Spatial Statistics

Assignment No 7

Local Spatial Autocorrelation

Anselin Local Moran ‘s I

Muhammad Bilal
Matriculation: - 12214473

Q.No.1
Study Area (one primary many secondary craters): -

To start by selecting crater points that shows one primary crater has many secondary craters an area on lunar surface as shown in figure 1.

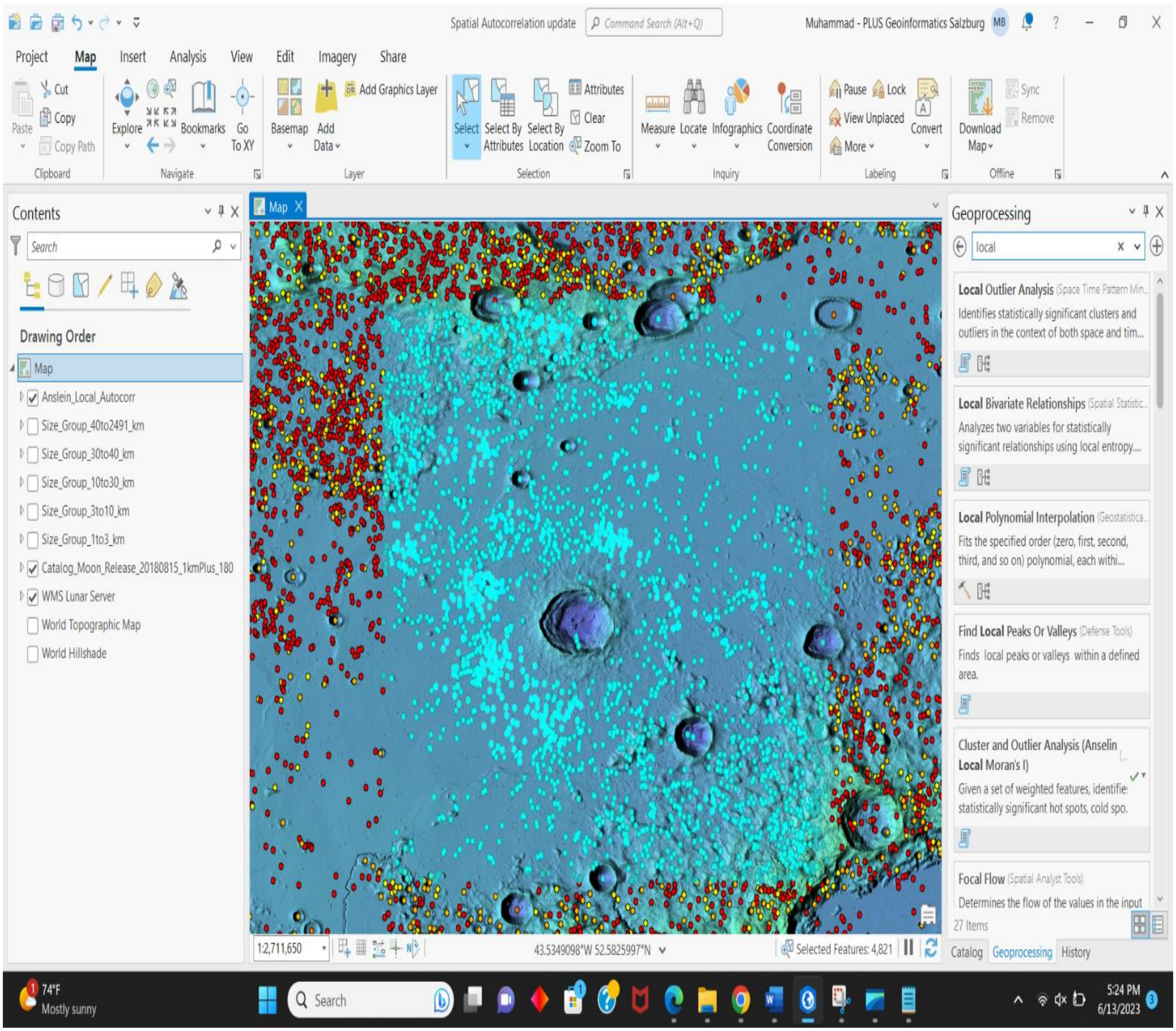

Figure 1

Q.No.2
Calculate Local Spatial Autocorrelation for study area.

