Tutorial Set 3: Spatial data analysis

Exercise Site20_3-4 Developing a Yield Goal and N prescription maps

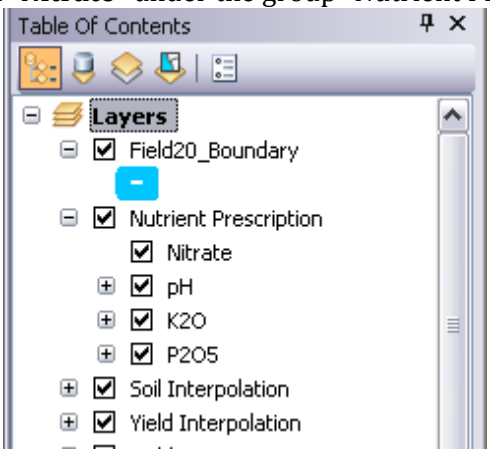
Learning objective: Developing a Yield Goal map based on a multi-layer yield history and then obtaining nitrate prescription map

Techniques: ArcToolbox – Spatial Analyst – Map Algebra – Raster Calculator & ArcToolbox – Spatial Analyst – Neighborhood – Focal Statistics

Data Source: Dataset3

Part 1: Layer management

1. Open previously save project.
2. Add a subgroup named "**Nitrate**" under the group "Nutrient Prescription".



Part 2: Understanding formulas

Yield normalization:

$$Y' = \frac{Y}{\overline{Y}}$$

Y' : relative crop yield at a field location in a specific year;
Y : crop yield at a field location in a specific year;
$\overline{Y}$: average yield of a field in a specific year;

Temporal statistics of historical yields:

- Average of time-series data

$$\overline{Y'} = \frac{Y_1' + Y_2' + \ldots + Y_n'}{n}$$

$\overline{Y'}$: average relative crop yield at a field location over n years;

$Y_1', Y_2', \ldots, Y_n'$: relative crop yield at a field location over n years;

n : number of harvesting years

- Standard deviation of time-series data

$$Y'_{std} = \sqrt{\frac{(Y'_1 - \overline{Y'})^2 + (Y'_2 - \overline{Y'})^2 + \ldots + (Y'_n - \overline{Y'})^2}{n-1}}$$

Y'_{std} : standard deviation of relative crop yield at a field location over *n* years

- Coefficient of variation (%) of time-series data

$$Y'_{cv} = \frac{Y'_{std}}{\overline{Y'}} \times 100$$

Y'_{cv} : coefficient of variation of relative crop yield at a field location over *n* years

Yield goal:

$$YG_{corn} = 1.1 \times (\frac{\overline{Y}_1 + \overline{Y}_2}{2}) \times \overline{Y'}$$

$\overline{Y}_1, \overline{Y}_2$: average corn yield of 2 different harvest years

Part 3: Creating a Yield Goal for corn based on a 5-year yield record

The 5 years of yield layers:

corn06 (Y_{corn06}) = 2006 corn yield

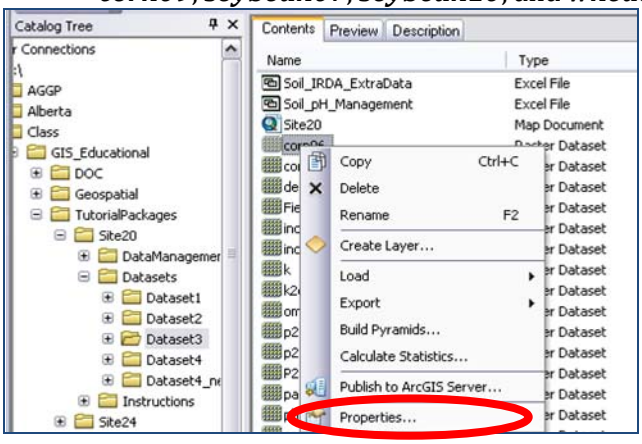
soybean07 ($Y_{soybean07}$) = 2007 soybean yield

