Assignment 9-1: Analyze geographic access to Federally Qualified Health Centers and Shelters (50 points)

Emergency officials, city planners, and health and human service organizations rely on GIS proximity tool to assess population access to many health-related facilities including hospitals, clinics, pharmacies, shelters, etc. Federally Qualified Health Centers (FQHCs) provide subsidized, health services to underserved poor populations. There are 17 FQHCs in Pittsburgh, well-located in poverty areas and determining population access to these to these is done using proximity buffers. Shelters in Pittsburgh are important social services for at risk populations such as the homeless, victims of domestic violence, or those in need of shelter from a natural or other man-made disaster.

In this assignment, you'll compare two methods of estimating the number of persons who have good geographic access to FQHCs: buffers versus service areas (travel time polygons) computed using Network Analysis. You will also use Esri's online network tools to determine walking distances to shelters and the populations that are in the proximity of those shelters.

Get set up

Rename the Assignment9-1folder to **Assignment9-1YourName**. Open Assignment9-1.aprx.The needed map layers are already included in the map FQHC Drivetime Study:

- **PittsburghBlockCenterPoints**, center points for block polygons with POP10 = 2010 population attribute
- **FQHC**, FQHC points with Name = name of FQHC
- **Shelters**, overnight shelters in the City of Pittsburgh, downloaded from the Allegheny County Health and Human Services website
- **PittsburghStreets_ND**, street network created from TIGER files using average travel times by street type (as in tutorial 9-5)
- **Pittsburgh**, outline of city

Requirements for FQHC Proximity Study

- Suppose that a travel time of three minutes or less by car to an FQHC is considered good geographic access. Given a street network, it's easy to estimate three-minute travel time polygons for the FQHCs.

- For buffers, you need a buffer radius that roughly approximates three-minute maximum travel times. Suppose that non-rush-hour urban traffic—including stops, turns, and so on—averages 15 miles per hour overall. Using 15 miles per hour (or 15/60 miles per minute), three minutes corresponds to 1-mile radius buffer for straight-line travel from a residence on the buffer's perimeter to an FQHC. Of course, travel distance for residences on the buffer's perimeter where turns are necessary to get to a FQHC would be longer than 1 mile.

- Create 1-mile, dissolved buffers for the 17 FQHCs in Pittsburgh.
- Create dissolved 3-minute service area polygons for the same FQHCs using PittsburghStreets_ND (not arcgis.com) as the Network Data Source. This will save you credits. Assume that any block center point that is inside a buffer or service area has good access to one or more FQHCs (even though parts of some blocks will be outside the buffers or service areas).
- Determine the population and percent total population that has good geographic access to FQHCs based on buffers and service areas.

	Population	**Percentage**
Buffer		
Service Area		
Total		

Requirements for Shelter Walkability Study

- Open the map Shelter Walkability Map and change the network data source from the local Pittsburgh streets to www.arcgis.com. Note that this service will cost credits, but you will create just two buffers around 8 shelters. Generating service areas uses 0.5 credits per service area based on the number of facilities so you will use only 8 credits.

- Use Shelters as the Import Facilities, use Walking Time as the Mode, and 5, 10 as the Cutoffs. Under Output Geometry of the Service Area table choose Dissolve.

- Determine the population and percent total population that has good walking geographic access to shelters.

	Population	Percentage
0-5 Minute Walking Buffer		
5-10 Minute Walking Buffer		
Total Population		

Layouts, figures, and a report

- Create a layout that includes your finished map with FQHCs, buffers, travel-time polygons, block population points, and Pittsburgh outline layers turned on. Include a legend. Export the layout as **Assignment9-1FQHCYourName.jpg.**

- Create a layout that includes your finished map zoomed to the shelter buffers, walk travel-time polygons, streets, and Pittsburgh outline layers turned on. Include a legend and a map scale. Export the layout as **Assignment9-1SheltersYourName.jpg.**

- Create a Microsoft Word document called **Assignment9-1YourName.docx** that includes your layouts as Figures 1 and 2 and includes the statistics requested above as Tables 1 and 2. Include a sentence about your observation about the buffer estimates compared to the superior service-area estimates for FQHC and a sentence about the population with access to overnight shelters.

What to turn in

Compress and upload your Assignment9-1YourName folder as a .ZIP file to Canvas under Assignment9 > Submit Assignment.

Assignment 9-2: Carry out a cluster analysis of tornadoes (50 points)

GIS is used by many infrastructure related organizations to aid in natural disasters such as fires, floods, earthquakes, and tornadoes. This assignment will focus on tornadoes. A tornado is a rotating column of air, a condensation funnel that is generally visible, touching the ground, and extending up to a cumulonimbus cloud. Tornado intensity is measured by the enhanced Fujita (EF) scale.

