# Tutorial Set 3: Spatial data analysis

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

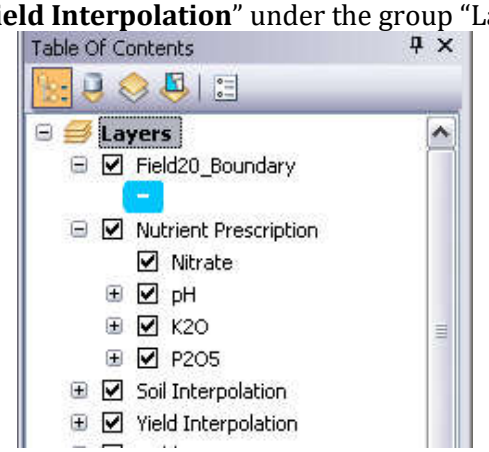
**Learning objective:** Developing a Yield Goal map based on a multi-layer yield history and then obtaining a nitrate prescription map

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

**Data Source**: Dataset3

## **Part 1**: Layer management

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




## **Part 2**: Understanding formulas

Yield normalization:

$$y_{relative_{year}} = \frac{Y_{actual_{year}}}{\overline{Y}_{year}}$$

Temporal statistics of historical yields:

- Average

$$_{avg}y_{relative} = \frac{y_{relative_{year1}} + y_{relative_{year2}} + \ldots + y_{relative_{yearN}}}{N}$$

- Standard Deviation

$$_{StDev}y_{relative} = \sqrt{\frac{(y_{relative_{year1}} - {}_{avg}y_{relative})^2 + \ldots + (y_{relative_{yearN}} - {}_{avg}y_{relative})^2}{N-1}}$$

- Coefficient of Variation (%)

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

Yield Goal:

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

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

The following layers drag and place under the **Yield Interpolation** group (these are interpolated layers obtained from Lesson 2 Exercise 2)**:**

$Y_{corn06}$ = 2006 corn yield

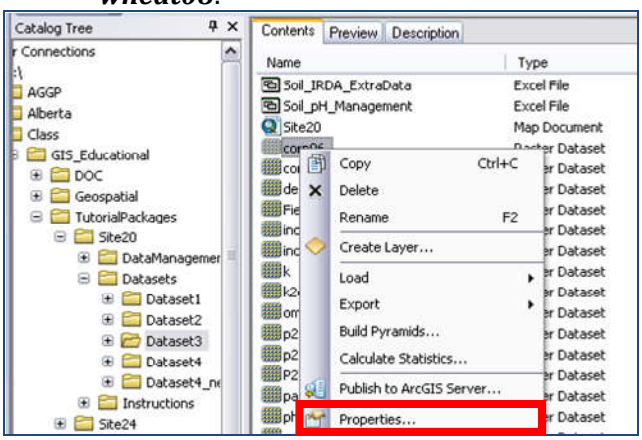
$Y_{soybean07}$ = 2007 soybean yield

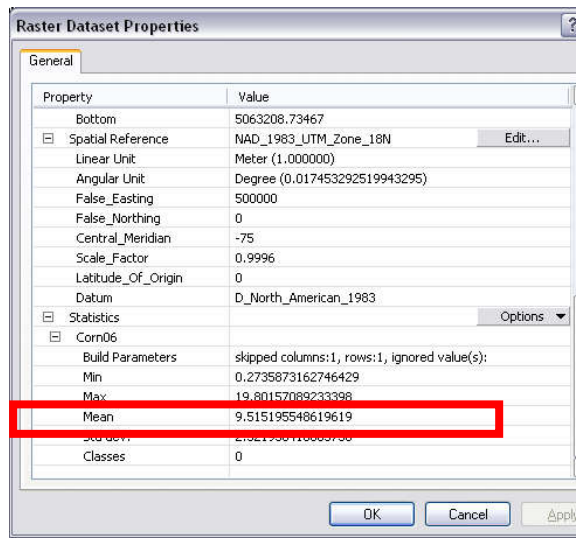
$Y_{wheat08}$ = 2008 wheat yield

$Y_{corn09}$ = 2009 corn yield

$Y_{soybean10}$ = 2010 soybean yield

1. Get the field average; such as the field average of 2009 corn yield = $\overline{Y}_{corn06}$ .
   In the **Contents** view of **ArcCatalog**, right-click on layer ***corn06*** and select **Properties**. In the **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***.



