Geographic Information Systems (GIS) for ACCR

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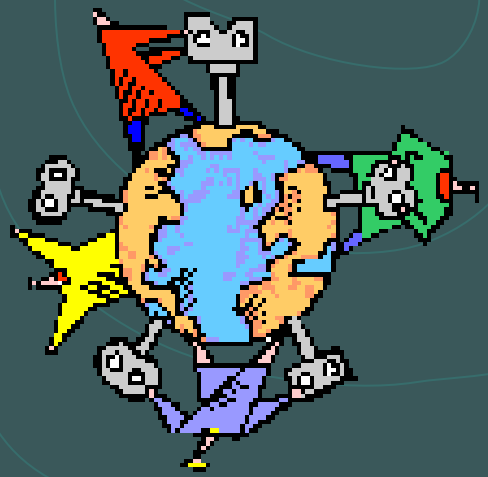
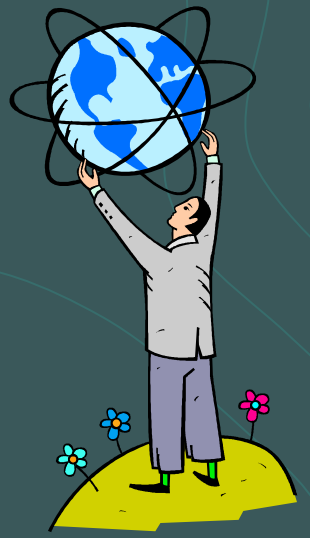
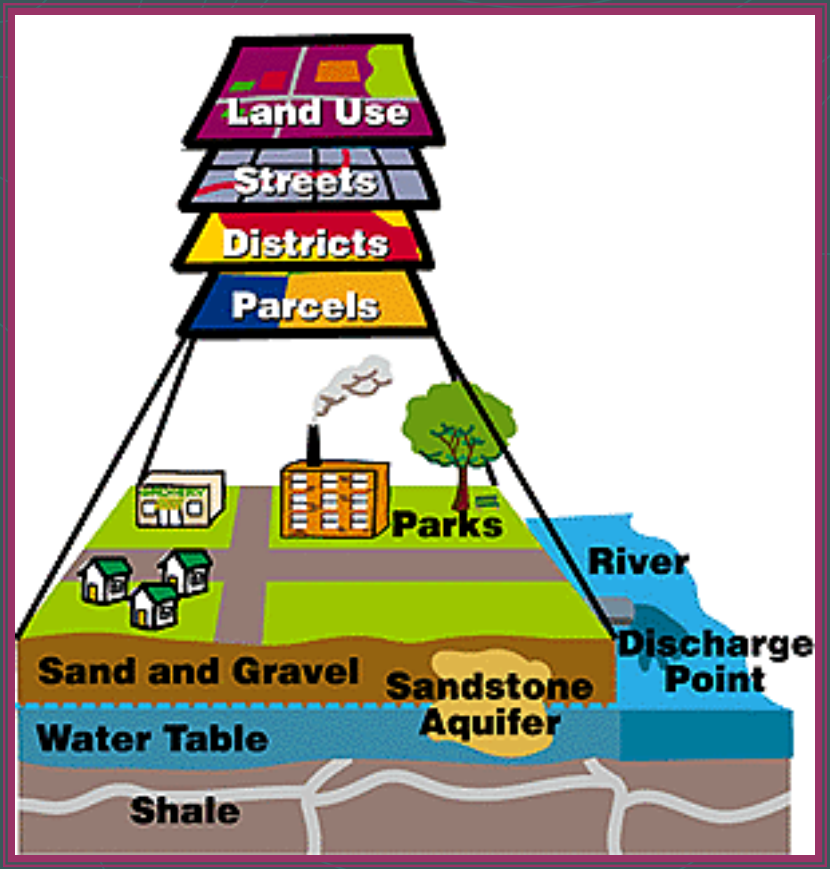
Geography

- Geography is the study of anything that varies on the face of the earth.
- What varies on Earth? Just about everything, certainly cancer.





What is GIS ?



- A method to *visualize, manipulate, analyze, and display spatial data*
- "Smart Maps" *linking a database to the map*

Geographic Information Systems

A Definition of GIS

GIS is a *System* of computer software, hardware and data, and personnel to help manipulate, analyze and present information that is tied to a spatial location –

- ***spatial location*** **–** usually a geographic location
- ***information*** **–** visualization of analysis of data
- ***system*** **–** linking software, hardware, data
- ***personnel*** **–** a thinking explorer who is key to the power of GIS

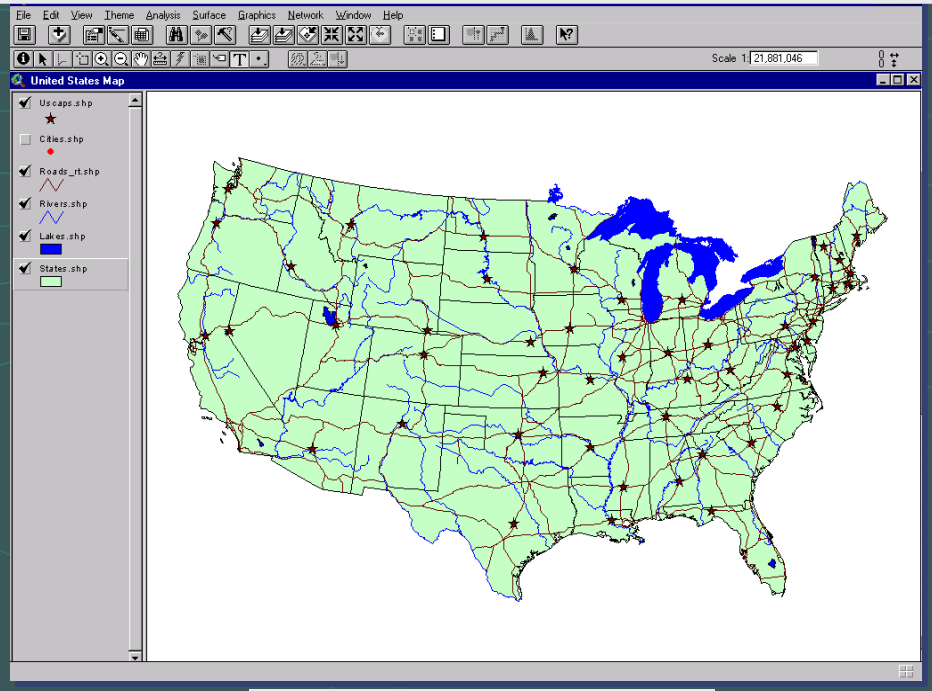
What is *Not* GIS ?

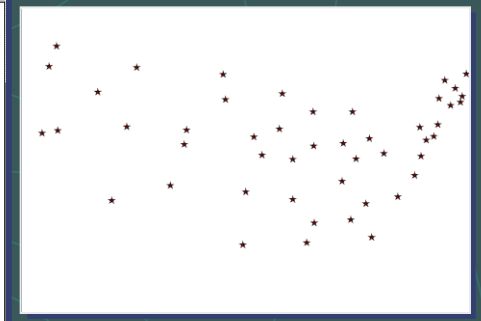
- GPS – Global Positioning System
- A static map – paper or digital
  - **Maps are often a "product" of a GIS**
  - **A way to visualize the *analysis***
- A software package

Five Data Layers

"Alike" Features

Rivers

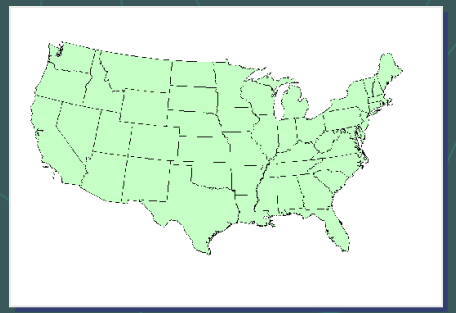




Capitals

Roads

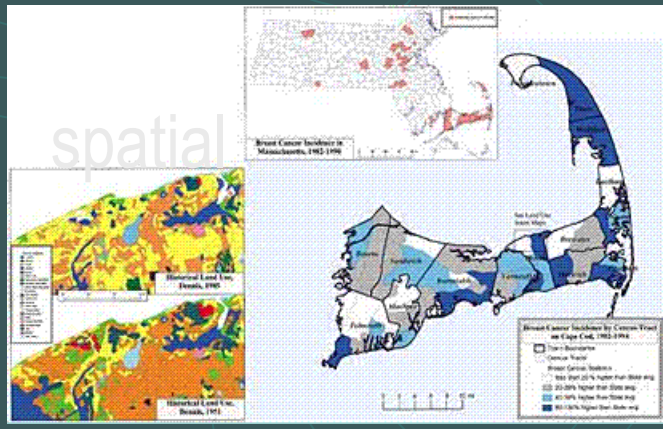
Lakes



States

What GIS Can Do?

