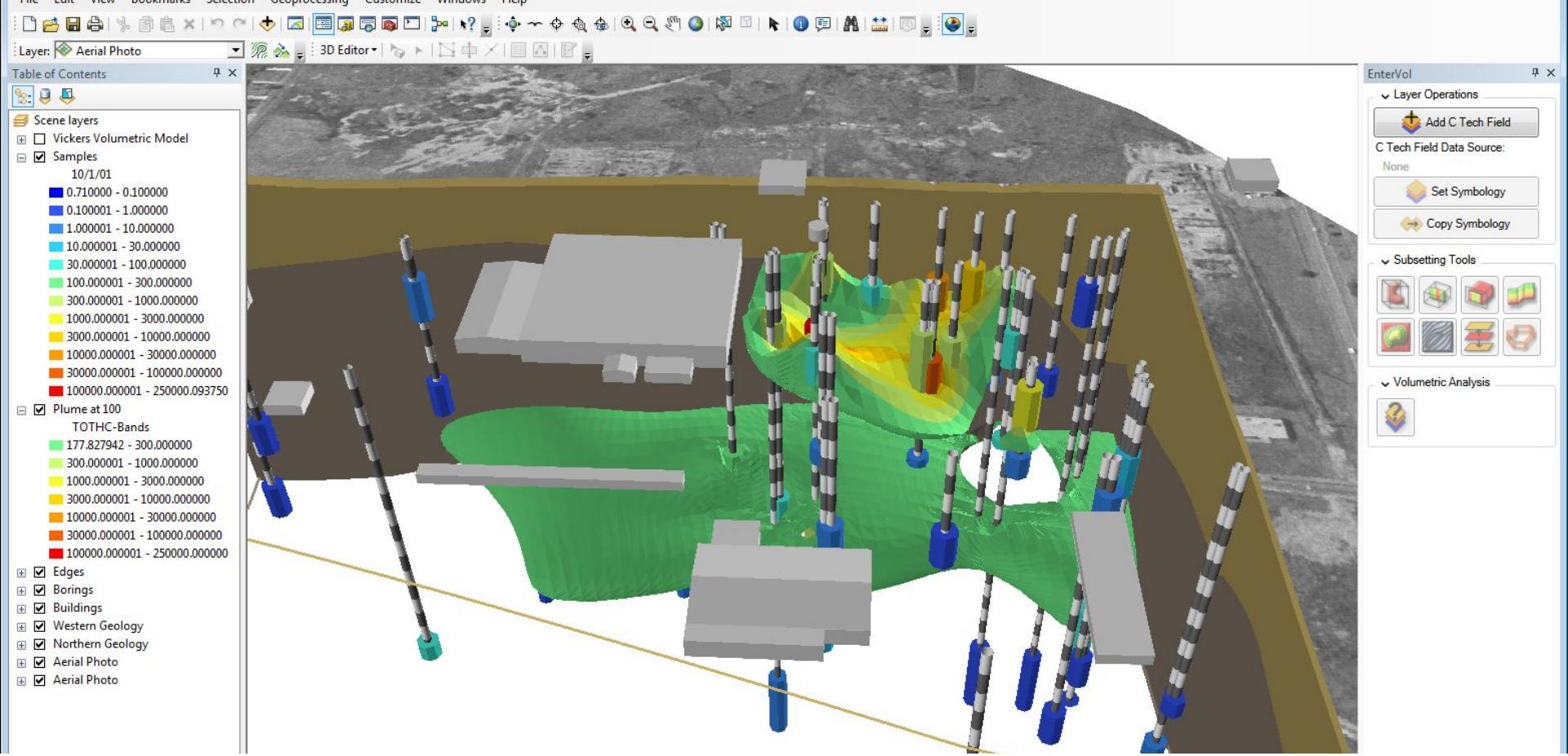

Geographic Centers of
Floods in Archive,
1985-2010
n = 3713
G. R. Brakenridge
Dartmouth Flood Observatory
CSDMS, INSTAAR, University of Colorado

