Spatial Modelling and Analysis

Lecture 8

Raster Reclassification and Overlay Analysis

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PNG University of Technology - 2022

Lecture Outline

1. Raster Reclassification
2. Overlay Analysis
3. Raster Overlay Tools
4. References

1. Raster Reclassification

- ✓ One way to convert surface data into more usable information for an analysis is to reclassify the surface.
- ✓ Reclassification can be temporal and Permanent
- ✓ Reclassifying a surface sets a range of values equal to a single value.
- ✓ Reclassifying surfaces is often done to reduce the number of output categories for an overlay analysis.
- ✓ The tool called reclassify tool is used for permanent reclassification.

1.2. Reasons for Reclassification

For example:

you may want to group together various types of forest into one forest class to simplify the information in the raster.

Reclassify slope in specific class range

You want to set specific values to NoData to exclude them from analysis.

Suitability Analysis where the Reclassify tool is used to transform values of various input raster datasets to a common scale.

Temporal mapping in mapping layout (different classification method)

Source: Lange, J, 2020

1.3. Temporal Reclassification

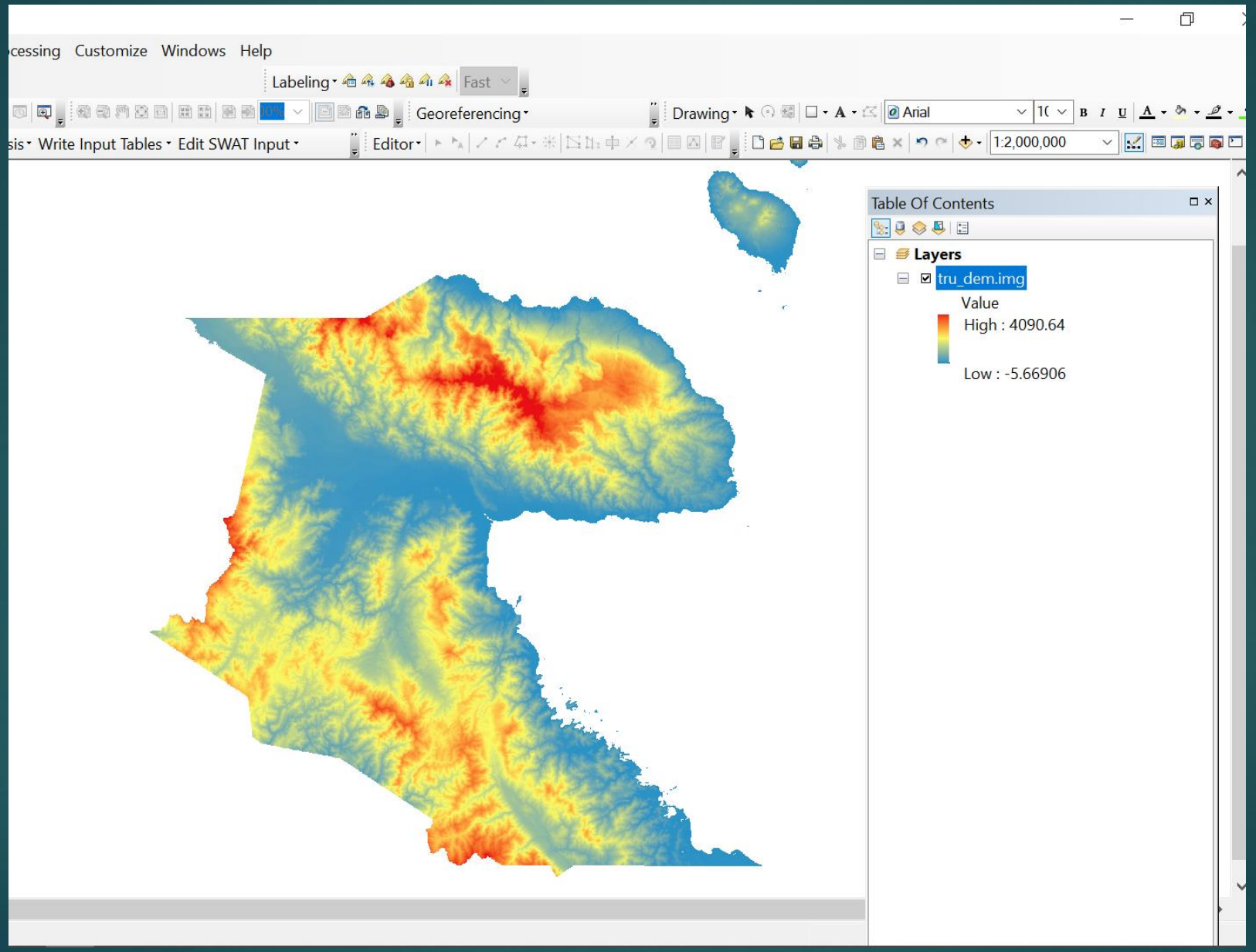


Image source: T.Sekac, 2022

1.3.1.Temporal Reclassification categories

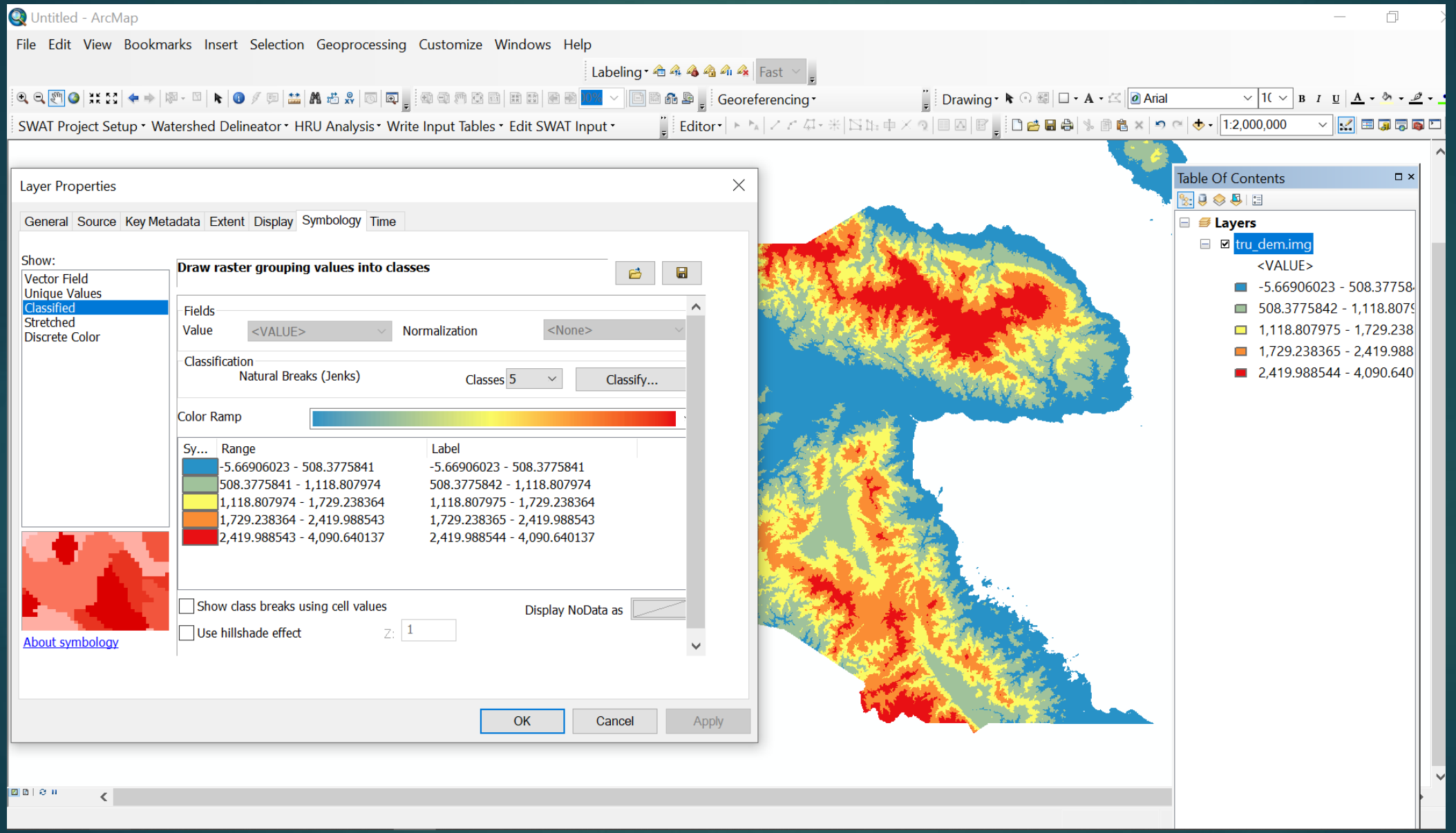


Image source: T.Sekac, 2022

1.4. classification Method

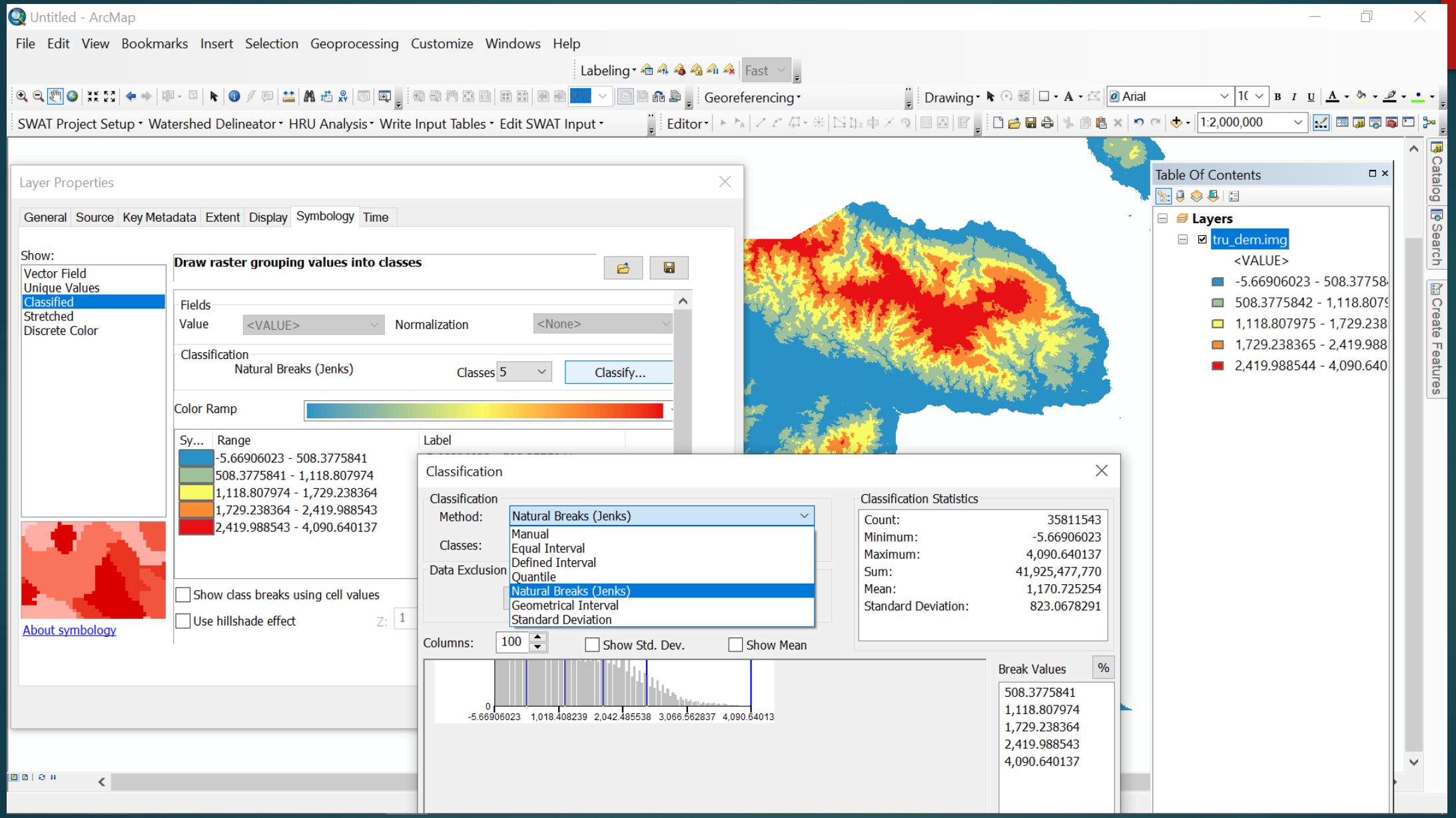


Image source: T.Sekac, 2022

1.5. Example Reclassification

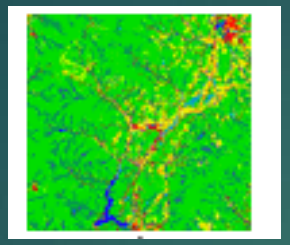
Step 1

Step 2

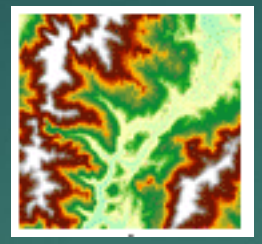
Step 3

Step 4

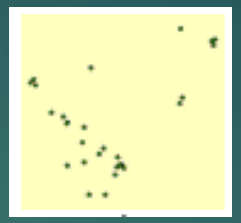
Land use



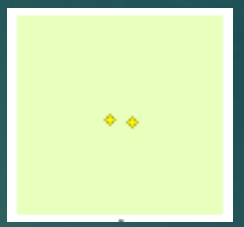
Elevation



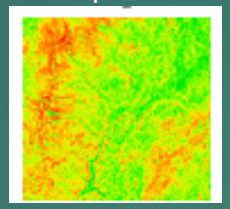
Recreation



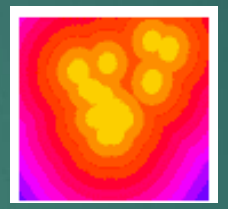
School



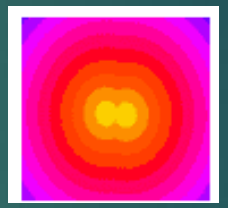
Slope



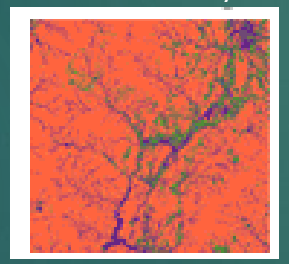
Distance



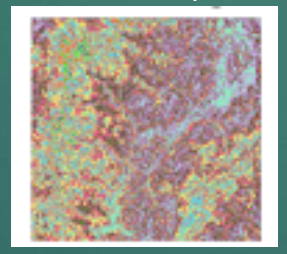
Distance



Reclassify

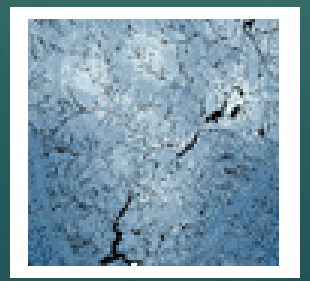


Reclassify



Reclassify

Reclassify



Weighted and Combine Dataset

Source: https://pro.arcgis.com/en/pro-app/2.8/tool-reference/spatial-analyst/understanding-reclassification.htm

1.6. Reclassify tool

From temporal classification to permanent reclassification out put.
Old values to New Values

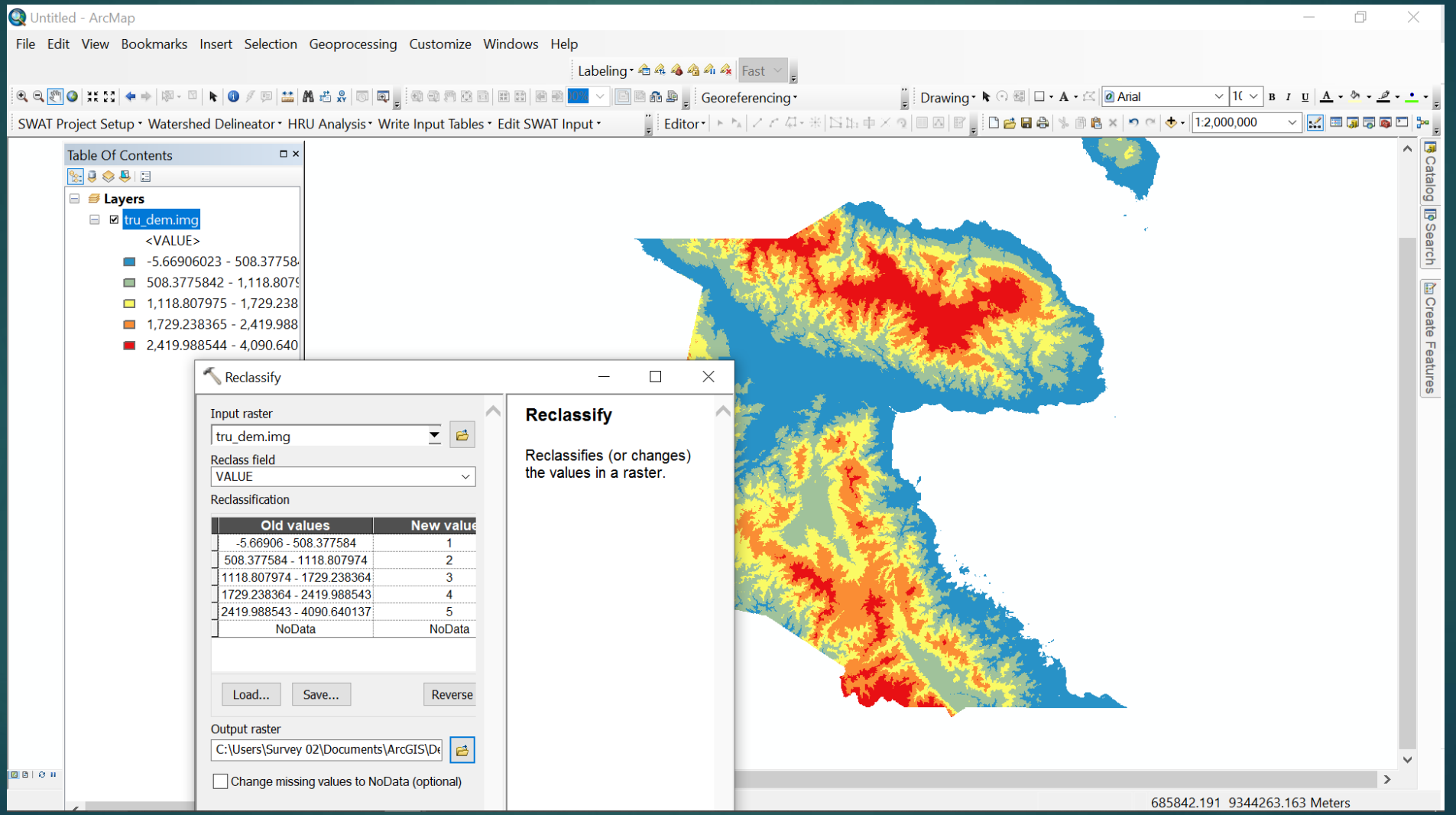
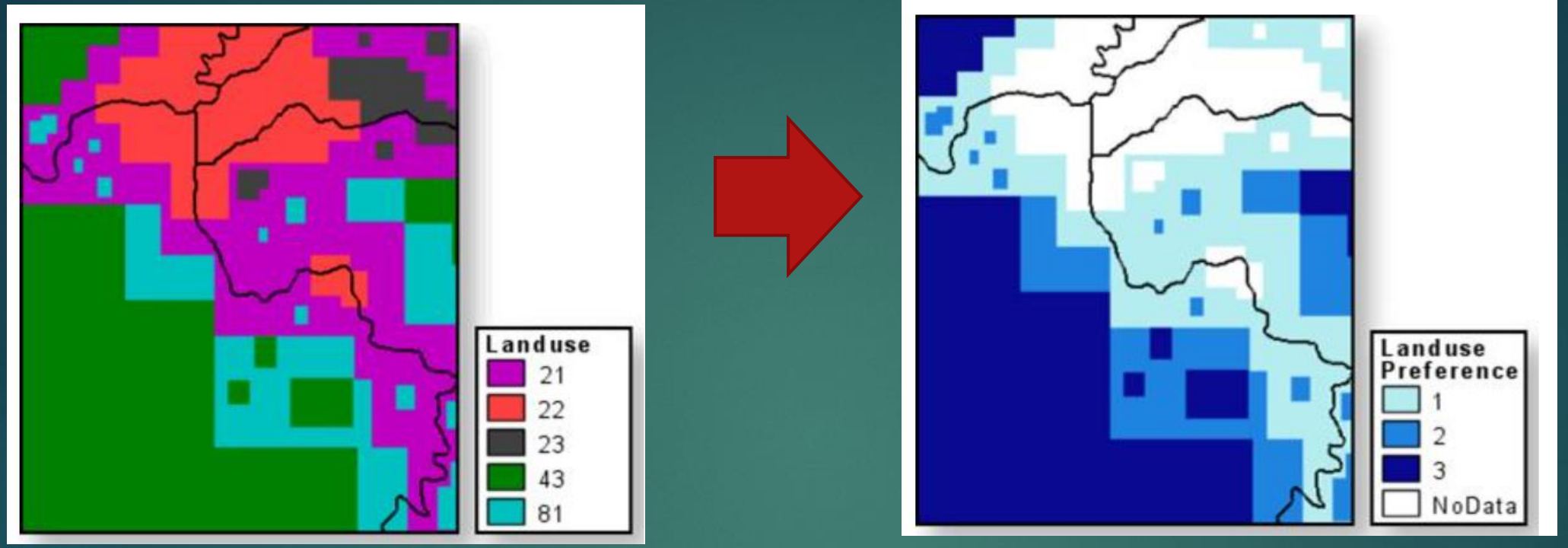


