Tutorial Set 3: Spatial data analysis

Exercise Site20_3-5 Development of yield productivity management zones

Learning objective:	Developing yield-based nutrient management zones according to multi-layer yield history
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 saved project.
- 2. Add a subgroup named "YieldZone" under the group "Nutrient Prescription".



Part 2: Creating a map of **Average-Relative Yield**, a map of **Standard-Deviation-Relative Yield**, and a map of **Coefficient of Variability**

 Understand the formulas. Temporal statistics of historical yields: Average Yield

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

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 (%)

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

Class of Yield

$$CY = \begin{cases} Yield \ Always \ High \ (Nitrogen = -1) & if \\ Yield \ Always \ Low \ (Nitrogen = 1) & if \\ Yield \ Always \ Low \ (Nitrogen = 1) & if \\ Yield \ Variable \ Average \ (Nitrogen = 0) & if \\ Otherwise \end{cases} y_{relative} +_{StDev} y_{relative} < 1$$

- 2. Review *Exercise_Site20_3-4* to obtain the field average of yield. $\overline{Y}_{corn06} = 9.51$; $\overline{Y}_{corn09} = 10.51$; $\overline{Y}_{soybean07} = 4.28$; $\overline{Y}_{soybean10} = 6.29$; $\overline{Y}_{wheat08} = 2.44$
- Create the map of Average-Yield.
 Go to ArcToolbox > Spatial Analyst Tools > Map Algebra> Raster Calculator.
 Formulas used:



Map algebra expression =

"Nutrient Prescription\Nitrate\yg"/1.1*2/(9.51+10.51)

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

Output raster = AVG_Y

Click **OK** to proceed.

4. Create the map of **Standard-Deviation-RelativeYield**. Go to **ArcToolbox > Spatial Analyst Tools > Map Algebra> Raster Calculator**.

Layers and variables								Exp2 Float	~
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Map algebra expression =

0.5 * SquareRoot(Power("Yield Interpolation\Corn06"/9.51-"Nutrient

Prescription\Nitrate\YieldZone\AVG_Y",2)+Power("Yield Interpolation\corn09" / 10.51-"Nutrient Prescription\Nitrate\YieldZone\AVG_Y",2)+Power("Yield Interpolation\Soybean07"/4.28-"Nutrient Prescription\Nitrate\YieldZone\AVG_Y",2)+Power("Yield Interpolation\Soybean10"/6.29-"Nutrient Prescription\Nitrate\YieldZone\AVG_Y",2)+Power("Yield Interpolation\Wheat08"/2.44-"Nutrient Prescription\Nitrate\YieldZone\AVG_Y",2))

Output raster = *SD_Y*

Click **OK** to proceed.

5. Create the map of Coefficient of Variability using the **Raster Calculator**. Go to **ArcToolbox** > **Spatial Analyst Tools** > **Map Algebra**> **Raster Calculator**. Enter the following map algebra expression. A new raster *CY* is added to the **Table of Contents**.

Layers and variables	^								Conditional	^
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Algebra expression_=

Con(("Nutrient Prescription \YieldZone\AVG_Y" + "Nutrient Prescription \YieldZone\SD_Y") < 1,-1,Con(("Nutrient Prescription \YieldZone\AVG_Y" - "Nutrient Prescription \YieldZone\SD_Y") > 1,1,0))

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



Low Yield Zone

Part 3: Converting raster to vector (e.g., polygon)

1. Reclassify the raster layer *CY* to a new raster in which pixels with the same values are merged. Go to **ArcToolbox** > **Spatial Analyst Tools** > **Reclass** > **Reclassify**. Set the parameters as follows and then save the new raster to *CY_RC*. Click OK, and then the new layer *CY_RC* is added to the **Table of Contents**.

Input raster		
CY		I 🖻
Reclass field		
VALUE		¥
Reclassification		
Old values	New values	
	-1	Classify
0	0	
1	1	
NoData	NoData	
		Delete Entries
Load Save	Reverse New	Values Precision
		<u></u>
Output raster		
Output raster H:\Class\GIS_Educational\Tu	itorialPackages\Site20\Da	atasets\Dataset3\CY_RC 🛛 🛗

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

CY_RC			- 🖻
Output raster			
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Veighborhood ((optional)		
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Units:	⊙ Cell	ОМар	
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Other smoothing options could be attempted as well. The benefit of the median filter is that it does not reduce the spread of the data, but simply allows the most frequently apparent values to be assigned to the neighbor pixels. 3. Reclassify the raster layer *CY_RC_SM* again, as after performing the **Focal Statistics** the new raster contains non-integer values. Go to **ArcToolbox** > **Spatial Analyst Tools** > **Reclass** > **Reclassify**. Set the parameters as follows and then save the new raster to *CY_RC_new*. Click OK, and then the new layer *CY_RC_new* is added to **Table of Contents**.

CY		I 🖻
Reclass field		
VALUE		~
Reclassification		
Old values	New values	
-1	-1	Classify
0	0	Linimum
1	1	Unique
NoData	NoData	
	~	Delete Entries
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Load Save Dutput raster	Reverse New Values	Precision
Load Save Output raster H:\Class\GIS_Educational\Tu	Reverse New Values torialPackages\Site20\Datasets\D	Precision

 Convert the smoothed and reclassified raster layer *CY_RC_SM* to a polygon shapefile. Go to ArcTookbox > Conversion Tools > From Raster > Raster to Polygon. A new layer *CY_shp* showing zones of nitrate prescription is added to the Table of Contents.

Input raster			
CY_RC_SM		•	8
Field (optional)			-
VALUE			~
Output polygon feature	5		
H:\Class\GIS_Educatio	nal\TutorialPackages\Site20\Datasets\Dataset3\ <i>CY_sh</i> t	,	
Simplify polygons (op	vtional)		



5. Save the project.