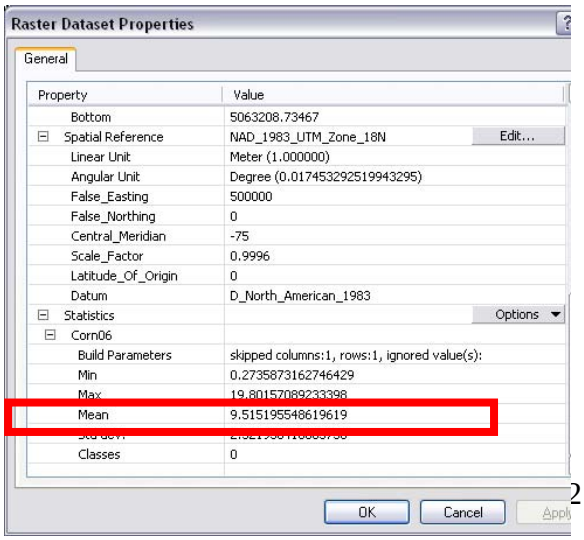
wheat08 ($Y_{wheat08}$) = 2008 wheat yield

corn09 (Y_{corn09}) = 2009 corn yield

soybean10 ($Y_{soybean10}$) = 2010 soybean yield

1. Get field average; such as field average of 2009 corn yield = $\overline{Y}_{corn06}$.
   In **Contents** view of **ArcCatalog**, right click on the layer ***corn06*** and select **Properties**.
   In **Raster Dataset Properties** dialog window, scroll down to the section **Statistics** > **Corn06** > **Mean**.
   The average corn yield of 2006 = **9.51**.
   Repeat this step to obtain the average yields for the rest of yield layers: ***corn09***, ***soybean07***, ***soybean10***, and ***wheat08***.





So, the average yield of each yield data:

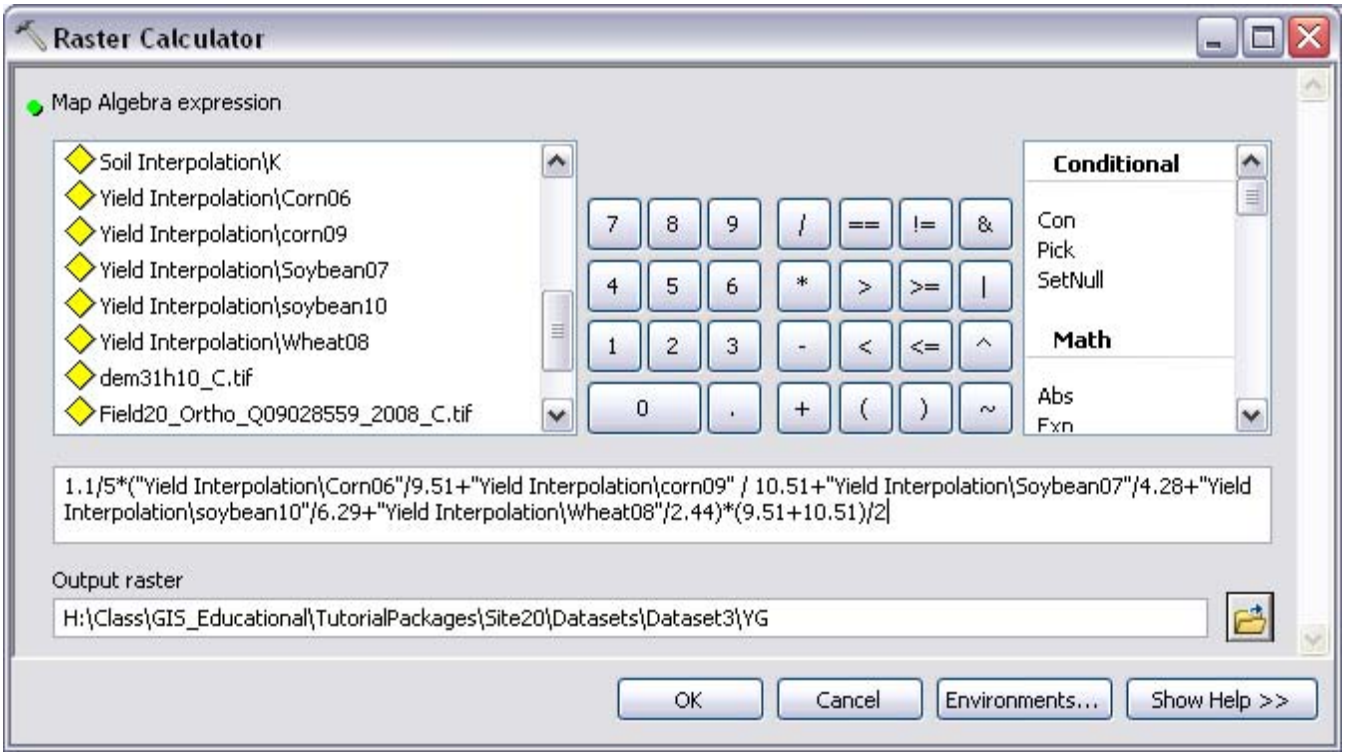
$\overline{Y}_{corn06} = 9.51$; $\overline{Y}_{corn09} = 10.51$; $\overline{Y}_{soybean07} = 4.28$; $\overline{Y}_{soybean10} = 6.29$; $\overline{Y}_{wheat08} = 2.44$

