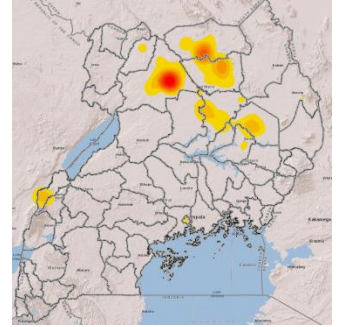


# Hot Spot / Kernel Density Analysis: Calculating the Change in Uganda Conflict Zones



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## Overview

This tutorial uses **Armed Conflict Location and Event Dataset (ACLED)** data to create hot spot maps of conflict events in Uganda for two time periods – 2000 to 2004 and 2005 to 2010. Students then calculate the change in conflict and create a final map to display where Uganda has experienced an increase and decrease in conflict over this time period.

By the end of this tutorial, students will be familiar with the following tools:

- Kernel Density Tool
- Raster Calculator
- Setting your Geoprocessing Environments

## Setting Up

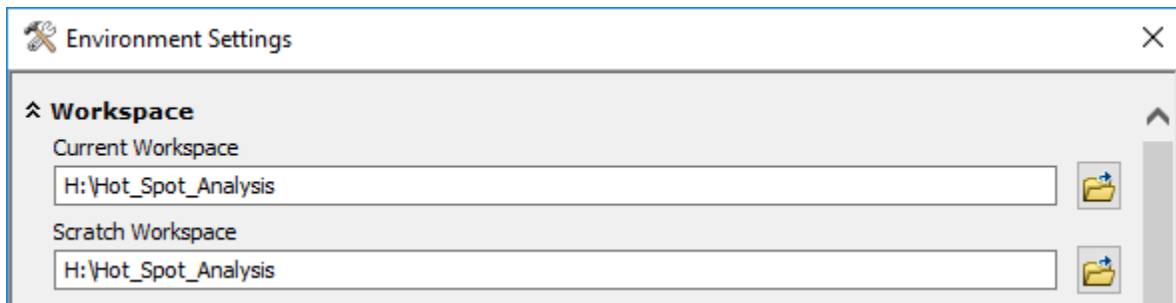
1. Ensure the **H:** and **S:** drives are mapped. For assistance on mapping network drives, please visit: <https://sites.tufts.edu/datalab/accounts-network-drives/>
2. Create a folder on your **H:** drive called *Hot\_Spot\_Analysis*
3. Start ArcMap and open the **UgandaConflict.mxd** from **S:\classes\DHP\_P207\Hot\_Spot\_Analysis\** (or alternatively, download the data from our [website](#))
4. Once open, immediately save the **UgandaConflict.mxd** file to your *Hot\_Spot\_Analysis* folder on your **H:** drive
5. Take a moment and look at the data. The data were acquired from the following sources:
  - a. Conflict Data: [ACLED](#) - Armed Conflict Location and Event Dataset
  - b. Geographic Boundary Data: [GADM](#) - Global Administrative Areas Database
6. **Question:** What is the coordinate system and linear units of the data frame? Does it match the spatial reference for the data layers?

## Enabling Spatial Analyst Extension

1. From the menu bar select **Customize** → **Extensions** and check the **Spatial Analyst** check box. Now you can use the Spatial Analyst functionality. (Note that you must do this every time you use this tool at a new computer.)

## Setting up your Analysis Options in Geoprocessing Environments

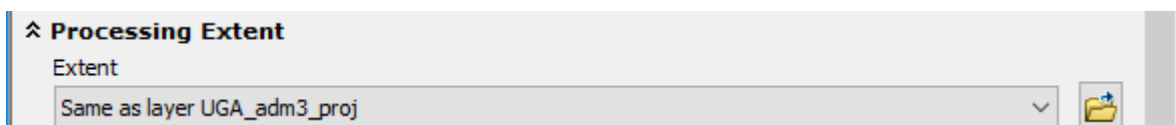
1. From the **Geoprocessing** dropdown menu select **Environments...**
2. Under **Workspace**, click on the browse (📁) button for **Current Workspace** and **Scratch Workspace** and navigate to the *Hot\_Spot\_Analysis* folder you created on your **H:** drive.