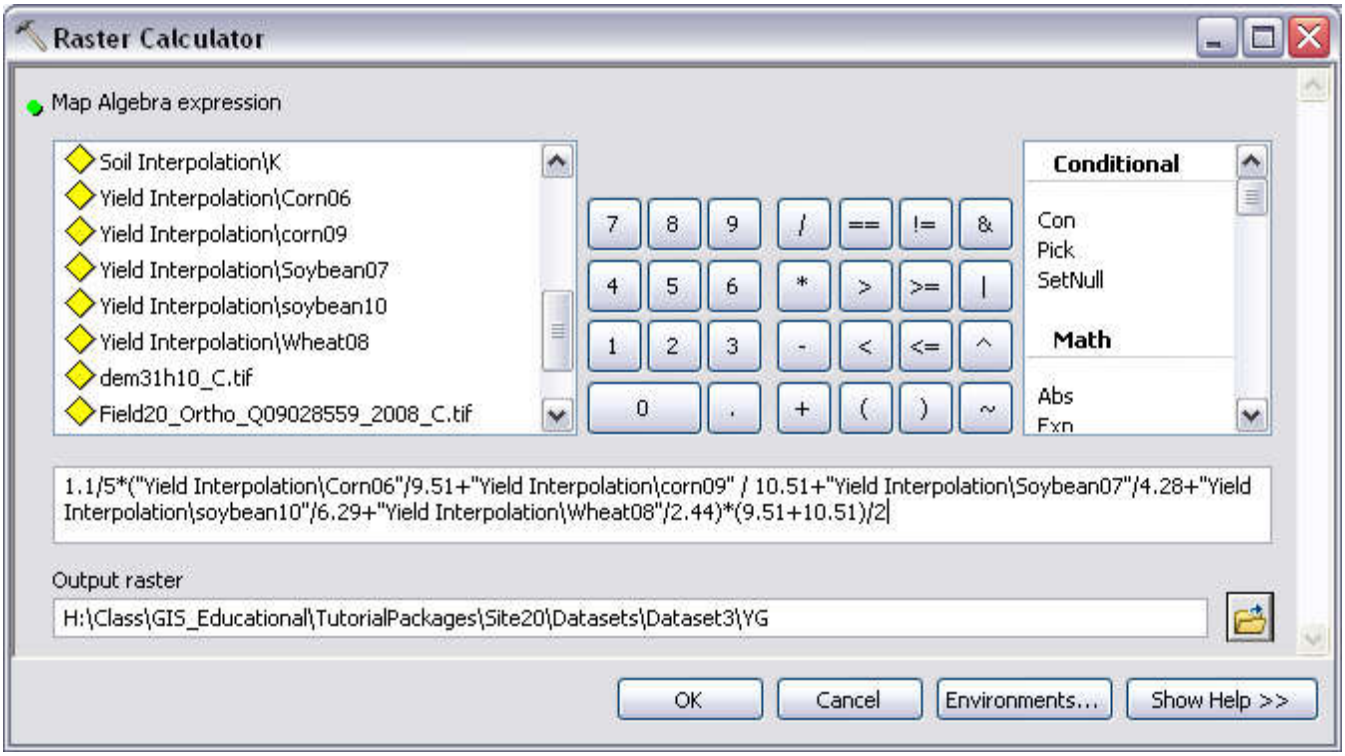




*Take note of these values for further use:*

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

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

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



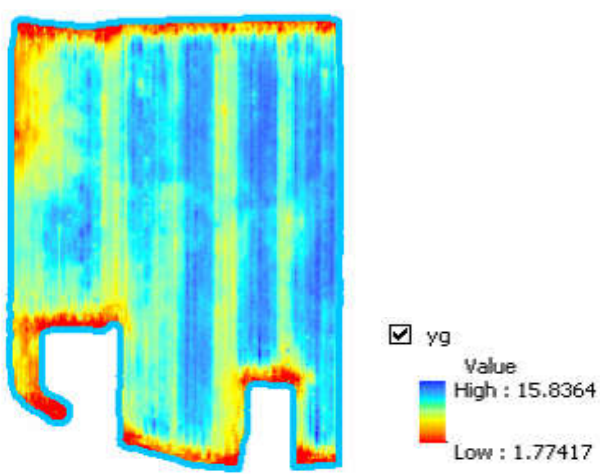

**Map algebra expression =**

1.1 / 5 * ("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) * (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:



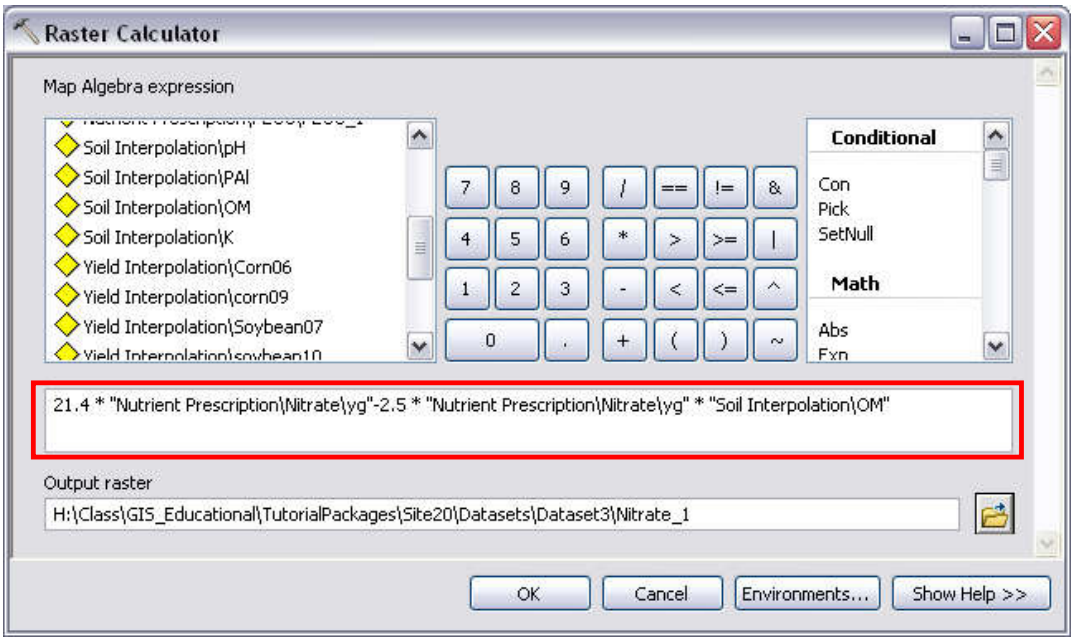

**(Yield Goal: ton/ha)**

**Part 3**: Creating a nitrate prescription variability map

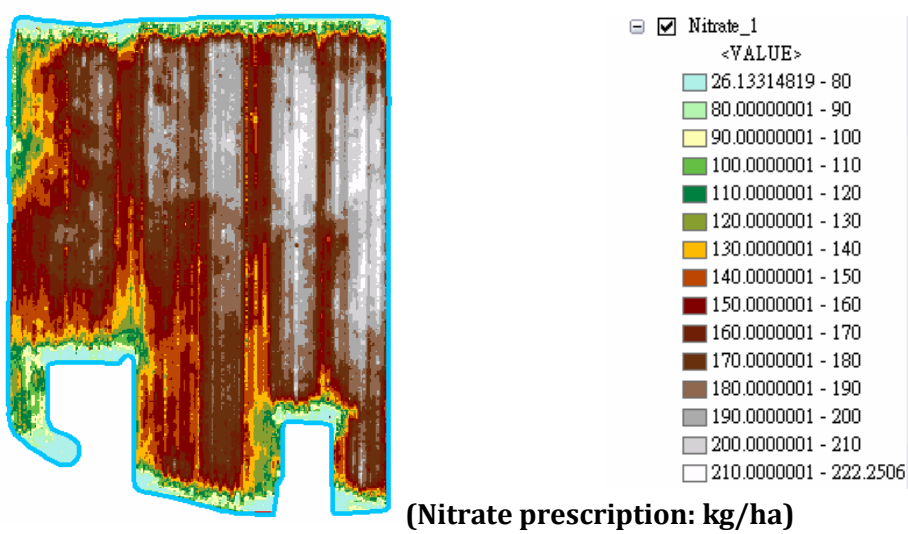
1. Understand the formulas used to estimate N (kg/ha) prescription for corn. YG is the yield goal calculated in Part 2 and OM is the field interpolated organic matter (%) map obtained from Lesson 2 – Exercise 1.

