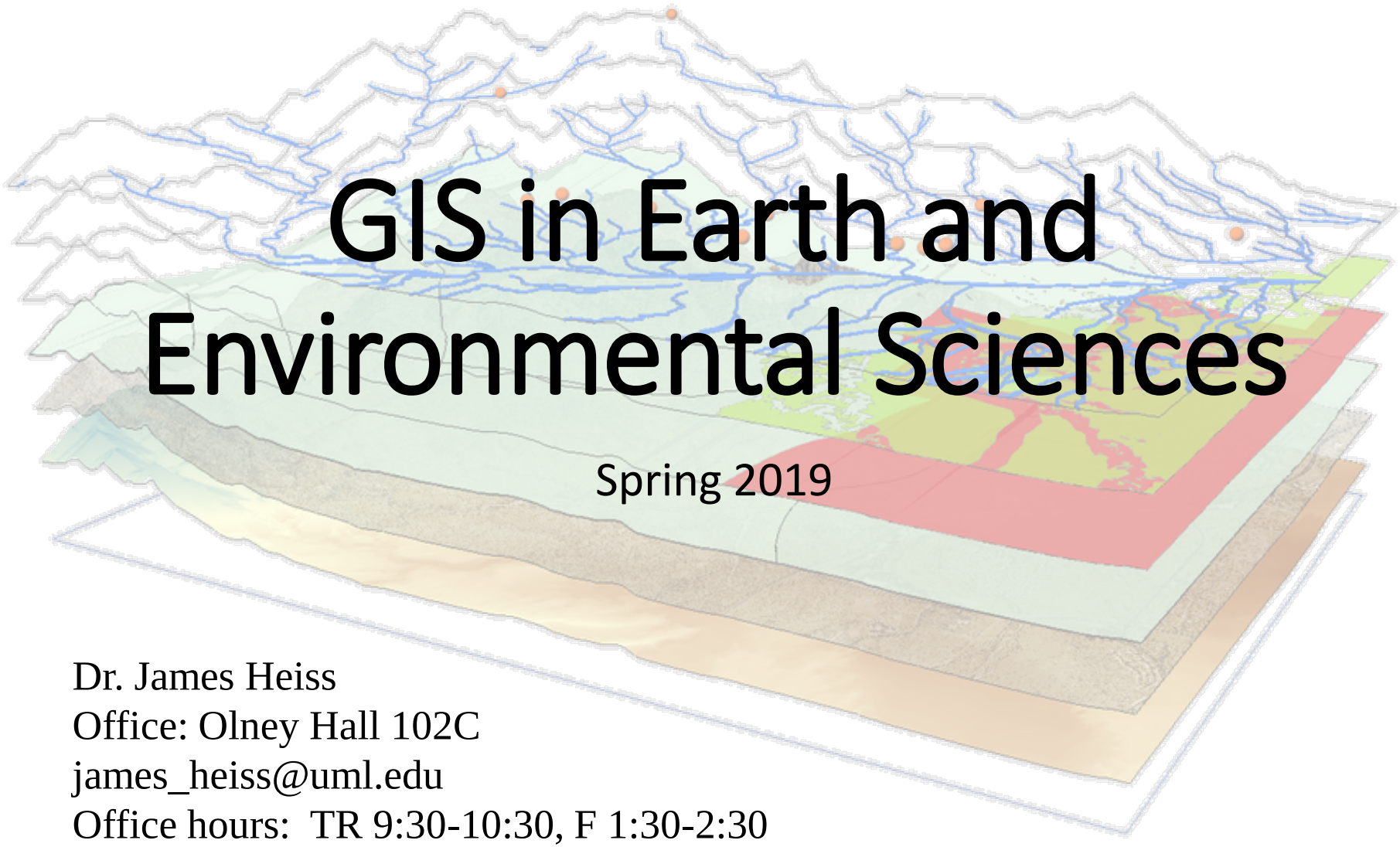


GIS in Earth and Environmental Sciences

Spring 2019

Dr. James Heiss
Office: Olney Hall 102C
james_heiss@uml.edu
Office hours: TR 9:30-10:30, F 1:30-2:30

Photo source: University of Arizona

Syllabus

Course Objective

The objective of this course is to provide a theoretical and practical introduction to Geographic Information Systems (GIS). The ESRI's ArcGIS will be used extensively during class and for laboratory assignments. The course emphasizes practical application and laboratory exercises and is heavily hands-on.

Textbook and Flash Drive

Price, Maribeth, 2014, Mastering ArcGIS, 8th Edition.

You will need a personal flash drive >8gb. All data files for in-class assignments, labs, and tutorials will be stored on this flash drive. No data files, assignments, or lab reports can be stored on lab PCs.

Learning Outcomes

- After successful completion of this course you will be able to:
- Explain and demonstrate proficiency of major concepts/skills of GIS, spatial data, attribute data, data structures, coordinate systems, data projection, spatial analysis, vector and raster datasets, metadata, and several analytical GIS tools
- Navigate within the ArcGIS software environment and perform introductory-level analytical skills such as joining data, creating buffers, digitizing, georeferencing, and conducting geospatial queries, performing raster and terrain analysis
- Distinguish between spatial and attribute data
- Differentiate vector and raster data and how the data type affects storage, display, and analysis
- Collect, process, and analyze geospatial data
- Discuss the strengths and weaknesses of GIS for spatial analysis

Syllabus

Course Requirements

Class Participation

Students are expected to be in class for lectures and in-class exercises. The best way to lean GIS software is to work with it and to work with others on GIS objectives, both of which are done in class.

In-class exercises:

GIS is complex and learning by doing is the most effective learning strategy. These assignments are intended to demonstrate or reinforce concepts or skills that can be applied in laboratory assignments. In-class exercises are due at the end of the class period. Any student not present in class that misses an in-class exercise will receive a grade of zero for that assignment.

Lab assignments:

Lab assignments will involve working within ArcGIS and will be completed outside of class. The deliverable includes maps, tables, and text presented as a report (see lab rubric). Labs are due on the assigned date (see class schedule).

Exams:

Two exams are scheduled that will cover topics and skills learned in class and will include a hands-on component. Attendance is mandatory for all exams. Any discussion about missing an exam must occur prior to the exam.

Final project

Students will complete and report on a final GIS project of their choosing. This will involve 1) developing an objective and a set of research questions that can be answered using GIS, 2) seeking and identifying the geospatial data to answer that question, 3) selecting the appropriate GIS methods, 4) analyzing and interpretation of results, and 5) presenting the project to the class.

Grading

In-class exercises	20%
Labs	40%
Exams	30%
Final project	10%
Total:	100%

Percentage	Letter Grade
>92	A
90 – 92	A-
88 – 89	B+
83 – 87	B
80 – 82	B-
78 - 79	C+
73 – 77	C
70 - 72	C-
68 – 69	D+
60 – 67	D
<60	F

Email

Any email that you send to me must have ENVI3010S19 at the beginning of the subject line. Any email that you receive from me will have ENVI3010S19 in the subject line.

Course Topics

Geospatial data
Data management
Spatial reference systems
Geodesy
map projections
Interpolation
Stream flow direction
Stream flow accumulation

Analytic toolboxes
Cartographic design
Vector analysis
Raster analysis
Raw data collection
Georeferencing

Course website

jamesheiss.com/ENVI3010S19.html

What is GIS?

Geographic Information System

- Computer tools that allow analysis of data tied to location
- Database that is designed to work with map data
- GIS involves:
  - Data entry
  - Data management
  - Thematic mapping
  - Data analysis
  - Map layout
- GIS NOT mapping software

What can GIS do?

- US Dept. of Agriculture
- Elk Habitat in Black Hills, WY
- GPS tagging and tracking
  - Location, date, time
- Tie Elk location data to other spatial datasets
- GIS explains <u>why</u>

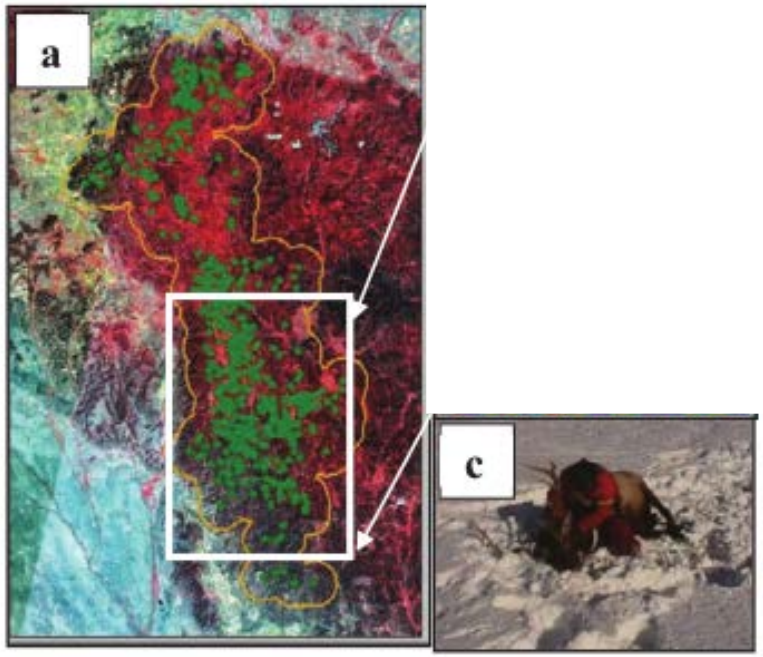
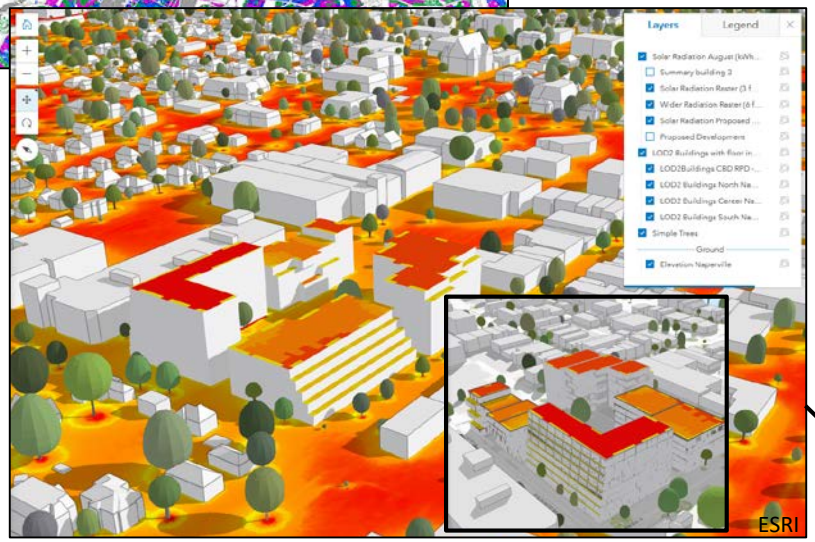