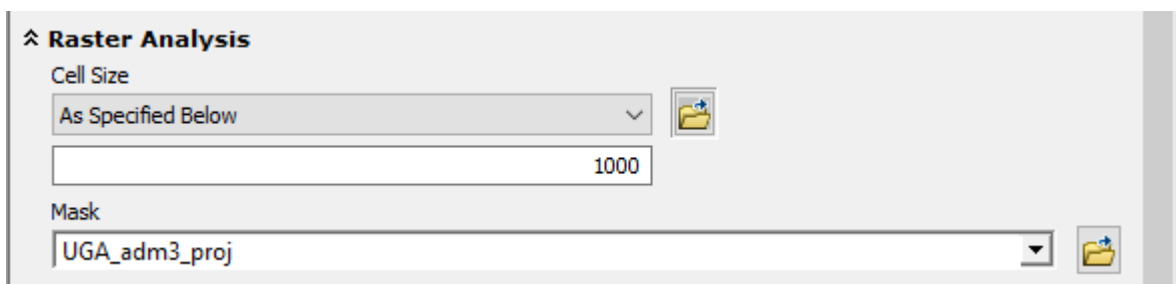
3. Under **Output Coordinates**, set **Output Coordinate System** to *Same as Display*. This ensures that all new raster datasets created are in the same coordinate system/projection as the data frame.



4. Under **Processing Extent**, set **Extent** to *Same as Layer UGA\_adm3\_proj*.  
This defines the geographic processing extent of all new raster datasets created during analysis. We set the processing extent such that new calculations performed use the same bounding box extent as *UGA\_adm3\_proj*.



5. Under **Raster Analysis**, set the **Cell Size** to *As Specified Below* and type in *1000*.  
(This ensures all of the raster datasets we create will have the same cell size, allowing us to compare them.)  
Additionally, set the **Mask** to *UGA\_adm3\_proj*. This “clips” the new raster to the shape of Uganda.

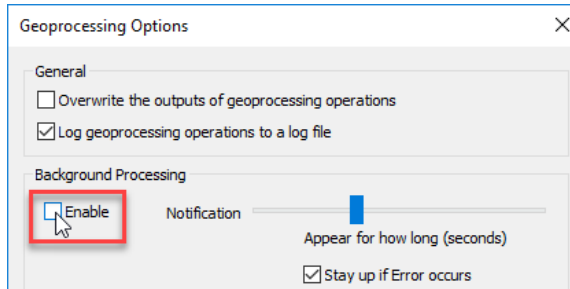


6. Click **OK**

7. Click on **Geoprocessing** → **Geoprocessing Options...**

Disable *Background Processing* by unchecking the corresponding box. Click **OK**.

(Disabling background processing ensures all tools run in the foreground. While this means that you must wait for a tool to finish before proceeding, it allows you to see when a tool has finished running and whether there were any errors, which makes troubleshooting significantly easier.)