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

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 the **Table of Contents**.




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

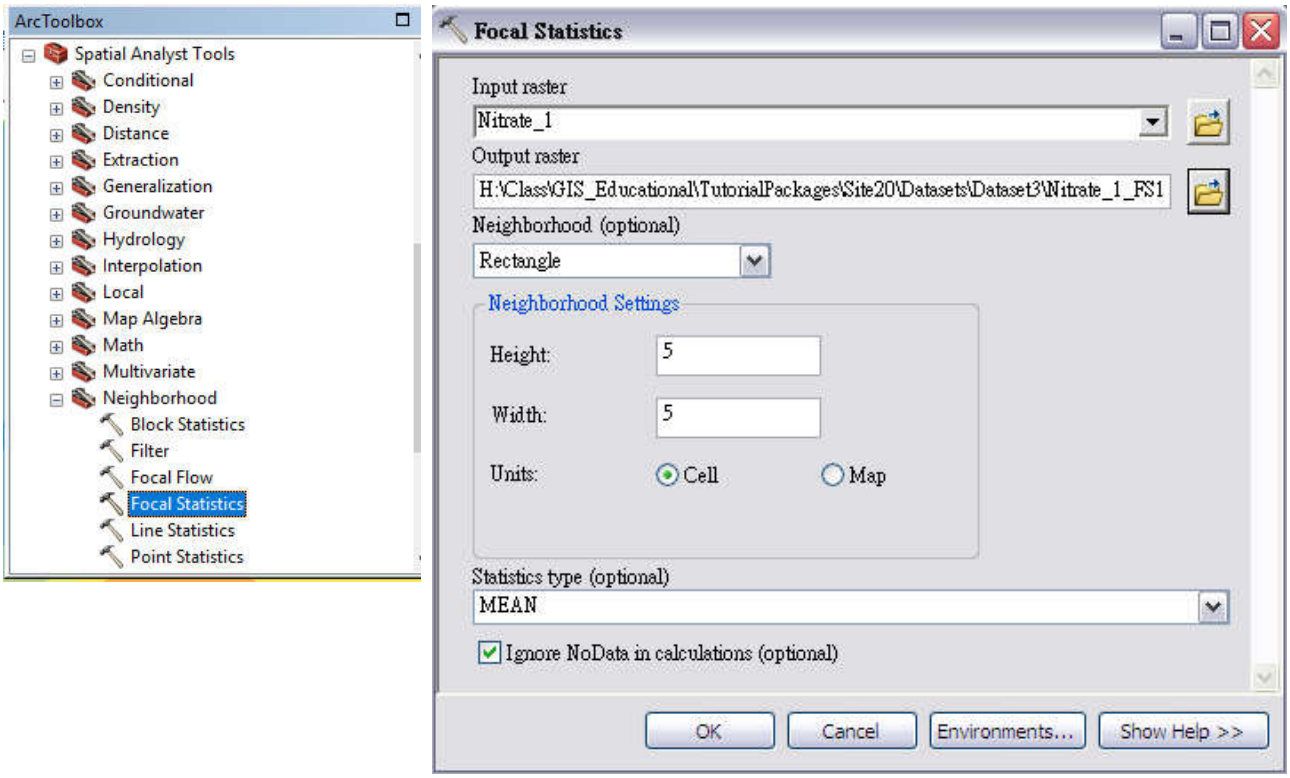


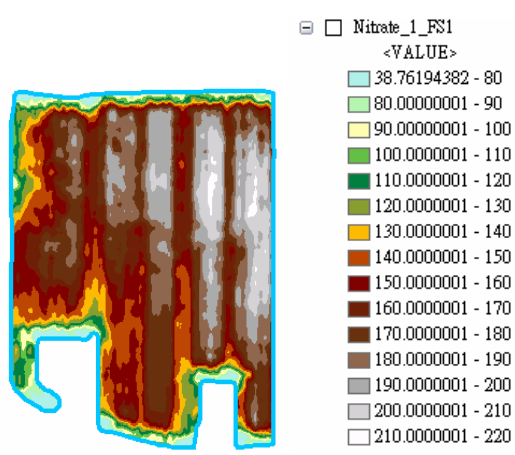

**(Nitrate prescription: kg/ha)**

*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