2. Go to **ArcToolbox** > **Spatial Analyst Tools** > **Map Algebra**> **Raster Calculator** to generate a **Corn Yield Goal** map.

Formula:

$$YG_{corn} = 1.1 \times (\frac{\overline{Y}_1 + \overline{Y}_2}{2}) \times \overline{Y'}$$

$$YG = 1.1 \times \frac{(\overline{Y}_{corn06} + \overline{Y}_{corn09})}{2} \times (\frac{Y'_{corn06} + Y'_{soybean07} + Y'_{wheat08} + Y'_{corn09} + Y'_{soybean10}}{5})$$



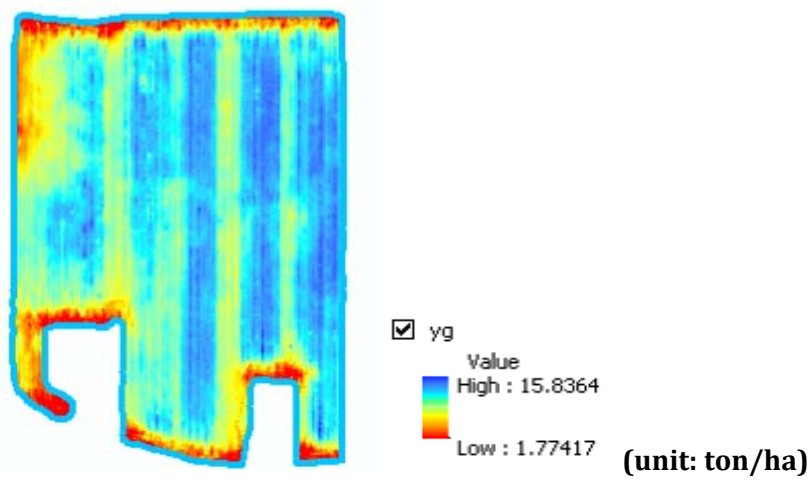
Map algebra expression =

1.1 / 5 * (9.51 + 10.51) / 2 * ("Yield Interpolation\Corn06"/9.51 + "Yield Interpolation \ corn09" / 10.51 + "Yield Interpolation \ Soybean07" / 4.28 + "Yield Interpolation \ soybean10" / 6.29 + "Yield Interpolation \ Wheat08" / 2.44)

(Note: DO NOT directly copy and paste the equation into to Raster Calculator, errors will occur!!!)

Output raster = ***YG***
Click **OK** to proceed.

