Chapter 41: Local Index of Spatial Association Tools (LISA)

Local Index of Spatial Association (LISA) methods are a set of functions that give some sense of spatial sampling density and spatial variability. Three types are available in SADA: Moran's I, Ripley's K, and Geary's C.

Ripley's K

A formal Ripley's K implementation is used to assess the spatial pattern of point data. This method is used often in epidemiological studies to determine if there is any clustering in disease events. We use a similar method here to determine if there is any clustering in the sample data. It is more accurate to say, we use it to determine where areas of low sampling density are found. These areas may be candidate for new sample locations (see secondary sampling designs chapter). This provides some measure of improvement over adaptive fill which considers only gaps defined by nearest neighbors.

Let's begin with a description of Ripley's k. This method basically measures the average number of points within a certain distance of each other. In particular a window of size h is centered about each point and the number of points found within the window is computed. This window is then moved to every point and the number is recomputed. These values are then averaged producing producing an average value for the distance window h. The estimator for K(h) is given as

$$\hat{K}(h) = \frac{\sum_{i=1}^{N} \sum_{j=1(j \neq i)}^{N} w_{ij} I(h_{ij} \leq h)}{\lambda N}$$

Where λ= N/|A| where N is the number of samples, A is the area of the site and w_{ij} is a spatial weight used to account for edge effects near the boundary.

In SADA we produce a moving window of sample counts over an extent of grid nodes.

For a specific distance of h, SADA will create a continuous map of count data using a defined base grid. For each grid node, SADA will compute the number of points within a distance h. This can provide a sense of the spatial distribution of clusters for a given distance h.

Moran's I

Moran's I is another measure of spatial autocorrelation usually used in exploratory data analysis (geostatistical measures are discussed in the chapter on advanced geospatial methods). The statistic is calculated in much the same spirit as Ripley's K in the sense that a moving window of radius d is postioned at data points around the site and the weighted variance of data points within the window are computed. The weighting methods can vary. If this is repeated overall measurements for a distance d, then we have Moran's I estimate at distance d. The statistic is expressed as follows.

$$I(d)=\frac{\frac{\sum_i^N \sum_j^N w_{ij}(d)(x_i-\bar{x})(x_j-\bar{x})}{\sum_i^N \sum_j^N w_{ij}(d)}}{\frac{\sum_i^N (x_i-\bar{x})^2}{N}}$$

In SADA for specific value d_0, we show the local variance within a window centered at each node.

Geary's C

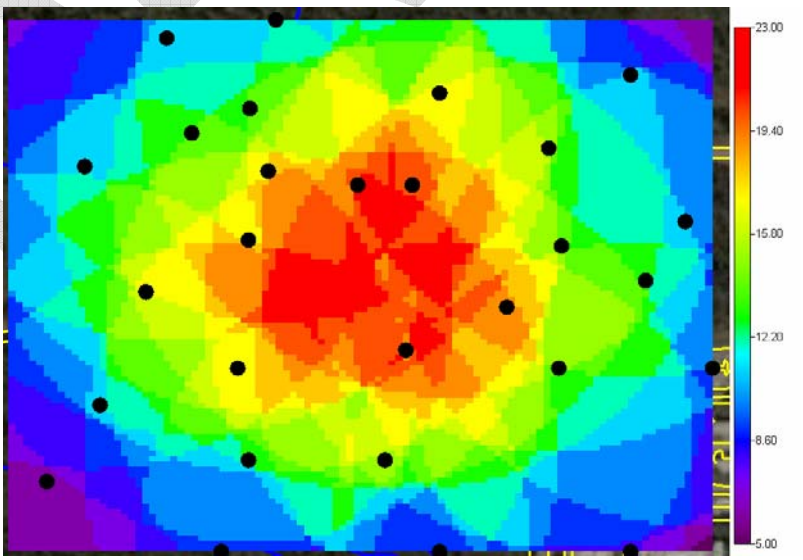
This is another method in assessing spatial variance. In Geary's C we compute semivariance as follows.

$$c(d)=\frac{\frac{\sum_i^N \sum_j^N w_{ij}(d)(x_i-x_j)^2}{2\sum_i^N \sum_j^N w_{ij}(d)}}{\frac{\sum_i^N (x_i-\bar{x})^2}{(N-1)}}$$

In SADA for specific value d_0, we show the local variance within a window centered at each node

Using LISA Tools in SADA

Open the file LISA.sda. Make sure you've selected Genearl, Soil, and Ac-225. Select Draw a LISA map from the drop-list of available interviews. First we'll set the grid up. The moving windows in each of these three methods will be centered over each node of the grid. Click on setup the grid step. Note that it is 100x100. Now click on the step Set LISA Parameters. Set the search radious to 1000. First select Ripley's K and press show the results.



The result is a map of the number of data encountered within a window size of 1000 when centered over each grid node. Now try both Moran's I and Geary's C yourself