- **Integrate** many different types of data
  - Spatial data + Non-spatial data (statistical, texts,..)
- With GIS we can easily:
  - Draw maps and visualize distributions
  - Edit and alter existing data
  - Accurately measure distances and areas
  - Overlay maps of different areas
  - **Internet GIS** for public access.

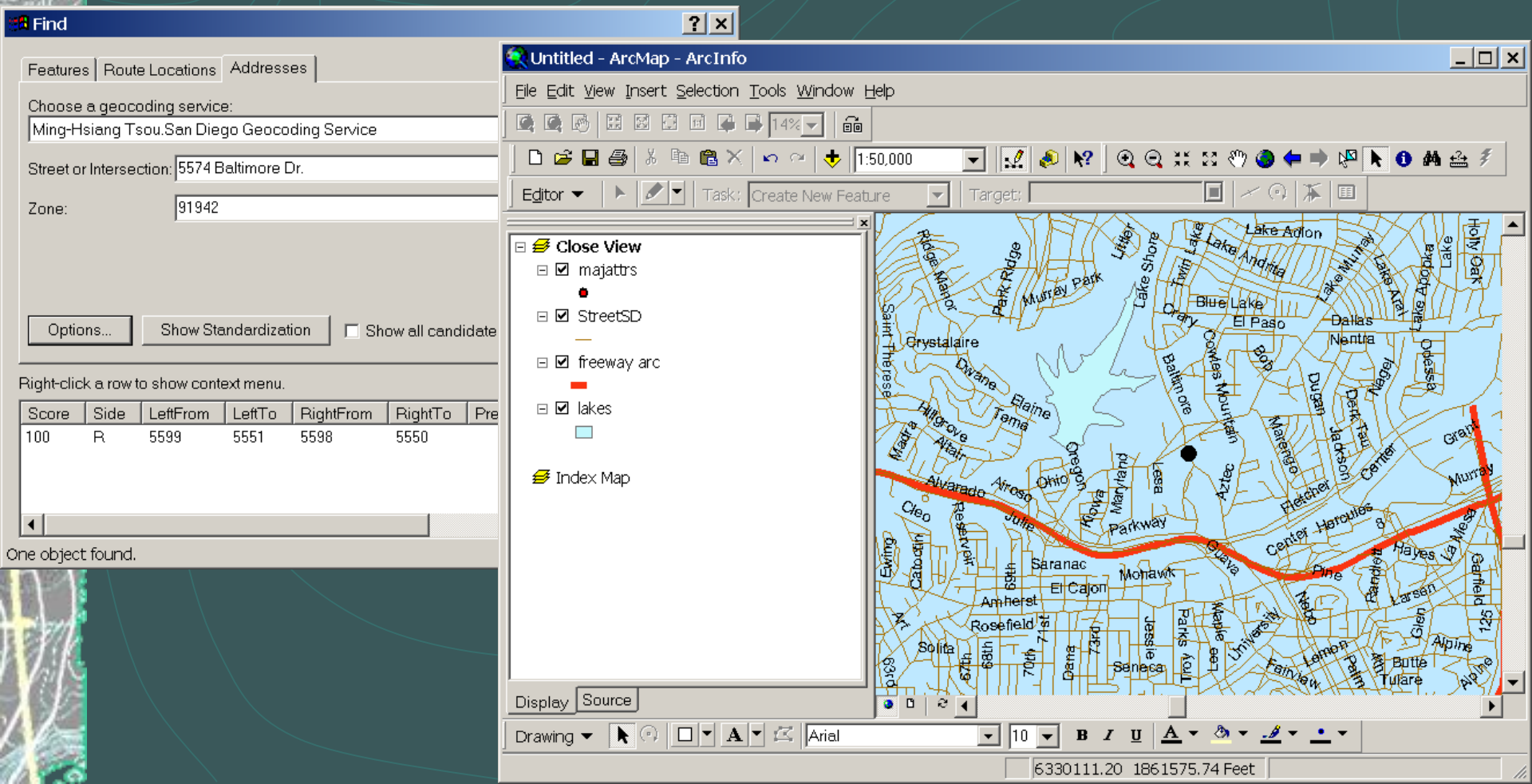


Spatial Data

- Estimates are that 80% of all data has a *spatial* component
  - **Data from most sciences can be analyzed** "spatially"
- What percentage of Registry data should have a spatial component?
  - Do you know anyone who lives in a PO Box?

Address Matching

- Convert patients' addresses to the geospatial location on maps.



Database

"Not Easy to Interpret"

