3Lab assignment 2: Raster Geoprocessing

This assignment deals with georeferencing, image analysis and raster geoprocessing.

Question 1

Open the Image Analysis tool. Add 3 bands (3,2,1 - RGB) of the Landsat image of Cape Town to the data frame.

a) Make an RGB composite showing the image in natural colour. Adjust the display settings using the brightness, contrast, stretching and histogram options. Turn the background off. Insert a screenshot of your best looking natural colour composite. Try adjusting the histogram to improve the rendering.

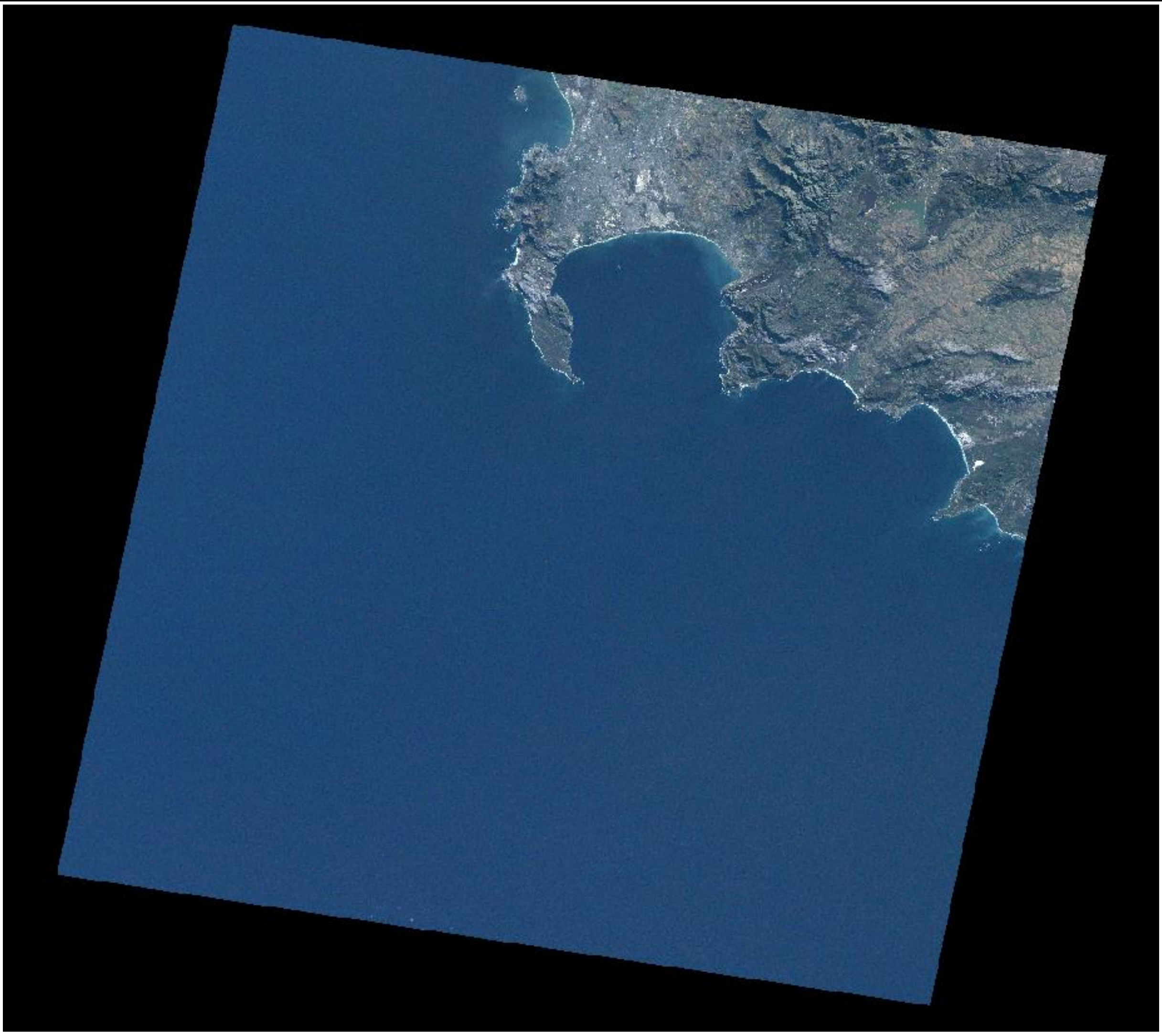
b) Which tool would you use to cut out the sea area – clip or mask? Use this tool to focus only on the land part of the image.

