

Incorporating Time into ArcGIS

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Center for Digital Scholarship

Hesburgh Library, University of Notre Dame

library.nd.edu/cds/

Outline

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- The Center for Digital Scholarship
- Brief review of GIS concepts
- Illustrating time on a map
- Temporal Data
 - Vector
 - Raster

Center for Digital Scholarship

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- Center services:
 - Text Analysis
 - Research design
 - Data management
 - Statistic analysis
 - Geographic Information Services

What is GIS ?

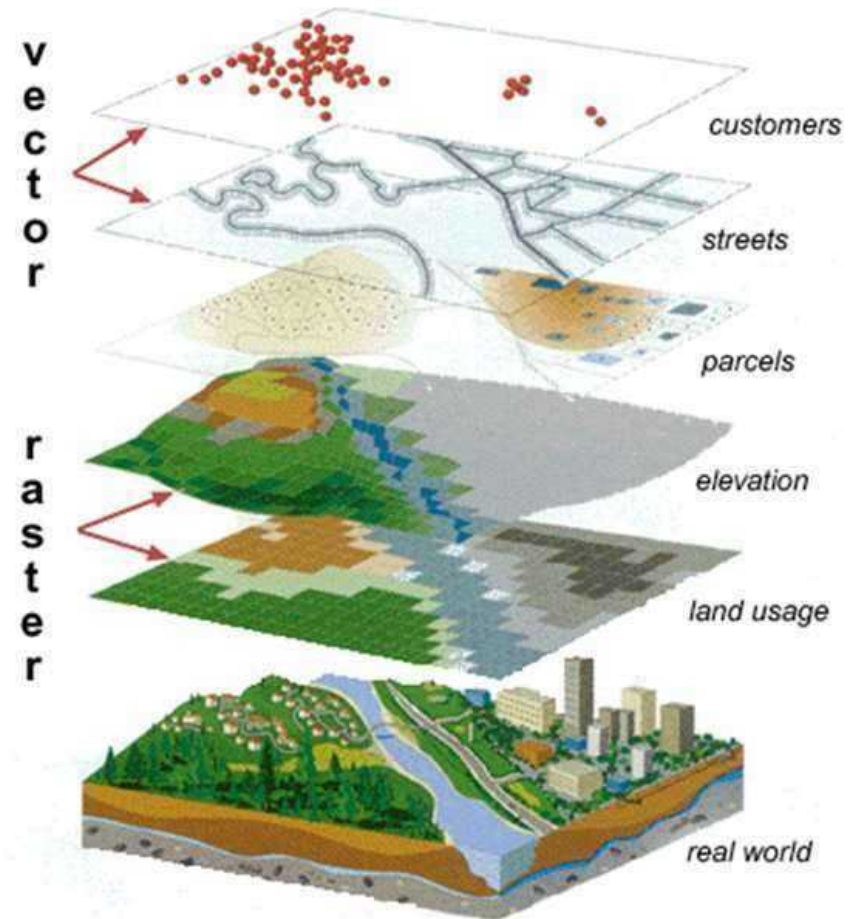
In short: “computerized mapping software”

Formal definition

A Geographic Information System (GIS) is a
computerized database management system for
capture, storage, retrieval, manipulation, analysis and
display of spatial (i.e. locationally defined) data

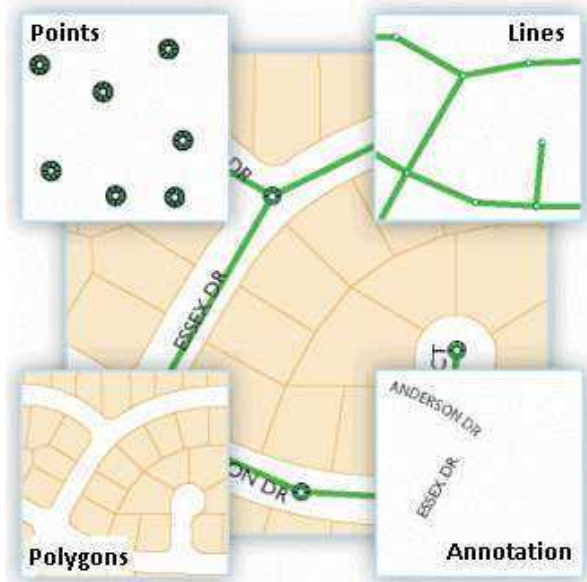
Layers

- A GIS is composed of layers of spatial information
- Can be different types of data
- Everything is referenced to a coordinate system
 - e.g. latitude / longitude



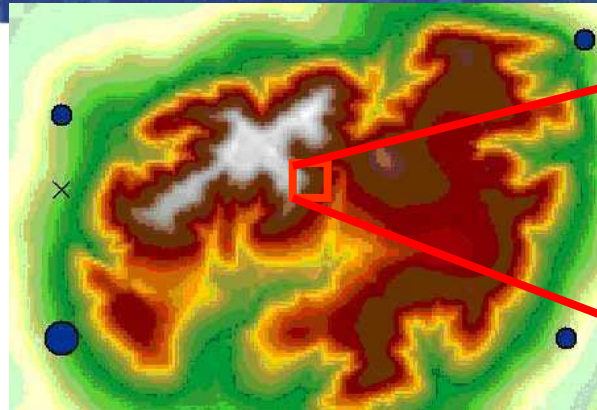
GIS digitally models the real world using:

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Three types of geometry

- Points
- Lines
- Areas



Cells in an image

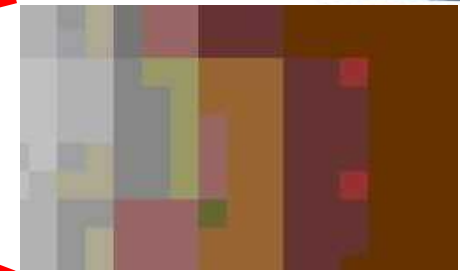


Table Owners

Object ID	Owner ID	Owner name	Percent owned
62932	12416	Mr Poulenc	50
62932	14562	Ms Beach	50
67810	16733	Ms Zwilich	100
62866	10930	Mr. Satie	100
53956	21394	Mr. Ravel	100
56460	26669	Mr Puccini	100

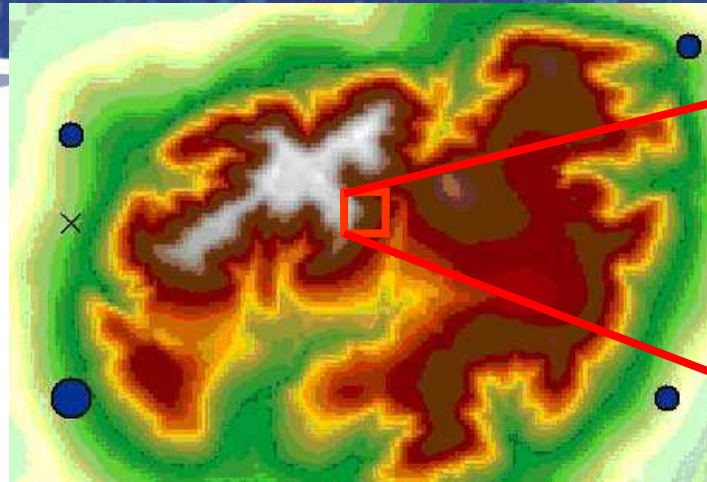
Feature class Parcels

Object ID	Shape	Shape length	Shape area	Parcel ID	Assessed value	Type
14352	Polygon	407.3	10678.8	56460	\$58,000.00	6
17234	Polygon	438.5	12371.4	53956	\$56,000.00	6
19923	Polygon	395.0	9242.8	62866	\$45,000.00	6
23049	Polygon	396.4	9241.4	67810	\$52,000.00	6
26965	Polygon	421.5	9482.5	62932	\$47,000.00	6

Data tables

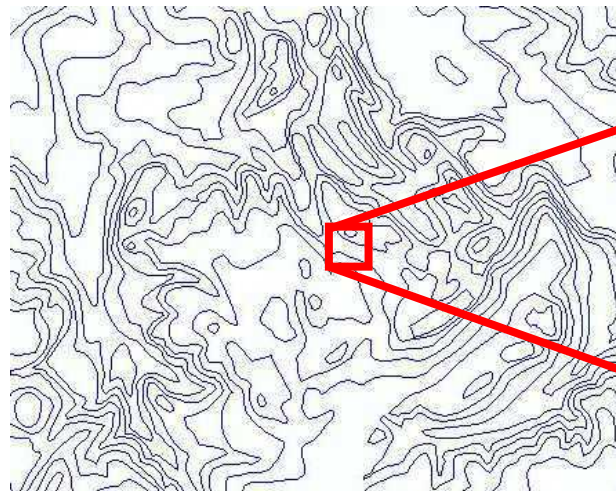
Raster Data

Based on pixel



Vector Data

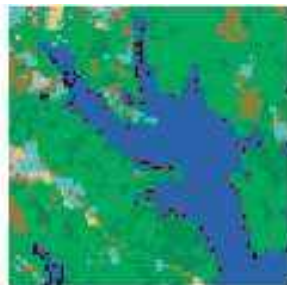
Based on discrete points



Rasters



Orthophoto



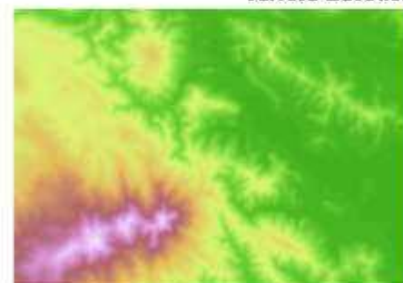
Land Use



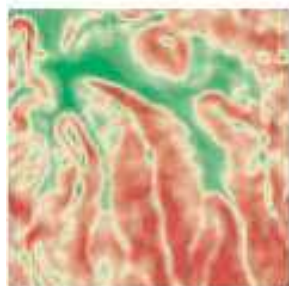
Concentration



Aerial Imagery



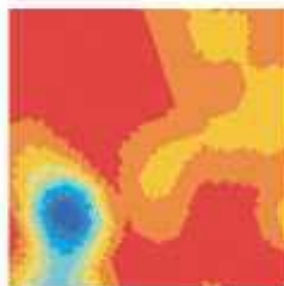
Surface Elevation



Slope



Elevation



Population



Land Use Classes

- Agriculture
- Bare ground
- Water
- Deciduous Trees
- Deciduous / Pine Mixed
- Grassland
- Pine
- Shadow
- Urban / Developed

Vectors

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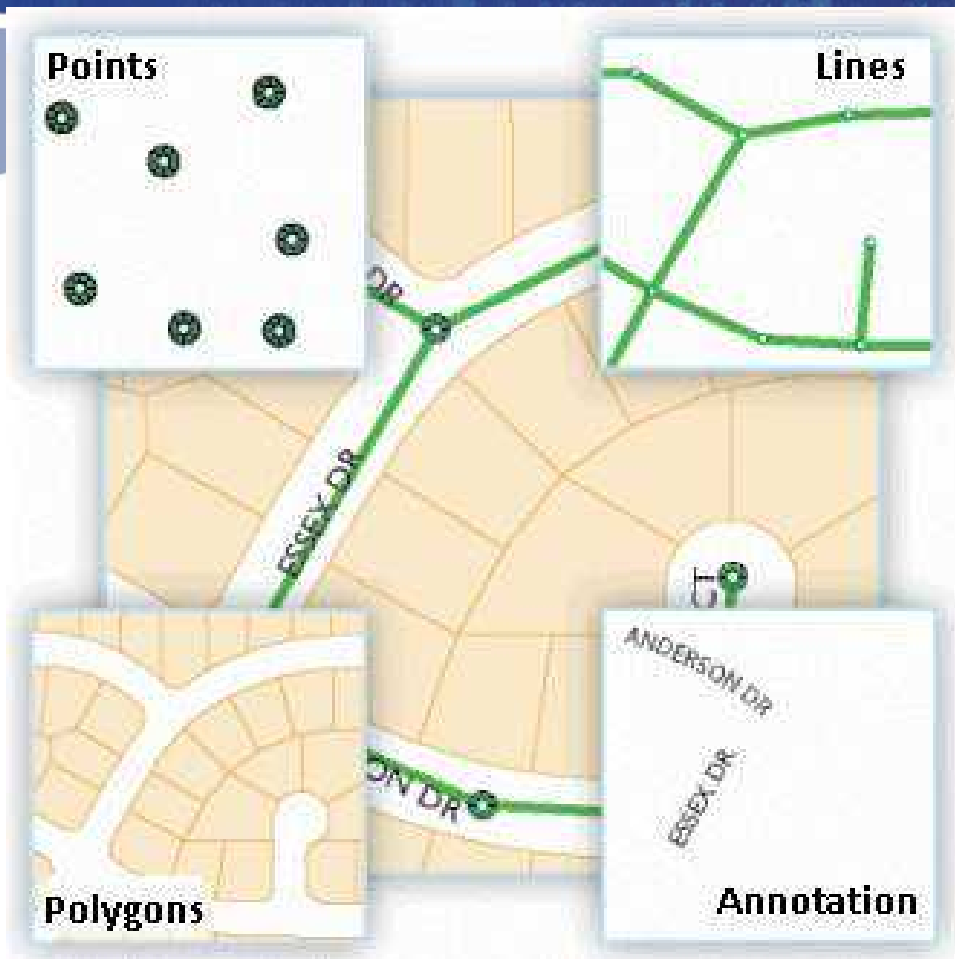


