Projecting the Effects of Climate Change on Local Surface Water and Groundwater Supplies

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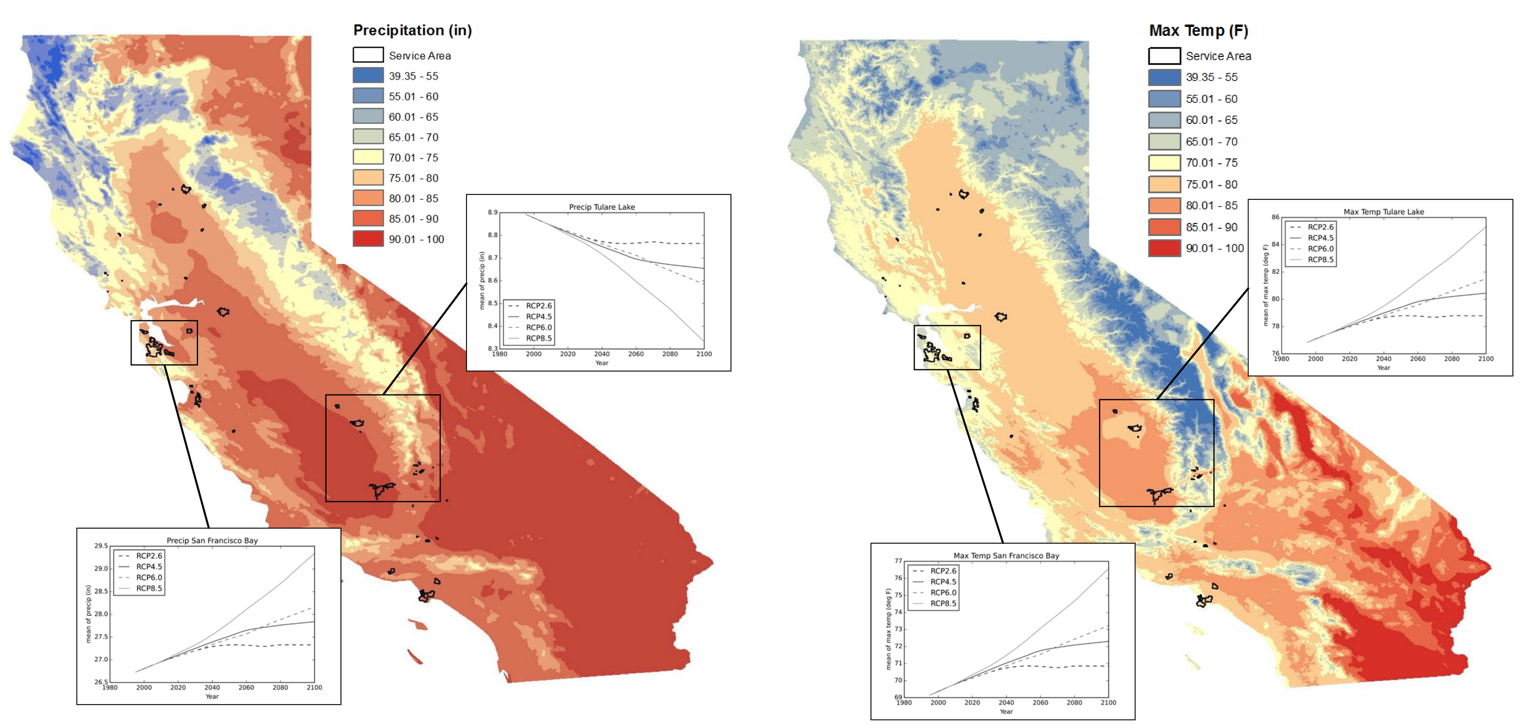
Background and Motivation