Image source: T.Sekac, 2022

1.7. Categorical data- Land Use Land Cover Reclassification



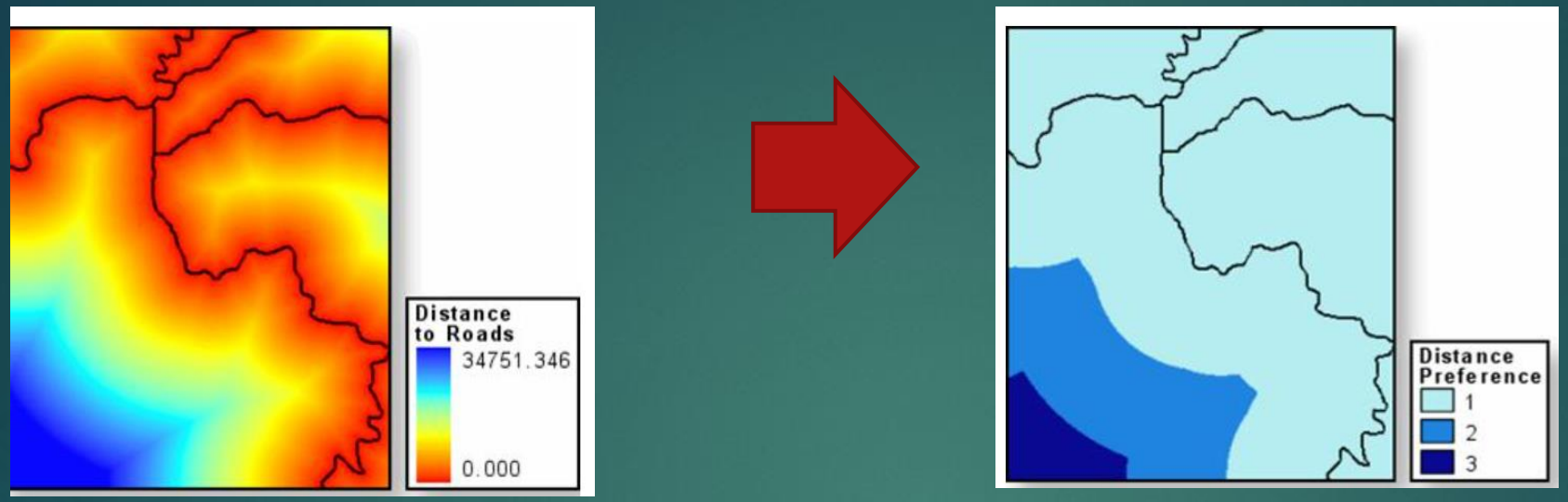
- one-to-one value change.

- For example: deer habitat analysis, the values on a land use raster, need to be changed to a preference range of high (3), medium (2), and low(1), The types of land most preferred by deer are reclassified to higher values. For instance, forest is reclassified to 3, pasture land to 2, and low-density residential land to 1.

- Areas where no deer, like urban and industrial might be reclassified to NoData.

Source: http://www.geography.hunter.cuny.edu/~jochen/gtech361/lectures/lecture11/concepts/Reclassifying%20raster%20data.htm

1.8. Continuous data- Distance Map



Value ranges may be reclassified into a specific number of groups.
Analysis of deer habitat, the second layer in the suitability model is based on the preference of deer for locations far from roads.

A distance map (continuous data) is created from the existing roads theme.

Thousands of distance values reclassified into 3 groups.

The farthest group receives the highest deer preference value, a value of 3, and the nearest group, a value of 1.

Source: http://www.geography.hunter.cuny.edu/~jochen/gtech361/lectures/lecture11/concepts/Reclassifying%20raster%20data.htm

1.9. Reclassification Technique

Input

1	3	1	1
0	N	2	-1
1	2	5	0
0	1	N	N

Reclassify By Table

in	out
0	a
1	x
2	b
3	f
4	c
5	s

Output

x	f	x	x
a	N	b	N
x	b	s	a
a	x	N	N

1	3	1	1
0	N	2	-1
1	2	5	0
0	1	N	N

Reclassify By Range

in range	out
0 to 1.5	a
1.5 to 3.5	b
3.5 to 10	c
N	d

a	b	a	a
a	d	b	N
a	b	c	a
a	b	d	d

Source: http://www.csun.edu/~dlb10399/Docs/Geog306_Spring09/Lectures/Lecture6.306_09.pdf

2. Overlay Analysis

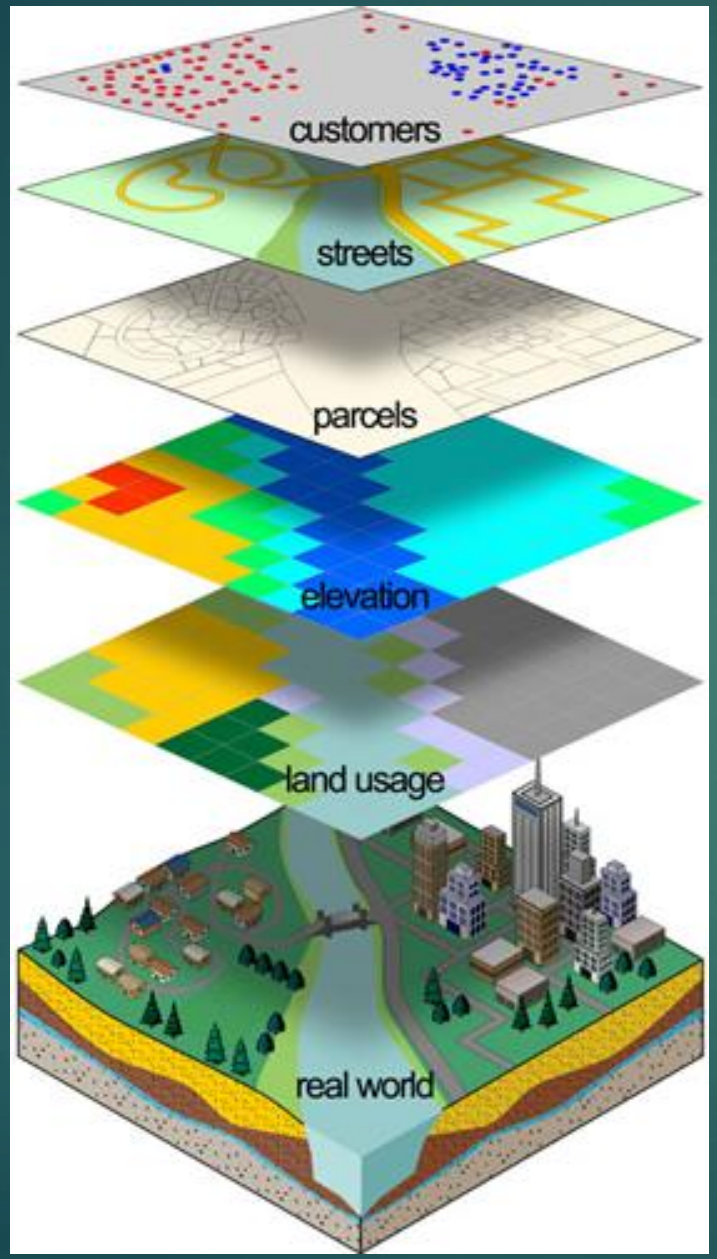
Overlay is a GIS operation that superimposes multiple data sets together for the purpose of identifying relationships between them.

An overlay creates a composite map by combining the geometry and attributes of the input data sets.

Tools are available in most GIS software for overlaying both Vector or raster data.

Overlay operations are both perform in vector and raster data structure to serve different purpose.

