

Moderating Climate Change with Soil Carbon Management

CARBON CYCLE INSTITUTE MARIN CARBON PROJECT



INTRODUCTION

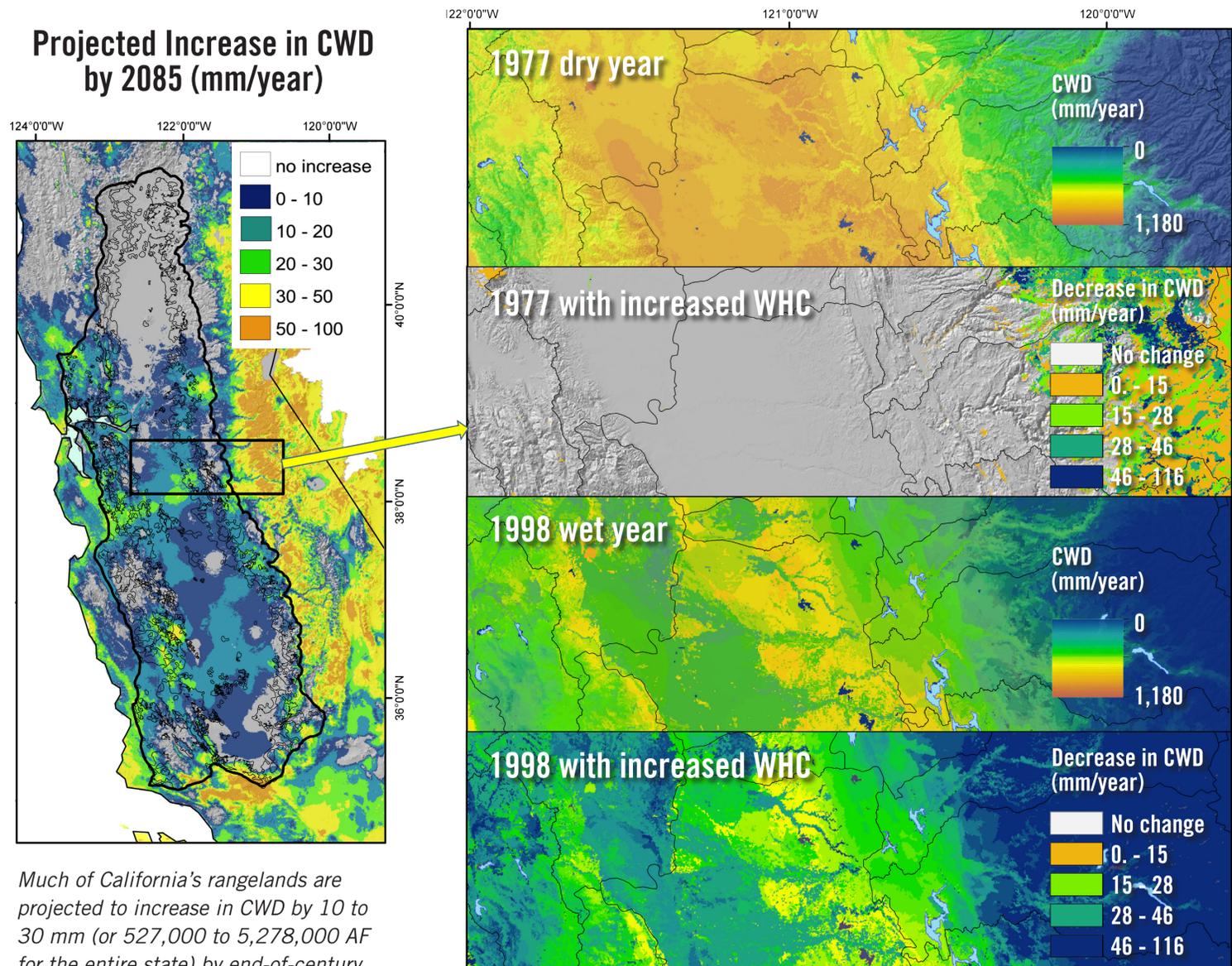
- Climate change is ongoing with changes in weather patterns and increases in extreme events, such as the current California drought.
- Biosequestration removes carbon from the atmosphere and stores it in plants and soil, increases soil water holding capacity, increases net primary productivity, and enhances other ecosystem services.
- Marin Carbon Project (MCP) research showed increases in soil water holding capacity (WHC) associated with topical applications of compost.
- The 25% WHC increase modeled here is based on first year increases in soil carbon on MCP treatment plots. (Ryals, R and W. Silver, 2013. Ecological Applications, 23(1), pp. 46–59).
- Composting is a particularly powerful biosequestration strategy due to both the avoidance of methane production by diversion of organic materials away from anaerobic decomposition in landfills and manure lagoons, and through enhanced NPP resulting from soil quality improvement following compost application. (DeLonge et al, 2013, Ecosystems 16: 962–979).

