INTRODUCTION TO WIND MODELING USING ARCGIS

The focus of this report was to create wind drift probability model using orchard and the pesticides that are sprayed on them. The map sheet name that was the main focus in this report was North Kingston. The map sheet number was 21H02. The weather station that was used for this report was Greenwood A and the month was June. The software that will be used during this project will be ArcGIS and specific tools will be used and also a number of raster calculators will be used during the process of this project

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October 16, 2014

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Introduction

The purpose of this project was to create a wind model that showed the direction that the wind would take in a given month. The orchards that were focused on for this project were the orchards in the North Kingston map sheet. The month that was assigned was the month of June and the weather station that was used to gather the data from was the Greenwood A weather station. Also the NTS (or National Topographic System as it is called) name is the 21H02.

This report will go thought all the processes that it took to come up with the final product that you will find near the end of this report. The first thing that this report will go over will be the making of the Wind Rose Diagrams and how excel was used to create them. The rest of the report will discuss the following topics and also their procedures. Those topics are as follows: Description of Particle Drift Model, Region Group, Extract by Attributes, Area Grid, Pesticide Grid, Distance Grid, Drift Concentrate, Aspect Map, Remap Table, Reclass Grid and Reclass Table, Mean Frequency Concentration, Model Builder, and Final Cumulative Pesticide Concentration Grid.

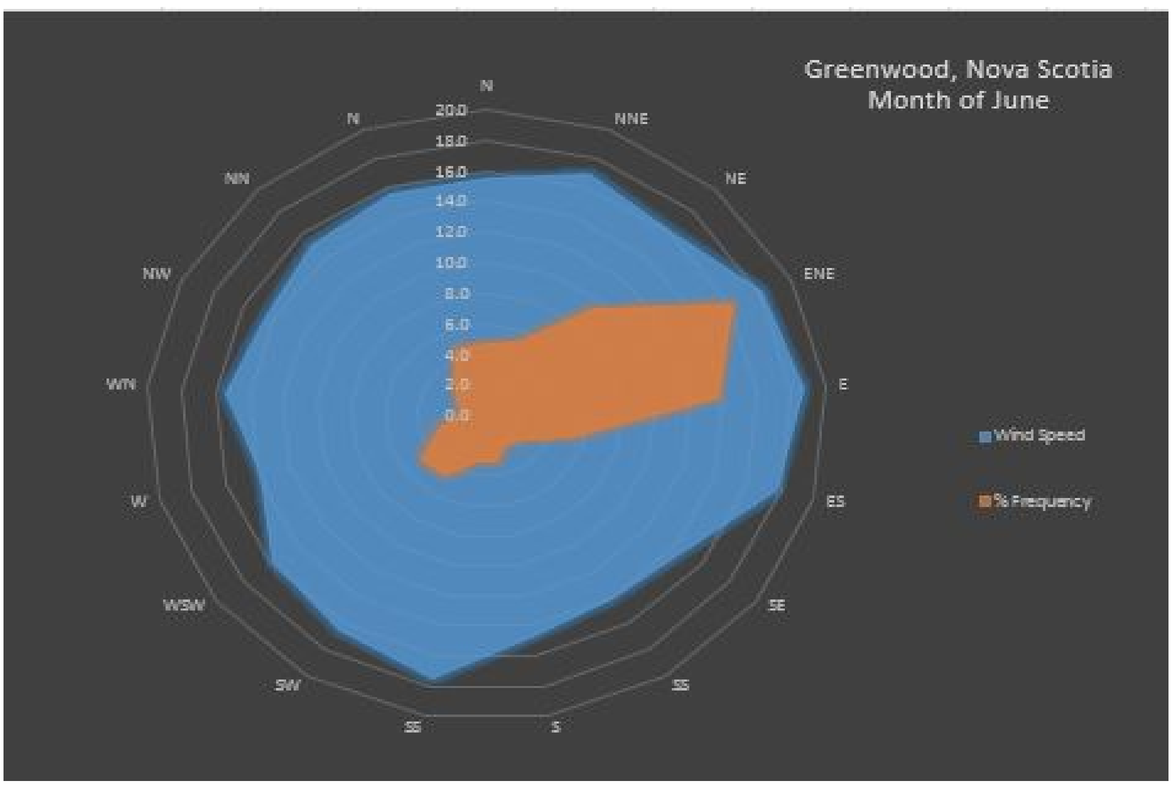
Each topic will have its own section just like the Wind Rose Diagrams. Each section will also talk about the procedures for each topic; there will also be map algebra syntax that can be put into a Raster Calculator to make that particular grid and a break down to each part of that syntax. Then the final section of this report is the conclusion, it will bring everything together and that includes all of my thoughts during and at the end of this project.

Wind Rose Diagrams

The first wind rose diagram you see in Figure 1 showing two sets of data together. The larger set of data that is shown in this diagram, the transparent blue, is showing the wind speed for the month of June. Then the smaller set of data that is being shown in this diagram is displaying the percent frequency for the month of June. (*NOTE: Our instructor had assigned specific months for each student to use during this project and the month of June was assigned to me hence why the month of June was used*)

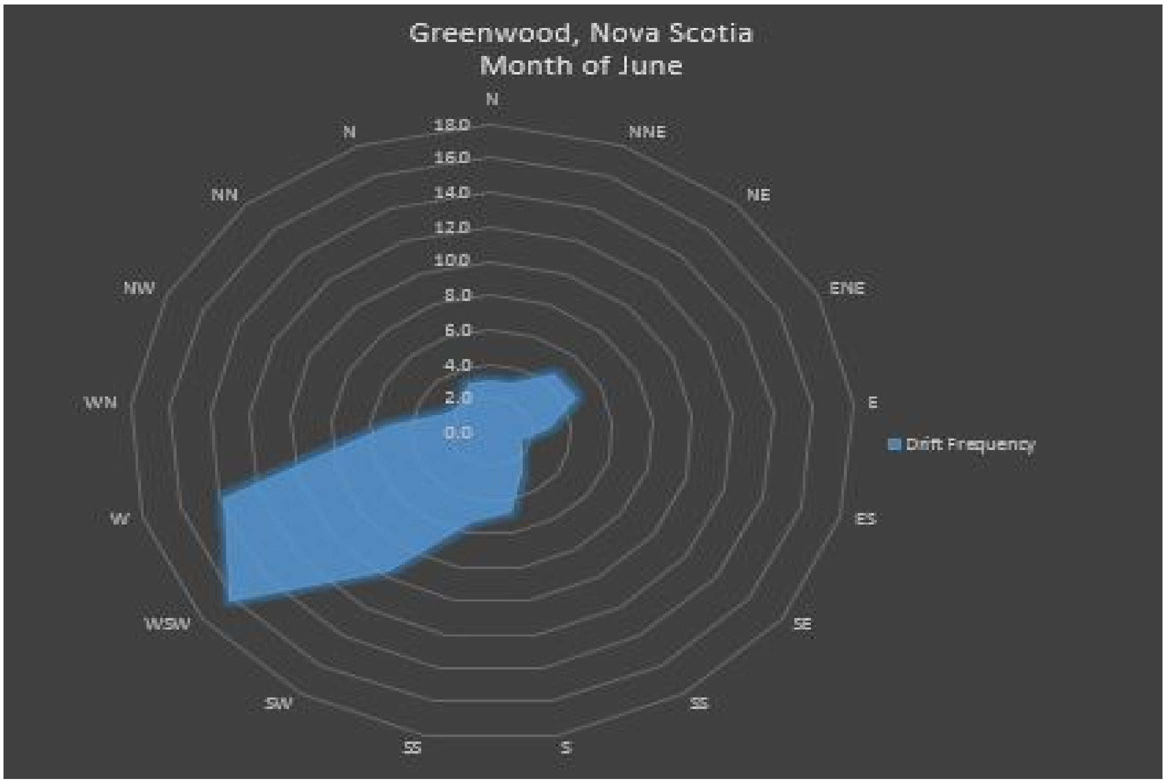
This diagram is also showing what direction most of the wind is coming from and it also shows what direction the percent frequency is coming from.