Floods

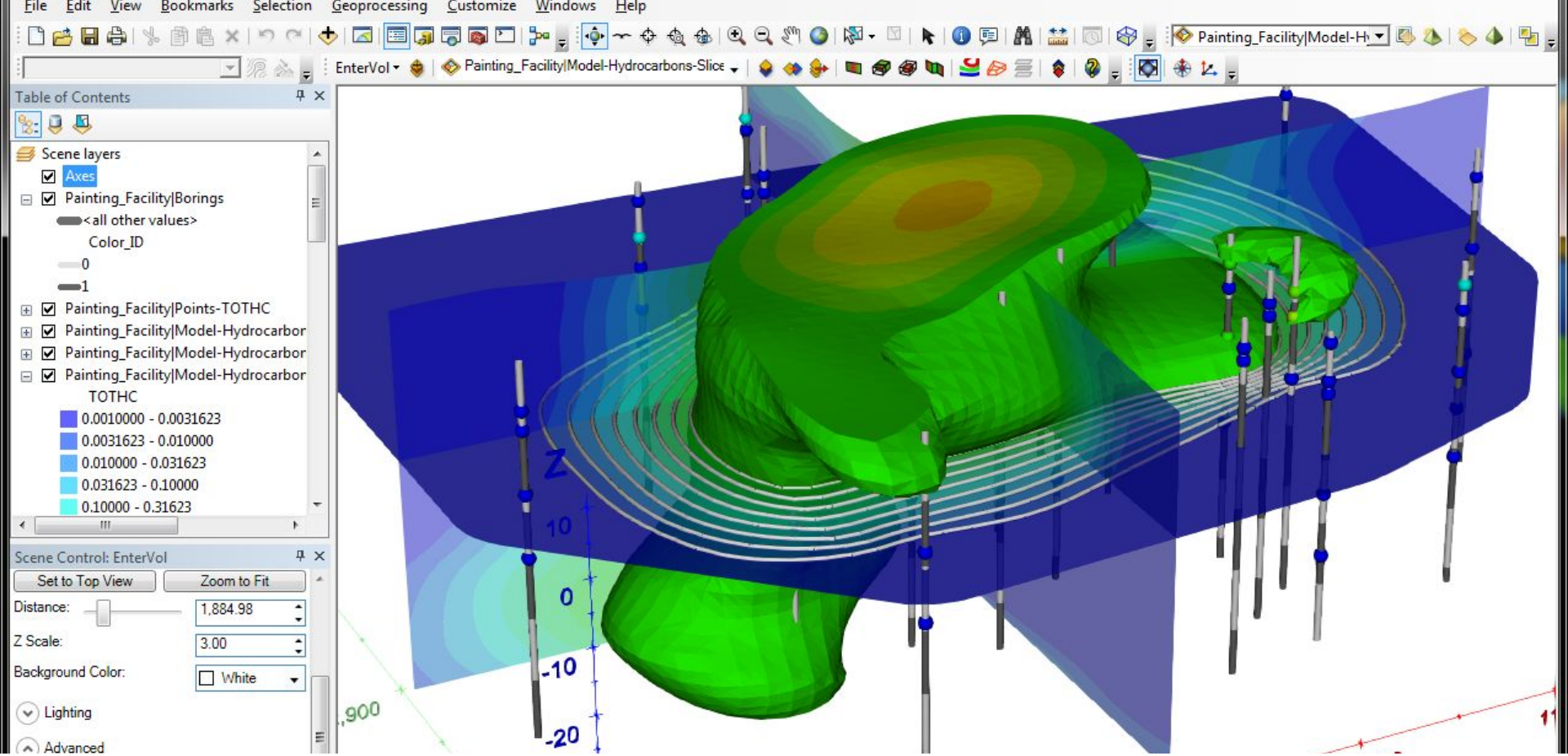
National Flood Insurance Program



Groundwater Contamination

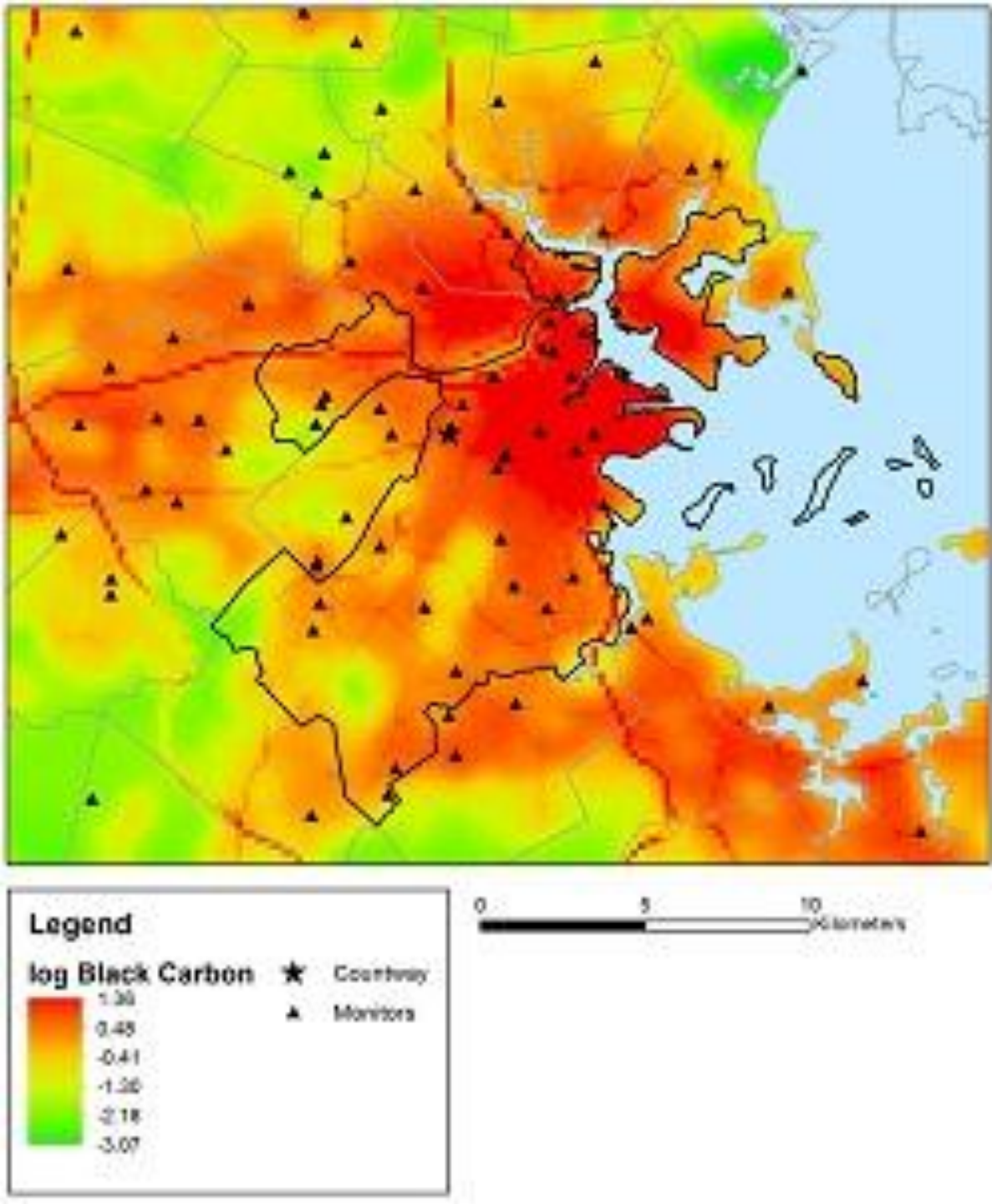


Groundwater Contamination

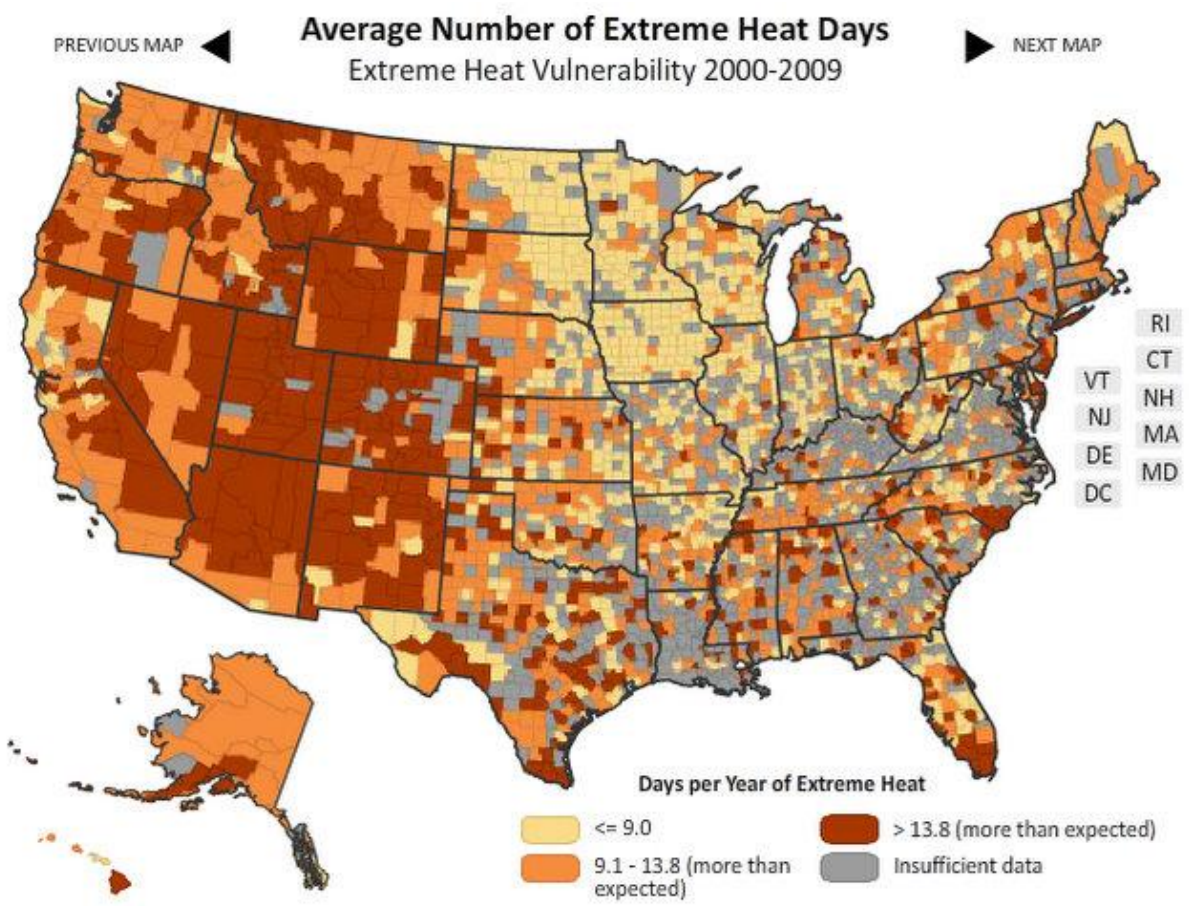


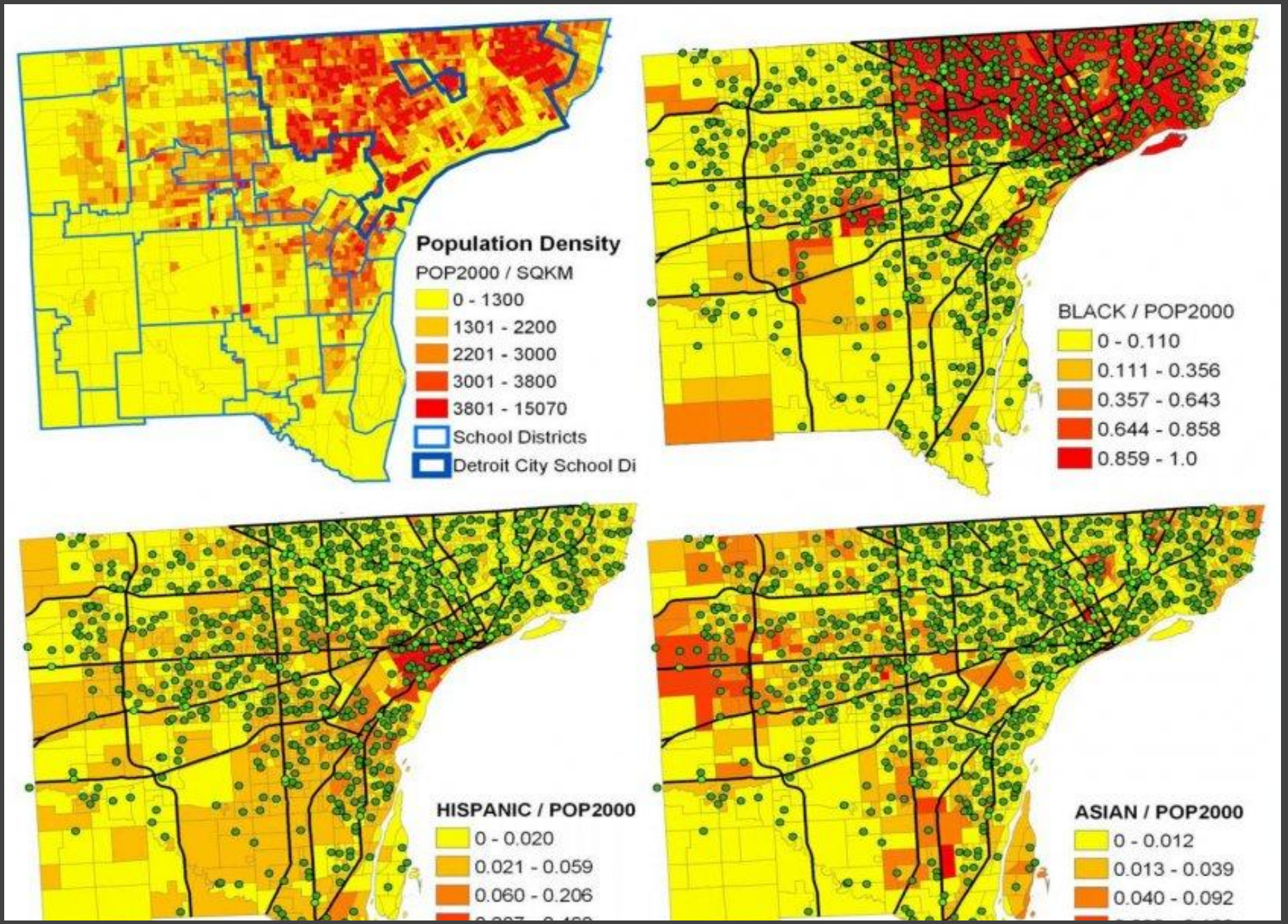
Groundwater Contamination

Air Quality

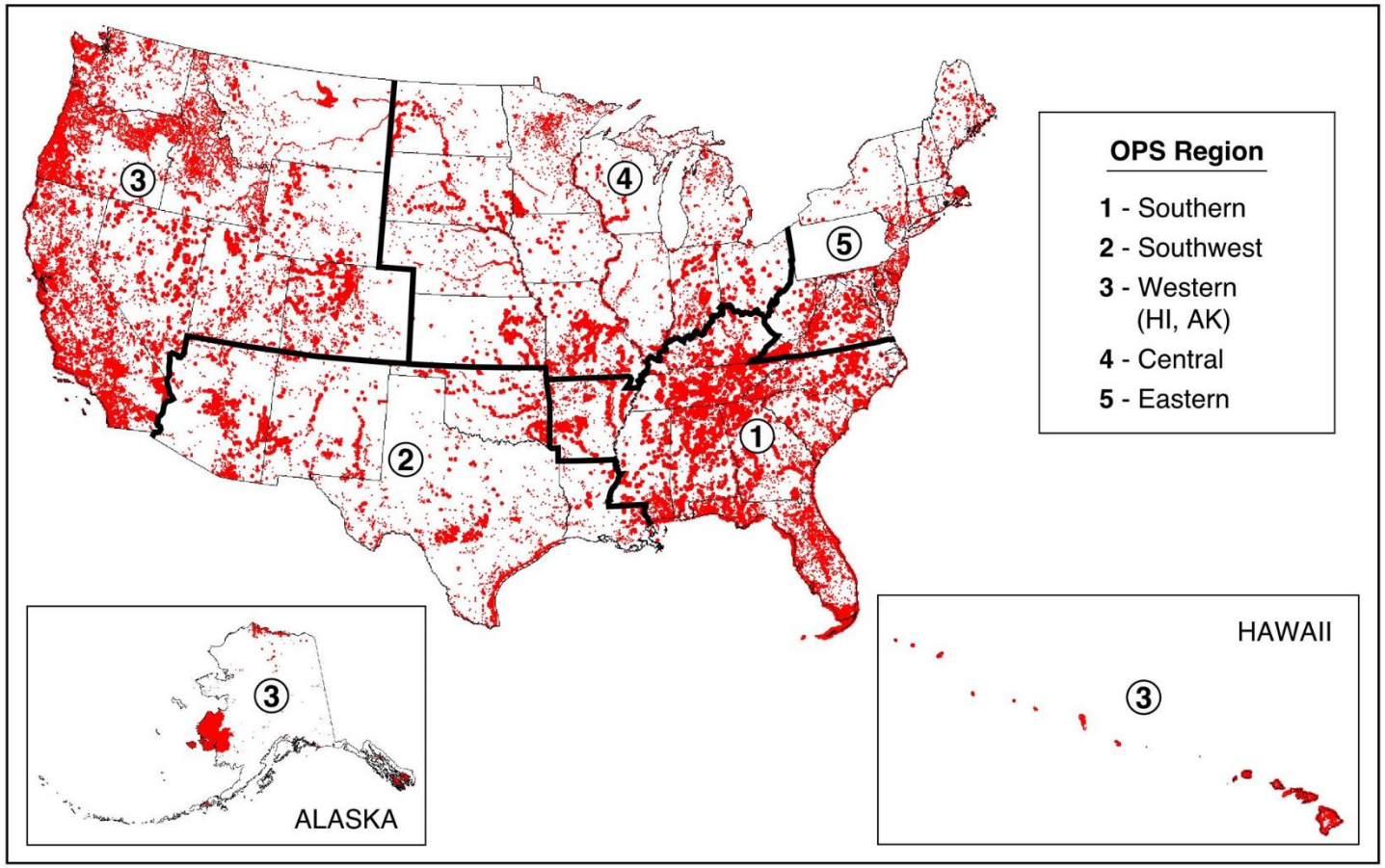

Legend
log Black Carbon
1.39
0.45
-0.41
-1.35
-2.18
-3.07
