

Tutorial Set 3: Spatial data analysis

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

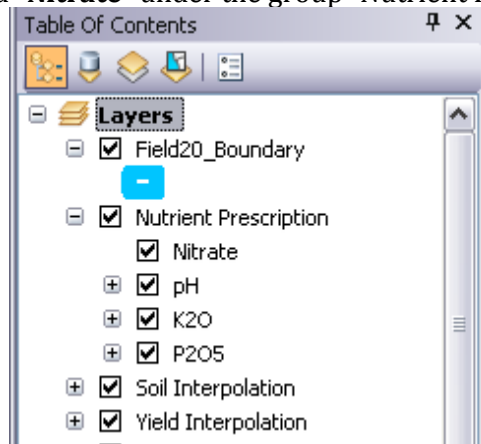
Learning objective: Developing a Yield Goal map based on a multi-layer yield history and then obtaining nitrate prescription map

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:

$$y_{relative_year} = \frac{Y_{actual_year}}{\bar{Y}_{year}}$$

Temporal statistics of historical yields:

- Average

$$avg\ y_{relative} = \frac{y_{relative_year1} + y_{relative_year2} + \dots + y_{relative_yearN}}{N}$$

- Standard Deviation

$$StDev\ y_{relative} = \sqrt{\frac{(y_{relative_year1} - avg\ y_{relative})^2 + \dots + (y_{relative_yearN} - avg\ y_{relative})^2}{N - 1}}$$

- Coefficient of Variation (%)

$$CV = \frac{StDev\ y_{relative}}{avg\ y_{relative}} \cdot 100$$

Yield Goal:

$$YG = 1.1 \cdot \overline{y_{relative}} \cdot \overline{Y_{average_{crop}}}$$

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

Layers:

Y_{corn06} = 2006 corn yield

$Y_{soybean07}$ = 2007 soybean yield

$Y_{wheat08}$ = 2008 wheat yield

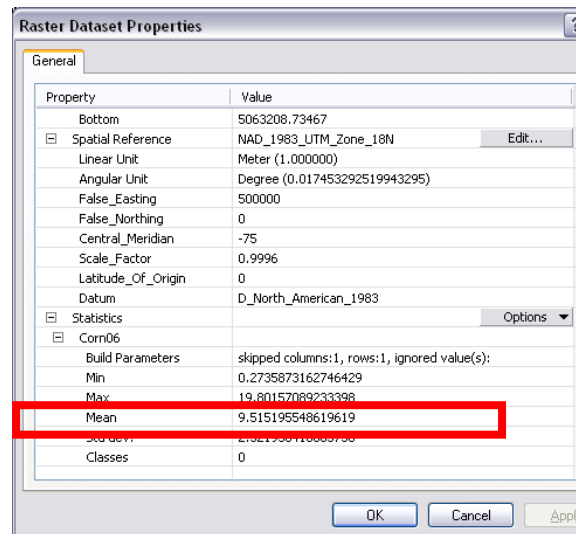
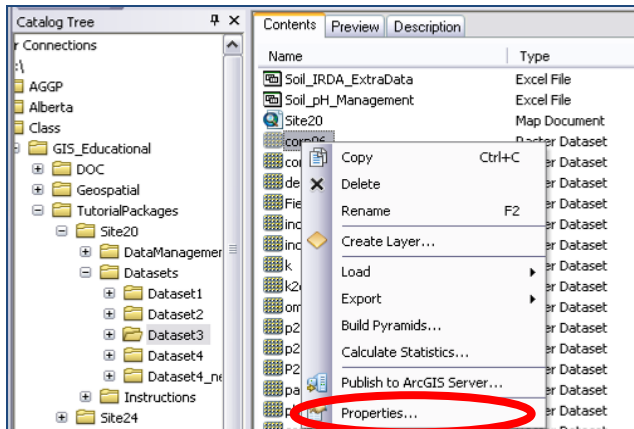
Y_{corn09} = 2009 corn yield

$Y_{soybean10}$ = 2010 soybean yield

1. Get field average; such as field average of 2009 corn yield = \overline{Y}_{corn09} .

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 **corn09**, **soybean07**, **soybean10**, and **wheat08**.