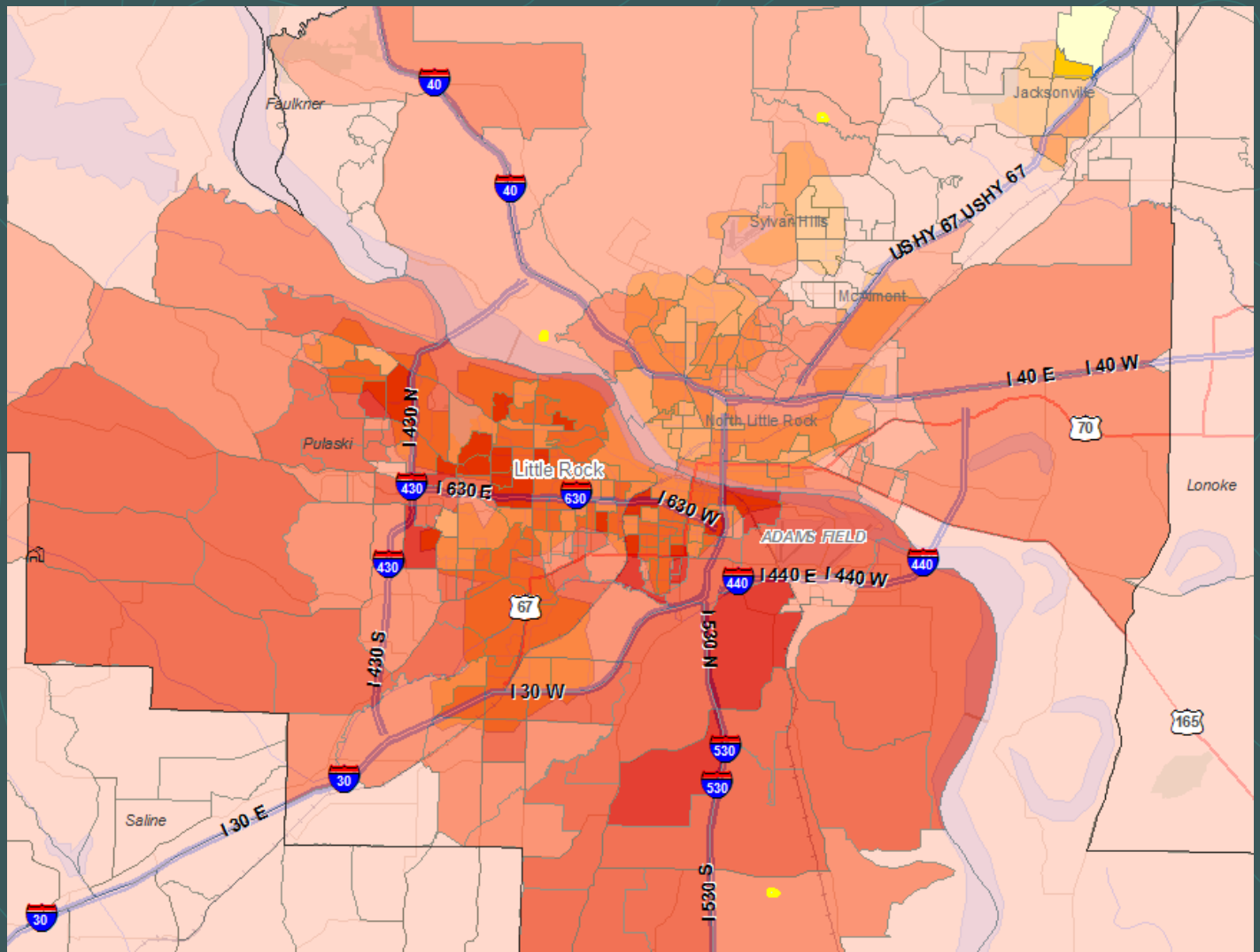
File Edit Table Field Window Help

0 of 51 selected

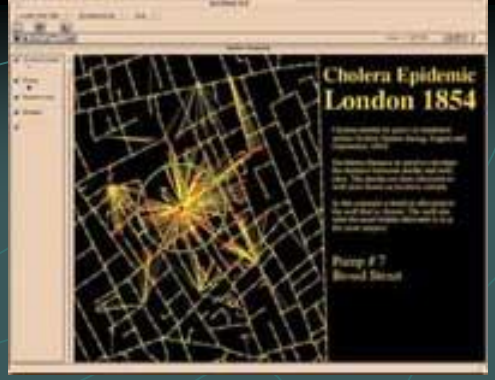
Attributes of States.shp

Shape	Area	State_name	State_fips	Sub_region	State_abbr	Pop1990	Pop1997	Pop90_sqmi	Households	Males	Females	White	Black	Ameri_es	A
Polygon	67286.878	Washington	53	Pacific	WA	4866692	5604260	72	1872431	2413747	2452945	4308937	149801	81483	2
Polygon	147236.028	Montana	30	Mtn	MT	799065	888723	5	306163	395769	403296	741111	2381	47679	
Polygon	32161.664	Maine	23	N Eng	ME	1227928	1244828	38	465312	597850	630078	1208360	5138	5998	
Polygon	70810.153	North Dakota	38	W N Cen	ND	638800	644782	9	240878	318201	320599	604142	3524	25917	
Polygon	77193.624	South Dakota	46	W N Cen	SD	696004	736549	9	259034	342498	353506	637515	3258	50575	
Polygon	97799.492	Wyoming	56	Mtn	WY	453588	484529	5	168839	227007	226581	427061	3606	9479	
Polygon	56088.066	Wisconsin	55	E N Cen	WI	4891769	5189399	87	1822118	2392935	2498834	4512523	244539	39387	
Polygon	83340.595	Idaho	16	Mtn	ID	1006749	1210819	12	360723	500956	505793	950451	3370	13780	
Polygon	9603.218	Vermont	50	N Eng	VT	562758	591659	59	210650	275492	287266	555088	1951	1696	
Polygon	84517.465	Minnesota	27	W N Cen	MN	4375099	4690847	52	1647853	2145183	2229916	4130395	94944	49909	
Polygon	97070.748	Oregon	41	Pacific	OR	2842321	3245429	29	1103313	1397073	1445248	2636787	46178	38496	
Polygon	9259.514	New Hampshire	33	N Eng	NH	1109252	1171443	120	411186	543544	565708	1087433	7198	2134	
Polygon	56257.220	Iowa	19	W N Cen	IA	2776755	2859263	49	1064325	1344802	1431953	2683090	48090	7349	
Polygon	8172.482	Massachusetts	25	N Eng	MA	6016425	6106984	736	2247110	2888745	3127680	5405374	300130	12241	1
Polygon	77328.337	Nebraska	31	W N Cen	NE	1578385	1660613	20	602363	769439	808946	1480558	57404	12410	
Polygon	48560.579	New York	36	Mid Atl	NY	17990455	18177296	370	6639322	8625673	9364782	13385255	2859055	62651	6
Polygon	45359.239	Pennsylvania	42	Mid Atl	PA	11881643	12051902	262	4495966	5694265	6187378	10520201	1089795	14733	1
Polygon	4976.434	Connecticut	09	N Eng	CT	3287116	3277113	661	1230479	1592873	1694243	2859353	274269	6654	
Polygon	1044.850	Rhode Island	44	N Eng	RI	1003464	988370	960	377977	481496	521968	917375	38861	4071	
Polygon	7507.302	New Jersey	34	Mid Atl	NJ	7730188	8018326	1030	2794711	3735685	3994503	6130465	1036825	14970	2
Polygon	36399.515	Indiana	18	E N Cen	IN	5544159	5874844	152	2065355	2688281	2855878	5020700	432092	12720	
Polygon	110667.293	Nevada	32	Mtn	NV	1201833	1652983	11	466297	611880	589953	1012695	78771	19637	
Polygon	84870.185	Utah	49	Mtn	UT	1722850	2034167	20	537273	855759	867091	1615845	11576	24283	
Polygon	157774.187	California	06	Pacific	CA	29760021	32197302	189	10381206	14897627	14862394	20524327	2208801	242164	28
Polygon	41192.862	Ohio	39	E N Cen	OH	10847115	11202691	263	4087546	5226340	5620775	9521756	1154826	20358	
Polygon	56297.954	Illinois	17	E N Cen	IL	11430602	11890919	203	4202240	5552233	5878369	8952978	1694273	21836	2
Polygon	66.063	District of Columbia	11	S Atl	DC	606900	535027	9187	249634	282970	323930	179667	399604	1466	
Polygon	2054.506	Delaware	10	S Atl	DE	666168	731218	324	247497	322968	343200	535094	112460	2019	
Polygon	24228.213	West Virginia	54	S Atl	WV	1793477	1828832	74	688557	861536	931941	1725523	56295	2458	
Polygon	9739.753	Maryland	24	S Atl	MD	4781468	5100839	491	1748991	2318671	2462797	3393964	1189899	12972	1
Polygon	104099.108	Colorado	08	Mtn	CO	3294394	3885615	32	1282489	1631295	1663099	2905474	133146	27776	
Polygon	40318.777	Kentucky	21	E S Cen	KY	3685296	3906565	91	1379782	1785235	1900061	3391832	262907	5769	
Polygon	82195.436	Kansas	20	W N Cen	KS	2477574	2582933	30	944726	1214645	1262929	2231986	143076	21965	
Polygon	39819.194	Virginia	51	S Atl	VA	6187358	6728895	155	2291830	3033974	3153384	4791739	1162994	15282	1
Polygon	69831.624	Missouri	29	W N Cen	MO	5117073	5387753	73	1961206	2464315	2652758	4486228	548208	19835	
Polygon	113711.522	Arizona	04	Mtn	AZ	3665228	4528866	32	1368843	1810691	1854537	2963186	110524	203527	
Polygon	70002.392	Oklahoma	40	W S Cen	OK	3145585	3318622	45	1206135	1530819	1614766	2583512	233801	252420	
Polygon	49046.813	North Carolina	37	S Atl	NC	6628637	7411239	135	2517026	3214290	3414347	5008491	1456323	80155	

Visualization
"Worth a Thousand Words"