3. The result of ***YG*** map is as shown:



(unit: ton/ha)

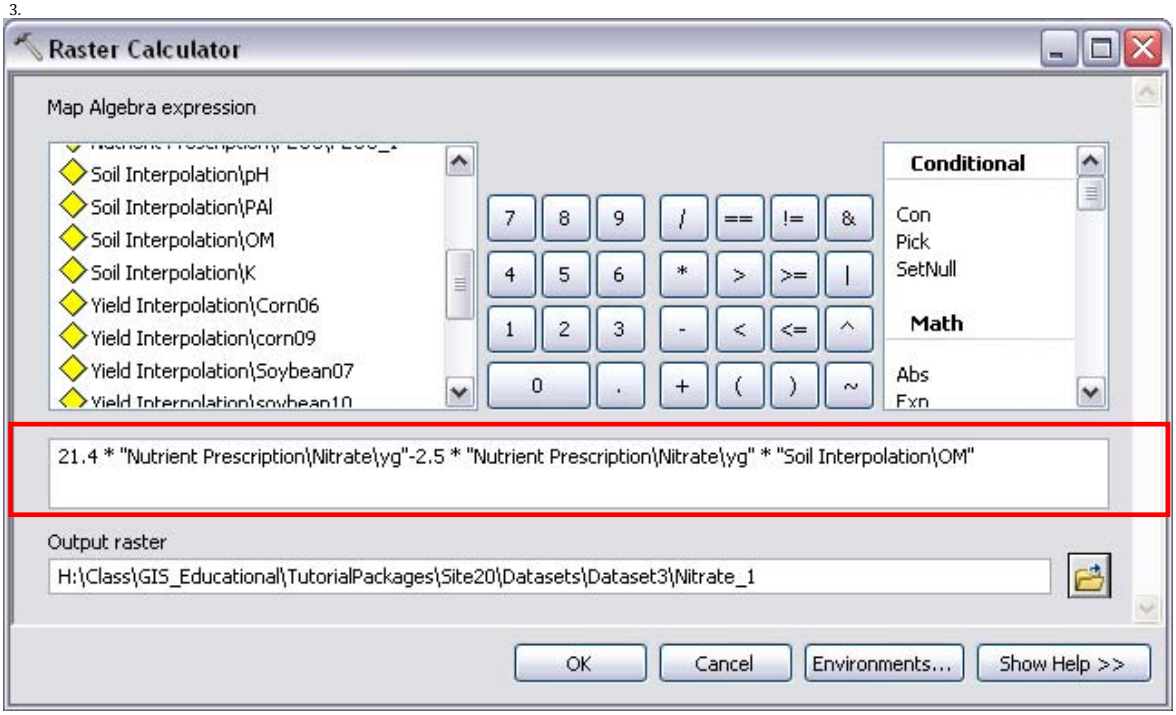
Part 3: Creating a N prescription map

1. Formulas used to estimate N (kg/ha) prescription for corn

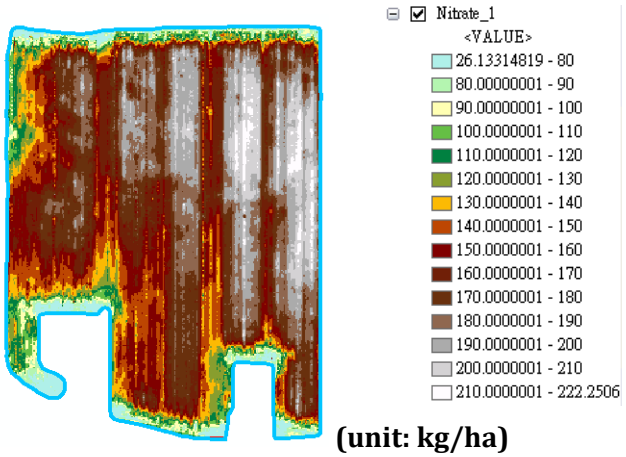
$$N = 21.4YG - 2.5YG \cdot OM$$

2. Go to **ArcToolbox** > **Spatial Analyst Tools** > **Map Algebra> Raster Calculator**. Generate a N prescription map (***Nitrate_1***) by entering the following map algebra expression.