Courtney
Monitors
0
5
10

Extreme Heat Days

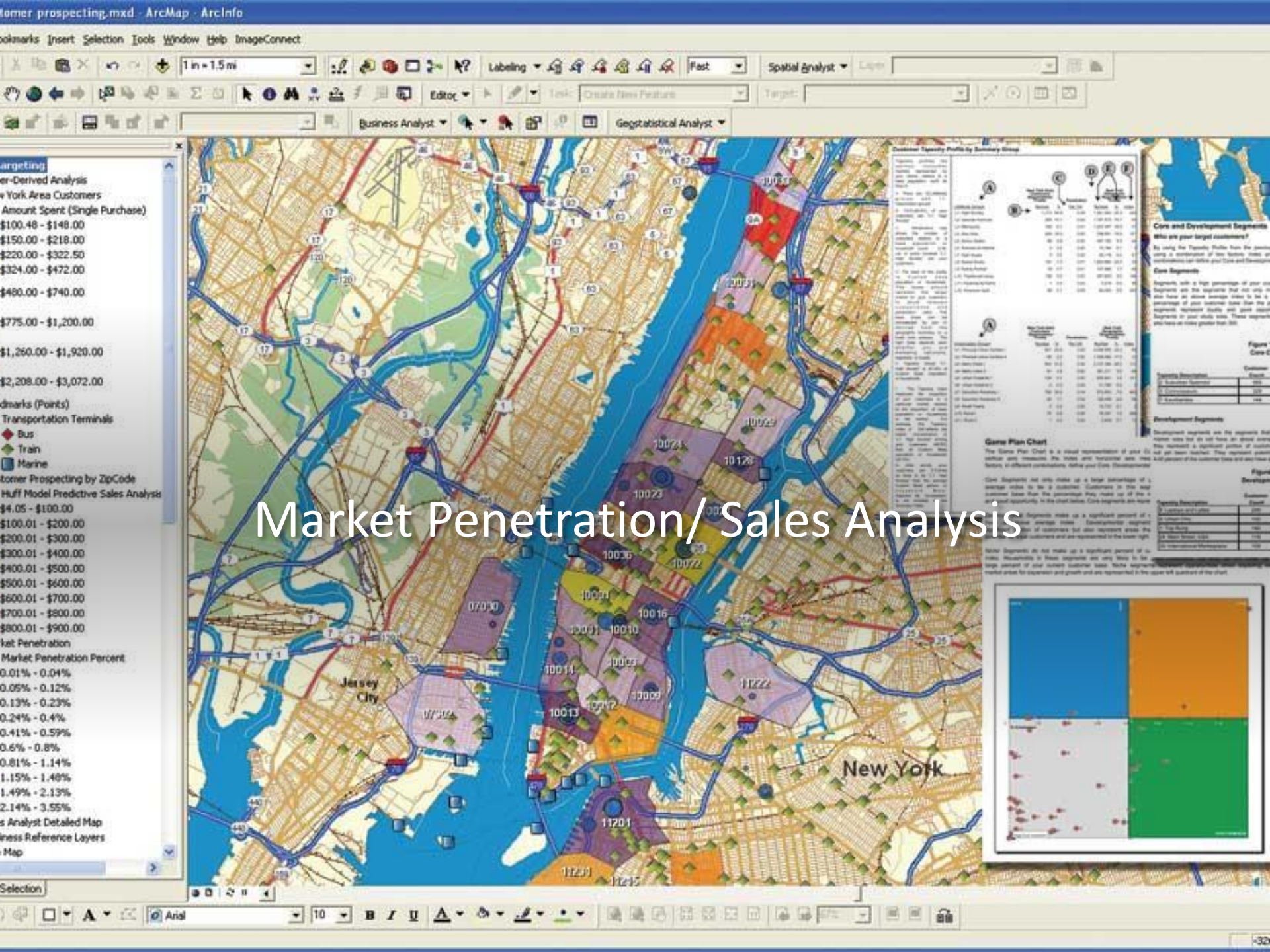



Population Density
POP2000 / SQKM
0 - 1300
1301 - 2200
2201 - 3000
3001 - 3800
3801 - 15070
School Districts
Detroit City School Di
BLACK / POP2000
0 - 0.110
0.111 - 0.356
0.357 - 0.643
0.644 - 0.858
0.859 - 1.0
HISPANIC / POP2000
0 - 0.020
0.021 - 0.059
0.060 - 0.206
ASIAN / POP2000
0 - 0.012
0.013 - 0.039
0.040 - 0.092