Medical Geography



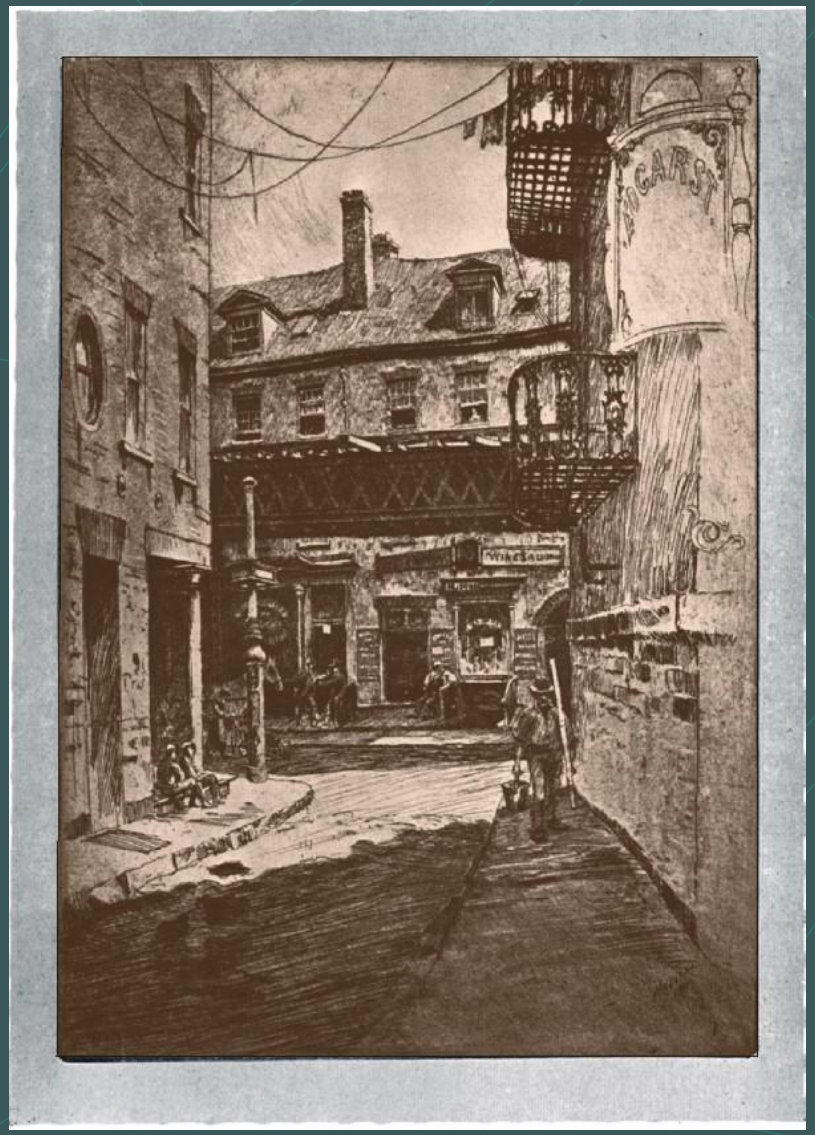
- Control of infectious disease very important
- Disease control requires understanding
- Geography can provide intelligence
- **Location** can influence health
  - John Snow's 1854 study – cholera mapping
- **Spatial analysis** can assist in solving medical problems

Dr. John Snow's London Street Map (1854)

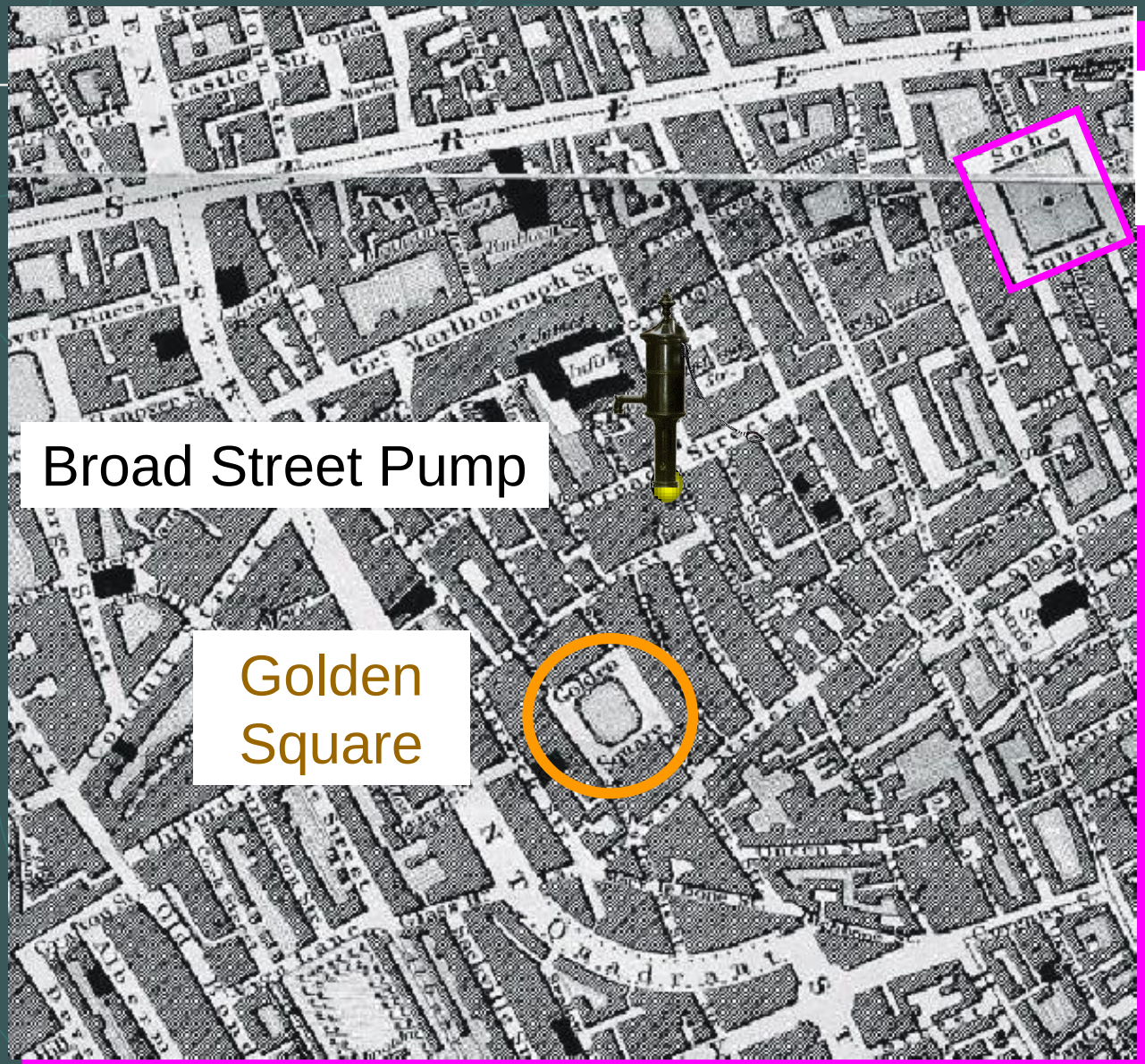
London was without cholera from the latter part of 1849 to August 1853

"The most terrible outbreak of cholera which ever occurred in this kingdom, is probably that which took place in **Broad Street, Golden Square,** and the adjoining streets, a few weeks ago."