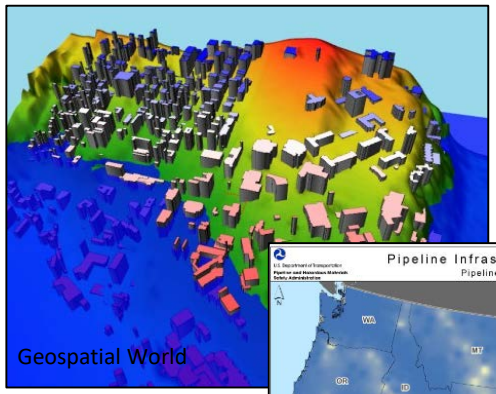
Fig. I.1. Analyzing elk habitat use: (a) elk locations and study area; (b) locations on a map of distance to nearest road; (c) collaring an elk

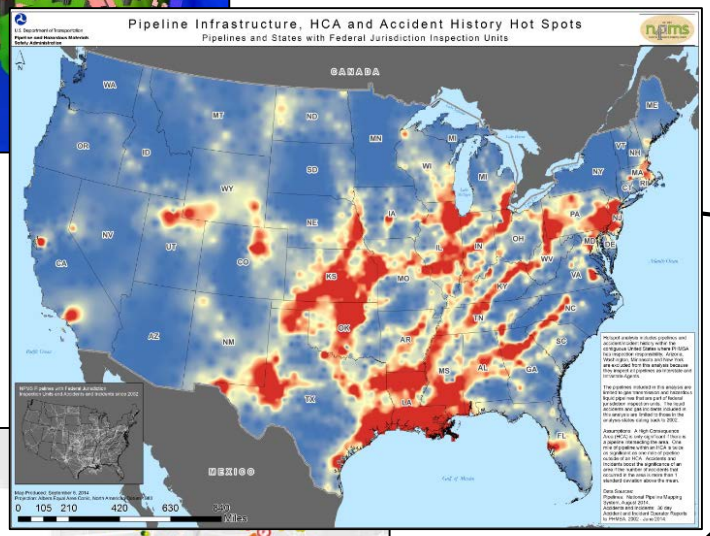
GIS applications

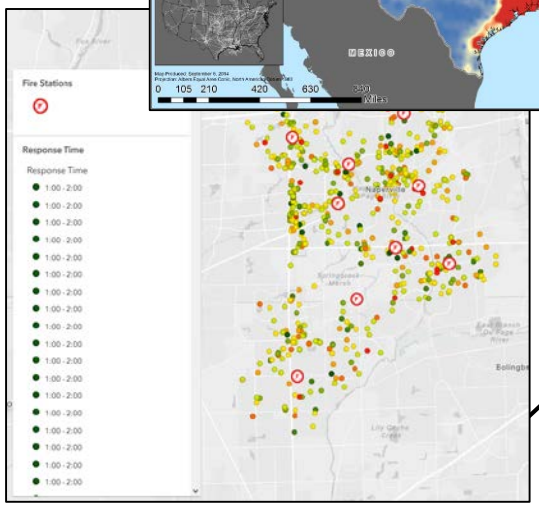


- Geoscience
- Government
- Defense and intelligence
- Engineering and construction
- Business
- Health and human services
- Conservation
- Natural resources
- Aviation

GIS applications







ESRI

- Real Estate
- Education
- Transportation
- Utilities
- Telecommunication
- Public safety
- Marketing
- Insurance

CNN Money Companies Markets Tech

BEST JOBS IN AMERICA

Money/Payscale.

Full List | High Pay | Job Growth | Quality of

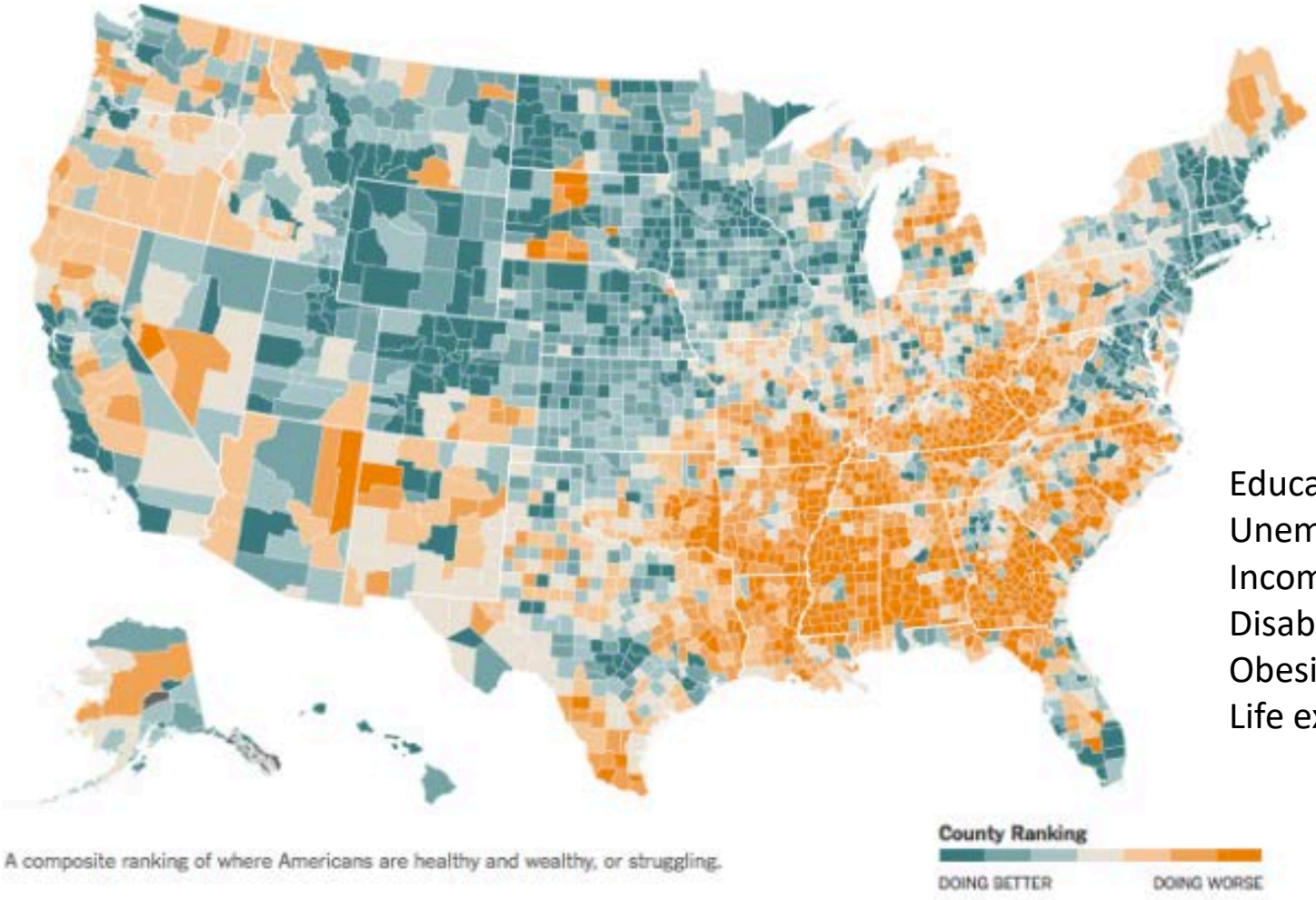
Low stress | Security | Flexibility | Future growth | Satisfaction | Benefit to

Low stress

Rank	Job title	Best Jobs rank	% who say their job is low stress
1	Biomedical Engineer	10	**70.0**
2	Transportation Engineer	51	**69.0**
3	Statistician	64	**64.0**
4	Web Developer	67	**57.7**
5	Geographic Information Systems Analyst	97	**55.6**
6	Technical Writer	88	**54.9**
7	Test Software Development Engineer	30	**54.2**
8	Marketing Consultant	61	**53.5**
9	Civil Engineer	6	**53.3**
10	Optometrist	56	**53.1**

Where Are the Hardest Places to Live in the U.S.?

JUNE 26, 2014



A composite ranking of where Americans are healthy and wealthy, or struggling.