Table Owners

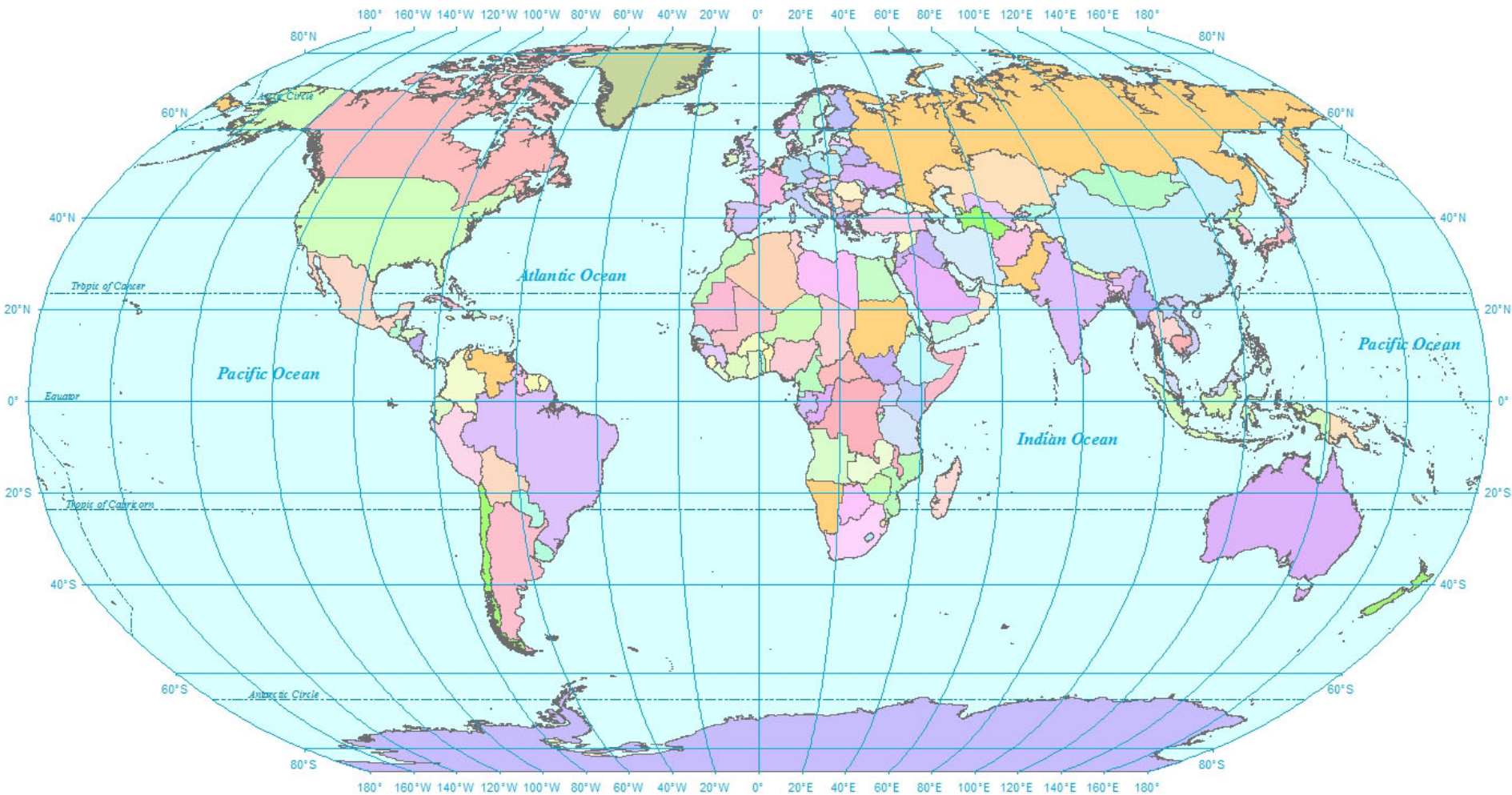
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26965	Polygon	421.5	9482.5	62932	\$47,000.00	6

Attribute Data

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Attribute Data

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Attributes of Country Areas											
ObjectID	FIPS_CHT	GMI_CHT	CHTRY_NAME	POP_CHTRY	CURR_TYPE	CURR_C	LANDLO	SQKM	SQMI	Shape	
393218	BF	BHS	The Bahamas	272209	Dollar	BSD	N	12163.91	4696.49	Polygon	
458752	CS	CRI	Costa Rica	3319438	Colon	CRC	N	51286.8	19801.83	Polygon	
458753	PM	PAN	Panama	2562045	Balboa	PAB	N	74445.89	28743.56	Polygon	
524288	BH	BLZ	Belize	207586	Dollar	BZD	N	22166.04	8558.31	Polygon	
524289	CJ	CYM	Cayman Is.	31777	Dollar	KYD	N	209.25	80.79	Polygon	
524290	CU	CUB	Cuba	11102280	Peso	CLP	N	109495.2	42276.1	Polygon	
524291	ES	SLV	El Salvador	5752470	Colon	SVC	N	20646.47	7971.6	Polygon	
524292	HO	HND	Honduras	5367067	Lempira	HNL	N	112618.31	43481.93	Polygon	
524293	NU	NIC	Nicaragua	4275103	Cordoba Oro	NIO	N	128594.63	49650.38	Polygon	
589824	AA	ABW	Aruba	67074	Euro	EUR	N	200.35	77.35	Polygon	
589825	DR	DOM	Dominican Republic	7759957	Peso Oro	DOP	N	48516.99	18732.41	Polygon	
589826	HA	HTI	Haiti	7044890	Gourde	HTG	N	27254.61	10523	Polygon	
589827	JM	JAM	Jamaica	2407607	Dollar	JMD	N	11072.63	4275.14	Polygon	
589828	NT	ANT	Netherlands Antilles	191572	Euro	EUR	N	791.72	305.68	Polygon	
589829	TK	TCA	Turks & Caicos Is.	14512	US Dollar	USD	N	299.61	115.68	Polygon	
655360	GY	GUY	Guyana	754931	Dollar	GYD	N	211507.8	81663.16	Polygon	
655361	TD	TTO	Trinidad & Tobago	1292000	Dollar	TTD	N	5030.55	1942.29	Polygon	
655362	VE	VEN	Venezuela	19857850	Bolivar	VEB	N	914737.19	353180.03	Polygon	
720896	AC	ATG	Antigua & Barbuda	65212	EC Dollar	XCD	N	538.66	207.98	Polygon	
720897	MH	MSR	Montserrat	12771	EC Dollar	XCD	N	112.95	43.61	Polygon	
786432	AV	AIA	Anguilla	9208	EC Dollar	XCD	N	91.57	35.36	Polygon	
786433	VI	VGB	British Virgin Is.	18194	US Dollar	USD	N	115.74	44.69	Polygon	
786434	RQ	PRI	Puerto Rico	3647931	US Dollar	USD	N	9176.41	3543.01	Polygon	
786435	SC	KNA	St. Kitts & Nevis	42908	EC Dollar	XCD	N	196.24	75.77	Polygon	

Record: 0 Show: All Selected Records (0 out of 250 Selected.) Options

Tabular data associated with each feature

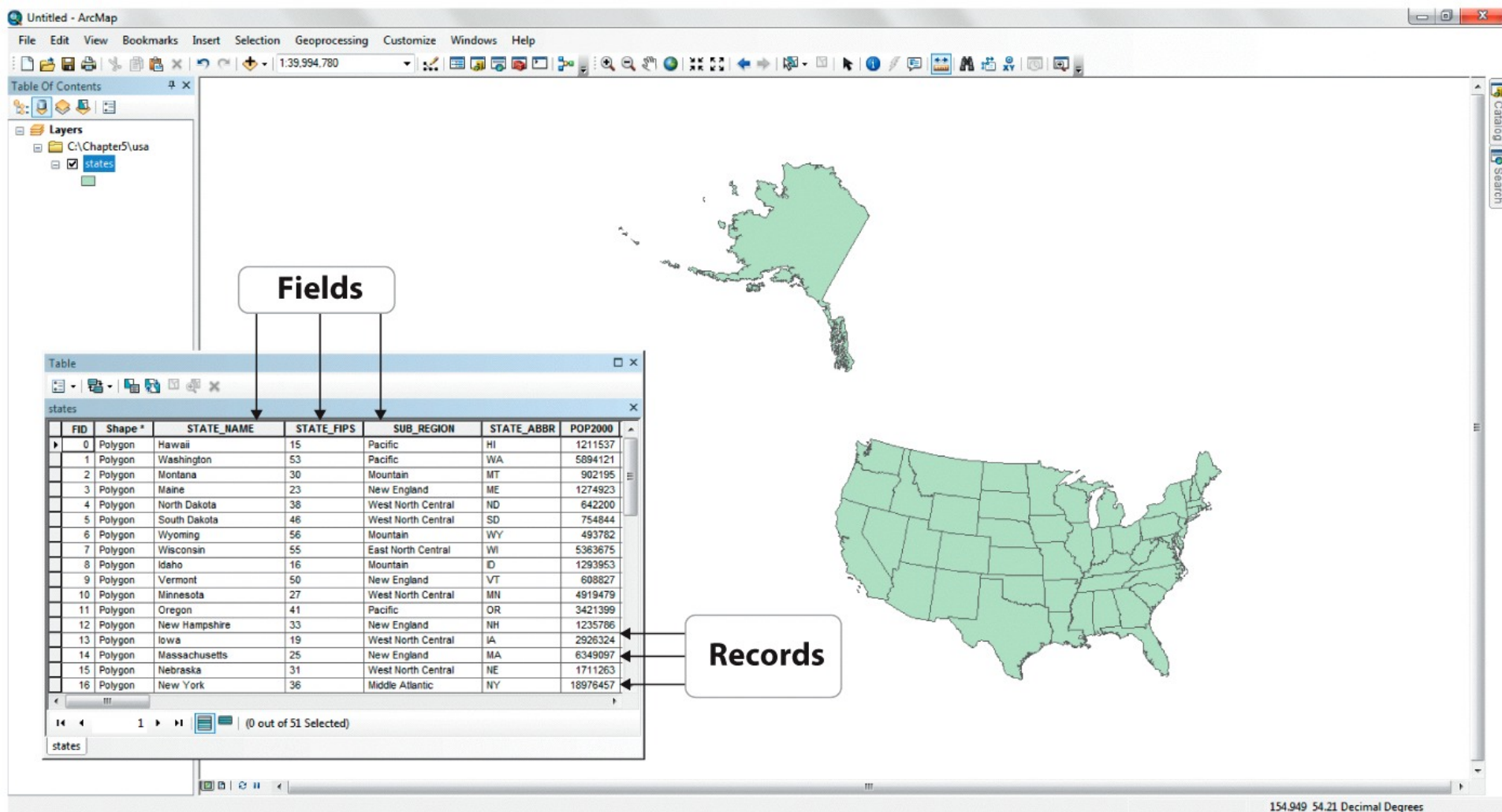


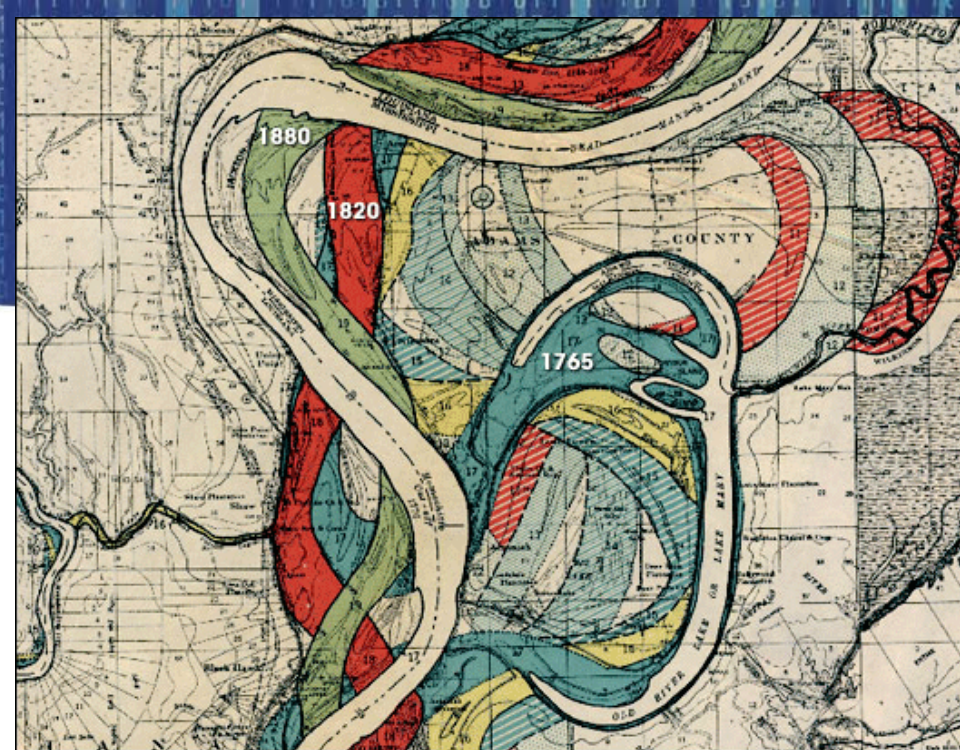
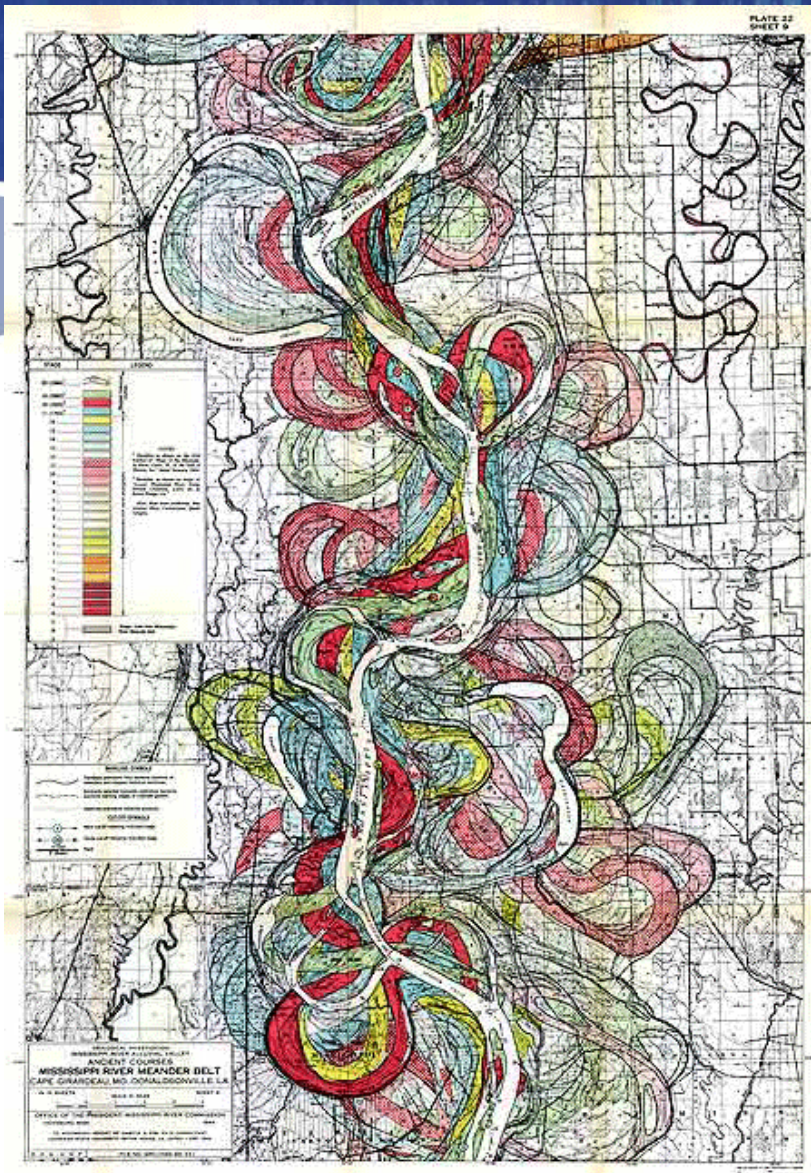
Figure 5.8
Introduction to Geospatial Technologies, Second Edition
 © 2014 W. H. Freeman and Company