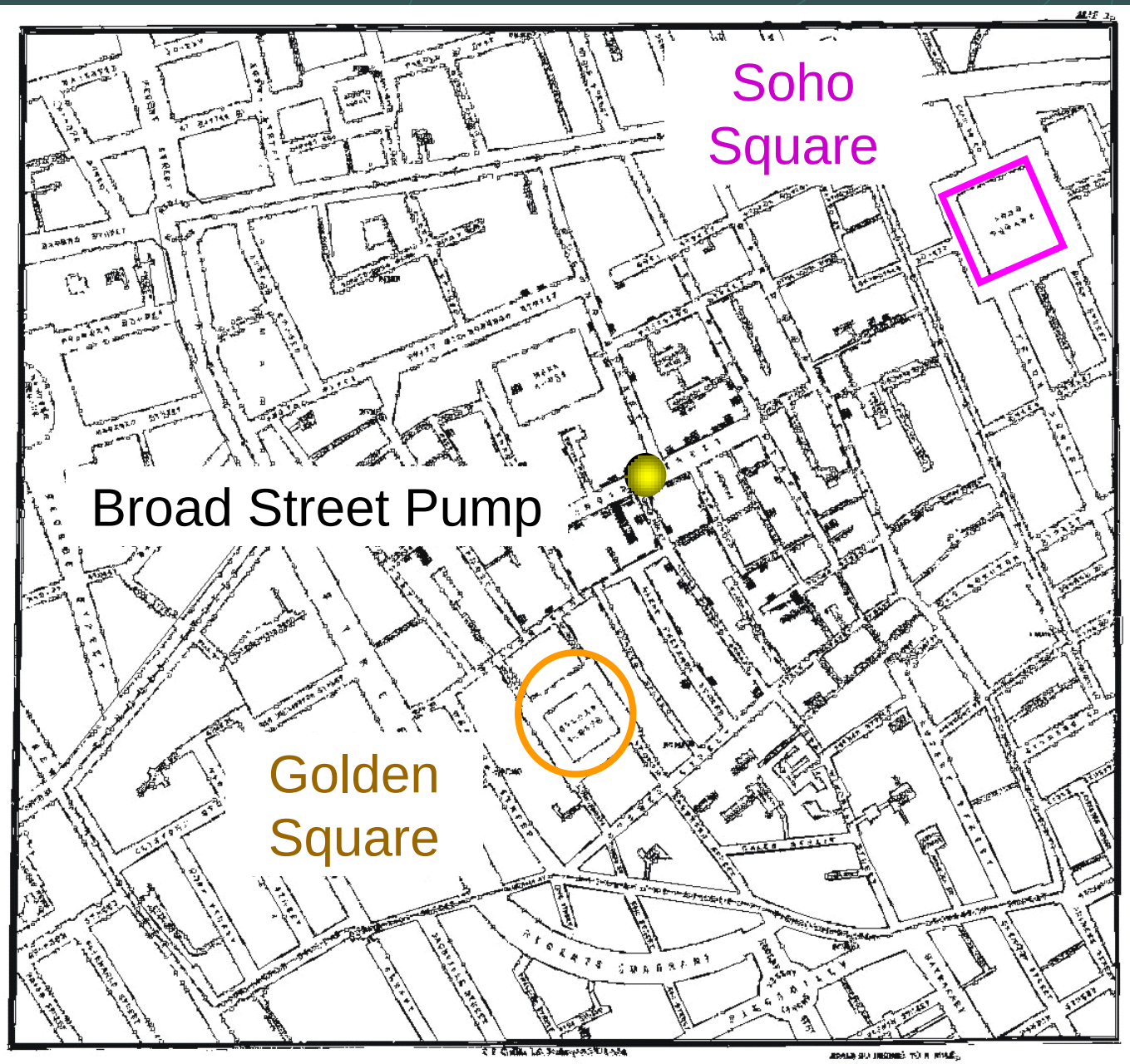
- John Snow, September



Greenwood's Map of London 1827



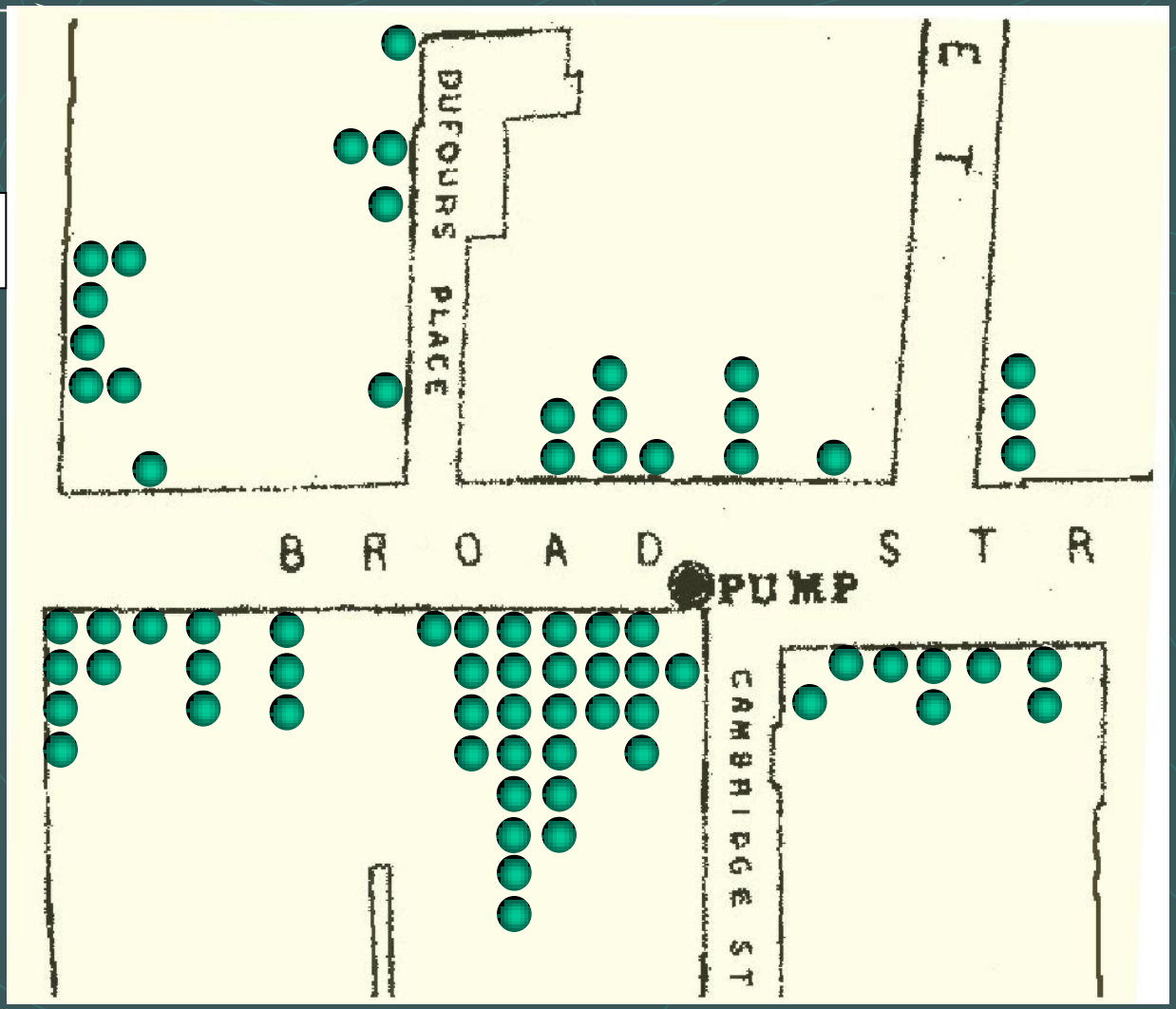
C.F. Cheffins Map modified by Dr. John Snow 1850-54



Pump Locations

"…I found that nearly all the deaths had taken place within a short distance of the pump."

death



Steps taken by Snow

- Acquired a map.
- He acquired **incidence data**.
- Inventoried potential sources of contamination.
- Combined this information on a map.
- Draw conclusions from the map.

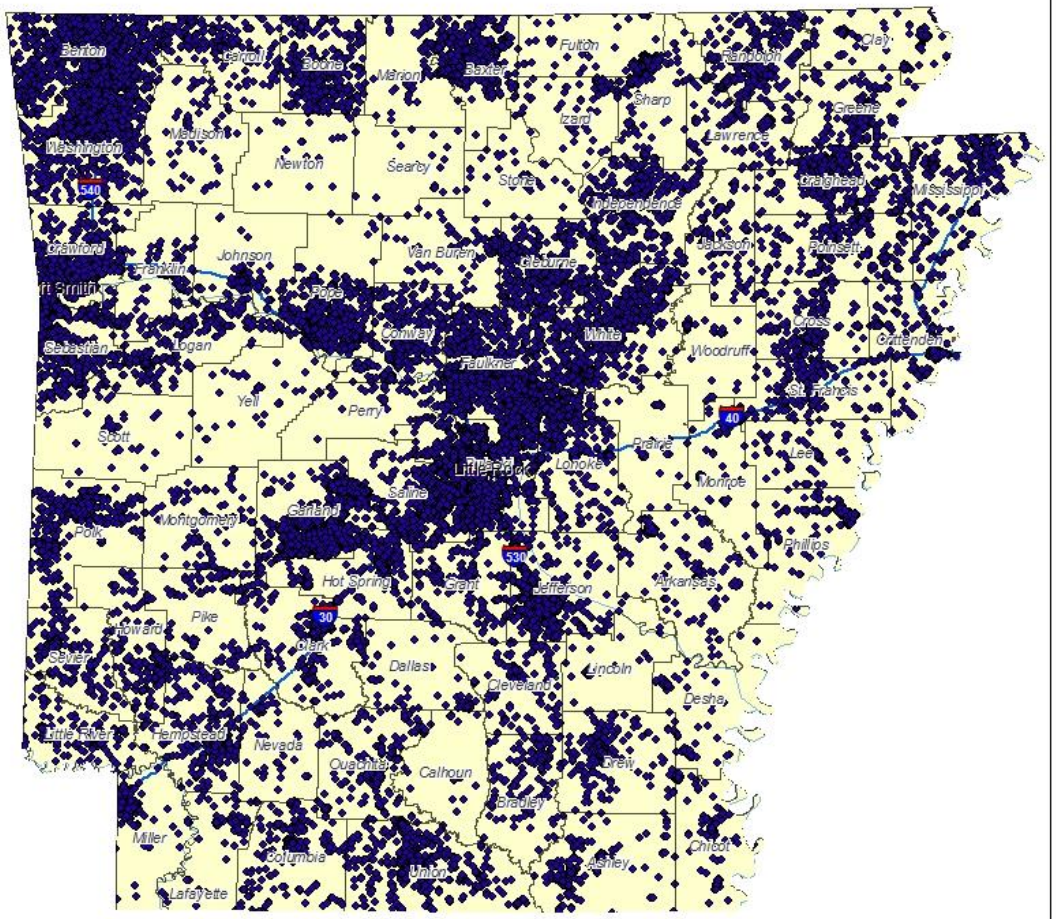
GIS Applications in Cancer Registry

1. Data Visualisation and Exploration
2. Data Integration
3. Monitoring
4. Geostatistics and Modelling
5. Spatial Interaction
6. Data Sharing and Web Services

