

## Interpolation

Visiting every location in a field to make land related measurements is usually difficult or expensive. So such measurements are conducted at strategically dispersed locations, and predicted values are assigned to all other locations. Input points can be either randomly or regularly spaced or based on some sampling scheme. Surface interpolation functions create a continuous surface from sampled point values. In this activity, an interpolated surface is created to visualize distribution of Phosphorous (P value) content across the field.

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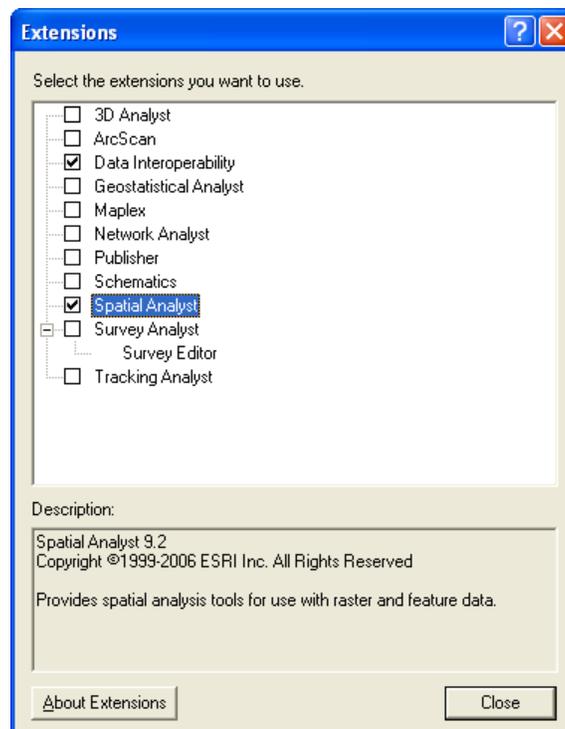
### Explorer's Guide

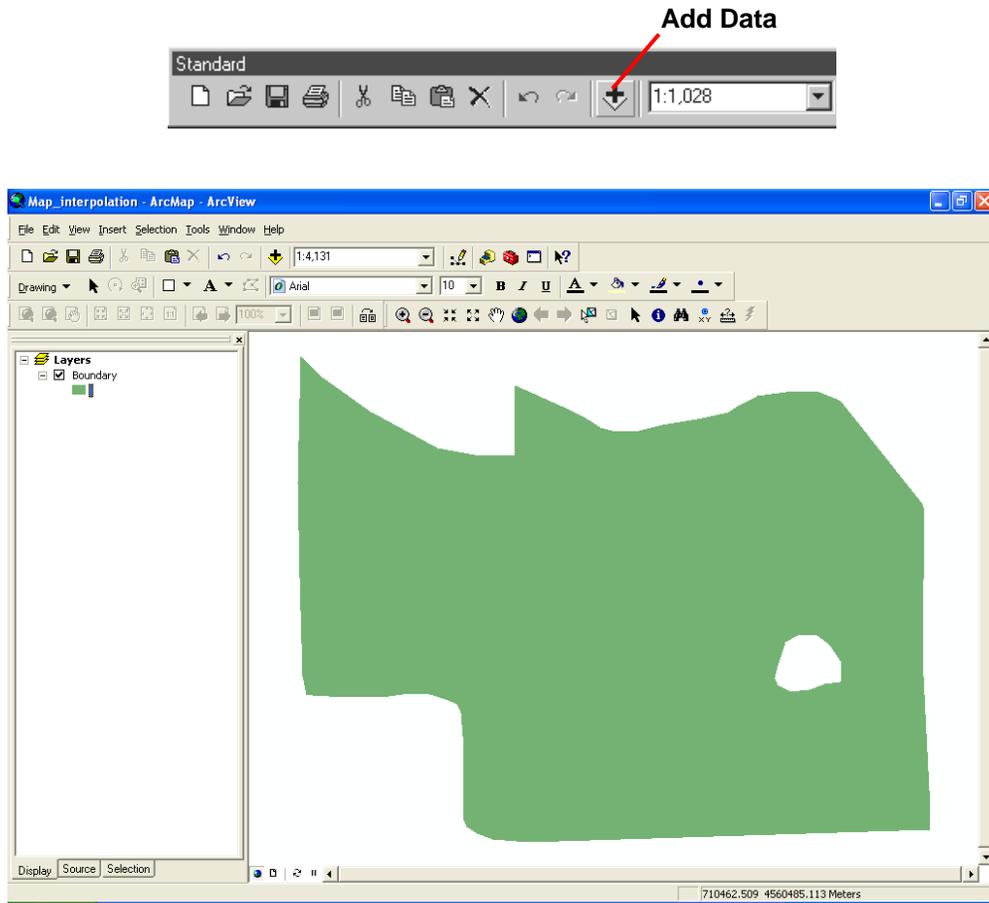
#### **Before You Start**

Line up according to height. Then, have 2-3 students leave the line. Knowing the height of those who remain standing the next to the vacant places, estimate what the height of absent students should be. Use averaging techniques (1-2 taller and 1-2 shorter students). This method is the simplest form of interpolation in one dimension (along one line).

