

Kriging Statlet

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Summary

This Statlet implements a procedure called Kriging, which is widely used to analyze geospatial data. Given a set of measurements taken on a variable at various locations within a two-dimensional region, estimates are derived for the value of that variable throughout the region. The primary output is a map of the estimated value, together with the variance of the estimate.

Sample StatFolio: *krigingstatlet.sgp*

Sample Data

The file *BroomsBarn.sgd* contains a widely analyzed set of data obtained at the Rothamsted Agricultural Research Center in the UK. Soil samples were taken at 435 locations throughout a 77 ha field at Broom’s Farm Barn. Measurements were made of the exchangeable potassium, pH, and available phosphorus of each of the samples. A small section of that data is shown below:

East	North	K	pH	P	X1 Boundary	X2 Boundary
20	940	26.0	7.2	5.5	0	1240
20	980	22.0	7.2	5.2	0	920
20	1020	18.0	6.8	2.6	40	740
20	1060	19.0	6.4	1.3	80	540
20	1100	26.0	6.1	1.3	80	0
20	1140	23.0	6.6	6.9	140	0
20	1180	32.0	7.8	6.6	220	160
20	1220	28.0	8.0	7.8	260	240
60	740	55.0	6.8	2.6	300	240
60	900	19.0	6.0	1.0	360	40

The samples were taken at 40-m intervals at locations defined by the *East* and *North* columns.

Data Input

To analyze the data, enter the names of the variables into the following data input dialog box:

- **Y:** numeric column containing the data to be analyzed.
- **X1:** numeric column containing the location of the samples in dimension #1. The locations may be in any units and do not have to be regularly spaced.
- **X2:** numeric column containing the location of the samples in dimension #2. The units should be the same as *X1* so that valid distances between samples may be calculated.
- **X1 Boundaries:** numeric column containing the coordinates of the region's boundary points along the horizontal dimension.
- **X2 Boundaries:** numeric column containing the coordinates of the region's boundary points along the vertical dimension.
- **Select:** subset selection.

In the discussion below, $X_{i,j}$ represents the *i*-th value of the *j*-th variable, for $i = 1, \dots, n$ and $j = 1$ or 2.

Note that the samples do not need to be located on a rectangular grid, although they often are.

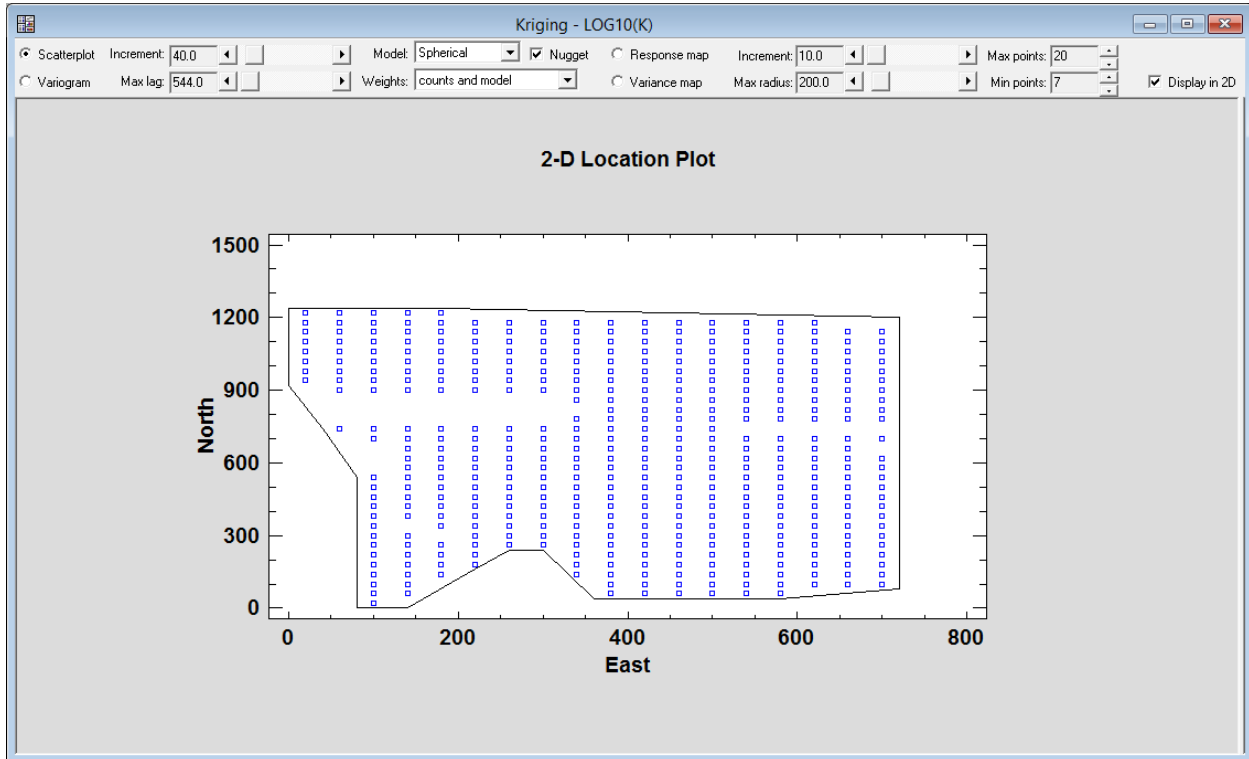
The boundary columns define the region to be Kriged by specifying a set of coordinates that may be connected to form an enclosed polygon. For the sample data, the boundary points are:

X1 Boundary	X2 Boundary
0	1240
0	920
40	740
80	540
80	0
140	0
220	160
260	240
300	240
360	40
580	40
720	80
720	1200
180	1240
0	1240

To form a closed boundary, the last point should be identical to the first.

Analysis Window

To execute the procedure, select *Statlets – Kriging* from the Statgraphics menu. This will display an analysis window similar to that shown below:



The toolbar contains a number of controls that allow you to specify desired options:

- **Scatterplot:** Select this button to display a plot of the locations at which data was collected. If you uncheck the *Display in 2D* checkbox, both the locations and the observed response will be plotted.
- **Variogram:** Select this button to display the experimental variogram. The variogram measures the variance between pairs of points located a distance h apart from each other, as a function of h .
- **Increment:** Specifies the distance between estimates of the variogram.
- **Max lag:** Specifies the largest lag distance at which the variogram will be calculated.
- **Model:** Specifies the type of model used to describe the experimental variogram.
- **Weights:** Specifies the weights used by the nonlinear least squares algorithm when fitting the variogram.

- **Nugget:** Indicates whether to include a term in the variogram model called the *nugget*, which is the value of the variogram for a lag equal to 0. If not included, the variogram will be forced to pass through the origin.
- **Response map:** Plots the estimated response throughout the region where data was collected. The estimated response is obtained by Kriging.
- **Variance map:** Plots the estimated variance of the response estimate throughout the region.
- **Increment:** Specifies the distance between response estimates, which are calculated on a rectangular grid.
- **Max radius:** An observation is only included in the estimated response if the distance between the location of that observation and the target location does not exceed this value. This requirement is overridden if there are less observations within the specified radius than the *minimum points* setting below.
- **Max points:** Specifies the largest number of points that may be included in the estimate.
- **Min points:** Specifies the smallest number of points that must be included in the estimate.

The various options are described in detail in the document titled *Kriging*.