Illustrating time

- Adds an additional dimension to the map
 - Makes it even harder to represent
- **Spatiotemporal Visualization:** Techniques for representing time on a map

Illustrating time on a map

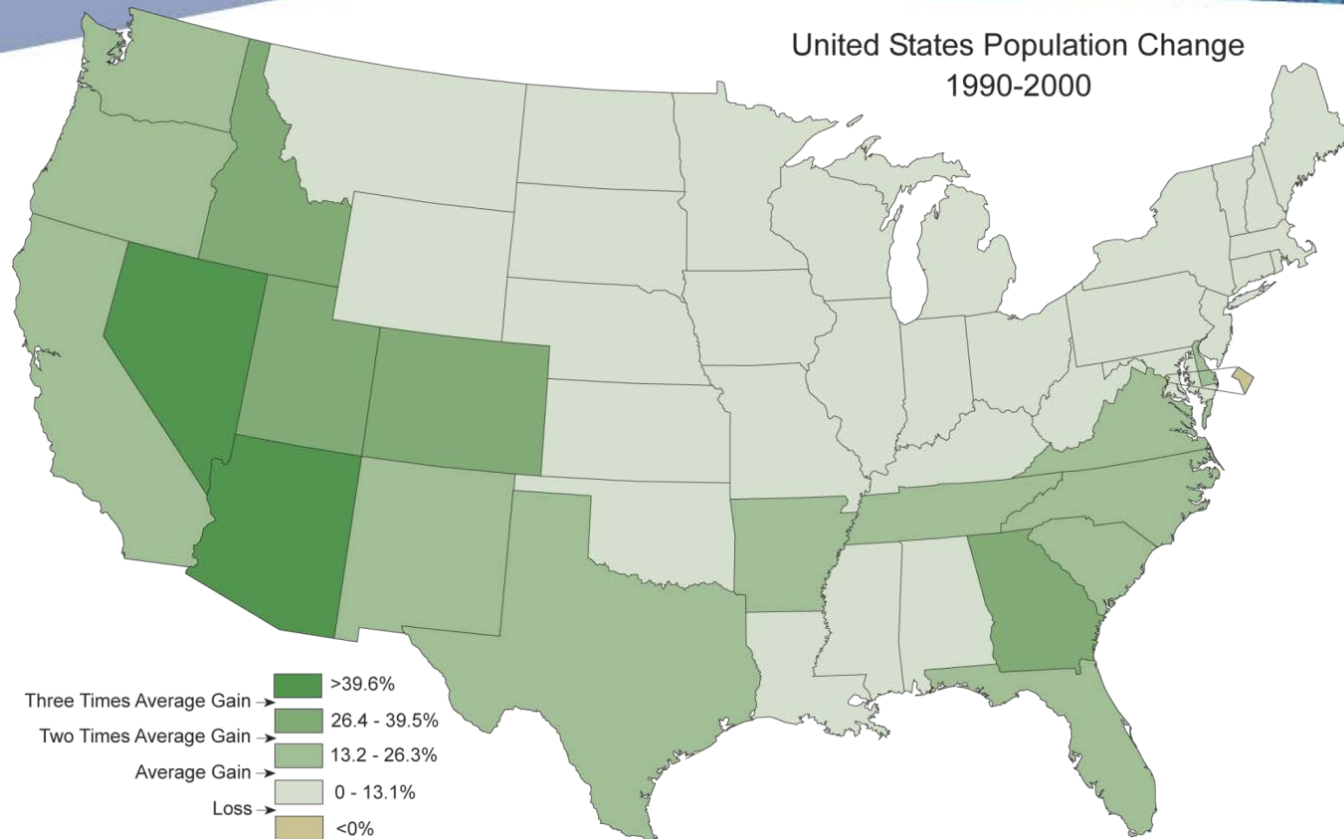
- **Single static map**
 - Specific graphic variables and symbols are used to indicate change or to represent an event. Figure 6.19(a) applies color tints to represent the age of the built-up areas;
- **Series of static maps**
 - A single map in the series represents a 'snapshot' in time. Together, the maps depict a process of change. Change is perceived by the succession of individual maps depicting the situation in successive snapshots. It could be said that the temporal sequence is represented by a spatial sequence, which the user has to follow, to perceive the temporal variation. The number of images is, however, limited since it is difficult for the human eye to follow long series of maps (Figure 6.19(b));
- **Animated map**
 - Change is perceived to happen in a single image by displaying several snapshots after each other just like a video cut with successive frames. The difference with the series of maps is that the variation is deduced not from a spatial sequence but from real 'change' in the image itself