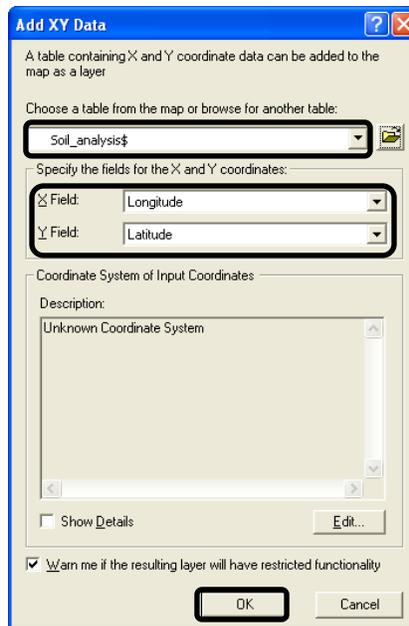
#### **Learning by Doing**

1. Start ArcMap and go to Tool > Extensions to turn on the Spatial Analyst Extension as shown below. Add Boundary.shp to the map.

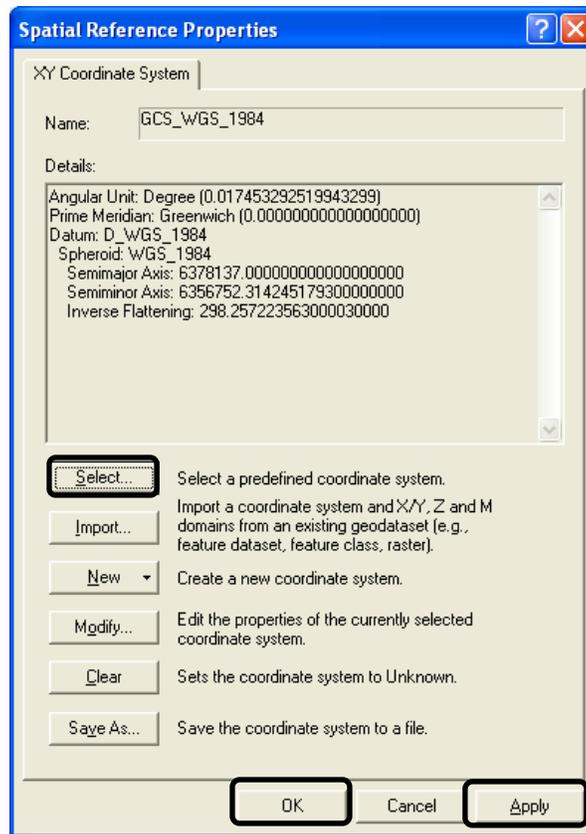
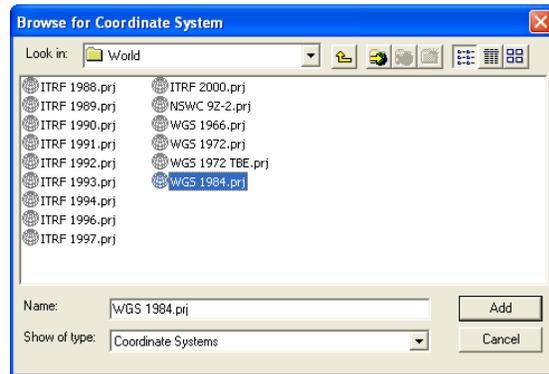
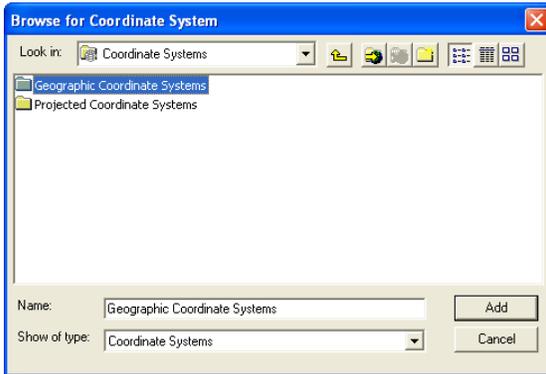




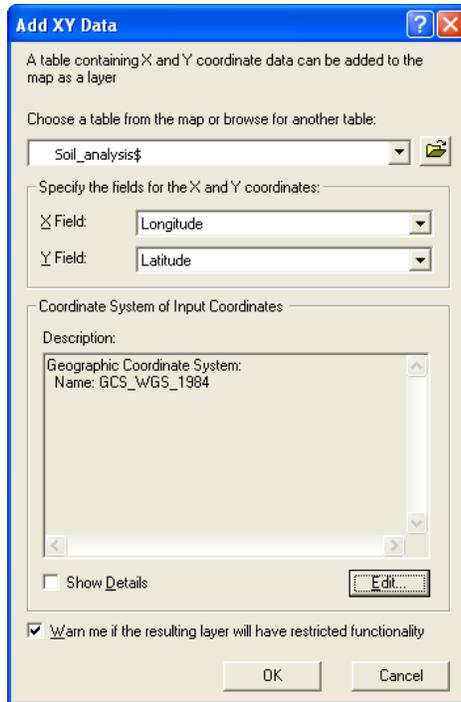
2. To add soil analysis data into this map go to Tool > Add XY data. Make sure you select the excel worksheet file as shown below.