Analysis Options

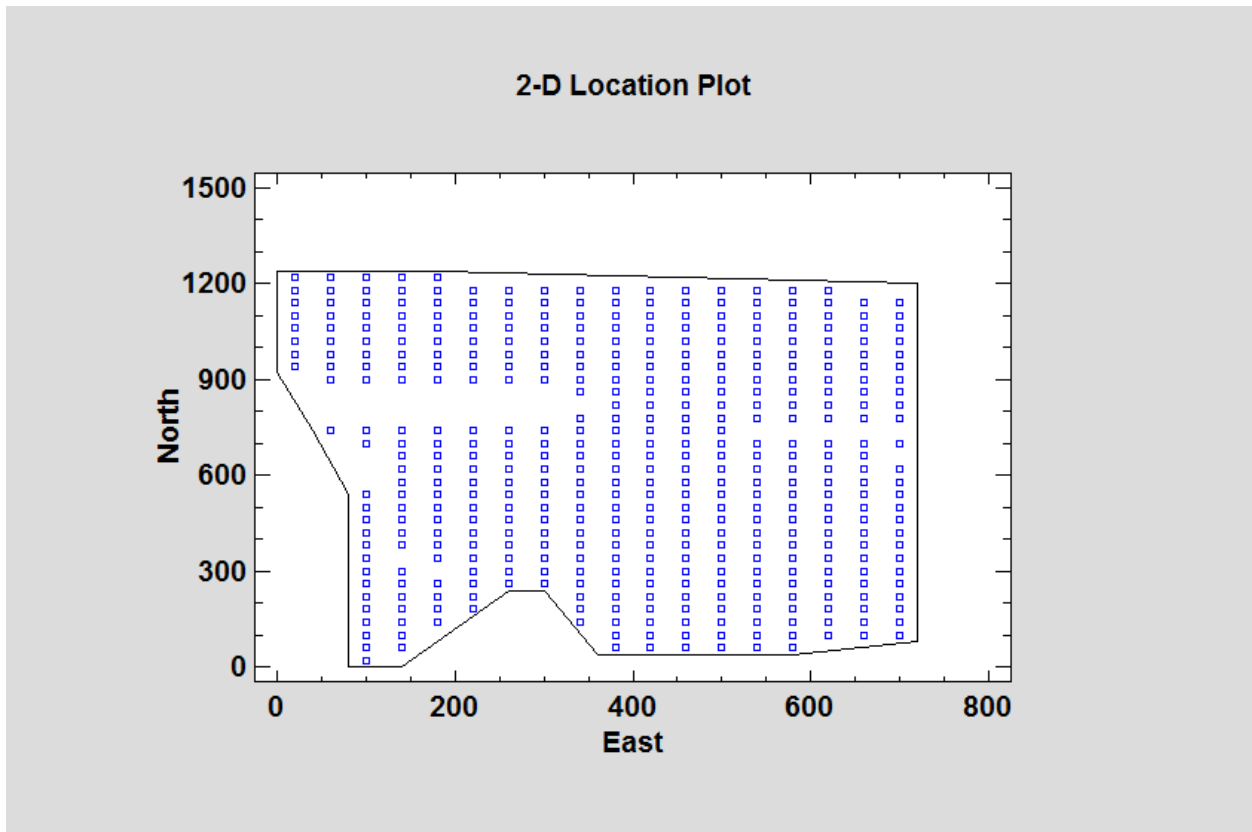
The *Analysis Options* dialog box is used to control the minimum value, maximum value, and increment of the Statlet scrollbars.

	Minimum	Maximum	By
Variogram increment:	0	400	4
Variogram max lag:	0	13600	136
Kriging increment:	0	200	2
Kriging max radius:	0	2000	20