Education
Unemployment
Income
Disability rate
Obesity
Life expectancy

Source: New York Times

Flood analysis

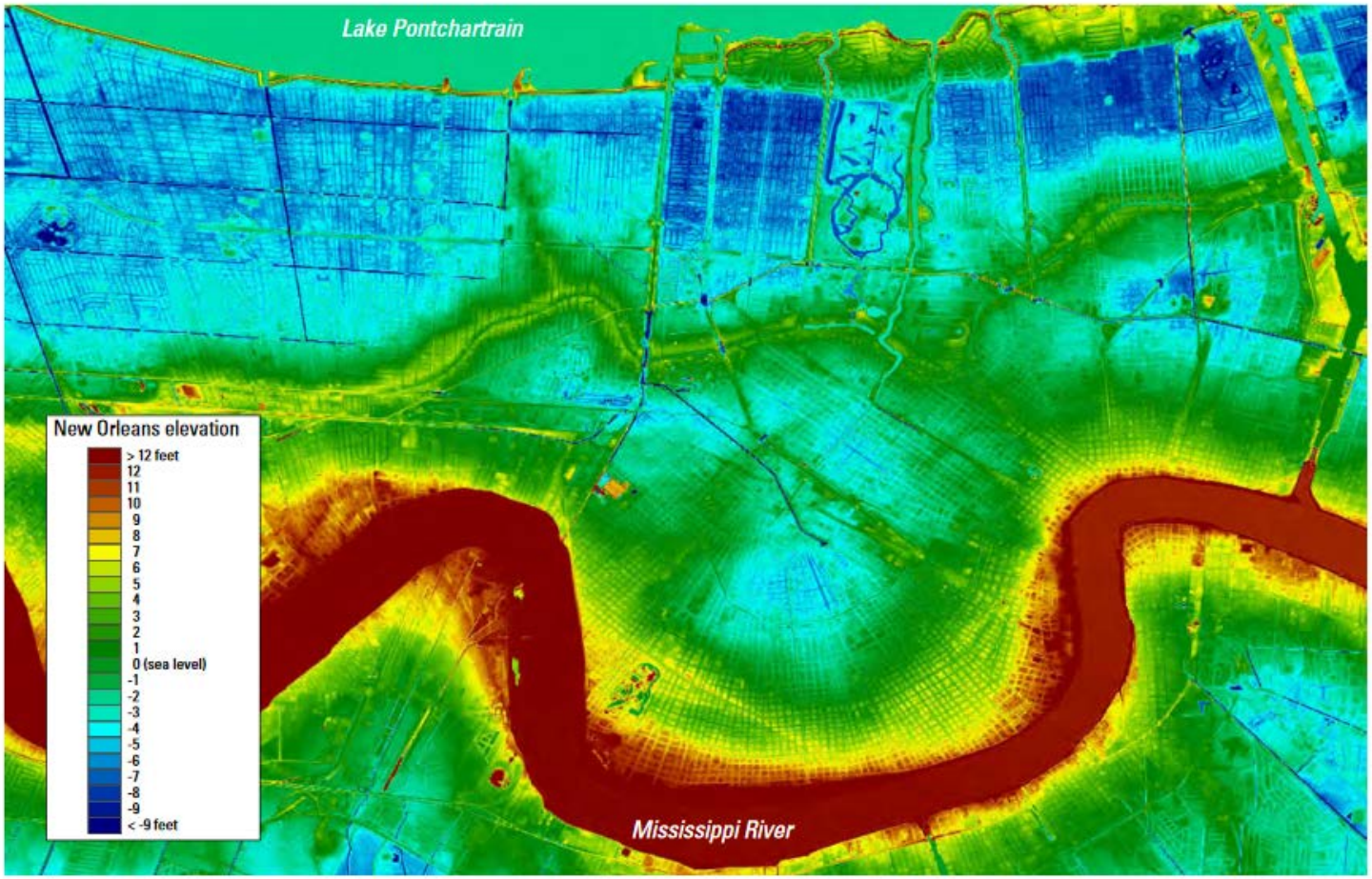
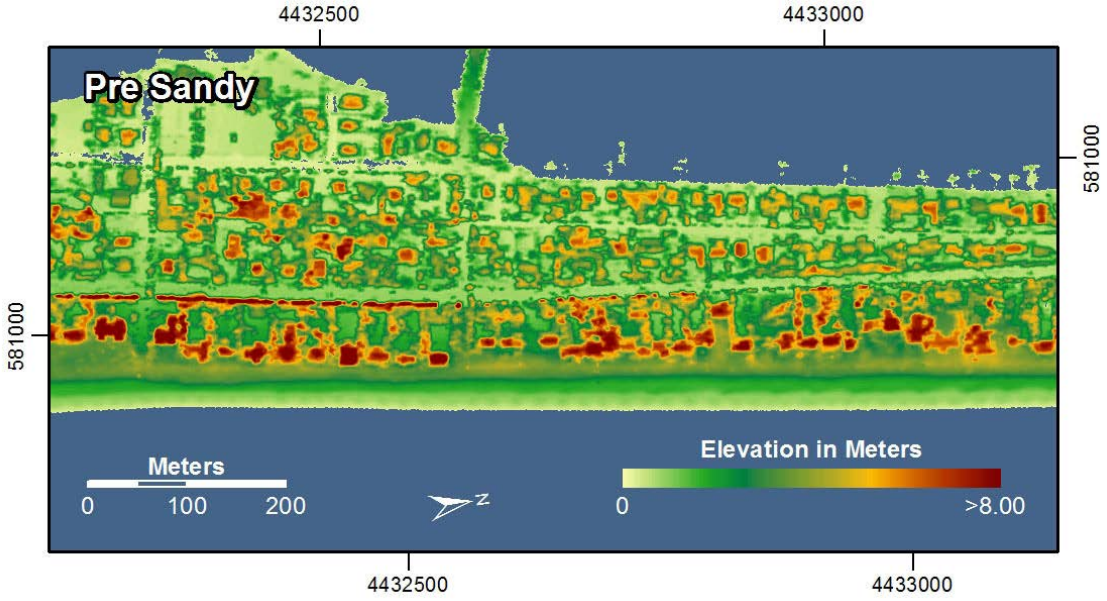
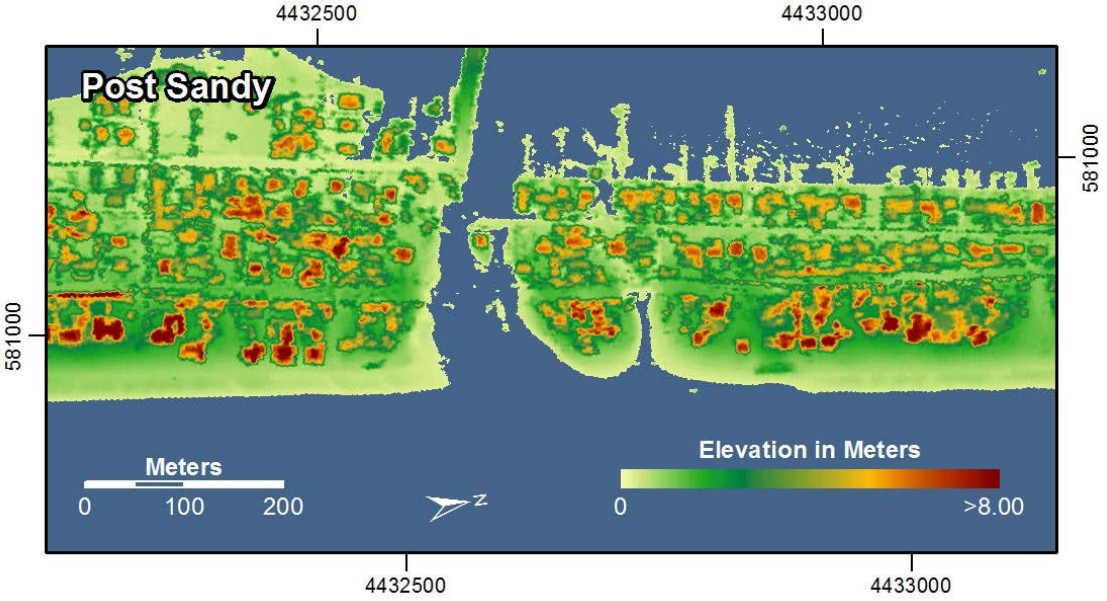


Figure 1. High-resolution elevation data of New Orleans, La., derived from light detection and ranging (lidar) data collected in 2002. Note that the land along Lake Pontchartrain and the Mississippi River is higher than the land in the center of the city, which is below sea level, resulting in what is often referred to as the bowl shape of New Orleans. Also note that on this map the level of Lake Pontchartrain has been set to a constant value. In reality, the level of the lake changes. In many cases, lidar measurements over water are inaccurate; therefore, elevation of the water surface is inferred from surrounding areas or other data sources.