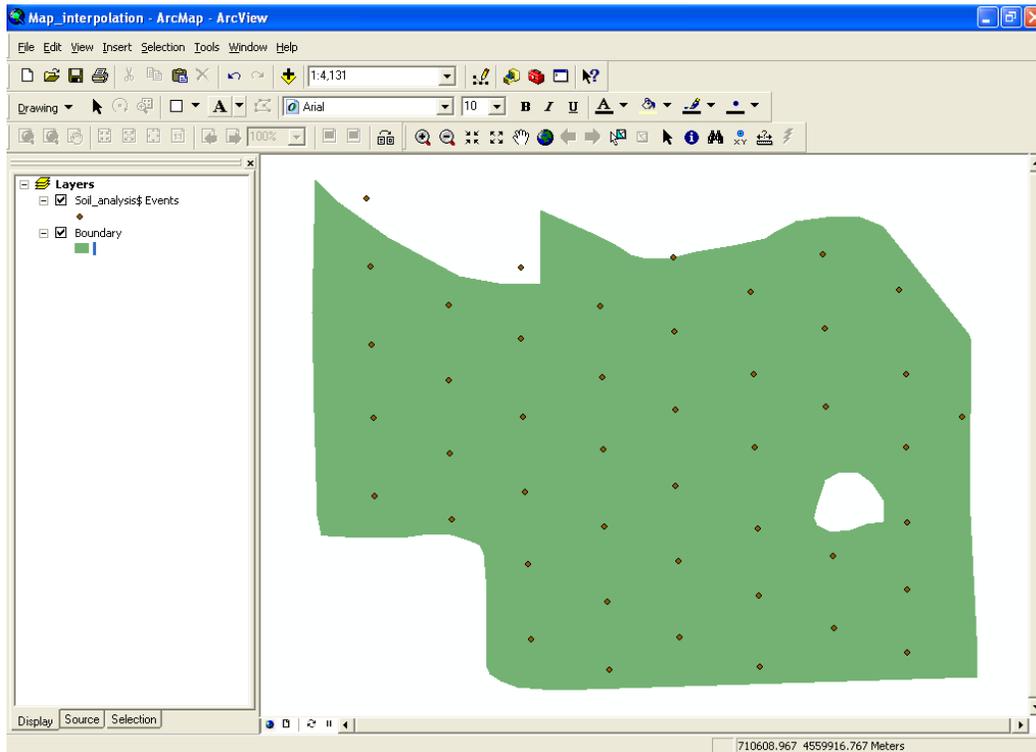
- To assign a coordinate system go to Edit and Select Geographic Coordinate System > World > WGS 1984.prj . Your XY data should now have the spatial reference as indicated below.



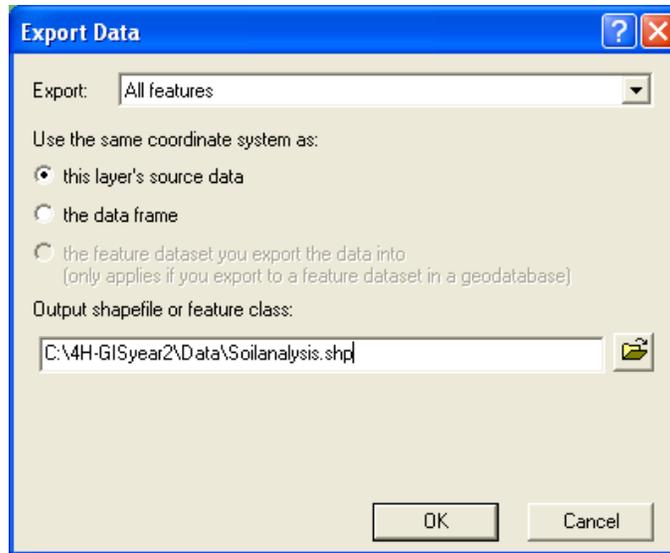
- Click Apply and OK .Click OK in the Add XY data dialog box as shown below.