Data Visualization and Exploration

- 2D visualisation capabilities – maps
  - Distributions
  - Patterns
  - Clusters
- 3D visualisation capabilities – surfaces
- 4D visualisation capabilities – temporal (Future projects)
  - Animations
  - Eg. Applied to spread/retreat of disease
- Increases understanding of disease
- Enables informed planning for disease management

Arkansas Cancer Incidence



Arkansas Multiple Myeloma Incidence

Legend

- Multiple Myeloma

0 5 10 20 30 40 Miles

N

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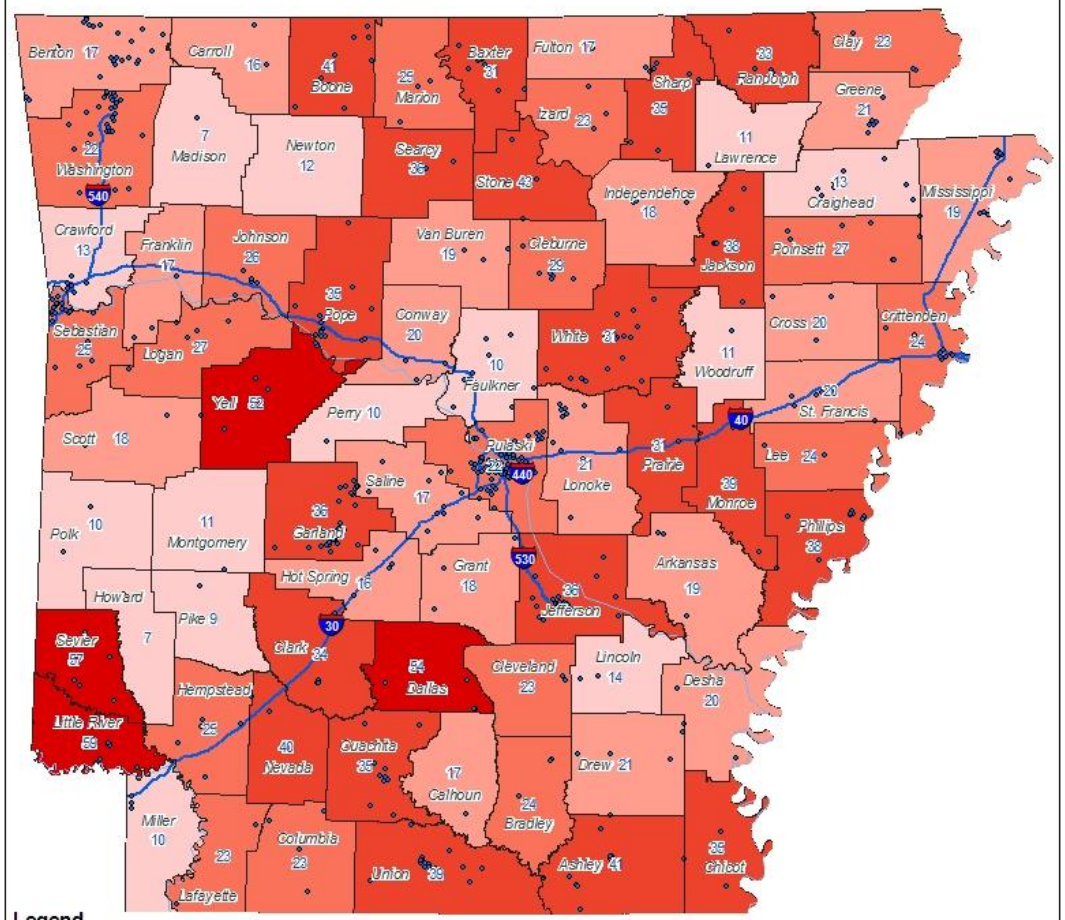
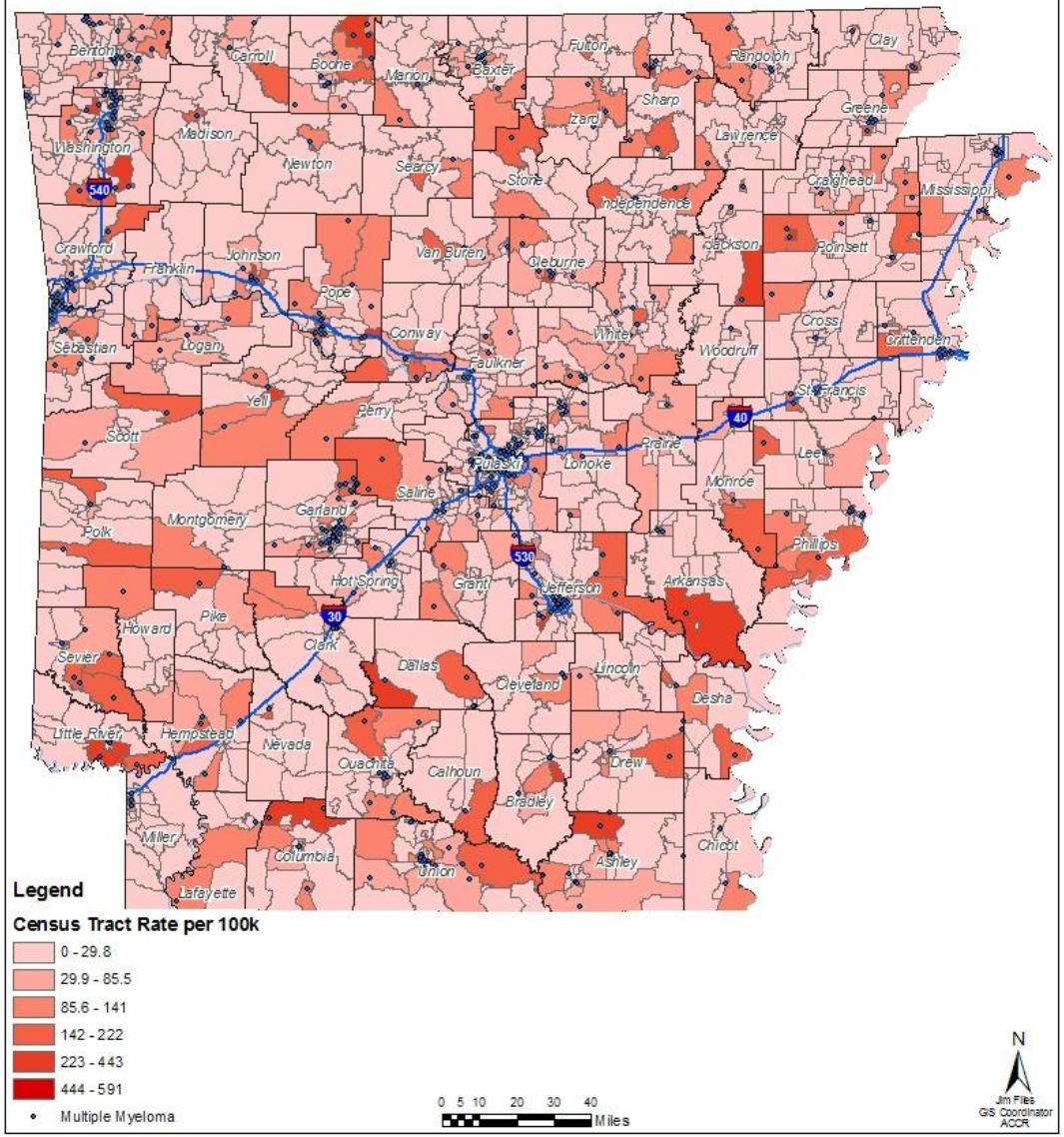
GIS Coordinator
ACCR

