



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

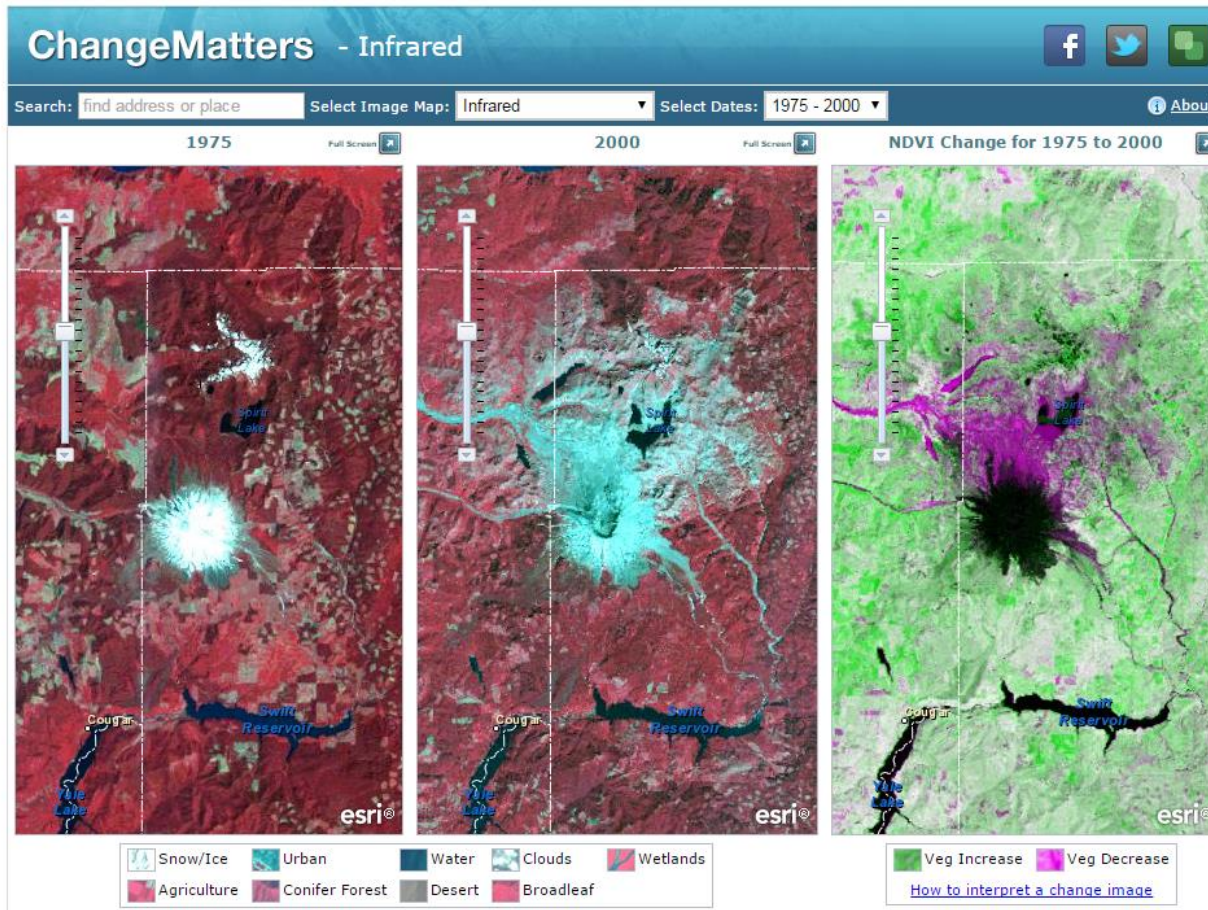
Is this spatial analysis?

ChangeMatters Viewer

Pan and zoom around the maps to understand earth changes that have happened over time. Advanced change detection tools are also available by clicking any full screen button.

