Temporal Geographic Information System (TGIS) to Forecast Future Water Consumption in Phoenix, Arizona

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Abstract

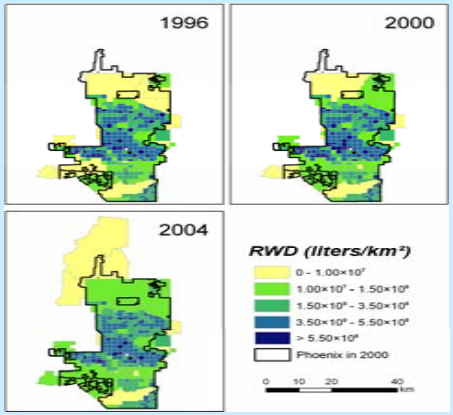
Predicting the dynamics of residential water use in an arid city is a central input to facilitate future sustainability. This study uses Bayesian Maximum Entropy (BME) to account for composite space-time variability in historical water use data and uncertain data (i.e., soft data) to represent future points. The generation of soft data uses a stochastic empirical law between water use and a secondary data source, in this case, population density. We propose an adjusted stochastic empirical law that covers uncertainty in the secondary data, and hence a more generalized methodology to generate information-rich soft data. This updated soft information is processed in BME, which produces maps of water use until the year 2030. Our forecasting results indicate that Phoenix's residential water use increases until reaching a peak the years 2012 and 2017, and afterward gradually decreases by 2030. The developed methodology is flexible enough to be applied to different forecasting applications, and a driving force to develop a more generalized method that uses a stochastic empirical law consisting of multiple independent variables that are closely related to water use whenever available.

Objectives

- To represent accurately future water usage in Phoenix
- To test new application for BME using secondary data to produce future predictions

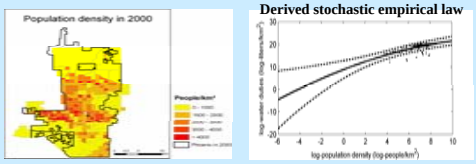
Historical Water Use Data

- Phoenix's Residential Water Duty (RWD, liters/km^2) for the years 1995-2004
- Examples only for the years 1996, 2000, and 2004

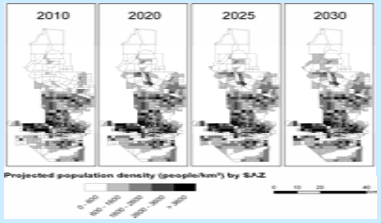


Generated Water Use for Future Points

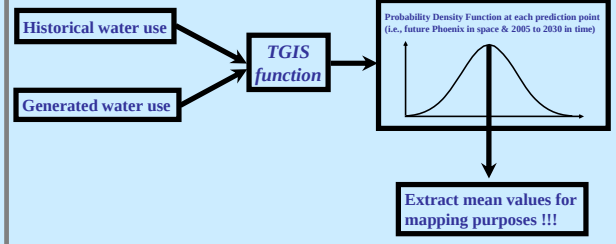
Obtain a stochastic empirical law between historical water use and population for the year 2000



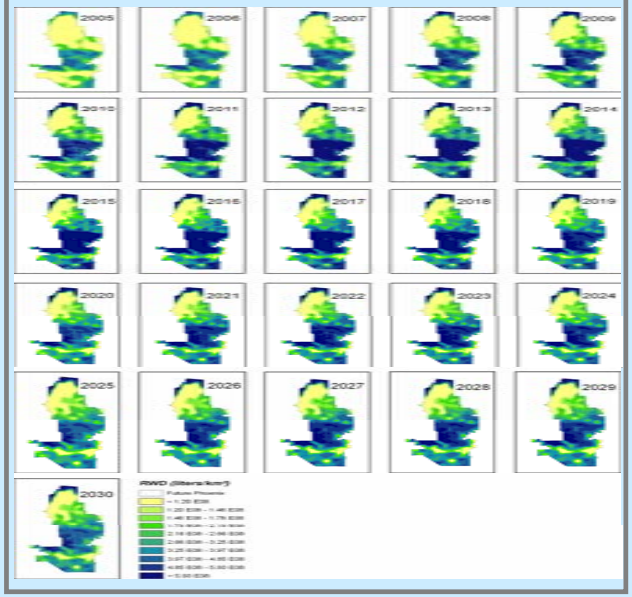
Apply the derived law to population projected over future years to generate future water estimates



Knowledge Processing



Mapping Results



Conclusions

- This work accurately represents future water use by assimilating
  - space-time dynamics of data
  - uncertainty related to data extrapolation
- This method of forecasting can be adapted to socio-economic and environmental applications

Acknowledgment

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