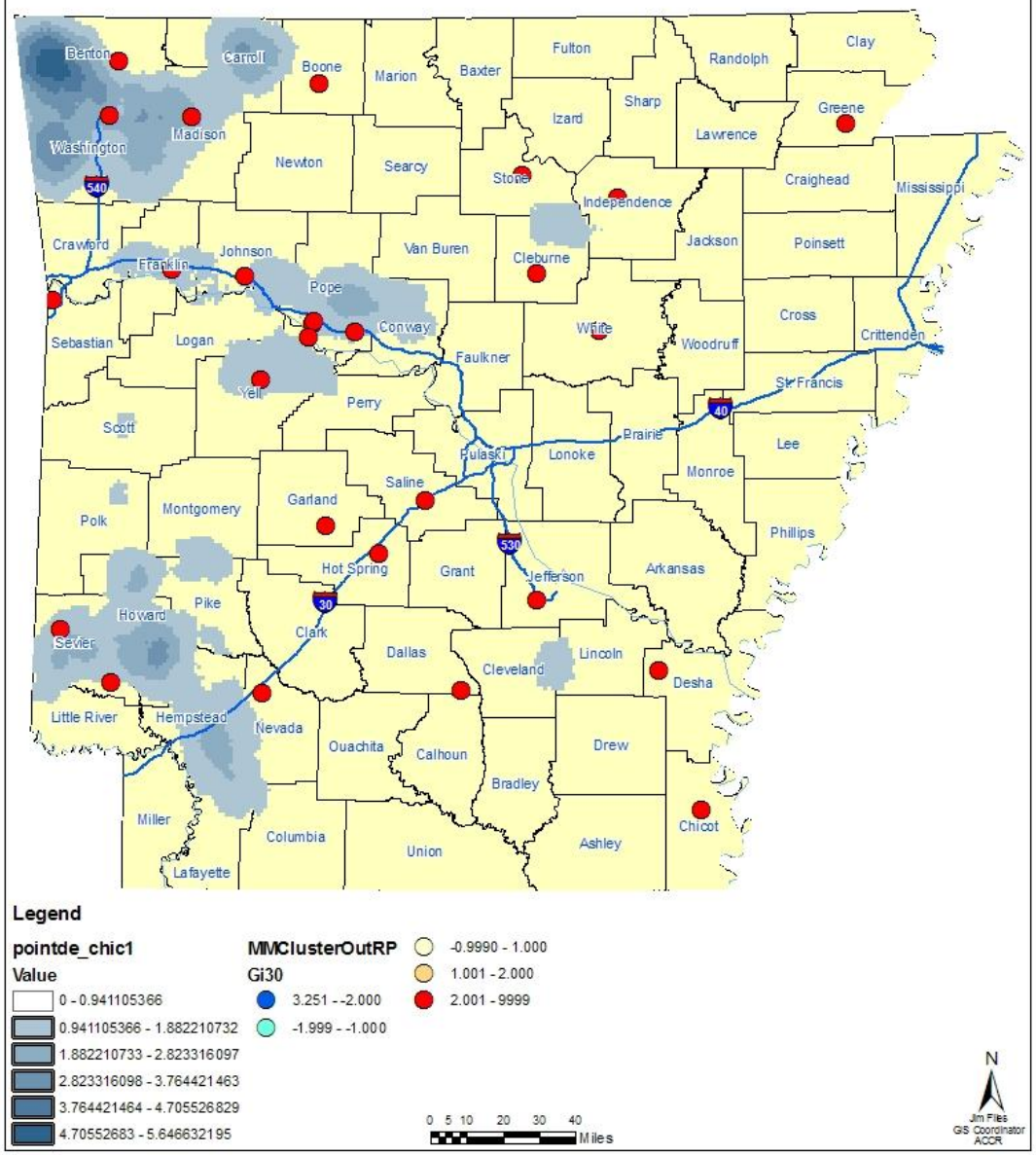
Arkansas Multiple Myeloma County Rate



Arkansas Multiple Myeloma Census Tract Rate



Arkansas Multiple Myeloma Hot Spots with Chicken House density



Legend

pointde_chic1
Value
- 0 - 0.941105366
- 0.941105366 - 1.882210732
- 1.882210733 - 2.823316097
- 2.823316098 - 3.764421463
- 3.764421464 - 4.705526829
- 4.70552683 - 5.646632195

