Quantifying Climate Change Impacts to City of Santa Barbara Water Supplies

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1 ABOUT THE PROJECT

The City of Santa Barbara relies on local surface water from Lake Cachuma and Gibraltar Reservoir, located in the Santa Ynez River (SYR) watershed. The City is interested in understanding potential impacts of climate change on water held in these reservoirs to help inform the Long Term Water Supply Plan with a time horizon out to 2050. This analysis provides a range of potential variations in streamflow for the SYR watershed, and therefore inflow to the reservoirs, from 2020 to 2058.

Photo Credit: City of Santa Barbara Public Works

2 OBJECTIVES

1. *Analyze* historical Santa Ynez River watershed reservoir supply
2. *Model* historical Santa Ynez River watershed streamflow
3. *Simulate* climate change impacts on future local reservoir supply

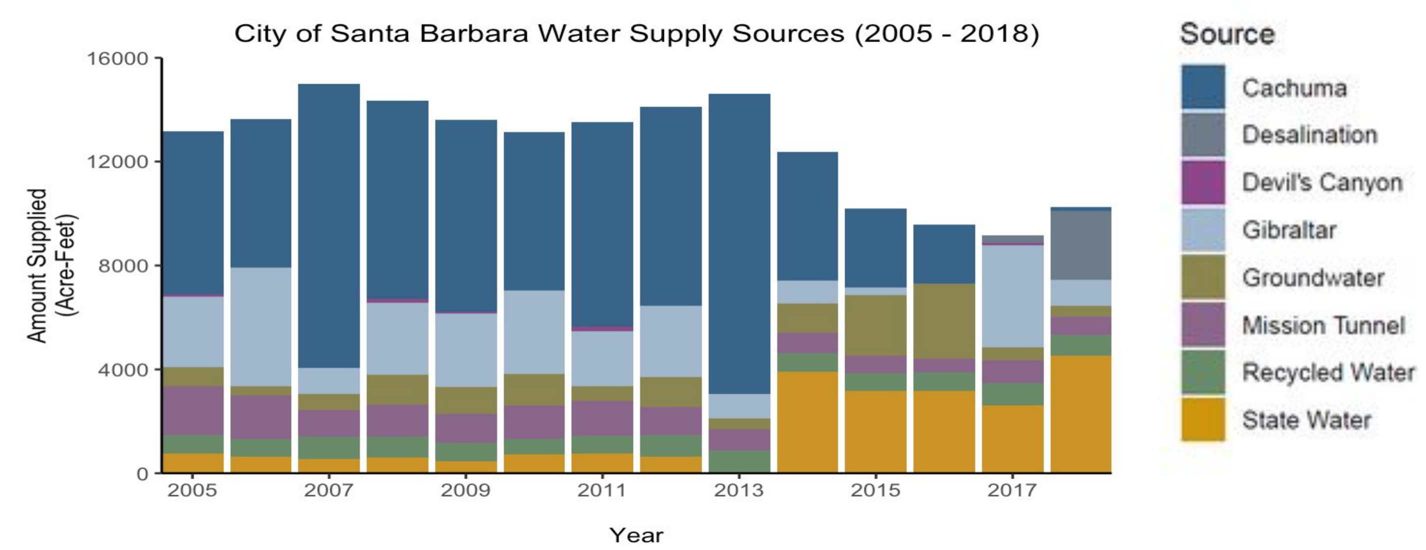
KEY FINDINGS

Average streamflow into Lake Cachuma could decrease by up to 40%.

Other climate models simulate ± 20% average streamflow and up to a 20% increase in streamflow contribution to Lake Cachuma.

3 WATER SOURCES

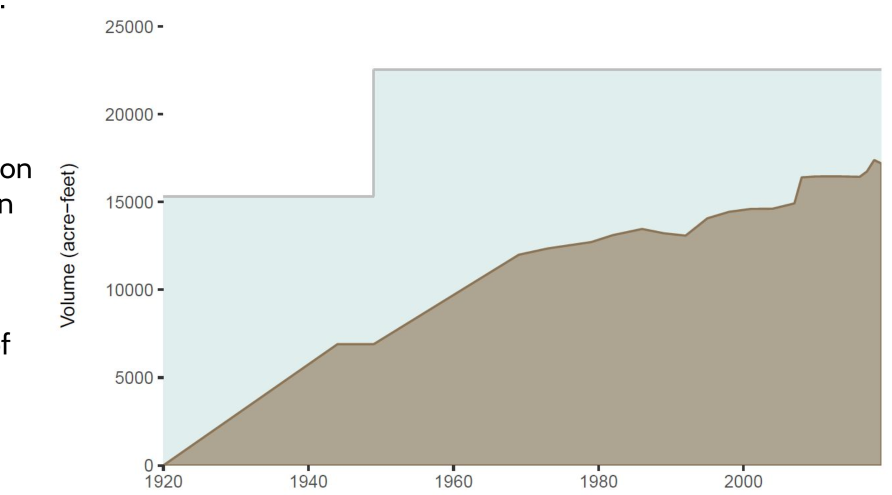
The City has six main water sources that include: surface water from Lake Cachuma, Gibraltar Reservoir, and the State Water Project, groundwater, desalination, and recycled water. In extended drought periods the City relies mainly on the State Water Project, desalination, and groundwater to supplement low surface water supplies. The latest drought substantially reduced water supplied from Lake Cachuma to the City (2014 - 2018). Given that the City relies predominantly on surface reservoirs during non-drought years, it is critical to anticipate and plan for potential future climate change impacts on these water sources.



4 RESERVOIR SEDIMENTATION

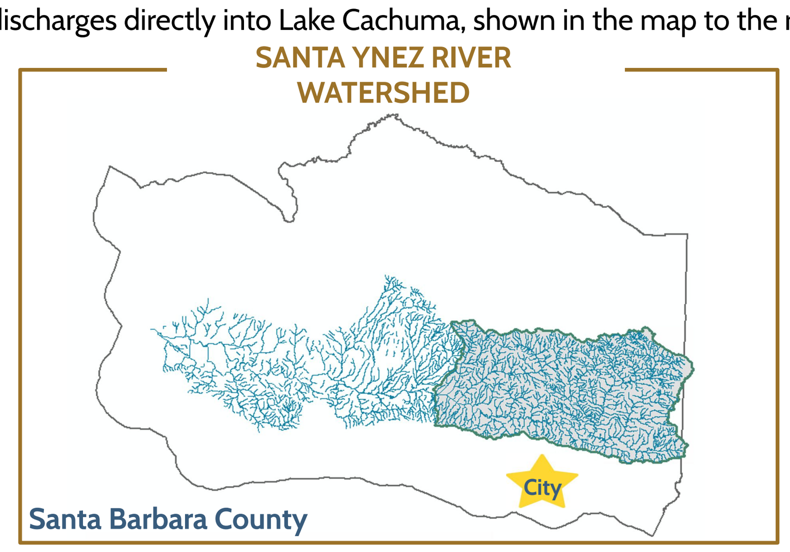
The frequency and intensity of wildfires in California are projected to increase as a result of extended dry periods.[1] Rain events following wildfires can exacerbate sediment transport. In the SYR watershed, sedimentation reduces storage capacities of the reservoirs, mainly in the upstream Gibraltar Reservoir.

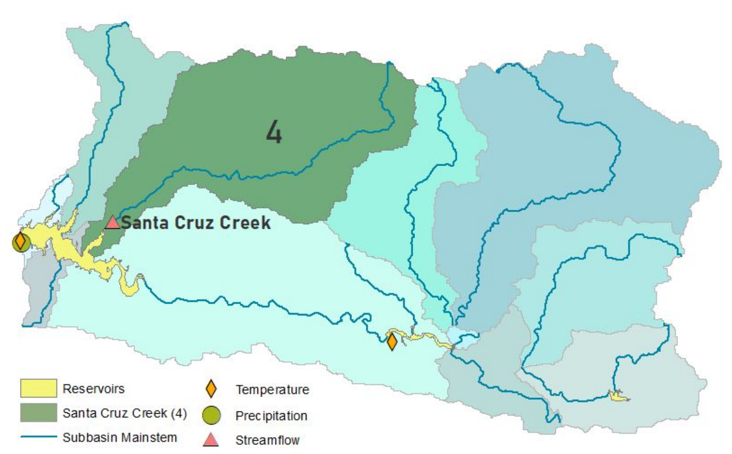
Gibraltar Reservoir Capacity (right): Historical sedimentation in brown and water storage in blue, indicating decreasing water capacity in Gibraltar Reservoir.The solid grey line indicates the total capacity of the reservoir from 1920 to 2019.