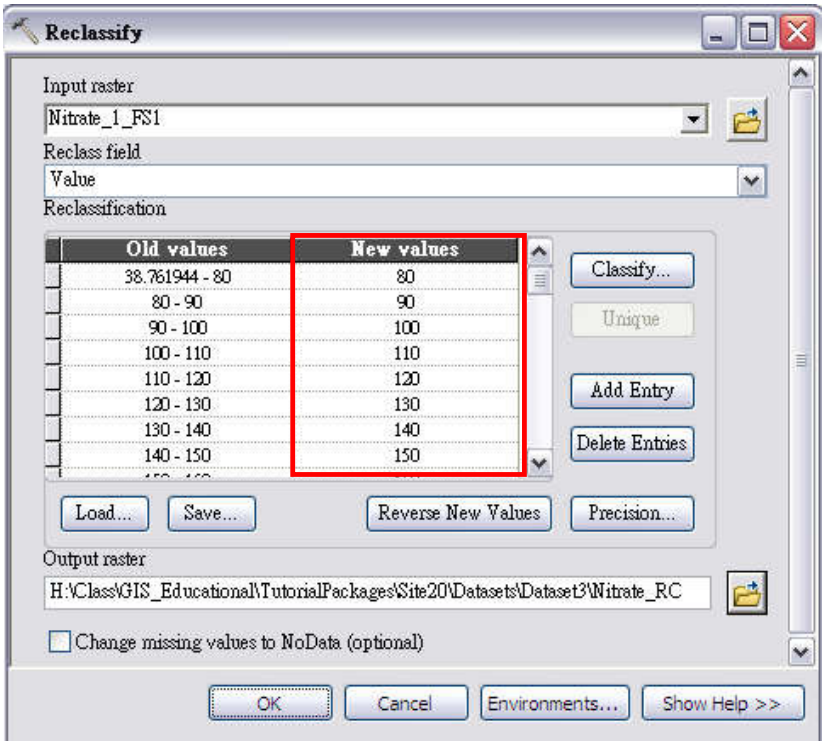
1. Use the **Focal Statistics** tool to smooth the layer ***Nitrate_1***.
   Go to **ArcToolbox** > **Spatial Analyst Tools** > **Neighborhood** > **Focal Statistics**. In the **Focal Statistics** dialog window, set the parameters as follows.
   Click **OK**, and the smoothed layer ***Nitrate_1_FS1***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