Hazardous Liquid Pipeline Accident

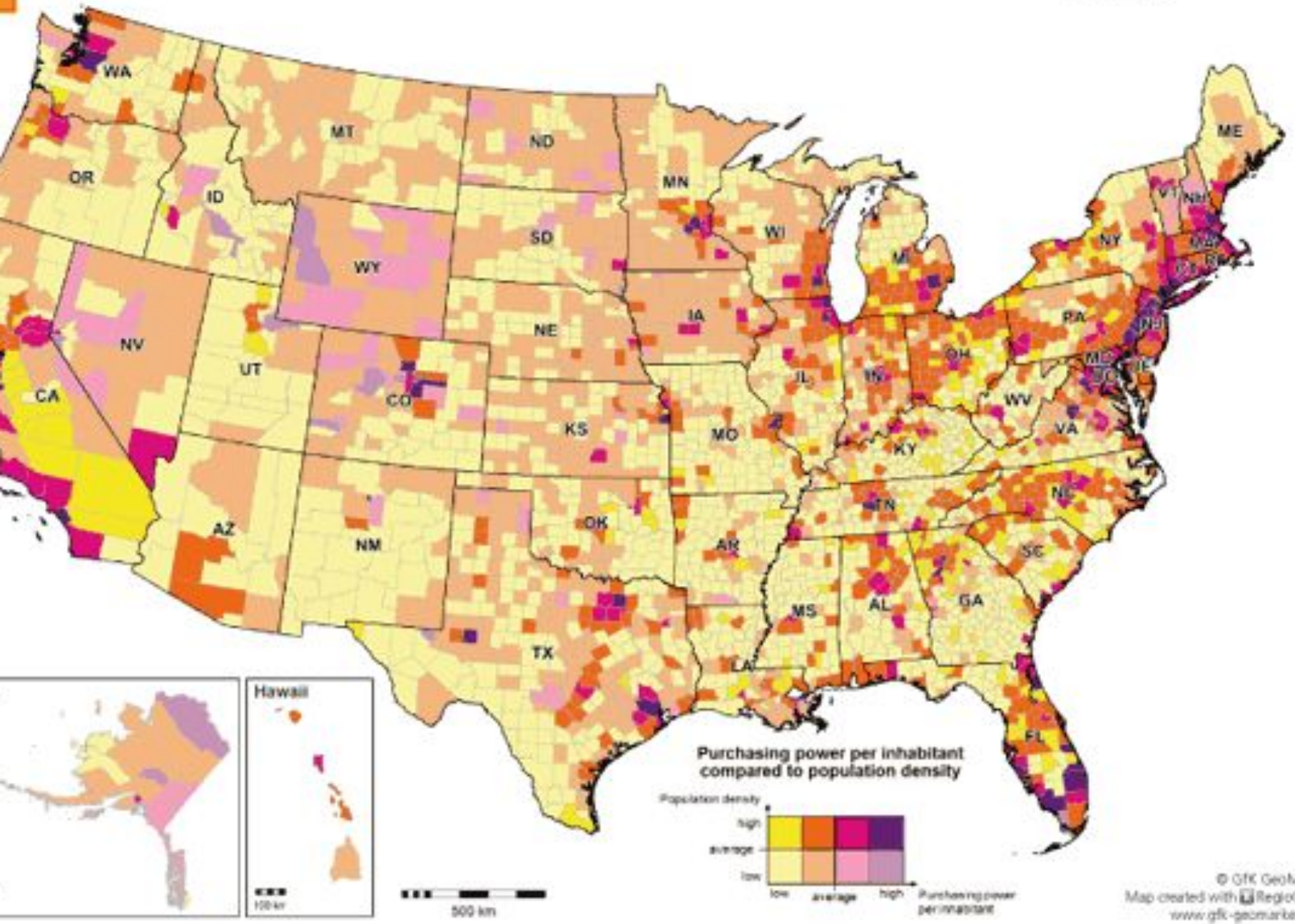


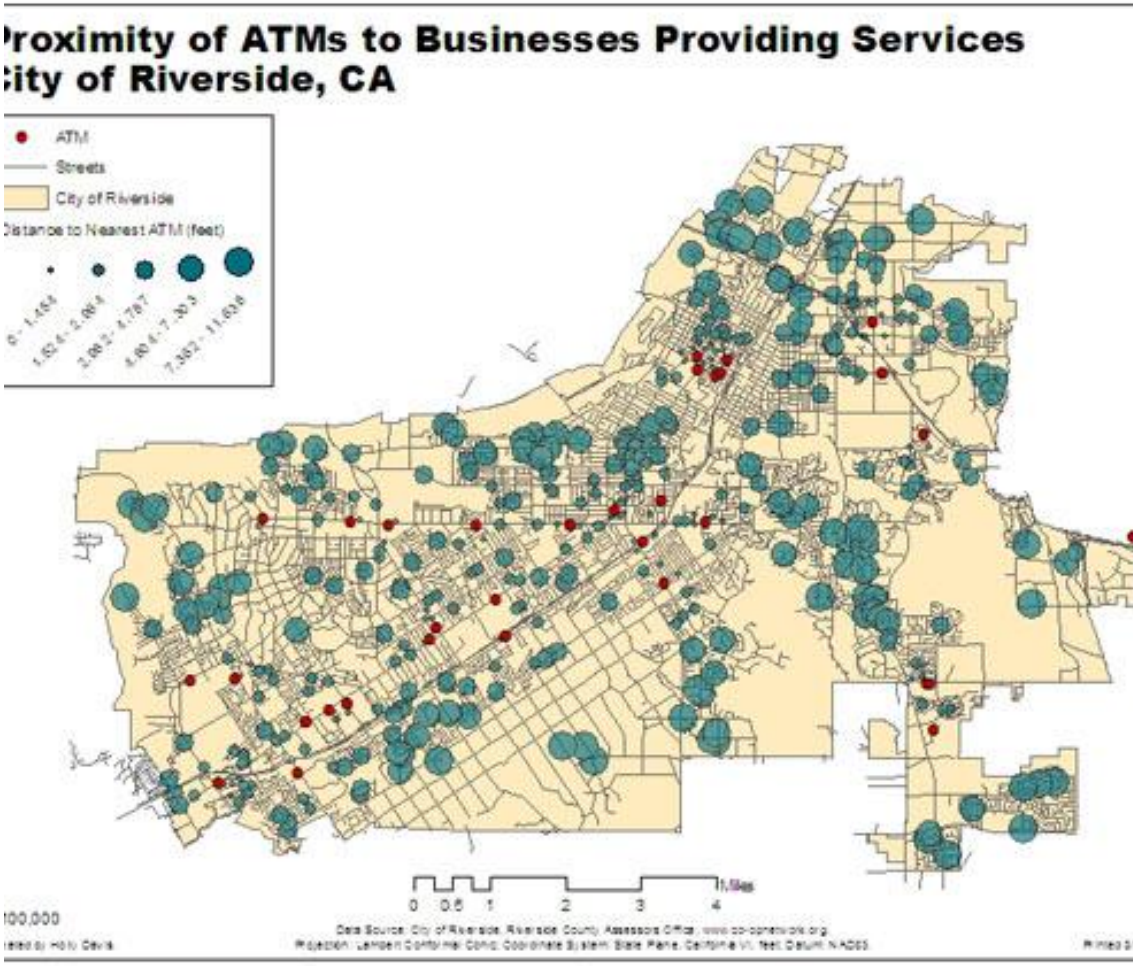

Business
10916.69
10847.17
Buy
OMXRGI
OMX RIGA GI
984.13
6025.9680
5993.7030
Buy
28289.06
27956.04
Buy
1632.51
OMX18
OMX ICELAND 8
6230.9
Sell
1172.94


