Spatial Analysis in ArcGIS Online

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Goals

1. **Understand what spatial analysis is.**
2. **Understand why spatial analysis is a unique characteristics of GIS and why it is powerful in education and in greater society.**
3. **Build skills in spatial analysis using ArcGIS Online.**

What is GIS I?

1. Classical Definition: GIS is a tool that can access, integrate, and distribute layers of map information. The five parts of a GIS include hardware, software, data, procedures, and people.

2. A more Modern Definition (?): GIS lets us visualize, question, analyze, interpret, and understand data in new ways. This can reveal relationships, patterns, and trends.

What is GIS II?

3. Give it some context: A transformation is taking place. Businesses and government, schools and hospitals, nonprofit organizations, and others are taking advantage of it. All around the world, people are working more efficiently because of it. Information that was limited to spreadsheets and databases is being examined in a new, exciting way—all using GIS.

4. A workflow definition: People intuitively understand maps. When a decision needs to be made, GIS helps us gather information and place it on a digital map. We then use GIS to evaluate the decision geographically. Once we fully understand the geographic consequences of the decision, we can act in an informed, responsible manner.

What is GIS III?

5. The value proposition: The benefits of GIS generally fall into five basic categories:

- **Cost savings resulting from greater efficiency**
- **Better decision making**
- **Improved communication**
- **Better geographic information recordkeeping**
- **Managing geographically**

6. Or, a simple definition: GIS helps us see where things are—and decide where they should be.

Bottom line: GIS is more than maps. It is more than visualizing. It allows us to do spatial analysis.

What is spatial thinking and analysis?

My working definition of spatial thinking:

"Identifying, analyzing, and understanding the location, scale, patterns, and trends of the geographic and temporal relationships among data, phenomena, and issues."

Esri Definition of Spatial Analysis: "The process of examining the locations, attributes, and relationships of features in spatial data through overlay and other analytical techniques in order to address a question or gain useful knowledge. Spatial analysis extracts or creates new information from spatial data.

Or: It is how we understand our world — mapping where things are, how they relate, what it all means, and what actions to take.

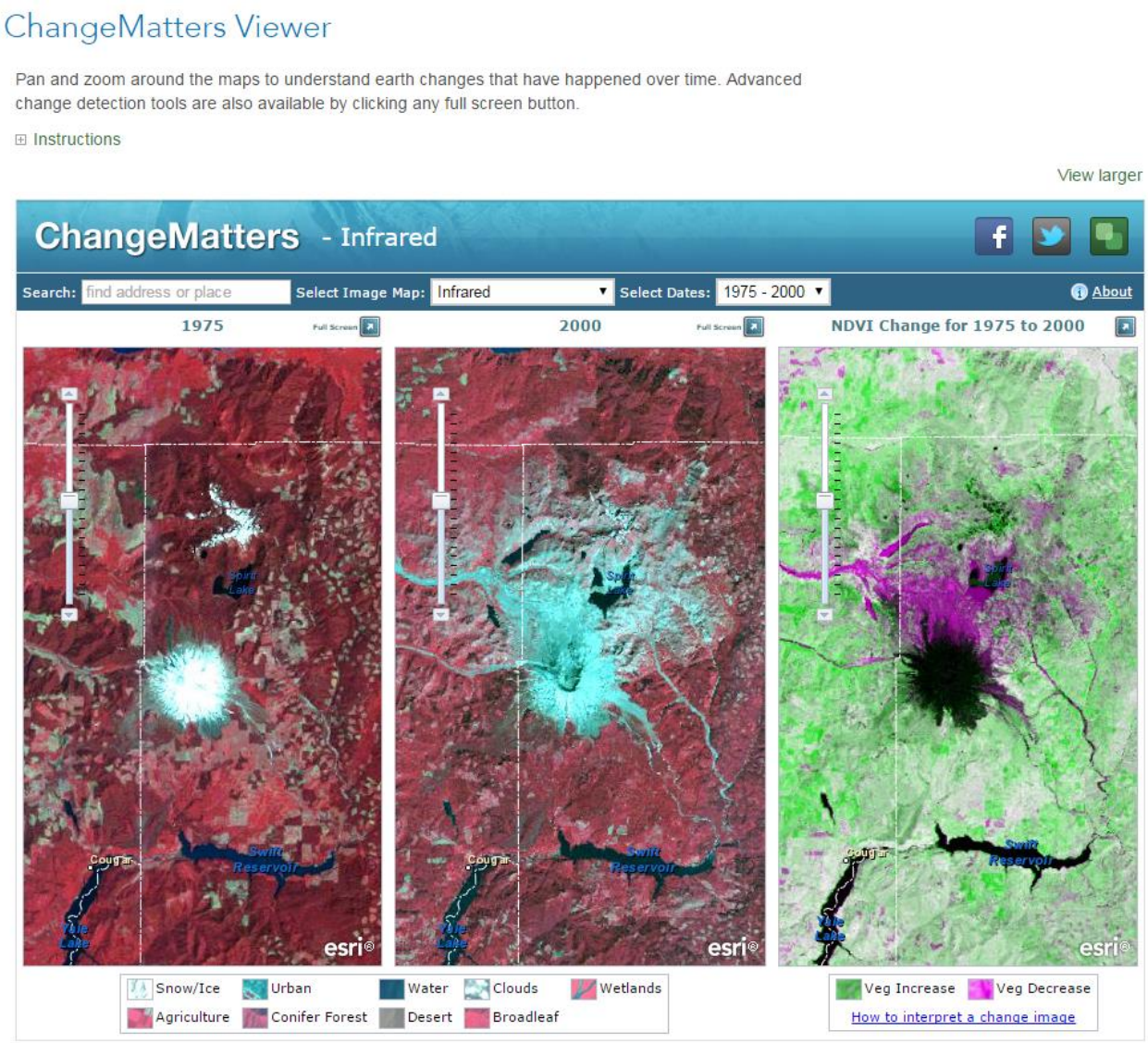
Components of Spatial Analysis

- Understanding where.
- Measuring size, shape, distribution
- Determining how places are related
- Finding the best locations and paths
- Detecting and quantifying patterns
- Making predictions

http://www.esri.com/products/technology-topics/spatial-analysis

https://dl.dropboxusercontent.com/u/91042629/The_Language_of_Spatial_Analysis_2013.pdf

Is this spatial analysis?



You need data and tools to do spatial analysis!

Finding and Using Spatial Data

Old Paradigm

--Download data→ Unzip→ Format→ Project→Tabular Manipulation→ Use.

New Paradigm

--Access data in cloud→ Use.

We are not *quite* to the point of fully using the new paradigm … yet.