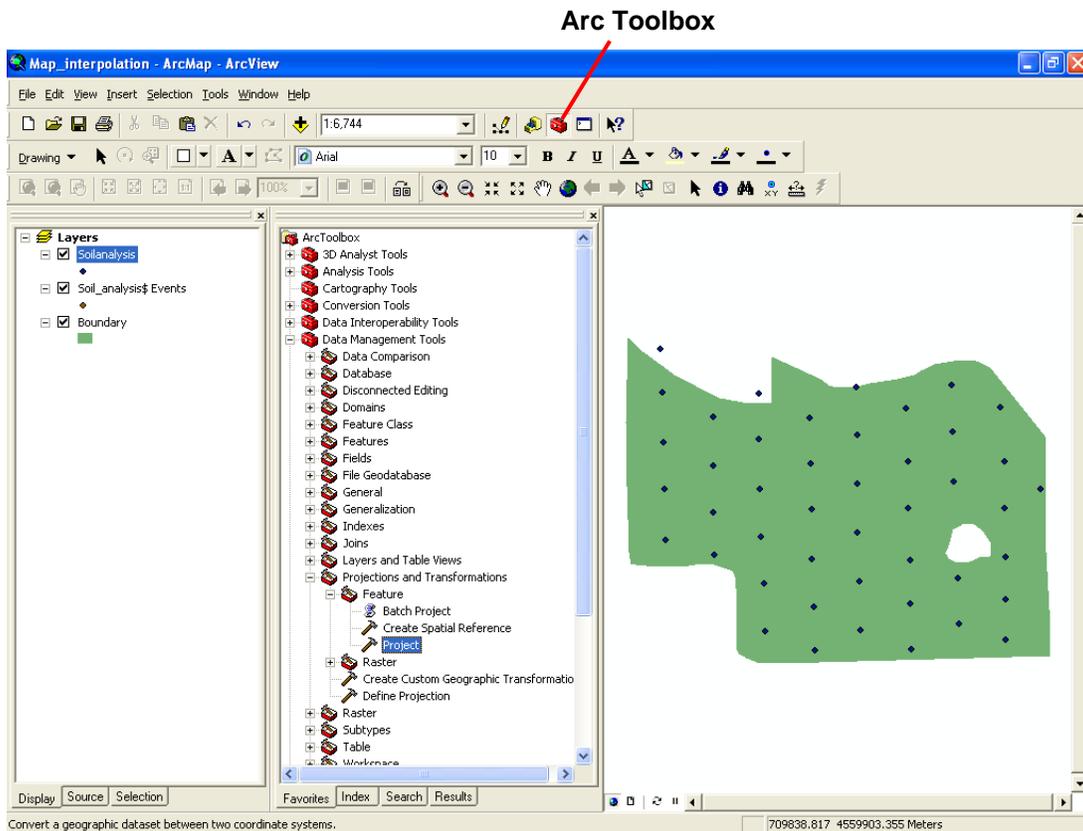
5. Your map should be as given below.



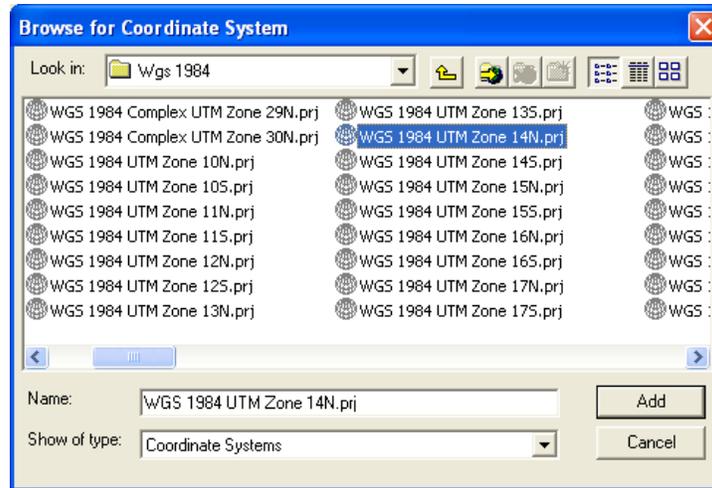
6. Right Click on the soil analysis XY data you just added and go to Data > Export Data to convert this data to shapefile. Click Yes to add this exported data to the map as a layer.



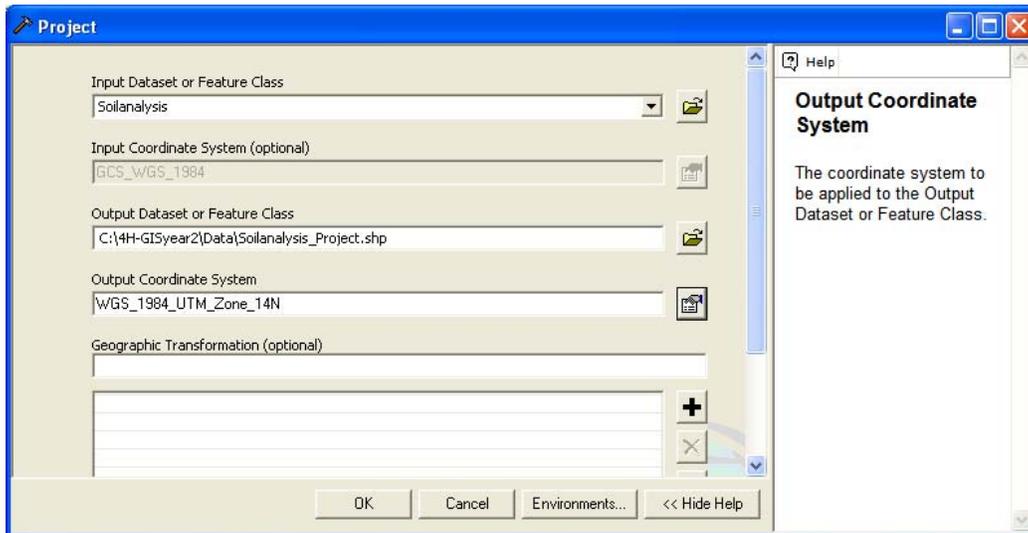
7. Now you need to change the projection of this layer before doing interpolation. Go to ArcToolbox and go to Data Management Tools > Projections and Transformations > Feature > Project as shown below.



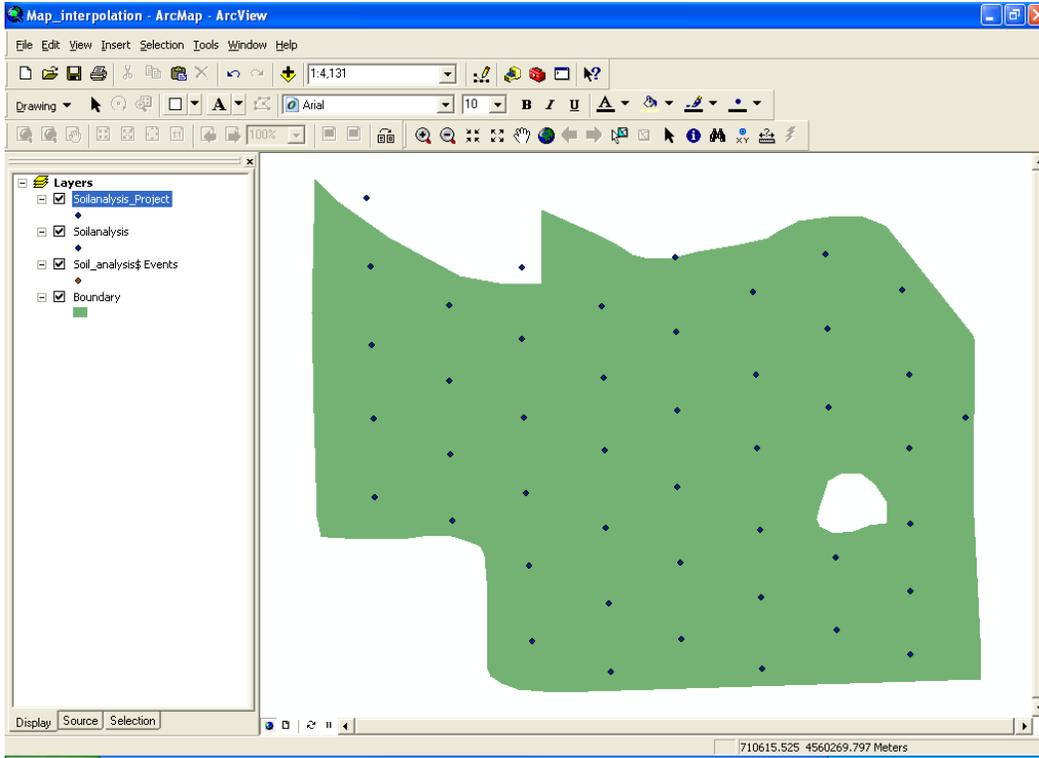
8. Double click Project and make sure you select the soil analysis layer file as the input file. To specify the output coordinate system click select > Projected coordinate system > Utm > WGS 1984 >WGS 1984 UTM Zone 14N.prj as shown below.



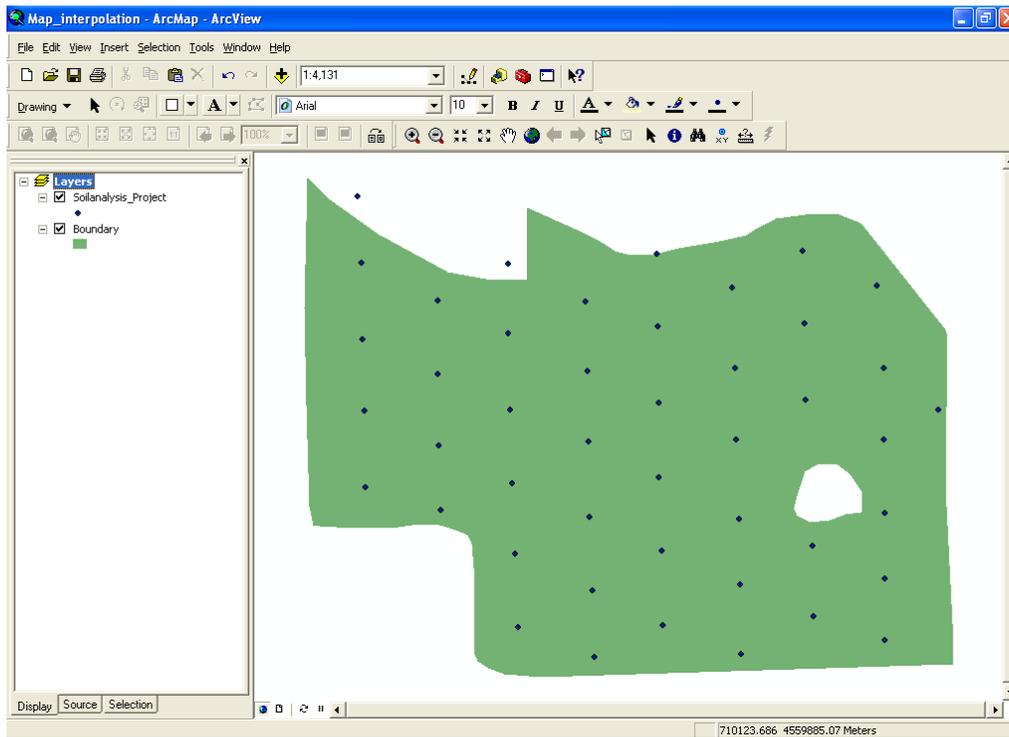
9. Your Project dialog box should be as shown below.



