Analyzing Cholera in 1854 in London
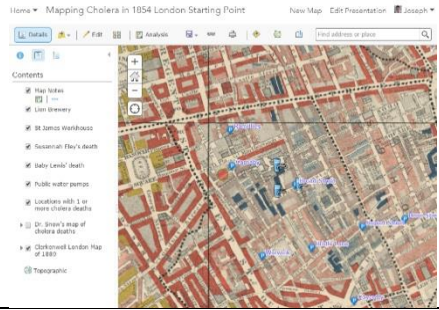
Summary	Analyze the August-September 1854 Cholera epidemic in London using ArcGIS Online.	
Disciplines	Health, Geography, History, GIS.	
Level	University and upper secondary.	
Time Required	2-3 hours.	
Tools Used	ArcGIS Online from Esri. www.arcgis.com. Requires an organizational subscription. Requires broadband web connection.	
Teaching Methods	Ideal: Each student runs the lesson on his or her own device (tablet or laptop). Alternative: Instructor runs with 1 computer and projector, guiding students in engaged discussion and instruction.	
Prerequisites	Some GIS background in analysis very helpful. Some knowledge about the London 1854 cholera epidemic helpful.	
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1. Analysis I: The Setting and Study

- Search for and open Mapping Cholera in 1854 Starting Point: http://esrit3g.maps.arcgis.com/home/webmap/viewer.html?webmap=87c0f79108e246d49f97a6cfe4fce157 by author t3gjjkerski.
- Log in to your account in ArcGIS Online. Examine your "My Content" zone in ArcGIS Online. Create a folder called "cholera". Save the map in your cholera folder.
- Examine Dr. Snow's original map. Discuss the pros and cons of the map symbols he used.
- Examine the 1889 Clerkenwell map. Examine how this area of London has changed from the 19th Century to today, and how it has remained the same.
- Examine the location of Baby Lewis' death and note its proximity to one of the public water pumps. Read in the popup why her death was important to Dr. Snow's study.
- Examine the location of Susannah Eley's death and read in the popup why her death was important to Dr. Snow's study.
- Examine the location of the St James Workhouse and the Lion Brewery, read the information about them in the popup. Examine the pattern of the cholera deaths in and near the workhouse and brewery, and discuss the implications of each.

- Examine the location of the Pesthouse Field, read the information in the popup, and discuss the implications.

2. Analysis II: Style, Tabular Analysis, Scale
- **Change Style** for Locations with 1 or More Cholera Deaths from Show Location Only to Deaths using Counts and Amounts (Size). Analyze the pattern.
- **Show Table** for Locations 1 or More Cholera Deaths and examine the attributes. Sort in descending order on Deaths to get a sense for the range. Note that there are 322 features (points) in the data set. Select Deaths > Statistics, and note the sum of values (578 deaths).
- **Change Style** to Heat Map; experiment with Area of Influence slider bar. When done, change style back to Show Location Only.
- **Show Table** for Public Water Pumps and examine the attributes.
- **Measure Distance** from east to west across the study area, and between a few of the public water pumps using the Measure tool to get a sense for the scale of the study.

3. Analysis III: Proximity
- **Filter** pumps to select the Broad Street Pump (name=Broad Street; use "unique" to see the names and then choose Broad Street).
- **Analysis > Use Proximity > Create Buffers -** Buffer the Broad Street pump by 500 feet.   Name result Buffer 500 ft Broad St. Save to your cholera folder.
- **Analysis > Use Proximity > Create Drive Time Areas >** (1) Public Water Pumps > (2) Walking Time 2 minutes > (3) Overlap > (4) Name resulting layer as "Walk Time 2 Min Broad St" and save to cholera folder. Change the style if you'd like. Compare the shape of walking time to Broad Street Pump vs. the shape of the 500 foot buffer and the reasons for the differences.
- **Remove Filter** for the public water pumps, and **Buffer** *all* pumps by 500 feet. Name resulting layer Buffer 500 ft All Pumps. Note the patterns.
- **Analysis > Summarize Data > Summarize Within** Points within 500 feet of pumps: (1) Choose area layer to summarize: Buffer 500 ft All Pumps > (2) Choose layer to summarize: Locations of 1 or more cholera deaths > (3) Add statistics: Deaths > For statistic, select "Sum." > (4) Choose field to group: None.   > (5) Result layer name: Summarize Deaths within 500 ft of Pumps.
- Analyze resulting table for your Summarize Deaths layer: Examine the "count of points" vs. "Sum Deaths". What were the 3 top pumps in terms of deaths?
- Save map, share map, discuss sharing options.
- Populate the **metadata** for your map by using the Information button to the upper left of your map > More Details. Discuss metadata and discuss the implications of the fact that you are now a data producer—creating data in the ArcGIS Online cloud.
- Explore your "My Content" zone. Note the many layers you have created thus far.

