Wetland Mapping: Exercise 2 – Create the CTI Layer and classification of the wetlands
ArcMap 10

Note: In the following instructions you will be asked to browse the directory location of your Wetland Mapping training folder. That location is represented by a drive letter of x: Please note that the screen shots used in the examples were created utilizing data that was located on C:\temp (i.e. the value of x: was C:\temp). Be sure to use the actual drive letter assigned by the computer to your flash drive and be aware that your screens will reflect that letter and not C:\temp as in the samples. Check with your instructor for more details if you have questions.

Creating the CTI layer has many steps. For simplicity's sake, in this exercise we will start with the existence of the final raster for specific catchment area (AS) and the slope (β) layers. This exercise will demonstrate how to implement the equation:

\[ CTI = \ln \left( \frac{AS}{\tan(\beta)} \right) \]

Once the CTI layer is created we will then run a low pass filter over the scene to reduce some of the variability such as anomalous cells.

**Part 1: Steps to create the CTI layer**

Open ArcMap 10. From the main menu bar, click on the **File** menu and click on **Open**

In the Open window, browse to `\WetlandMapping\Exercise2.mxd` and click on that icon to open the ArcMap document for this exercise. You should see a familiar false color infrared image of the Chanhassen study area:
Our first step is to verify the work areas are set up properly. In the Arc Map 10 main menu bar, click on the **Geoprocessing** menu and in drop down, click on the **Environments...** button:

![Environment Settings Dialog Box](image)

Click on **Workspace**:

Verify that the Current Workspace is your class **OutputData** folder and that the Scratch Workspace is set to the **ScratchArea** folder in your Wetland training folder. Your screen should look like:

![Current Workspace Dialog Box](image)
Click **OK** on this window and click **OK** on the Options window and you’re set to go for the rest of the session. Now that the environments are set we can begin our processing steps.

Our next step is to load the Specific Catchment Area (SCA) and Slope layers.

- Click on the **Add Data** icon in the ArcMap standard tool bar
- Browse to the `x:\WetlandMapping\ClassData` folder
  and while holding down the **Ctrl** key click on the `sca.img` icon and the `slope.img` icon;
- You should see the following in the Add Data window

![Add Data Window](image)

- Click on the **Add** button, both layers should be added and your screen should now look something like this:
Acquaint yourself with the data. As an example, unclick all of the layers in the Table of Contents except the slope layer. You will be seeing a black and white representation of degree of slope in the image. Bright areas indicate regions of higher slope. Notice how the lakes and waters are essentially black, indicating 0 slope and we can see the high slope region of the banks surrounding these lakes.

In Exercise 1, we used the Raster Calculator tool in the Spatial Analyst Tool Box to create our NDVI layer. In this exercise we will be using this same tool to create our CTI layer. Make sure the Spatial Analyst extension is clicked the **Customize > Toolbars** drop down menu.

Shortcut: You can also enable a tool bar by right clicking anywhere in the unused portion of your ArcMap menu bars. A list of all possible menu bars will appear and simply check the desired choice(s)

If the ArcToolbox window is not visible, enable it by clicking **Geoprocessing > ArcToolbox**.

In the ArcToolbox, navigate to **Spatial Analyst Tools > Map Algebra** and double click on the **Raster Calculator** tool.

Notice in the **Layers and variables** box that all of the raster layers in your table of contents are visible.
We’ll now build the CTI layer. Remember, our formula is \[ \ln \left( \frac{AS}{\tan(\beta)} \right) \]. In addition, a small value of 0.0001 will be added to the slope rater so we will not get any divide by zero errors. Watch in the expression area of the tool as the tool builds our formula a step at a time:

- In the Math functions list, double click on Ln
- Double click on the sca layer in Layers and variables
- Click on the \( \div \) divide button
- In the Trigonometric functions list, double click on Tan entry
- Double Click on the slope layer in Layers and variables
- Click on the \( + \) addition button and add 0.0001
- Change the Output raster name to be cti

Verify that your screen looks like the following:

![Image of the Raster Calculator with the CTI formula entered]

Click OK to build the CTI raster layer. The new layer should be added to your ArcMap scene:
The next step is to pass a 3x3 filter over the output layer to remove some of the variability in the image. We will use the Filter tool in the Spatial Analysts Tool box to accomplish this. Open the ArcToolbox and then open the Spatial Analyst Tools choice followed by the Neighborhood tool set as seen on the left.