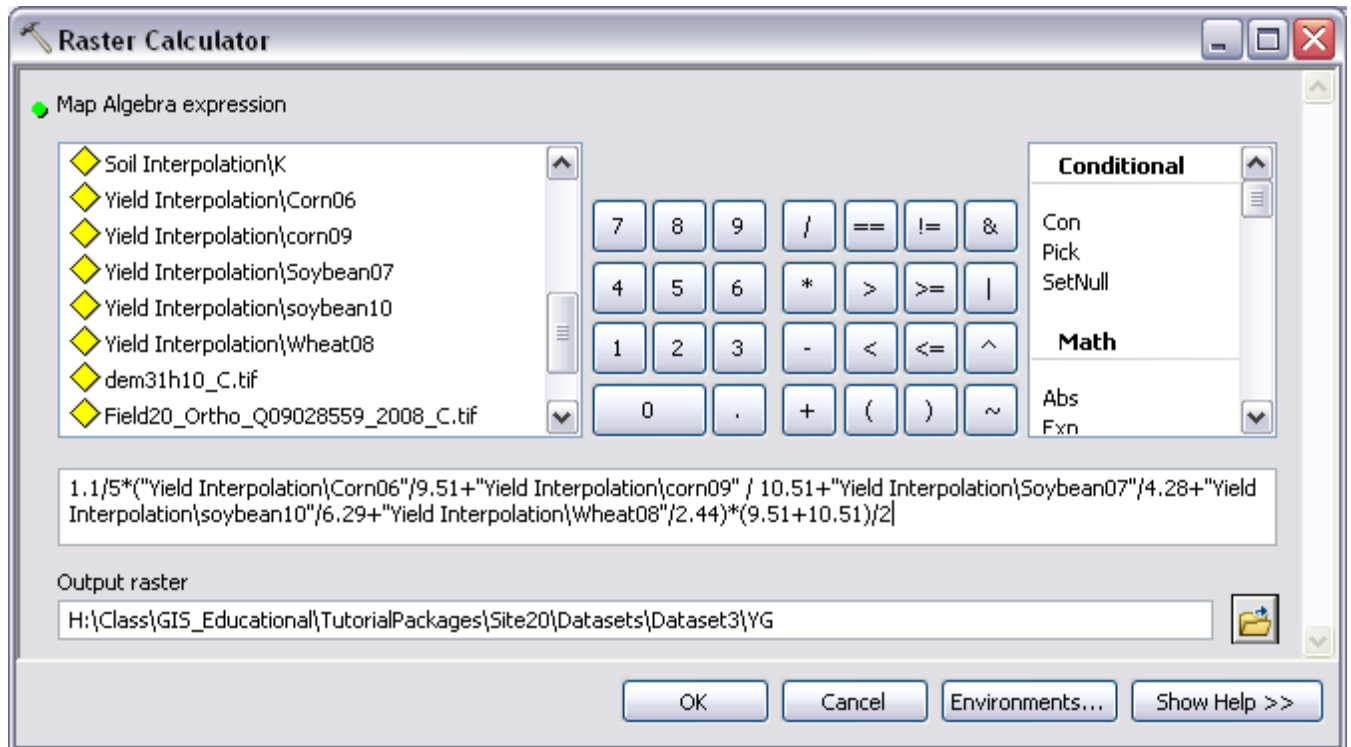
Take note of these values for further use:

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

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

Formula used:

$$YG = 1.1 \cdot \left(\frac{y_{relative_{corn06}} + y_{relative_{soybean07}} + y_{relative_{wheat08}} + y_{relative_{corn09}} + y_{relative_{soybean10}}}{5} \right) \cdot \frac{(\overline{Y}_{corn06} + \overline{Y}_{corn09})}{2}$$



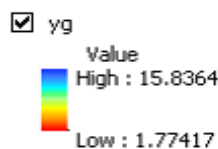
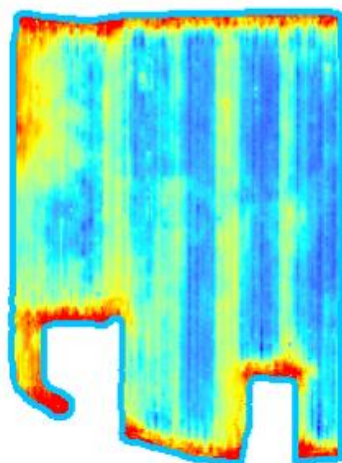
Map algebra expression =