MMClusterOutRP
Gi30
- 3.251 - -2.000
- -1.999 - -1.000

- -0.9990 - 1.000
- 1.001 - 2.000
- 2.001 - 9999

0 5 10 20 30 40
Miles

N

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GIS Coordinator
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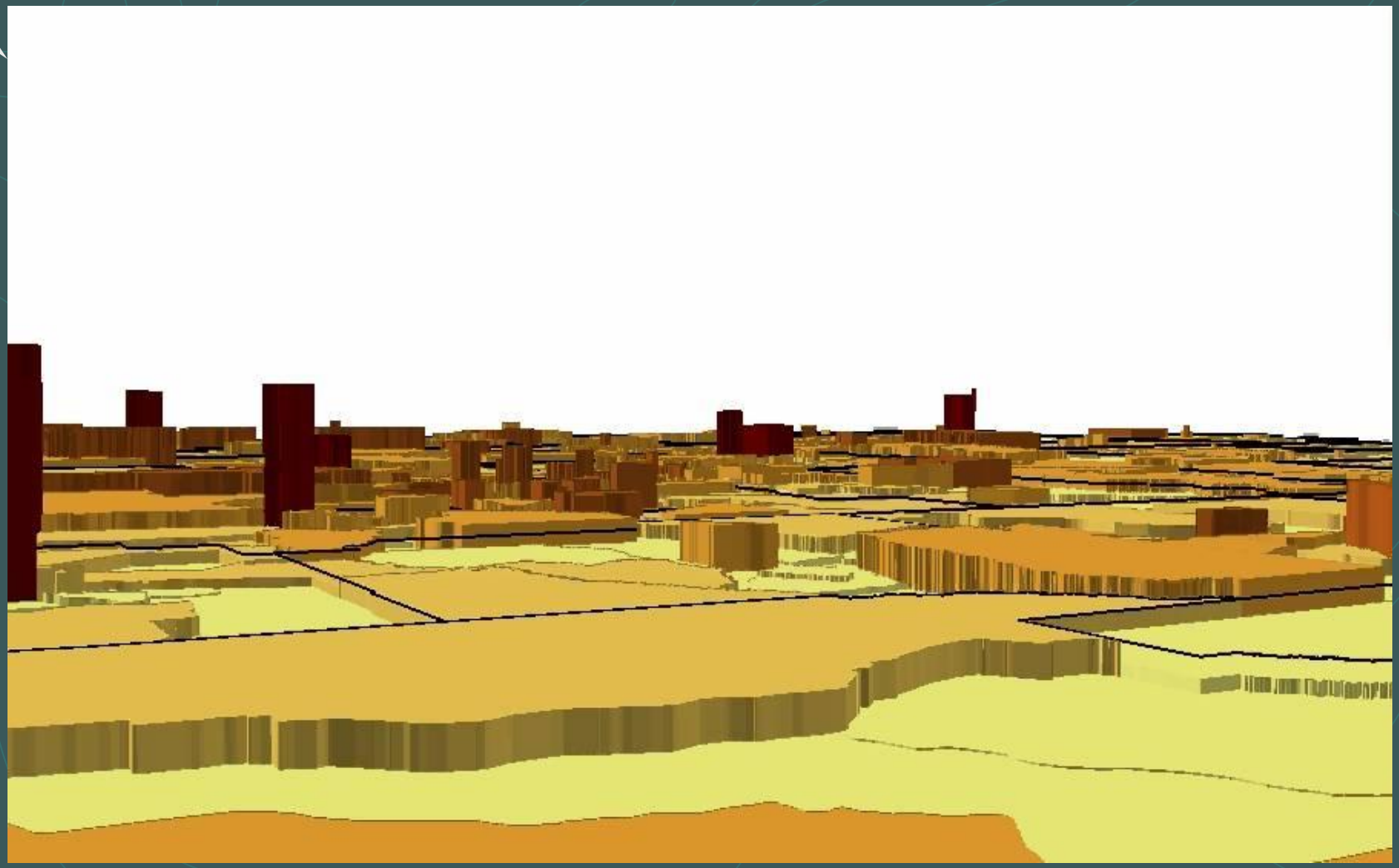
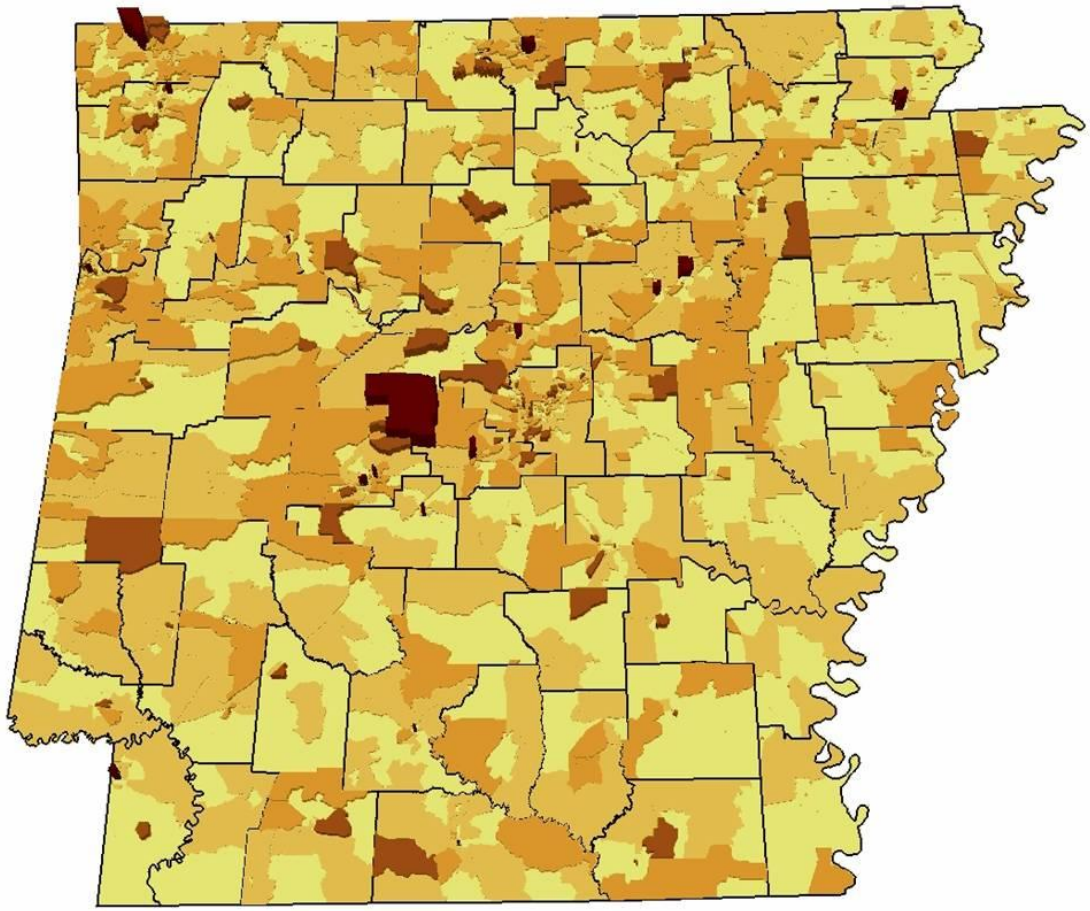
Example 3D Visualization



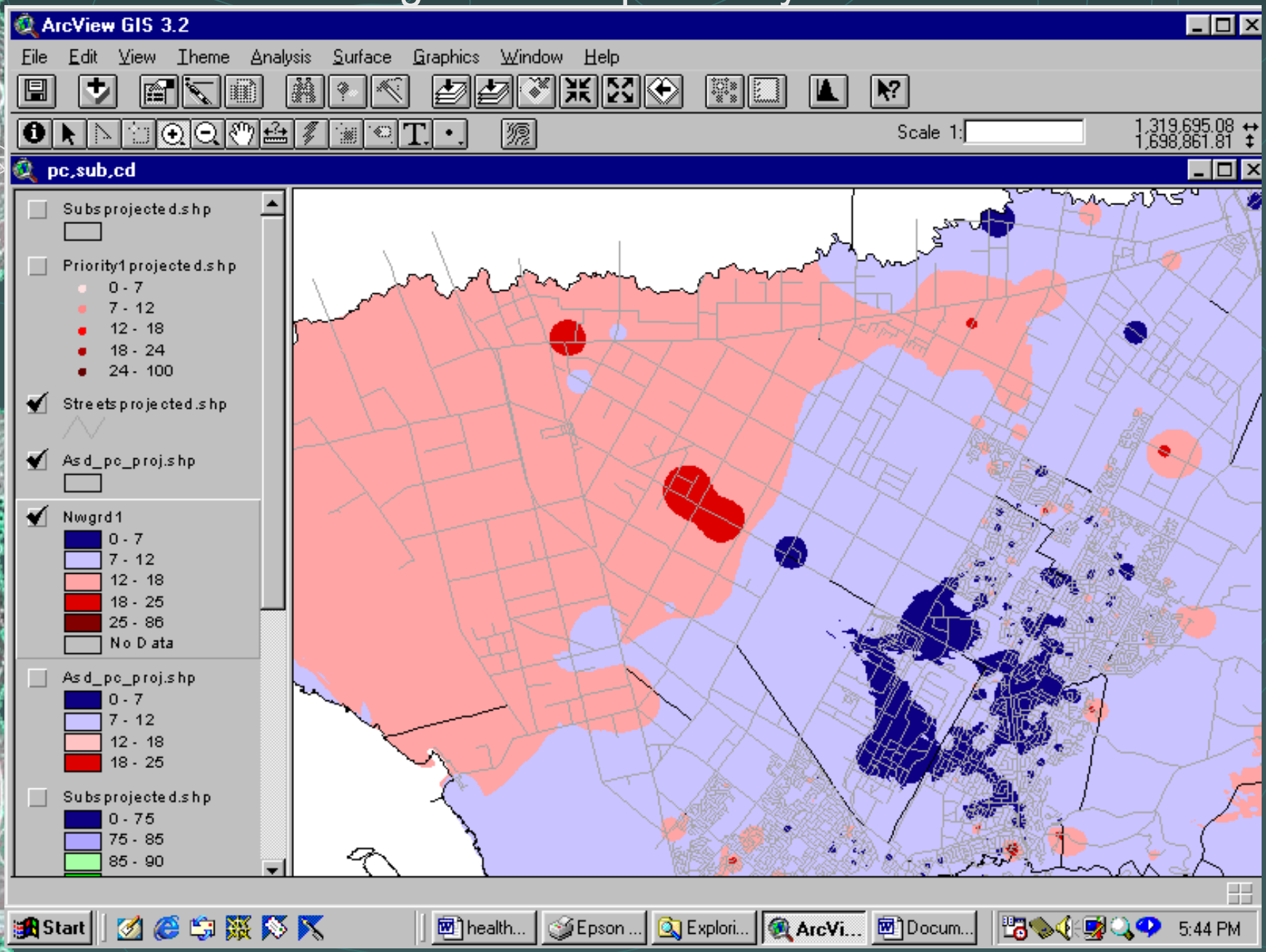
3D Fly through



Geostatistics and Modeling

- Explore statistical relationships in data
  - Build geostatistical surfaces
  - **Detect clusters**
  - Significant change over time and space
  - “Statistical Alarm Bell”
  - Display outlier or influential cases by location
- Statistical analysis also useful in finding zones of significantly higher disease prevalence

Surface building and hot spot analysis



Summary

- **GIS can provides spatial dimension to Cancer research** (visualization, modeling…).
- **GIS can be used for many public heath applications and services.** (efficient allocation of health care resources, equity in accessibility to services…)
- **Internet GIS** can provide the public health information in real-time. (evaluation, decision support systems, emergency response…)

Website

- ACCR: http://www.healthyarkansas.com/arkcancer/arkcancer.html
- NAACCR GIS: http://www.naaccr.org/GIS