Static Maps

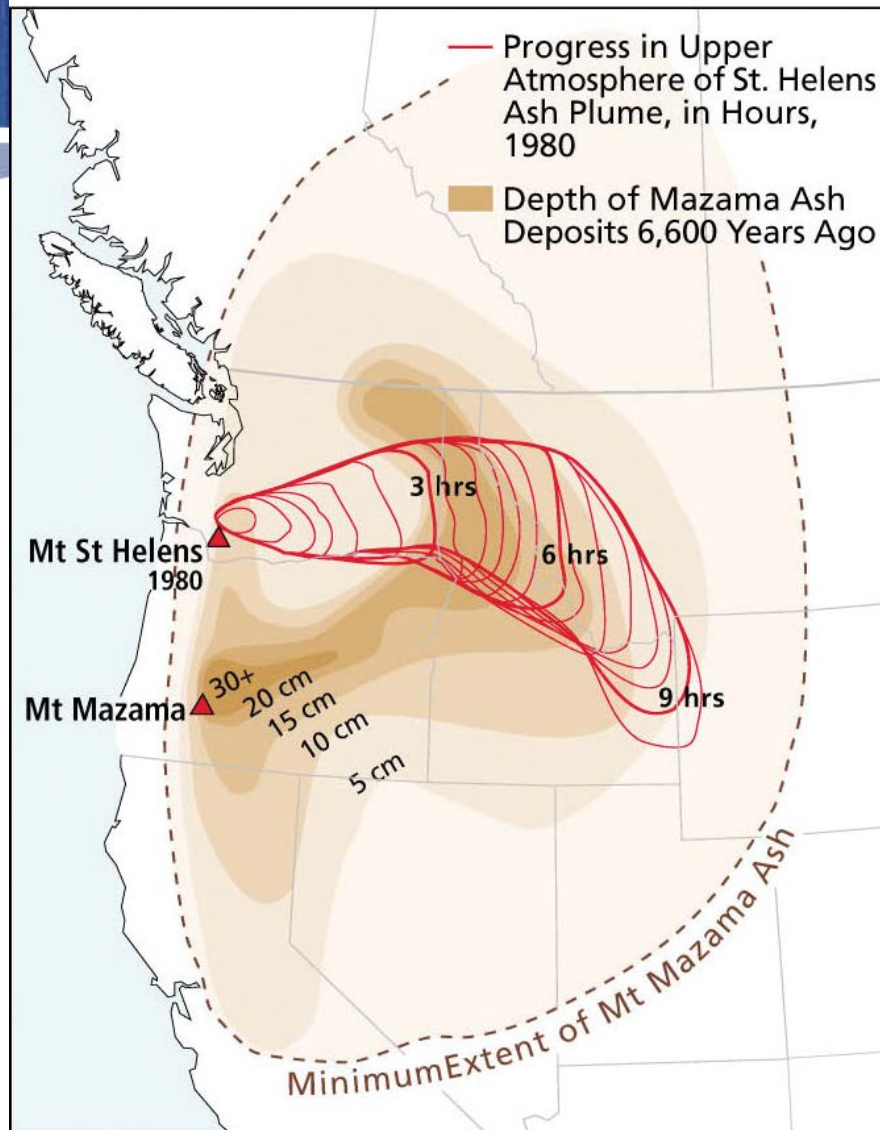
Ancient Courses of the Mississippi Meander Belt, US Army Corps of Engineers, 1944.

United States Population Change
1990-2000



Mount Mazama and Mount St. Helens Ash Fall

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Mean center of population for the US (shows westward expansion)

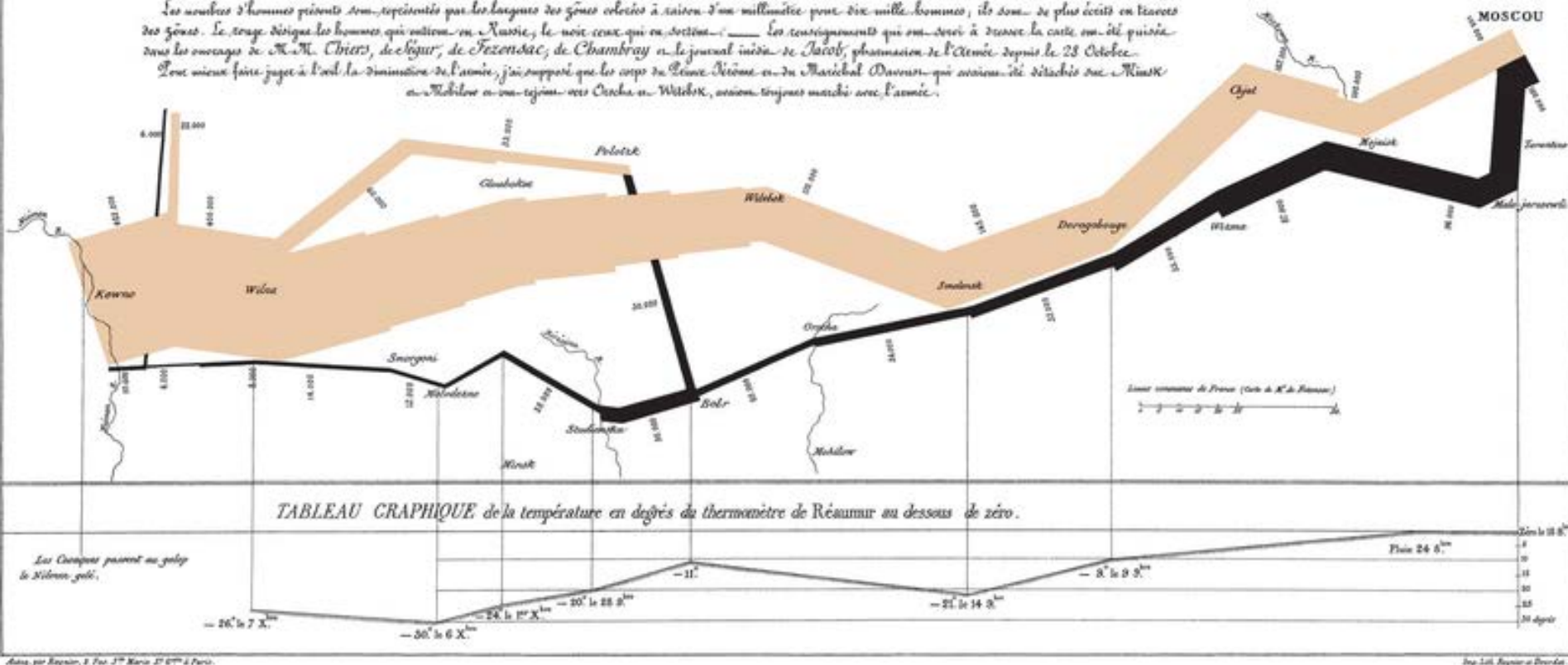
Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dessiné par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.

Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui ont péri en Russie, le noir ceux qui en sont revenus. Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Chézy, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 23 Octobre.