For that purpose, I used Cluster and Outlier Analysis (Anselin Local Moran's I) tool in ArcGIS Pro. local spatial autocorrelation calculates spatial autocorrelation statistics for each individual location in the dataset. This allows for the identification of spatial clusters and outliers at the local level. Below in figure 2 you can see the parameters set for this tool.

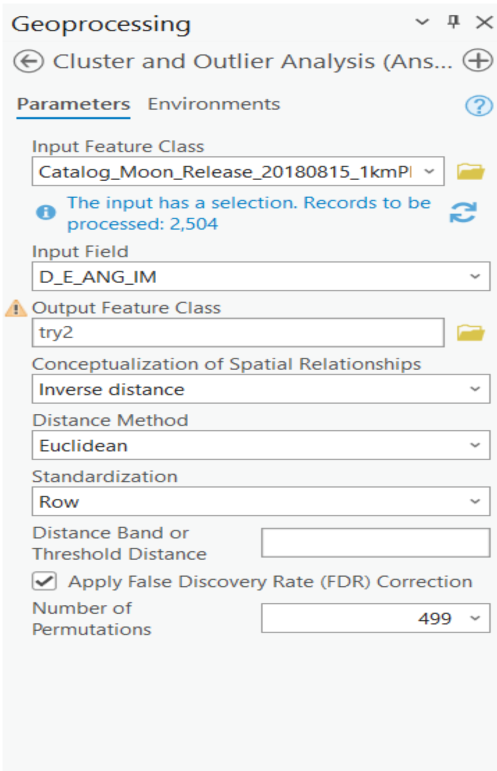

Figure 2

Permutations: - This assesses the statistical significance of the local Moran's I value obtained from observe data. It helps determine whether the observed spatial patterns are statistically significant or if they could have occurred by chance.

The procedure involves randomly shuffling the attribute values among the spatial locations while keeping the spatial relationships intact. This generates a null distribution of local Moran's I value under the assumption of no spatial autocorrelation. By comparing the observed local Moran's, I value with the null distribution, we can determine if the observed values are statistically significant.