Figure 1: Wind Frequency



The second wind rose that you see in Figure 2 is showing the Drift Frequency for the month of June. See *NOTE* on the pervious page is understand why the month of June was used in this project. The Drift Frequency diagram is showing what direction the pesticide would "travel" when the wind is coming out of the East-North-East.

Figure 2: Drift Frequency



Description of Particle Drift Model

This section of the report will go over the description of the particle drift model that was used to make the final product. In this section there will be detail given about the wind speed that was used in the making of the particle drift model, also the particle size that was modelled will be discussed in this section and then there will also be some discussion of the spray height that was represented in this model. Then the last thing that this section will cover will state the presumed pesticide application in liters per hectare.

The wind speed that was used in the making of this particle drift model was 4.8 km/h (*NOTE: this wind speed came from our Applied GIS I Instructor Mark Hebert).

The particle size that was used in the making of this Particle Drift Model was that of a 15 Micron particle size. (*NOTE: this particle size was given to us by our Applied GIS I, or GISD 3020 as it is sometimes called, Instructor Mark Hebert).

Then the Spray Height that was used in the making of the Particle Drift Model was that of a 1080 meter height. (*NOTE: this spray height was given to us by our Applied GIS I, or GISD 3020 as it is sometimes called, Instructor Mark Hebert).

The presumed pesticide application in liters/hectare was 3.2 liters of pesticide per hectare. (*NOTE: this number of liters of pesticide per hectare was given to us by our Applied GIS instructor Mark Hebert).

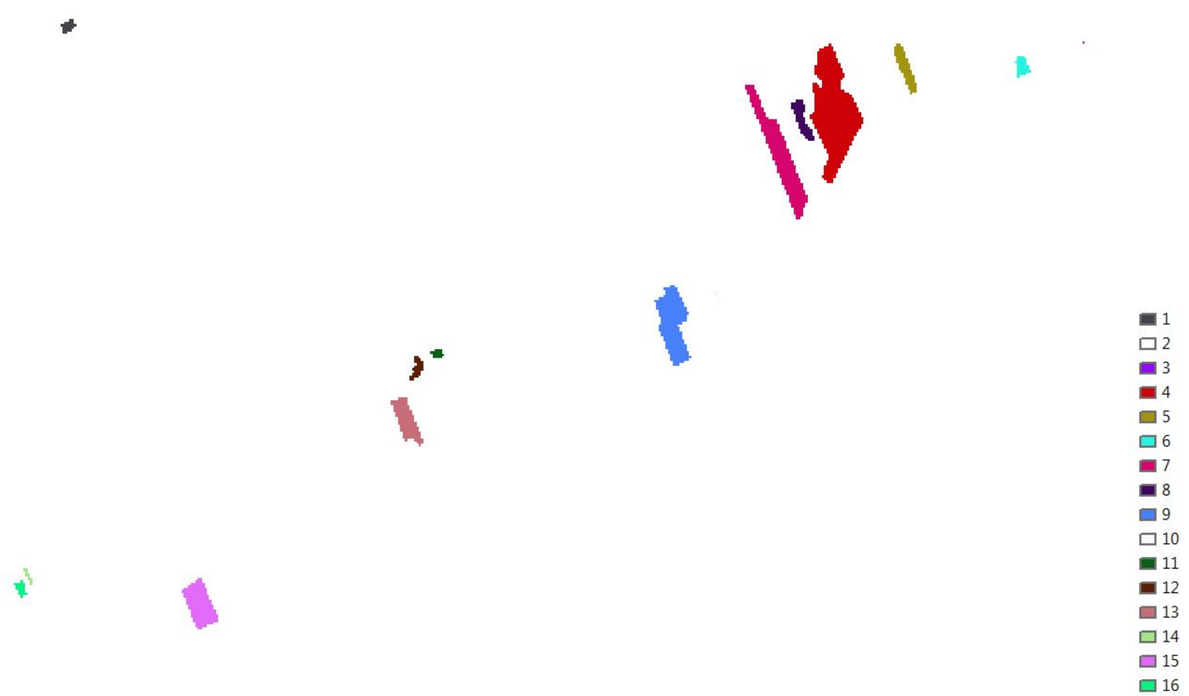
Region Group Procedure

The region group tool was used to give each orchard a unique number to identify them better from the non-orchard areas. Using the feature to raster tool you can convert the **OrchardPoly_C** to a raster dataset, called **Orchard_feat**. Then using that new raster dataset that you just created, in your region group procedure.

So, take your **Orchard_feat** and plug it into your map algebra as your in_raster and then the **number_neighbors** should be "**EIGHT**", and then the final step is to name your output, in this case the output is going to be called **orchard_num.**

Syntax: RegionGroup (in_raster, {number_neighbors}, {zone_connectivity}, {add_link}, {excluded_value})
Expression Used: RegionGroup ("orchards", "EIGHT")
Output: orchard_num

Figure 3: orchard_num



Extract By Attributes Procedure

The extract by attributes tool was used to extract each orchard to make individual shapefiles. For the breakdown of the extract by attributes syntax for this procedure goes like this, the **in_raster** would be your **orchard_num**, if you look in the attribute table you will get each of your individual orchards from. Then in the expression the **where_clause** is found this is where you would put what the value equals, so it would look something like this **"value=8"**. The value is changed each time you run to tool it goes from 1-16 (because that is how many orchards are in my study area). Then the final step, just like the region group procedure, you have to name the **output**, in this case the output is named **Orchard8**, and this again changes each time you run the tool and this will go on until all of the orchards are extracted. The expression below you can see the map algebra that was used in the making of (in this example) the shapefile **Orchard8**.

Syntax: ExtractByAttributes (in_raster, where_clause)
Output: Orchard8
Expression Used: ExtractByAttributes ("orchard_num", "value = 8")

Figure 4: Orchard8

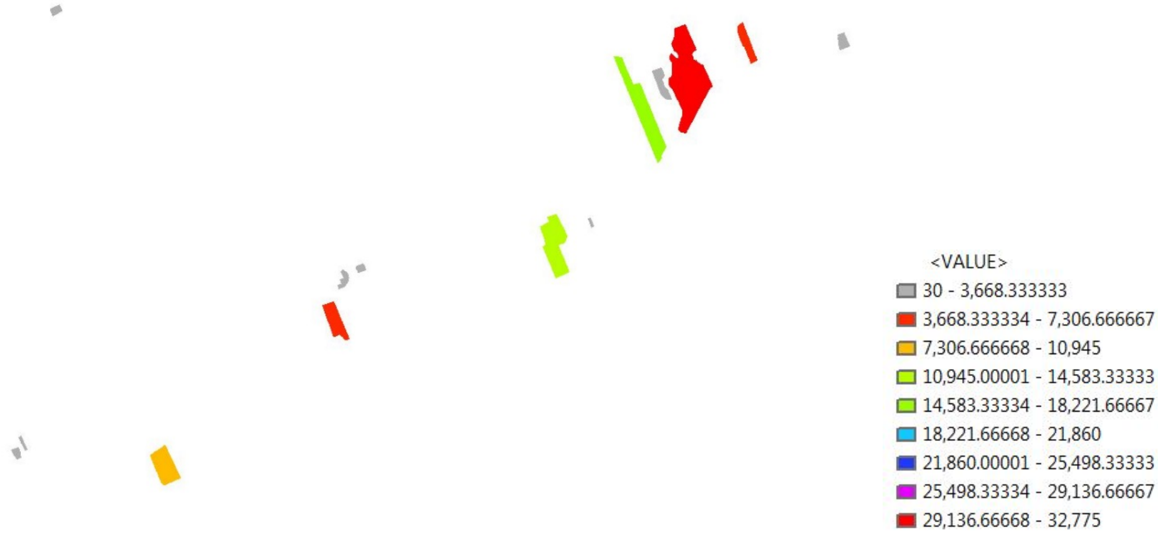
Area Grid

The map algebra can be seen below, the following write-up will go step by step through that process on how to make the output look like in **Figure 5** below. The first step in the map algebra that you see below is take this map algebra and put it into a raster calculator. The next step is to insert the data that you are working with, in my case and in this step of the project I am working with **orchard_num** and the **lookup_field "COUNT"**. Then the last step it to name the output and also make sure that it is going into the correct folder that you are working within. The final output for this part of the project is called **Orch_Area**.

Syntax: Lookup (in_raster, lookup_field)
Output: Orch_Area
Expression Used: Lookup ("orchard_num", "COUNT")

The figure you see below is the result of using the lookup tool. If you go into the **Orch_Area** attributes table you can see that the value field has been changed to show the numbers in an area value.

Figure 5: Orch_Area



Pesticide Grid

The map algebra that you see below was used to create the pesticide grid, you can see the output in **Figure 6** below. The expression used in this step of the project as you can see below, was to determine how much pesticide gets sprayed in per hectare. So, the **4.2** in the map algebra below comes from how many liters per hectare that particular farmer uses. Then the **0.01** comes from the calculations that we made that you can see in the italic section that is also bolded. Then the raster that was used along with the 4.2 and 0.01 was the Orch_Area that we created earlier in the project.

"To determine total liters used per orchard we assume in this case that the farmer applies 4.2 liters per hectare in the model month. ***Since each pixel is 10m by 10m or 100m2 or 100/10000 = 0.01 ha, we can multiply the area raster by 0.01****."* (this was taken right from the PDF called GISD 3020 Grid Modelling and Map Algebra 04 – Demo 3 ; page 6 ; at the bottom of the page)

Output: pesticide
Expression Used: 4.2 * "Orch_Area" * 0.01

Figure6: pesticide

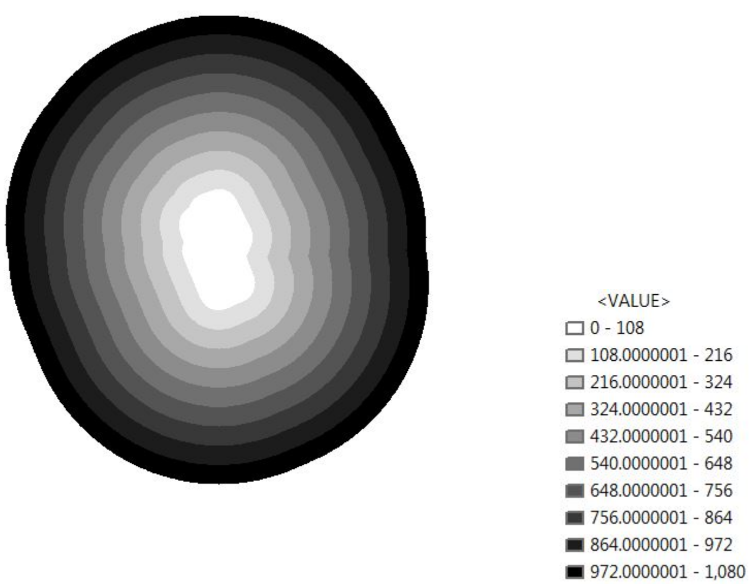
Distance Grid

The map algebra you see below was used to create the shapefile **Distance8** (and all the other distances 1 to 16). The **EucDistance** tool was used to show the total area that was affected and I assumed that the particle size was **15 micron** and the wind was at about **4.8 km/h**. This is represented by the **max drift** distance of **1080m**. So, I put Orchard8 into the expression as the **in_source_data** and then I plugged the **1080 meters** in as the **maximum_distance**. Then I named the output name **Distance8**; the distance, part of the name, represents that we are working with distance in this section of the project and then the number 8 represents the orchard number that we are working with at that time. So you do the same thing with the rest of the orchards.

Syntax: EucDistance (in_source_data, {maximum_distance}, {cell_size}, {out_direction_raster})
Output: Distance8
Expression Used: EucDistance ("Orchard8", 1080)

The figure below shows that output of the **EucDistance** tool that was run using the map algebra expression above.