Buttons: OK, Cancel, Help

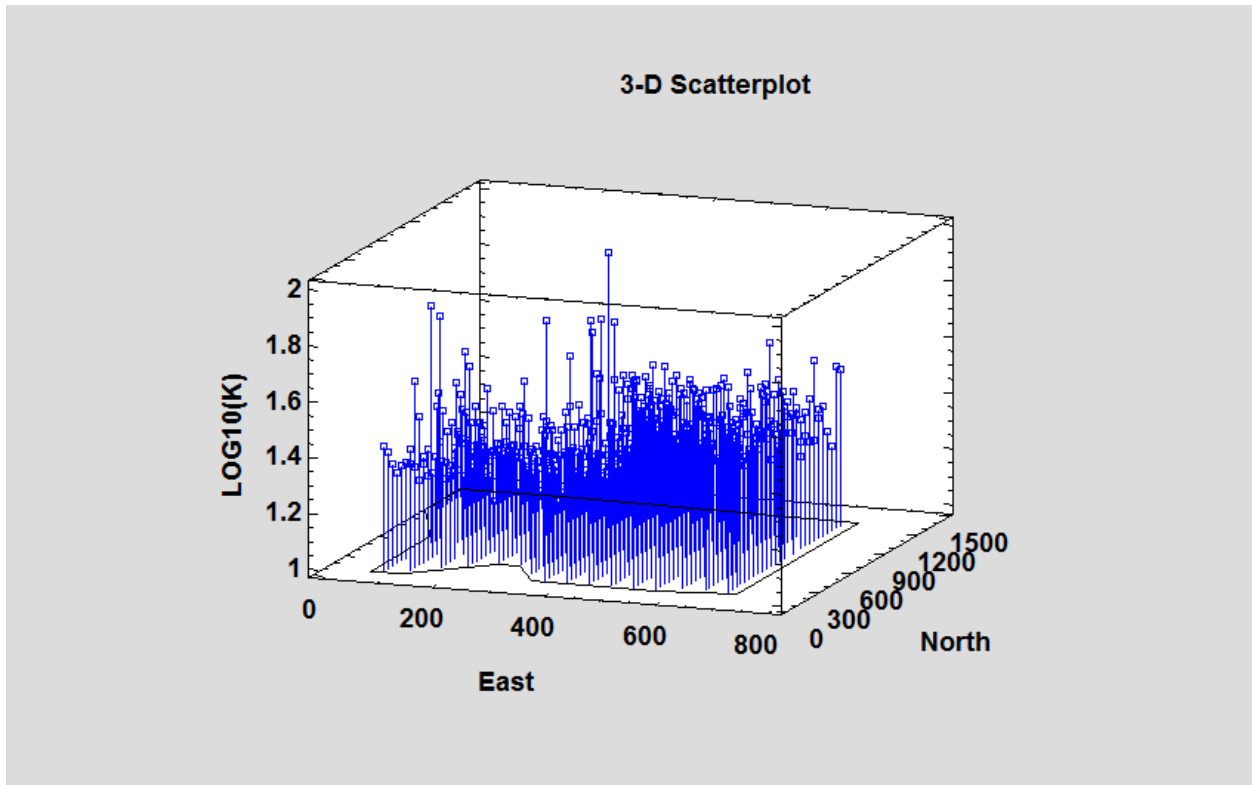
2-D Location Plot

This plot shows the locations at which samples were obtained:



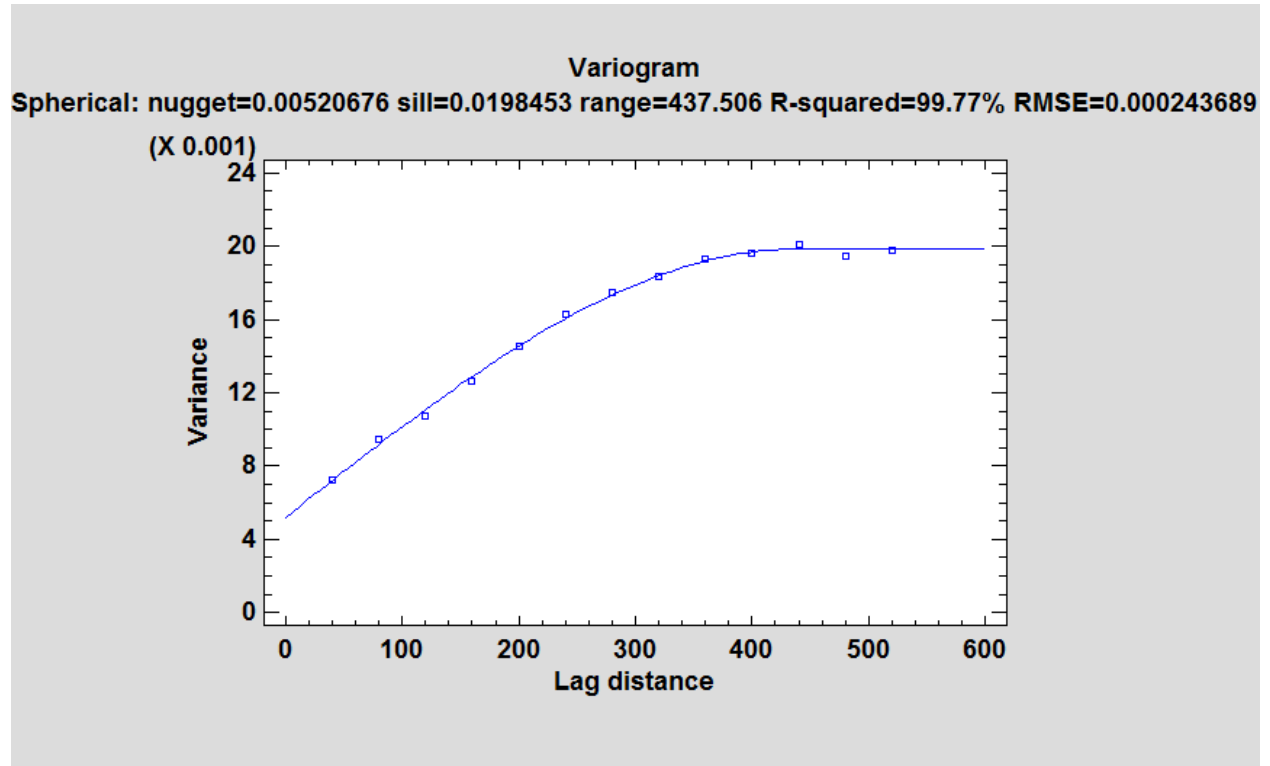
3-D Scatterplot

This plot shows the measurements taken at each location:



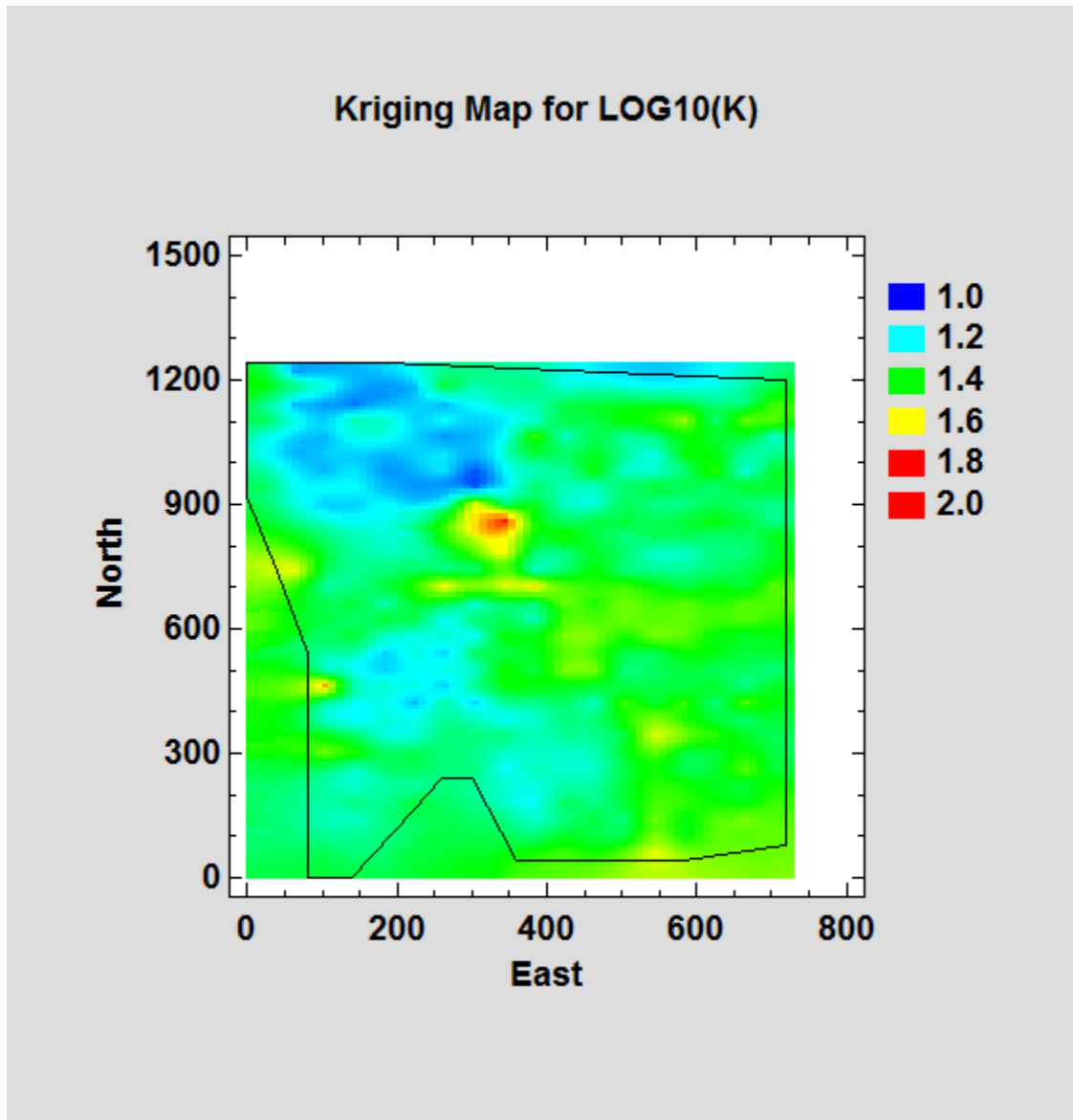
Variogram

This plot shows the estimated variogram together with the fitted model:



Response Map

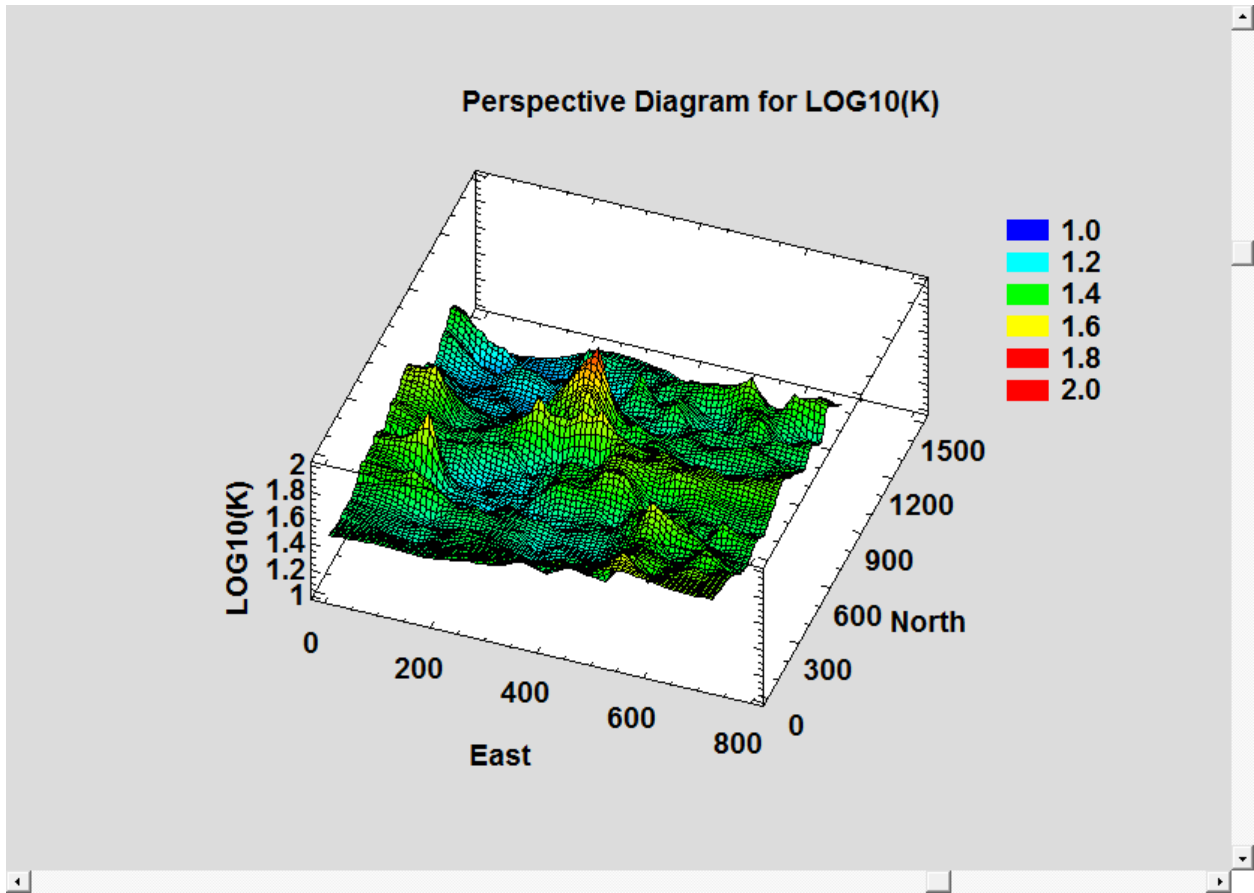
This plot shows the estimated response:



In the above plot, the estimated LOG10(K) is color coded from dark blue at 1.0 to dark red at 2.0. The above plot was made by setting the Kriging increment to 10 m.

