**Macro-ecology: Drought**

**Title: California Drought - how bad is it?**

**Objective: Drought effects on natural and agricultural ecosystems: Implications for water, carbon, and people.**

**Main message** – carbon sink strength is down, water flow is down, crop yield is down and associated planning and development markets need to respond in a timely and proactive manner.

Assessment of impacts of current drought of utmost importance to land and freshwater planning and management in CA. Need to understand extent and impacts to respond in a way that mitigates impacts on people and nature.

**INTRODUCTION**

1. **Drought in global context**
   1. Definition (from Mishra & Singh 2010).
      1. ‘drought means a sustained, extended deficiency in precipitation’ (WMO, 1984)
   2. 5 types of drought (meterological – lack of rainfall; hydrological – geology major influence; agricultural drought; socio-economic drought, groundwater drought)
   3. Most severe of all 20th century hazards exacerbated by climate change and increasing water demand, but least predictable and least explored of all natural hazards (Mishra & Singh, 2010).
      1. Severe droughts on all major continents with documented ecological and socio-economic impacts.
         1. 10% of U.S. experienced severe drought over last century (National Climate Data Center, 1992) – most costly natural hazard.
   4. Occurrence is complex – positive feedback mechanisms (reduced soil moisture 🡪 reduced humidity)
2. **Drought Impacts – water, carbon, and people**
   1. Water resources
   2. Carbon
      1. N.American 2000-2004 drought reduced carbon sink from 30-298 Tg C/year (Schwalm et al., 2012).
   3. Socio-economic impacts
      * 1. In terms of people affected, most important natural hazard (economic impacts, displacement etc.) (Mishra & Singh, 2010)
        2. Water resources and carbon – ecosystem service components
        3. Crops – clear that future droughts threaten climate-sensitive economic sectors (e.g. Agriculture)(Mishra & Singh, 2010); important to understand impacts at multiple scales to reduce vulnerability.
   4. Assessment of impacts of droughts of utmost importance to land and freshwater planning and management; Because of large-scale characteristics, should be studied in a regional-context (Mishra & Singh 2009)
   5. Ecosystem and land use types will respond differently – important to understand different impacts (Wolf et al., 2013)
3. **Drought in CA**
   1. Context:
      1. CA in its third driest year of 106 on record and agricultural, urban, and envt’l water needs are increasing (Howitt, Medellín-azuara, & Macewan, 2014)
      2. 80% of State in extreme to extraordinary drought and 100% in severe drought or worse.
      3. Jan 17, 2014, Gov. Brown declared a Statewide drought emergency, and protection of San Joaquin River Delta; major reductions in water allocations.
      4. Decreased water availability by 6.6 million acre feet per year compared to an average year
      5. Greatest reduction in water availability to agriculture ever seen.
      6. Statistically, expected to continue into 2015

**Research Questions**

What are the spatial and temporal dynamics of the current drought?

How much has the carbon sink strength been reduced by the current drought?

Are natural systems more resilient than agricultural systems to drought?

What are the impacts of drought on ecosystem services?

**Methods:**

How severe is the current drought in CA? We plan to synthesize ecosystem CO2 dynamics and remotely sensed indices to frame the severity of the CA drought.

1. How bad is current drought? How do drought patterns vary in space and time?  
   What is the spatial and temporal dynamics of drought?  
   *map drought*  
   data: 1895-2000  
   ecoregions - *need to find the shapefiles*  
   pdsi - <http://www.wrcc.dri.edu/wwdt/time/>  
   <http://www.cgd.ucar.edu/cas/catalog/climind/pdsi.html>  
   Analysis - trend analysis  
   Antonio, Paul
2. How much has C sink strength been reduced by the current drought?  
   MODIS data EVI - Enhanced Vegetation Index and LST - Land Surface Temperature - 1Km resolution, GPP  
   FluxNet (flux files 4 sites: water and CO2 grams of carbon/m-2)  
   determine sink or source of carbon to the atmosphere over time  
   Mirela, Antonio, Paul, Sparkle
3. Are natural ecosystems more resilient than agricultural ecosystems?  
   *Quantify (map) resilience  
   Compare resilience between agricult vs natural ecosystems*  
   To be determined - differentiate different ecosystems categories  
   RUE - Rain Use Efficiency (NPP - Modis/rainfall - PRISM)  
   NPP annual, GPP every 8 days, rainfall monthly  
   PRISM, rainfall maps from ca.gov  
   How does the ratio of crop yield to irrigation water change? Sara, Mirela, Tim, Leah, Debora
4. What are the effects of drought on ecosystem services? *How much ground water levels changed as a consequence of drought?* look at streams data from USGS to see if it has diminished; crop data

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