The impact of climate change on the water energy nexus

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Motivation

Water energy production options involve complex tradeoffs. One example is air cooling of thermal power plants which will save water but lower efficiency and electricity supply. Similarly, biofuels use water to produce energy. Choosing between options requires accurate forecasting of relative water and energy prices. This study provides a methodology for evaluating relative water and energy prices.

Technological Challenges

Accurate forecasts require mapping nexus linkages, measuring historical relative price trends, and incorporating climate impacts. Past efforts to map and measure energy water linkages have been very incomplete. In particular, we are unaware of no prior studies of relative water energy price changes and the impact of climate change.

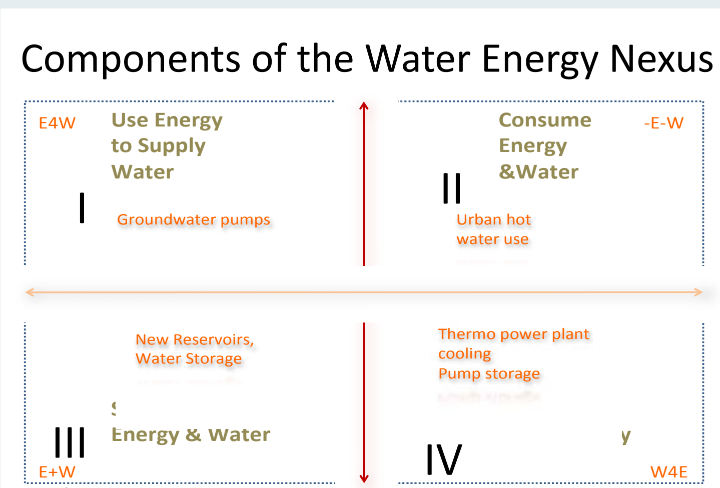

Figure 1. *Components of the Water Energy Nexus*

Research

Water and energy interactions are mapped in four quadrants: (I) the use of energy to supply water, (II) the use of water and energy, (IV) the use of water to supply energy and (IV) the use of water and energy (Figure 1). The relative price of water and energy influences the scale of these activities. For example, energy to supply water activities (I) are favored when water becomes relatively expensive. Activities that use water to supply energy (IV) are favored as water becomes cheap.

Rao et. al. (2017) found amble evidence of a rise in the relative price of water. Worldwide, the energy intensity of water has increased (20% since 1975) due to reliance on long distance water transfers, groundwater pumping and desalination Figure 2). Worldwide, the water intensity of electricity has probably not increased, given options for generating electricity with little water (dry cooling, windmills, solar). Finally, the cost of energy dominates the price of water but cost of water barely shows up in the price of energy. Other things equal, this suggests a future need for more energy for water activities.

	1975	2010
Total global energy use (EJ)	NA	463.6
Global energy use for water (EJ)	5.9	10.2 (2.5%)
Global water use (M3) ✓ Up 20%	2.876E+12	4.17E+12
Water energy intensity (EJ/M3)	2.05E-12	2.45E-12
Energy cost (% water price)		9%

Figure 3. *Growing Importance of Energy for Water*

The impact of climate change is less certain. Global warming may increase the demand for cooling, and thus the needed for water as an input for cooling (quadrant IV). However, global drying, a distinct possibility in California, would increase the need for energy to supply water (quadrant I). In California, a hot dry climate scenario both drives up energy demand and decreases energy generation (quadrant III) (Dale and others, 2015; 2017).

References

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