[Instructions](#)

[View larger](#)



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>



The image is a screenshot of the 'Spatial Reserves' website. The page title is 'Spatial Reserves' with the subtitle 'A guide to public domain spatial data'. The main content is a blog post titled 'Listing of Free GIS Data Sources from Robin Wilson' dated November 10, 2013, by Joseph Kerski. The post discusses the history of GIS data sources and the utility of crowdsourcing tools. It includes a link to the resource 'Free GIS Data' and a brief description of its contents. The website also features a search bar, RSS feed, Twitter link, and sections for 'Contributors', 'Recent Posts', and 'Recent Comments'. The 'Recent Posts' section lists several articles, including 'The secret lives of phones: someone, somewhere knows where you are' and 'Digital Preservation and Formats from the US Library of Congress'. The 'Recent Comments' section shows a comment from 'Digital'.

10 Spatial Analysis Exercises in the Public Domain Data Book

Exercises for GIS Guide to Public Domain Data book

These 10 exercises for the GIS Guide to Public Domain Data book build skills in discovering, assessing, formatting, and using spatial data in a GIS environment, as well as analysis to make real-world decisions with those data. For more information, see <http://spatialreserves.wordpress.com>

Switch to
builder mode

A story map



Exercise 3

Siting a fire tower
in Loess Hills,
Nebraska



Exercise 3: Siting a
fire tower in the
Loess Hills of
Nebraska, USA

In Exercise 3, you determine the optimal site for a fire tower in the Loess Hills of Nebraska, USA, by examining elevation, slope, aspect, land cover, and distance to streams using data from the USGS and a data conversion program. The GIS Guide to Public Domain Data



Exercise 1: Assessing the impacts of potential



Exercise 2: Siting a high-speed Internet cafe in



Exercise 3: Siting a fire tower in the Loess Hills



Exercise 4: Analyzing floods and floodplains



Exercise 5: Assessing potential hurricane



Exercise 6: Analyzing land use and



Exercise 7: Creating a map for an ecotourism



Exercise 8: Citizen Science invasive species

◆ 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

The screenshot shows the Boulder County GIS Portal website. The browser address bar displays www.bouldercounty.org/gov/data/pages/gisdldata.aspx. The page header includes the Boulder County logo and navigation links for 2013 Flood, Home, Contact, Departments, Government, Elections, and Jobs & Volunteer. A navigation menu lists categories such as Families & Adults, Open Space & Recreation, Property & Land, Roads & Transportation, Environment, Safety & Law, and Licenses, Permits & Records. A left sidebar menu highlights 'Maps & Data' with sub-items like 'GIS Downloadable Data'. The main content area is titled 'Geographic Information Systems (GIS) Downloadable Data' and provides instructions on using ArcGIS Explorer and Google Earth. Below this is a table of downloadable files with columns for Metadata (HTM), Google Earth (KMZ), ESRI Layer Package (LPK), and ESRI Shapefiles (ZIP).

	Metadata (HTM)	Google Earth (KMZ)	ESRI Layer Package (LPK)	ESRI Shapefiles (ZIP)
Buildings				
Building Footprints	HTM (13 KB)	KMZ (6.5 MB)	LPK (3.2 MB)	ZIP (4.6 MB)
Comprehensive Plan				
Archaeologically Sensitive Areas	HTM (16 KB)	KMZ (50 KB)	LPK (340 KB)	ZIP (78 KB)
Environmental Conservation Areas	HTM (53 KB)	KMZ (176 KB)	LPK (285 KB)	ZIP (557 KB)
Geological Hazards	HTM (15 KB)	KMZ (699 KB)	LPK (1.0 MB)	ZIP (706 KB)
Mineral Resource Areas	HTM (15 KB)	KMZ (64 KB)	LPK (134 KB)	ZIP (66 KB)
Natural Communities, Rare Plants, Riparian Corridors, Critical Wildlife Habitat	HTM (519 KB)	KMZ (130 KB)	LPK (203 KB)	ZIP (261 KB)
Significant Agricultural Land	HTM (17 KB)	KMZ (150 KB)	LPK (409 KB)	ZIP (151 KB)

At the bottom of the browser window, a download bar shows 'Floodplain (1).zip' and a 'Show all downloads...' button.