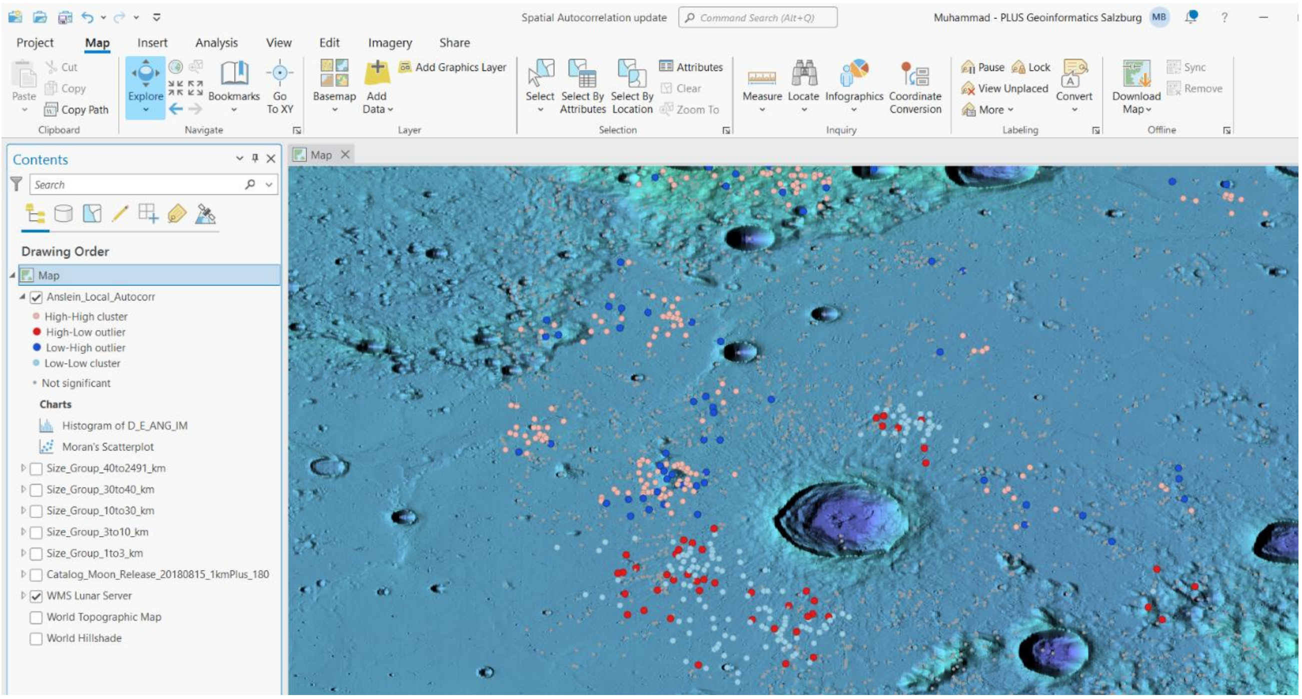

Figure 3

The tool gives 3 types of result the first is

1: - Local spatial autocorrelation value can be classified into four categories:

- High-High (HH): Locations with high values surrounded by other locations with high values, indicating spatial clusters of similar high values.
- Low-Low (LL): Locations with low values surrounded by other locations with low values, indicating spatial clusters of similar low values.
- High-Low (HL): Locations with high values surrounded by other locations with low values.
- Low-High (LH): Locations with low values surrounded by other locations with high values.

2: - There is also histogram that shows the distribution of craters in terms of their orientation.

3: - Lastly there is Moran's Scatter Plot that helps visualize the spatial autocorrelation patterns of the analyzed attribute values at each location. It consists of two axis. X-axis: The attribute values for each location. Each point on the X-axis represents the attribute value at a specific location. Y-axis: The spatial lag or the average value of the neighboring locations' attribute values.

Below in figure 4 Points that cluster in the upper-right quadrant indicate positive spatial autocorrelation. Points that cluster in the lower-left quadrant indicate negative spatial autocorrelation.

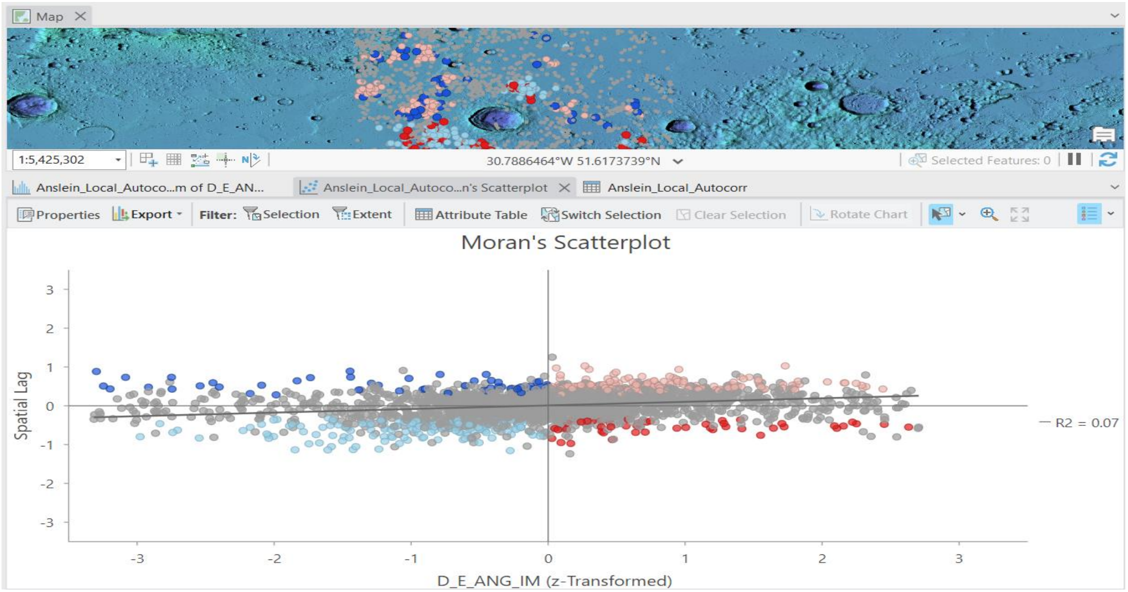

Figure 4

Q.No.3
Which craters presumably stem from materials that were ejected due to the primary impact (secondary cratering)?