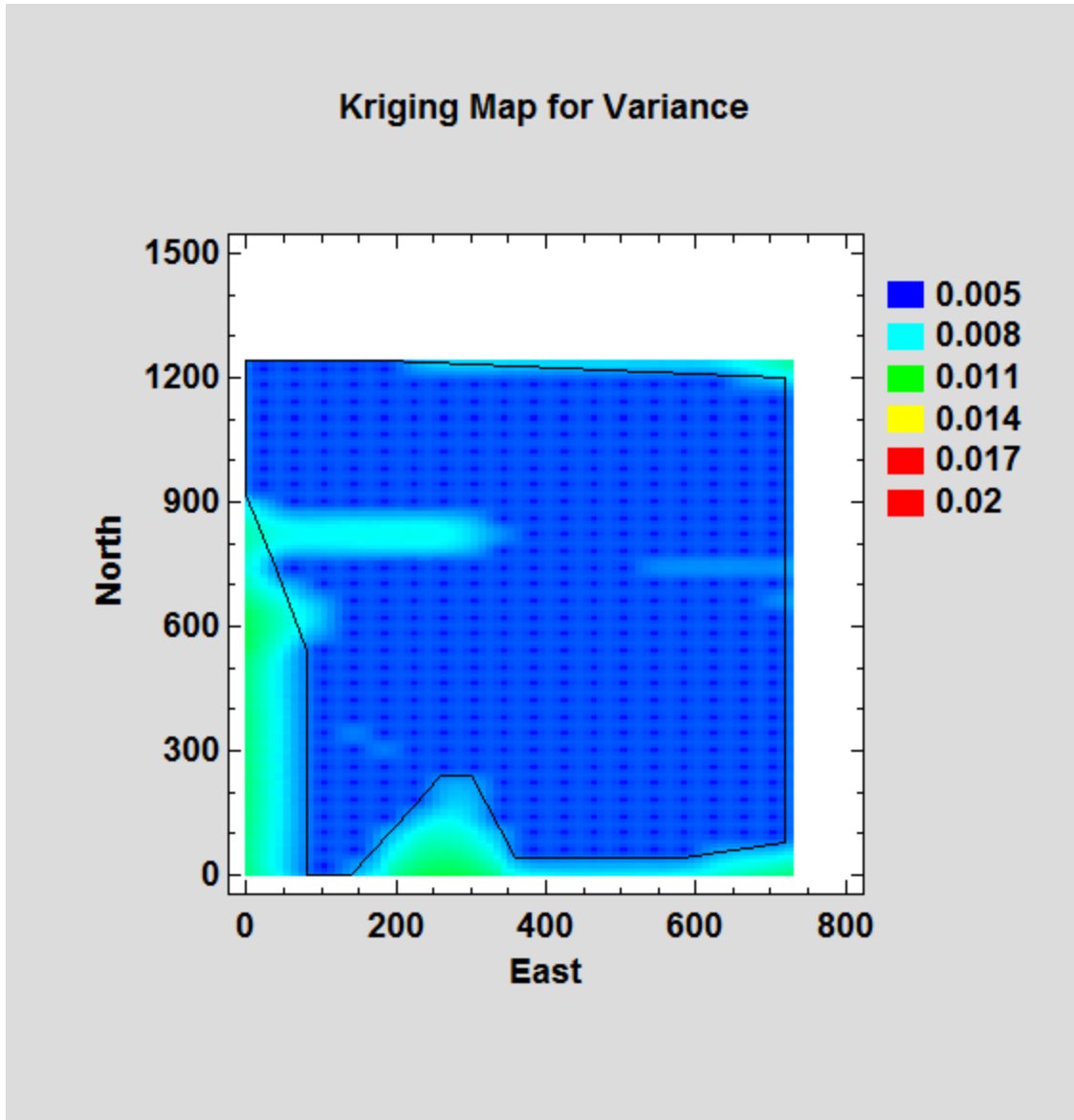
3-D Response Map

Unchecking the *Display in 2D* checkbox displays the response as a *Perspective Diagram*:



Variance Map

This plot displays the variance of the estimated response:



3-D Variance Map

Unchecking the *Display in 2D* checkbox displays the variance as a *Perspective Diagram*:

