**ESS162 Lab5: CA wildland ecology**

**This is a partner report lab**

**This will be due right class on lab on Fri Feb 19 (one weeks from the coming Friday)**

**Goals this week:**

You will be plotting and analyzing datasets that describe the spatial patterns of ecosystem distribution across California. You will be working ArcGIS, Google Earth and Excel.

The datasets are contained in a single zip file on the class website (Lab5.zip), which you will download and unzip into a single folder.

The key datasets are:

1. AET.kmz is a Google Earth kmz image of the annual mean AET across CA, where green indicates higher rates of AET
2. Biomass2.kmz is a Google Earth kmz image of the Biomass across CA, where green and blue indicate higher tree biomass.
3. DNDMI4km.kmz is a Google Earth kmz image of the death of forest trees during CA’s 2012-15 drought, where red indicates greater vegetation loss due to fires or tree death.
4. P-ET4km3.kmz is a Google Earth kmz image of the annual mean P-AET across CA, during CA’s 2012-15 drought, where red indicates ET > P (areas that came under severe water stress).
5. Whr4km.kmz is a Google Earth kmz image of the vegetation types across CA, where the different colors are different vegetation types.
6. biomass\_k1\_2016.tif, which is a much higher resolution layer of forest biomass that you will open in ArcMap
7. landcov0 polygon, which is a much higher resolution and more detailed layer of vegetation type that you will open in ArcMap
8. srgrayi1kml.tif, which is a shade relief image of CA that you will use as a base map in ArcMap.
9. CAecology.xlsx is an Excel spreadsheet of the gridded raster data for the local water across all of CA. You can think of it as the actual numbers that underlie the various shp and kmz described above.

**Get ArcMap running:**

We’re going to give ArcMap a shot this week. You have two options for how you will work with Arc.

Option 1: Apporto.

Login at: https://uci.apporto.com/user/login

Launch UCI lab desktop

Maximize the screen with the upper left outwards arrow symbol

At this point it should behave like a normal Windows 10 machine

Open Google Chrome in Apporto, go to Canvas (https://canvas.eee.uci.edu/courses/34130), and download the lab5 files and unzip on the virtual desktop

Start ArcMap in Apporto

Option 2: Your Windows machine

You can get a free copy of ArcGIS as a student – it will probably expire after a year or sooner – but, hey, it’s free.

Which option should you use?

If you have a Mac or older Windows machine or one that is limited wrt available memory, you should stick with Apporto, at least initially. If you’re not especially interested in exploring GIS, then stick with Apporto, it will be easier and there’s no reason to take up the space on your computer. If you’re unsure, you can start with Apporto and if you like GIS you can grab a copy and explore more. If you want to learn more about GIS and have a Mac or just want to learn all you can, speak with down the road – there are other GIS options that are open sources on cross platform.

**Tools, steps and commands:**

We’ll be jumping back and forth between machines this week. These instructions are written assuming you do the Arc pieces on Apporto and the Excel and Google Earth on your personal machine. Adjust things if you do it a different way.

Go to Canvas (https://canvas.eee.uci.edu/courses/34130) on your personal machine, download the lab5 files and unzip on your desktop.

Google Earth Pro (on your personal machine)

Open and familiarize yourself with the various kmz files – you don’t need to make any plots – the goal here is just to see what the data in the Excel file looks like.

ArcGis (on Apporto)

Start ArcMap

Introductions – Menus, Geoprocessing, Toolbars, Toolbox

View – data vs layout

Add data layers - biomass\_k1\_2016.tif, srgrayi1kml.tif, landcov0 polygon

Table of contents, order, on-off

Zoom, pan, identify, measure

Symbology for color ramp on biomass, stretch

Biomass transparency over shaded relief

Open and look at table for landcover

Symbology for WHR class 1

Layout view

Now load high high resolution image layer (more like Google Earth)

Add Data, GIS Servers, Add ArcGIS Server, Use GIS Services, Next, Server

URL: <http://gis.apfo.usda.gov/arcgis/services>

Add Data, GIS Servers, arcgis on gis.apfo.usda.gov, NAIP, USDA\_CONUS\_PRIME

Create and hand 5 images total – 1) big view of biomass over shaded relief, 2) big view of WHR over shaded relief, 3) zoom view of biomass over shaded relief, 4) zoom view of WHR over over shaded relief.

