Spatial Extrapolation Mapping Based on Aggregated Data: Countywide Extrapolation of Phoenix Water Use Data

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Abstract

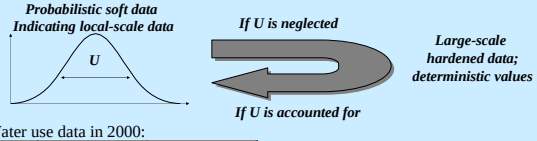
Understanding water use in the context of urban growth and climate variability requires accurate representation of regional water use. It is challenging, however, because water use data are often unavailable, and when available they are geographically aggregated to protect the identity of individuals. This poster aims to map local-scale estimates of water use in Maricopa County, Arizona, based on data aggregated to census tracts and measured only in the City of Phoenix. To complete our research goals we describe two types of data uncertainty sources (i.e., extrapolation and downscaling processes) and then generate data that account for the uncertainty sources (i.e., soft data). Our results ascertain that the Bayesian Maximum Entropy (BME) mapping method of modern geostatistics is a theoretically sound approach for assimilating the soft data into mapping processes. Our results lead to increased mapping accuracy over classical geostatistics, which does not account for the soft data. The confirmed BME maps, therefore, provide useful knowledge on local water use variability in the whole county that is further applied to the understanding of causal factors of urban water demand.

Objectives

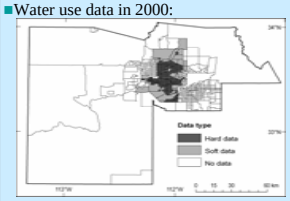
- To represent water usage with a targeted local-scale (areas < 7km^2).
- To represent countywide water usage.

Available Data

- Measured Water Duty (MWD, liters/km^2) values with observation areas less than 7km^2; uncertainty-free hard data (local-scale data) that need no downscaling processes.
- MWD values with observations areas greater than 7km^2; uncertain hardened data (larger-scale data) that need downscaling processes.
- The hardened data do not include data uncertainty (*U*) related to downscaling.
- A mathematical downscaling framework can derive *U*.
- Relationship between the hardened data and soft data (local-scale water duty given larger-scale water duty):

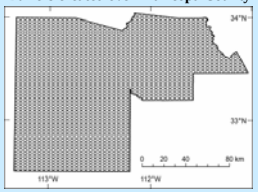


- Water use data in 2000:



Generated Data

Buffers created over Maricopa County



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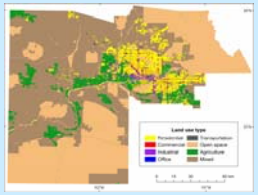
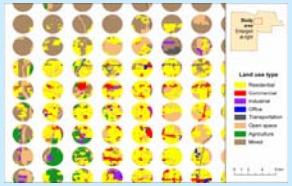
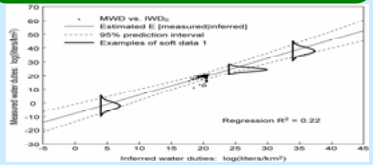
Land use data in 2000





Calculate inferred water duties (IWD) for each buffer using SRP water duty multipliers

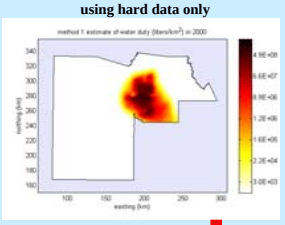
Apply a regression between IWD and MWD within the city to the IWD of each buffer to generate soft data



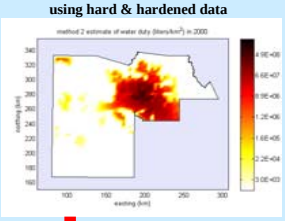
At each buffer location there are hardened data (first order statistical moments only; thin sold line) or soft data consisting of first and second order (dotted lines) moments

Mapping Results

Method 1
using hard data only



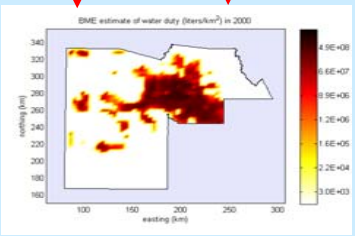
Method 2
using hard & hardened data



83.6% improvement

85.4% improvement

Method 3
using hard & soft data



Conclusions

- This work provided a general solution to situations in which data extrapolation is required.
- This work obtained the downscaled estimates of the water use based on data aggregated to census tract boundaries.
- This works expands the estimation from the City of Phoenix to Maricopa County.
- The resulting estimation maps are the empirical basis for decision support tools and scenario development of the region's future that consider climate change, water policy, and urban growth.

Acknowledgment

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