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

(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:



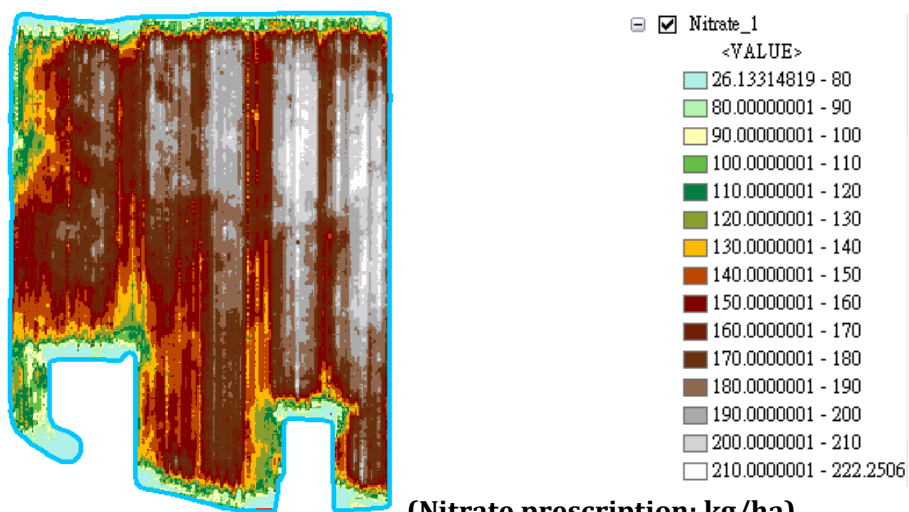
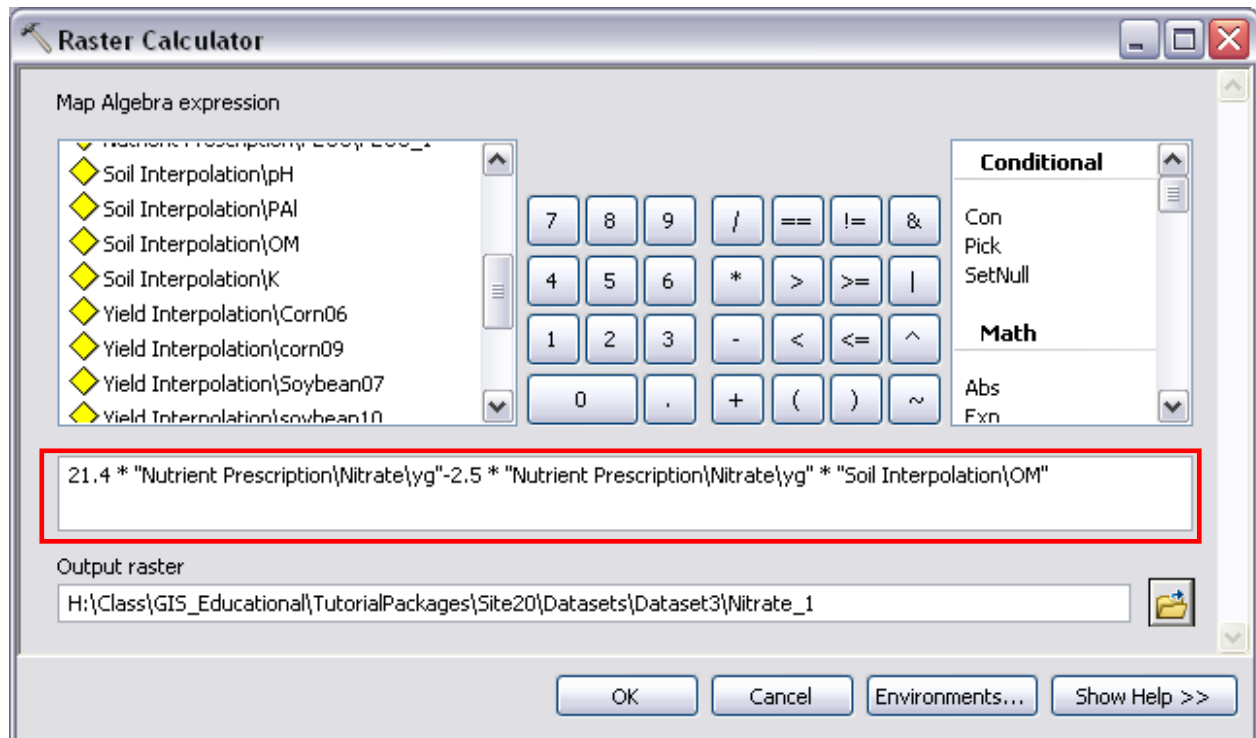
(Yield Goal: ton/ha)