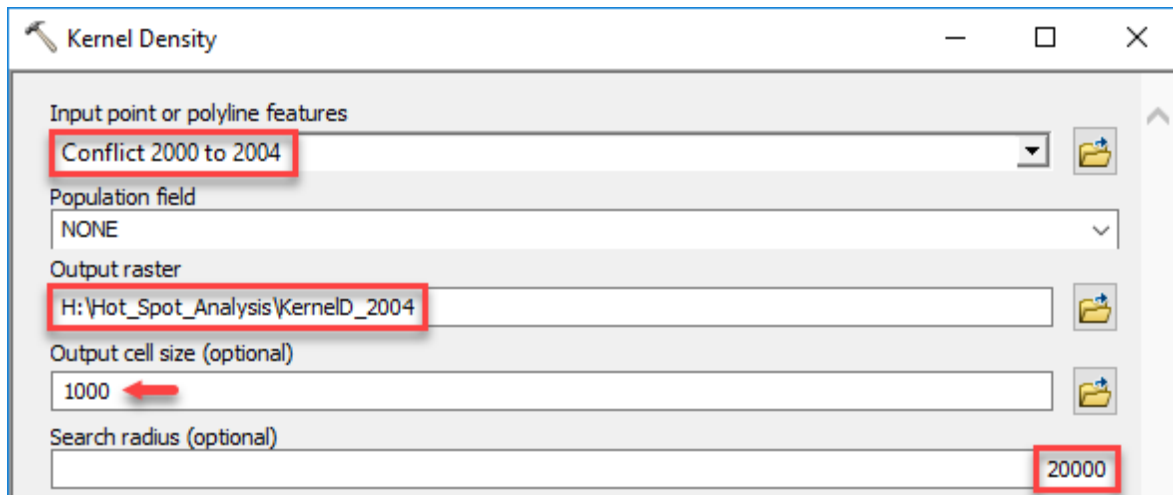
## Conducting the Analysis

1. Turn on the *Conflict 2000 to 2004* point layer.
2. Open *ArcToolbox*. In *ArcToolbox*, select **Spatial Analyst Tools** → **Density** → **Kernel Density**. This brings up the **Kernel Density** window.
3. Enter the values below for the various parameters.

Ensure you save the **Output Raster** into the *Hot\_Spot\_Analysis* folder on your **H:** drive.

Note that the **output cell size** defaults to *1000* because we specified it in our **Geoprocessing Environments**.

**Question:** What units are the *search radius* and *output cell size* in?

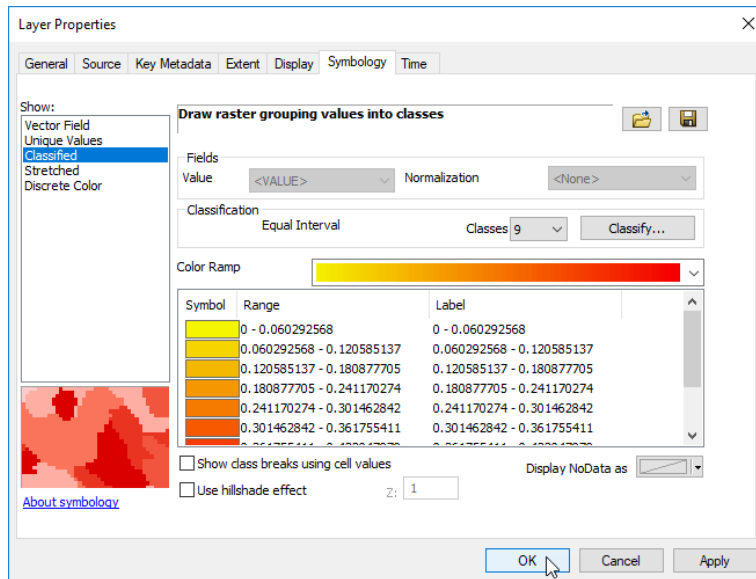


**A note on raster file names:** ArcMap requires raster datasets to have a **file name** no longer than 13 characters. Additionally, **spaces are not allowed** in the file names of raster datasets or the names of any **folders**. Therefore, to ensure all tools run without errors, *never use spaces in folder or file names* and ensure raster datasets have a *file name* no longer than 13 characters.

The output file name used in the example above (*KernelD\_2004*) is an illustration of a good file name for a raster dataset. Underscores are used instead of spaces and length is kept under 13 characters, but the name is still meaningful and gives us a good indication of what this raster dataset represents.

4. When complete, click **OK**.
5. A new raster layer should appear in your *Table of Contents*.

6. Change the **color scheme** of the new raster layer to a *hazard color model*, shown below.



7. Examine your new data layer. How well does it represent your point data?
8. Experiment with a few of the classification schemes found on the *Layer Properties* under **Classify...** How do these methods effect the way your hot spots are displayed?
9. Now rerun the **Kernel Density** tool a few more times and try different values for the *search radius*. Keep the *output cell size* at the default value of 1000, so we can compare the raster datasets.

Try the following search radii:

- 5,000 m
- 20,000 m
- 100,000 m
- 30,000 m
- 40,000 m

**Question:** What search radius is best? What makes you think this?

10. After we determine the best search radius in class, run the **Kernel Density** tool once again with the *Conflict 2000 to 2004* layer as input.