Thus, best practice today is still the hybrid model:

1. Start with ArcGIS Online to search for data.

2. Search local, state, national, international data depositories and portals.

Examples:

Local: Boulder County CO, Los Angeles County CA

State: www.tnris.org (Texas), CASIL (California), RIGIS (RI), NRIS (MT)

National: USGS, NASA, Census Bureau, NOAA, EPA, US DOT, USFWS, BLM, USFS, FAA, National Atlas, LINZ (New Zealand), IBGE (Brazil), OS (UK)

International: WRI, WWF, UNEP, World Bank, Natural Earth Data

What kinds of data can you add to ArcGIS Online?

Data Type	Open in ArcGIS Online	Open in ArcGIS Desktop
Map Notes	X	
Tables (CSV)	X	X
Zipped Shapefiles	X	X Unzip first
Zipped other data	X after unzipping and serving	X after unzipping
Images (JPG, PNG, TIF)	X	X
Feature services	X	X
Layer package, map package		X

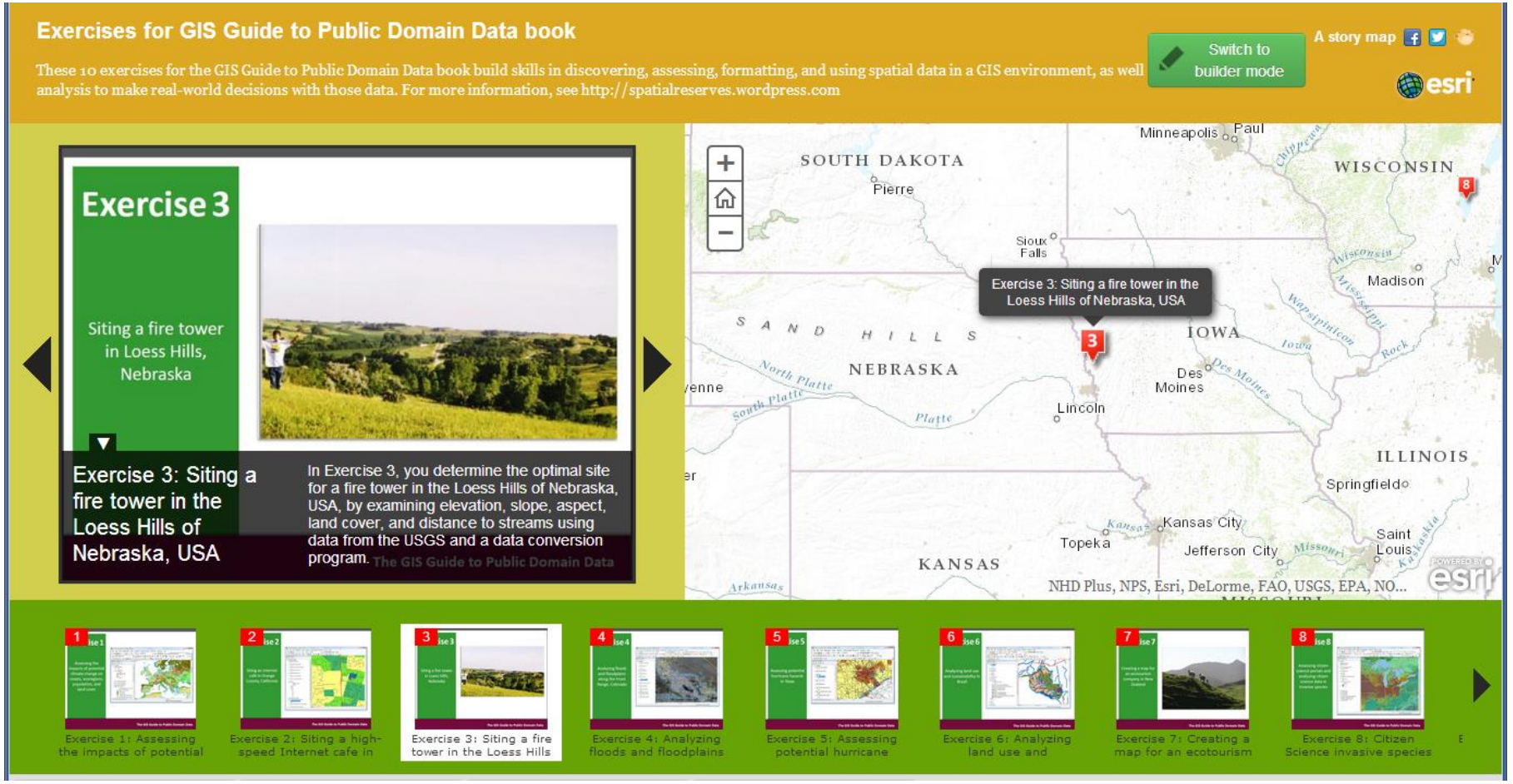
Data Types and Sources

1) Vector: Shapefiles, geodatabases, feature services, other vector formats.
2) Raster: ArcGrids, GeoTiffs and other images, Tiled image services.
3) Tabular: Excel tables, CSVs, TXT files, other formats.
4) Ground images: Wikipedia and other creative commons sources.

Data Sources and Issues (privacy, crowdsourcing, cloud vs. desktop, copyright, and how to use).

- ***The GIS Guide to Public Domain Data*, by Joseph Kerski and Jill Clark, Esri Press**
- **http://spatialreserves.wordpress.com**

10 Spatial Analysis Exercises in the Public Domain Data Book



- **Finding and using data on ArcGIS Online**

  --Often helpful to narrow the search, such as: quotes “riparian zones”

  --Keywords:

  <search string> owner:jjkerski or tags: “bike lanes”

  --Use Boolean operators:

  “recent fires” OR fires

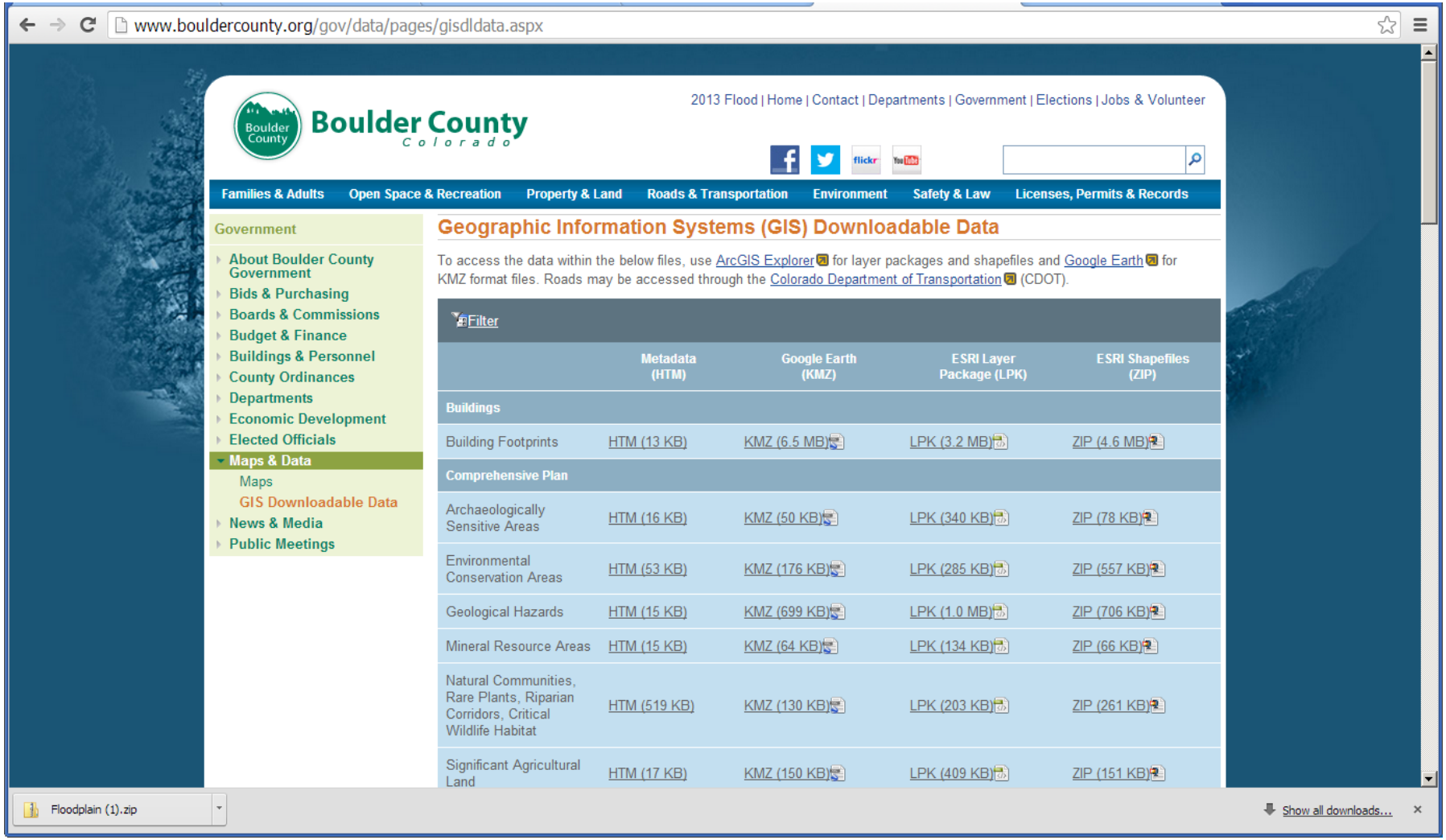
  owner:esri AND tags:streets

  --search in your specific map extent or in your organization

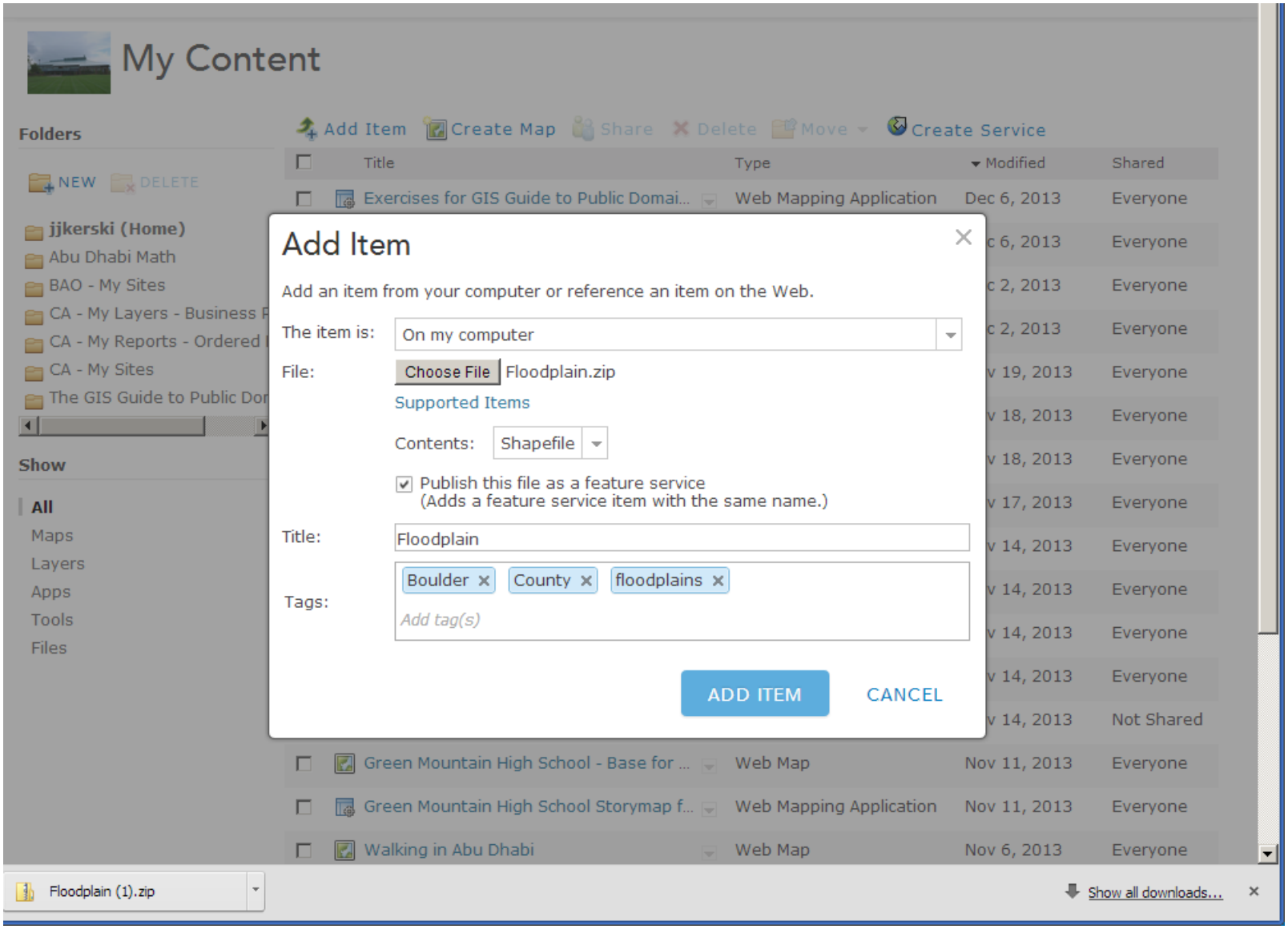
  More tips on: Using Search – Fields: http://resources.arcgis.com/en/help/arcgisonline/index.html#//010q0000000n000000

- **Accessing and using data portals**

Access Boulder County GIS Portal



Save data sets locally, Add to ArcGIS Online via “My Content”



Using ArcGIS Online Analytical Tools

- ArcGIS Online is a cloud-based GIS, not just an online set of web maps. Hence, you can use it for conducting spatial analysis.

