Homework 2

Climate Change Ecology, Spring 2015

Due Wednesday, February 18, 2015

Your name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Please answer the following questions in a different font (**like this**) to help me find your answers. You may work in a group (except where noted below), but your answers and your words must be your own. *When appropriate (here: use of information outside of Hannah textbook or lecture), cite all sources of information. Do not plagiarize.*

Please turn in a printout to me before class on Wednesday, February 18.

**I. Climate v**elocity

Download Loarie et al, Nature, 2009 (http://www.nature.com/nature/journal/v462/n7276/full/nature08649.html) and answer the below questions.

1. Conceptually, what is climate velocity? (2 points)

2. Write down the formula for the climate velocity at a given location, being sure to indicate the units of each term. (2 points)

3. Conceptually, what is the spatial gradient of temperature shown in Figure 1c? [Figure 1 contains information about how climate velocity was computed for California. You may wish to familiarize yourself with the topography of California.] (2 points)

4. Generally, where is the spatial gradient highest, and why? Lowest, and why? (2 points)

5. Where in Figure 1d is projected climate supposed warm fastest? (2 points)

6. Explain the contrast in climate velocity in the Central Valley versus in Northwest California. (2 points)

7. Figure 2 shows a global map of climate velocity. Indicate where climate velocity is high versus low, what the high and low values are (including units), and explain why. (2 points)

8. Why is climate velocity important for estimating impacts of climate change on plants and animals? (2 points)

9. Inspect Figure SPM.5 of the IPCC Fifth Assessment Report, Working Group 2, Summary for Policymakers. What groups of plants or animals are most at risk given future climate change? (2 points)

10. Loarie et al. use mean annual temperature for estimating climate velocity. Why might this not be the best measure for assessing impacts to plants and animals? (2 points)

**II. Climatic water deficit**

Use the Excel spreadsheet “CWDcalculator\_moscow\_id.xlsx” to answer the below questions. Some guidelines: a) Yellow cells are the only ones you need to change (if at all). b) The “Control” worksheet (tabs at bottom) considers the current climate; the “Scenario” worksheet is where you can change the climate. c) Many of the columns and rows are for calculation and don’t need to be inspected; see “Variable Descriptions” worksheet. d) “Daylength” worksheet is for calculation only (do not change). e) The second year is the year you should pay attention to because the calculation of soil moisture is better then.

A. Given the current climate in Moscow, ID (the state of the spreadsheet without you making any changes), inspect the cells in the “Control” worksheet and the graphs to answer the following:

11. When (what month) is the peak of water supply? (2 points)

12. When (what months) is there a positive climatic water deficit? (2 points)

13. For which growing season months (which variable corresponds to growth?) is there no deficit? (2 points)

14. Explain why CWD occurs when it does by invoking water supply, PET, and AET. (2 points)

15. Sum the annual CWD in the second year by either a) highlighting the appropriate cells and noting the “Sum” at the bottom of the window or b) in another cell, adding a “Sum” function of these cells. Do the same for AET. What are these values (units are mm)? (2 points)

16. From the Stephenson (1990) figure in the lecture Powerpoint file that plots plant formations on “annual deficit” and “annual AET” axes, what plant formation corresponds to your summed AET and CWD from the previous question? Does this seem about right given what you know about Moscow? (2 points)

B, Assess how climate change will influence the water balance terms by changing values in the “Scenario” tab. For each of the scenarios below:

* copy and paste the new graph below,
* describe important changes in the graphs,
* list what the summed AET and CWD values are and differences with the control scenario,
* describe what changes in the expected plant formations are, if any,

Excel hint: use a formula like “=Control!B2+3” for Scenario!B2, then drag the small square in the lower right corner of the highlighted cell to C2, then drag small square of highlighted B2 and C2 to B13 and C13. This is a quick way of apply the same formula to a set of cells.

17. Scenario 1: year-round warming (both MAXT and MINT of all months) of 3 deg C. (5 points)

18. Scenario 2: change in precipitation only based on expected changes in the Pacific Northwest: a 5% increase in all months except June/July/August, which will have an 8% decrease. (5 points)

19. Which effect is strongest of the two Scenarios? (2 points)

C. The Western Governors’ Association wants your help in estimating changes in natural resources given future climate change. Calculate the water deficit and estimated plant formation for a climate station of your own choosing in a much different place in the western US that represents a different vegetation type. Ensure you have a different one from your classmates by not working together.

20. Pick a station from http://www.wrcc.dri.edu/climatedata/climsum. Fill in the appropriate latitude. What station did you pick? What is its latitude? Use Google maps to estimate the dominant plant formation (i.e., based on satellite imagery). (3 points)

21. Copy the monthly means of MAXT, MINT, and precipitation into a separate copy of the spreadsheet. Copy the resulting water balance graph from the spreadsheet below. What is the plant formation based on AET, CWD, and the Stephenson figure using current climate? (5 points)

22. Determine climate changes for this location from http://www.climatewizard.org. Specify “End of Century”, the “High A2” emissions scenario, and the GCM “Ensemble Average”. Describe them here. (3 points)

23. Include these changes in climate in the “Scenario” worksheet. How does annual AET and CWD change following this expected climate change? Copy the resulting graph below. How does future climate change modify this? (5 points)

**III. Niches and climate change**

24. Consider a hypothetical animal species that prefers warm, wet conditions. Draw a two-dimensional diagram (temperature on the x axis from “cold” to “hot”, precipitation on the y axis from “dry” to “wet”) that indicates the fundamental niche space occupied by this species. (2 points)

25. Draw a hypothesized polygon indicated a possible realized niche of this species. (2 points)

26. Given expected warming, how will the physical locations associated with the species’ current fundamental niche change? In other words, what space will the current locations occupy in the future (draw another polygon on the niche diagram)? On your diagram, indicate areas that are newly available for this species to migrate into as well as areas that will become unsuitable for this species. (3 points)