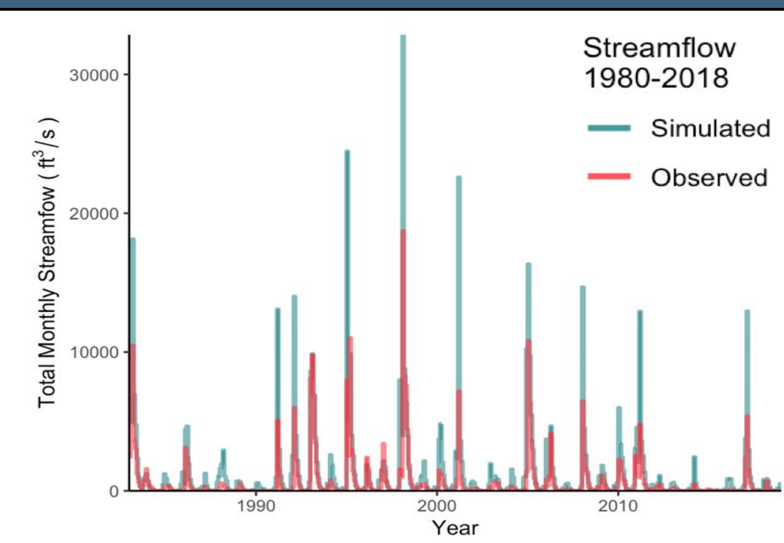
5 MODELING APPROACH

The Soil & Water Assessment Tool is used here to model potential impacts of climate change on upper SYR watershed streamflow. The model was set up using historical precipitation and temperature measurements from 1980 to 2018. To determine how accurately the model reflected SYR watershed streamflow, simulated and historical streamflow was compared for Santa Cruz Creek (SCC), a tributary that discharges directly into Lake Cachuma, shown in the map to the right.





Upper Santa Ynez River Watershed: *Above:* Precipitation, streamflow, and temperature stations used to model Santa Cruz Creek streamflow. *Left:* SYR watershed held within Santa Barbara County and north of the City (⭐).



Model Calibration (left): Monthly simulated and historical (observed) streamflow at Santa Cruz Creek from 1980 - 2018.

The model was adjusted to simulate streamflow in line with Santa Cruz Creek hydrology. While simulated was consistently higher than observed streamflow, the model correctly predicted the timing of storm flows. This alignment indicates the model appropriately reflects hydrologic processes in the SCC watershed. With the ability to replicate SCC flows relatively well, changes to temperature and precipitation could then be incorporated to simulate the range of potential impacts to streamflow from climate change.

6 CLIMATE CHANGE

Photo: Lake Cachuma, City of Santa Barbara

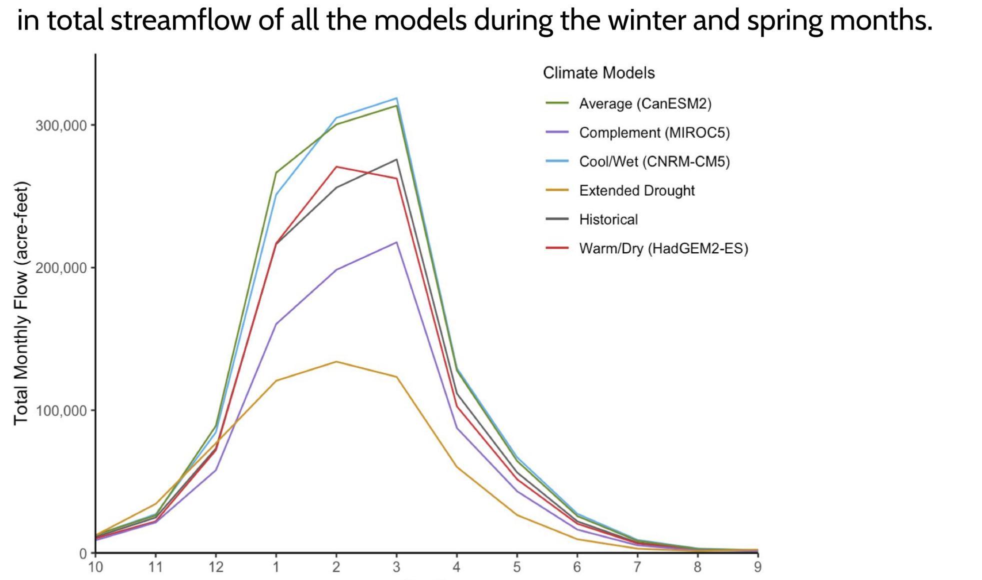
Five different climate models from Cal-Adapt, a climate data platform and adaptation planning tool, are used to represent the range of possible conditions for the high-emissions scenario (RCP 8.5) for 2020 - 2058. **The following scenarios are represented in this analysis:**