- The spatial analysis capabilities of ArcGIS Desktop still far exceed that of ArcGIS Online, given its 30 year head start, but more analytical capabilities are being added quarterly to ArcGIS Online.

- The spatial analytical tools in ArcGIS Online are easy to use. They are accessed from the arrows to the right of specific layers. Whether you see the analytical tools depends on (1) if you are using an ArcGIS Online organizational subscription, and (2) how the data are served in ArcGIS Online (i.e. ideally, as services)

Hands-On Activities

1. Plate Tectonics.
2. London cholera in 1854
3. Real Time Weather.
4. Floodplains and Geologic Hazards.
5. Crime.

Hands-On Activity: Plate Tectonics

- **Using Analytical capabilities in ArcGIS Online.**

- **Examine: Layers, CSVs, feature services, styling, filtering, tabular work, statistics, analysis.**

Questions include:

What is the spatial pattern of earthquakes?

Where did the deepest and most intense earthquakes occur?

What is the relationship of the pattern of earthquakes to plate boundaries?

Hands-On Activity: Plate Tectonics

- www.arcgis.com > Create folder for plate tectonics analysis > Search for Plates 4 Types map > Save map in your working folder.

- http://earthquakes.usgs.gov > Real Time Feeds and Notifications > Spreadsheet Format.

Hands-On Activity: Cholera Analysis, London 1854

- Using Analytical capabilities in ArcGIS Online

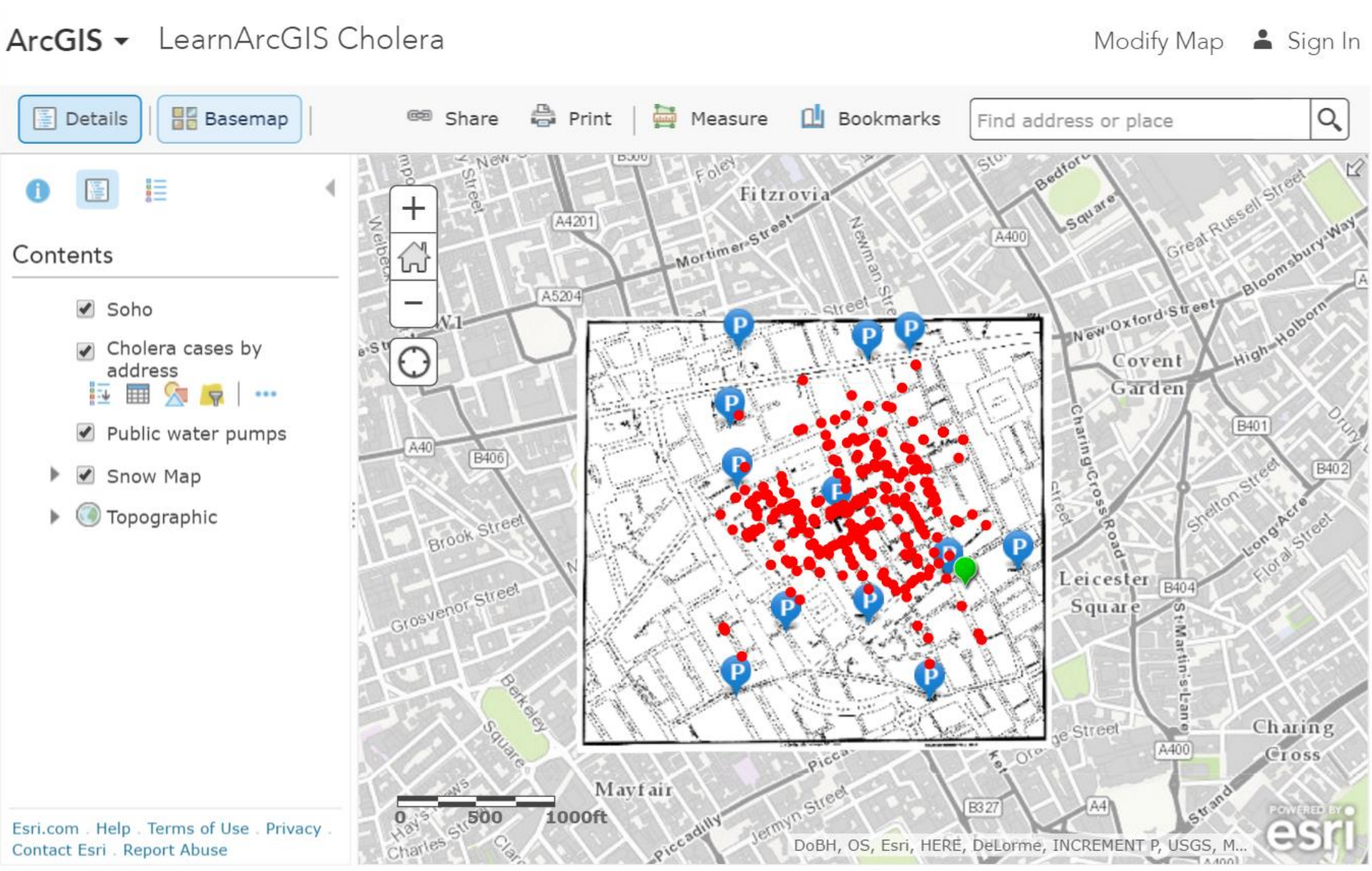
- Problem Statement: What percentage of the cholera outbreak cases are associated with the Broad Street well?

You will consider public water pumps, and locations with 1 or more deaths, in your assessment.

Hands-On Activity: Cholera Analysis, London 1854

- Start with: www.arcgis.com > Create cholera folder > Search for LearnArcGIS Cholera > Save it in your folder >

Then: A series of analytical steps designed to understand the patterns of the cholera deaths and to compute a route for Dr Snow and Rev. Whitehead to visit the cholera victims' homes.


ArcGIS
LearnArcGIS Cholera
Modify Map
Sign In
Details
Basemap
Share
Print
Measure
Bookmarks
Find address or place
Contents
Soho
Cholera cases by address
Public water pumps
Snow Map
Topographic
Esri.com . Help . Terms of Use . Privacy .
Contact Esri . Report Abuse
Fitzrovia
Covent Garden
Leicester Square
Charing Cross
Mayfair
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DoBH, OS, Esri, HERE, DeLorme, INCREMENT P, USGS, M...