Market Penetration/ Sales Analysis
New York
Jersey City

GfK GeoMarketing

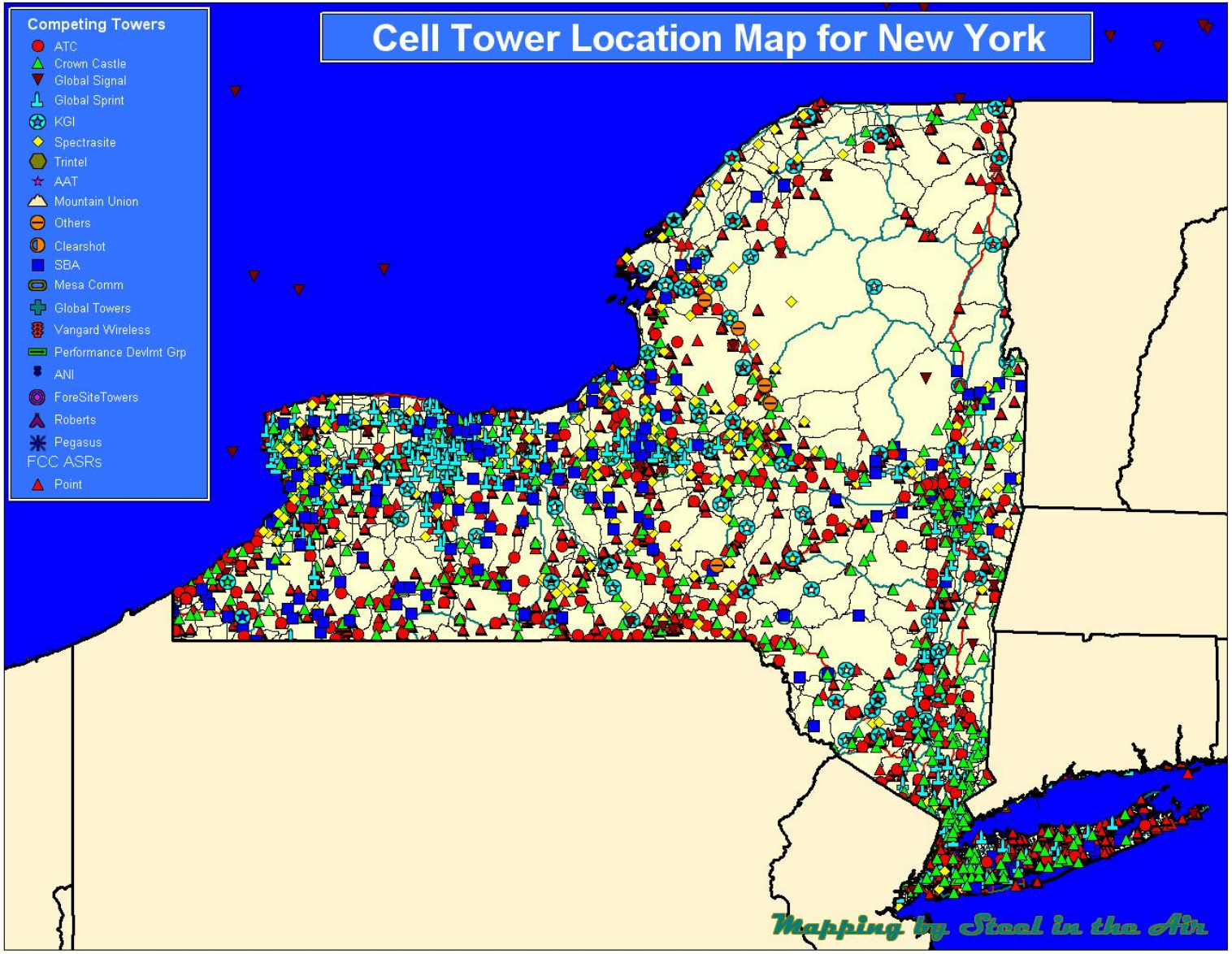
GfK Purchasing Power USA, 2009
Counties



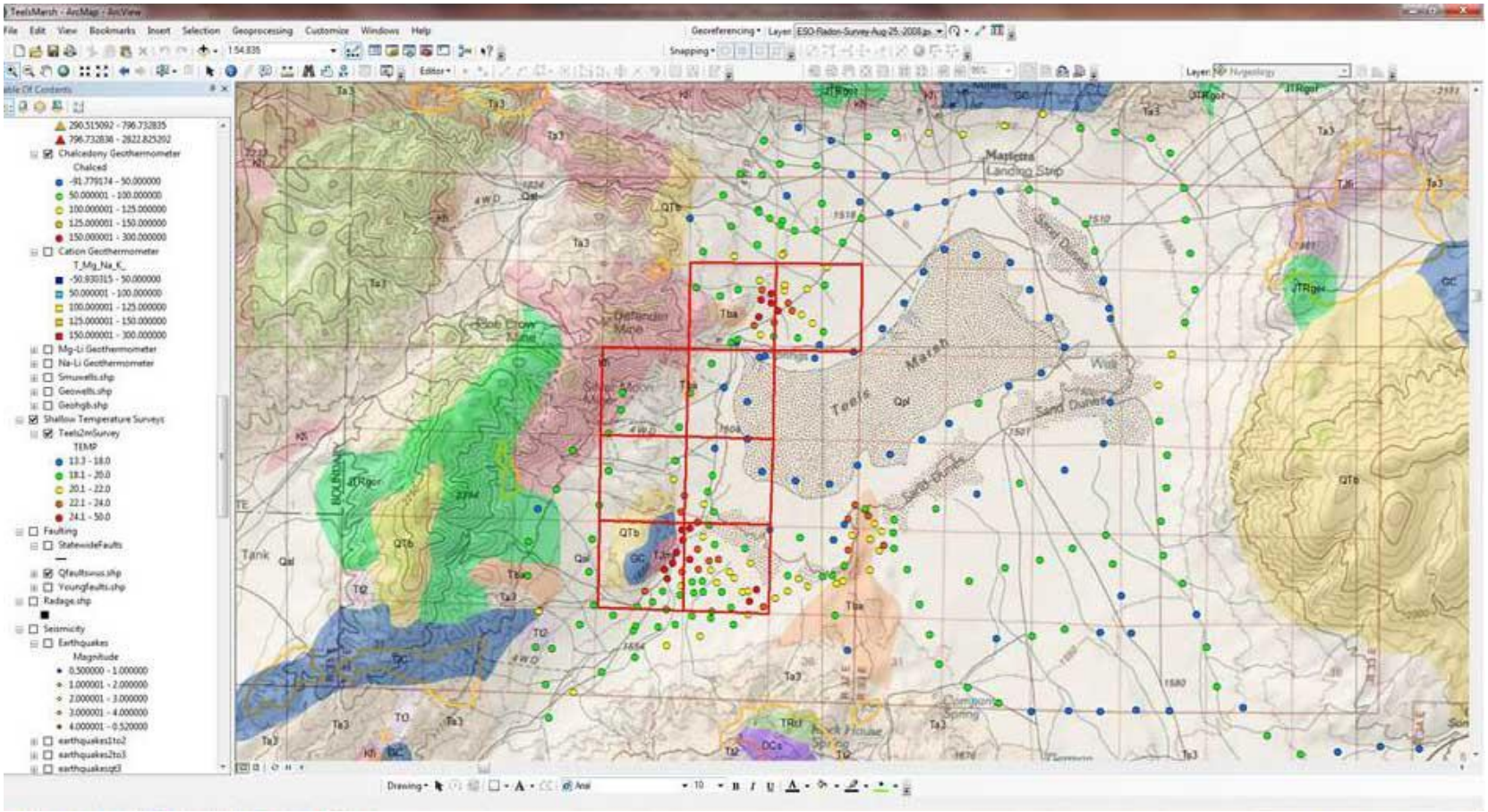


Identify Optimum ATM Locations

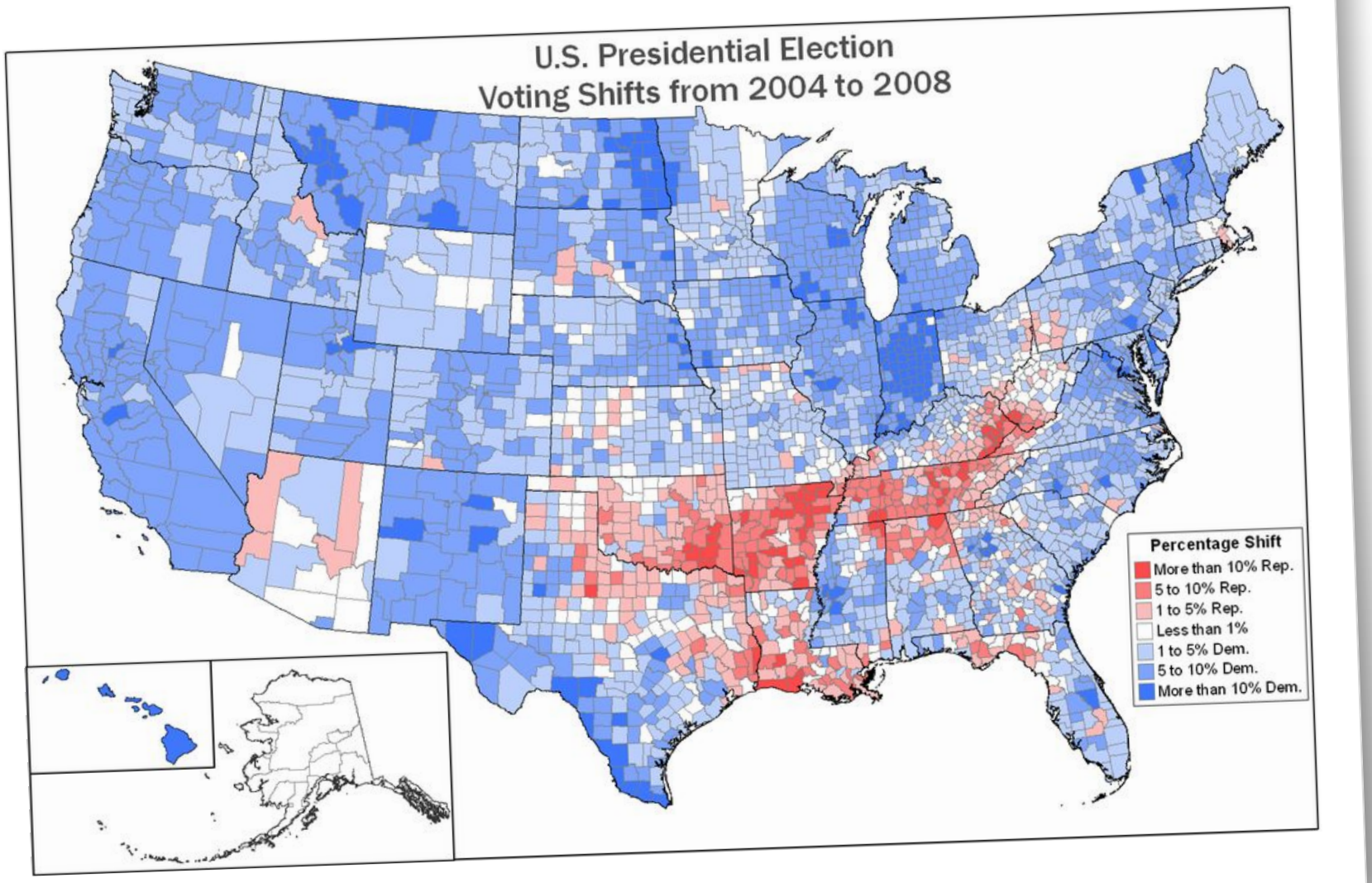
Cell Towers Location

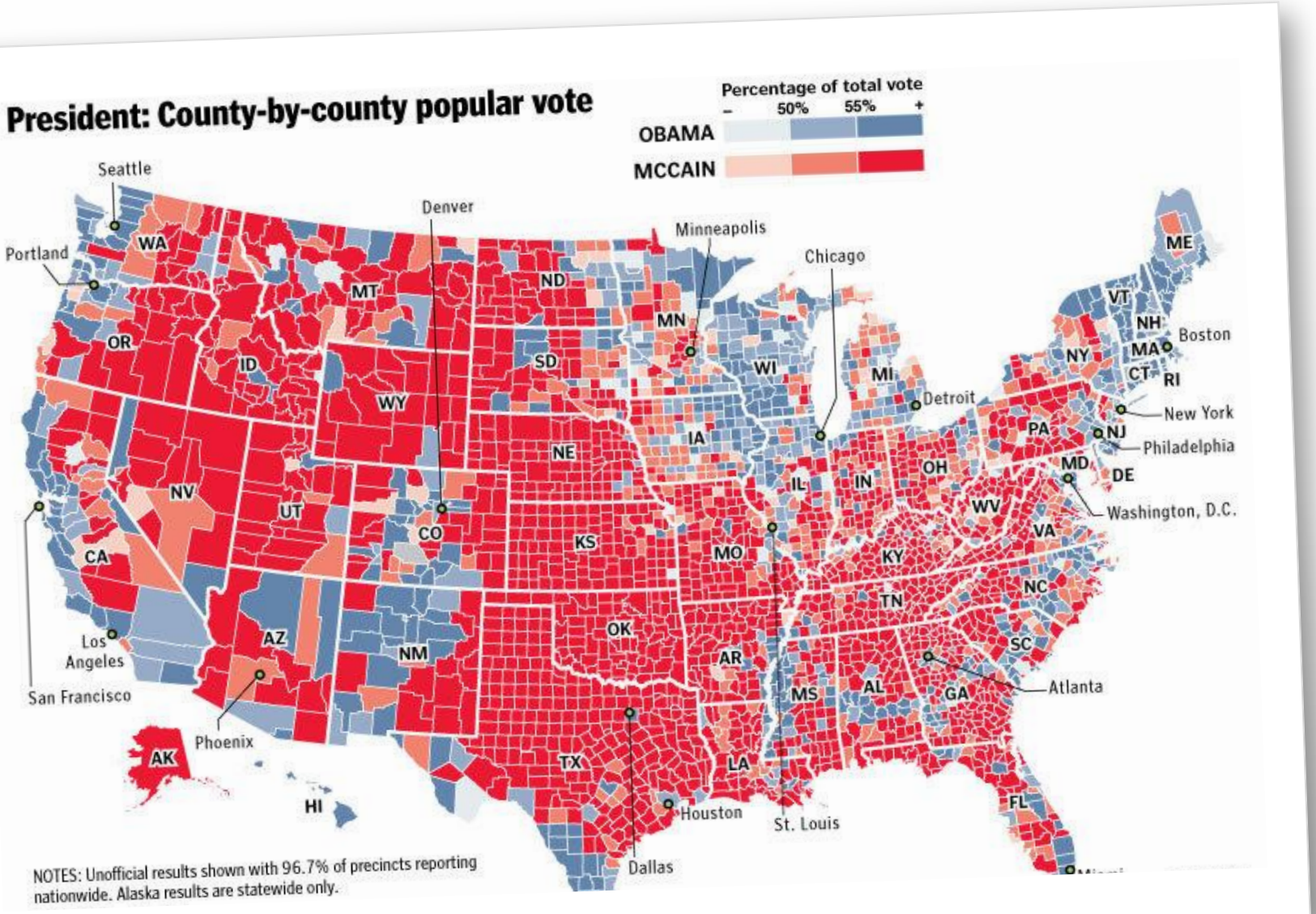


Oil Well Drilling - finding optimum location



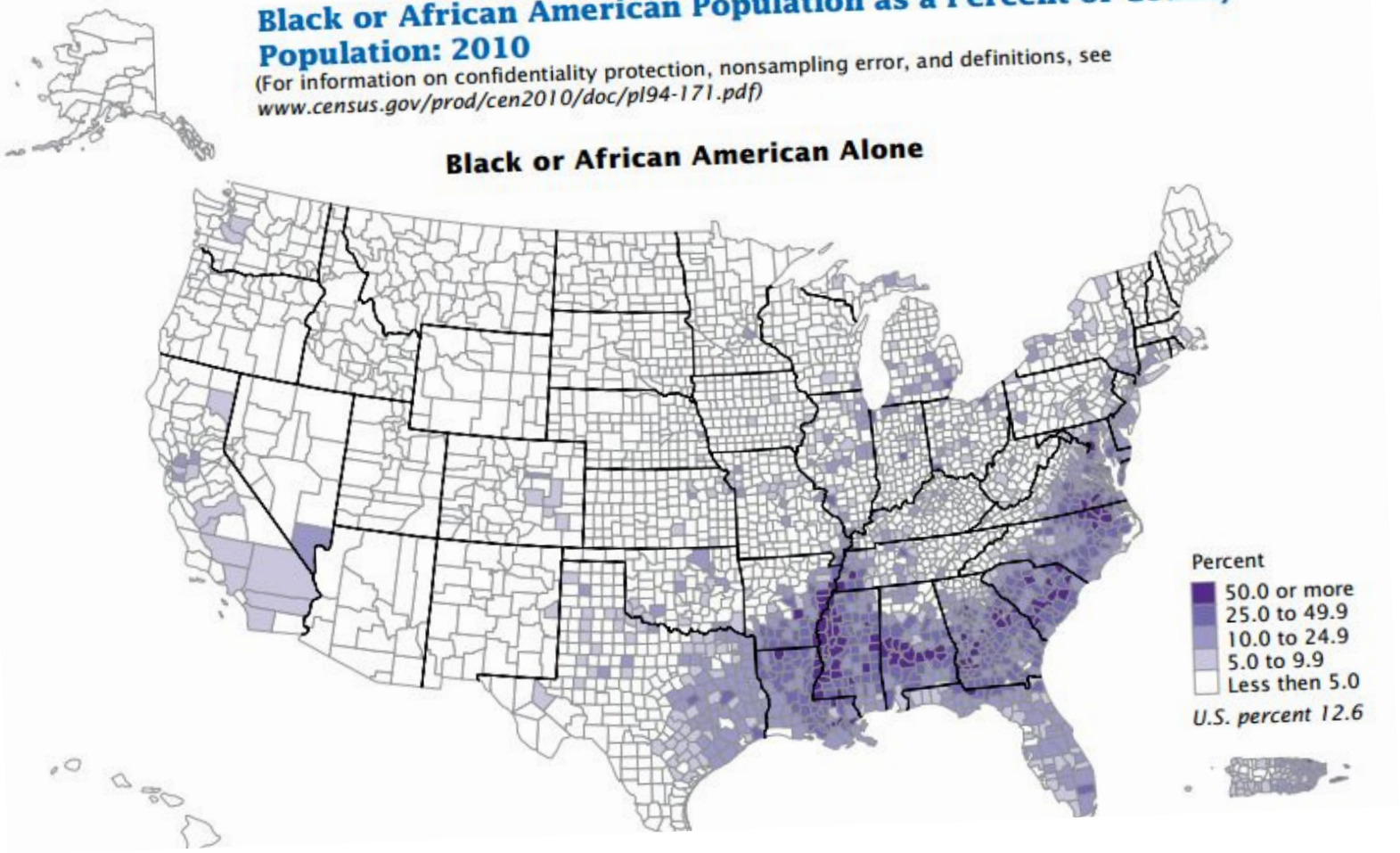
Political Science


U.S. Presidential Election
Voting Shifts from 2004 to 2008
Percentage Shift
More than 10% Rep.
5 to 10% Rep.
1 to 5% Rep.
Less than 1%
1 to 5% Dem.
5 to 10% Dem.
More than 10% Dem.

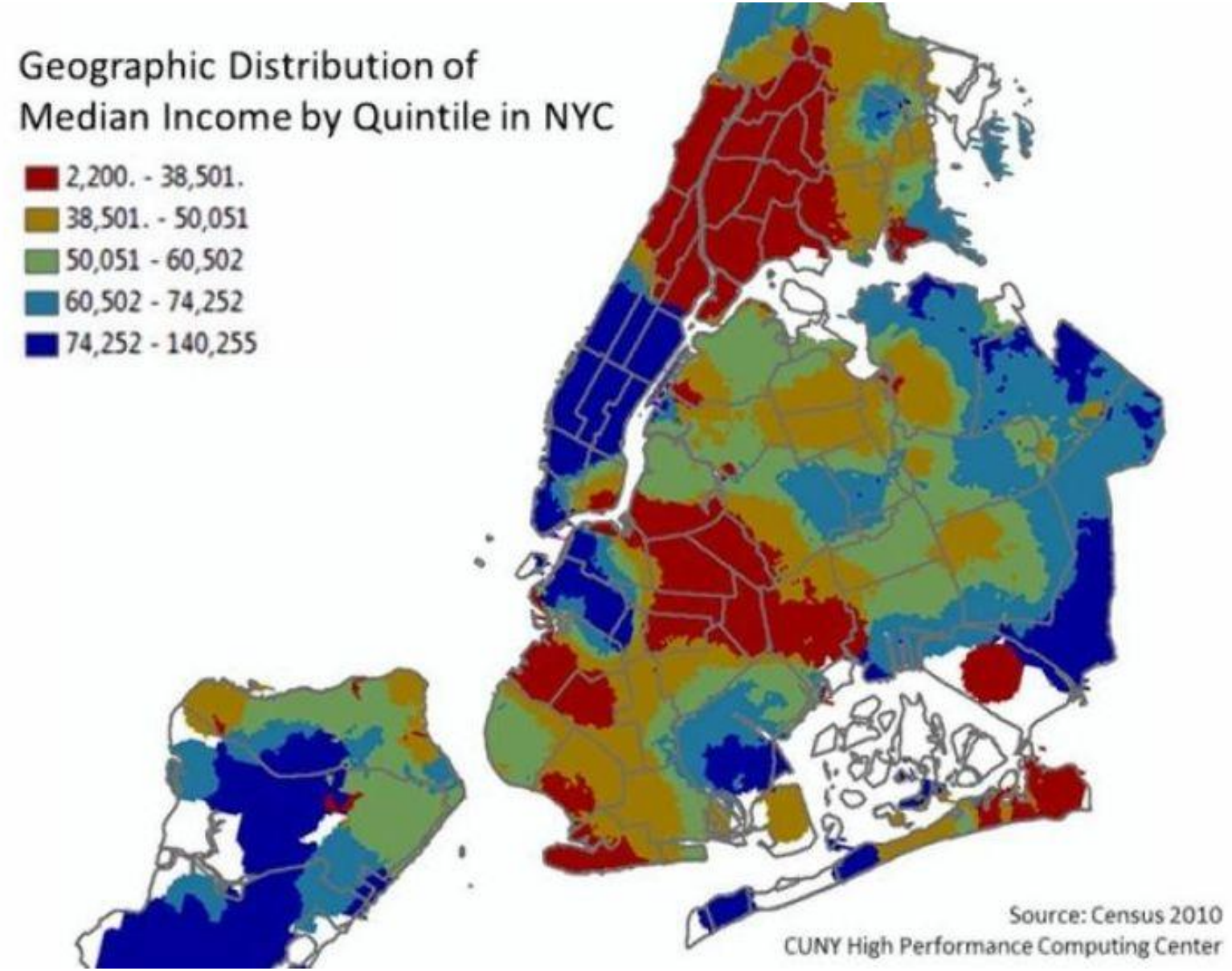

President: County-by-county popular vote
Percentage of total vote
– 50% 55% +
OBAMA
MCCAIN
Seattle
Portland
Denver
Minneapolis
Chicago
Detroit
New York
Boston
Philadelphia
Washington, D.C.
Atlanta
Los Angeles
San Francisco
Phoenix
Houston
Dallas
St. Louis
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
MD
DE
NJ
CT
RI
MA
VT
NH
ME
AK
HI
NOTES: Unofficial results shown with 96.7% of precincts reporting nationwide. Alaska results are statewide only.

Black or African American Population as a Percent of County Population: 2010

(For information on confidentiality protection, nonsampling error, and definitions, see *www.census.gov/prod/cen2010/doc/pl94-171.pdf)*