2.1. Vector-Raster Data Overlay



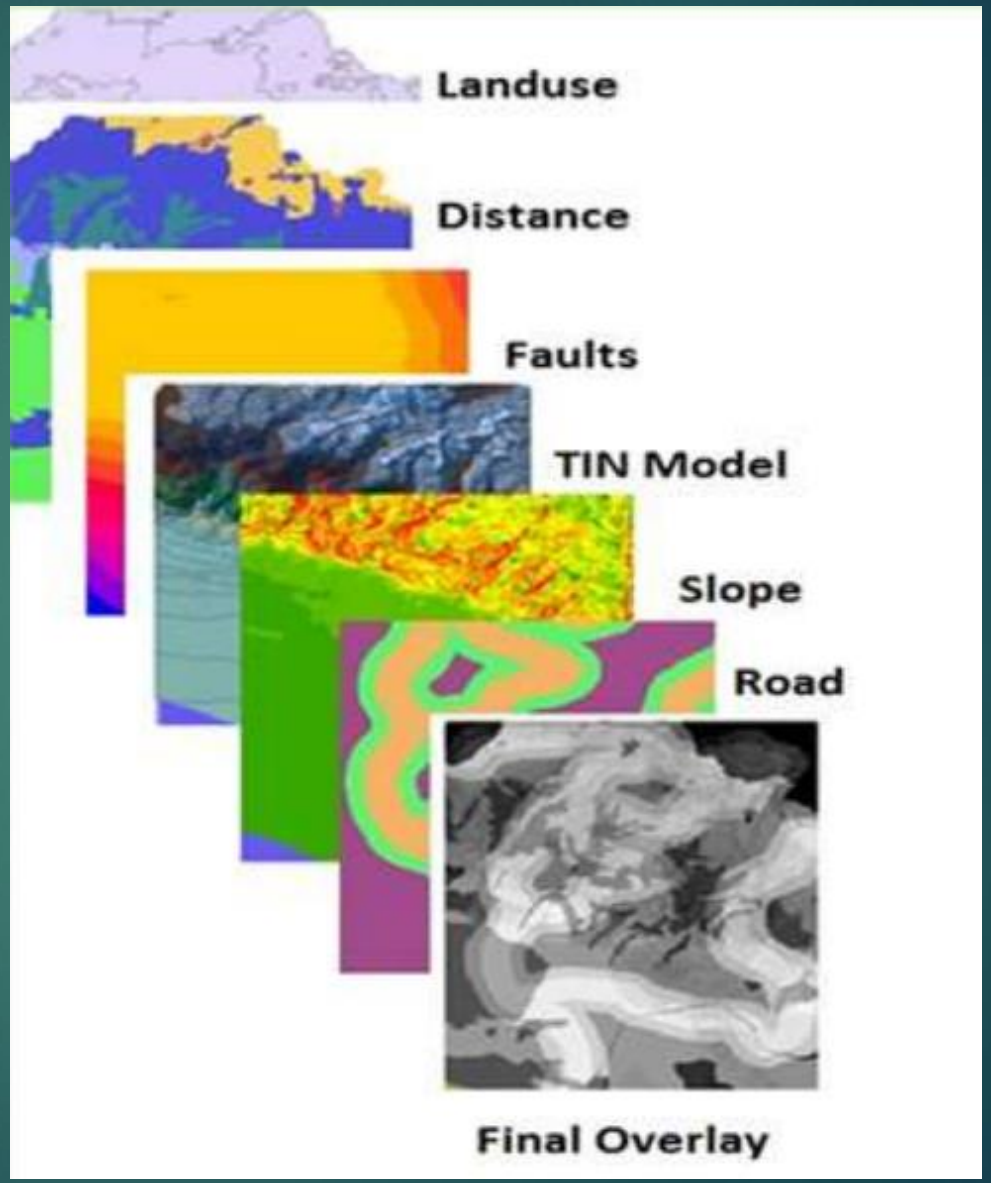
Vector to Raster data Overlay to solve a Real world problem

source: Westfield State University

2.2. Overlay Analysis – New Layer Created

In the overlay analysis new spatial data sets are created by merging data from two or more input data layers.

Overlay operations combine the data from same entity or different entities and create the new geometries and new unit of change entity.



Source: Siddiqui, M.A, et al RS/GIS-24 course module

2.3. Raster Overlay - Overview

Overlay of Raster datasets combine Pixel-based calculations or Map Algebra.

Known as cell by cell combination or operation.

Overlay in raster datasets include two or more different sets of data that derive from a common grid.

In the raster values are mathematically merged together to create a new set of values for a single output layer.

A new layer of values is produced from each pair of coincident cells

Source: Siddiqui, M.A, et al RS/GIS-24 course module

2.4. Raster Overlay - Application

Raster overlay involves two or more different sets of data that derive from a common grid.

The separate sets of data are usually given numerical values.

These values then are mathematically merged together to create a new set of values for a single output layer.

The Raster base overlay can be often used to create:

- risk surfaces,
- sustainability assessments,
- value assessments
- Hazard zones
- Other.

Source: Siddiqui, M.A, et al RS/GIS-24 course module

2.5. Example of Raster Overlay

1) An example of raster overlay would be to divide the habitat of an endangered species into a grid, and then getting data for multiple factors that have an effect on the habitat and then creating a risk surface to illustrate what sections of the habitat need protecting most.

2) Crop suitability weighted overlay analysis – Integrating several raster layers to create crop suitability.

3) Landslide hazard zonation – Integrated several raster layers that can generate landslide hazard zones.

2.6. Resolution and scale of measurement

The raster overlay is affected by the resolution (cell size) and scale of measurement.

The Scale of Measurement are:

- nominal,
- ordinal,
- Interval
- ratio).

It is advised that the resolution and the scale of measurement of both the input and analysis layer should be compatible.

2.7. Raster Base Analysis

If two grids are aligned and have the same grid cell size then it is relatively easy to perform overlay operations.

Forestry

0	1	1
0	0	0
1	1	1

+

Happy Valley Resort

1	1	1
1	1	0
0	0	0

=

Result

1	2	2
1	1	0
1	1	1

Neither forest nor resort = 0
Forest or Resort = 1
Forest and Resort = 2

0	1	1
0	0	0
1	1	1

Forest = 1
Other areas = 0

×

1	1	1
1	1	0
0	0	0

Resort area = 1
Other areas = 0

=

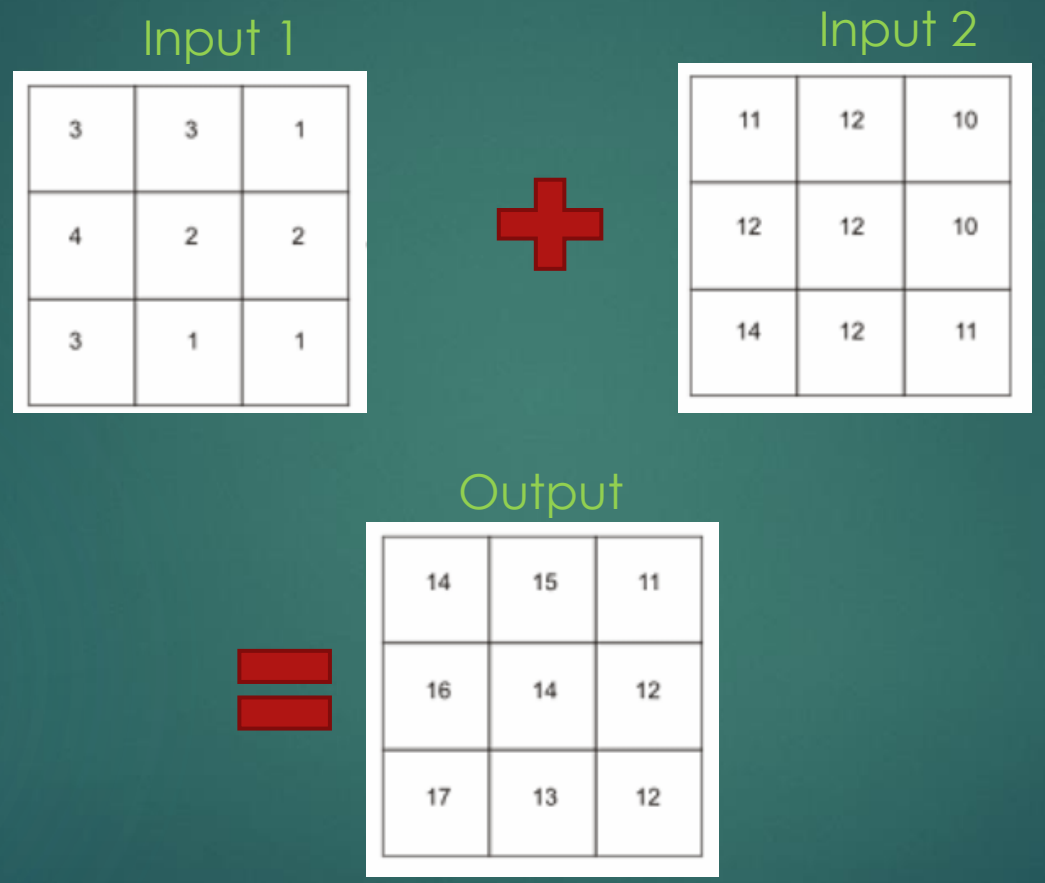
0	1	1
0	0	0
0	0	0

Forest and Resort = 1
Other areas = 0

Source: Siddiqui, M.A, et al RS/GIS-24 course module

2.8. Raster Overlay - Addition

An example of raster overlay by addition. Two input rasters are added together to create an output raster with the values for each cell summed.