Hands-On Activity: Real Time Weather

- **Using Analytical capabilities in ArcGIS Online**

- **Problem Statement: Examine patterns of temperature, pressure, wind speed, and direction.**

1) Symbolize weather variables: temperature, pressure, wind speed/direction. Examine patterns.

2) Create an interpolated surface from the weather data for 1 variable (for example, temperature).

Continuous Surfaces from Point Data: Heat Maps, Density Surfaces, and Hot Spot Maps

- *A **heat map** shows the occurrence of a set of points as a density surface.* Heat maps use a point density calculation to provide a graphical visualization of the density of your data as a smoothly varying set of colors from cool (low density) to hot (high density). The Heat Map tool (http://www.arcgis.com/home/item.html?id=4f46667fb85f42058397a762778b9210) uses a Gaussian blur to render the colors through contours that are concentric circles with a Gaussian distribution from a center point.

The effect of this blurring is similar to viewing an image through a translucent screen (http://en.wikipedia.org/wiki/Gaussian_blur).

- *The **Calculate Density** tool creates a density map from point or line features by spreading known quantities of an attribute across the map, resulting in a surface classified from least dense to most dense. Uses a more sophisticated tool than heat mapping, a kernel density algorithm.*

- ***A Hot Spot map*** *shows the results of statistically significant spatial clusters of high values (hot spots) and low values (cold spots). A mathematical algorithm is used and the results are expressed in terms of statistical confidence.*

- Both the Heat Map and Calculate Density tools indicate the density of features. Hot spot maps show clustering that is statistically significant, rather than just an indication of density.

- Selecting Heat Map –> Options will allow you to change the following: Change how the colors get applied to the density surface by adjusting the position of the two handles on the color ramp slider. Make the clusters become larger and smoother, or smaller and more distinct by adjusting the area of influence slider. Use Symbols to select a different color ramp. To have the map viewer calculate and set the optimal visible range, click Suggest next to the Visible Range slider, or manually set it.

- **Calculate Density:**

- https://developers.arcgis.com/rest/analysis/api-reference/calculate-density.htm

- **Find Hot Spots:**

- https://developers.arcgis.com/rest/analysis/api-reference/find-hot-spots.htm

- **Heat map:**

- **http://doc.arcgis.com/en/arcgis-online/create-maps/change-style.htm#ESRI_SECTION1_2DFD98C91EAE47A4BAE846E5DE75E978**

Hands-On Activity: Real Time Weather

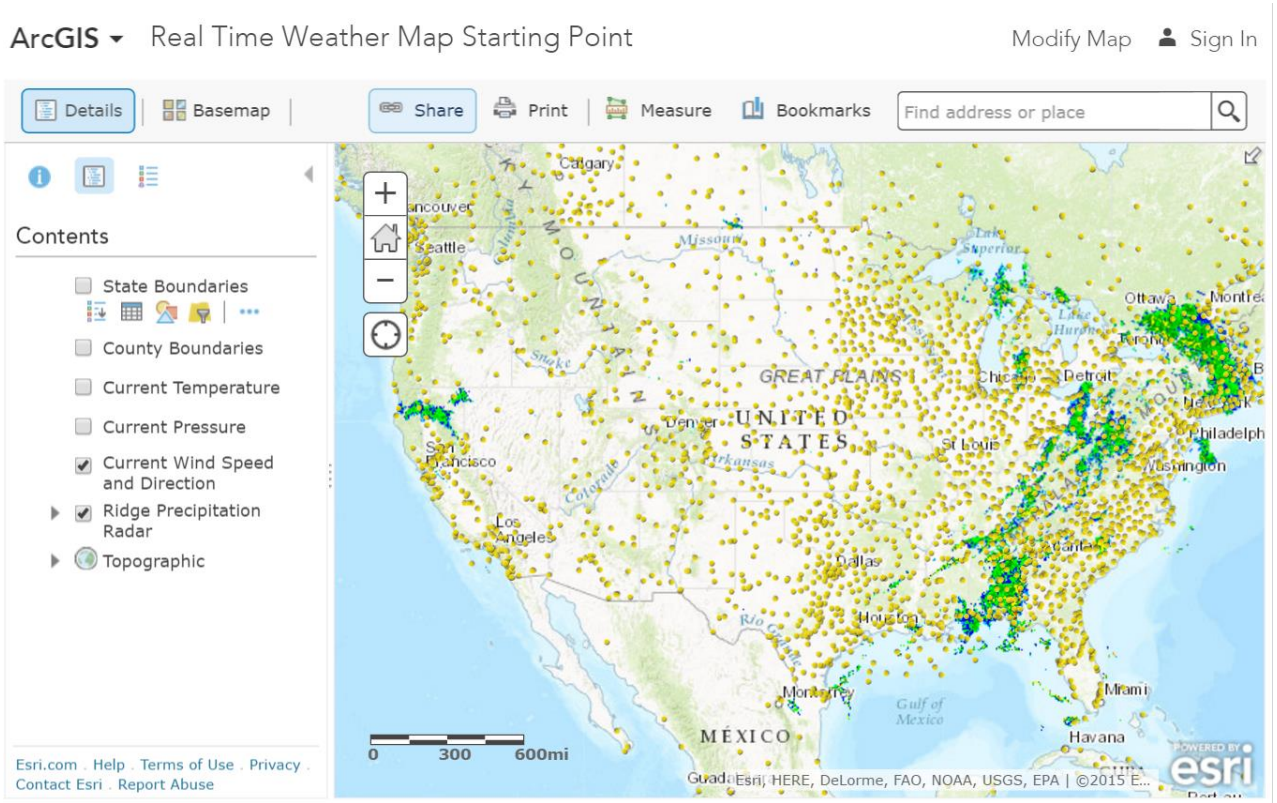
- Using Analytical capabilities in ArcGIS Online

- Problem Statement: Examine patterns of temperature, pressure, wind speed, and direction.

www.arcgis.com >

Search:

Real Time Weather Starting Point



Activity: Flood and Geologic Hazards Analysis

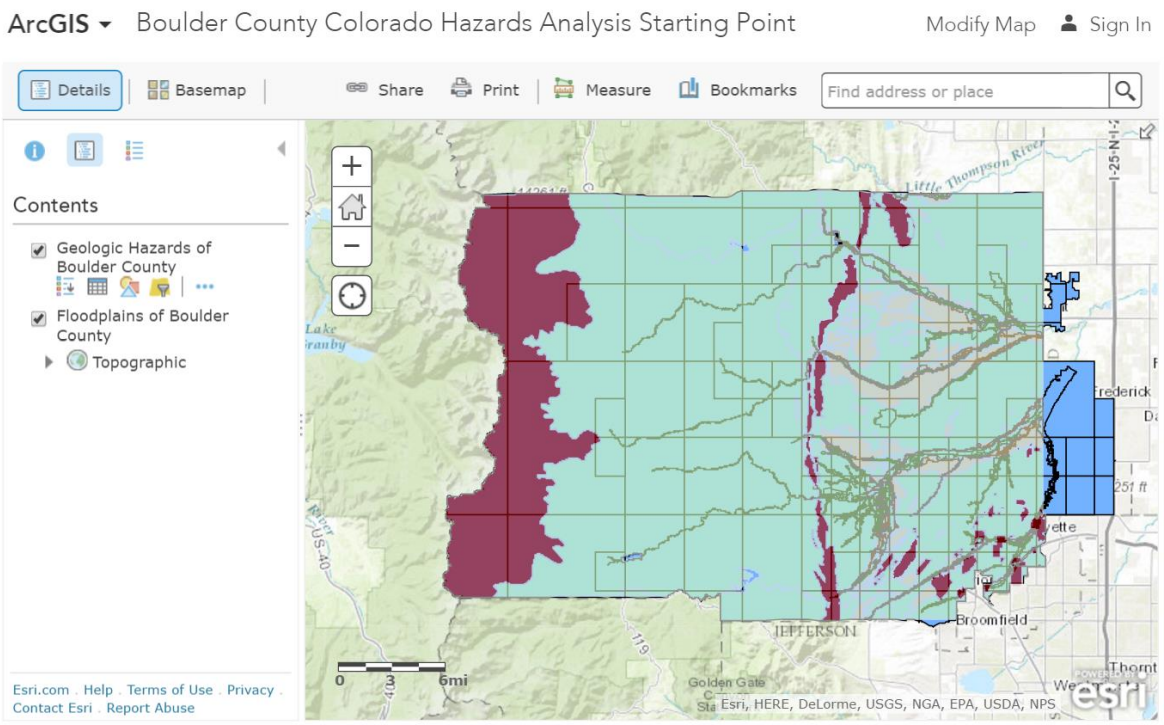
- Using Analytical capabilities in ArcGIS Online

- Problem Statement: Because of recent devastating floods that occurred in September 2013, the Boulder County Office of Emergency Preparedness, hearing of your excellent GIS skills, has asked you to prepare an assessment of the most vulnerable lands in the county to future flooding and the people on those lands.

You will consider floodplains, geologic hazards, land cover, soils, and demographics in your assessment.

Activity: Flood and Geologic Hazards Analysis

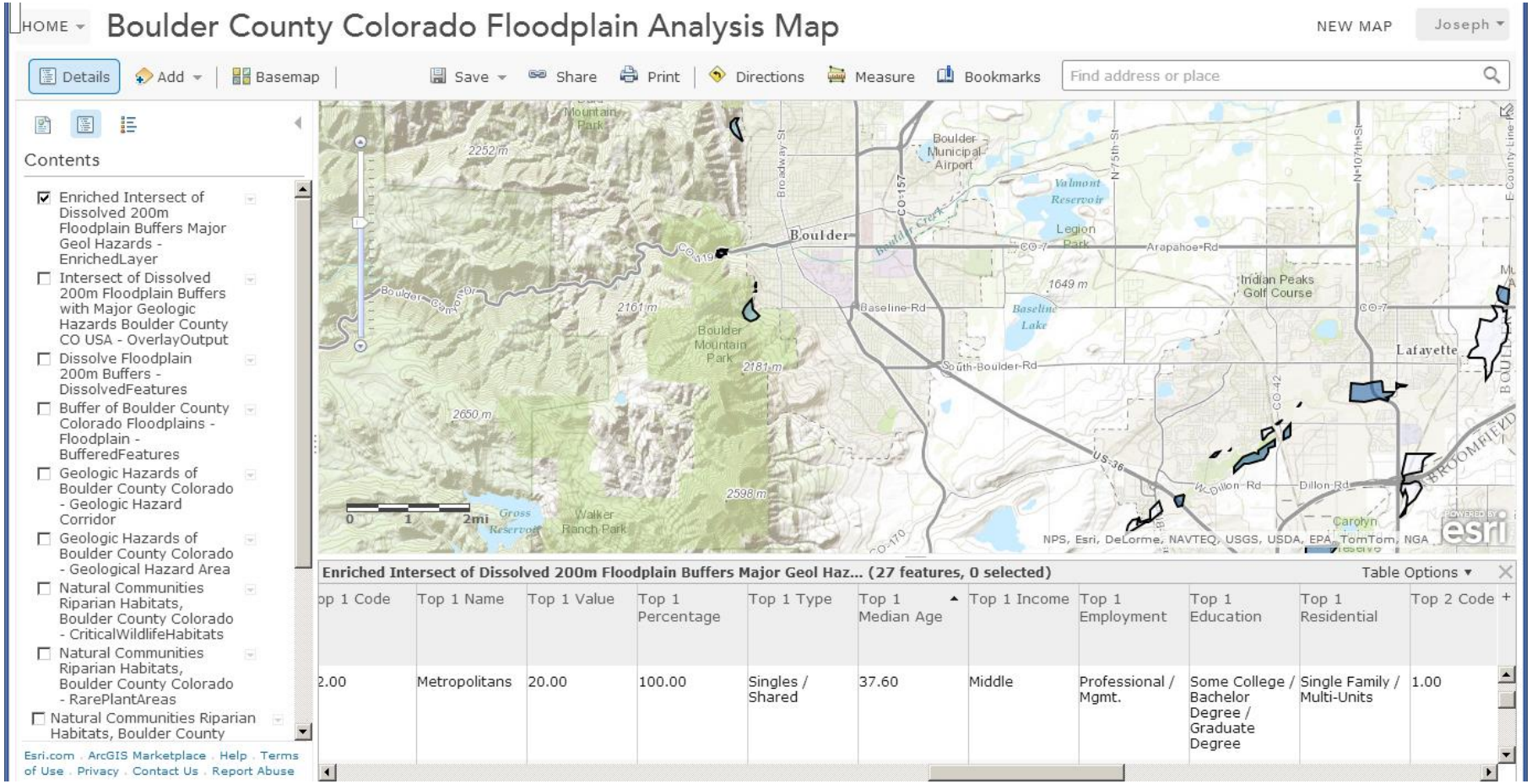
- www.arcgis.com > Create folder for flood hazards analysis > Search for map: Boulder County Colorado Hazards Analysis Starting Point > Open Map > Save in your working folder.