Max Temp. and Annual Precip Projections, 2050, RCP 8.5

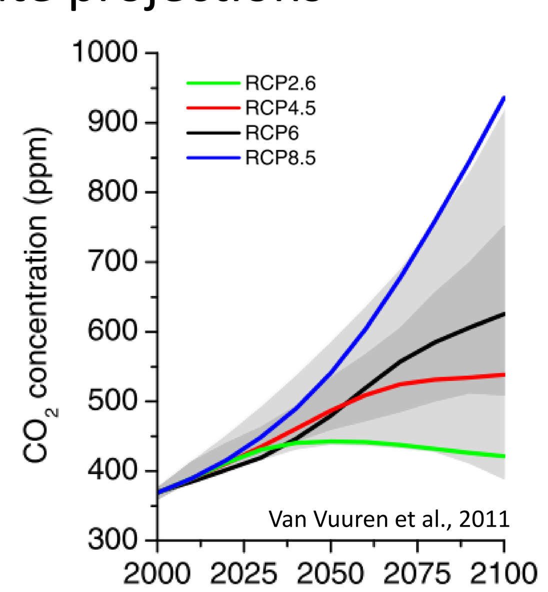


Question: What does climate change mean for water supply and availability?

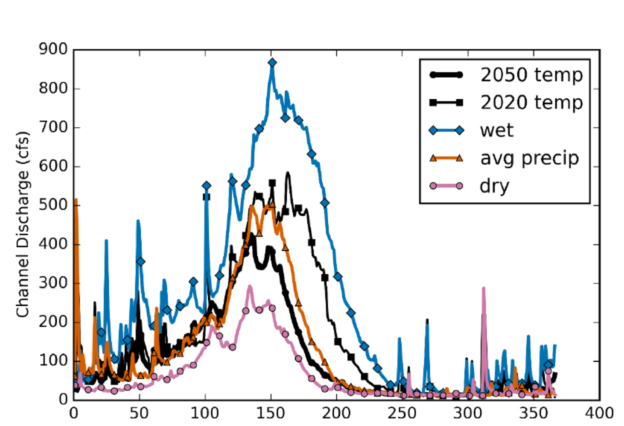
Methodology

Dataset: SimCLIM downscaled climate projections

- IPCC CMIP5
- Published in 2013
- Downscaled to ~1km x 1km cells
- Ensemble average of all 40 GCMs
- Rep. Concentration Pathways:
  - Best Case: RCP 4.5
  - Worst Case: RCP 8.5

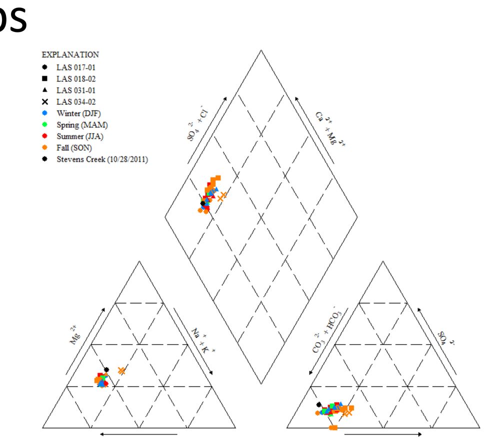


Projecting Surface Water Supplies



- Historical Record into "wet", "avg", "dry" years
- Scale total annual discharge w/precip projections
- 1st order temp adjustment for snow-melt system:
  - Use hydrograph from hist year w/ similar temps

Projecting Groundwater Supplies



Step 1: Determine source of recharge
- Local Geology and Geography
- Groundwater Chemistry
- GAMA reports, Bulletin 118, UWMP, etc