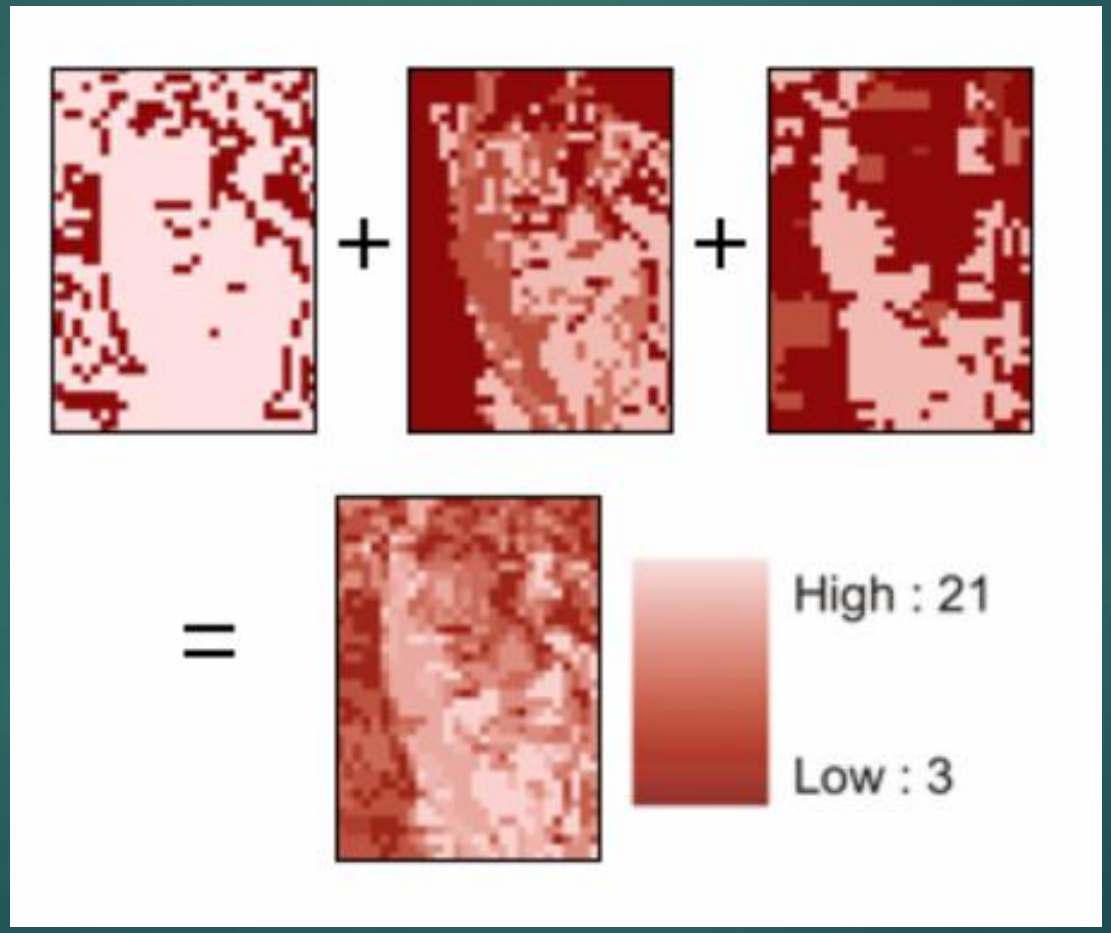


This approach is often used to rank attribute values by suitability or risk, then add them to produce an overall rank for each cell.

Source: ESRI, 2019

2.9. Raster Overlay – Suitability Modeling

Raster overlay by addition for suitability modeling. Three raster layers (steep slopes, soils, and vegetation) are ranked for development suitability on a scale of 1 to 7. When the layers are added (bottom), each cell is ranked on a scale of 3 to 21.



Source: ESRI, 2019

2.10. Map Algebra

Operation between Pixels/Raster Statistics

Raster map overlay introduces the idea of map algebra.

It means in the raster data processing, some analysis use individual cells only and some rely on neighboring or regional associations.

Thus the raster data processing methods can be classified into the following categories:

- ✓ Local operations
- ✓ Neighborhood operation
- ✓ Regional operations/Zonal

2.11. Map Algebra – Type of function

Common Raster Overlay operation that are use with every individual raster

Type of function:

Arithmetic

Statistics

Relational Operation

Boolean

2.12. Map Algebra – Example Operation

Type of function	Example operation
Arithmetic	Add, Subtraction, Multiplication, Divide
Statistics	Min, Max, Mean, Median
Relational Operation	>, <, =
Boolean	Not, And, Or

Source: https://vector.geospatial.science/textbook/section-two-overlay-analysis

2.13. Map Algebra – Example use

Type of function	Example Use
Arithmetic	Finding total risk out of individual risk factors
Statistics	Finding statistical trends
Relational Operation	Comparing values, finding all cells = X
Boolean	Can be used in combination with relational operators; find all cells = X and cells = Y

Source: https://vector.geospatial.science/textbook/section-two-overlay-analysis

3. Raster Overlay Tools

Raster overlay tools are located in several toolsets in the Spatial Analyst toolbox.

Zonal Statistics - Summarizes values in a raster layer by zones (categories) in another layer—for example, calculate the mean elevation for each vegetation category.

Combine - Assigns a value to each cell in the output layer based on unique combinations of values from several input layers.

Weighted Overlay - Automates the raster overlay process and lets you assign weights to each layer before adding (you can also specify equal influence to create an unweighted overlay).

Weighted Sum - Overlays several rasters, multiplying each by their given weight and summing them together.