Double click on the Filter tool. You should see the following:

For the input raster, browse to the location of the output file you created above:
For the Output raster, enter a name of **cti_filter**. Your screen should look something like:

![Filter window](image)

Click **OK** to run.

If necessary, click Close on the progress window to add the output to your ArcMap session. Notice how this new layer has been blurred slightly.

![ArcMap window](image)

**Congratulations! You've created your CTI layer.**
Part 2: Steps to classify wetlands

In this exercise will use the following layers: NDVI_r, cti_r raster layers and soils vector layer (due to time restrictions this CTI layer has been already reclassified with values of 0 for a dry cell and 1 for a wet cell) the threshold used to reclassify either dry or wet cells was of < 9.645 for any dry cell.

Our first step in this exercise is to load the ndvi_r, and cti_r and soils vector layer.

- Click on the Add Data icon in the ArcMap standard tool bar
- Browse to the x:\WetlandMapping\ClassData folder
- Select the cti_r, ndvi_r and soils vector layer and click on the add button

Both layers should be added and your screen should now look something like this:
The soils layer depicts the soil types in the study area. Our first step will be to convert this polygon layer into a coded raster with 3 meter cell size. To do this, we will use the Feature to Raster tool: Open the **Conversion Tools** in the ArcToolbox. Open the **To Raster** tool set and double click on **Feature to Raster**:
Click on the Input features dropdown arrow and select the ***soils*** layer

Click on the Field Drop down and select Reclass. The reclass field was added to the original soil vector layer to classify all hydric soils and lakes as number 1, representing wetness and 0 for the rest of values that are none hydric or lakes.

Name the output raster ***soils_r*** and make sure the cell size is **3**

![Feature to Raster](image)

Click **OK**

Depending on your site installation, you may or may not get the following window. If you do, Click **Close**

![Feature to Raster](image)
When complete, turn the soils vector layer off by unchecking it in your ArcMap Table of Contents.

You should see your new raster soils_r layer with values of 0 or 1.

Our next step will be to use raster calculator to combine the NDVI and CTI layers created in exercises 1 and 2.

In this next step, we will combine the CTI and NDVI into a single raster layer using Combinatorial And tool operator. This tool is buried a ways into the ArcToolbox and can be found in Spatial Analyst Tools > Math > Logical > Combinatorial And.
From the drop down list for Input Raster or Constant value 1 pick ndvi_r

From the drop down list for Input Raster or Constant value 2 pick cti_r

For the Output raster name enter inputA

Click OK to run the tool
Also, we will use again the raster calculator tool to add the results of the Combinatorial And to the soils raster layer to form a new intermediate raster called inputB. We will use the addition process in spatial calculator.

In the ArcToolbox, open **Spatial Analyst Tools > Map Algebra** and double click on **Raster Calculator**
Notice in the **Layers and variables** box that all of the raster layers in your table of contents are visible here.

The next step is to combine the intermediate InputA raster with the soils raster to create a new layer, InputB. Open the Raster Calculator and make the following entries:

- Double click on *inputA* layer in the Layers and variables section
- Single click on the “calculator keyboard” button
- Double click on the *soils_r* layer in the Layers and variables section
- Name the Output raster *inputB*

Verify that your screen looks like this:
And click **OK** to build the raster layer. The new layer should be added to your ArcMap scene:
Since our last step was straight addition of the two layers we now have 3 valid values in InputB raster, 0, 1 and 2. Our final step is to recode these values. Navigate to the reclassify tool in the ArcToolbox: **Spatial Analyst Tools > Reclass > Reclassify** and from the Input raster dropdown menu select **inputB**:

![Reclassify Tool Image]

We want to recode InputB so its resulting cells are either dry (0) or wet (1). Make the changes shown below as well as adding an Output raster named Wetland:

![Reclassify Input Image]

Click **OK** to process the recode operation.
Arrange the layer in the table of contents by clicking the NAIP08.img layer and dragging it up below the wetland raster layer you created. Change the transparency of the Wetland layer to 50% by Double clicking on the layer and in the Layer Properties, Display tab make the following entry:
Click **OK**

Take some time to examine your final output:

Congratulations! You’ve created your classified Wetland layer.