Excel (on your personal machine)

Open CAecology.xlsx Add columns for vegetation band:

=1+TRUNC(D2/200) and fill down (where D2 is elevation)

Create a table of the mean (or mode) value for each elevation band

=AVERAGEIF($M:$M,"=1",E:E)

=MODE(IF(M:M=1,H:H)) (you’ll need to enter “ctrl shift enter” once you’ve typed the equation in – should show curly brackets)

Fill down and change target elevation band for each row

Fill right

End product is a table of how everything varies with elevation

Plot elevation gradients of everything and include

Explain the elevation gradients

**Writeup (you will need to move things back and forth from your personal machine to Apporto)**

**Create and hand in 4 images based on ArcGIS – 1) big view of biomass over shaded relief, 2) big view of WHR over shaded relief, 3) zoom view of biomass over shaded relief, 4) zoom view of WHR over shaded relief.**

Maps of biomass over shaded relief were made in QGIS

Map

Description automatically generated

Map

Description automatically generated

Maps of WHR class over shaded relief were made in ArcGIS

Map

Description automatically generated

Map

Description automatically generated

The map is zoomed in and covers the Bay region and parts of the Central Valley and the Sierra Nevada Mountains.

**Make line plots of the average (or mode) elevation gradients of vegetation type through tree death (5 properties) and include**

**Explain the average (or mode) elevation gradients**

**Chart, scatter chart

Description automatically generated**

Orographic lifting and the resulting rain shadow effect helps to explain the pattern in elevation and precipitation. As moist air that originates from the Pacific Ocean travels to the east, it gets lifted by the Coast Ranges, the Klamath Mountains, and the Sierra Nevadas. During the lifting process, air masses cool and condenses into precipitation, and the further it rises, the more it will cool and the more precipitation is produced. Therefore, precipitation initially increases with elevation. However, this relationship falters at elevations higher than 2000 m. A possible explanation for this is the width of the mountain ranges over which the air masses travel. As air initially travels up the western slopes of the mountain ranges, there is a positive correlation between elevation and precipitation due to the orographic effect. However, when air masses reach summits on the western edge of the mountain ranges, they might then descend and warm adiabatically before encountering another upwards slope further to the east of the same mountain range and is then lifted again. However, because air masses had dropped a significant portion of their precipitation on the western slopes of the mountain ranges, they will drop less precipitation as they travel up these slopes that are further to the east but are part of the same mountain ranges. As a result, the correlation between elevation and precipitation falters at elevations higher than 2000 m.

There is a strong negative correlation between elevation and both minimum and maximum temperatures. This can be explained by the relationship between the pressure, volume, and temperature of gases. Atmospheric pressure decreases with elevation, resulting in the same amount of heat in an air parcel being spread over a larger volume, which leads to lower temperatures.

The relationship between actual evapotranspiration (AET), biomass, and elevation can be explained by both temperatures and biomass. Initially, AET increases with elevation due to increasing vegetation biomass with elevation. As vegetation biomass increases, an ecosystem’s total leaf surface area tends to increase, allowing for increased rates of transpiration that increases AET. This initial increase in vegetation biomass is a function of temperature and precipitation: the initial decrease in temperature allows photosynthesis to increase so that plants can fix more carbon; in addition, the increase in precipitation with elevation allows for plants to have more access to water, decreasing the risk of water stress and allowing plants to have higher rates of transpiration in order to build more biomass.

The trend between AET and elevation reverses at elevations higher than roughly 1000 m. As elevation continues to increases, temperatures drop below the optimum for photosynthesis, resulting in decreased photosynthesis that leads to decreased vegetation biomass and, subsequently, decreased AET. In addition, temperatures continue to drop with elevation, which is a contributing factor in the decrease in AET with elevation.

There seems to be an initial negative correlation between runoff. This initial decreasing trend can be explained by the increase in AET from increasing biomass that outpaces the increase in precipitation with elevation. However, runoff fairly consistently increases with elevation at elevations higher than 1000 m. This increase is initially driven by an increase in precipitation with elevation due to orographic lifting and then by decreasing AET with elevation due to decreasing vegetation biomass and temperatures.

The relationship between tree death and elevation seems to match the relationship between biomass and elevation. Therefore, it would seem that tree death is proportional to vegetation biomass: as vegetation biomass increases, so does the amount of tree death.

**Make the following scatterplots and include: AET vs Biomass, Tmax vs Biomass, Precip vs Biomass**

**Explain the scatter plots**

Graphical user interface, chart, scatter chart

Description automatically generated

This plots on the left were made by plotting raw values that weren’t averaged into elevation bands, while the plot on the right was made by plotting averaged elevation band values.

There is a positive relationship between vegetation biomass and AET, as vegetation biomass is a key control of AET. As vegetation biomass increases, the number of leaves to conduct transpiration also increases, resulting in increased AET.

The positive relationship between vegetation biomass and precipitation, on the other hand, is determined by precipitation rather than vegetation. As precipitation increases, plants have more access to water, allowing for more stomata to be opened, more leaves to be built for more stomata, and longer growing seasons, resulting in higher rates of photosynthesis that leads to higher vegetation biomass.

The relationship between temperature and vegetation biomass can be explained by the effects of temperature on photosynthesis. Photosynthesis tends to have a temperature optimum and is limited at high temperatures due to photorespiration and water stress and limited at low temperatures. Because photosynthesis is the main method by which plants build biomass, vegetation biomass mimics the pattern between temperature and photosynthesis.