Future residential outdoor water availability under climatic uncertainty

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Introduction

Uncertainty in surface water supplies as a result of climate change may alter future water available for outdoor use. Water supplies for the Phoenix metropolitan area come from surface sources, which are subject to climate change, and from groundwater pumping. For these analyses we assume sustainability in groundwater (pumping = recharge), in accordance with the 2025 goal of the Groundwater Management Act (GMA), and two levels of indoor water use. We focus on the proportion of lot size dedicated to landscape plantings and a continuum of water available for irrigation spanning xeric to mesic landscapes. We present alternative strategies for managing future uncertain water resources.

Modeling

We used WaterSim 3.0, a water simulation model created by DCDC (Gober et al. in review[b]), to examine the potential impacts of future climatic conditions on residential water supplies for the Phoenix Metropolitan area in 2030. WaterSim evaluates potential water supplies in relation to water demand (based on population and individual use) and, in conjunction with policy levers, forecasts the gallons of water available to each individual on a daily basis (GPCD). Runoff projections for the Salt-Verde watershed, based on downscaled climate models from the 2007 IPCC Assessment Report, suggest a potential range in surface water runoff of -80% to +124% of the historical average (Ellis et al. 2008) (Figure 1). We apply this projected range of runoff as input to WaterSim in order to determine GPCD in 2030 as a function of climate factor, the proportional change from average historical runoff (Figure 2).

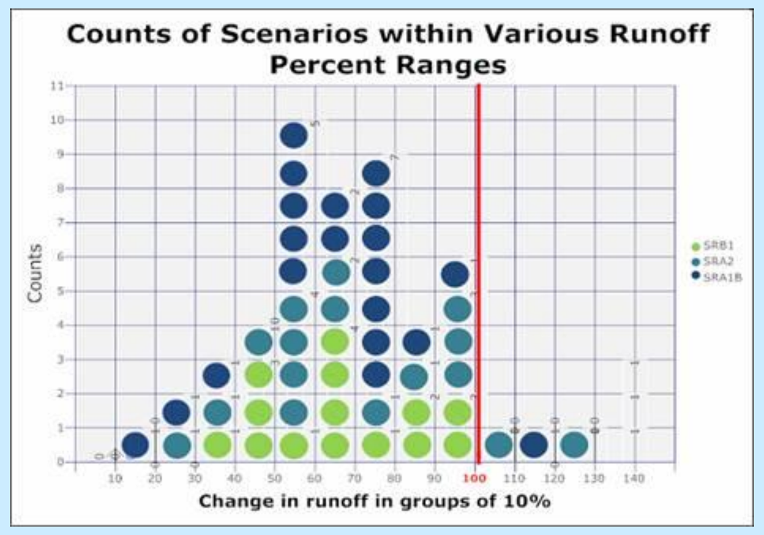

Figure 1. Projected Salt-Verde Watershed runoff, grouped by percent of historical levels, using downscaled IPCC climate models and scenarios.

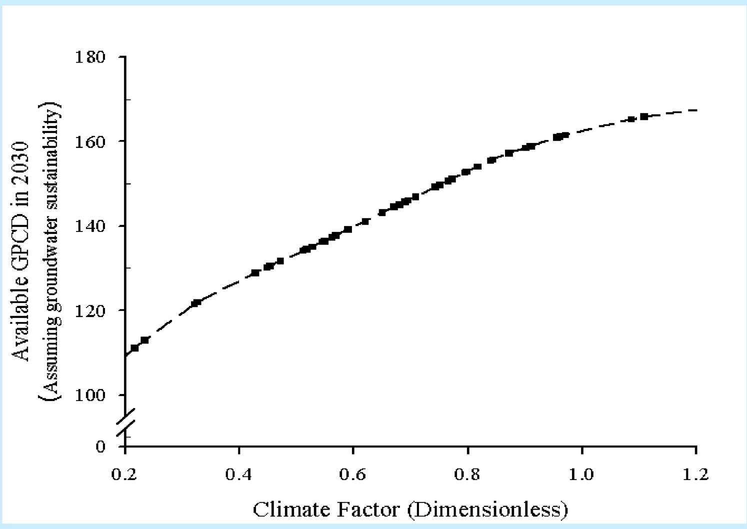

Figure 2. WaterSim simulation results: Daily per capita water consumption (GPCD) in 2030. Adapted from Gober et al. in review[a].

Methods

The Gober et al. (in review[a]) GPCD estimates for 2030 were converted to an annual basis assuming 2.67 people per household. We used SAS® to create a three dimensional array of possible combinations of: 1) residential landscape area available for plantings (50 to 800 m^2; mean = ~400 m^2), 2) liters of water m^{-2} needed to sustain outdoor vegetation (0 to 6000 l m^{-2}), and 3) indoor water use (55 to 85 GPCD) in order to calculate the projected amount of water available in 2030 for use outdoors.

From this array only positive responses were used and, by extracting the maximum amount of water for each combination, a household estimate of the amount of outdoor water supply was possible.

The response data were smoothed using the Loess function in SigmaPlot, and are presented as a contour plot.