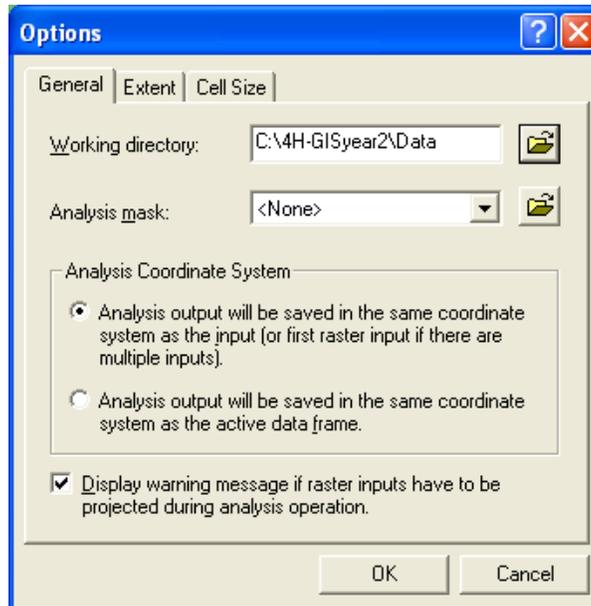
10. Click OK and this will take some time to project the feature class. Exit Arc Toolbox. Your screen should look like this.



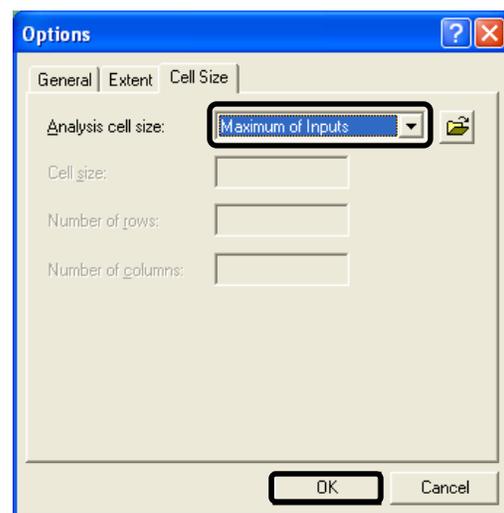
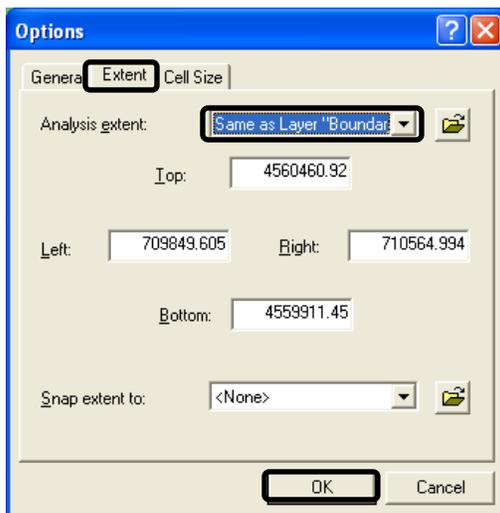
11. Remove the soilanalysis and soil\_analysis\$ Events as you have a projected shapefile of soil analysis data. Right click the layer on the layer panel and click remove. Your screen should be as indicated below.



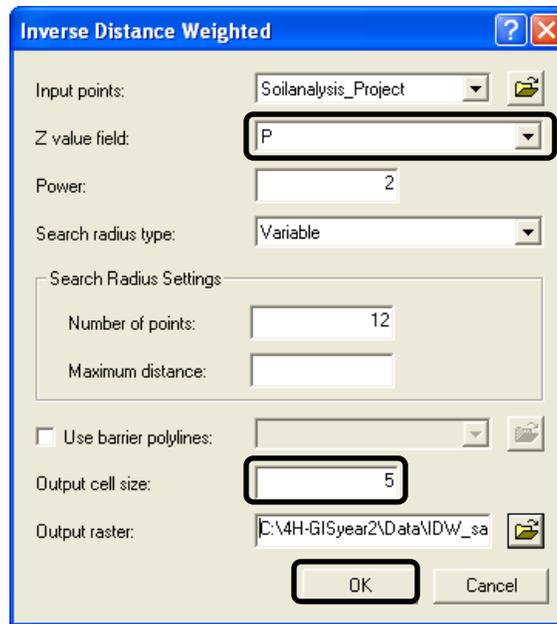
12. Make sure you have added the spatial analyst tool to your map. You are now ready to do the interpolation.
13. In Spatial Analyst toolbar go to Options and specify the working directory as shown below.