According to the National Oceanic and Atmospheric Administration (NOAA) preliminary data there were 1,376 tornadoes in the United States in 2021, compared with 1,075 in 2020. Tornadoes killed over 100 people in 2021. In 2020, 76 people perished in tornadoes. As a result of population growth and economic development it is clear that property losses are also increasing. According to catastrophe modeling company RMS, insured losses in the United States from these storms average about $17 billion each year, nearly equal to the losses incurred by hurricanes.

While a tornado can appear almost anywhere, the greatest number in the United States occur in the "Tornado Alley", an area including Texas, through Oklahoma, Kansas, Nebraska, Iowa, and South Dakota, but tornado formation is now tending to develop further east. In this assignment, you will explore tornadoes from 2000 through 2008 that had at least one injury or fatality each.

You'll use k-means clustering, combining several measures of impact, to identify areas with the most fatalities, injuries, and damages: are they inside or outside of Tornado Alley?

Get set up

Rename the Assignment9-2 folder to **Assignment9-2YourName**. Open Assignment9-2.aprx. Following are definitions of attributes that you'll use from the tornadoes feature class:

- **F_SCALE** = Fujita Tornado Damage Scale:
  - 0 = light damage (winds , 73 MPH, shallow trees blown over)
  - 1 = moderate damage (73-112 MPH, mobile homes pushed off foundations)
  - 2 = considerable damage (113-157 MPH, mobile homes demolished)
  - 3 = severe damage (158 – 206 MPH, most trees in forest uprooted)

    - 4 = devastating damage (207-260 MPH, well-constructed houses leveled)
    - 5 = incredible damage (261-318 MPH, automobiles fly through the air for over 100 meters, trees debarked)[1]
- **AREA** = area hit by tornado (tenths of miles squared)
- **DAMAGE** = property damage in $ millions
- **INJ** = number of injuries
- **FATAL** = number of fatalities

The "distances" of 1 between values of F_SCALE category numbers (0, 1, 2, 3, 4, 5) clearly do not represent a measure of relative cost or impact of tornadoes. You'd expect the distance between categories to increase as tornadoes become more damaging. As an estimate, you'll use the square of F_SCALE (F_SCALE_Sqd = 0, 1, 4, 9, 16, 25) for clustering.

Note that while you can modify the weight or distance between values in an attribute such as F_SCALE, all numerical input attributes are equally weighted amongst themselves because Multivariate Clustering automatically standardizes all numerical input attributes. Therefore, even though you might determine that injuries are twice as important as damages and that fatalities are three times as important as damages, Multivariate Clustering gives all three of these attributes the same weight for clustering purposes.

Run k-means clustering

Use the following with the Multivariate Clustering tool:

- **F_SCALE_Sqd**, **AREA**, **DAMAGE**, **INJ**, and **FATAL** as inputs
- Seeds from the field, Seed (which has 5 rows with Seed = 1 and therefore leads to 5 clusters)

[1] http://www.spc.noaa.gov/faq/tornado/f-scale.html

Interpret and symbolize grouping results

Create a table: Calculate means of input attributes by cluster and create meaningful labels for each of the groups in a table for the means and on your map.

Show three categories for each cluster and attribute: High, Medium, and Low. For example, for clusters assign High Impact, Medium Impact, and Low Impact; for FATAL assign High Fatalities, Medium Fatalities, and Low Fatalities; and so forth.

Change colors to show impact (for example, with red being high impact, orange being medium, and pale yellow being low). Make the symbol sizes large to small by category of impact.

Note: There are five groups. *Three groups will be assigned as low impact, one as medium impact, and one as high impact*. Edit the legend in the layout to combine the three low impact groups as one symbol.

Present results

On your map, select states Texas, Arkansas, Oklahoma, Kansas, Nebraska, South Dakota, and Iowa to represent Tornado Alley.

Make a layout with your map and legend and export it to your assignment folder as **Assignment9-2YourName.jpg**.

Create a short report in Microsoft Word, **Assignment9-2YourName.docx**, including your table of means and labels as Table1 and the layout as Figure1.

Briefly describe how you got the clusters (in tornado attribute space). Discuss your map in terms of Tornado Alley. For example, how do your results for Tornado Alley compare to the rest of the United States using impact as the criterion?

What to turn in

Compress and upload your Assignment9-2YourName folder as a .ZIP file to Canvas under Assignment9 > Submit Assignment.