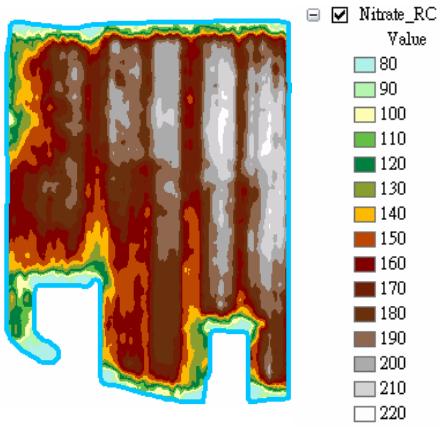


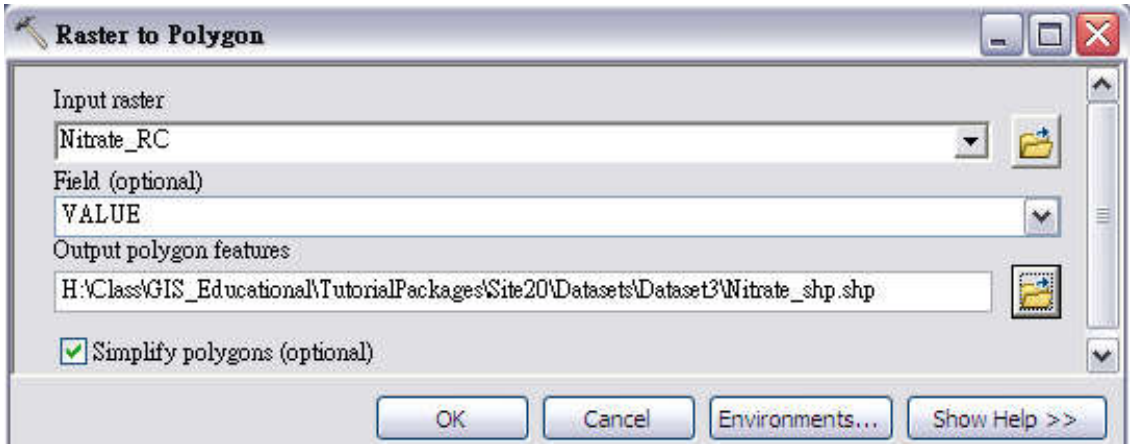

*Here is the resulting smoothed nitrogen prescription map. Other smoothing options could be attempted as well. This step can be repeated to obtain the best zoning delineation.*

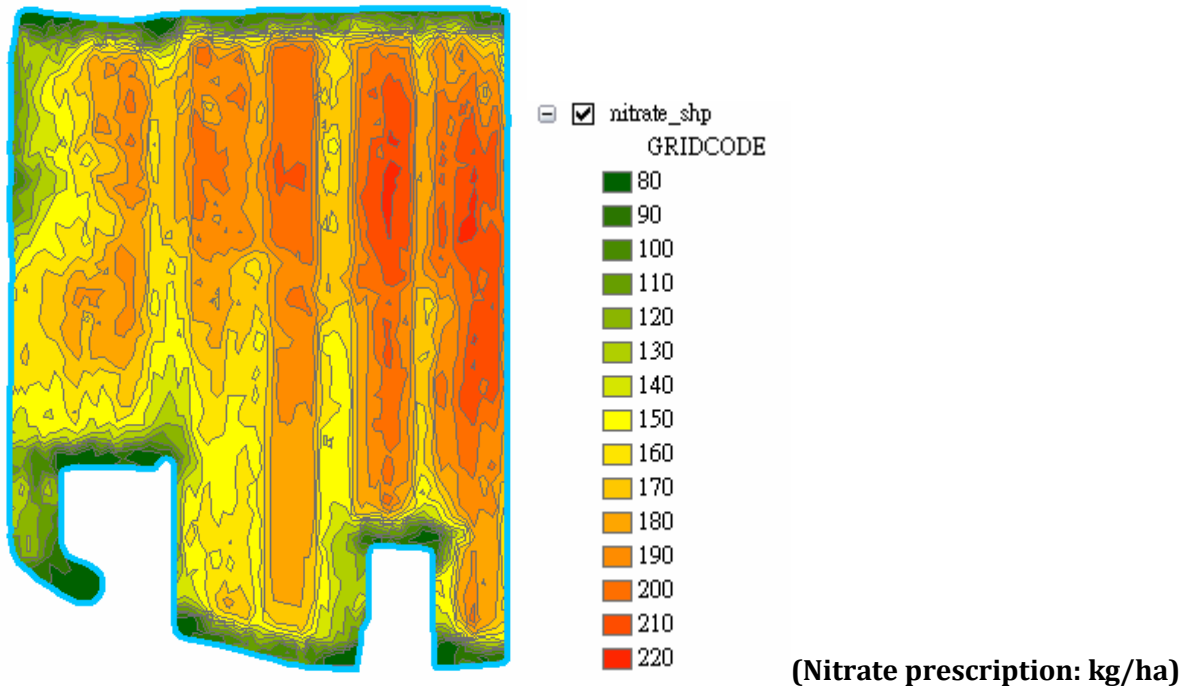
2. Reclassify the raster layer ***Nitrate_1*** to a new raster containing pixels with integer values. Go to **ArcToolbox** > **Spatial Analyst Tools** > **Reclass** > **Reclassify**. Assign new values to reclassify ***Nitrate_1*** by clicking **Classify…** and set the number of classes to 15 and break values to be the same as presented below (intervals of 10 kg/ha). Click OK and save it as ***Nitrate_RC***. This process format pixel values from "floating" to "integer".




3. Convert the 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.