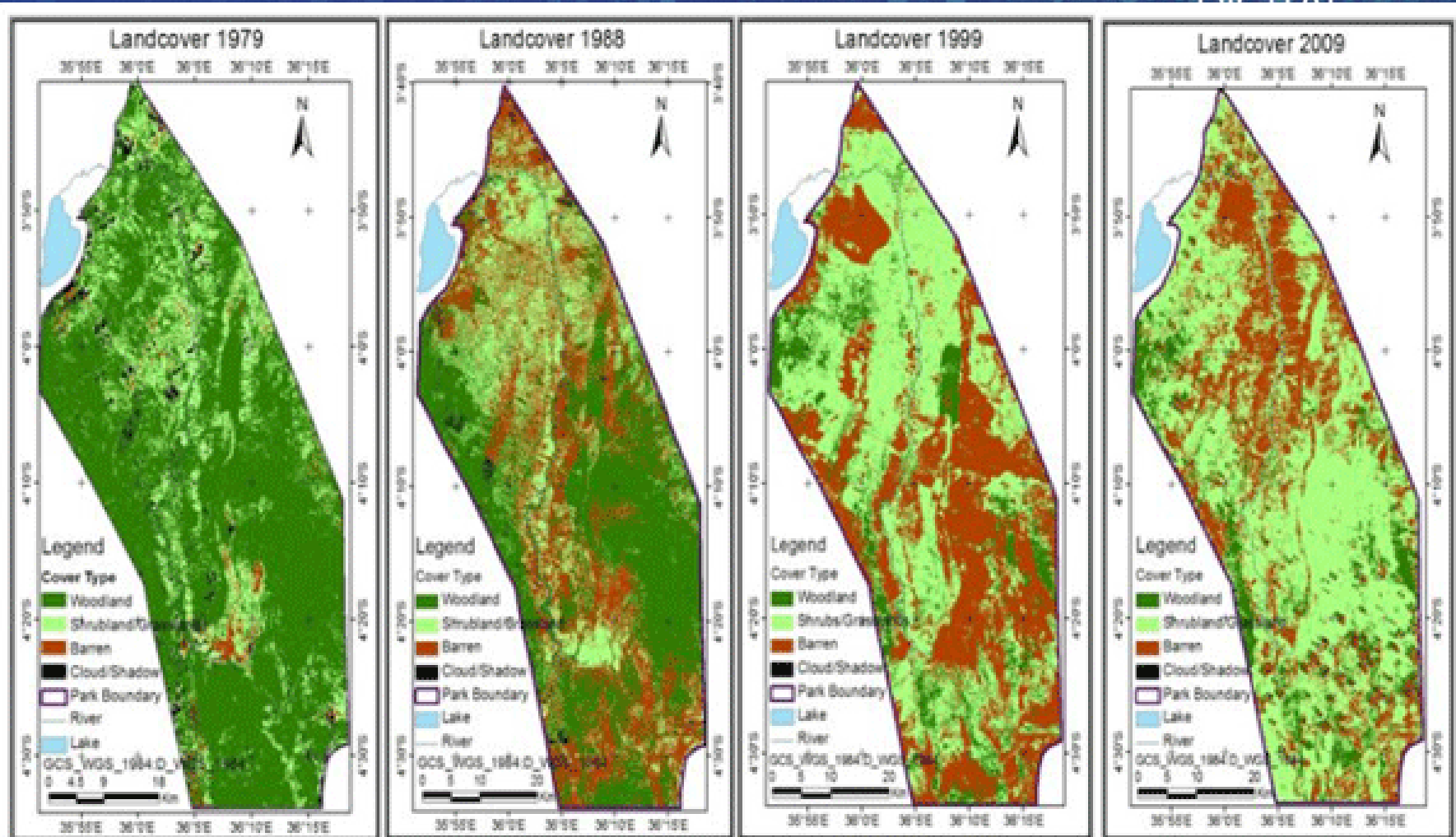
Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps de Cléve-Nicolas et du Maréchal Davoust qui avaient été détachés sur Minsk et Mielnik et qui rejoignent l'armée à Wilna, avaient toujours marché avec l'armée.



Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813 by Charles Minard, 1861

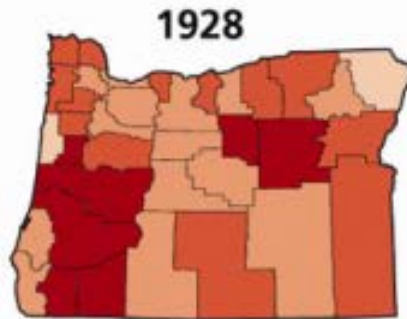
In 1861, Charles Joseph Minard, a French engineer created a flow map that graphed out the ill-fated march of 1812 by Napoleon's soldiers to and from Moscow during the brutal winter months. Shows the horrific morbidity of Napoleon's soldiers over time and space as they marched to Russia and then back to Poland.

The area (pink and black) is scaled to the size of the army



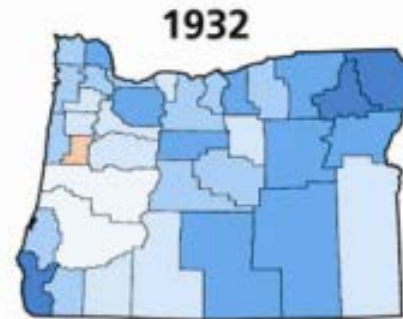
Time Series Maps

Presidential Elections 1928–2000



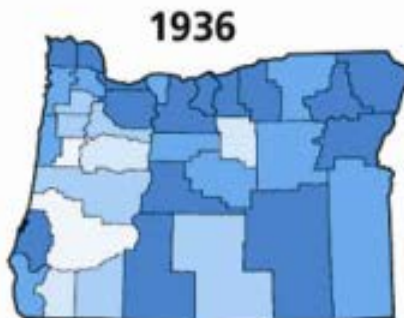
Oregon
Hoover _____ 64%
Smith _____ 34%

U.S.
Hoover _____ 59%
Smith _____ 41%



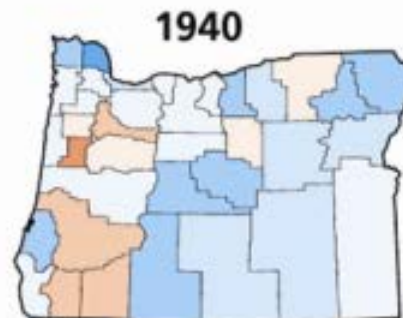
Oregon
Roosevelt _____ 58%
Hoover _____ 37%
Thomas _____ 4%

U.S.
Roosevelt _____ 58%
Hoover _____ 40%
Thomas _____ 2%



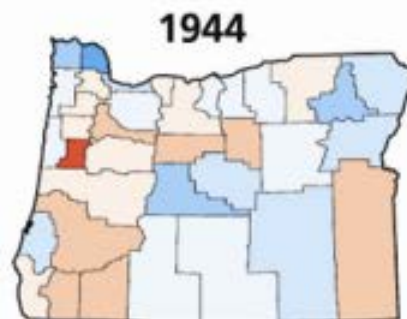
Oregon
Roosevelt _____ 63%
Landon _____ 29%
Lemke _____ 5%

U.S.
Roosevelt _____ 61%
Landon _____ 37%
Lemke _____ 2%



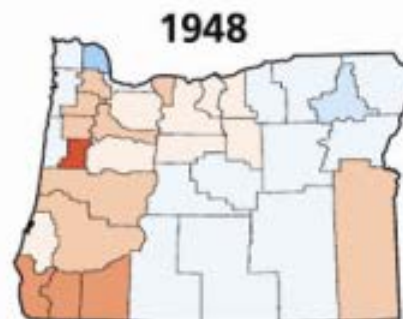
Oregon
Roosevelt _____ 53%
Wilkie _____ 45%