- Warm | Dry
- Cool | Wet
- Average
- Complement
- Extended Drought*

*Extended drought is considered an unlikely yet **high consequence scenario.** It is important to evaluate and understand.

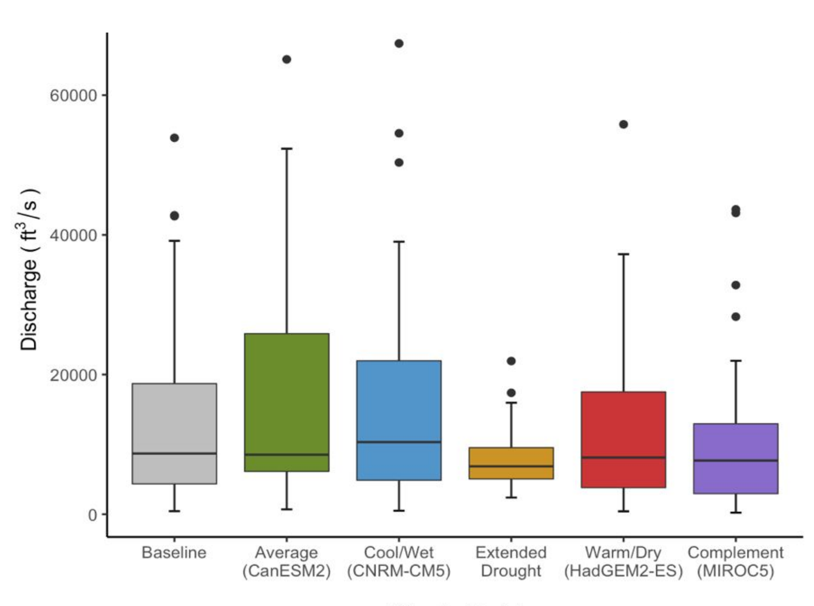
7 RESULTS

Seasonality. The timing of streamflow has important implications for water availability throughout the year. The climate models used in this analysis project both increases and decreases in monthly streamflow as well as potential shifts in the timing of streamflow. The *cool/wet* and *average* models project increases in streamflow, while the *complement* and *drought* models project a decrease in streamflow. The extended *drought* model projects a slight increase in streamflow during the fall and early winter and the largest decrease in total streamflow of all the models during the winter and spring months.



