### **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:

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

Temporal statistics of historical yields:

• Average

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

• Standard Deviation

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

• Coefficient of Variation (%)

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

Yield Goal:

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

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<b>Fait 3</b> . Creating a <b>field Guai</b> for corn based on a 3-year	vielu recoru

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

 $Y_{sovbean07}$  = 2007 soybean yield

 $Y_{wheat08}$  = 2008 wheat yield

 $Y_{corn09}$  = 2009 corn yield

 $Y_{sovbean10}$  = 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*.



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Take note of these values for further use:  $\overline{Y}_{corn06} = 9.51$ ;  $\overline{Y}_{corn09} = 10.51$ ;  $\overline{Y}_{soybean07} = 4.28$ ;  $\overline{Y}_{soybean10} = 6.29$ ;  $\overline{Y}_{wheat08} = 2.44$ 

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

Formula used:

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

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#### Map algebra expression =

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## (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:



#### 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.

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

 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.

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



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**.

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	✓ Ignore NoData in calculations (optional)



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".

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Change missing values to N	oData (optional)			

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.

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Here is the final polygonal nitrogen prescription map

4. Save the project.