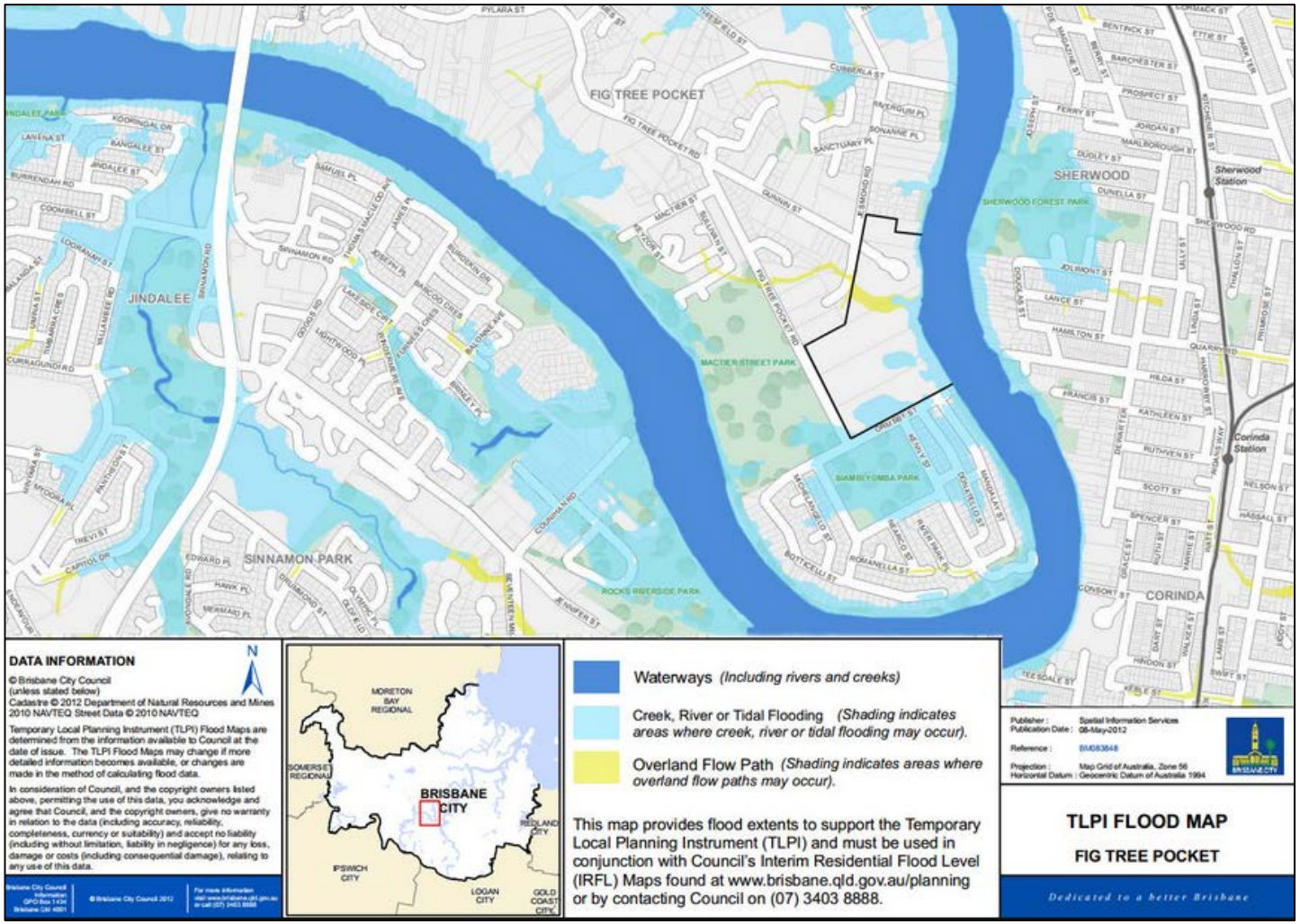




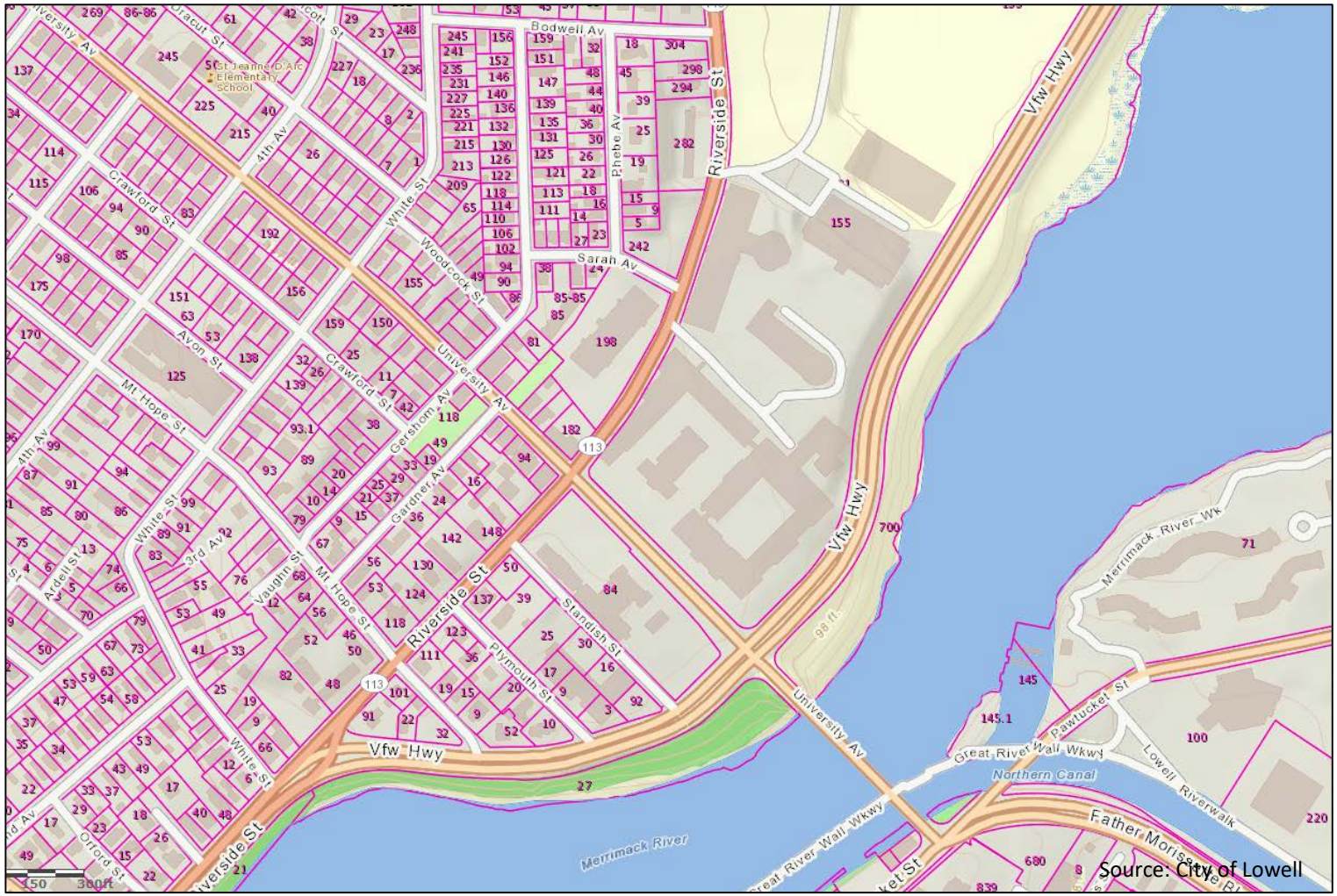
Pre- and post-storm terrain analysis

Photo source: Penn state

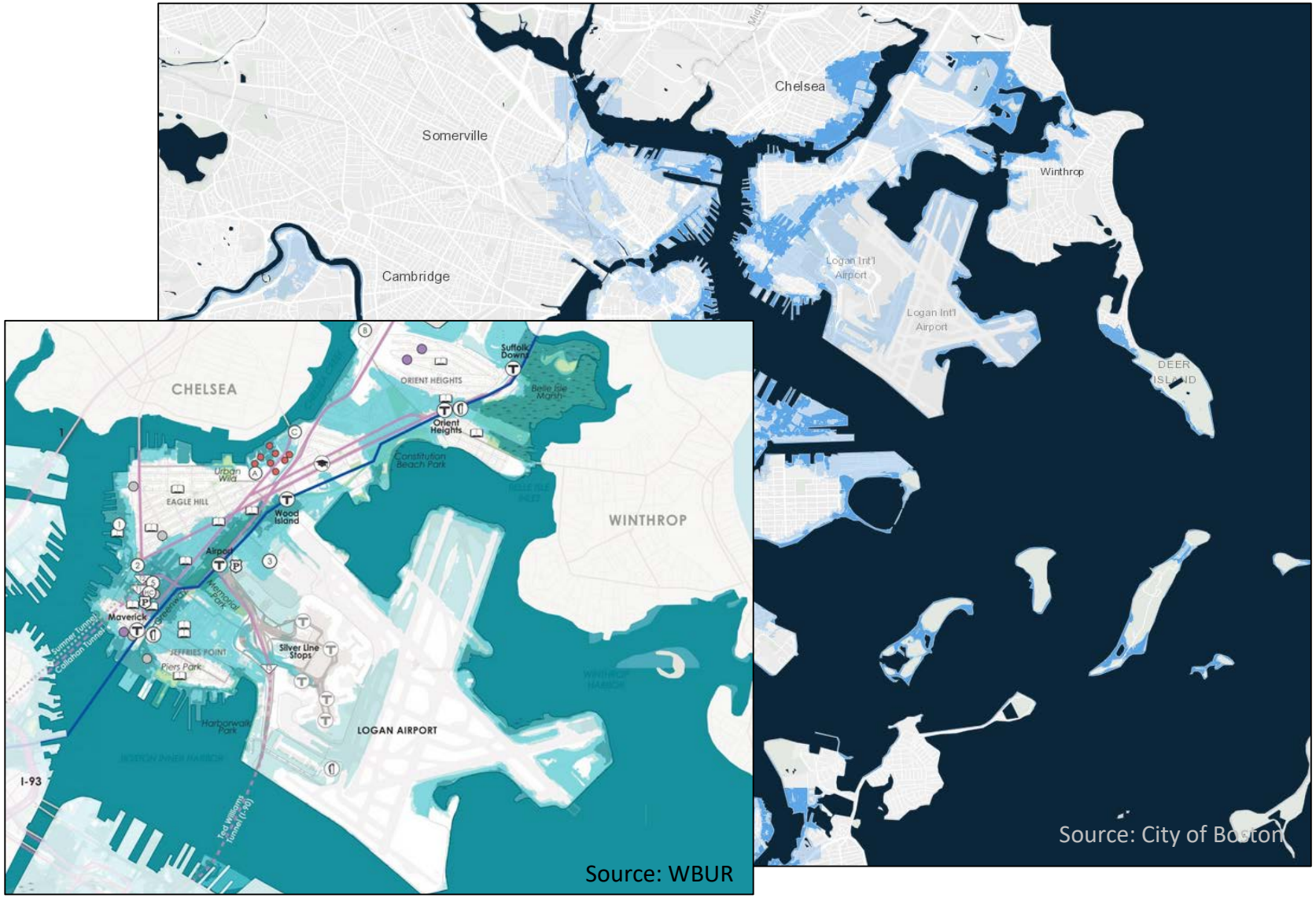
Sea level rise and storm surge analysis



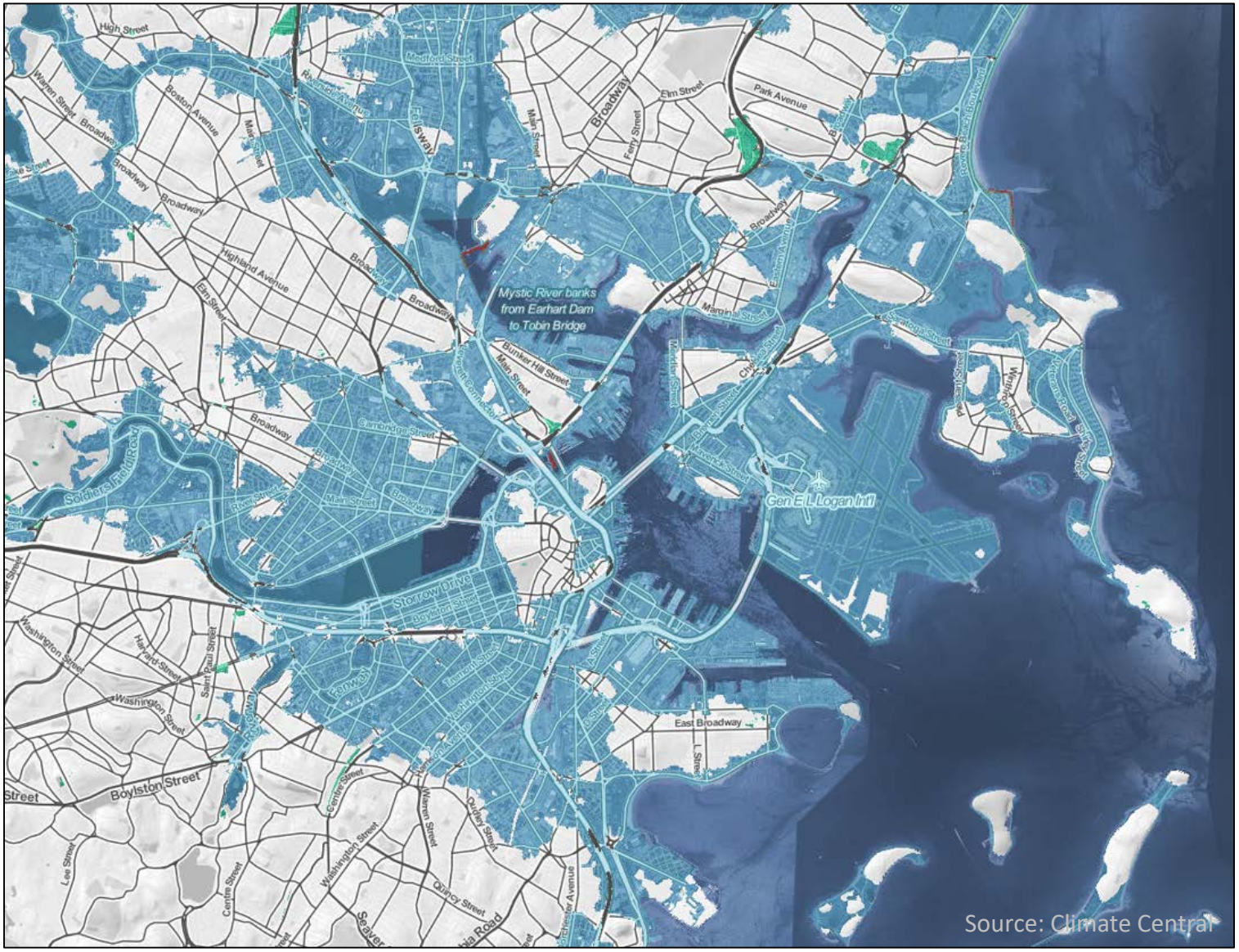
Demographics and land parcels

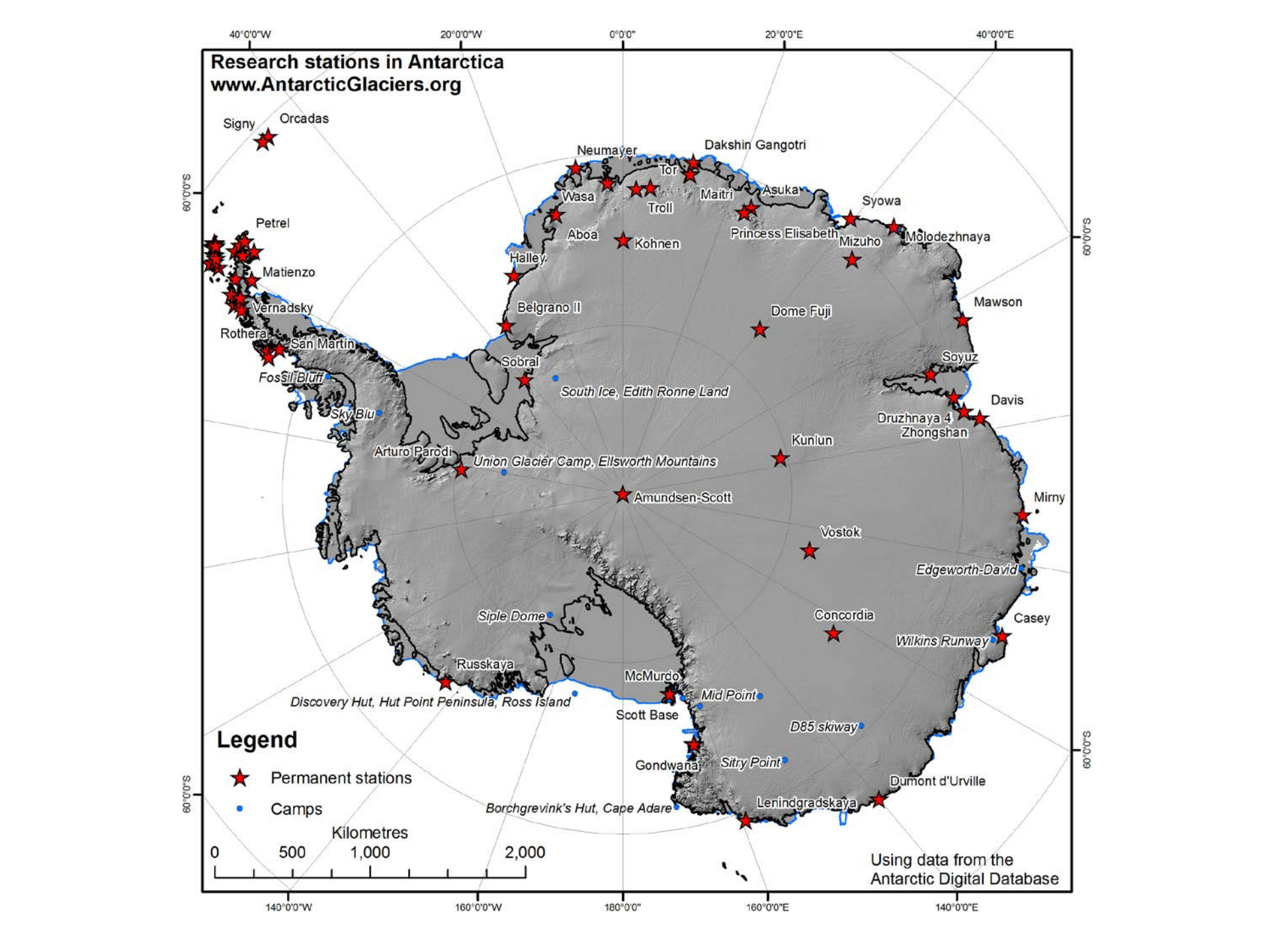


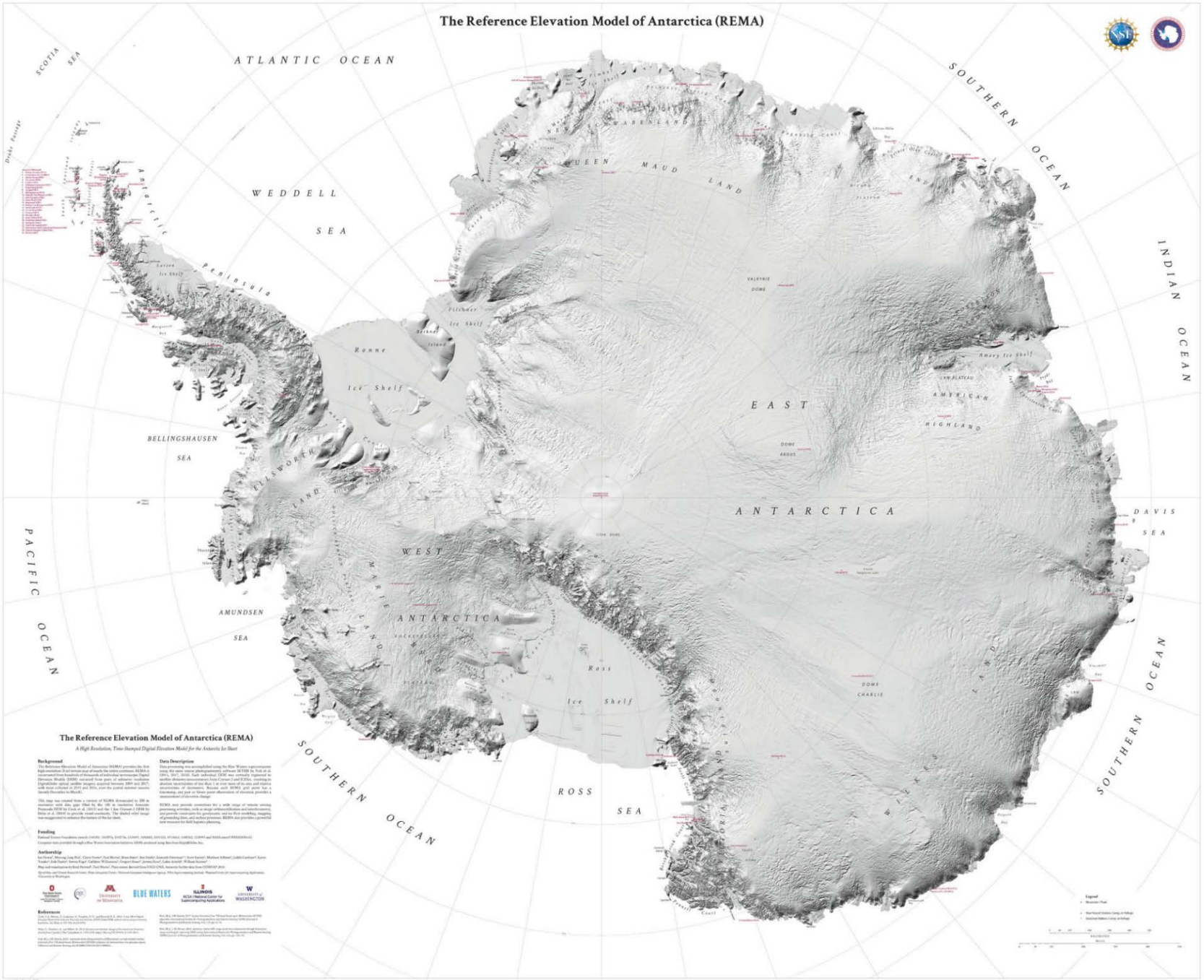
Sea level rise and storm surge analysis



Sea level rise and storm surge analysis

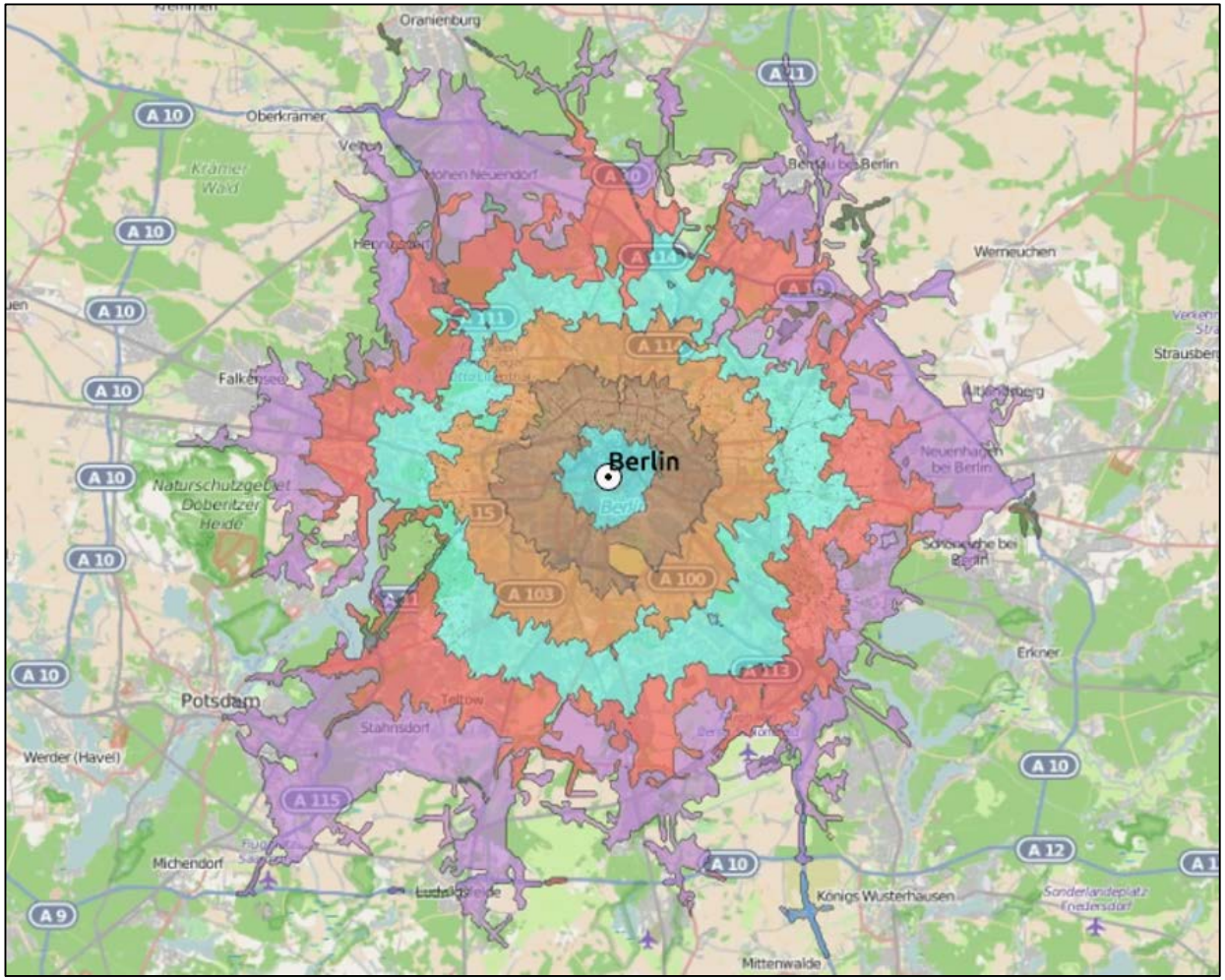


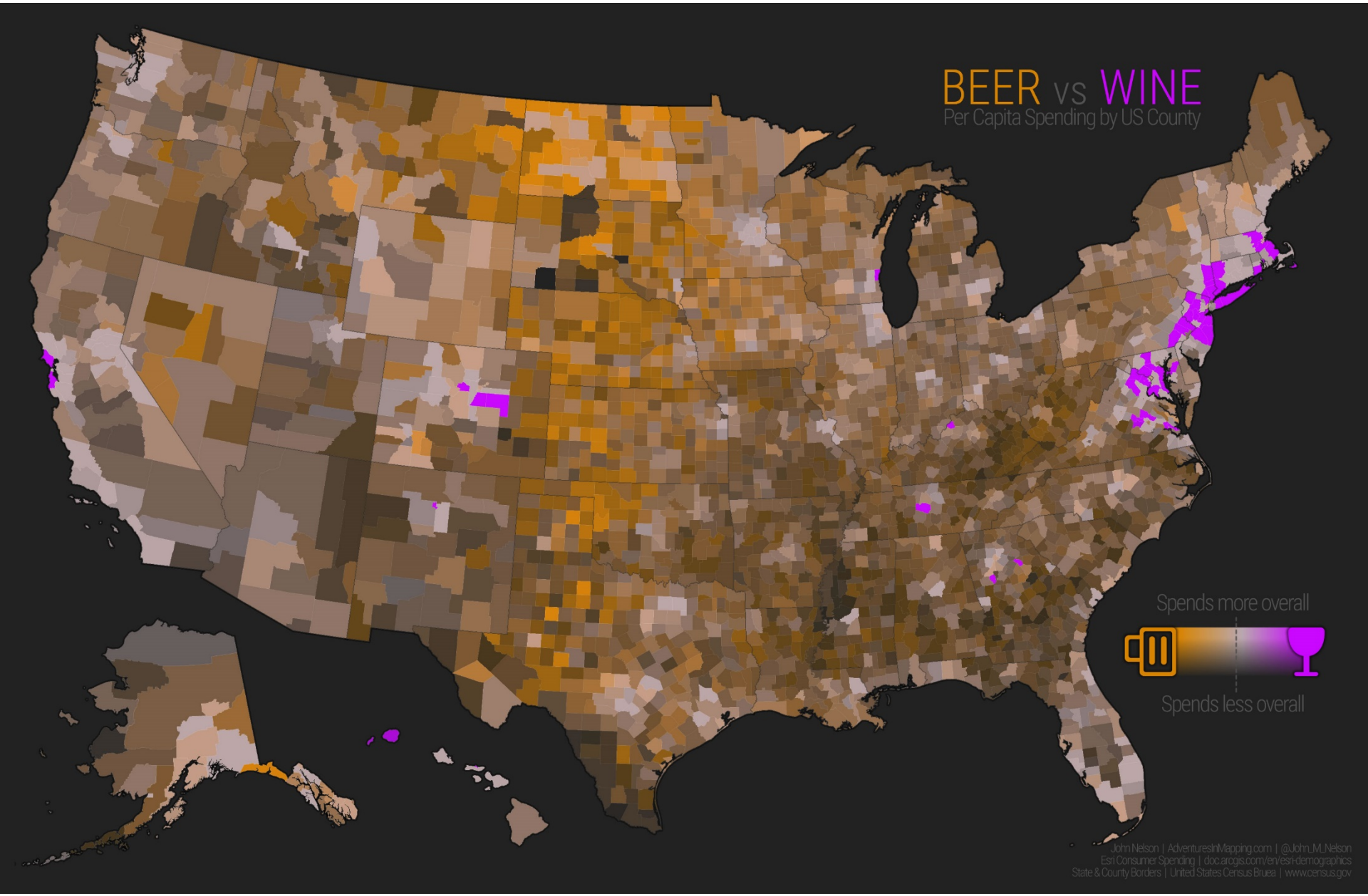

Research stations in Antarctica
www.AntarcticGlaciers.org
40°0'0"W
20°0'0"W
0°0'0"
20°0'0"E
40°0'0"E
60°0'0"S
Signy
Orcadas
Neumayer
Dakshin Gangotri
Tor
Wasa