Once created, change the name of this new layer in the table of contents to *Density2000\_2004*.

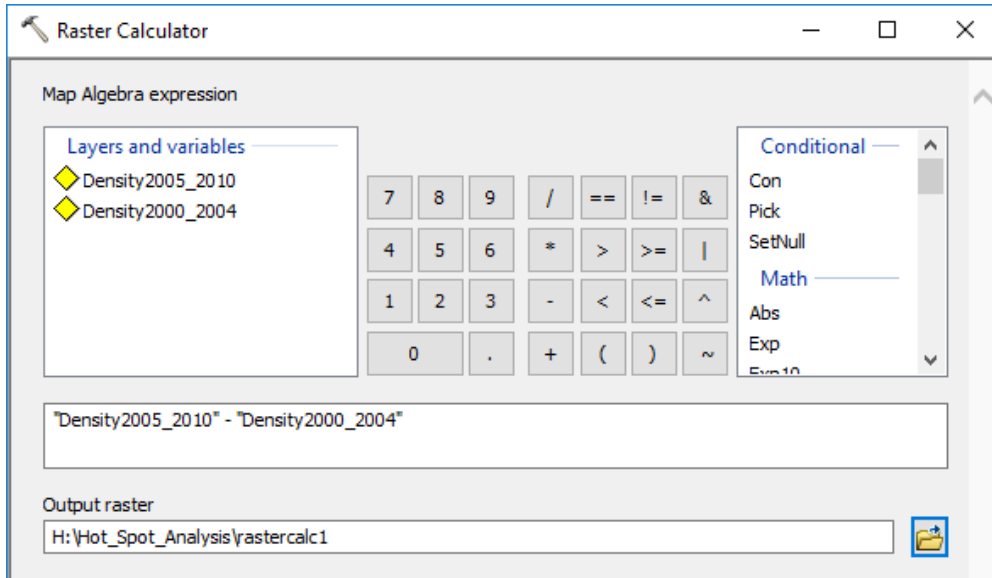
**Note** that if you attempt to specify the name of the input as *Density2000\_2004*, you will get an error. This is because ArcMap requires raster datasets to have a **file name** no longer than 13 characters.

Ensure you use a short (but meaningful) file name with **no spaces** and feel free to give the raster dataset a longer and more legible name in the table of contents.

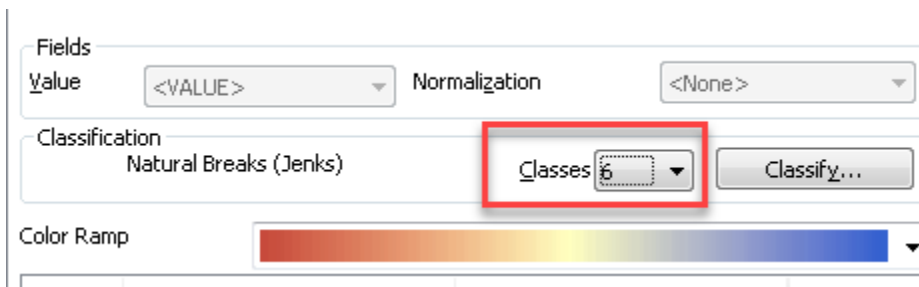
11. Now, run the **Kernel Density** tool with the *Conflict 2005 to 2010* layer as input. Ensure you use the same optimized *search radius* and *cell size* we used to create *Density2000\_2004*. Change the name of this new layer in the table of contents to *Density2005\_2009*.
12. You should now have two raster density surfaces in your project – *Density2000\_2004* and *Density2005\_2009*. **Symbolize** them both using a *hazard color model* and remove any extra density layers you made.
13. Compare the two different time period density surfaces. Do you notice any differences?
14. Save your project.