3.



In **Layer Properties** dialog window, select **Symbology** and classify as in the following, and then click **OK**.

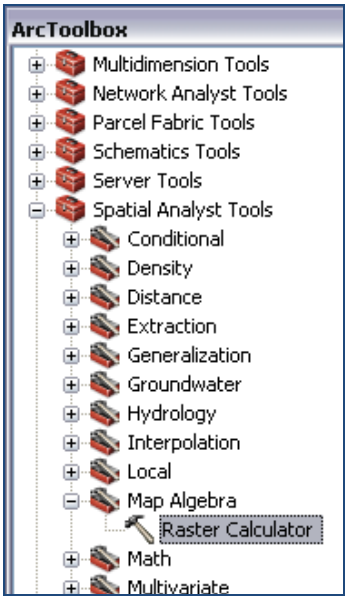


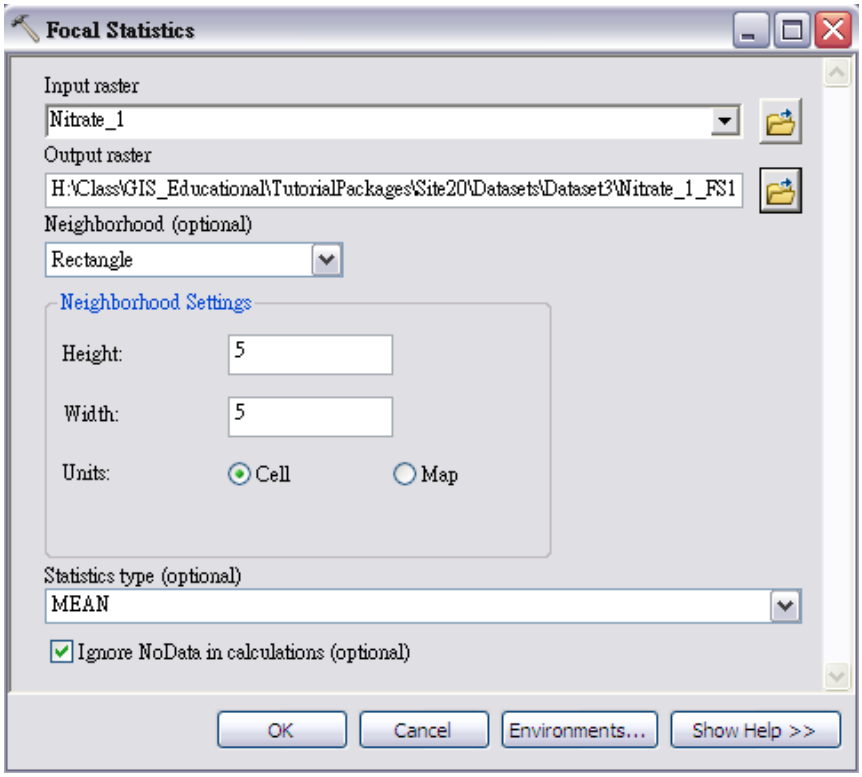
(unit: kg/ha)

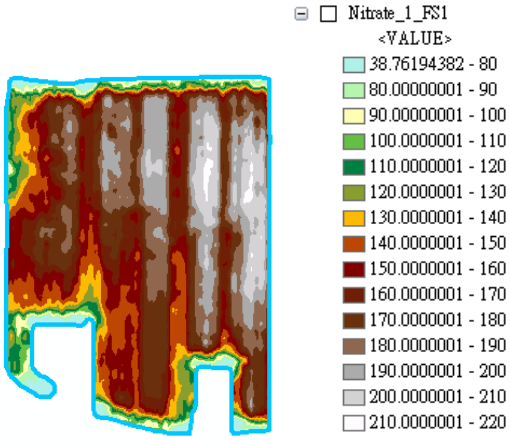
Here is the resulting nitrogen prescription map based on continuous yield goal estimates and an interpolated organic matter map