Troll
Maitri
Asuka
Syowa
Petrel
Aboa
Kohnen
Princess Elisabeth
Mizuho
Molodezhnaya
Halley
Matienzo
Belgrano II
Dome Fuji
Mawson
Vernadsky
Rothera
San Martin
Sobral
Soyuz
Fossil Bluff
South Ice, Edith Ronne Land
Davis
Sky Blu
Druzhnaya 4
Zhongshan
Kunlun
Arturo Parodi
Union Glacier Camp, Ellsworth Mountains
Amundsen-Scott
Mirny
Vostok
Edgeworth-David
Siple Dome
Concordia
Casey
Wilkins Runway
Russkaya
McMurdo
Mid Point
Discovery Hut, Hut Point Peninsula, Ross Island
Scott Base
D85 skiway
Gondwana
Sitry Point
Dumont d'Urville
Lenindgradskaya
Borchgrevink's Hut, Cape Adare
Legend
Permanent stations
Camps
Kilometres
0
500
1,000
2,000
Using data from the
Antarctic Digital Database
140°0'0"W
160°0'0"W
180°0'0"
160°0'0"E
140°0'0"E

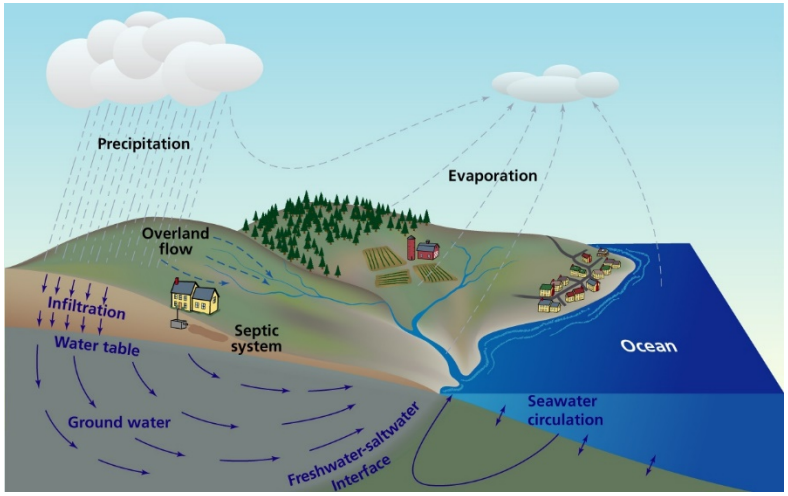


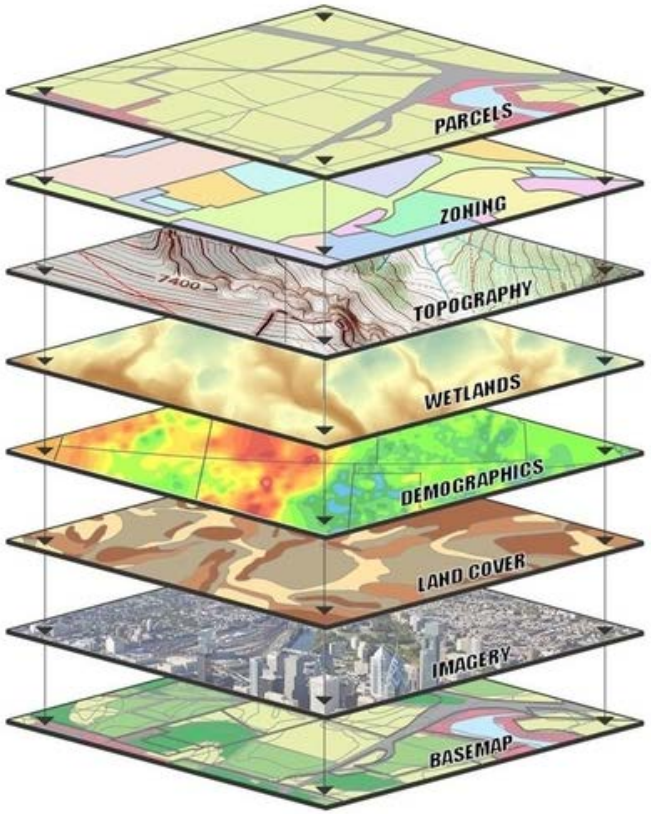
Source: National Geospatial-Intelligence Agency

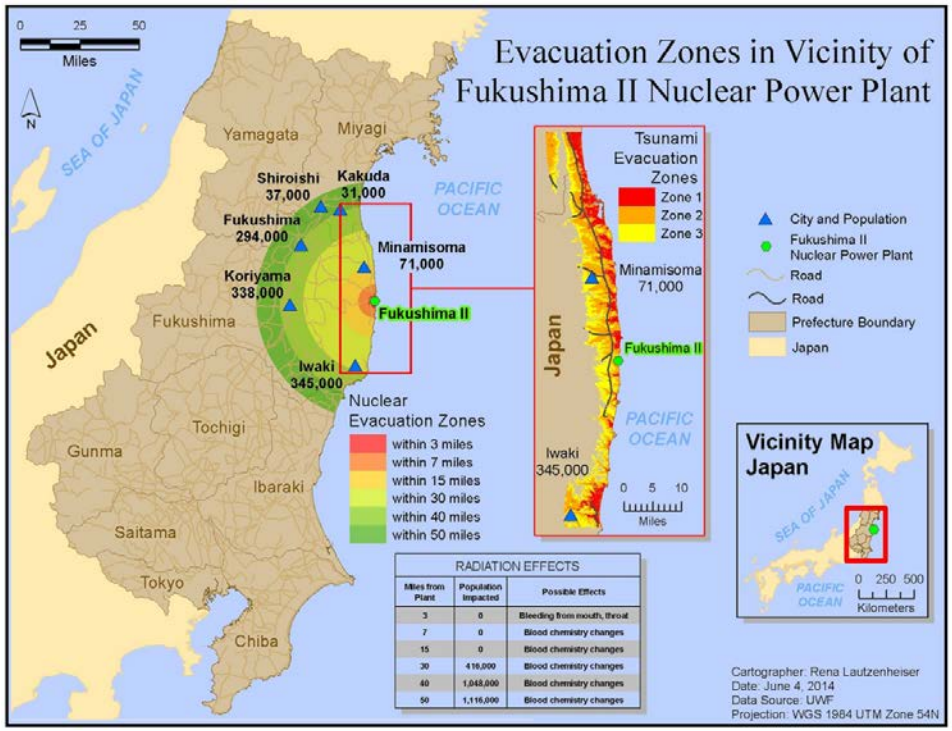
Berlin car accessibility from city center divided into 5 minute isochrones




BEER vs WINE
Per Capita Spending by US County
Spends more overall
Spends less overall
John Nelson | AdventuresInMapping.com | @John_M_Nelson
Esri Consumer Spending | doc.arcgis.com/en/esri-demographics
State & County Borders | United States Census Bruea | www.census.gov







Campus Buildings

OBJECTID	SHAPE	Name of Building	Size of Building	Operational Hours	Acc
1	Polygon	Gym	1768.992398	8:30am-5:00pm	Emp
2	Polygon	Gym	1043.515552	8:30am-5:00pm	Emp
3	Polygon	J	3834.247963	8:30am-5:00pm	Emp
4	Polygon	OA	14550.305355	8:30am-5:00pm	Emp
5	Polygon	G	11507.921772	8:30am-5:00pm	Emp
6	Polygon	S	2690.197171	8:30am-5:00pm	Emp
7	Polygon	L	11246.731494	8:30am-5:00pm	Emp
8	Polygon	E	10625.150848	8:30am-5:00pm	Emp
9	Polygon	F	4913.179712	8:30am-5:00pm	Emp
10	Polygon	O	25929.942586	8:30am-5:00pm	Emp

Search 0 of 27 selected

Image source: California State University http://heleneloyan.cikeys.com/update/gis-layers/

California's Camp Fire

A story map of damage

The GIS team in Butte County, CA, developed a story map to help organize their initial damage assessment and to provide county residents with evaculation, damage, service, and lost pet information.