Figure 7: Distance8

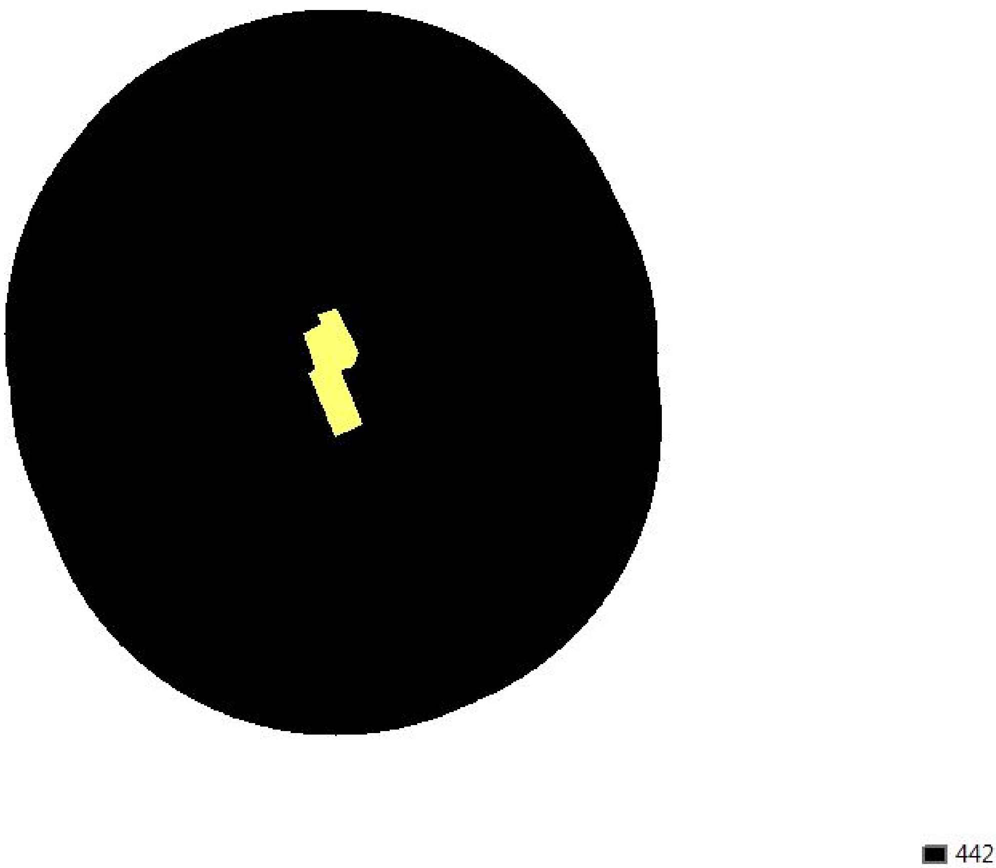


Drift Concentrate

The drift concentrate gird was a two-step process. The first step in this process was to create the **Drift_Con1** shapefile. This is done by using the **EucAllocation** tool. This tool takes the integer value of total liters of pesticide in the **pest1** grid and allocate it over the **1080 meter** from the **Orchard1** shapefile. The map algebra is shown below to show what it looks like when it gets put into the raster calculator.

Syntax: EucAllocation (in_source_data, {maximum_distance}, {in_value_raster}, {cell_size}, {source_field}, {out_distance_raster}, {out_direction_raster})
Output: Drift_Con8
Expression Used: EucAllocation ("Orchard8", 1080, Int ("Pest8"))

Figure 8: Drift_Con8

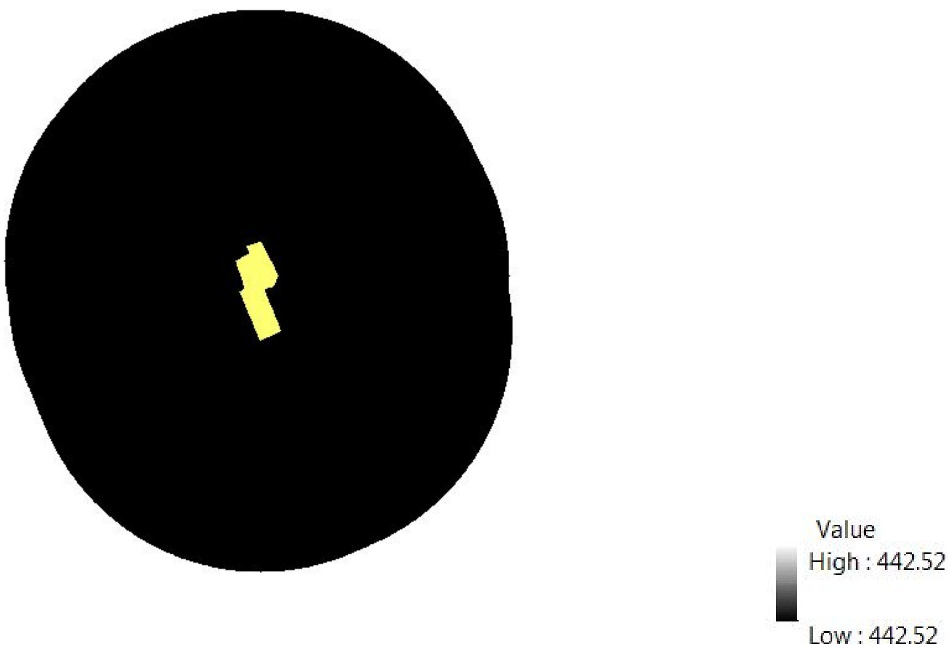


The second part of the of the drift concentrate grid is maintaining the decimal precision for the small orchards, so we use the following map algebra to adjust just as follows. We use the same tool as in the first step, but we add some other tools to maintain the decimal. That is shown in the following map algebra.

Syntax: EucAllocation (in_source_data, {maximum_distance}, {in_value_raster}, {cell_size}, {source_field}, {out_distance_raster}, {out_direction_raster})
Output: Drift_Con8A

Expression Used :(EucAllocation ("orch1", 1080, Int (100 * "pest1"))) / 100.000

Figure 9: Drift_Con8A



Aspect Map

There are two steps to this aspect map the first step is to create a distance grid but using the following expression and shapefiles. The tool that was used in this step is the EucDistance tool. The in_source_data for this expression is the **Orch_num** and then the max distance was the 1108. The map algebra below shows how the expression looks when it is put into a raster calculator. Also below you can see the output from running that expression in the raster calculator.