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

My Content

Folders

- NEW
- DELETE
- jjkerski (Home)
- Abu Dhabi Math
- BAO - My Sites
- CA - My Layers - Business P
- CA - My Reports - Ordered
- CA - My Sites
- The GIS Guide to Public Dor

Show

- All
- Maps
- Layers
- Apps
- Tools
- Files

Add Item

Add an item from your computer or reference an item on the Web.

The item is: On my computer

File: Choose File Floodplain.zip

Supported Items

Contents: Shapefile

Publish this file as a feature service (Adds a feature service item with the same name.)

Title: Floodplain

Tags: Boulder County floodplains

Add tag(s)

ADD ITEM CANCEL

Title	Type	Modified	Shared
Exercises for GIS Guide to Public Domai...	Web Mapping Application	Dec 6, 2013	Everyone
		Dec 6, 2013	Everyone
		Dec 2, 2013	Everyone
		Dec 2, 2013	Everyone
		Nov 19, 2013	Everyone
		Nov 18, 2013	Everyone
		Nov 18, 2013	Everyone
		Nov 17, 2013	Everyone
		Nov 14, 2013	Everyone
		Nov 14, 2013	Everyone
		Nov 14, 2013	Everyone
		Nov 14, 2013	Everyone
		Nov 14, 2013	Everyone
		Nov 14, 2013	Not Shared
Green Mountain High School - Base for ...	Web Map	Nov 11, 2013	Everyone
Green Mountain High School Storymap f...	Web Mapping Application	Nov 11, 2013	Everyone
Walking in Abu Dhabi	Web Map	Nov 6, 2013	Everyone

Floodplain (1).zip

Show all downloads...

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

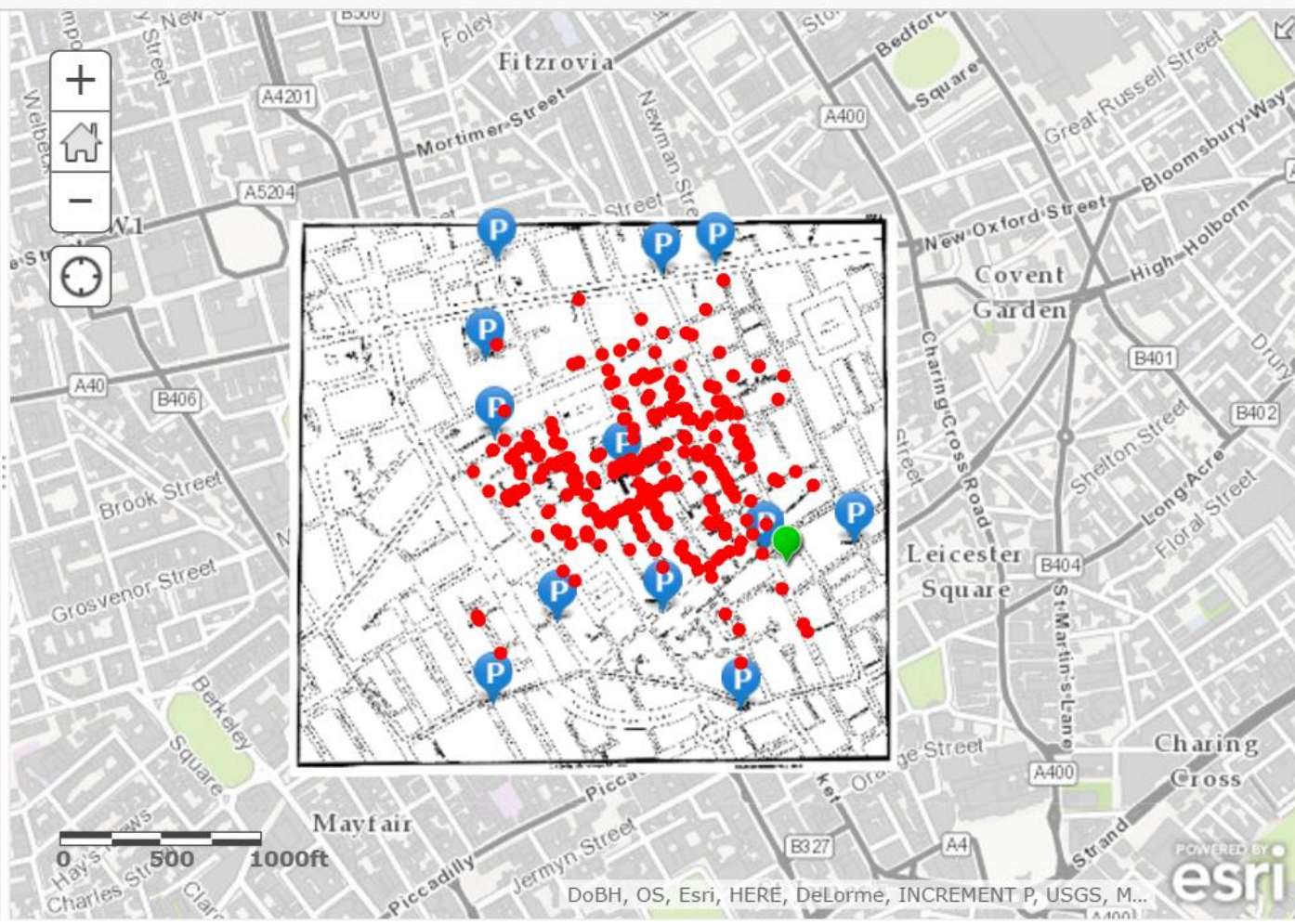
◆ Start with: www.arcgis.com > Create cholera folder > Search for LearnArcGIS Cholera > Save it in your folder >

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.

[Details](#) | [Basemap](#) |
 [Share](#) | [Print](#) | [Measure](#) | [Bookmarks](#) |

Contents

- Soho
- Cholera cases by address
 -
 -
 -
 -
 -
- Public water pumps
- Snow Map
- Topographic



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.

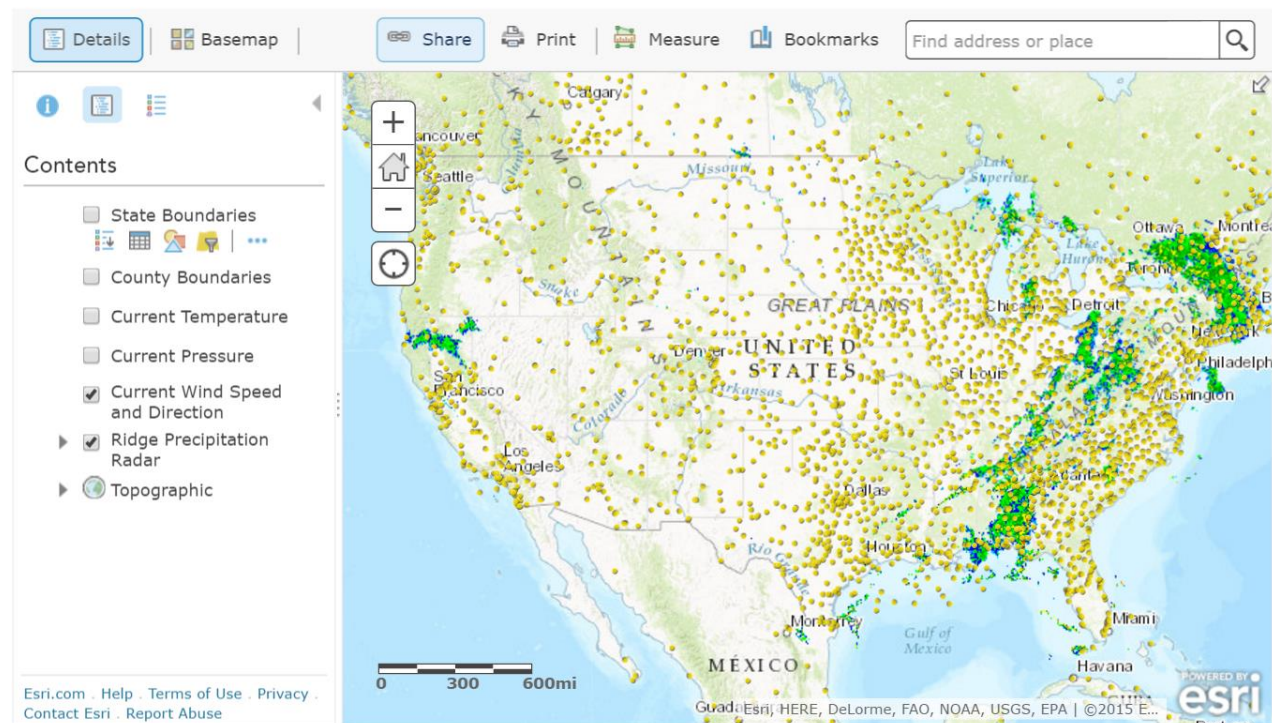
www.arcgis.com >

ArcGIS ▾ Real Time Weather Map Starting Point