Part 3: Creating a nitrate prescription variability map

1. Understand the 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 Nitrate prescription map by entering the following map algebra expression. A new raster **Nitrate_1** is added to **Table of Contents**.

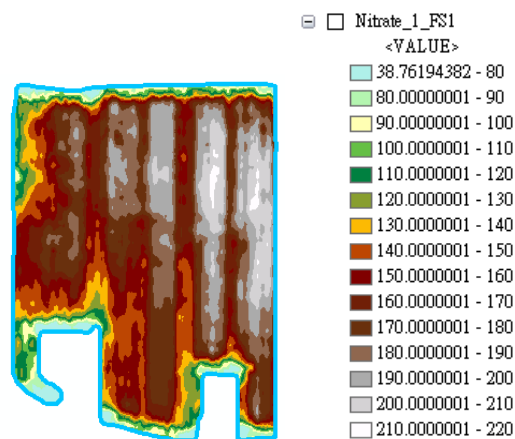
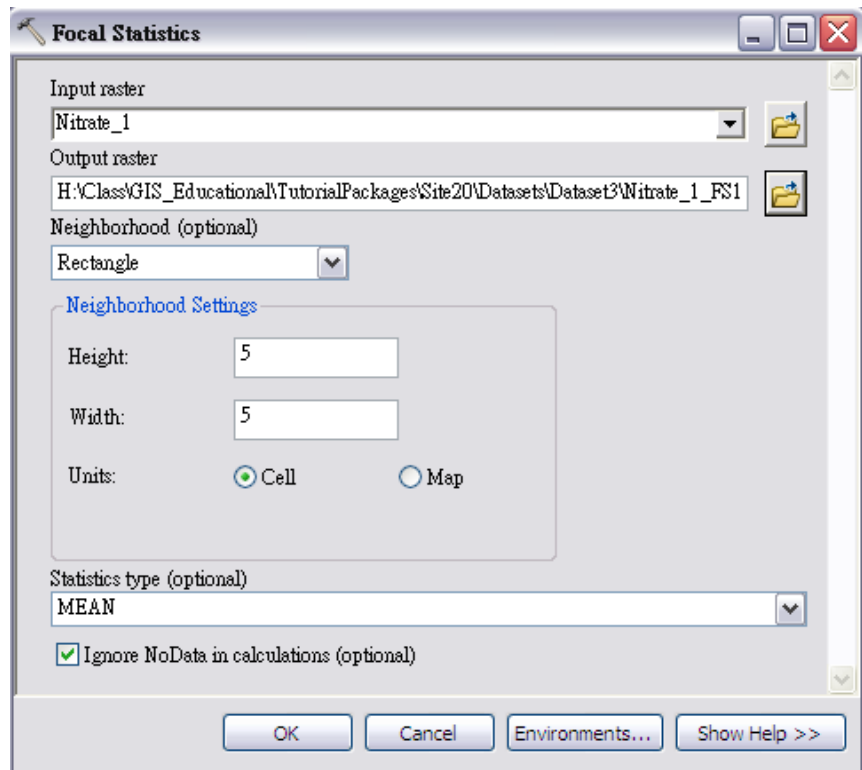
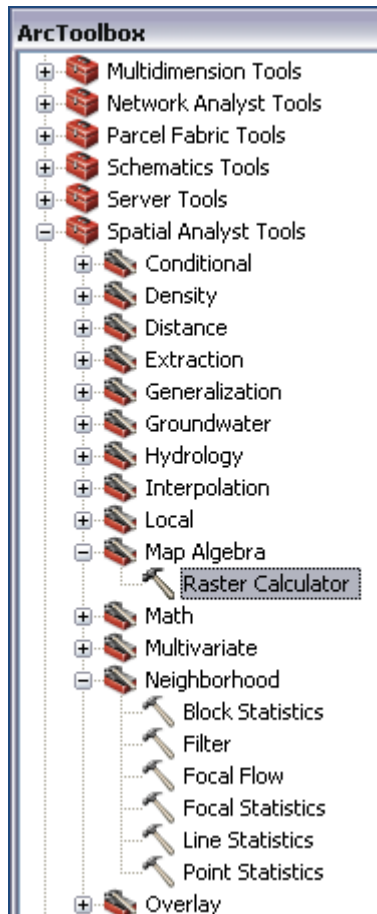