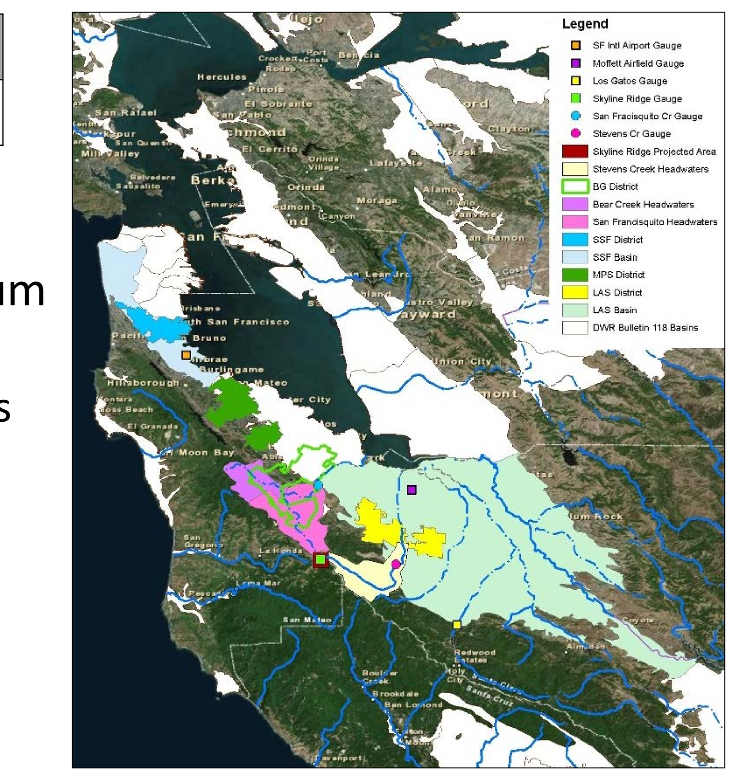
Step 2: Calculate Recharge from Direct Precip
- Water Budget (incl. Precip, ET, Soil Moisture Storage)

Step 3: Apply Surface Water results to Channel-zone recharge est.

Final Product: Estimated change in groundwater recharge

San Francisco Bay Area

District	Local Surface	Groundwater
Los Altos	~5%	30%



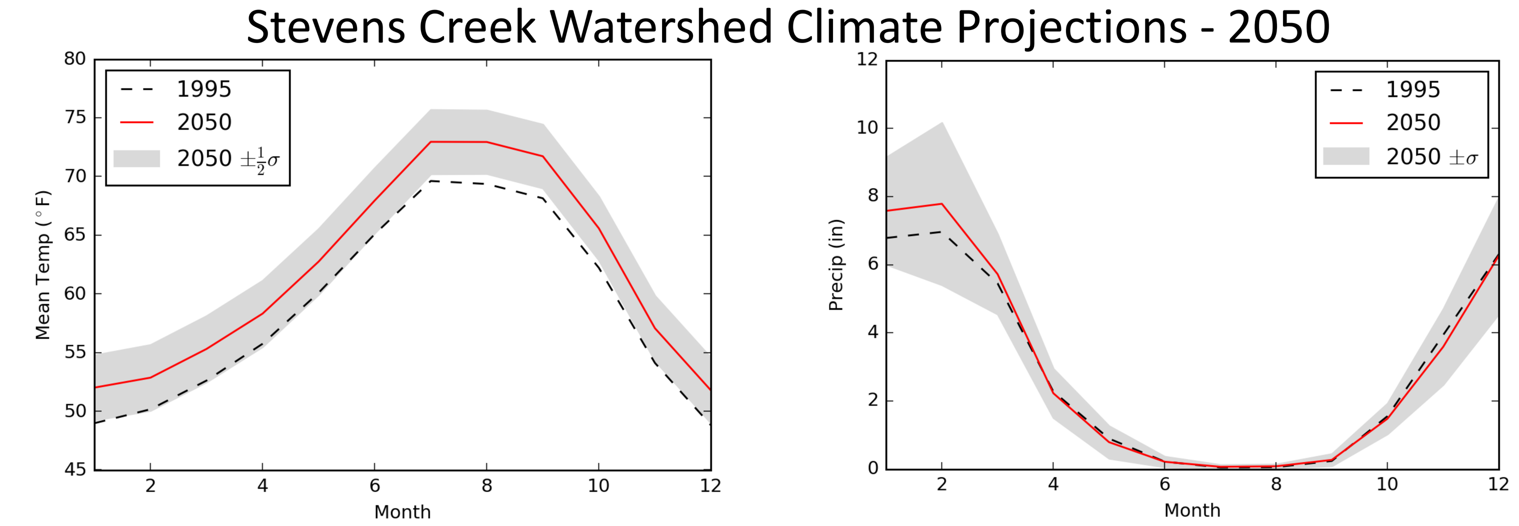
Geology:
- Santa Clara Formation/younger alluvium
  - Primarily unconsolidated sediments
  - 70% impervious cover, with A, B, C soils