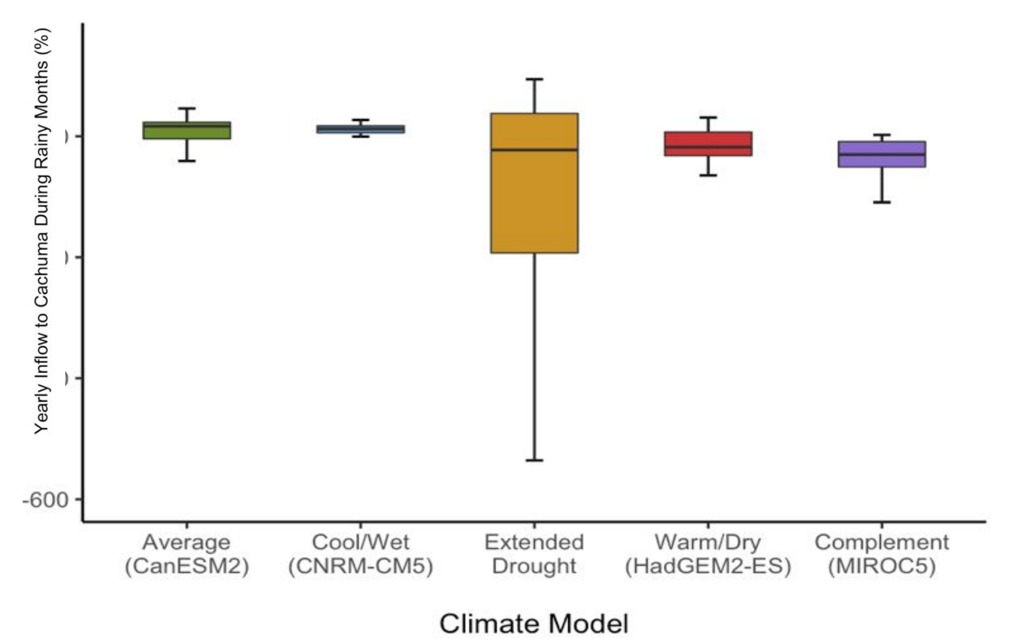
Modeled Streamflow: Total monthly streamflow for each model and historical streamflow across a water year, which begins in October (1980 - 2058).

Streamflow. Projected changes in streamflow from 2020 to 2060 indicate a wide range of possibilities. The extended *drought* model projects the lowest median discharge (6,860 ft³/s) and a ~40% reduction from the historical baseline. The *cool/wet* model projects the highest median (10,327 ft³/s) and a ~20% increase from the historical baseline. Additionally, the *drought* model displays the least amount of variation in streamflow.



Streamflow Statistics: Range of projected streamflow for the five climate scenarios compared to the baseline (2020 - 2058).

Inflow. This analysis estimated potential upper SYR inflows to Lake Cachuma under different climate scenarios. Considering the 25th percentile, or boxplot lower borders, the *extended drought* model projects up to a 200% reduction in streamflow contribution to Lake Cachuma. The other models project a potential increase of streamflow contribution ranging from 0 to 20%. This extreme range of possible futures is representative of the uncertainties presented by climate change and its localized impacts.



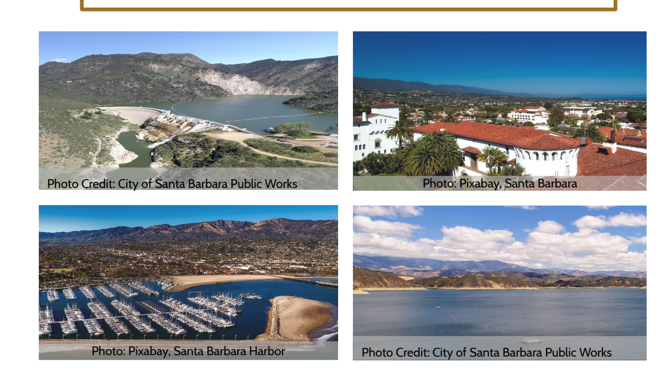
Cachuma Inflow: Projected percent change of the SYR contribution to Lake Cachuma for 2020 - 2058, in comparison to the simulated baseline streamflow for 1980 to 2018.

8 CONCLUSIONS

1. Preparing for potential reservoir supply limitations and increased future demand, necessitates flexibility in the water portfolio.
2. The non-drought climate models anticipate a wide range of average yearly streamflow from -40% to +20% compared to historical flows.
3. The drought model indicates average streamflow contribution to Lake Cachuma could decrease by two-fold.

SEDIMENT

Gibraltar Reservoir has acted as a sediment trap in the upper SYR watershed for nearly 100 years. As water storage capacity reaches 0, downstream Cachuma Reservoir may experience increased sedimentation.



Climate change impacts to Santa Ynez River watershed streamflow are variable. Understanding implications of an extended drought will help the City of Santa Barbara strategize use of their diverse water supply sources.

ACKNOWLEDGEMENTS

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References: [1] Westerling, A.L., et al. 2011. "Climate Change and Growth Scenarios for California Wildlife."; Littel, Jeremy S., et al. 2009. "Climate and Wildfire Area Burned in Western U.S. Ecoprovinces, 1916 - 2003."

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