CLIMATE CHANGE AND HYDROLOGY

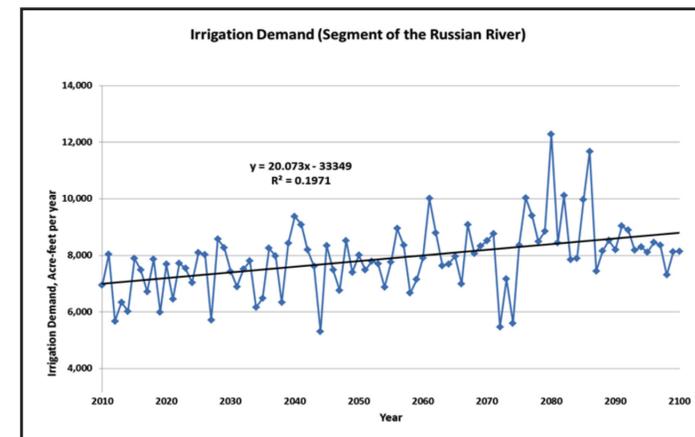
- The hydrologic impacts of climate change include changes in water availability and increases in demand for water.
- This translates into environmental stress that relates to wildfire, forest die-off, desertification, and loss of riparian zones and groundwater.
- Climatic water deficit is a key indicator of landscape stress.

CLIMATIC WATER DEFICIT (CWD)

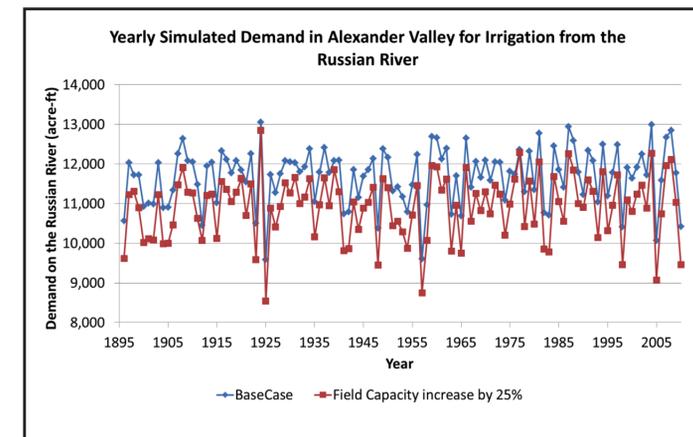
- Annual evaporative demand that exceeds available water
- CWD = potential – actual evapotranspiration
- Defines the level of hydroclimatic stress on the landscape
- Integrates climate, energy loading, drainage, and available soil moisture storage and addresses irrigation demand



Much of California's rangelands are projected to increase in CWD by 10 to 30 mm (or 527,000 to 5,278,000 AF for the entire state) by end-of-century.



CWD has been shown to correlate to irrigation demand in the Russian River's Alexander Valley. Projections indicate a potential increase in demand of nearly 2,000 ac-ft/yr by the end of the century.



If we increase water holding capacity of the soil by 25%, we reduce CWD and correlated losses due to demand from the Russian River by approximately 6.6% or 776 AF/year.

Climatic water deficit is shown for a wet year, 1998, and dry year, 1977, for a slice across the Central Valley and up into the Tuolumne River basin. Also shown is the change in CWD when soil water holding capacity is increased by 25%. Whereas in a dry year compost only contributes to reducing CWD in relatively shallow soils (because there isn't enough precipitation to fill the increased WHC in deeper soils), in wetter years all soils see a big decrease in CWD due to filling of soils including the increased WHC. Thus, all else being equal, benefits of increased WHC accrue primarily in shallower, non-irrigated soils in drier years. In addition, when rainfall occurs in less frequent, more intense events, as expected in CA under climate change scenarios, the effects of increased soil organic matter, including increased rates of infiltration, increased pore space, and increased hydraulic conductivity, result in the capacity to absorb and hold more rainfall, and sustain the landscape through the season.

IMPLICATIONS AND NEXT STEPS

- Climate change is likely to reduce the extent and productivity of both rangelands and arable lands due to increases in climatic water deficit.
- Increases in evaporative demand and irrigation demand will reduce groundwater and surface water availability.
- Increases in soil water holding capacity and infiltration rate can increase ecosystem resilience by reducing the climatic water deficit, increasing productivity and available water, and helping to compensate for changing climatic conditions, including drought, increased rainfall intensity, and decreased rainfall predictability.
- Amendments of compost to rangelands can sequester carbon in soils, mitigate greenhouse gas emissions and increase soil water holding capacity and infiltration rate.
- Sensitivity analyses can help identify soil types that may benefit the most from strategic soil management and addition of compost.
- Local experimentation is needed to provide confidence in the mapping of climatic water deficit and changes due to compost amendments.
- These quantification and mapping methods can be applied to regions, river basins, or continents.