Recharge from:
- Channel-zone recharge (west)
- Artificial recharge at spreader dams, percolation ponds, gravel pits, etc.
- Deep percolation from landscape irrigation
- Direct precipitation

Recharge Source	Percent
Managed - Purchased	35%
Managed – Stored Local Water	15%
Natural Channel-Zone	25%
Direct Precip	10%
Deep Percolation	15%

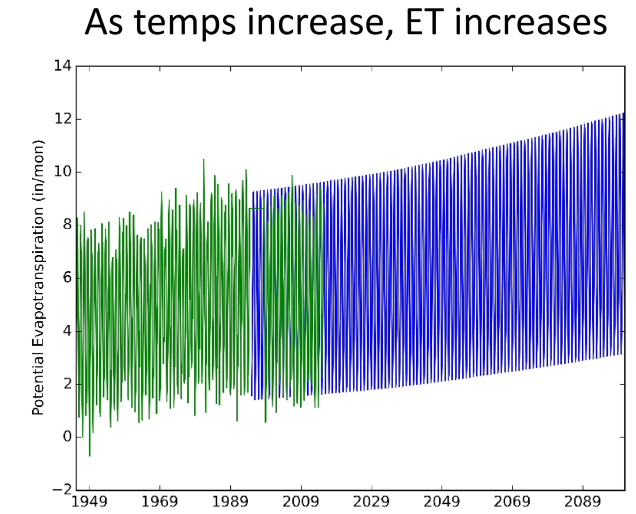
Climate data projects:
- Warmer temps in South Bay Area
- Similar annual precip, but shifted timing