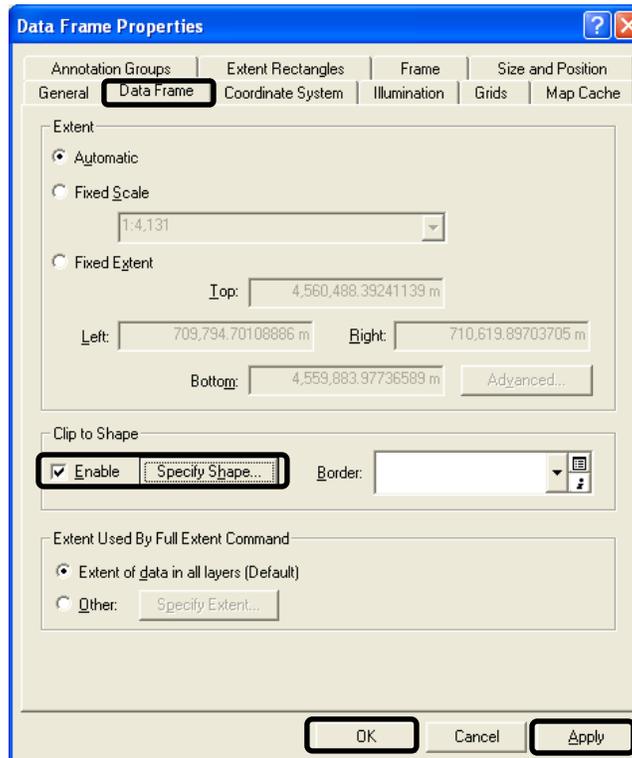
14. Go to Extent tab and select the same as Layer "Boundary" as given below. Select Maximum of Inputs for the cell size.



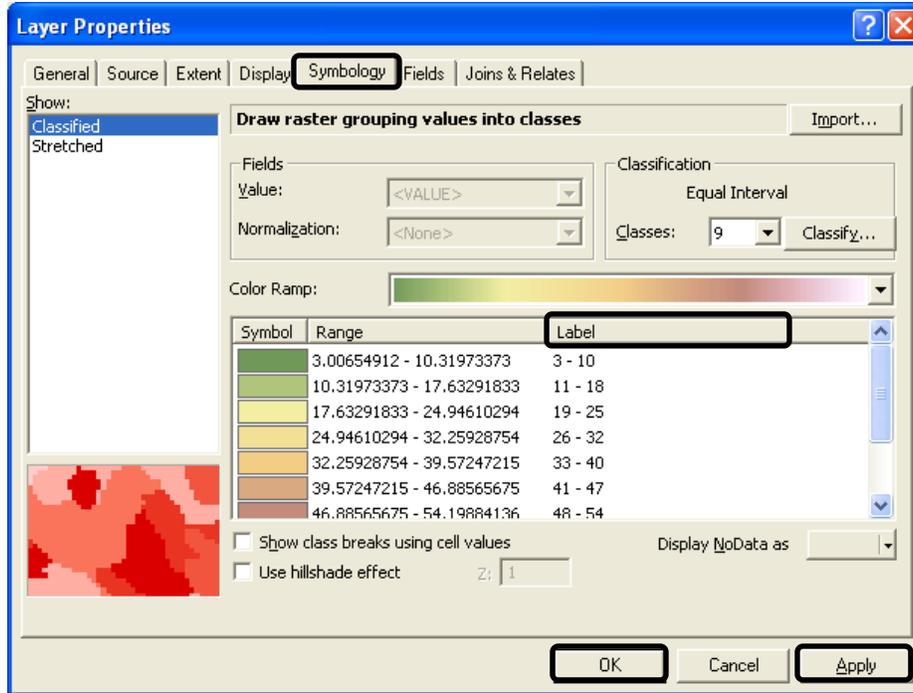
15. Click OK when done. Go to Spatial Analyst > Interpolate to Raster > Inverse Distance Weighted. Specify the Z value as "P" and output cell size as "5". Specify the output raster directory as indicated below.



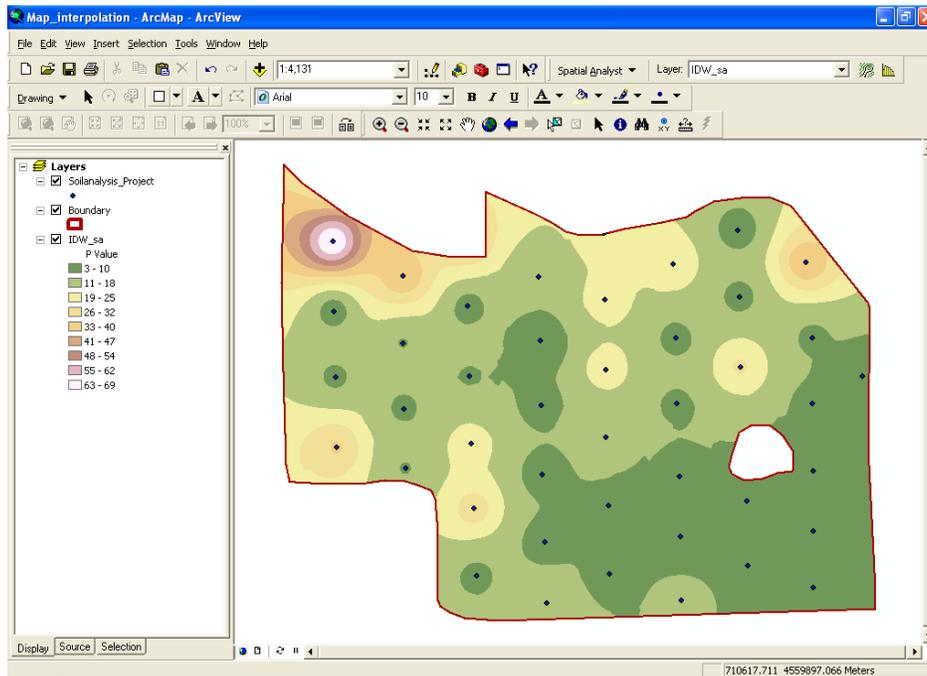
16. Interpolation will take some time. To clip the interpolation surface within the field boundary, Go to View > Data Frame Properties and enable clip to shape as shown below. This will clip the grid to the extent of the field boundary, deleting every pixel of the interpolated surface outside the field boundary.