U.S.
Roosevelt _____ 55%
Wilkie _____ 46%



Oregon
Roosevelt _____ 51%
Dewey _____ 46%

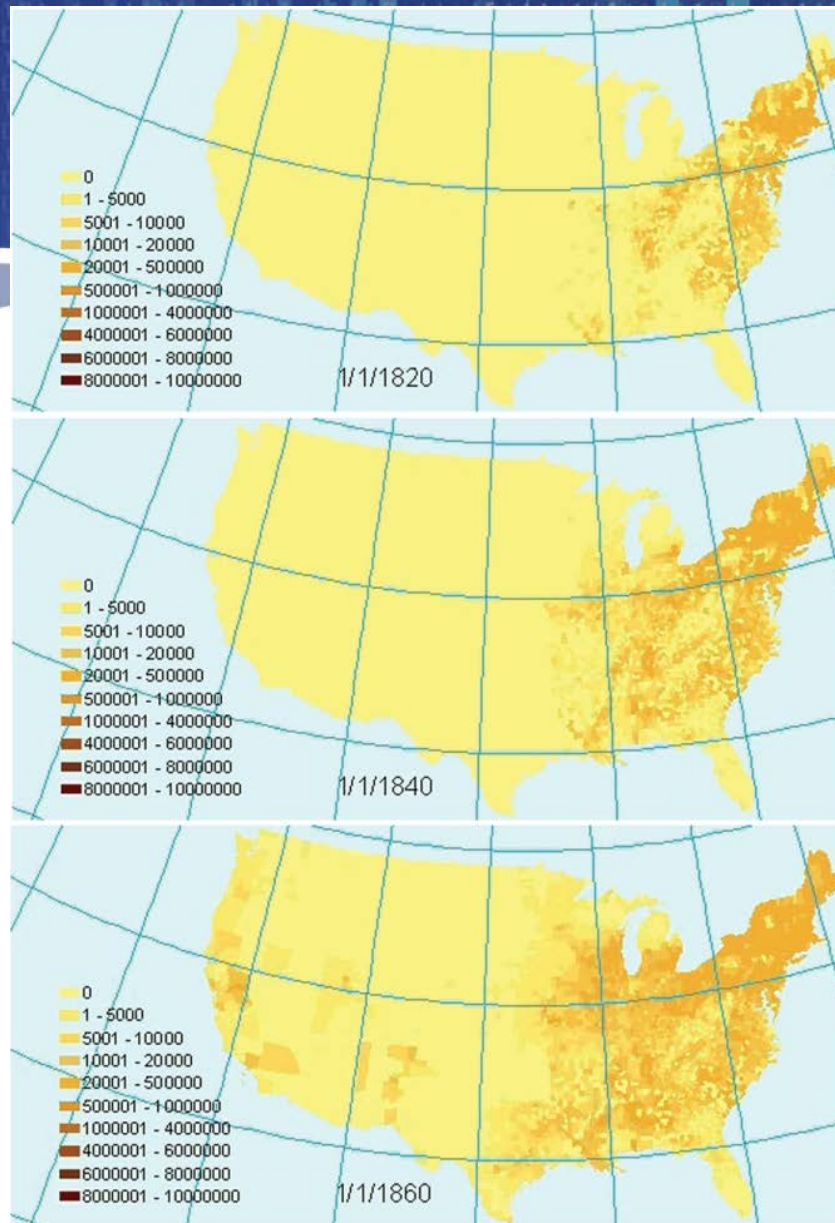
U.S.
Roosevelt _____ 54%
Dewey _____ 46%



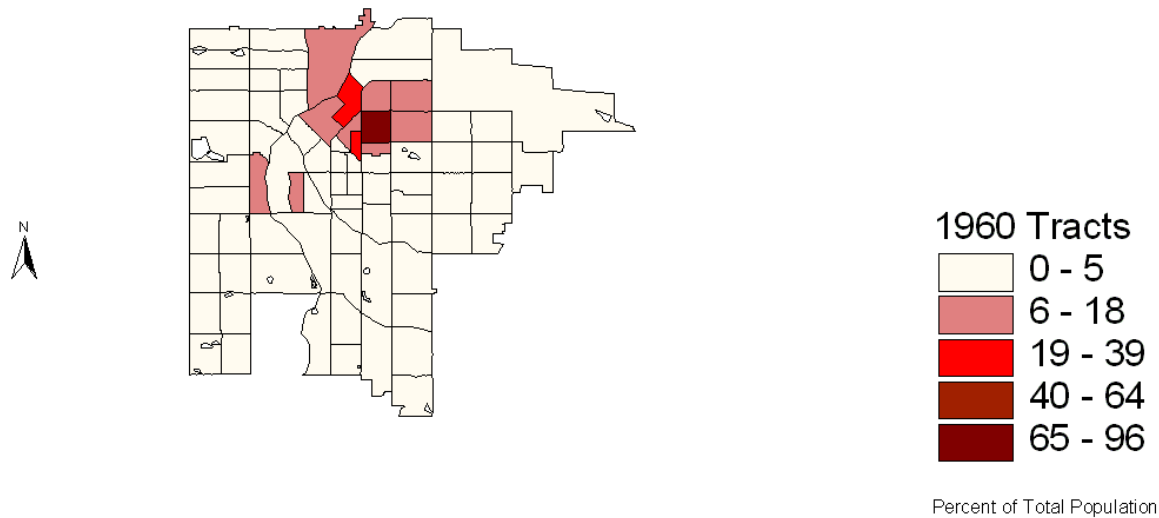
Oregon
Truman _____ 46%
Dewey _____ 49%
Wallace _____ 3%

U.S.
Truman _____ 50%
Dewey _____ 45%
Thurmond _____ 2%
Wallace _____ 2%

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Change in African-American Population
1960 - 2000
Denver, Colorado



Animated Maps

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1910



Time in ArcGIS

- Vector: Time tools
 - Need to have repeated features
 - Not repeated fields
- Raster: NetCDF Tools
 - Each time is a different layer
 - Hard to process in ArcGIS
 - Other GIS packages are better
- For both types of data, can create animations or query particular times

- Atlas of Historic County Boundaries
 - <http://publications.newberry.org/ahcbp/>
- National Historic Geographic Information System
 - <https://www.nhgis.org/>
- NOAA's Gridded Climate Datasets
 - <http://www.esrl.noaa.gov/psd/data/gridded/>

GIS resources in the library

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- Center for Digital Scholarship
 - Bank of 8 computers with extensive GIS software
 - ESRI ArcGIS
 - DIVA-GIS
 - GRASS
 - Quantum GIS
 - Google Earth Professional
 - 42" sheet-feed map scanner
 - 8 baseline GPS units and 2 high-end data collectors

GIS resources in the library

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- Staff
 - **Matthew Sisk (CDS)**: General GIS questions, Data acquisition and management, Satellite imagery analysis
 - **Milan Budhathoki (CRC)**: Industry GIS, Vector analysis, GIS Analysis