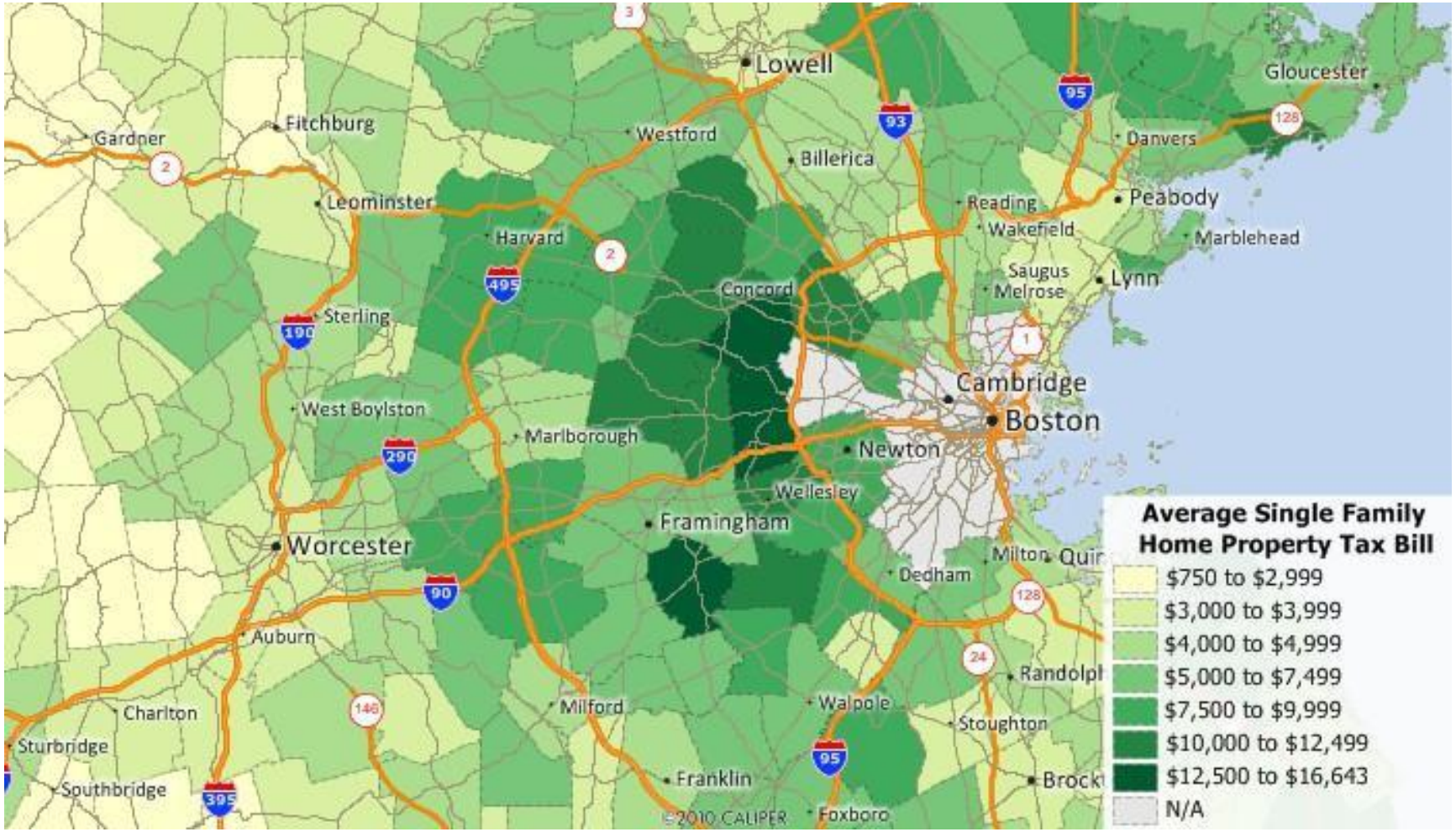


Real Estate

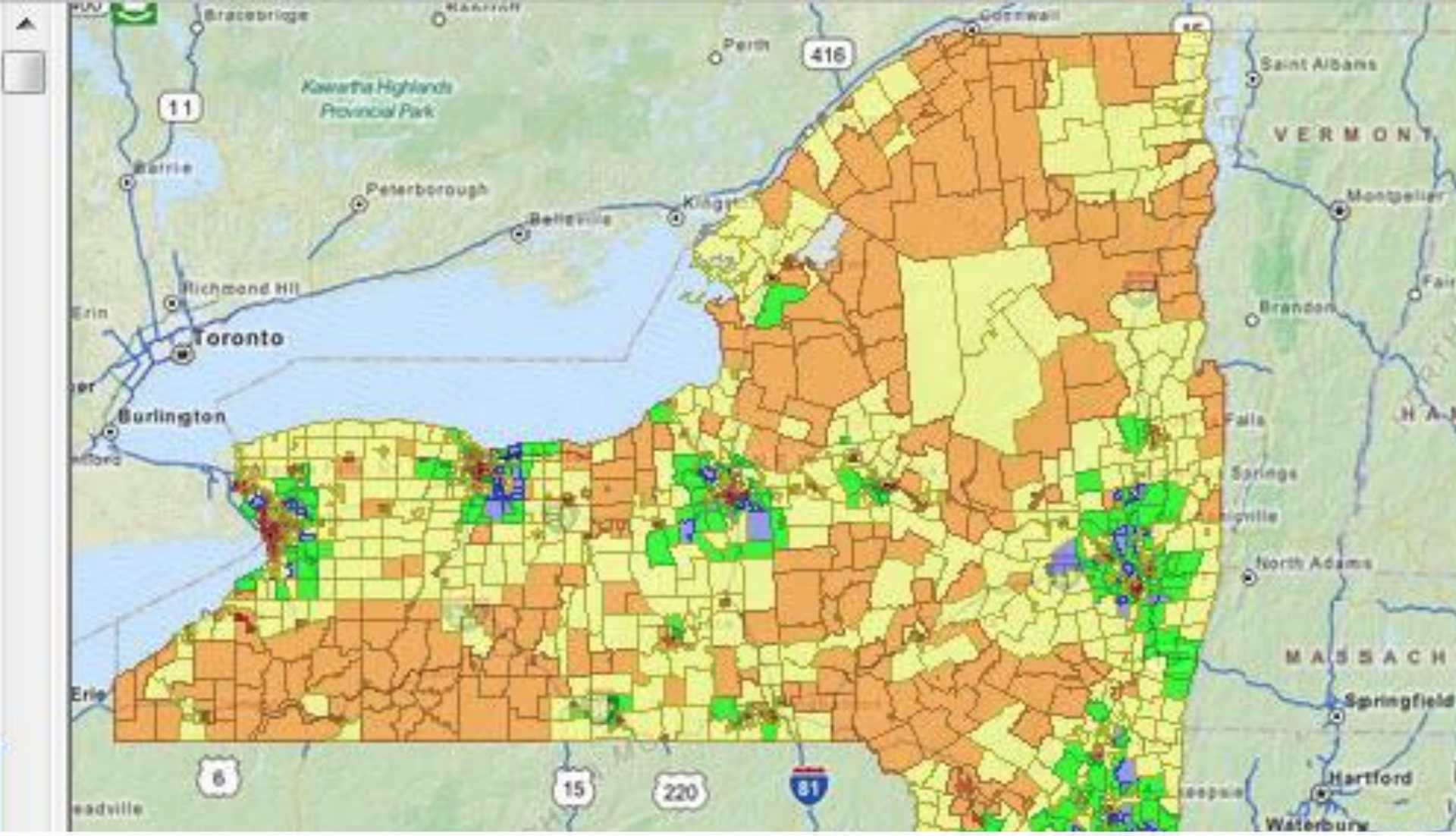

Geographic Distribution of
Median Income by Quintile in NYC
2,200. - 38,501.
38,501. - 50,051
50,051 - 60,502
60,502 - 74,252
74,252 - 140,255
Source: Census 2010
CUNY High Performance Computing Center

Housing Sales Prices

Property Tax

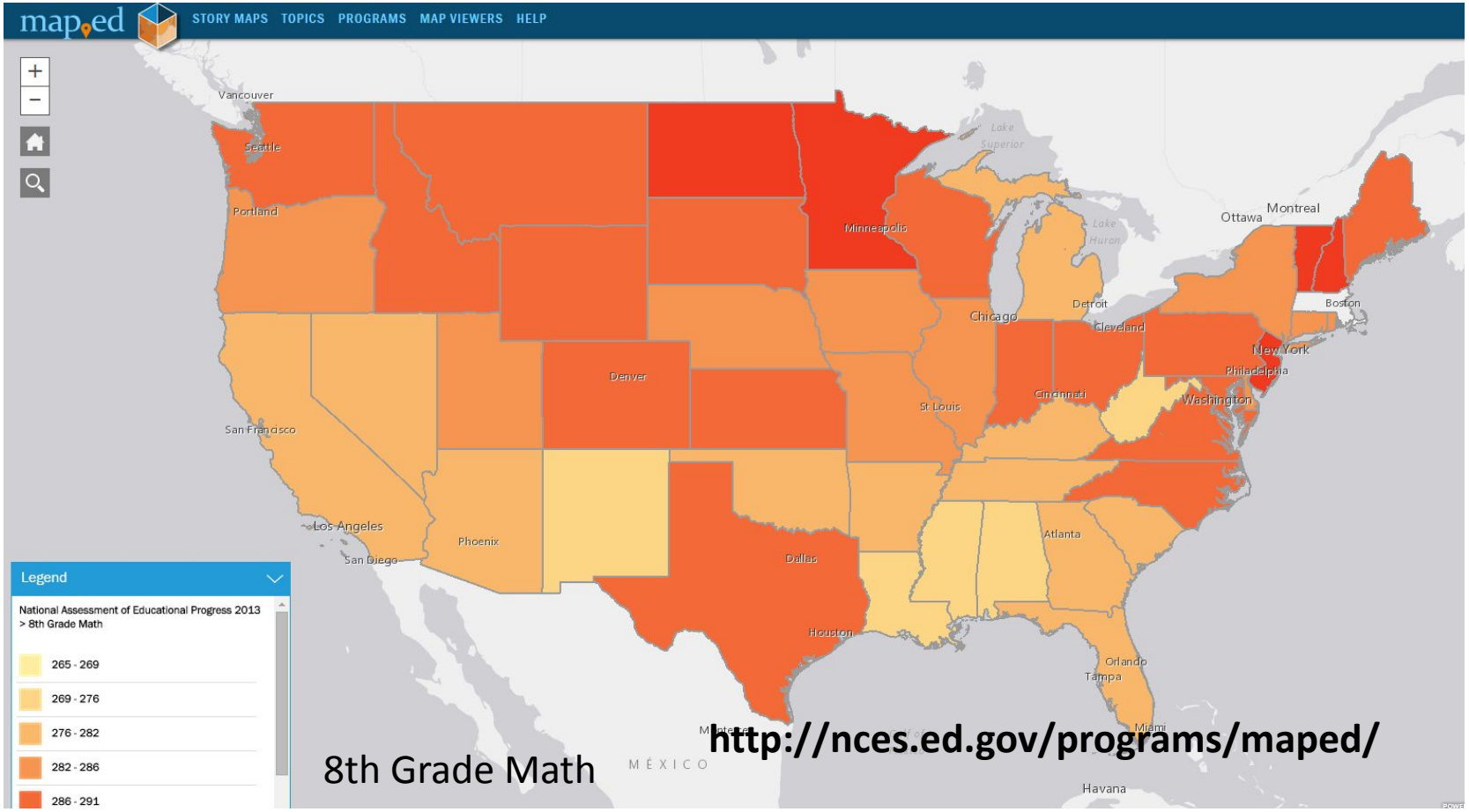


Education


Bracebridge
Perth
416
Kawartha Highlands Provincial Park
11
Barrie
Peterborough
Belleville
Kingston
Cornwall
Saint Albans
VERMONT
Montpelier
Brandon
Richmond Hill
Toronto
Erin
Burlington
Falls
Springs
North Adams
MASSACH
Springfield
Erie
6
15
220
81
Hartford
Waterbury
422
Pittsburgh
Altoona
22
81
Allentown
80