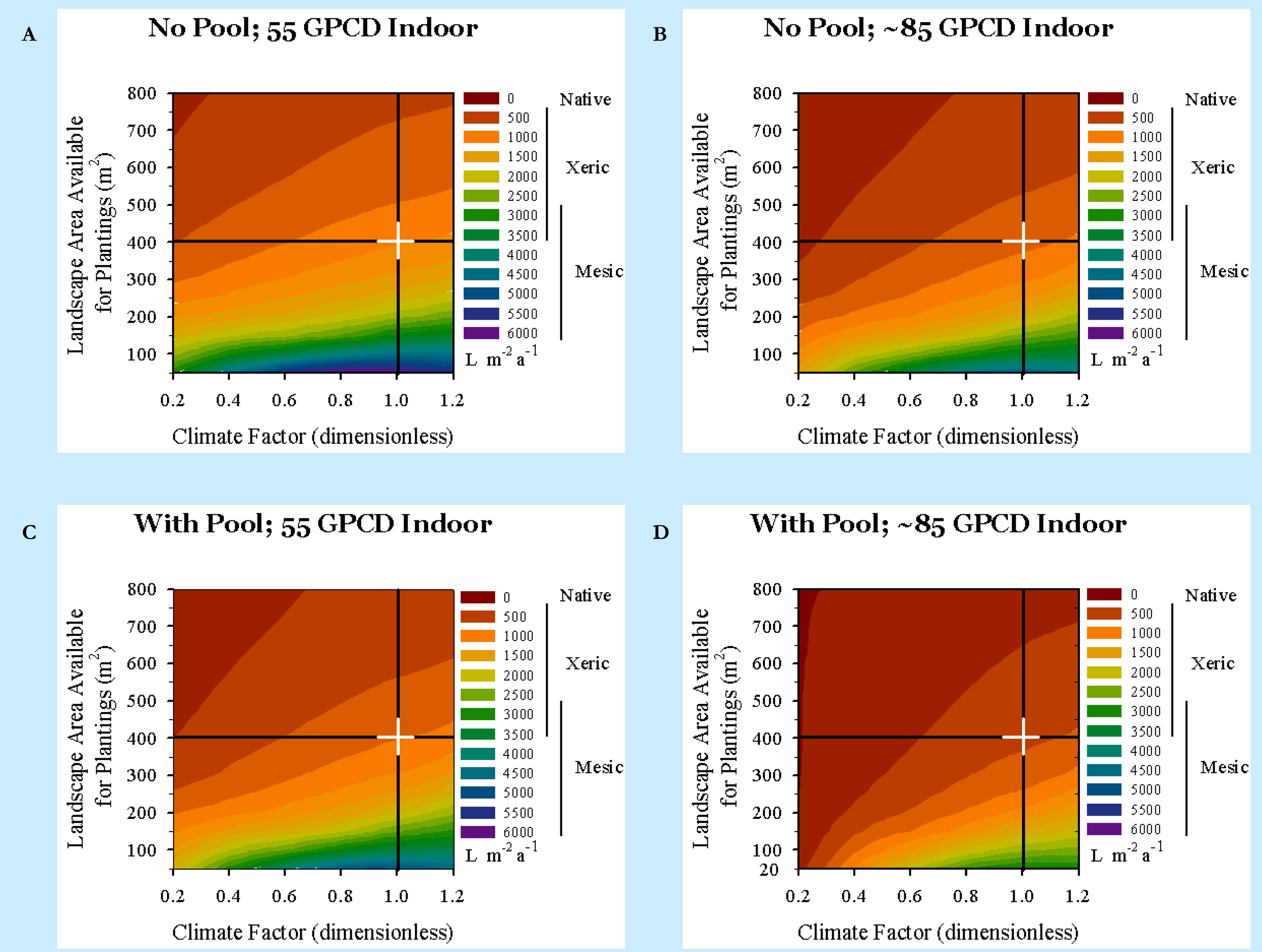

Figure 3. Projected outdoor water availability in 2030 as a function of climate factor and landscape area available for plantings. Results are given for homes without (A and B) and with (C and D) a backyard swimming pool. Indoor use was set at 55 (A and C) and ~85 (B and D) GPCD, the endpoints of typical indoor use. A reference mark (in white) designates the amount of runoff expected for an unchanged climate and the average lot size.

Figure 4. Examples of xeric (top) and mesic (bottom) landscapes.

Conclusions

The landscape type that will be supported by water availability in 2030 will depend upon lot size, presence or absence of a swimming pool, and indoor water use (Figure 3). By eliminating backyard swimming pools and limiting indoor water use (Figure 3A), single family homes will be able to support mesic landscaping at larger lot sizes and decreased surface water supplies. The desire to maintain swimming pools and higher levels of indoor use (Figure 3D) will limit landscape options to xeriscapes at all but the smallest lots and runoff close to or above the historical average. Single family homes with large yards will be limited to xeriscape for all conditions and in some cases will be limited to native plantings able to survive on ambient water. The assumption of groundwater sustainability, based on the GMA goal of safe yield (pumping = recharge) by 2025 for the Phoenix AMA, drives these landscape restrictions.

References

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