(Nitrate prescription: kg/ha)

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

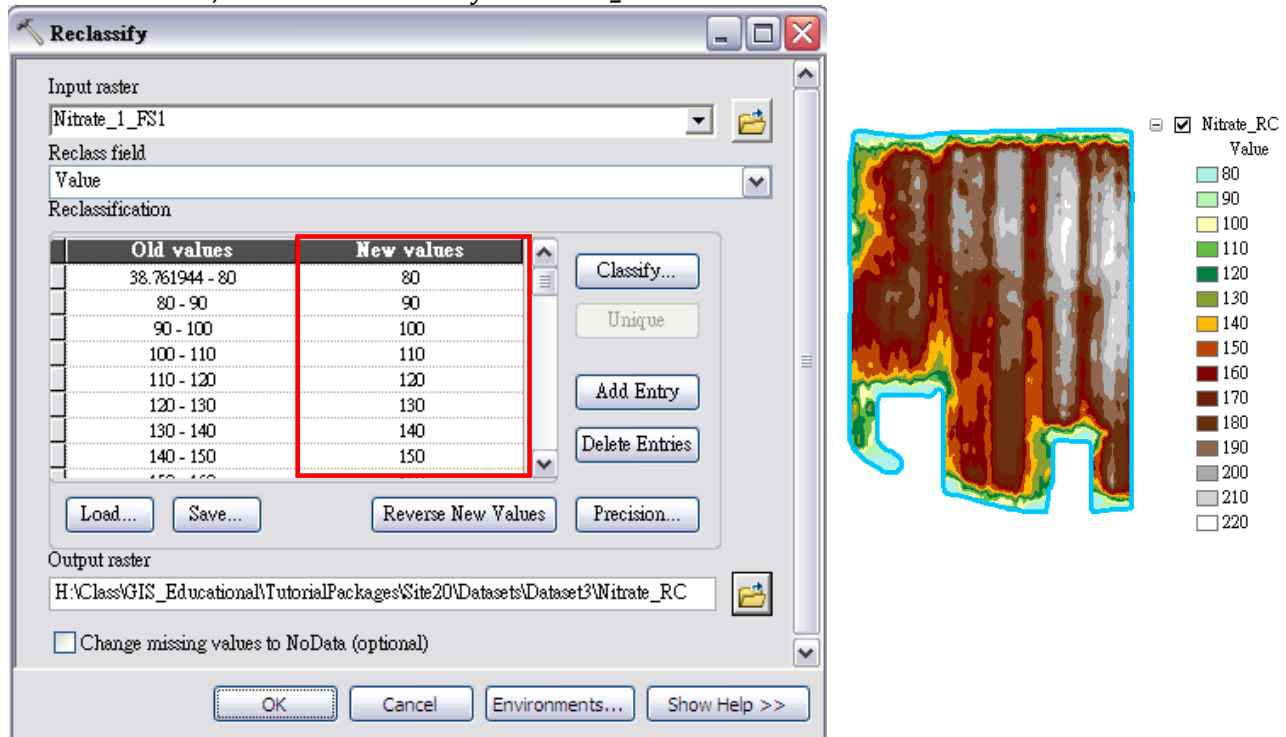
Part 4: Converting raster to polygon

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**.

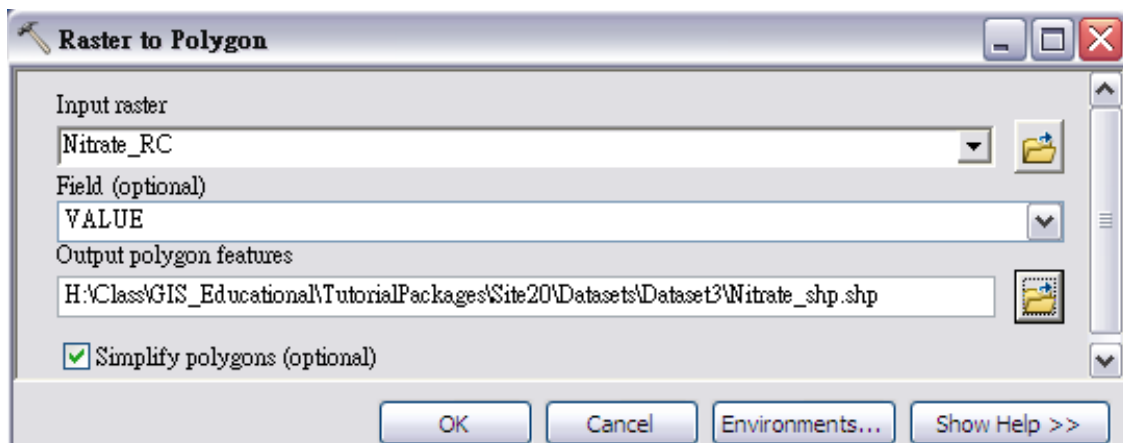


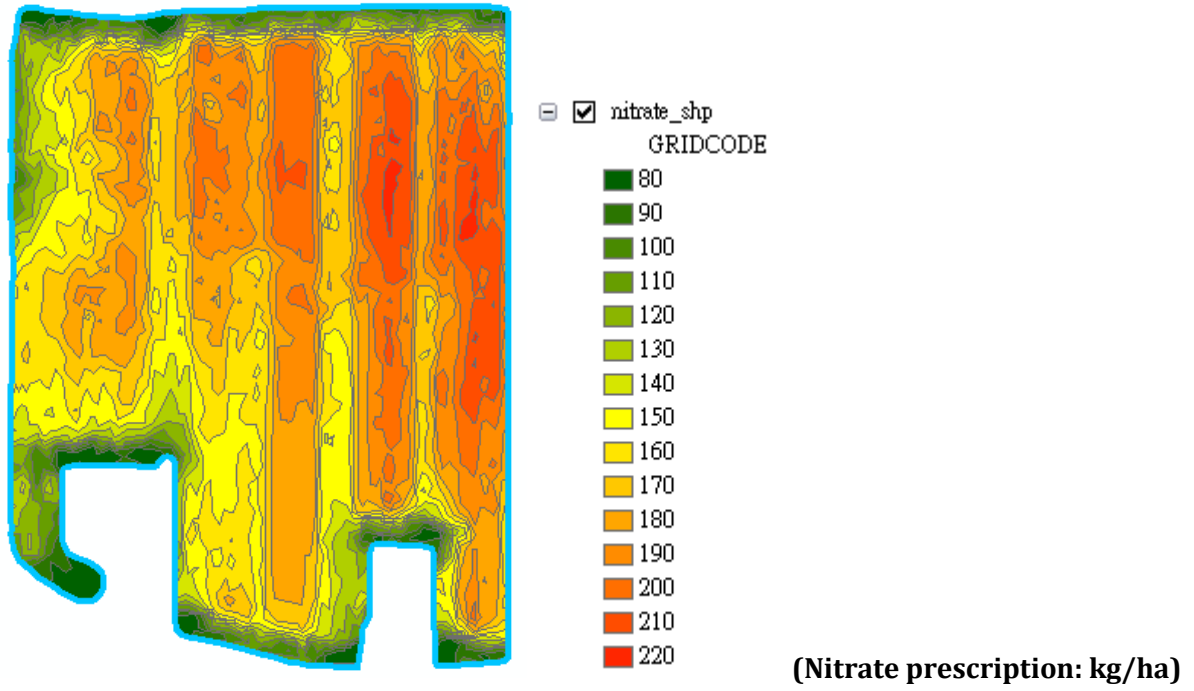
Here is the resulting smoothed nitrogen prescription map. Other smoothing options could be attempted as well. This step can be repeated to obtain the best zoning delineation.

- 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**.



- Convert raster to a polygon.
Go to **ArcToolbox > 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.