## Performing Change Detection Analysis

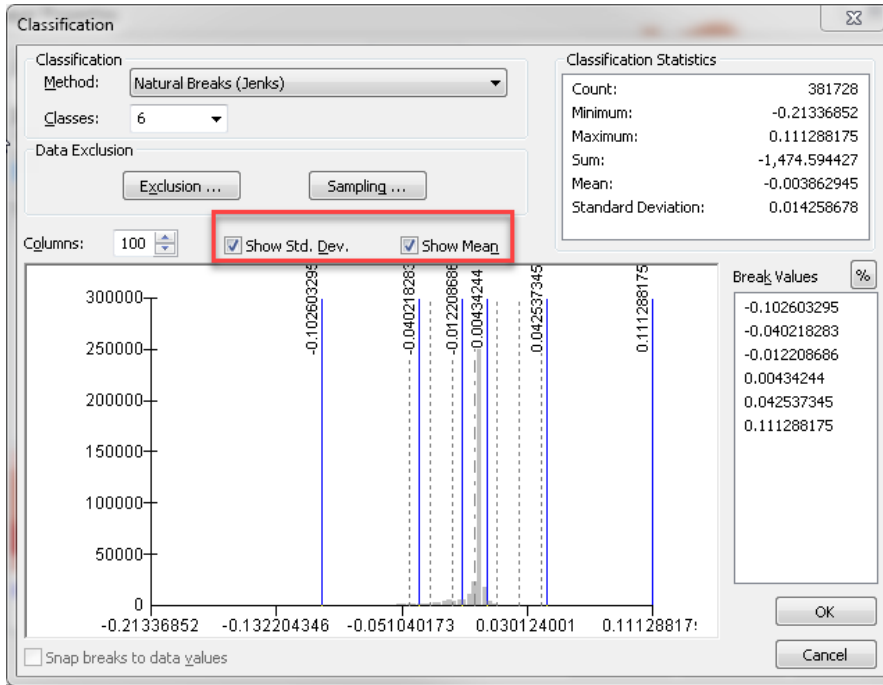
1. While visual comparison is helpful, we want to *quantify* the change over time by subtracting one density surface from the other.
2. We want to create a new raster layer that is the result of subtracting the *Density2000\_2004* layer **from** the *Density2005\_2009* layer. Therefore, positive results would indicate an increase in conflict over time and negative results would indicate a decrease in conflict over that time period.
3. In *ArcToolbox*, navigate to **Spatial Analyst Tools → Map Algebra → Raster Calculator**. This brings up the **Raster Calculator** Window.
4. Build the expression "**Density2005\_2010**" - "**Density2000\_2004**". Double click on the layers to add them to the expression box. (Using the Raster Calculator Keypad is helpful. It reduces the chance of syntax errors.) Click **OK**.



