GEOM90008 Foundations of Spatial Information

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ASSIGNMENT 2, MODULE 2: RASTER ANALYSIS

1. OBJECTIVE

To practice and gain an understanding of different map algebra operations. You should grasp how map algebra can be used in GIS for developing suitability models for applications such as this study on land suitability for cows in Gippsland, Victoria.

2. INTRODUCTION

In this exercise you will be introduced to the use of the raster analysis in ArcGIS Pro. You will learn about grid data layers in ArcGIS and techniques for manipulating and analyzing them using Boolean logic. You will also learn how an elevation data can be used to generate watersheds or catchment areas for varied applications, for example flood prediction modeling, chemical precipitation models, delineating palaeodrainage for hydrology and geological study etc.

Please note this tutorial is written for ArcGIS 2.5.

3. DATA REQUIRED

The data is from Gippsland, and available in your LMS subject directory. The files needed for this exercise from the Gippsland dataset are:

- dem1000.asc (dem1000.zip) – 1000 metre digital elevation model (DEM)
- rain.asc (rain.zip) – Rainfall for July in Gippsland

4. PROCEDURE

4.1 Importing grid data into ArcGIS

Download the file called dem1000.zip and extract it to obtain the dem1000.asc. This is an ASCII formatted file containing elevation data for Gippsland with a grid resolution of 1000 metres.

- Open Geoprocessing pane. Find Copy Raster.
- Select the file you just downloaded called dem1000.asc (*Input Raster*). If you could not see the file inside the folder, change *All supported types* to *Raster (All Local Types)*.

- Provide a file name for the output file (perhaps elev1000) and save it to your working directory.
- You can store the DEM in your directory for the semester or download a new version each time and follow the procedure above.

4.2 Watershed modeling

Now we are going to generate the watershed in Gippsland to get an idea about the drainage pattern of that region. For this go to Geoprocessing pane and search for the following tools – i.e., Fill, Flow Direction and Flow Accumulation.

4.3.1 Fill Operation:

- Run the Fill tool
- Input: elev1000
- Output: fill_ elev1000

4.3.2 Flow Direction Operation:

- Run the Flow Direction Tool
- Input: fill_ elev1000
- Output: FlowDir_Fill1
- Flow Direction Type: D8

4.3.2 Flow Accumulation Operation:

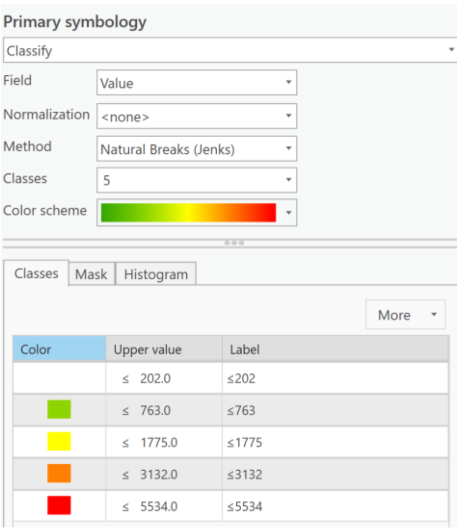
- Run the Flow Accumulation Tool
- Input: FlowDir_Fill1
- Output: FlowAcc_Flow1
- Flow Direction Type: D8

You can now see the stream network across Gippsland. Note, the colors show the different number of flow accumulation.

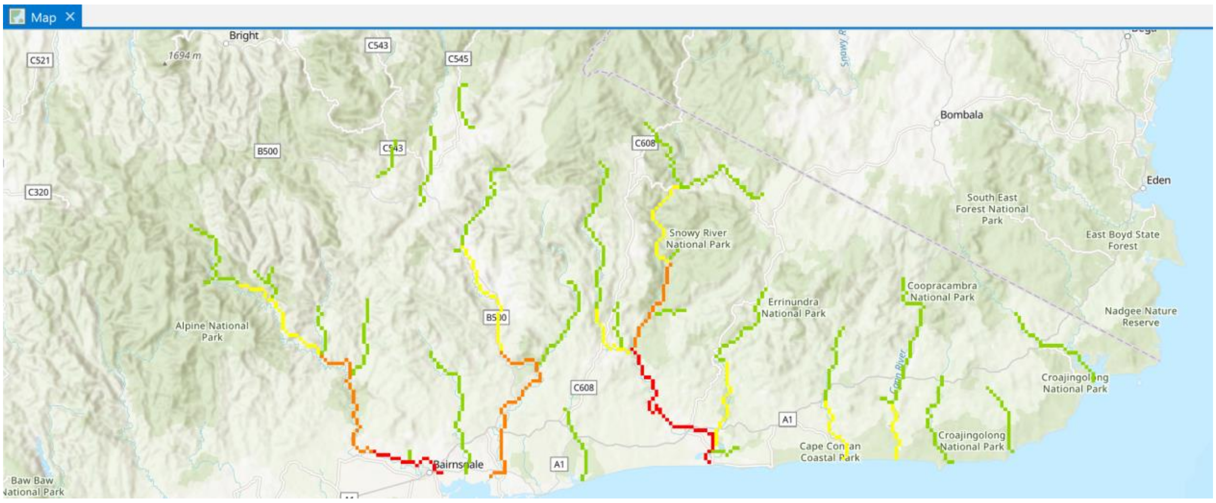
4.3.3 Drawing the pour points:

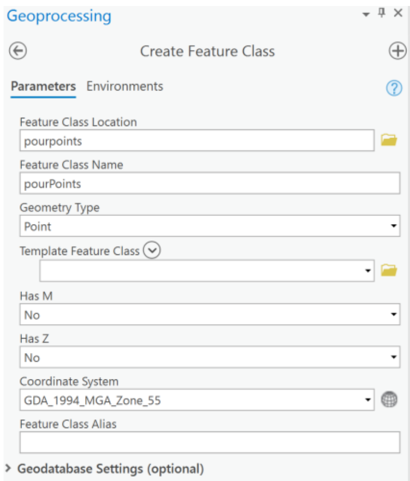
The pour points are the points that collect the water from nearby high elevation areas. The pour points should be typically located at the junctions of two tributaries or the end point of a stream. Thus, we are interested in the high flow accumulation regions. In order to better visualize the stream network, change the color of the region with the lowest flow accumulation count to *no colour*.

Hints: right click on FlowAcc_Flow1 > Symbology. Set the symbology settings based on the figure.



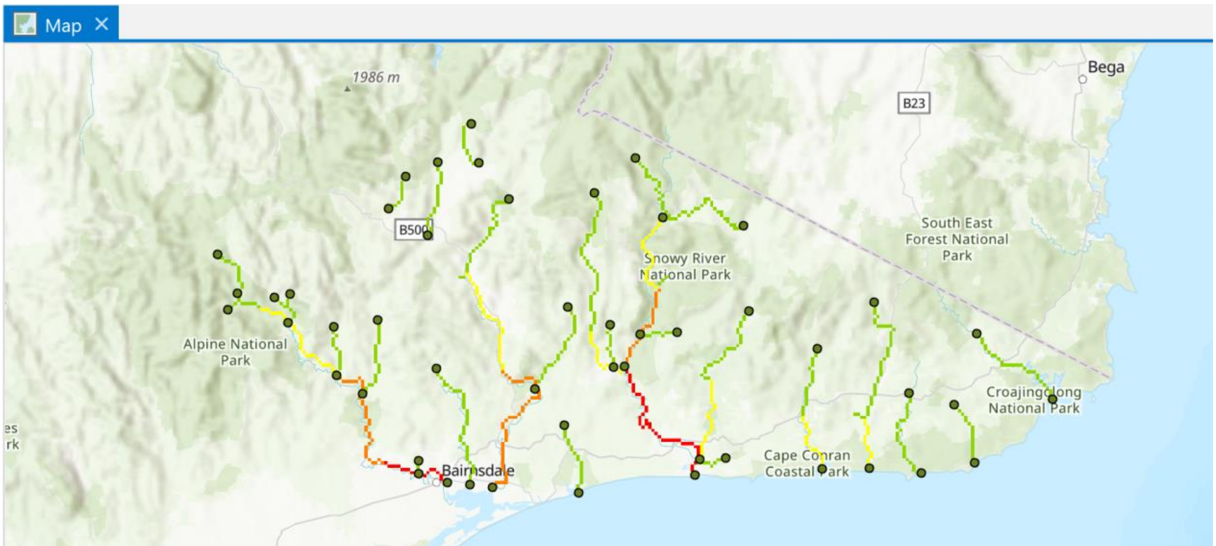
Now you can clearly visualize the stream network. In some cases if the flow accumulation count is too high, you may have to reclassify the flow accumulation map into two classes assigning white color to the lower range and a distinct color (say Red) to the higher range for better visualization of stream network in order to draw the pour points effectively.