4. Analysis IV: Routes
- **Analysis > Use Proximity > Find Nearest –** to create a visualization of the nearest pump to each cholera death: (1) Choose layer from which nearest locations are found: Location of 1 or more cholera death > (2) Find nearest locations in: Public Water Pumps > (3) Measure: Line Distance >

(4) For each location in the input layer: Uncheck "limit the number of nearest locations". For Limit the search range, choose 500 feet. > (5) Result layer name: Nearest Water Pump to Cholera Deaths. Analyze results and discuss implications.

- **Show Table** of your resulting "nearest" map. What is the shortest straight line distance between a pump and a cholera death? Which water pump does this line connect? What is the shortest distance between the Broad Street Pump and a cholera death?
- **Analysis > Use Proximity > Plan Routes –** Plan the route of John Snow and his assistant to visit each **house** to discover where cholera deaths had occurred. > (1) Choose point layer representing stops to visit: Locations of 1 or more deaths > (2) Travel mode for routes: Walking time. > (3) Routes begin at: Add a point to the map at Dr. Snow's "office location" at the intersection of the two major streets Oxford Street (East-West) and Charing Cross Road (North-South), which lies to the northeast of the points. Start time: Leave this alone, thus defaulting to the current time. > (4) Routes end at: Return to Start. > (5) Maximum number of vehicles to route: 2 "vehicles" - in other words, 2 people walking: Given the critical nature of the situation and the need to cover a great deal of ground in the shortest time possible, Dr. Snow will be walking to each location with Reverend Whitehead. > (6) Maximum number of stops per vehicle = 200. > (7) Time spent at each stop: 5 min. > (8) Limit the total route time per vehicle to 48 hours. Again, given the critical nature of the situation, they need to complete their work in under 2 days. > (9) Result layer name: "Route to Locations with Cholera Deaths", and place in cholera folder.
- **Show Table** of your Route to Locations with Cholera Deaths.   Which of the two routes contains more stops? What is the total time in minutes for the route with more stops? In hours? Will the two men be able to complete their work in under 48 hours?
- **Show Table** of your Route to Locations with Cholera Deaths – Assigned Stops.   This is the table Dr. Snow and Reverend Whitehead will use to visit each point. Do you think it would have taken more time to visit each stop in 1854 than today, or less time? Why?
- **Show Legend** of your two new route layers. Which route – Route 1 or Route 2 – covers mostly the west half of the points? Which covers mostly the east half of the points?
- **Analysis > Use Proximity** > **Plan Routes –** so that Dr. Snow can sample the water quality at each pump. > (1) Choose point layer representing stops to visit: Public Water Pumps. > (2) Travel Mode: Walking Time. > (3) Routes begin at: Add point to map at his "office location" at the intersection of Oxford Street and Charing Cross Road, northeast of the cases. Start time: Leave this alone, thus defaulting to the current time. > (4) Routes end at – Return to Start. > (5) Max "vehicles" = 1. > (6) Max number of stops per vehicle = 50. > (7) Time spent at each stop to examine water quality: 20 minutes. > (8) Limit total route time per vehicle: Uncheck: Do not limit the total time. > (9) Result layer name: "Route to Pumps" and place in cholera folder.
- **Show Table** for the Route to Pumps layer. What is the total time required for Dr. Snow to visit each pump and test the water, in minutes? In hours?
- Summarize what you have learned about the 1854 cholera epidemic in a few paragraphs, including how spatial thinking and the use of web maps and analysis helped you to understand the situation. If time, give a short presentation to your peers about what you have learned. If time, create an ArcGIS presentation from your web map and layers, or a story map web mapping application, to support your presentation. ◆