Source :ESRI, 2019

3.1. Zonal Statistics

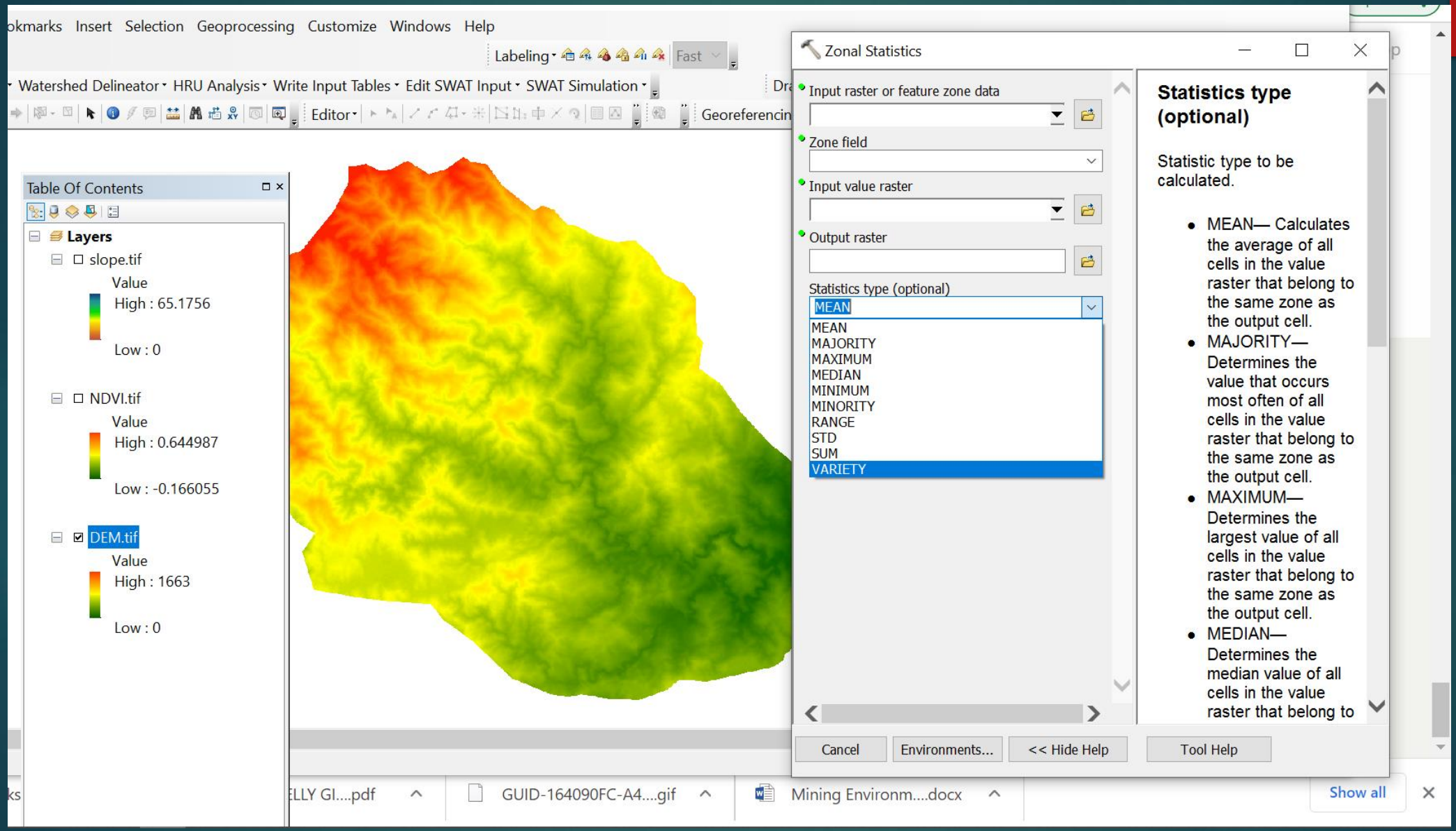


Image Source: T.Sekac, 2022

3.2. Combine Tool

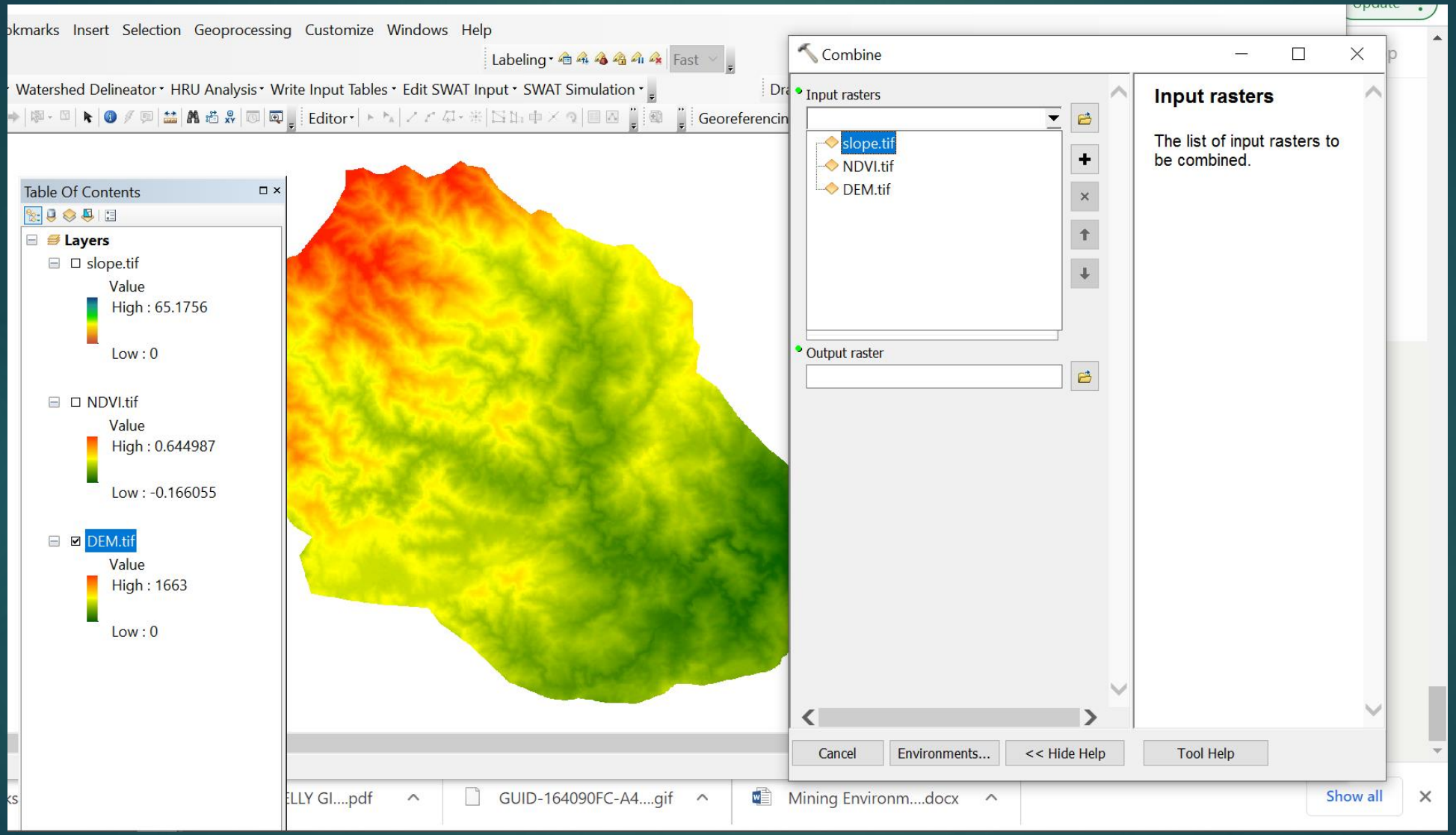


Image Source: T.Sekac, 2022

3.3.Weighted Overlay tool

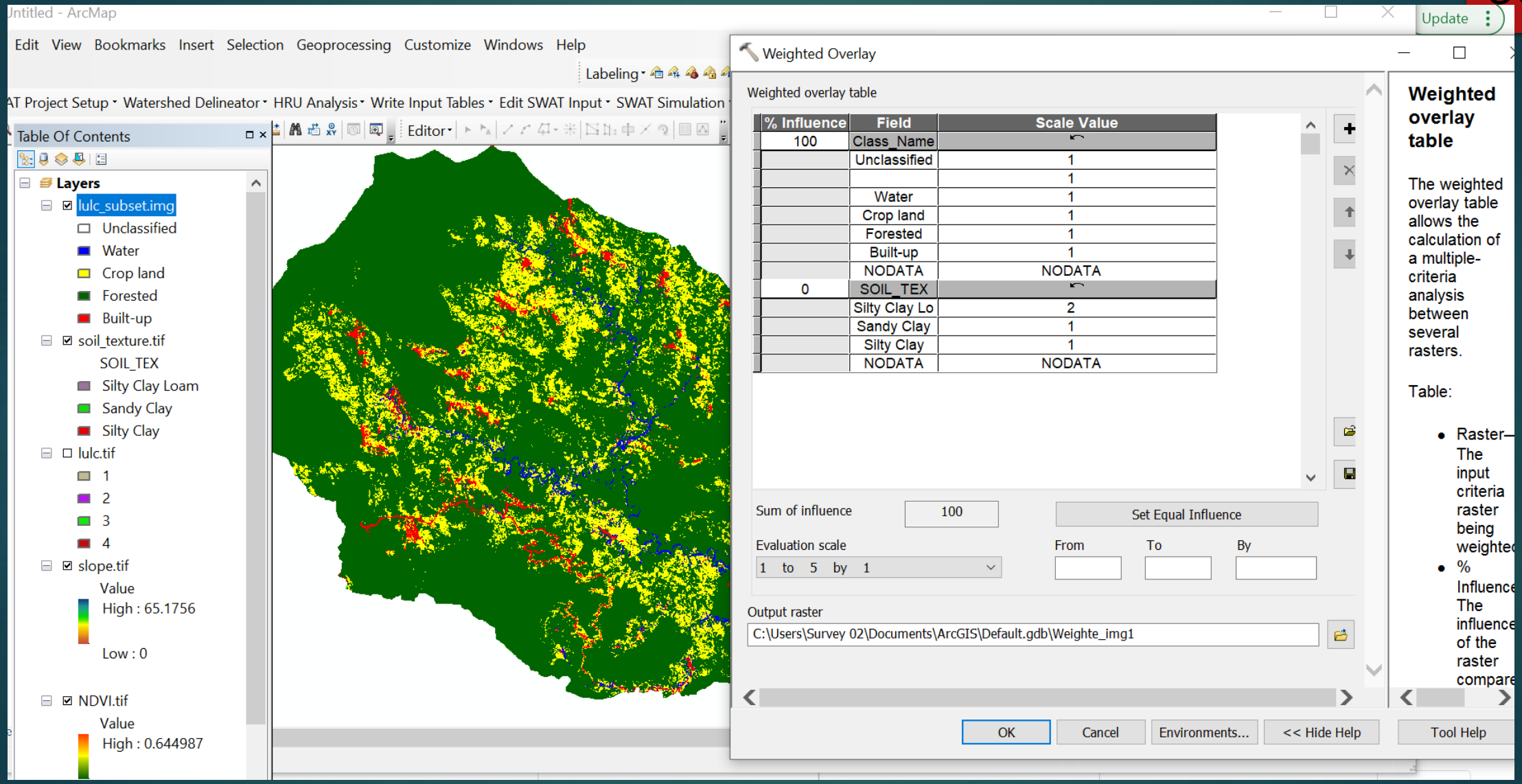


Image Source: T.Sekac, 2022

3.4. Weighted Sum

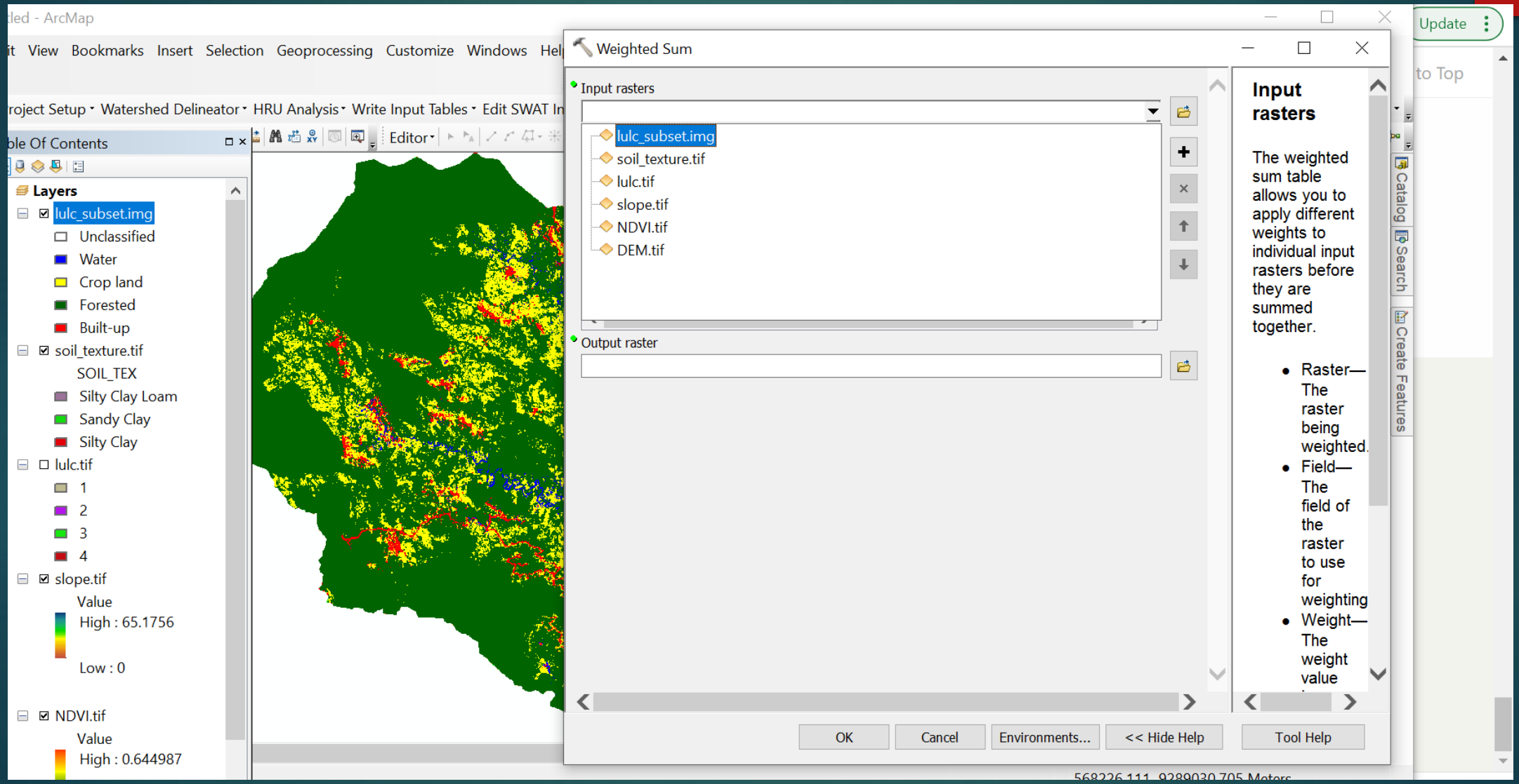


Image Source: T.Sekac, 2022

4. References

ESRI, (2019). Overlay analysis. Retrieve from: https://desktop.arcgis.com/en/arcmap/10.6/analyze/commonly-used-tools/overlay-analysis.htm

Siddiqui, M.A and Islamia, J.M (_). GIS-06: Spatial Analysis (1) Overlay Operations & Analysis in GIS. RS/GIS-24 course module. Retrieve from: http://aditi.du.ac.in/uploads/econtent/SPATIALANALYSIS_overlay.pdf

ESRI, (2002). Using ArcGIS spatial analysis. Redlands, CA. Pp. 164189.

Lange, J, (2020). Reclassify Raster Data in ArcGIS Pro Spatial Analyst Extension. Retrieve from: https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/reclassify-raster-data-in-arcgis-pro-spatial-analystextension/#:~:text=Reclassification%20is%20the%20process%20of,both%20ArcMap%20and%20ArcGIS%20Pro.

ESRI – ArcGIS Pro. Understanding reclassification: Retrieve from: https://pro.arcgis.com/en/pro-app/2.8/tool-reference/spatial-analyst/understanding-reclassification.htm