c) Measure the approximate area and perimeter of Robben Island (using your RGB composite) (in km/km^2).

d) Determine the coordinates of the approximate centroid point of Robben Island (in decimal degrees).

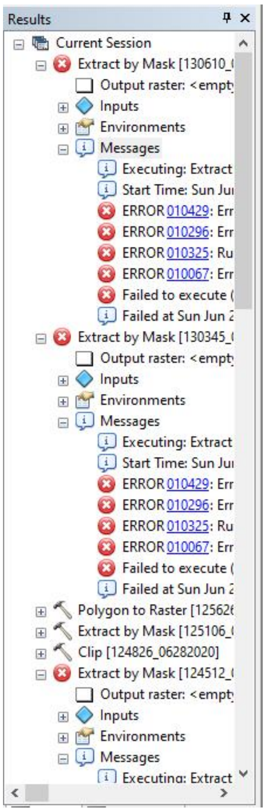
e) Measure the largest distance across the island (in km).

Insert a screenshot of the area you used for your measurements.



b) Land Mask by Extraction (using SpatialAnalyst Raster Calc SetNull(RasterValues = 0, Raster)

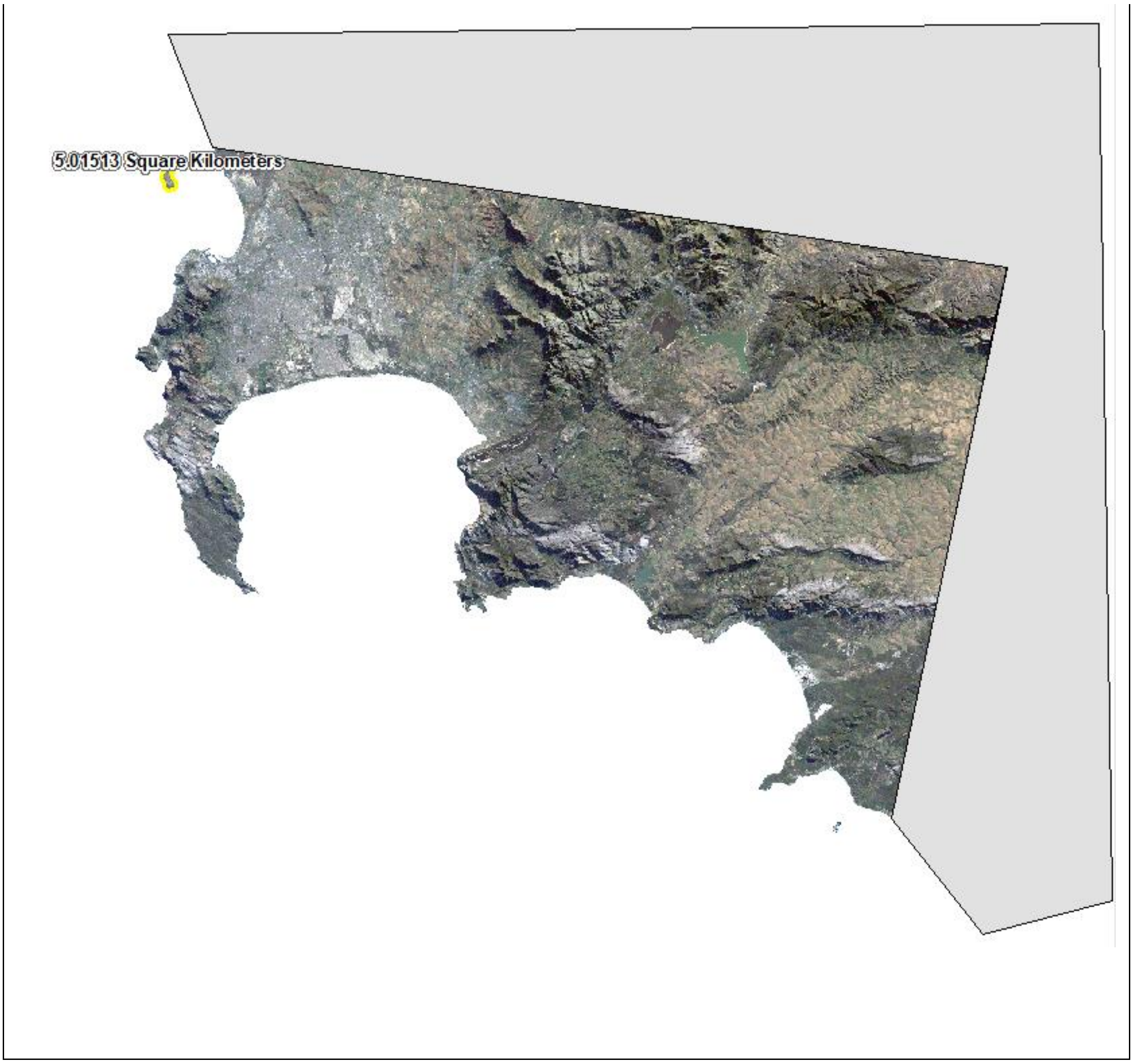
Persistent errors “ensure data source is not corrupt” , may be related to my ArcMap 10.3