Modify Map  Sign In

Search:

Real Time
Weather Starting
Point



Activity: Flood and Geologic Hazards Analysis

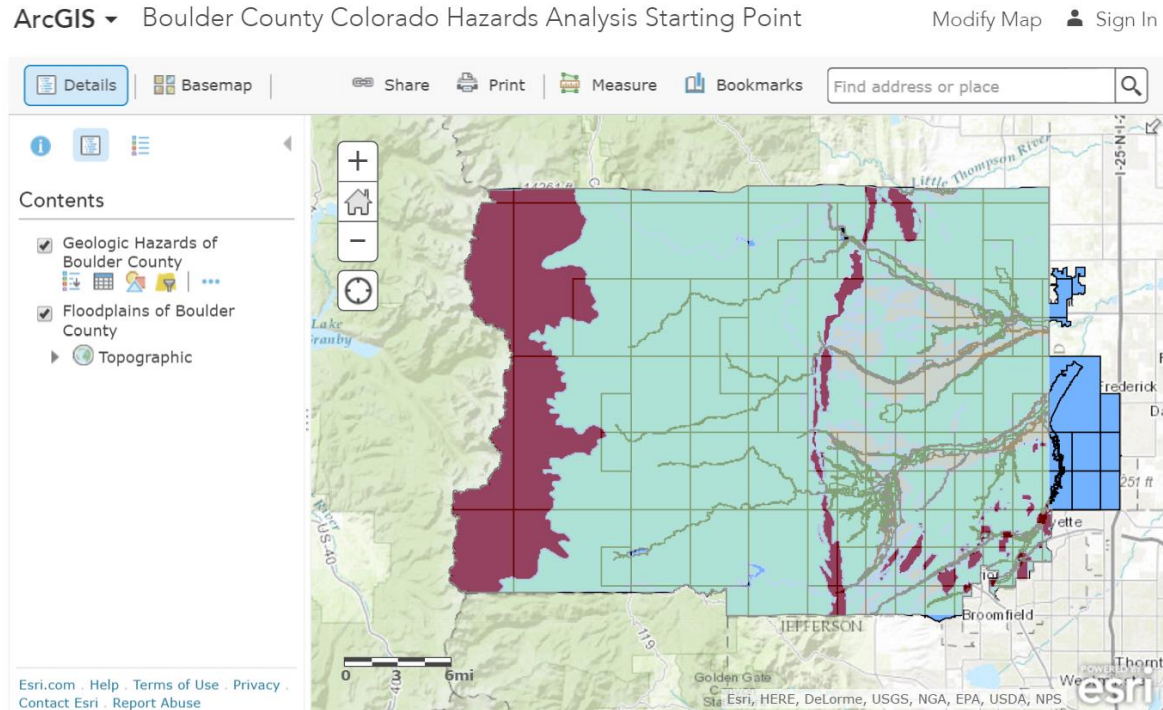
◆ Using Analytical capabilities in ArcGIS Online

◆ **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

HOME ▾ Boulder County Colorado Floodplain Analysis Map NEW MAP Joseph ▾

Details Add ▾ Basemap Save ▾ Share Print Directions Measure Bookmarks Find address or place 🔍