Analysis Workflow

- 1. Filter Floodplains layer to only consider the true floodplains. Filter geologic hazards layer to only consider Major Hazards.
- 2. Proximity→ Buffer floodplains by 200 meters.
- 3. Dissolve the buffer's internal polygons.
- 4. Manage Data→ Overlay→ Intersect the dissolved floodplain buffers with Major Geologic Hazards.
- 5. Sort on Analysis Area and only consider the largest polygons.
- 6. Data Enrichment, with Group Quarters and % Wetlands.

Final Results

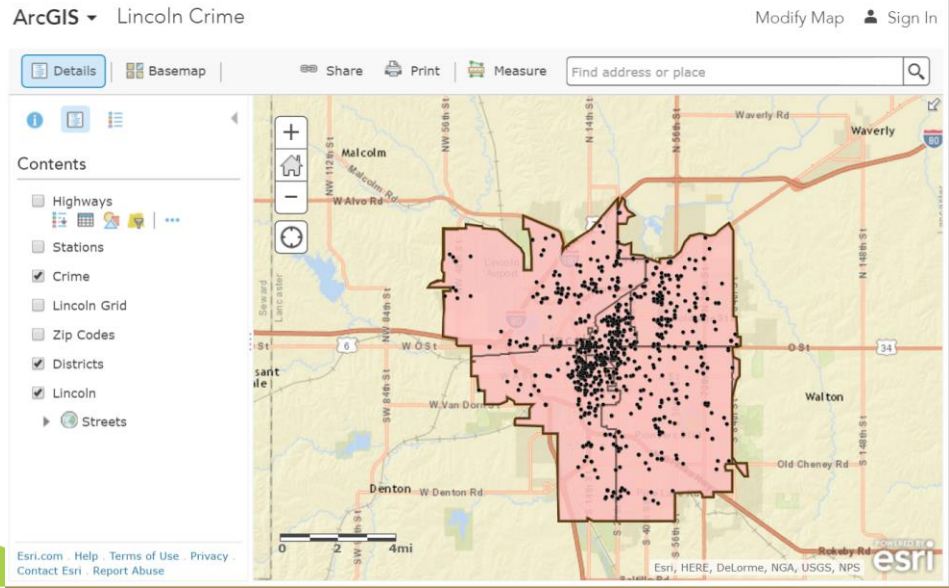


Activity: Crime Analysis 1 of 5

*1. Search for **Lincoln_Crime.** Save as **crime_lastname** with proper metadata.*

*2. **Police Stations**>>Filter.* name is Team Station (unique)

3. ***Police Stations**>>Perform Analysis>>Use Proximity>>Create Drive-Time Areas* Time is 5 minutes.



Crime, 2 of 5

4. ***Crime****>>Perform Analysis>>Summarize Data>>Aggregate Points*
5 Minutes from Team Station

- Field to group = offense
- Check Add Percentage
- ASSAULT 111 37.12%
  AUTO THEFT 21 7.02%
  LARCENY 167 35.85% Total Crime 299

Investigate table and graph created within the polygon.

4b. **Next - > Summarize crime by grid cell.**

Crime, 3 of 5

*5. **Crime**>>Change Style>>Heat Map*

- Try additional analysis by offense:
- Filter for Assault
- Filter for Auto Theft
- Filter for Larceny

A **heat map** is a graphical representation of data where the individual values area represented as colors. No new data is formed. The data is styled.

Crime, 4 of 5

Density surfaces show where point or line features are concentrated. It shows the predicted distribution throughout the landscape. A mathematical algorithm is used and new data is produced.

- *6. **Crime**>>Perform Analysis>>Analyze Patterns>>Calculate Density*

Options:

- Search Distance = Miles (Default)
- Clip Output to Lincoln
- Number of Classes = 10
- Output Area Units = Square Miles

Crime, 5 of 5

- **Hot Spot Analysis** identified statistically significant spatial cluster of high values (hot spots) and low values (cold spots). A mathematical algorithm is used and new data is produced.