17. Change the symbology of the interpolated surface. For this go to layer properties and navigate to symbology tab. Right click on Labels and go to format labels. Specify 0 decimal points as shown below. Click Apply and OK. Change the symbology of the boundary shapefile to view it along with other layers.



18. Your screen should be similar to the one given below.

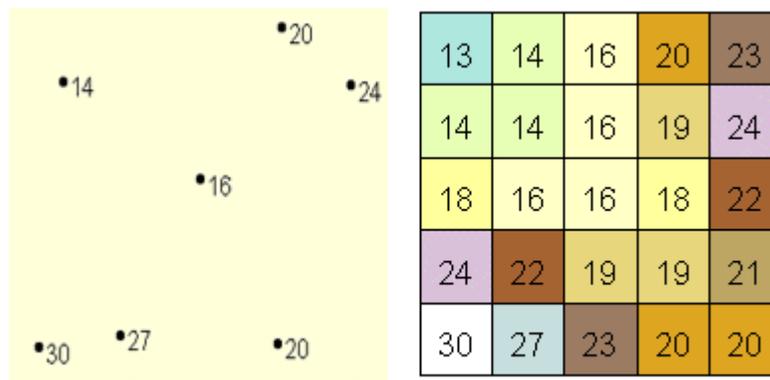


## How Does It Work

Yield variability can be due to the differences in physical and chemical soil properties. The inconsistency of various soil properties can be evaluated using the results of laboratory analyses performed on samples obtained from various locations within a field.

Field data are collected at dispersed locations. An adequate number of samples should be collected to accurately characterize the nutrient levels in soil. Sampling near farm lanes and field boundaries should be avoided as the soil varies due to external factors. A predicted surface is then generated from these dispersed point values by interpolation. The assumption that makes interpolation a viable option is that spatially distributed objects are spatially correlated which means things that are close together tend to have similar characteristics. The values of points close to sampled points are more likely to be similar than those that are farther apart. A typical use for point interpolation is to create an elevation surface from a set of sample measurements. For example if it is snowing on one side of the street there is high chance that it is snowing on the other side of the street. The chance of snow reduces across the town and further reduces across the state.

The illustrations below show the distribution and values of sample points and the raster generated from them. The left illustration shows a point dataset of known P value in soil property. The illustration on the right shows a raster interpolated from these points. Unknown values are predicted with a mathematical formula that uses the values of nearby known points.



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Surface interpolation functions make predictions from sample measurements for all locations in a raster dataset, whether or not a measurement has been taken at the location. There are a variety of ways to derive a prediction for each location; each method is referred to as a model. With each model, there are different assumptions made of the data, and certain models are more applicable for specific data—for example, one model may account for local variation better than another. Each model produces predictions using different calculations.

The interpolation tools are generally divided into deterministic and geostatistical methods. IDW, Spline, and Trend are deterministic and Kriging is a geostatistical method. The Inverse Distance Weighted (IDW) and Spline methods are referred to as deterministic interpolation methods because they assign values to locations based on the surrounding measured values and on specified mathematical formulas that determine the smoothness of the resulting surface. IDW interpolates a surface from points using an inverse distance weighted technique.

### **Additional Challenge**

Create an interpolated surface using pH value of soil? What will the surface with OM (organic matter) values look like?

### **Vocabulary**

**Crop yield** is a measure of the output per unit area of land under cultivation

**Grid:** Equally sized square cells arranged in rows and columns. Each cell contains a value for the feature it covers.

**Interpolation** is a estimating an unknown value that falls between known values.

**Inverse Distance Weighted (IDW)** is an interpolation technique that determines cell values in a grid with a set of sample points that have been weighted so that the farther a point is from the cell being evaluated, the less important it is in calculating the cell's value.

**Surface model** is an approximation of a surface, generalized from sample data

**Soil pH** is a measure of the acidity of the soil. It affects the availability of soil nutrients.

**Phosphorus (P)** in soil is an important element in the development of plant reproductive parts.

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