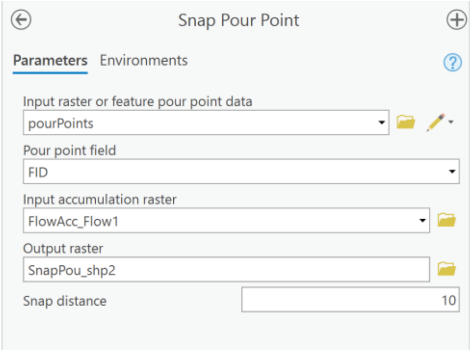
In order to draw the pour points, create a new point shape file called pourPoint.shp (use *Catalog pane* to create the new shape file). Select a folder to create file. Right click on the folder and select New -> Shape File.

To create the points inside the shape file, you should use Edit ribbon. Select the shape file in Contents pane and click on *Create* in Edit ribbon. Select the shape in the Create Features pane. Start drawing the pour points typically at the junctions or at the end position of the channels. Save your drawing using *Save* button in Edit ribbon.



4.3.4 Snap the pour points:

Search for *Snap Pour Point* in Geoprocessing pane and set the parameters as follows.

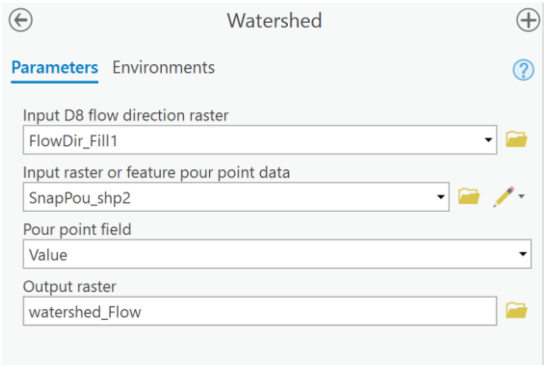


- Input raster or feature pour point data: pourPoint.shp
- Pour point field: FID
- Input accumulation raster: FlowAcc_Flow1
- Output raster: ..\SnapPou_shp2
- Snap distance: 10
- Click Run.

This will create a snapped pour point feature class.

4.3.4 Watershed generation:

Search Watershed in Geoprocessing pane. Use the following settings.



- Input flow direction raster: FlowDir_Fill1
- Input raster or feature pour point data: SnapPou_shp2
- Pour point field: Value
- Output: watershed_Flow
- Click Run

This will create a watershed map of Gippsland which we will use later for a visual investigation for cow habitat suitability mapping.

Now let's get back to the original elev1000 feature class to generate an elevation and slope map.

4.3 Change the colors of the display

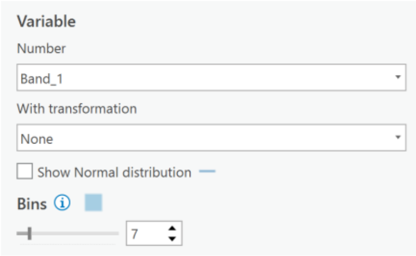
- Right click on elev1000. Go to Symbology.
- Choose 'classify' option.
- Change the number of classes to 7.
- Choose a colour palette in the 'color ramp' option.

The legend has now been updated to reflect the new classes and color scheme. Take some time to become familiar with the legend editor. Each cell in a grid layer has a value, which puts it into one of the classes in the legend. Each cell is filled with the color of its class, solid fill only. Changing the fill pattern won't change the display. The grid layer will always display with a solid fill.

4.4 View the distribution of the data

- Click on the elev1000 layer to make it active. Click on Data ribbon.

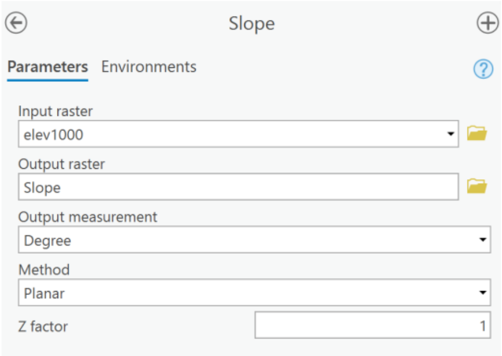
- Click the Create Chart button and choose histogram. Set the values based on the figure.