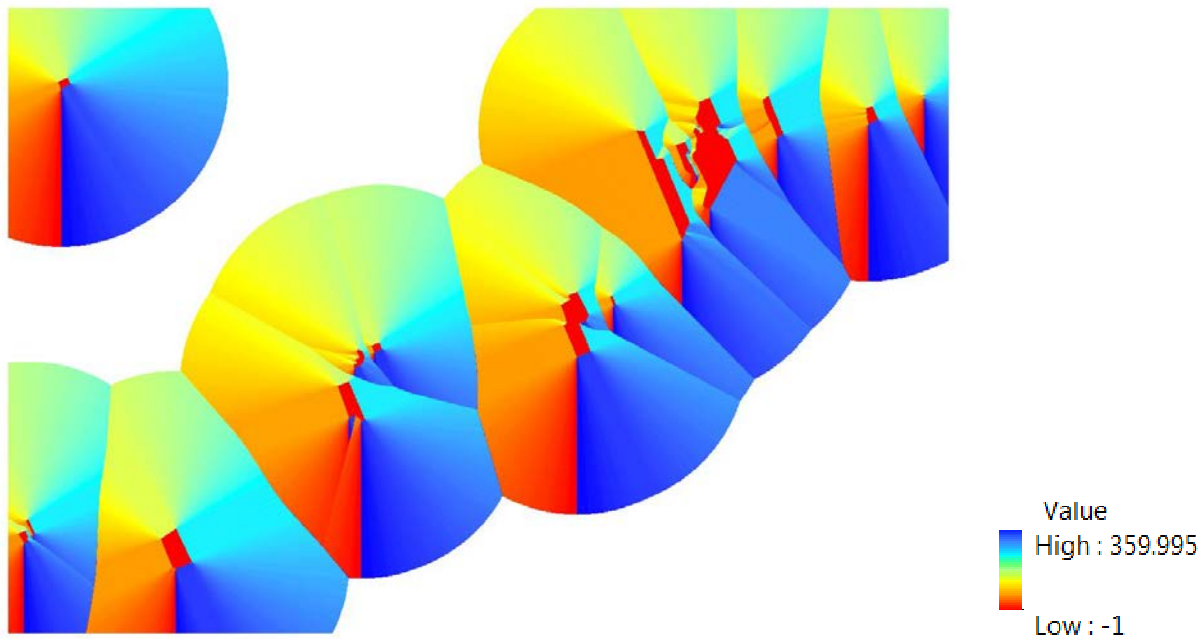
Syntax: EucDistance (in_source_data, {maximum_distance}, {cell_size}, {out_direction_raster})
Output: Dis1108
Expression Used: EucDistance ("orchards", 1108)

Figure 10: Dis1108

Then the second part in making the aspect map is to actually make the aspect map and that is done by running the aspect tool within the raster calculator. That is done by taking the **Dis1108** output that you just created and plug it into the Aspect tool as the **in_raster**. The map algebra below shows how that is done and also Figure 11 shows what the output looks like after running the Aspect tool within the raster calculator.

Syntax: Aspect (in_raster)
Output: Aspect1108
Expression Used: Aspect ("Dis1108")

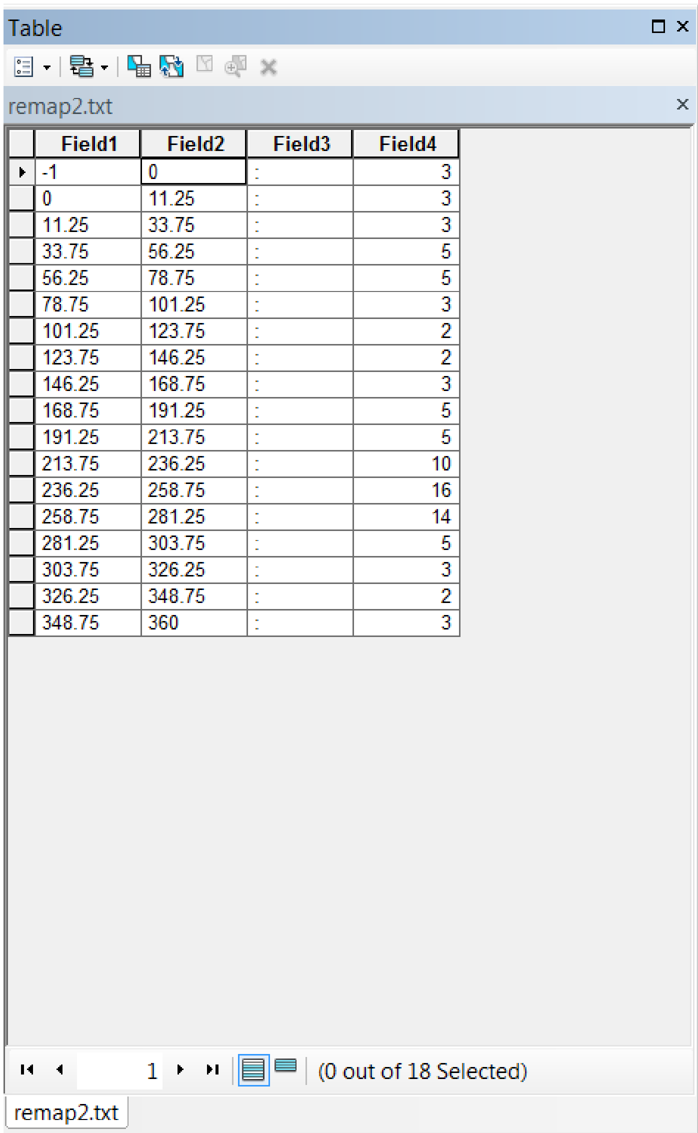
Figure 11: Aspect1108



Remap Table

In **Figure 12** you can see the remap table that was used in the next step of the project to create a **Reclass Grid**. This remap table is showing the integer value of wind frequency that was figured out in the first few steps of the project.

Figure 12: remap2.txt



Field1	Field2	Field3	Field4
-1	0	:	3
0	11.25	:	3
11.25	33.75	:	3
33.75	56.25	:	5
56.25	78.75	:	5
78.75	101.25	:	3
101.25	123.75	:	2
123.75	146.25	:	2
146.25	168.75	:	3
168.75	191.25	:	5
191.25	213.75	:	5
213.75	236.25	:	10
236.25	258.75	:	16
258.75	281.25	:	14
281.25	303.75	:	5
303.75	326.25	:	3
326.25	348.75	:	2
348.75	360	:	3

Reclass Grid and Reclass Table

To make the Reclass grid we have to take the remap table, **remap2.txt** that we created in the previous step. So, you take that table and plug it into the expression that will then be put into the raster calculator, that expression is shown below with the syntax, which shows the breakdown on what you need to put into the expression, also shown below there is the output that we created from running the expression in the raster calculator, and the last thing that is shown for this process is a screen capture of what the output looks like.

The first thing that you need to plug into the Reclass command, which then gets put into the raster calculator, is the **in_raster** and that would be the final output from when I ran the Aspect command in the raster calculator and that output is **Aspect1108**. Then the next thing, which is also the final thing that needs to be put into the raster calculator before you run the Reclass command is the **in_remap_file**. So, the command line should look something like the **Expression Used**, shown below.

