Using GIS to develop indicators of deforestation in Mozambique

Problem Statement – deforestation for charcoal

For much of the world's population, sourcing fuel supplies for cooking and heating is a fundamental problem. In the absence of more sophisticated power supplies, the use of fuelwood is a common solution to this problem, but one which can result in widespread deforestion.

This is certainly true of central Mozambique, where a long-running civil war prevented the civilian population from collecting firewood on a large scale for many years. However, with the advent of peace in 1992 and the subsequent clearance of land-mines, large areas of Mozambique's indigenous *miombo* woodland are being cleared to service a growing demand for charcoal in nearby urban areas such as the port of Beira. Merchants in urban areas pay intermediaries to fell trees for charcoal. Once trees have been cleared, bags of charcoal are transported from the rural areas by bicycle or truck to the cities.

The deforestation resulting from charcoal burning is spreading further and further inland, with the result that environmentally important areas such as Gorongosa National Park are now being threatened.

As a response to this threat, a scheme was developed to support villagers living around the park (Particularly in Nhambita) to cultivate crops under trees through an agro-forestry project through a Reducing Emissions from Deforestation and Degradation (REDD) initiative (https://www.iied.org/redd-protecting-climate-forests-livelihoods). A private company, Envirotrade, could sell carbon credits from the scheme, enabling villagers to make a living whilst the trees were establishing. Almost a hundred villagers signed up to this scheme and it was hoped that these villagers will act as a 'buffer' against the activities of the charcoal burners.

Did the scheme work? Here is a report written about the scheme following a field visit by a journalist:

https://redd-monitor.org/2013/06/18/carbon-discredited-new-report-on-envirotrades-nhambita-carbon-project-in-mozambique/

Data:

Landcover_2000.asc: An ESRI ASCII raster format grid of land cover for the study area, based on classified LandSat ETM satellite imagery. To reduce the size of the data

files used, this land cover map is provided for a small portion of the overall study area. There are 8 land cover classes on this map, each represented by a different number:
code 1 : water
code 2 : forest
code 3 : forest/grass1
code 4 : forest/grass2
code 5 : grass patch edge
code 6 : agriculture/grass
code 7 : sand/bare earth
code 8 : vlei (riverine grass)

Park_bnd: the boundary of Gorongosa National Park

fields: the locations of farmers' fields, which have signed up for the proposed agro-forestry scheme

Population_by_village: the population of different villages across Mozambique, based on the 1997 population census. In the attribute table for this data set, the **pop2000** field for each village indicates the total population there in 1997.

Note on data sources: the Mozambiquan population data are derived from this web site:

http://www.sahims.net/gis/

[This site is now dead, but you can find more data for Mozambique at the Humanitarian Data Exchange: https://data.humdata.org/search?q=mozambique]

The land cover map was produced by Dr. Jim Wright of University of Southampton, whilst the agro-forestry scheme data are fictitious, but comparable to a 'real world' data set for this park.

Note that the **Population_by_village** map layer covers the whole of Mozambique and is intended to show the Gorongosa study area in relation to the whole of Mozambique. The remaining three map layers cover a much smaller area, namely the national park and the area immediately west of it. All map layers share the same geographic reference system and do not require any change of reference system.

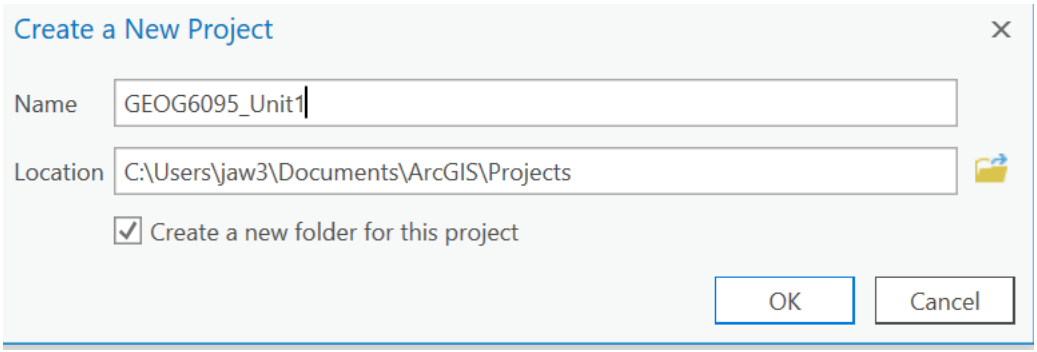
Task:

ArcGIS Desktop Instructions:
You will need to import the ASCII format raster data before proceeding further. To do this, within the ArcToolBox, click on *conversion tools* and choose *To raster*, then choose *ASCII to raster*. Selec the land cover file described under 'data' above as your *input ASCII raster file* and type in a suitable name for the *output raster*. Leave the *output data type* set to *integer* (an integer is a whole number with no decimal places, so this option means that each raster grid cell will contain a whole number. The other option here, *float*,

means that the numbers stored in each grid cell will contain a fractional part with decimal places).

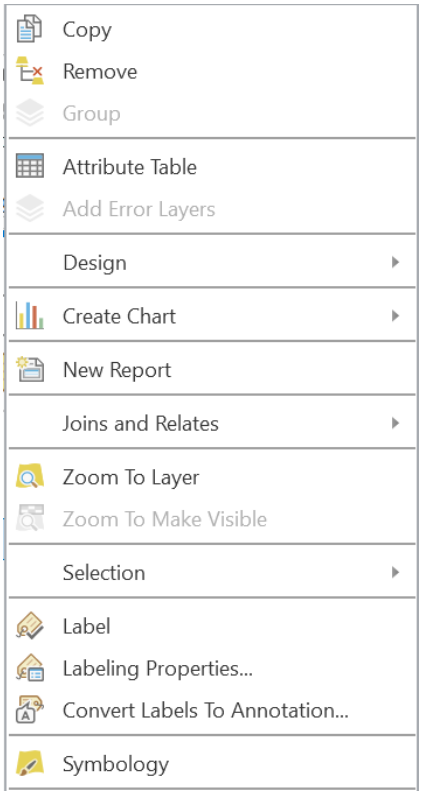
ArcPro instructions (quick start):

When ArcGIS Pro starts, under *blank templates*, choose *map.* Next, give your new project a name and choose a suitable location for it.

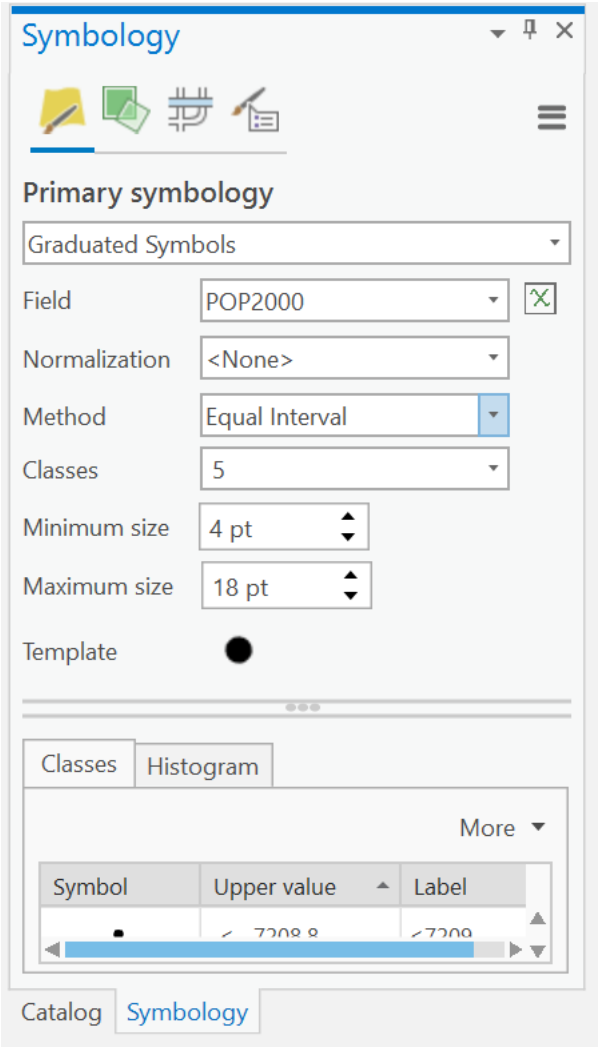


In the right-hand Catalog window, note that you can right-click and select *add folder connection* to set up a link to the folder with the map layers for this exercise. You can then navigate to the folder and drag and drop layers on to the map canvas. Please use **landcover_2000.asc** rather than **landcover_2000.txt** for this exercise (.asc is the required extension for ASCII text raster files in ArcGIS Pro, so only this file will read correctly into the software).

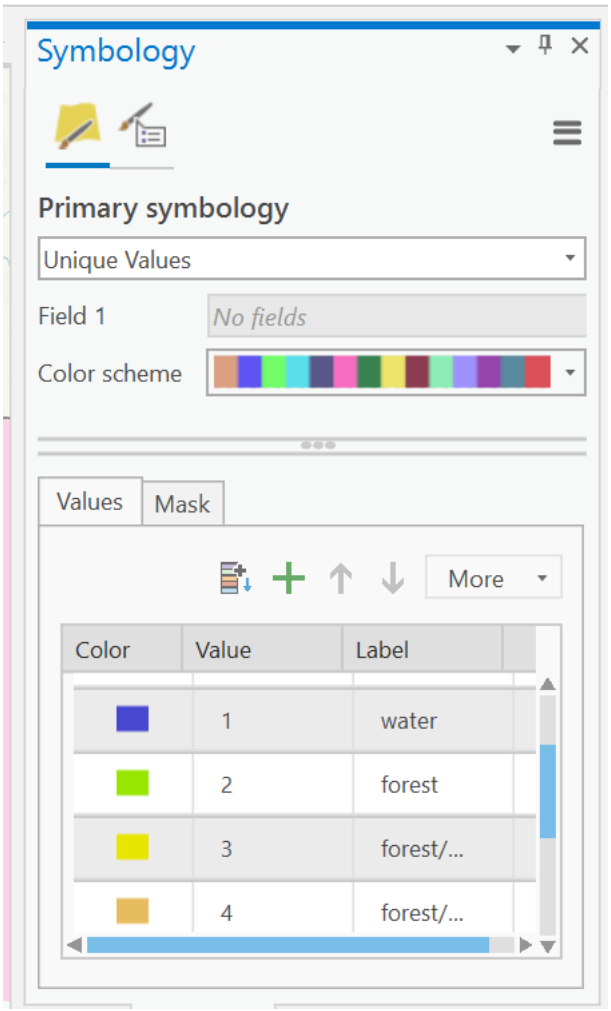
When you have loaded up your layers, you may wish to enhance your map display. For each layer, you can right-click on it in the left-hand panel and choose *symbology* to change its display*:*



With the **villages** layer, you may wish to use *graduated symbols* as your *primary symbology,* setting the point symbol sizes to be proportional to **pop2000**, the field with the village population counts. You may wish to change the *template* in doing so:



With the **landcover_2000.asc** layer, you may wish to use *unique values* as your *primary symbology,* so that each land cover class has a different colour. You may wish to change the colour and label for each class, reviewing the meaning of the land cover class codes 1 to 8 (see page 1) in doing so, e.g. changing the label for class '1' to be 'water' and making it a blue colour:



Part 1: Review the available data sets using your GIS software. Choose what you would consider to be appropriate pressure, state and response indicators for handling the management problem of deforestation.

[When you have considered which data you would choose for which indicator, turn the page and view the answers at the back of this handout]

Part 2: Post a brief message of a paragraph or two to the course web site, considering:

(a) What you consider to be the advantages of using GIS in this particular case study;
(b) What you consider to be the disadvantages of using GIS in this particular case study;
(c) Ultimately, whether you think the GIS technology is useful in helping manage the deforestation problem in Mozambique

Answers to Part 1:

• In the absence of any further data, a Pressure indicator might be population density, as described by the Population_by_village map layer. This assumes that demand for fuelwood and charcoal is proportional to population and that no alternative sources of fuel are available.
• An appropriate state indicator might be the percentage of land under the various forested land cover types.
• An appropriate response variable might be the total number of fields (or area of land) signed up to the agro-forestry scheme.