L&S/ESPM C46 Climate Change & the Future of California
ASSIGNMENT 4. Water balance, conservation, rangelands. (Ackerly, Silver)

Due Date: Monday, April 11, 2016

All items in bold require answers!

1 (2 pts).

In class I illustrated water balance graphs for the calendar year, from January to December. In California, it is conventional to work with 'water years', which start October 1 (about when the rains begin) and run through September 30 (the end of the following summer). 10/1/14-9/30/15 is referred to as the 2015 water year (or WY15). The data below is shown for water years – you can apply the concepts that were discussed in lecture exactly the same way, just do the calculations from October through September.

Table A shows the terrestrial water balance for Yosemite Valley (1220 m elevation) in Yosemite National Park. These are the average values for each month, for the period 1981-2010. In climate science it is common to work with thirty year averages like this, as they even out El Niño cycles and other shorter term phenomena, helping us see long term trends.

Table B shows the data for the 2015 water year, the fourth year of the recent drought.

All values in the tables are in mm.

1a. **For each table, calculate the following, summing over the entire year (and show the answers in the bottom row of the table):** total precipitation (PPT), total potential evapotranspiration (PET), climatic water deficit (CWD), annual evapotranspiration (AET), and hydrologic surplus (S). (Remember that these calculations assume there is no water storage in soils – this makes CWD higher and AET lower than would actually be observed in the ecosystem).

On a separate sheet, plot the data (by hand, or using excel or another program), with 1981-2010 on one plot and WY2015 on another. Indicate the PPT and PET curves, and the areas beneath or between the curves that represent AET, CWD and S.

2-3 sentence short answer: In the 30 year average data, what percent of rainfall is used in AET? How about in WY2015. Based on these results, would you expect the drought to impact plant growth or river flows more?

A. Yosemite Valley (1981-2010)

Month	PPT	PET	AET	CWD	S
Oct	64	68			
Nov	117	30			
Dec	159	18			
Jan	175	21			
Feb	175	36			
Mar	142	68			
Apr	73	100			
May	47	135			
Jun	13	153			
Jul	7	166			
Aug	3	145			
Sep	15	110			
TOTAL					

B. Yosemite Valley (2015)

Month	PPT	PET	AET	CWD	S
Oct	0	75			
Nov	76	49			
Dec	144	25			
Jan	4	37			
Feb	85	44			
Mar	16	79			
Apr	68	104			
May	31	135			
Jun	7	165			
Jul	42	167			
Aug	0	150			
Sep	2	116			
TOTAL					

1b. Now let's look at a couple hypothetical situations that did not actually happen but will help answer the question of how much the reduced flows (i.e. Surplus) were due to lower rainfall vs. higher PET. In Table C, copy the 1981-2010 PPT and the 2015 PET. In Table D, copy the 2015 PPT and the 1981-2010 PET. Now recalculate AET, CWD and S for each situation.

How much does surplus decline due to 2015 PET alone, when combined with historical rainfall. Calculate the decline based on this scenario compared to historical data (give results in mm): _____

How much does surplus decline due to the 2015 rainfall alone, compared to historical: _____

How much did surplus actually decline in 2015 vs. historical: _____

C. Yosemite Valley (1981-2010 PPT, 2015 PET)

Month	PPT	PET	AET	CWD	S
Oct					
Nov					
Dec					
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
TOTAL					

D. Yosemite Valley (2015 PPT, 1981-2010 PET)

Month	PPT	PET	AET	CWD	S
Oct					
Nov					
Dec					
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
TOTAL					

2 (2 points)

2a. Write a short paragraph (200-300 words) explaining the contribution of changing rainfall vs. warming temperatures to reduced water supplies, and the implications for the future of water supplies in California. For this paragraph, you can use all the technical terms and abbreviations from the water balance tables.

2b. Write another short paragraph (200-300 words) with a lay audience in mind (as if you were writing for the SF Chronicle or a blog site) that explains the same concepts, but uses only everyday language and ideas. You can use 'rainfall', 'heat', 'temperature', 'evaporation', 'stream flows', etc. but not the terms or abbreviations for PET, AET, CWD, and Surplus.

3 (2 pts).

Imagine that the California State Legislature is considering legislation to prohibit assisted migration of tree species. The legislation is being promoted by preservationists who believe that assisted migration is an inappropriate intervention by people in natural processes. You are an editor at the Sacramento Bee. Write an op-ed piece for the newspaper stating your opinion of this legislation, with a recommendation in favor or against passage by the legislature. Your audience would be legislators, their staff, and the general public who may weigh in and make their opinions known, so you want to explain your position and the reasoning behind it. Maximum 500 words.

4 (1 pt). Do this question after lecture on Wednesday 4/6

There are approximately 23 million hectares of rangeland in California. Using the 2013 California Greenhouse Gas Inventory, determine what percent of this area would need to be managed for carbon sequestration at a rate of 1 MT C/ha/y to offset 50% of the states agricultural emissions.

Useful information:
Emissions inventories: http://www.arb.ca.gov/cc/inventory/data/data.htm
3.66 MMT CO2e = 1 MMT C