How much will we use?

Forecasting urban water use in California with changing climate, demographics, and technology

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Introduction

The population of California is increasingly urban, with 98% of its **38 million people** currently living in cities and suburbs. It is also rapidly growing. Los Angeles, San Diego, and Sacramento were among the 12 fastest-growing cities in the last decade, and the state has grown by an estimated 4.5 million since 2000.

While the majority of California's freshwater withdrawals are for agriculture (27 billion m^3 in 2000), urban water demand is growing rapidly and straining available supplies.[1] **Warming due to climate change** is causing increases in water demand for landscapes and evaporative cooling, and may continue to drive up **future water demand**.

We are currently developing a **simulation model** to create spatially explicit forecasts of future urban water use over the next century. The user may estimate future water demand under a number of scenarios of climate change and demographic change. We have made use of **downscaled output** from global circulation models to estimate landscape water demand for each decade from 1950 to 2100.[2]

The computer model will be completed in **Spring 2011** and will be **freely available** on the Pacific Institute website at www.pacinst.org.

Methods

Our model simulates future water use in California for each county or hydrologic region. Variables include:

- **Population** (how many people?)
- **Demographics** (where they live?)
- **Land Use** (what kinds of houses and yards do they have?)
- **Technology** (effect of water conservation)
- **Industry** (changes in type and location)
- **Laws** (effect of landscape ordinances and plumbing codes)
- **Economics** (effect of water prices)

Unlike most water demand forecasting models, we attempt to account for **uncertainty** in model parameters. The model can be run tens or hundreds of simulations using **Monte Carlo** methods to re-sample input parameters.

The user can choose from among a range of **climate scenarios** (e.g. SRES A1, A2, B1, B2) or assume a static climate. This allows one to isolate what portion of future water demand is attributable to climate,[3] and what is caused by other factors.

One may also examine economic effects such as changes in water prices or rate structures. We also evaluate the effects of changes in **building codes**, plumbing and appliance standards in bringing about "passive savings" over time.

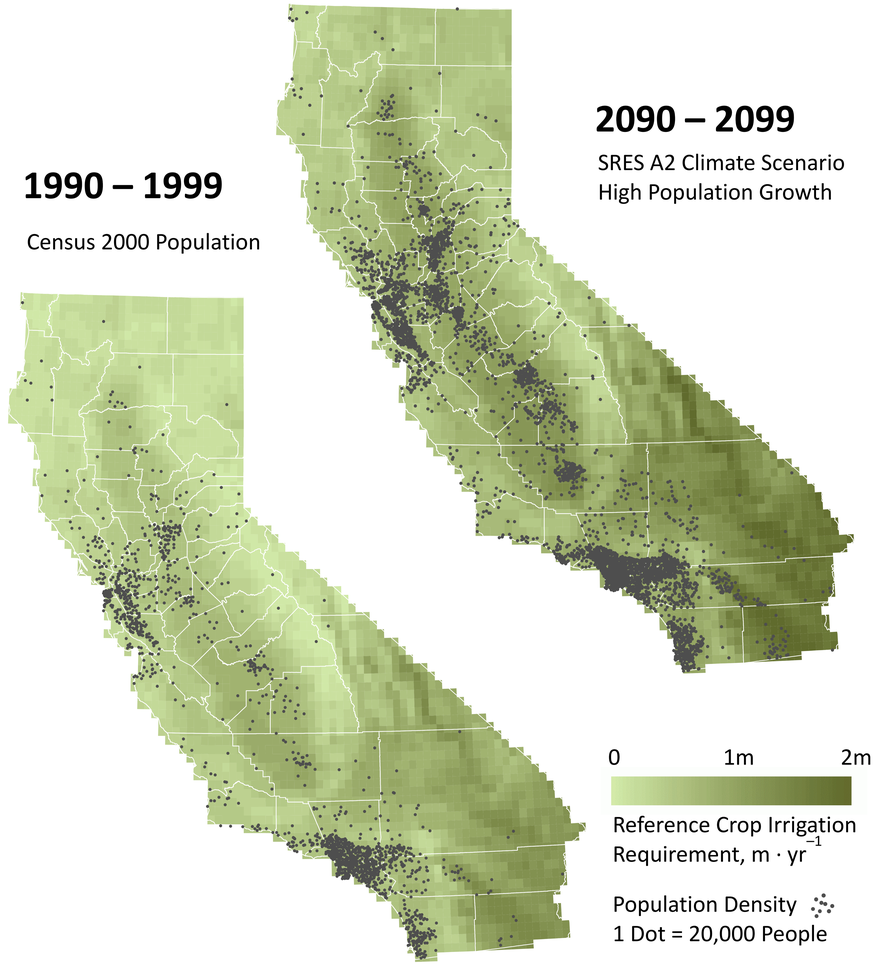

Figure 1: One scenario of future irrigation demand and population density in California.

References

[1] California Department of Water Resources, 2010, Water Plan Update 2005. Sacramento, CA. http://www.waterplan.water.ca.gov.

[2] Maurer, E.P., H.G. Hidalgo, T. Das, M.D. Dettinger, and D.R. Cayan, 2010, "The utility of daily large-scale climate data in the assessment of climate change impacts on daily streamflow in California," *Hydrology and Earth System Sciences* 14: 1125-1138.

[3] Polebitski, A. S., R.N. Palmer, and P. Waddell. 2010. "Evaluating Water Demands under Climate Change and Transitions in the Urban Environment," *Journal of Water Resources Planning and Management* 136: 27-36.

Results and Conclusions

Current conservation strategies and efficiency gains already underway are likely to cause a steady **decrease in per-capita water use** in coming decades. Yet, overall demand is likely to increase due to population growth and demographic patterns. Under current trends, statewide urban water demand may increase from 9 million acre-feet (maf) in 2005 (11 billion m^3) to 12 maf (15 billion m^3) in 2050.

Future growth is likely to occur in the hot, dry Central Valley, driving the trend toward increasing outdoor water use. **Climate change** is likely to cause a **modest increase** in urban water use by mid-century. Encouraging or requiring **low-water use** and **native vegetation** can offset this increase or lower overall urban demand.

Scenario-based planning can help to forecast future demands, analyze the impacts of policies, and better understand the uncertainty around our future water use. More aggressive **conservation strategies** allow for continued population growth without increasing water use.

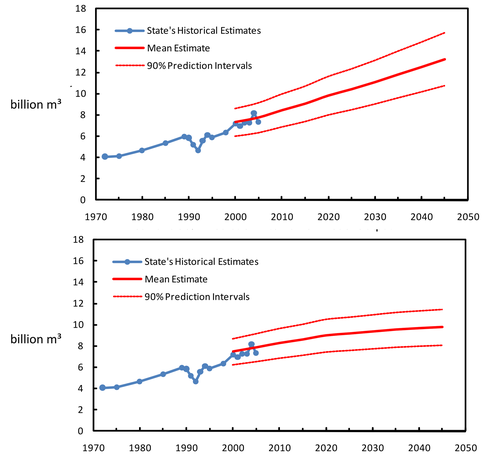

Figure 2: Estimated historical water use, and simulated future urban water use under (a) high and (b) moderate rates of population growth and climate change.

Acknowledgments

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