- *7.* ***Crime****>>Perform Analysis>>Analyze Patterns>>Find Hot Spots*

  Options: Clip Output to Lincoln

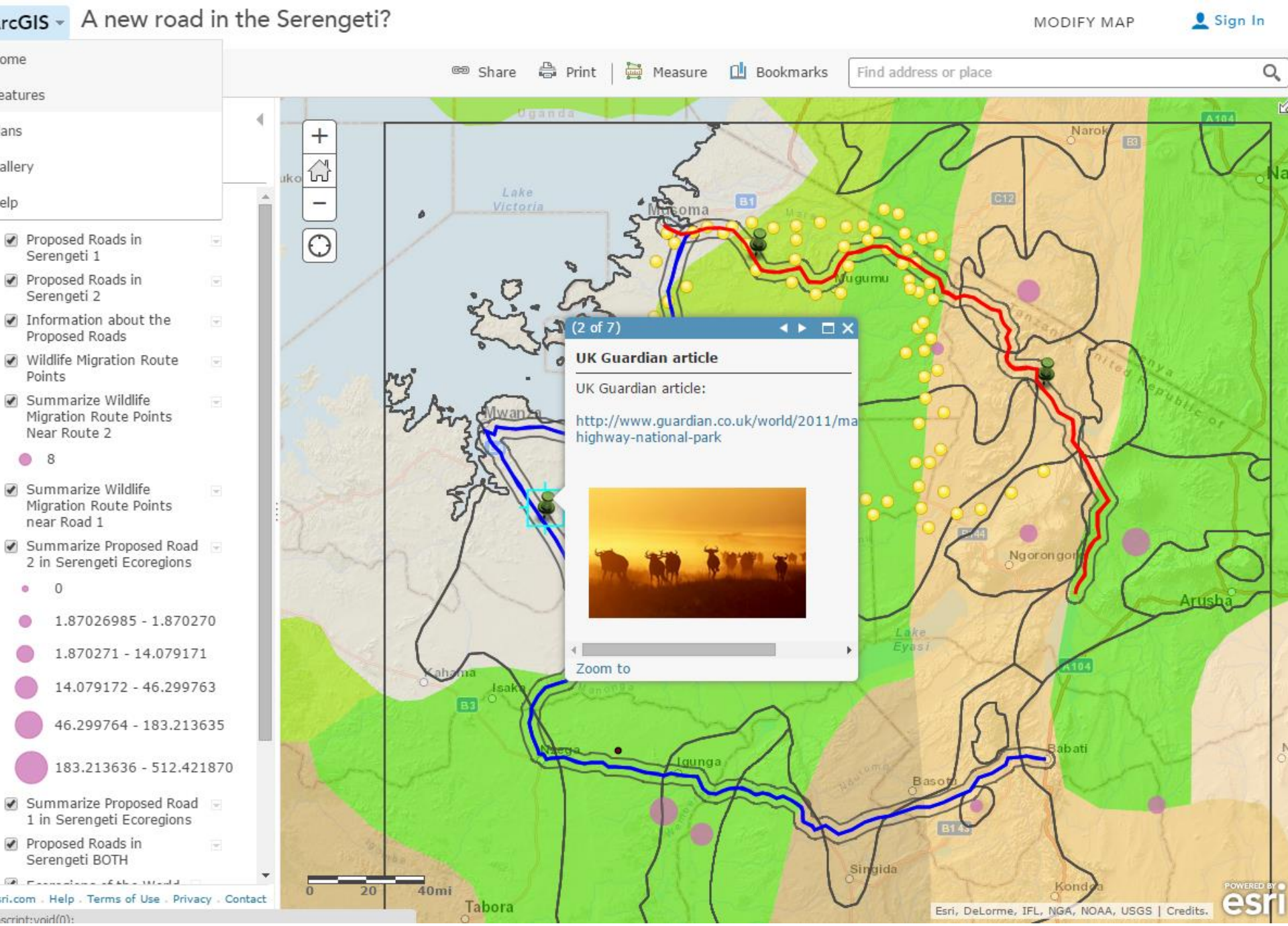
- *8. Save.*

Alternative instructional approach: A new road through the Serengeti?

- Using Analytical capabilities in ArcGIS Online

- Problem Statement: A new road is proposed through the Serengeti to link ports on the Indian Ocean with Lake Victoria. You will use spatial analysis to examine the route of two proposed roads, assessing the impact of each on wildlife migration and on the local ecoregions, and examining alternatives to the roads themselves.

You will consider the two routes proposed, wildlife migration, ecoregion, elevation, total length. Specifically: wildlife migration within 5 km from proposed roads, length of roads within each ecoregion.



rcGIS
A new road in the Serengeti?
MODIFY MAP
Sign In
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allery
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Share
Print
Measure
Bookmarks
Find address or place
Proposed Roads in Serengeti 1
Proposed Roads in Serengeti 2
Information about the Proposed Roads
Wildlife Migration Route Points
Summarize Wildlife Migration Route Points Near Route 2
8
Summarize Wildlife Migration Route Points near Road 1
Summarize Proposed Road 2 in Serengeti Ecoregions
0
1.87026985 - 1.870270
1.870271 - 14.079171
14.079172 - 46.299763
46.299764 - 183.213635
183.213636 - 512.421870
Summarize Proposed Road 1 in Serengeti Ecoregions
Proposed Roads in Serengeti BOTH
(2 of 7)
UK Guardian article
UK Guardian article:
http://www.guardian.co.uk/world/2011/ma
highway-national-park
Zoom to
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Musoma
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Esri, DeLorme, IFL, NGA, NOAA, USGS | Credits.
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Instructional Considerations

- You can have your stakeholders perform the analysis.

- Or -

- You can perform the analysis and have your stakeholders analyze the results (as I do often with the Serengeti lesson).

- Or –

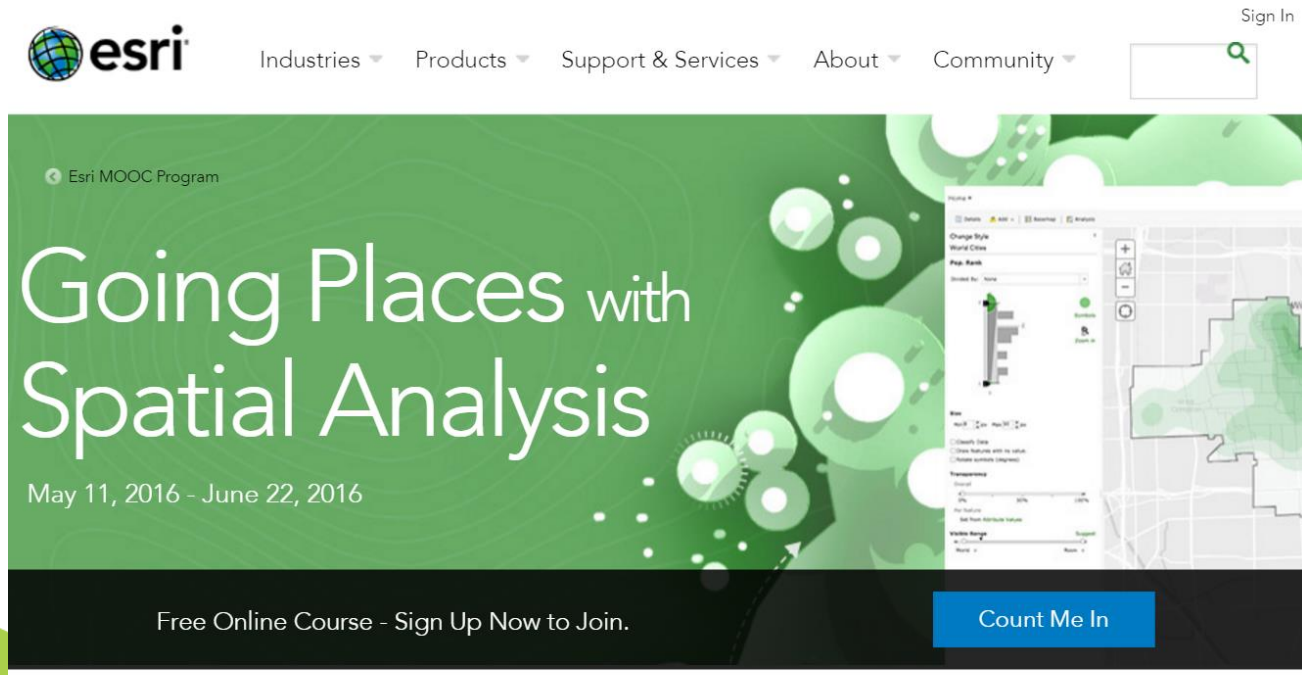
- A combination of the two.

- Or –

- Teach with visual analysis of patterns, linkages, and trends, without the quantitative measures.

Next Steps 1 of 2

- **Access these maps in ArcGIS Online. They are all public. Go through some of these analytical steps.**
- **Take the Going Places with Spatial Analysis MOOC – Esri.**



Gain a deeper understanding of spatial data analysis.

Next Steps 2 of 2

- Examine “How to teach with the ArcGIS Platform” documents, including video on spatial analysis tools:

http://www.esri.com/landing-pages/industries/education/higher-education/teach-with-arcgis-platform

- Review video tutorials: A Deeper Dive with ArcGIS Online: See playlist : http://www.youtube.com/geographyuberalles

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