Syntax: ReclassByASCIIFile (in_raster, in_remap_file, {missing_values})
Output: w_freq1108
Expression Used: ReclassByASCIIFile ("Aspect1108", "remap2.txt")

Figure 13: w_freq1108

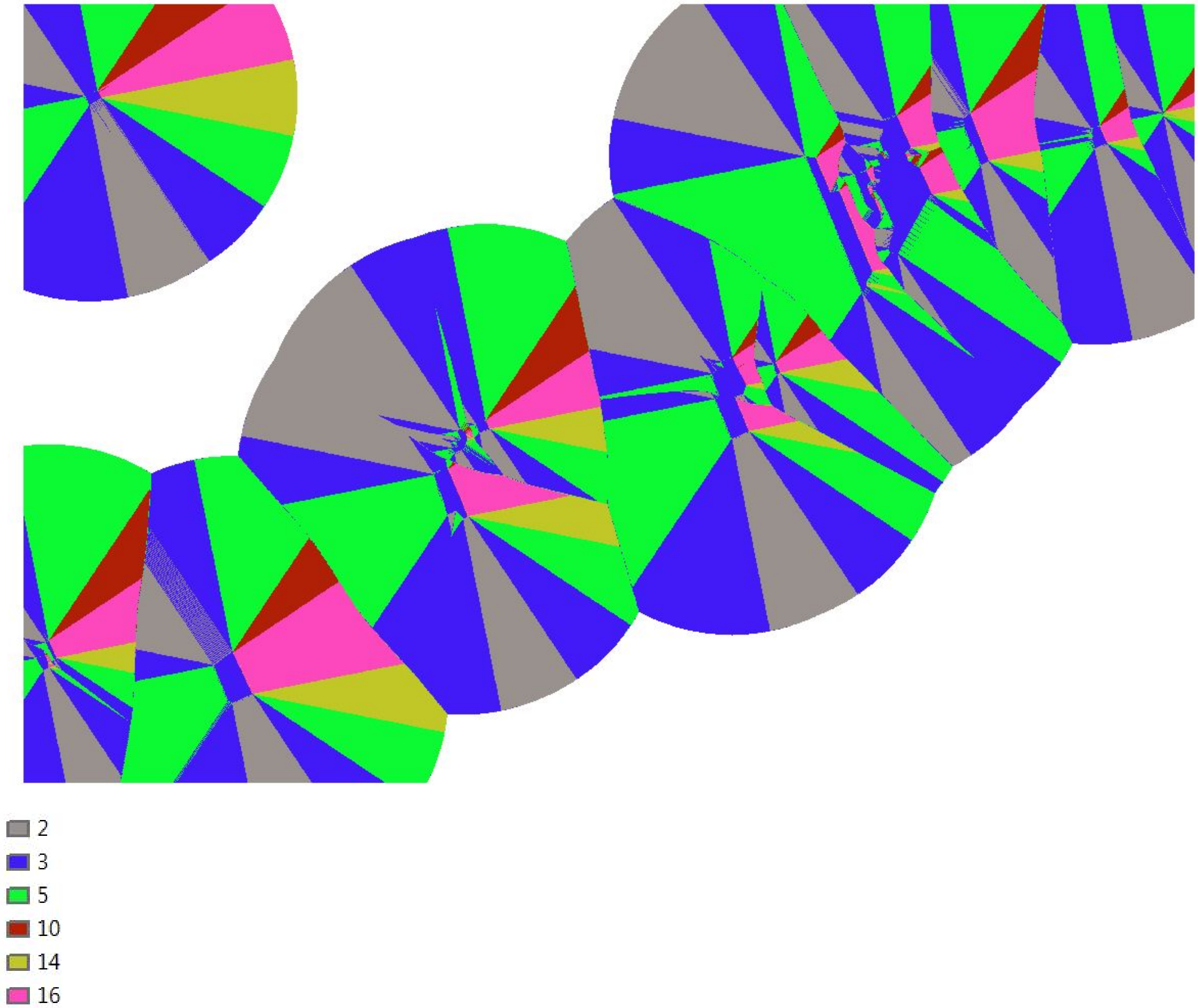
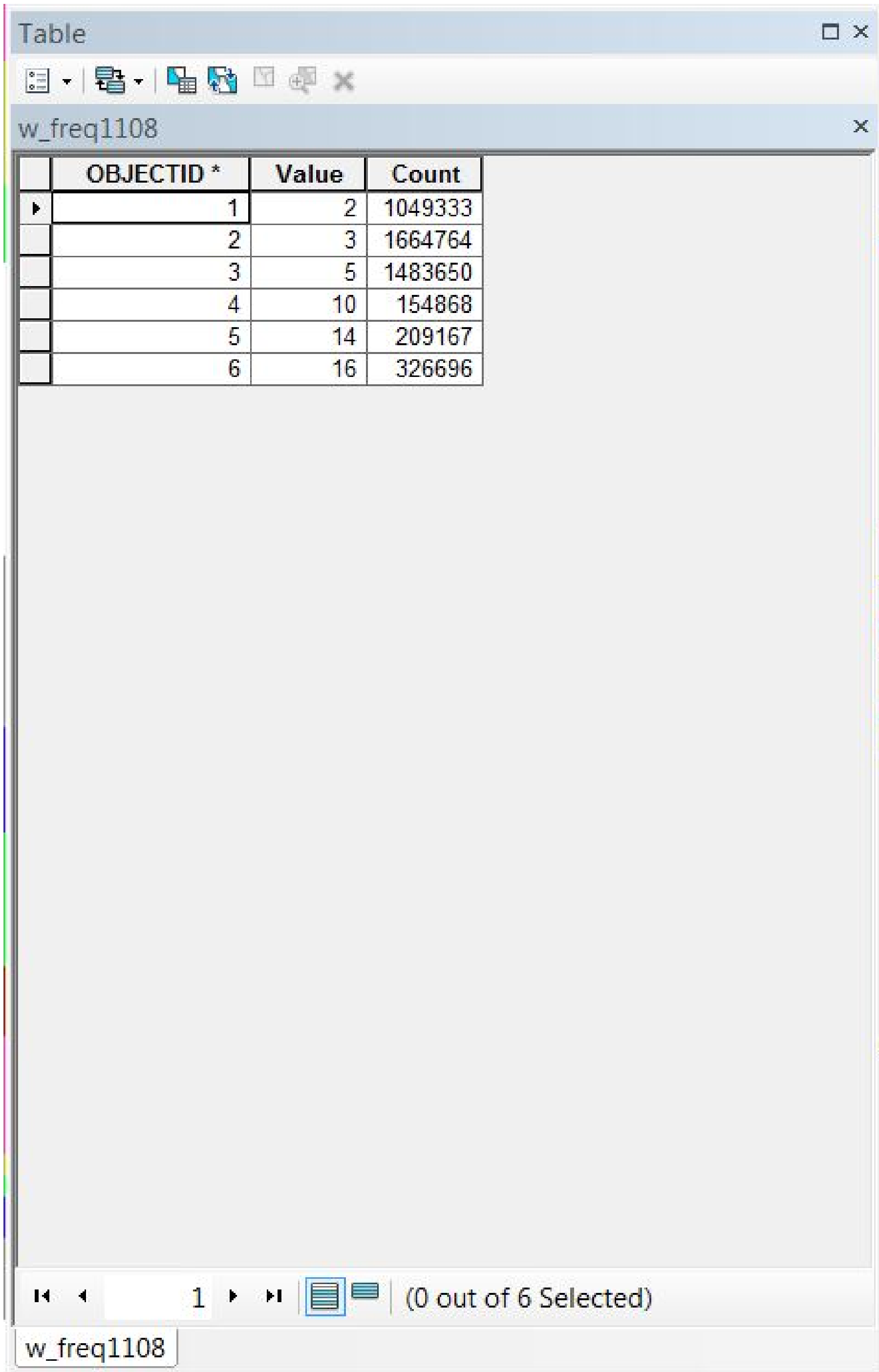