The X-axis displays the classes used in the grid layer legend, and the y-axis shows the number of counts, or COUNT, in the grid for each class.

Q1. Create a histogram for 20 classes (set bins to 20) of elevation and plot a histogram (put the histograms in your report). Describe the pattern of elevation in Gippsland based on this histogram. Is it very different to the results shown with only 7 classes? Why?

4.5 Derive slope from the elevation layer



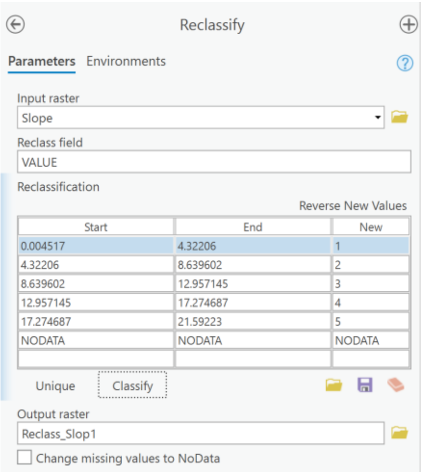
It is easy to perform analysis to create new grid layers. Suppose you want to map the steepness of slopes from an elevation layer.

- From Geoprocessing pane, search for *Slope*.
- Choose elev1000 as input layer.
- Provide a file name for the output file (slope) and save it to your working directory.

Q2. Are the slopes mainly high or low? Why? Use statistical tools and histograms to explain.

- To find out about the statistics in your grid, right-click on the grid and click Properties. Click the 'Source' tab in ArcGIS Pro.

4.6 Reclassify the slope layer



You can convert the floating-point grid layer, slope, into an integer grid layer by classifying its values into groups. You might do this to change the slope layer into a layer representing building suitability based on slope. The resulting integers could be used in later map calculations for suitability, whereby the slope is a factor to consider – our Boolean analysis.

- In Geoprocessing pane, search for *Reclassify*.
- Go to 'Classify' then choose '5 classes'.
- Click Run.

4.7 Explore the table of slope attributes.

You can make selections from the table that will highlight areas in the grid layer display.

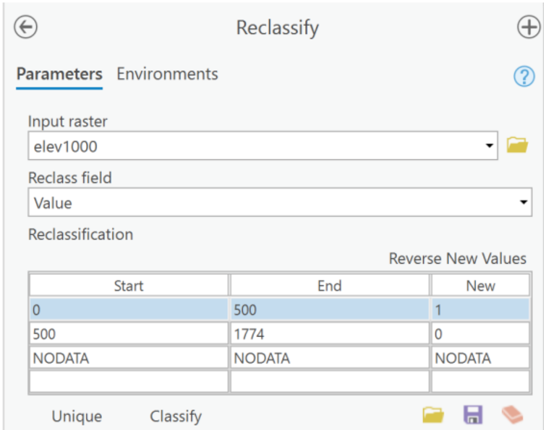
- Make the reclass of slope layer active. If the re-draw is a little slow you may try turning off the other layers by clicking the tick marks in the Table of Contents.

- View the attribute table of the slope layer by right clicking on the slope layer and selecting *Attribute Table*.
- Select a row in the table by clicking the cursor in that row.

Notice that when you select a row in the table, multiple regions of the map are selected and highlighted. This is because there is one record in the table for all grid cells with that value, even if they are not physically connected. Holding shift and clicking on a row in the table will add it to the selected set.

4.8 Reclassification by user defined intervals

Now let us reclassify our elevation map to create a new binary grid layer showing only particular elevations (those below 500 metres). This is the first step in our upcoming Boolean analysis.