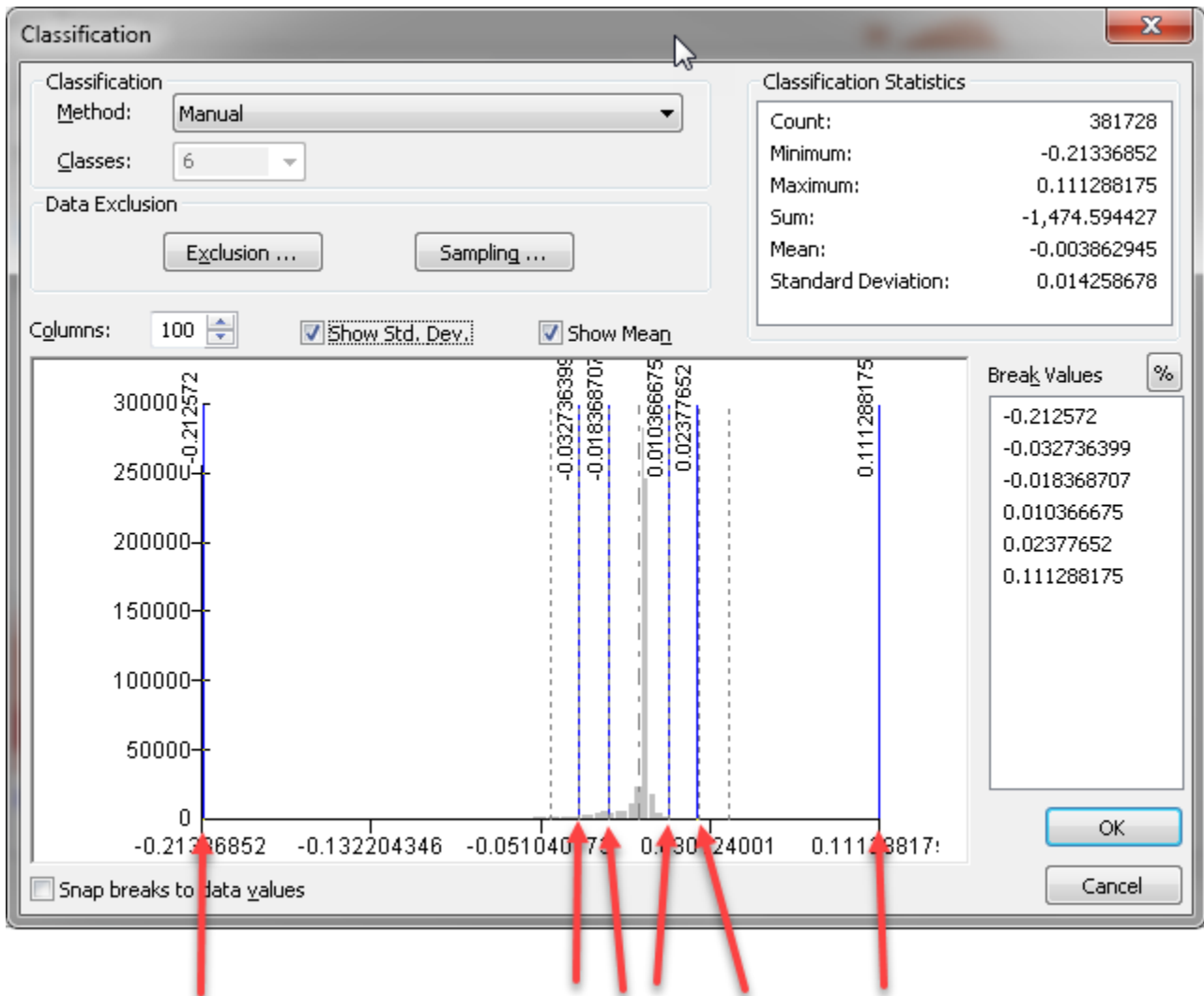
5. A new raster layer should appear in your table of contents.
6. Open the **symbology** of this new raster data set. Change the symbology type from **Stretched** to **Classified** on the left hand side.
7. Change the number of classes to 6 and then press **Classify** to see the histogram.



8. We are now going to symbolize the data by referencing the *mean* and *standard deviation* information. Check the little boxes for **Show St. Dev** and **Show Mean**. You will see shorted dotted lines appear in the histogram at 3 standard deviations per each side of the mean, which is shown with longer dashes. See screen shot below.



9. **Drag** the blue break value lines to the two dotted lines on either side of the **Mean** Dashed line. This will move the break values to be set at those 2 standard deviations. Then drag the two outside blue lines to the min and the max values. See screen shot to see how it should look. Press OK.



- Back in Symbology, choose a **diverging color scheme** to showcase the significant increases and decreases with very different colors. Then, set the two middle values to white to represent no change. Type in the appropriate label as well next to each break value (i.e. Increase, Decrease, No change, etc).

Symbol	Range	Label
	-0.21336852 - -0.212572	Significant Decrease
	-0.212572 - -0.032736399	Decrease
	-0.032736399 - -0.018368707	No Change
	-0.018368707 - 0.010366675	No Change
	0.010366675 - 0.02377652	Increase
	0.02377652 - 0.111288175	Significant Increase

Show class breaks using cell values      Display NoData as

Use hillshade effect      z:

- Make sure that **Increases** are shown in **red** and **decreases** are shown in **blue**. If necessary, you can flip the color ramp by clicking on “symbol” and **Flip Colors**.

- Examine your results.
- You have now made a thematic map depicting significant increases and significant decreases of conflict from the two time periods using a *diverging color model* and a **standard deviation** guides. In our map below, the search radius used was 30,000 meters.