To analyze which craters are secondary craters ejected due to primary impact. We will observe the histogram after selecting the High-High and Low-Low values from local Moran's I output because these values represent spatial autocorrelation among craters. If there are prominent peaks or clusters of bars on the positive or negative side of the X-axis, it indicates the presence of significant spatial clusters or patterns of positive or negative spatial autocorrelation. So, on the basis of that analysis the crater which is in pink color(H-H) or light blue color(L-L) tend to be originated from primary crater.

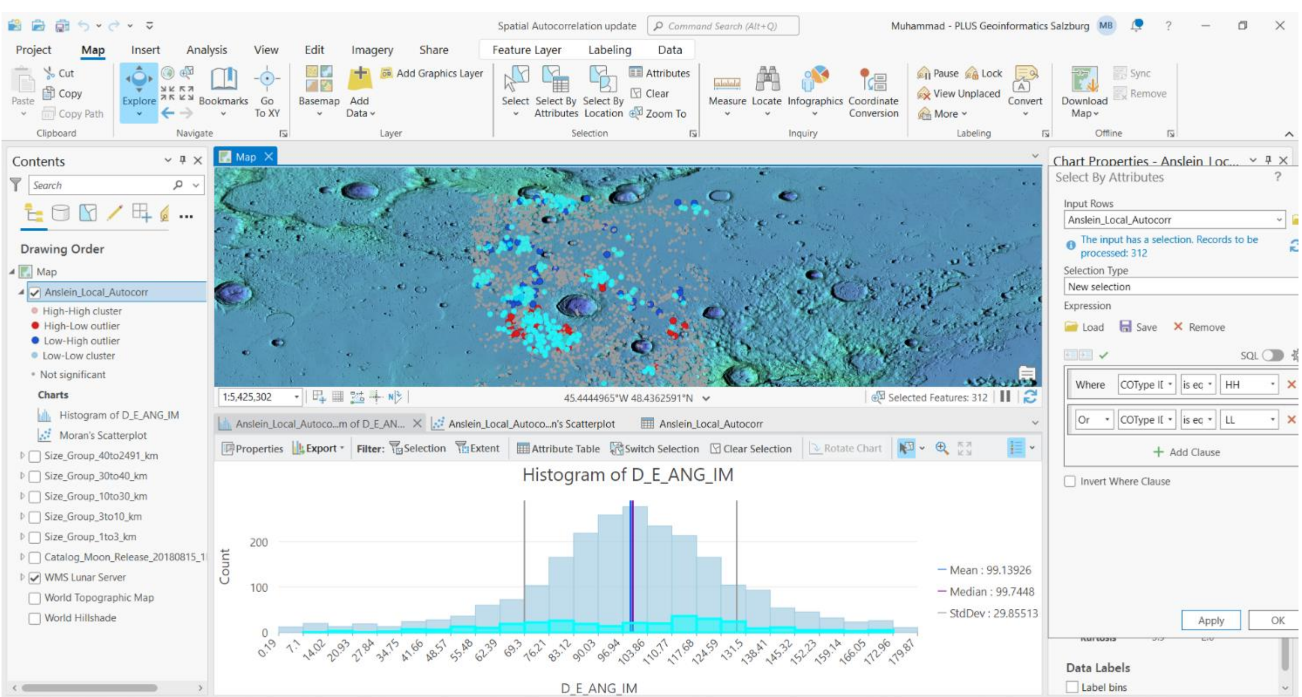

Figure 5

Q.No.4
What is FDR correction? Why do we use FDR correction in the case of local autocorrelation analysis?