Debris flow

The USGS is using a GIS to model the spatial distribution of post-fire debris flow potential. Debris flow models are based on terrain and soils information, rainfall conditions, and burn–severity data representing recently burned areas.

Burn Severity

The USFS is using a GIS to model burn–severity in recently burned areas.

Climate Ready Boston

GIS is a new Science

1970s: First example of GIS in the U.S. and Canada used data linked to property locations for environmental purposes

1980s: Computer chips advance to allow GUIs and commercial GIS takes hold – ESRI, PCI, MAPinfo

1990s: GIS becomes widely used in academia, government, and private businesses (oil and gas, mining), first academic journal dedicated to GIS established

2000s: Open source GIS, computationally intensive geospatial analysis tools developed, graphic capabilities improve

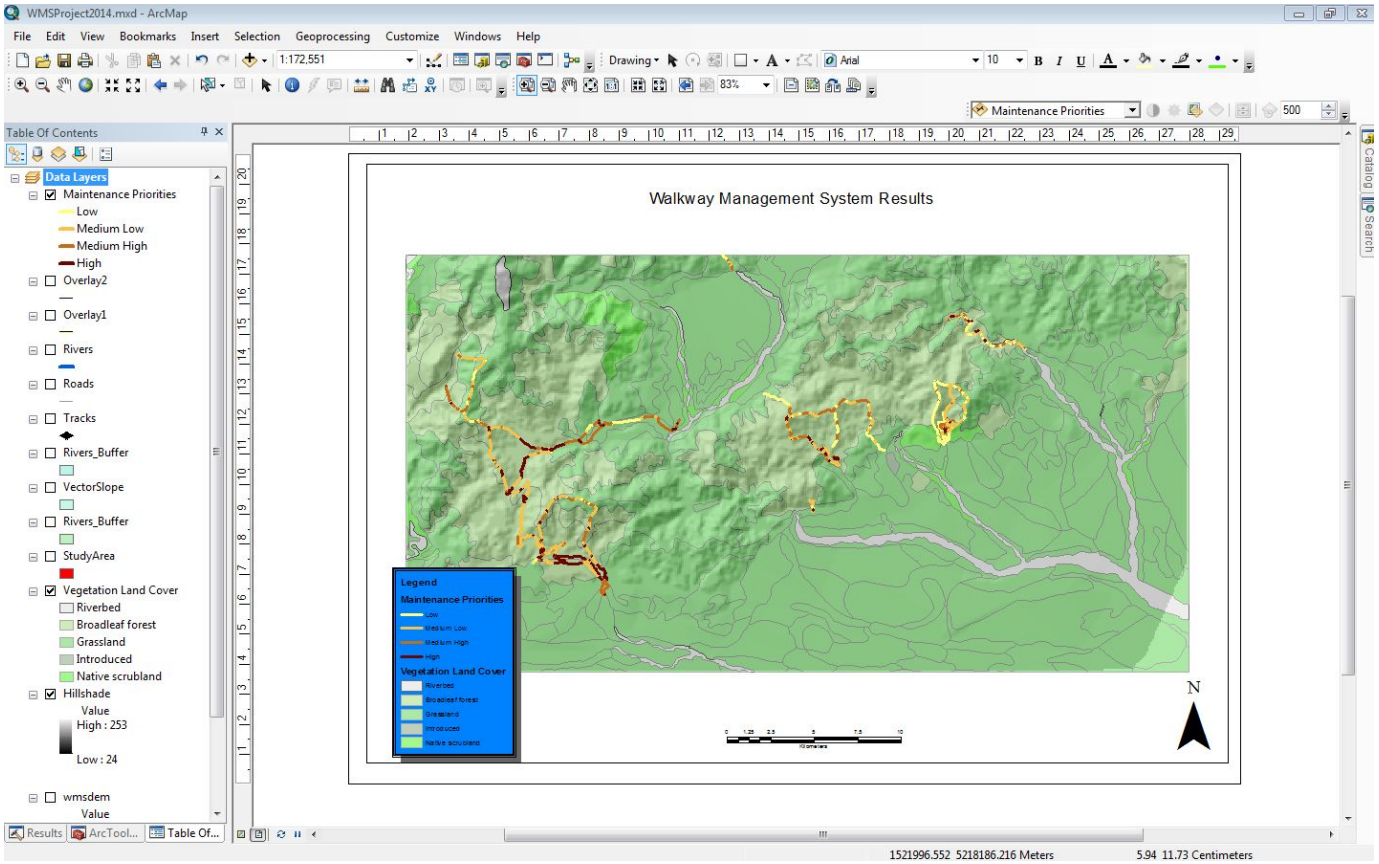
2010s: GIS becomes a basic tool in nearly all fields involving geospatial data

GIS Software

- IDRISI GIS – Clark University
  - Focused on raster analysis
- GRASS GIS
  - Free and open source
- QGIS
  - Free and open source
- ESRI ArcGIS
  - Industry and academic standard

ESRI ArcGIS

ArcGIS includes:
ArcMap, ArcCatalog, ArcScene, ArcGlobe

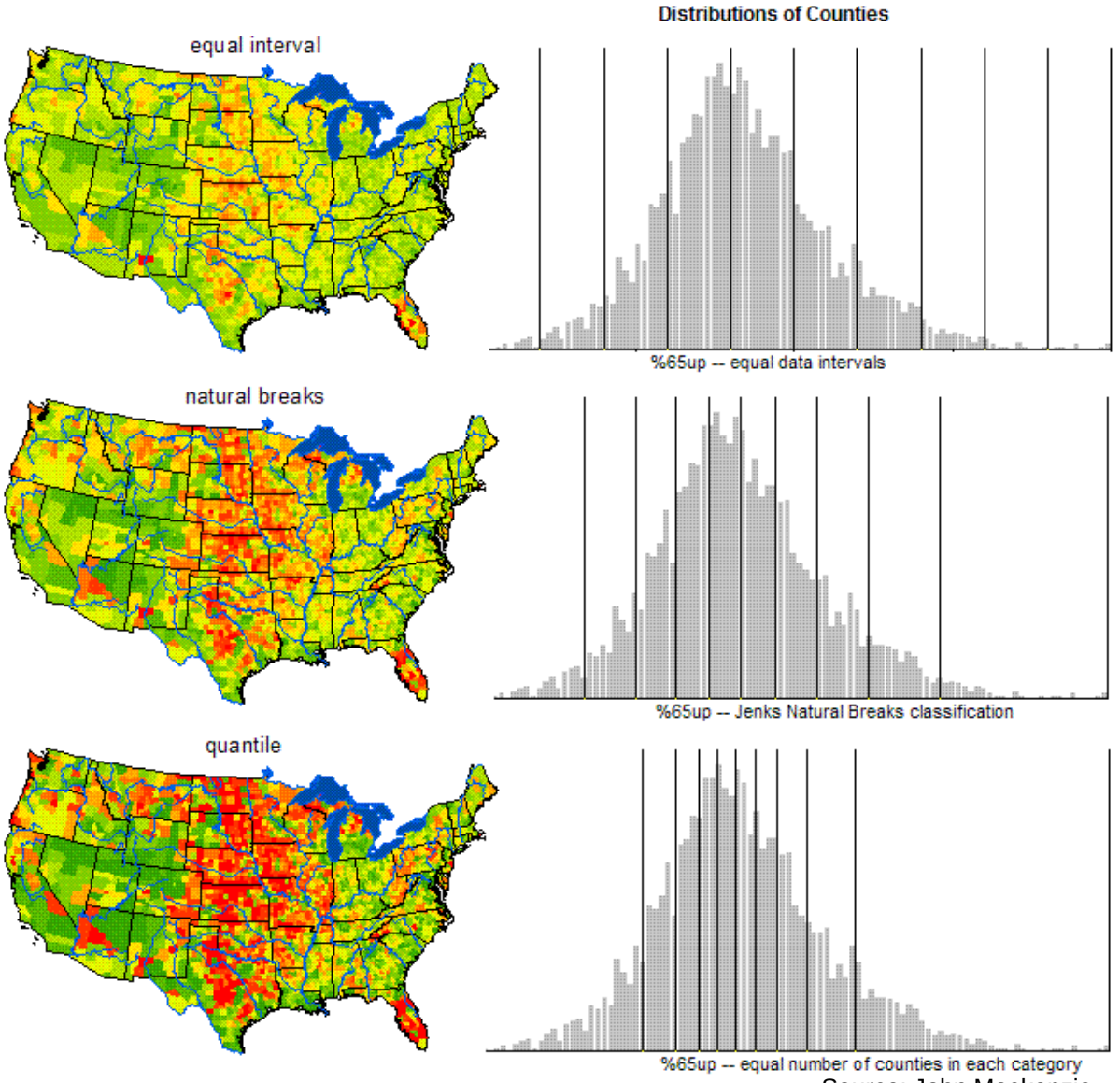


ArcMap Demo

Jamesheiss.com/ENVI3010S19/proj1.mdb

COMPARISON OF CLASSIFICATION METHODS

Percentage of US Population Age 65 or Older, by County



Source: John Mackenzie