c) Robben Island measures approx.: 5.01 km^2 with a 9.7 km perimeter

d) Centroid coordinate Point is near 33.805 S and 018.368 E

e) largest distance across the island is approximately 3.46 km



Question 2

Using the distance analysis and reclassifying tools. You want to calculate the cost (in this sense, relative difficulty based on the presence of roads which may be hazardous, as well as the distance to travel before reaching the nearest garden) for bees to move away from their hives towards nearby gardens in search of food. You need to calculate a cost raster to be used to calculate the cost distance raster in order to determine the difficulty for the bees to reach nearby gardens.

Method:

a) Add gardens_brussells_prj.shp. **Create a Euclidean distance raster** with a 10m cell size.
b) Add roads_brussells.shp. **Convert** the roads layer to a 10m raster using the “STATUUT” field as the attribute.
c) **Reclassify** this new roads raster as follows:
    1. Grootstedelijkeweg = 5
    2. Autosnelweg = 4

3. Hoofdweg = 3
4. Wijkennet = 2
5. Interwijkennet = 1
6. NoData = 0

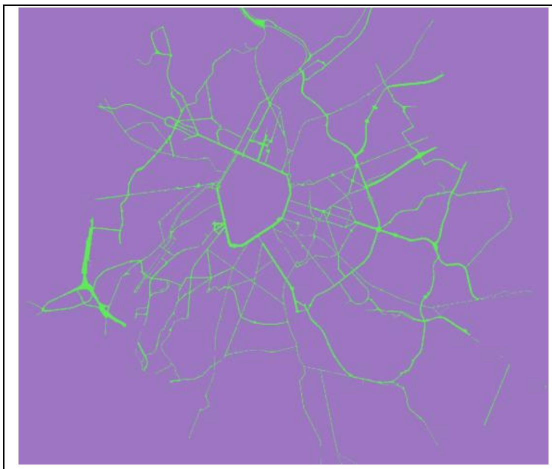
This is a cost raster. The higher the value, the more cost to the bees to pass over this type of road.