Contents

- Enriched Intersect of Dissolved 200m Floodplain Buffers Major Geol Hazards - EnrichedLayer
- Intersect of Dissolved 200m Floodplain Buffers with Major Geologic Hazards Boulder County CO USA - OverlayOutput
- Dissolve Floodplain 200m Buffers - DissolvedFeatures
- Buffer of Boulder County Colorado Floodplains - Floodplain - BufferedFeatures
- Geologic Hazards of Boulder County Colorado - Geologic Hazard Corridor
- Geologic Hazards of Boulder County Colorado - Geological Hazard Area
- Natural Communities Riparian Habitats, Boulder County Colorado - CriticalWildlifeHabitats
- Natural Communities Riparian Habitats, Boulder County Colorado - RarePlantAreas
- Natural Communities Riparian Habitats, Boulder County

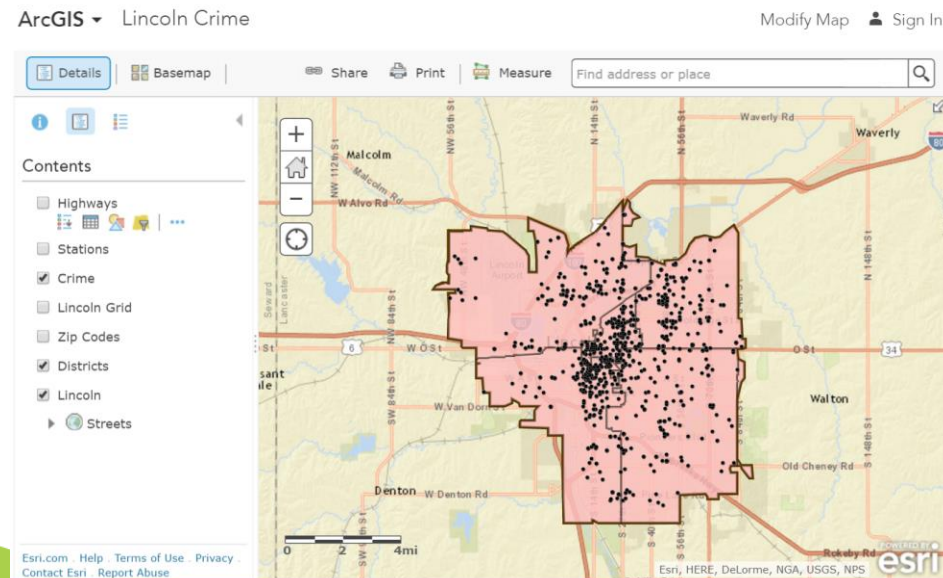
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Enriched Intersect of Dissolved 200m Floodplain Buffers Major Geol Haz... (27 features, 0 selected) Table Options ▾ ✕

Top 1 Code	Top 1 Name	Top 1 Value	Top 1 Percentage	Top 1 Type	Top 1 Median Age	Top 1 Income	Top 1 Employment	Top 1 Education	Top 1 Residential	Top 2 Code
2.00	Metropolitans	20.00	100.00	Singles / Shared	37.60	Middle	Professional / Mgmt.	Some College / Bachelor Degree / Graduate Degree	Single Family / Multi-Units	1.00

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 are 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.