Stevens Creek Watershed Climate Projections - 2050

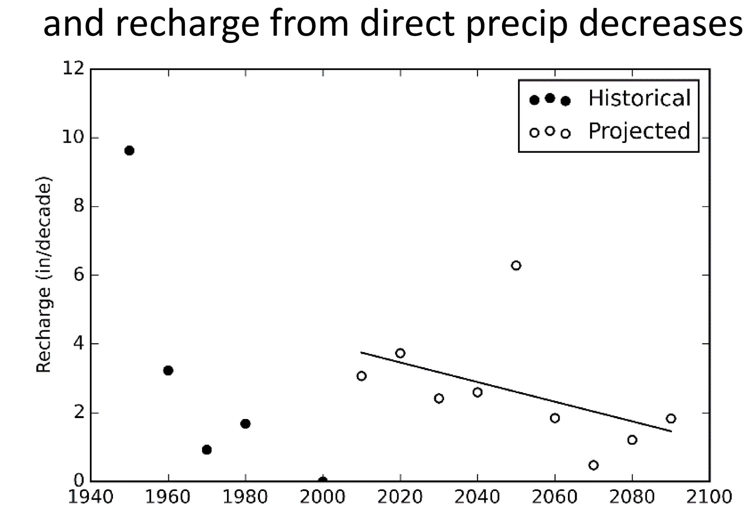


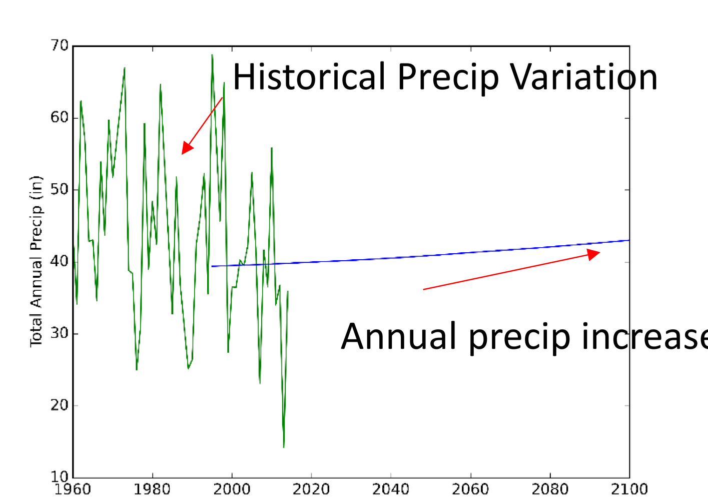
Groundwater supply projections

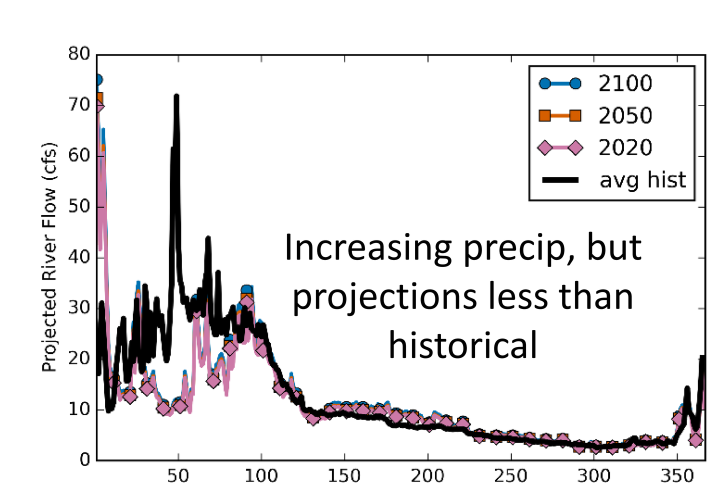
As temps increase, ET increases



and recharge from direct precip decreases



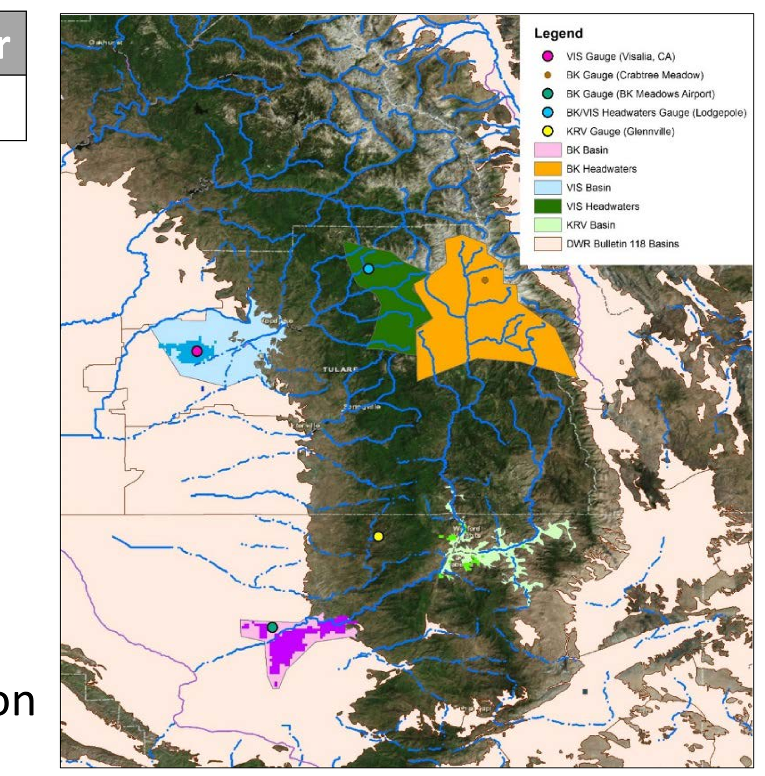




In SF Bay Area, timing of precip and temp increases first order water supply factors

Bakersfield

District	Local Surface	Groundwater
Bakersfield	17%	64%



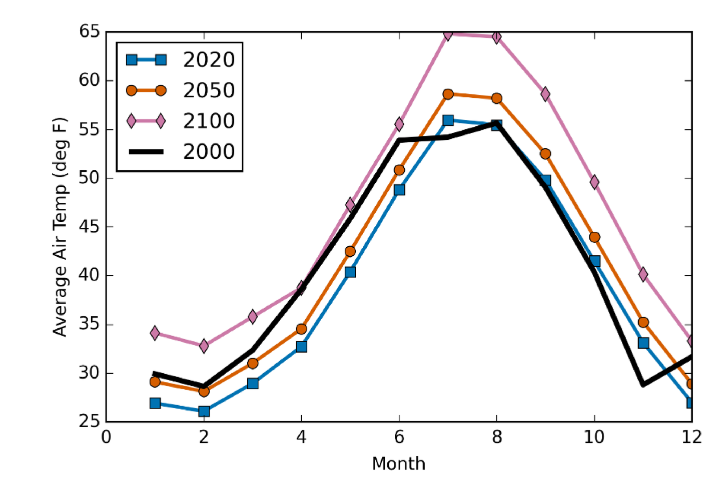
Geology:
- Kern River Formation
  - Poorly sorted silt, sand, gravel
  - Most soil type A or C