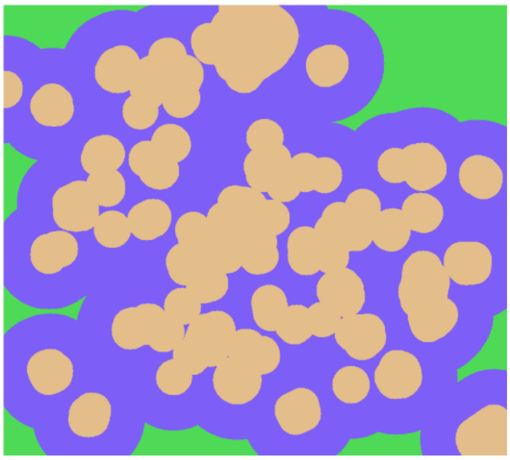
d) **Reclassify** the Euclidean distance raster with the following categories:
   1. 0 – 500 = 1;
   2. 500 – 1000 = 2
   3. 1000 – 2000 = 3
   4. 2000 – 3000 = 4
   5. >3000 = 5

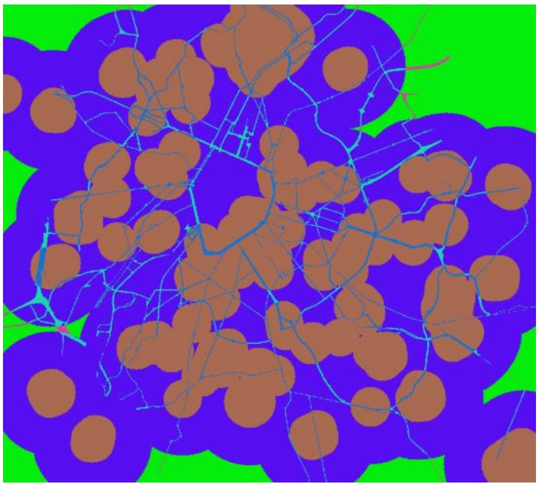
   The reclassifying creates a common scale for the two rasters and indicates the relative importance of the different categories. The lower the number, the lower the cost to the bees.

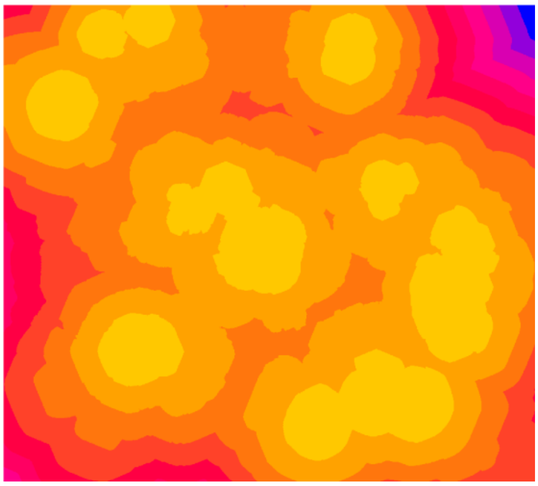
e) Create a more intricate cost raster by **ADDING** the reclassified roads and Euclidean distance rasters. (For this use the Map Algebra tool (raster calculator) in the Spatial Analyst tool bar.)
f) Use the **Cost Distance tool** to calculate the Cost Distance raster for bees moving away from their beehives (locations of hives given by the layer hive_locations.shp). Remember to set your environment so that the output extent of the cost-distance raster is correct.
g) Now use the "**Extract Values to Points**" tool under "Extractions" in the Spatial Analyst toolbar to extract the raster values to the gardens points (these are the centroids of the garden polygons – gardens_pts.shp). This will show the relative cost of moving from a hive location to a nearby garden. Which garden (**the first with a name**) is the most costly for bees to get to?

   Insert screen shots of your two reclassified rasters, the cost raster and the cost distance result.









Question 4

Read the papers provided and answer the following questions.

Paper 1: Cost Distance Analysis in an Alpine Environment: Comparison of Different Cost Surface Modules –

a) What is the difference between isotropic and anisotropic costs? Give an example from the paper.
b) Which tool in ArcMap is used for isotropic cost rasters and which tool is used for anisotropic cost rasters?
c) Different software creates different results – why is this? (Figure 5) What are causing the differences shown in Figure 6?

