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**GIS Midterm:**

**Section 1: Spatial Distribution of Fracking Wells (30 points)**

We will start our analysis by examining the spatial distribution of fracking wells. For this, you will need the fracking\_wells.shp and PA\_county.shp from the Midterm materials folder. fracking\_wells.shp contains the location of fracking wells in Pennsylvania for the year 2020. Data were collected by fractracker.org.

**Open PA\_county.shp and fracking\_wells.shp in the software of your choice, and answer the following questions: (5 points)**

1. **How many features are in each layer?**

* There are 23,379 features in the fracking\_wells shapefile
* There are 67 features in the PA\_county shapefile

1. **What is the name and EPSG code of the Coordinate Reference System for this geographic boundary file?**

* EPSG:3650 - NAD83(NSRS2007) / Pennsylvania North (ftUS)

1. **What are the units?**

* The units are in feet for both shapefiles

**To examine the spatial distribution to fracking wells, create a Kernel Density (Heatmap) of fracking wells. Set the radius to 100 kilometers and in symbology, select an appropriate color ramp, set mode to continuous with five classes. Overlay the KDE layer with the fracking wells layer. Paste the map below. (10 points)**

* Tip 1: When setting the resolution (i.e., pixel size), set the row to 1000. Adjust the resolution (increase or decrease) if needed.
* Tip 2: save the kernel density raster file, you will need it later!)
* UPLOAD MAP IMAGE

**What does the kernel density map tell us about distribution of fracking wells in Pennsylvania? Does it seem like wells are randomly distributed across PA? If not, what spatial point pattern process does it seem to follow? (5 points)**

* The kernel density map of fracking wells in Pennsylvania indicates that the distribution is not random. Instead, it reveals distinct clusters of wells located in the North East and South Western regions of the state. This pattern suggests that fracking wells are not evenly distributed across Pennsylvania but rather follow a “Clustered Point Process”. This clustering distribution pattern could be due to various factors such as geological conditions, economic incentives, or regulatory considerations that have led to the clustering of these wells in specific areas.

**Inferences based on visual inspections are good, but statistical tests are better. Use Ripley’s-K function to determine if fracking wells are randomly distributed across PA, and if not, the point pattern process it follows. Paste Ripley’s K function below and interpret the findings. (10 points)**

* Tip: the large number of fracking wells in PA will require large amounts of computational power to calculate Ripley’s K—most computers will not be able to handle this. To get around this problem, select a random sample of 500 fracking wells, and run Ripley’s K function on subset. Use the following syntax to get your random sample:

                       # Read in fracking wells

                        frack <- st\_read("fracking\_wells.shp")

                        # Make random selection

                        frack %>%

                        sample\_n(500) -> frack\_500

sample\_n is a function from the tidyverse package. Make sure you load this package before using.

(Even with 500 wells, it will take a little time. Be patient.)

* PASTE Ripleys K plot
* Based on the Ripley's K plot and summary statistics, fracking wells in Pennsylvania are not randomly distributed but rather follow a clustered point process as mentioned earlier. The isotropic curve is above the theoretical curve which indicates a clustering of fracking wells across the state. This Ripley's K analysis shows that the observed K function is above the theoretical K function, indicating clustering of fracking wells at all scales. In summary, the Ripley's K analysis suggests that fracking wells in Pennsylvania are significantly clustered as the observed K function exceeds the theoretical K function at all distance scales, indicating strong evidence of a clustering pattern.

### Section 2: Potential Causes of Fracking in PA (25 points)

1. There are two types of potential explanations for the spatial distribution of fracking sites: first order and second-order effects (5 points)
   1. Provide an example of a first-order effect that may explain some spatial variation in Pennsylvania fracking wells.
   2. Provide an example of a second-order effect that may explain some spatial variation in Pennsylvania fracking wells.