Figure 14: w_freq1108 Table



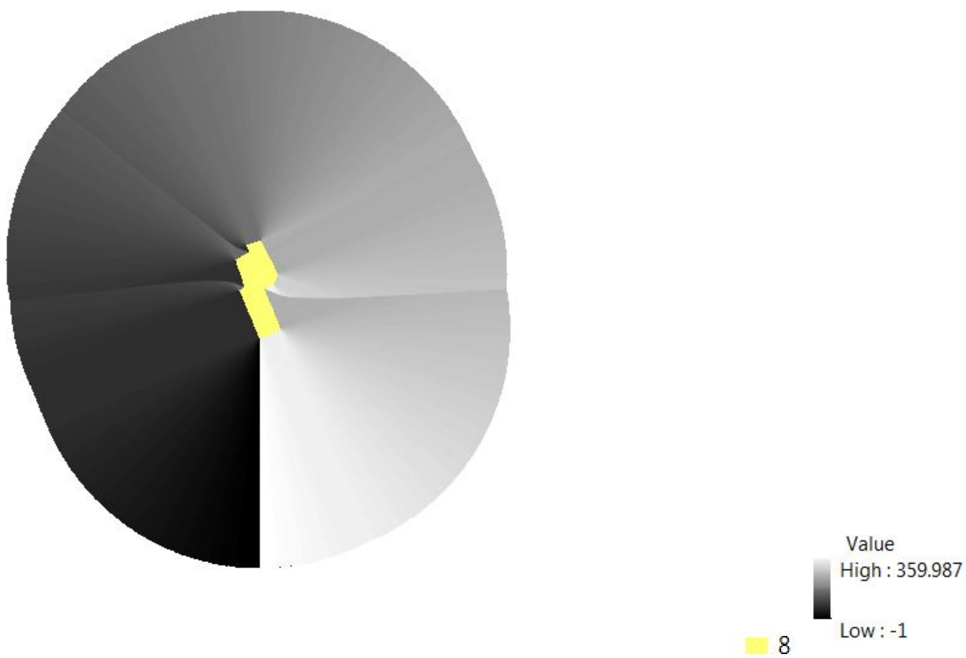
OBJECTID *	Value	Count
1	2	1049333
2	3	1664764
3	5	1483650
4	10	154868
5	14	209167
6	16	326696

Mean Frequency Concentration

This is the second to last step that needs to be done before the final step can be done. The first things that needs to go into the raster calculator is the Reclass shapefile that was created before. This step is shown in following map algebra and the result from running that map algebra is also shown below.

The map algebra for this step is to use the **ReclassByASCIIFile** command in a raster calculator. The first thing that is to be put in is the **Aspect8**, shown in **Figure 15**. Then the second thing that needs to be put into this command before you can run the raster calculator is the remap table, shown in **Figure 12: remap2.txt.**

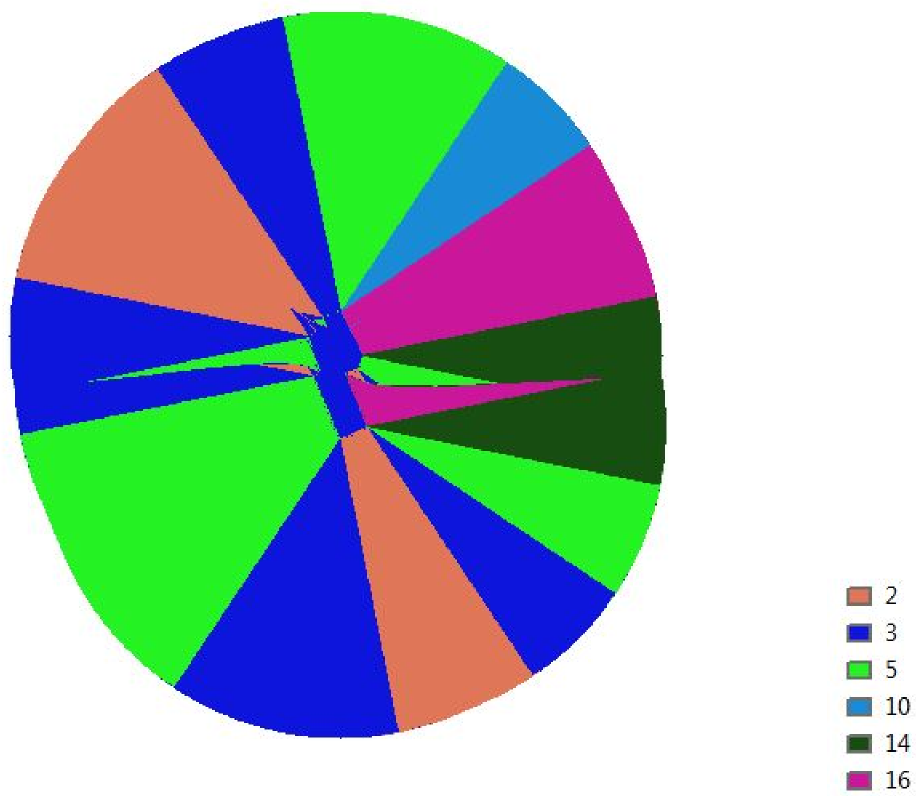
Figure 15: Aspect8



Output: Reclass8
Expression Used: ReclassByASCIIFile ("Aspect8", "remap2.txt")

After running the raster calculator the output looks something like this in **Figure 16**, seen below.