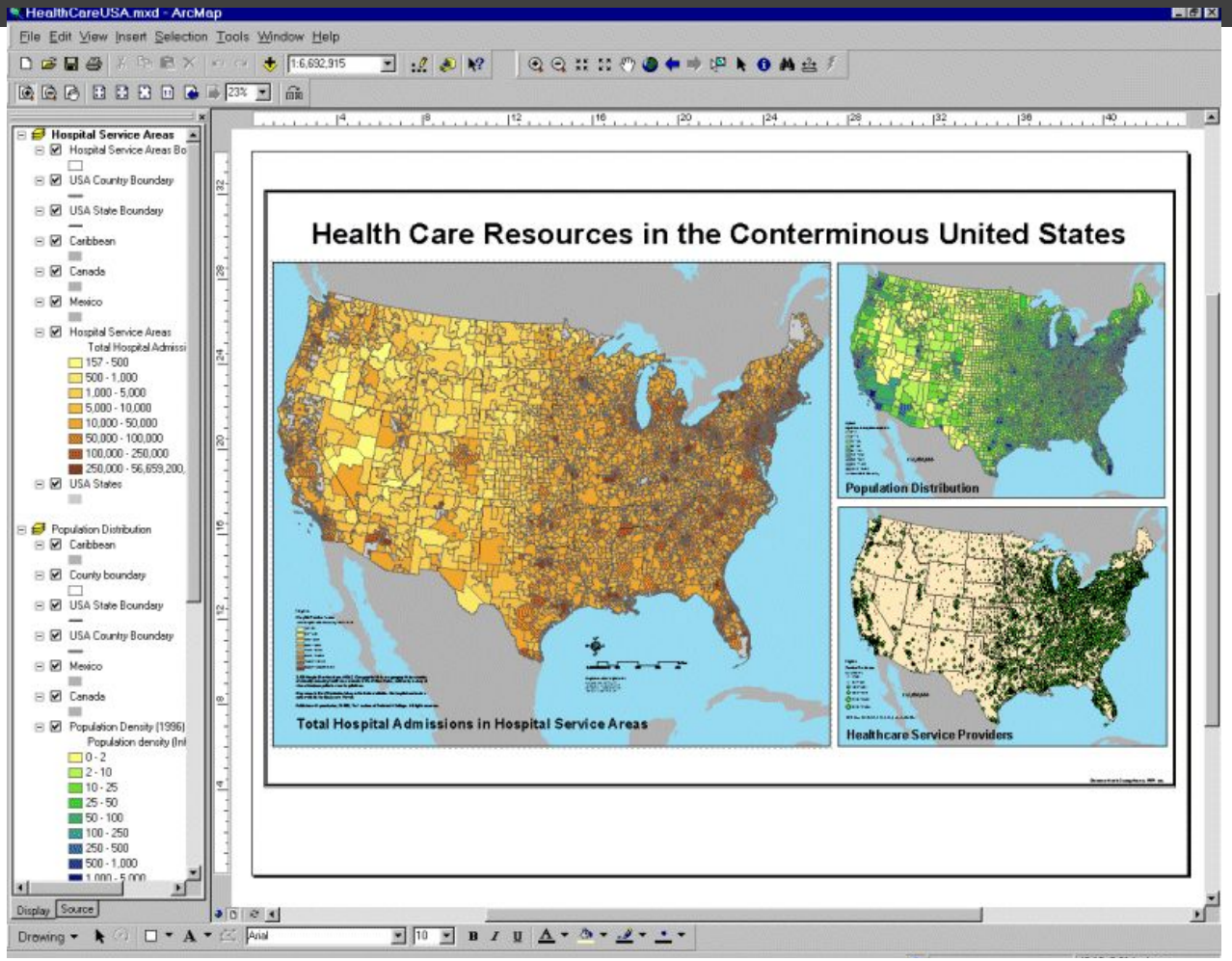
NYC Schools

National Assessment of Educational Progress 2013

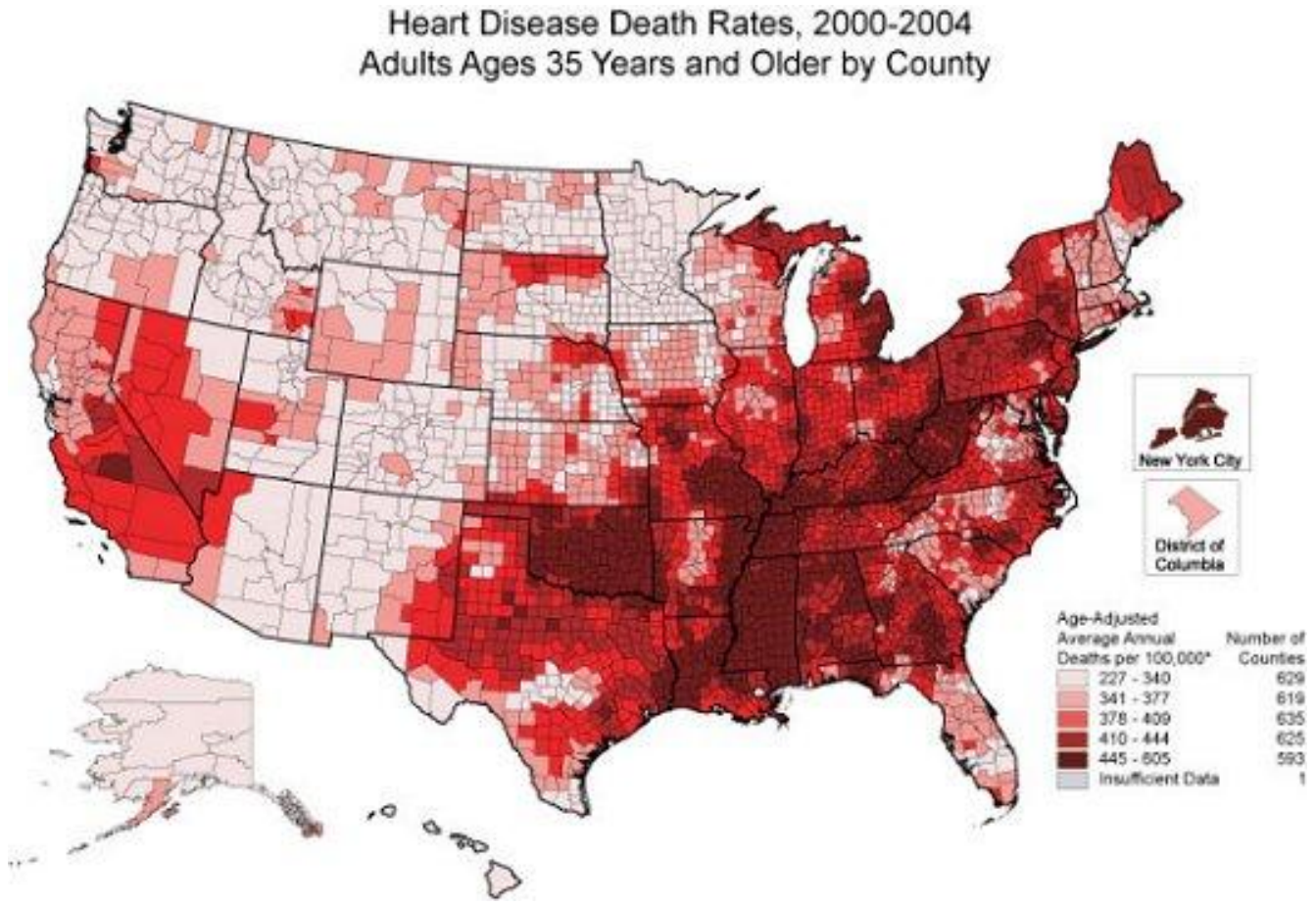


Health Care

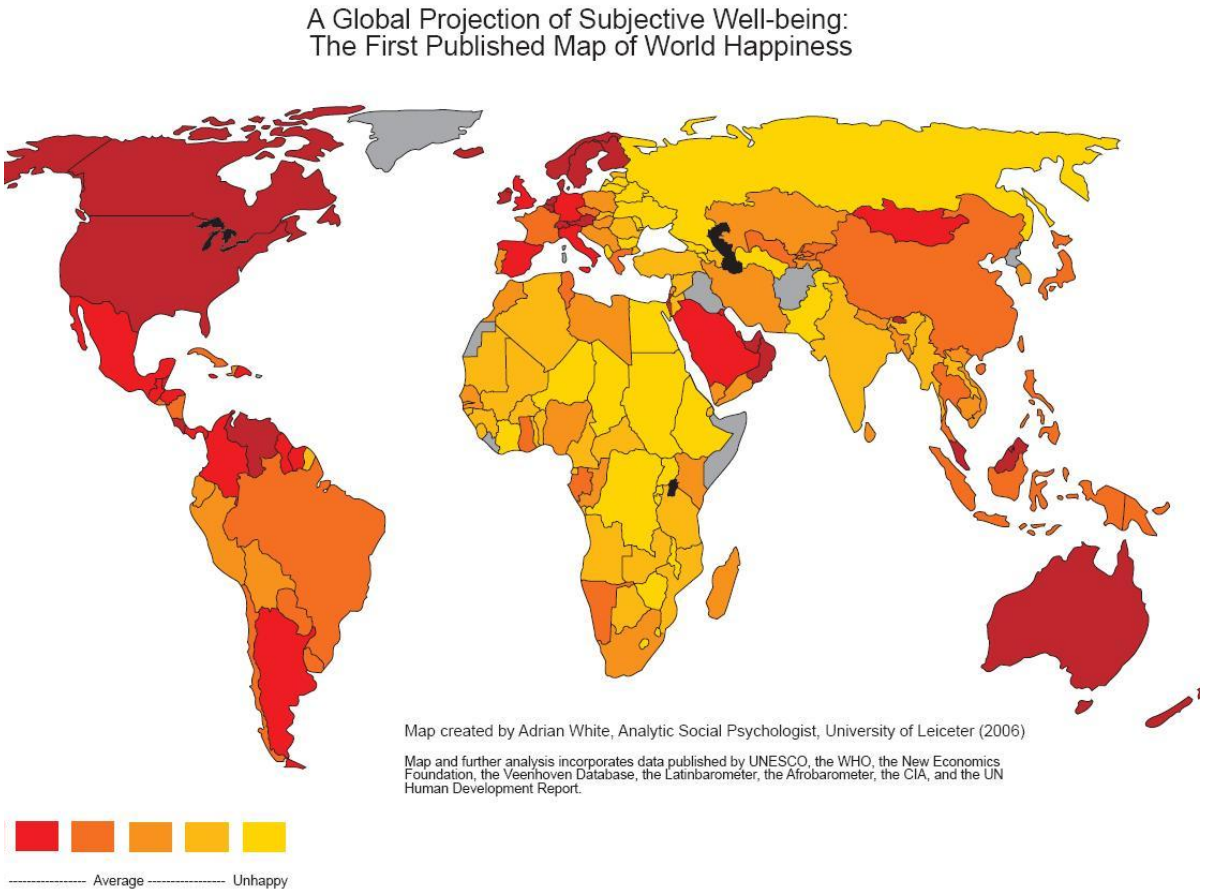
Sample Health Application



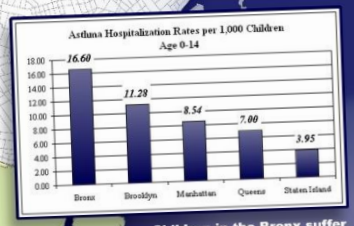
Human Health



World Happiness



Childhood Asthma and Poverty in The Bronx, New York



Children in the Bronx suffer a disproportionately higher rate of asthma than do those in any other borough of New York City.

One of the poorest areas in New York City, the South Bronx has one of the highest rates of asthma among children. Heavy truck traffic is a primary contributor to the poor air quality experienced by residents of this area.

Each dot represents one child with asthma.

Percentage of residents living below the poverty level:

- 0.0 - 9.5 %
- 9.6 - 21.6 %
- 21.7 - 34.7 %
- 34.8 - 44.6 %
- 44.7 - 100.0 %

NORTH

2 Miles

Designed and created by Brian Morgan
Lehman College, CUNY
April 2007

Special thanks to Dr. Juliana Maantay

Data sources:
U.S. Census, 2000;
NYC Department of Health and Mental Hygiene, May 2003

Guess?