Part 4: Converting raster to polygon

1. Use **Focal Statistics** tool to smooth the layer ***Nitrate_1***.
   Go to **ArcToolbox** > **Spatial Analyst Tools** > **Neighborhood** > **Focal Statistics**. In **Focal Statistics** dialog window, set the parameters as follows.
   Click **OK**, the smoothed layer ***Nitrate_1_FS1*** is added to **Table of Contents.**

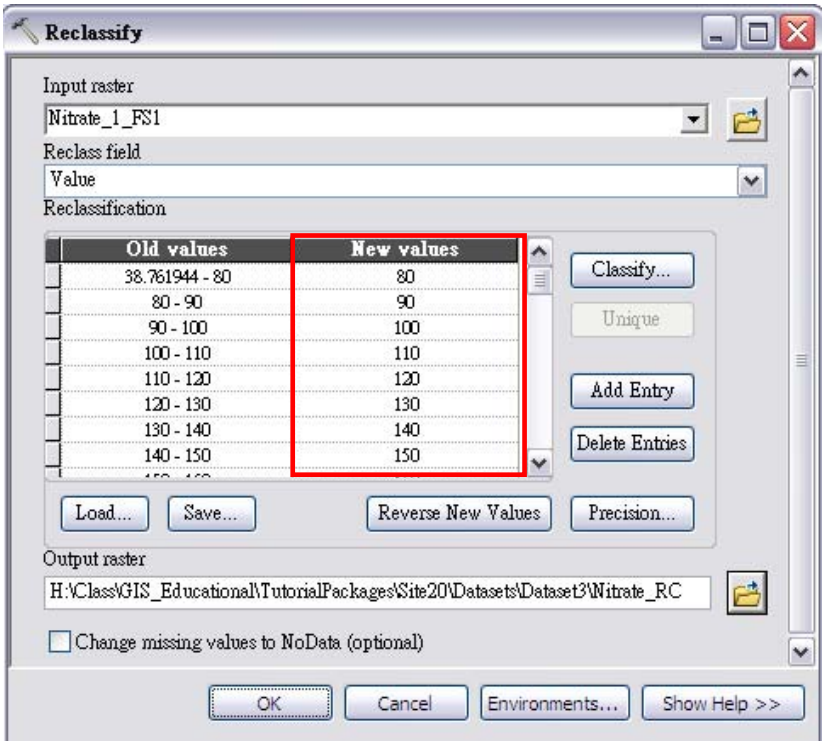


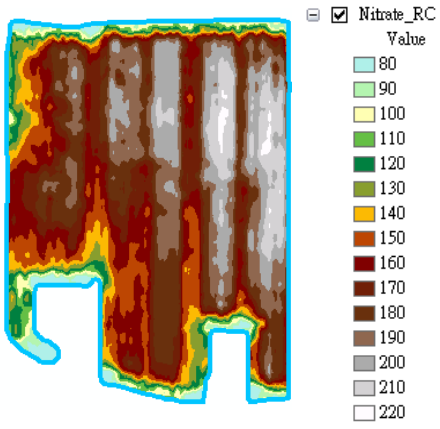




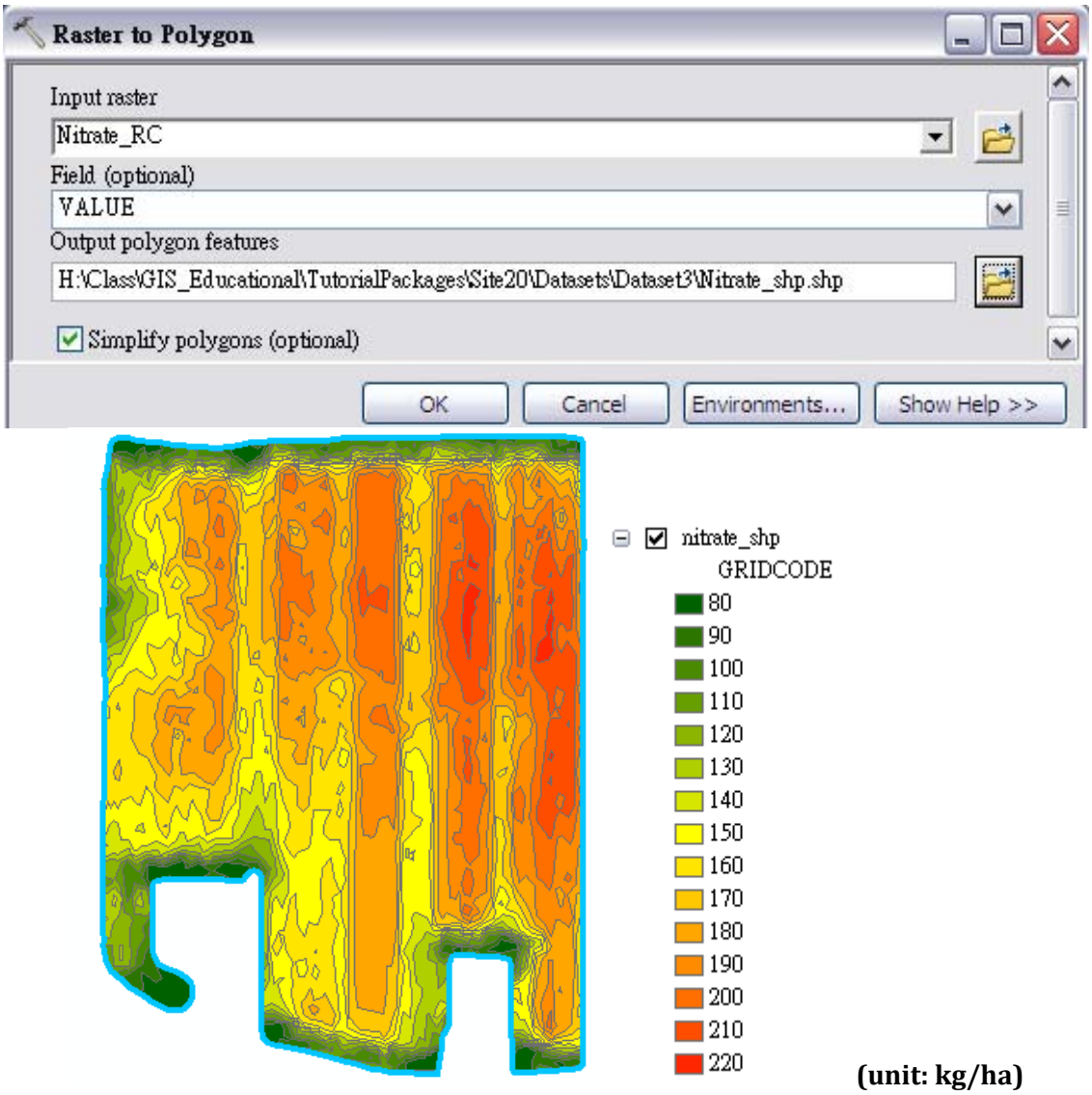
Here is the resulting smoothed nitrogen prescription map. Other smoothing options could be attempted as well. This step can be repeated to obtain the best zoning delineation.

2. Format pixel values from "floating" to "integer".
   Go to **ArcToolbox > Spatial Analyst Tools > Reclass > Reclassify**.
   Enter new values as shown and then save the new raster to ***Nitrate_RC***.
   Click **OK**, and then the new layer ***Nitrate_RC*** is added to **Table of Contents**.





3. Convert raster to a polygon.
   Go to **ArcTookbox > Conversion Tools > From Raster > Raster to Polygon**.
   Save output polygon as ***Nitrate_shp***. Click **OK** to proceed.



Here is the final polygonal nitrogen prescription map

4. Save the project.