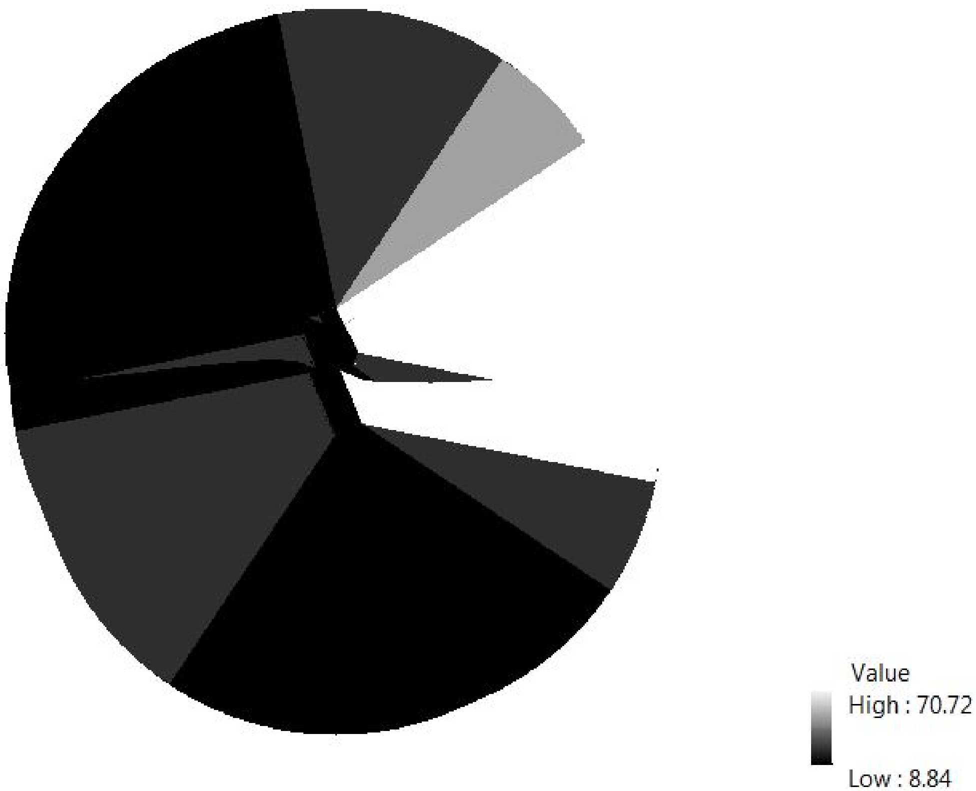
Figure 16: Reclass8



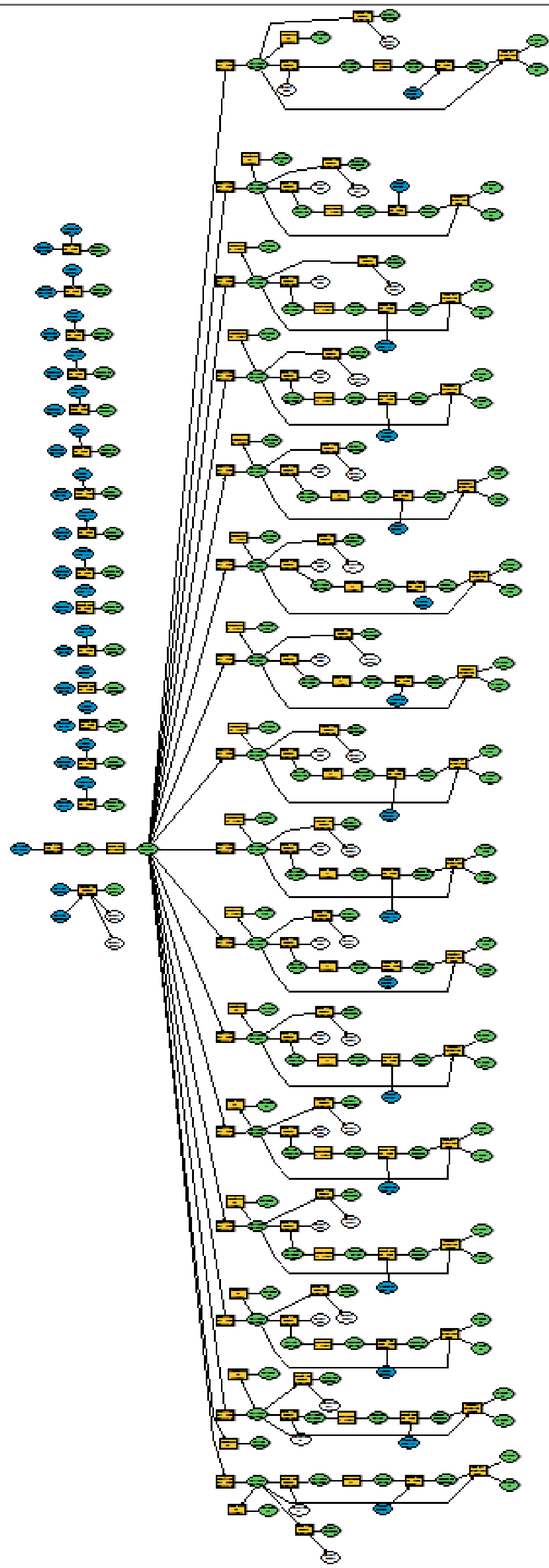
The final step to making the mean frequency is to take the following command and plug it into as raster calculator. For the map algebra to run this command you need the **Drift_Con8,** as shown in **Figure 8** (or whatever orchard you are with at the time) and you also need the Reclass shapefile **Reclass8**, as shown above in **Figure 16**. So, the map algebra is shown below along with the results that comes from running this command in a raster calculator.

Output: M_Freq8
Expression Used: "Reclass8" / 100.00 * "Drift_Con8"

Figure 17: M_Freq8



Model Builder



Final Cumulative Pesticide Concentration Grid

This is the final result that comes from doing all the commands and running all the tools on the previous pages. This is the frequency mean of the orchards from my study area that I was given by my instructor for Applied GIS I.

Figure 18: F_Mean

Conclusion

This report shows the step by step process that it takes to make the final cumulative pesticide concentration grid for farmers who spray their orchards with pesticide. This project gave me a better perspective on how far pesticides can travel with the wind and also it should give people a better idea of what is a safe distance to build their homes at so that they are not affected by the pesticides from framers spraying their orchards.

On the technology side of this report I have a better understanding of how each tool works. I also have a better understanding of how to use the raster calculator and what to put into to make a command run smoothly and not fail. Also I have a better understanding how the raster calculator works when it comes to what you can do with raster calculator.

Bibliography

N/A. (n/a, n/a n/a). *Viewing Gallery For - Apple Orchard*. Retrieved from Gallery Hip: http://galleryhip.com/apple-orchard.html