False Discovery Rate Correction is a method used to adjust sudo p values in multiple hypotheses testing scenarios. It addresses the issue of type 1(false positive) error when conducting multiple hypotheses testing simultaneously. FDR is used to examine the significance of local Moran's I value at each location in the dataset and conducting hypotheses test for each location without FDR correction led to the risk of type 1 error.

By applying FDR correction, it reduces the significance level that reduces the type 1 error helps to minimize the risk of incorrectly identifying spatial clusters or outliers due to random chance.

Q.No.5
Select and export craters to a new layer that show significant autocorrelation on a 1% significance level. The probability for what error type increases as the significance level is decreased. Explain in a few words why the probability for this error type increases

After FDR statistical test applied while calculating local Moran's I for each observation I got significance level close to zero e.g., 0.002, 0.006, 0.008 for my different classified layers like HH, LL, HL, LH. I export those locations into a new layer as shown in figure 6.

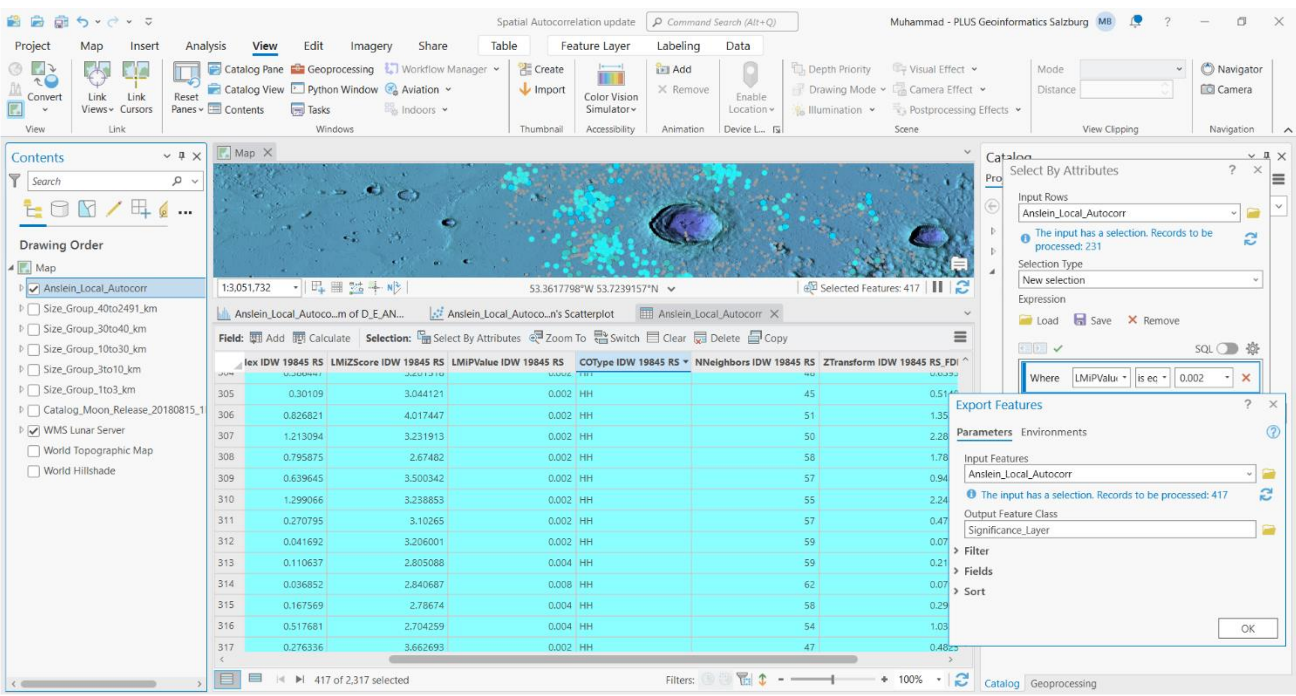

Figure 6

The decrease in the significance level gives the chance to increase the type 2 error that is false negative error. If we set more strict value for determining statistical significance it becomes more difficult to reject null hypothesis when it is actually false, So type 2 error increases.