Recharge from:
- Kern Water Bank
- Channel-zone recharge (east)
- Deep percolation from ag.

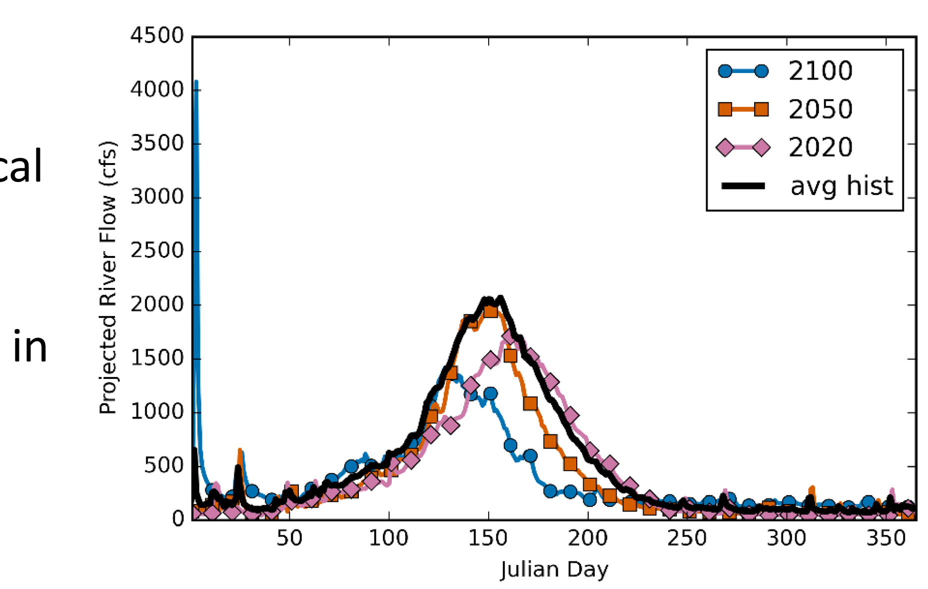
Too hot/dry in BK for direct precipitation

Climate data projects:
- Warmer temps in BK and Sierras
- Decrease in precip in wet months

Recharge Source	Percent
Natural Channel-Zone	80%
Direct Precip	0%
Deep Percolation of ag/urban	20%



Projected temps in Kern R headwaters similar to historical years:
- 2020: 1978 – 1980, 2010 – 2011, etc
- 2050: 1972 – 1974, 1984 – 1988, etc
- 2100: 1989, 1990, 200, 2004, 2012, etc



Hydrograph shape is avg. historical hydrograph with similar temps

Total discharge scaled by change in estimated runoff

By 2100:
- Overall decrease in runoff by up to 12% (worst case, RCP 8.5)
- Significant shift in timing of snowmelt (earlier) as temps increase
- Groundwater recharge will similarly decrease:
  - Channel-zone recharge largest source of recharge, likely decreases with surface water supply
  - Deep percolation of ag/urban runoff will likely decrease as watering becomes more efficient

Other considerations for Climate Change analysis on water supply include:
- Seasonal variability in precip (larger events, more runoff, less recharge?)
- Inter-annual variability (droughts, and wet periods)
- Changing groundwater elevations with climate

References

van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., … Rose, S. K., 2011, The representative concentration pathways: An overview. *Climatic Change*, *109*(1), 5–31.

Potential climate change impacts on the water supplies of California water service, January 2016, prepared by Gary Fiske and Associates, Inc., and Balance Hydrologics.