Paper 2: The Cost of Hauling Timber: A Comparison of Raster- and Vector- Based Travel-Time Estimates in GIS –

a) Create a simple workflow of the method followed by the author to create the travel-time raster for harvest sites to one plant location using a 10m cost raster. (Note: you need not do any of the calculations, merely show the steps taken to reach the travel-time raster.)

PAPER1: Alpine Environment

a) Isotropic costs are independent of the cell-crossing direction, by remaining equal any which way; it could be said this is generally true of vehicular transport within state bounds (assuming there would be no uni-directional tolls, or regional gas price variations for instance). Isotropic costs in the Gietl et. al, 2004 study of an Alpine Environment, are cost-distances that are modelled relative to frictions and forces (ie. energy required versus terrain properties, souch as slope or river current).

Anisotropic costs in the Alpine region are directly related to terrain properties of anisotropy, such as steep slopes or directional river bodies. This environmental physics contributing to anisotropic costs have only recently been introduced into the GIS modelling capabilities.

b) While GRASS is an open-source GIS algorithm (available as a QGIS plug-in for instance), IDRISI and ArcGIS algorithms covered in the Gietl et. al, 2004 study are proprietary, and in the case of ArcGIS versions 9.x and beyond, this is the Spatial Analyst extension with the Cost-distance for isotropic and path-distance for anisotropic calculation, as well as additional modules for corridor analysis.

c) Figure 5:
Despite using the same data set and weightings, the proprietary algorithms not only employ distinct calculation logic, but they are also imperfect and at the time relied on inherited algorithms from hydrology.
Figure 6:
User defined parameters specific to each software further differentiate the data processing criteria.

PAPER2: Hauling Timber

Assessing the feasibility of timber-haul costs

Raster Cost Grid Method

Figure 4. Map of study areas

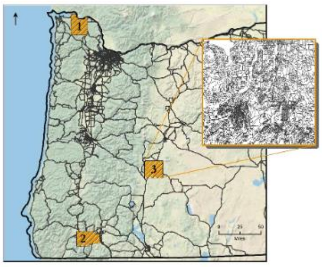


Figure 5. Map of study areas with connecting highways. Map inset shows road detail of all merged roads from all data sources within study area 3. (Data source: ESRI 2014, ODOT 2014, USDA Forest Service 2013, Bureau of Land Management 2012)

*Identify study areas for comparison and their distinctive features:

Area 1 (forested, forrested roads)

Area 2 (urban, highest road density)

Area 3 (mixed, pop <2000, rural/agricultural)

** Source appropriate Data layers, analyze data layer properties, limitations, discrepancies and inaccuracies to be accounted for.

*** Correct and correlate data layers (in this case regional and national scale road maps)

applying buffers and verifying manual data correction against GIS analyst

**** Determine Origins and Destinations of interest, viz. Processing facilities (3) and Harvest Sites (36+) relevant to each Area of study. Potentially add additional nodes within a buffer zone from the Study ROI.

Table 2. Number of harvest sites and processing facilities utilized as origins and destinations for each study area.

	harvest sites	processing facilities (within area)	processing facilities (outside area)	processing facilities (total)
Area 1	41	3	4	7
Area 2	36	4	4	8
Area 3	40	3	4	7
Total	117	10	12	22

Pseudo-algorithm for ArcGIS:

1. Create spatial layer containing all of Facility location data (which are operable)

2. clip layer to Study Area boundaries

3. Add Buffer area around Study Area boundaries, identifying additional facilities

4. Analyze with Facilities as origins (assumption: Travel time is assumed to be equal in each direction, fewer nodes signifying Facilities simplify data management)

5. Represent Harvest Sites by USDA Permanent Inventory plots (national hexagonal grid, + regional), filter for « forested » status by reclassifying

6. Clip reclassified layer with "forested" harvest sites to Study Area bounds

7. observe: Areas 1 and 3 both contained 41 destinationlocations, and Area 2 contained 34

8. align « forested » plot centroids with road-networks corrected data set (note: accesibility of plot, record : each centroid offset)

9. further road-network layer formatting…

10. Run Integrate Tool to insert common coordinate vertices for roads

11. Run : Network Analyst OD Cost Matrixtool on the road-network datasets (corrected, uncorrected)

Travel-time value = line segment length + speed limit attribute value; minutes as unit

12. Repeat #14 to : Calculate travel-time distance for all origin-destination pairs ; meters as unit

(note : meters for distance serves correlation analysis between corrected and uncorrected road-network layers)

13. Create Raster data set : convert uncorrected vector layer into raster grid (ie. 10 m cell)

Cell weighting values : speed limit (s/km) – compatibility with cost algorithm and road grid cells.

note : for overlapping speed limits, assign greater value to that cell (assumption : driver can choose)

14. Calculate: Least-cost distance for each processing facility in each Study Area -> output Raster 10m cost grid cell, across the continuous Raster surface:

Output raster contains least-cost distance (or minimum accumulative cost distance) of each cell to the input processing facility location

Repeat #14 : Least-cost distance 10m cell raster output for each processing facility witin Area

method: nodal network applied to raster, Cost Distance tool utilizes an 8-node connection model ;

analysis note:
Discriminate against linear feature distortion and inaccuracy across the raster surface

Highly dependent on Grid resolution, although found to be within agreement at under < 25m cell)

15. Overlay « Harvest forested site » locations over each output raster

16. Assign resulting value as the travel-time estimate for that pairing

17. Style Symbology, analyze results, refine if needed, finally output maps.

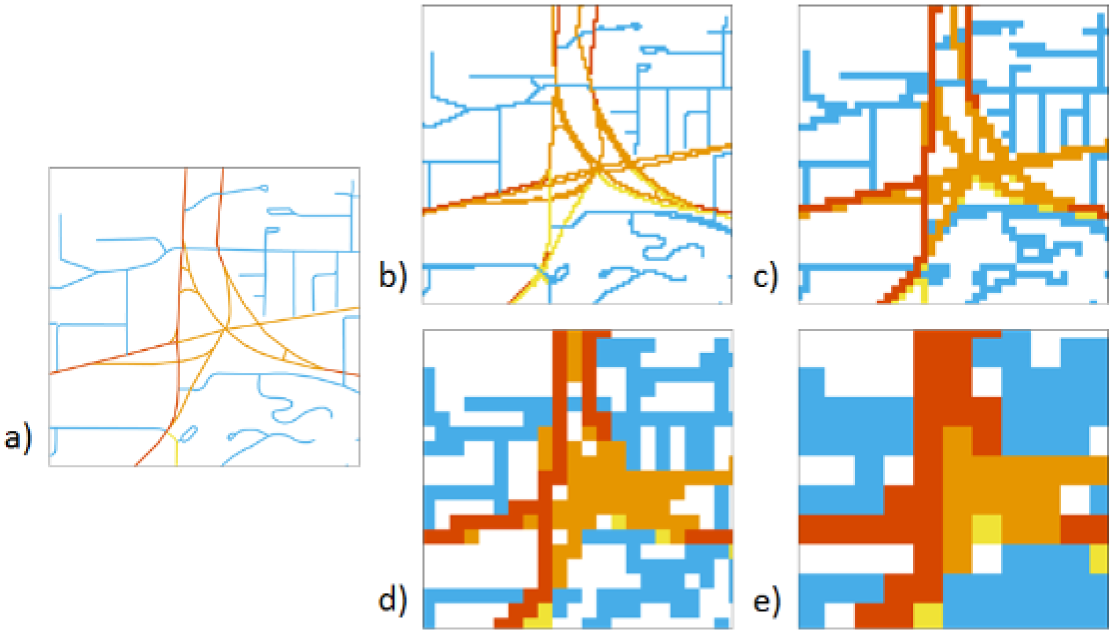


Figure 7. Representation of vector road layer (a) converted into a 10 m (b), 25 m (c), 50 m (d), and 100 m (e) raster cost grid.