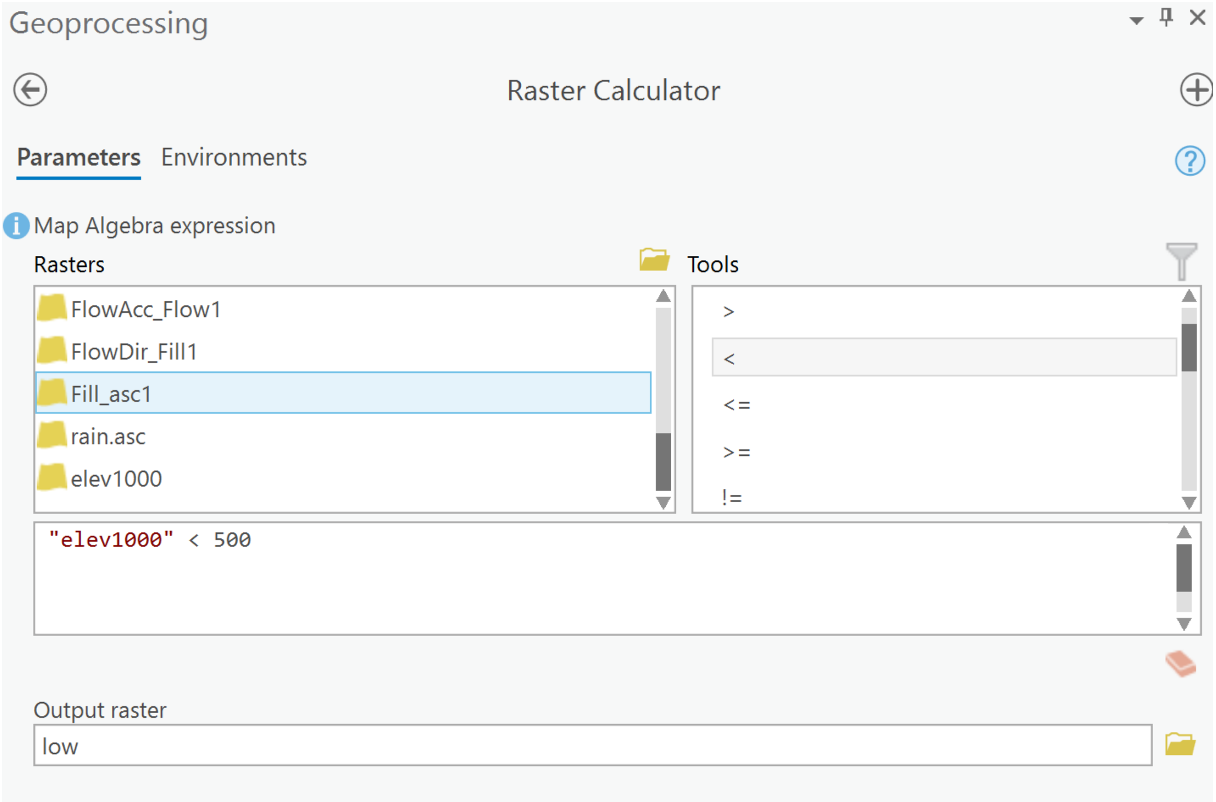
- We need to reclassify the elev1000 layer into a new layer, whereby elevation lower than 500m is suitable (assign value of 1) and elevation higher than 500 is NOT suitable (assign a value of 0).
- Search *Reclassify* in Geoprocessing pane.
- On the 'break values' type '500' for the first value and '1744' for the second value.
- For values between 0 and 500 (old values field) assign value '1' (new values field) and values between 500 and 1744 (old values field) assign value '0' (new values field).
- Provide a file name for the output file and save it to your working directory.
- Click Run.

A new binary grid will be created showing only those values requested.

4.9 Reclassification using the raster calculator

Now let us try another way of reclassifying our elevation layer into a binary grid layer. We will use the raster calculator. Using the raster calculator tool, we can create a Boolean overlay.

- Search for *Raster Calculator* in Geoprocessing pane.
- Write the following expression using the elev1000 layer: "elev1000" < 500
- Provide a name for output file
- Click 'Run'.