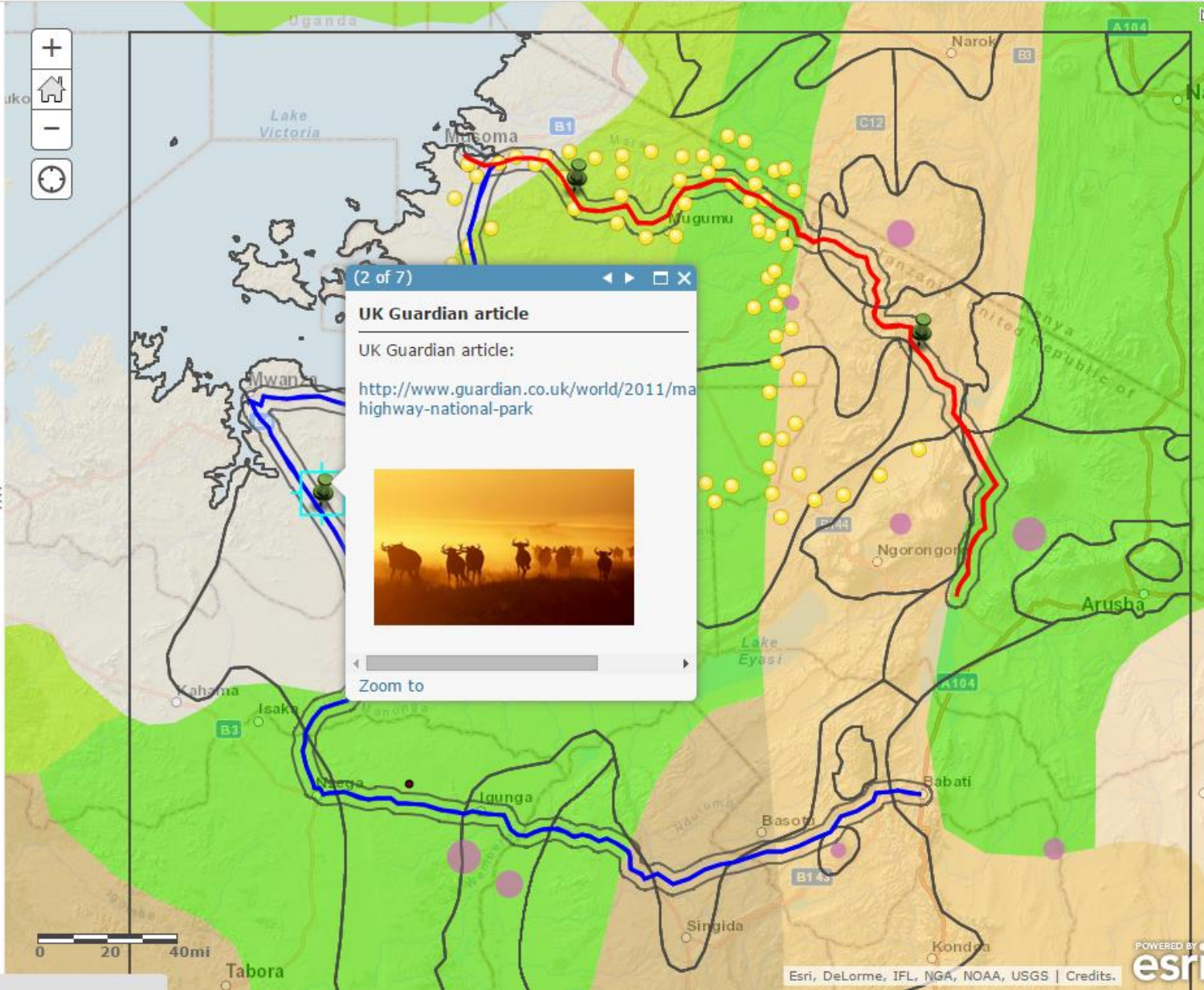
You will consider the two routes proposed, wildlife migration, ecoregion, elevation, total length. Specifically: wildlife migration within 5 km from proposed roads, length of roads within each ecoregion.

- Home
- Features
- Layers
- Gallery
- Help

- 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
- Extension of the World

Share | Print | Measure | Bookmarks

Find address or place



(2 of 7)

UK Guardian article

UK Guardian article:

<http://www.guardian.co.uk/world/2011/mar/highway-national-park>

Zoom to

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.

The image shows a banner for the Esri MOOC Program. At the top left is the Esri logo. To its right are navigation links: Industries, Products, Support & Services, About, and Community. A search box is on the far right. The main banner has a green background with the text 'Going Places with Spatial Analysis' in white. Below the title, it says 'May 11, 2016 - June 22, 2016'. At the bottom of the banner, it says 'Free Online Course - Sign Up Now to Join.' and a blue button labeled 'Count Me In'. On the right side of the banner, there is a small inset image showing a map interface with a legend and a scale bar.

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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