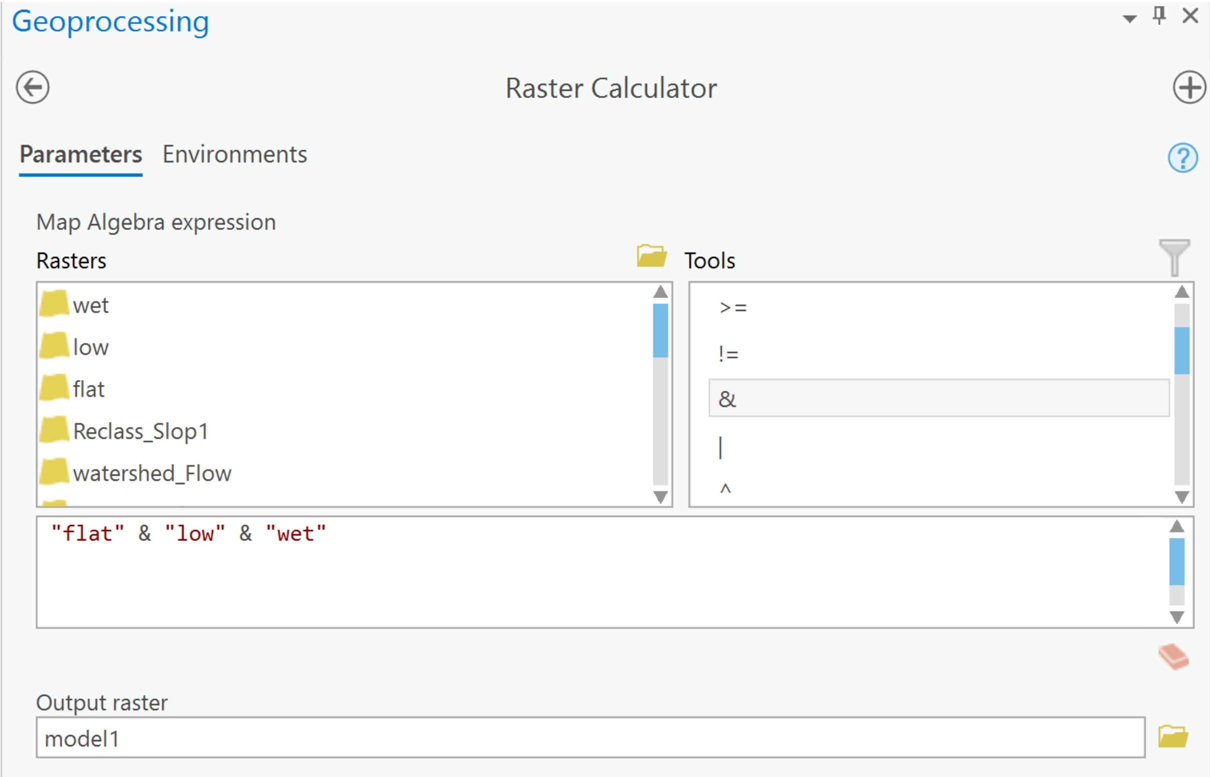
4.10 Constructing a cow habitat model using Boolean operands

We have seen how maps can be reclassified into binary or Boolean overlays that only show the particular condition we are trying to satisfy. The main component of this exercise is to create a habitat suitability map for cows in Gippsland. Cow habitat is constrained by the following conditions:

- Cows like elevations less than 500 metres since above this elevation the temperatures are too low. Call this map *LOW*.
- Cows can only inhabit slopes less than 5 degrees – otherwise they fall over in the night while sleeping. Call this map *FLAT*.
- Cows also require a rainfall of greater than 6000mm. You should use the file called ‘rain’ which contains the total rainfall for July in *mm*. This is not so much a constraint on the cow rather than the need for healthy feeding pastures. Call this map *WET*.

Important:

- The rain file should be unzipped and imported to grid using the same methodology described in Section 4.1.
- Boolean maps can be combined using the raster calculator tool under the spatial analyst by selecting the input grid and the operand to be used to test the condition. The figure below shows a sample of raster calculator tool.



4.11 Constructing models

This assignment requires you to construct the following models.

MODEL 1: Generate a map overlay which shows sites that are LOW and FLAT and WET for cows. Call the resulting map MODEL1.

Q3. What is the total area that matches this criterion? Describe the distribution of these areas. **Hint:** You are working with a grid. How many grid cells make up each area? How big are these grid cells?

MODEL 2: Generate a map that shows all possible habitats for cows by finding sites that are LOW or FLAT or WET. Call this map overlay MODEL2.

Q4. How does this map overlay differ from the previous map? What is the total area that matches this criterion?

MODEL 3: Now use the (+) operator to add FLAT, LOW and WET together. Call this map MODEL3.

Q5. What does this map show? Is the resulting map nominal, ordinal, or interval?

Q6. How do these results alter from MODEL 2?

Q7: Using different map algebraic combination examine which watershed regions best conform with the most suitable cow habitat site. Describe which type of map algebraic operation (i.e., local, focal, zonal and global operations) is suitable for solving this problem. Attach a map visualization of the results to your report.

5. Deliverable

Submit a document with just the answers to the questions.

6. Assessment

The mini-project is worth 2 marks. To receive 1 mark (a "pass") the answers have to be complete. To receive 2 marks, the answers have to be complete and correct. There are no fractions.