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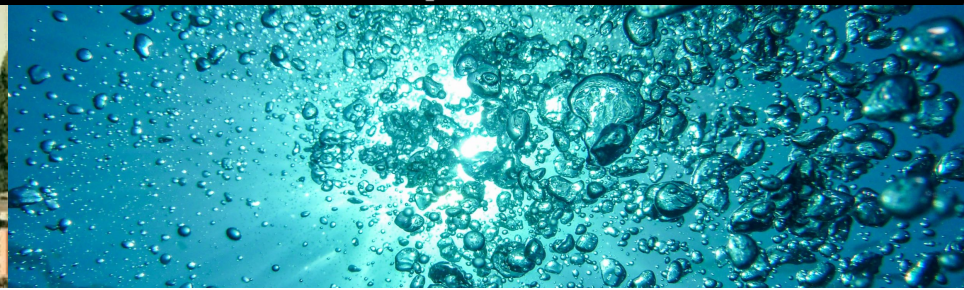
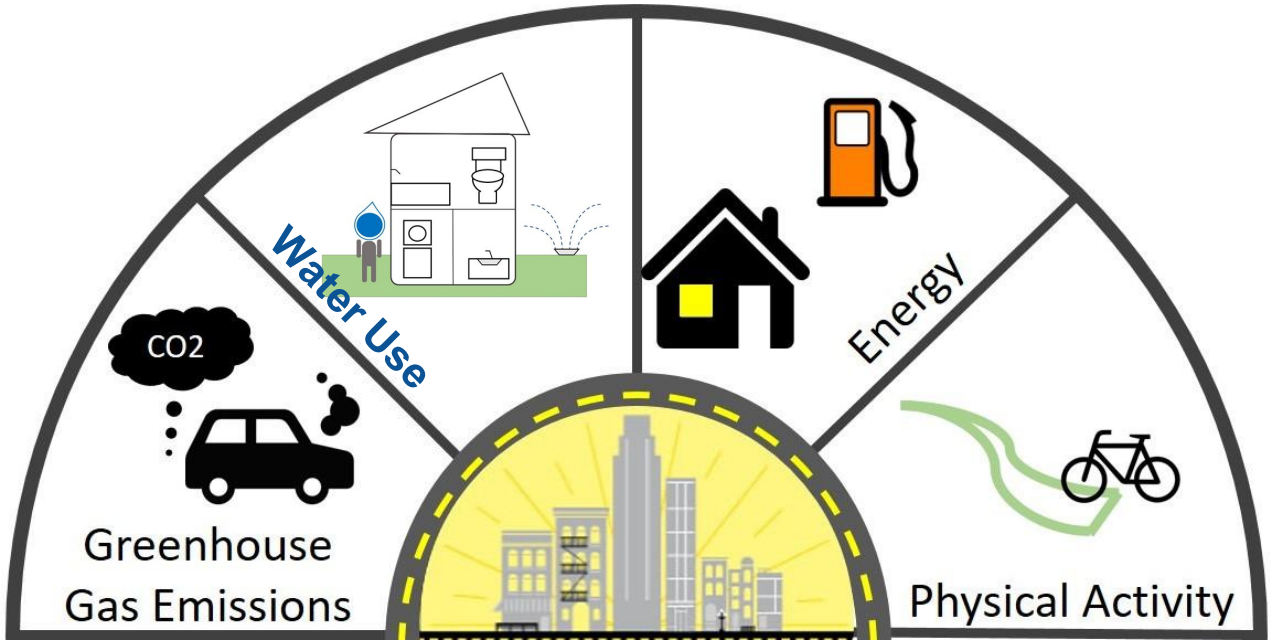


Forecasting Urbanization and Future Water Demand

Georgina M. Sanchez
Adam Terando
Jordan Smith
Ana M. Garcia
Chad Wagner
Ross Meentemeyer

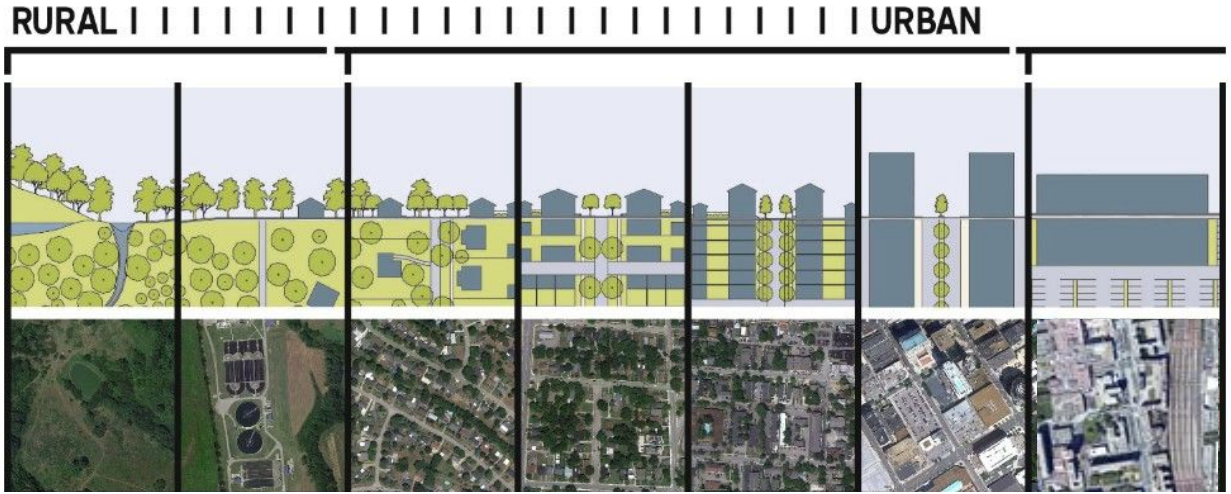
USGS | Groundwater Availability Assessment Technical Advisory Committee | June 22, 2018

Effect of the spatial pattern and shape of developed areas on human and environmental well-being



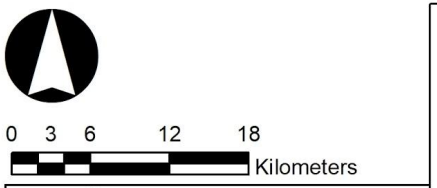
Linking land and water use planning

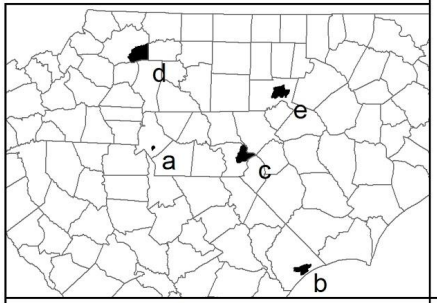
Understand the role that urban-suburban development choices play in contributing to pattern of water consumption rates.



Spatial pattern of development

Landscape metrics of sampled census tracts across the study region.





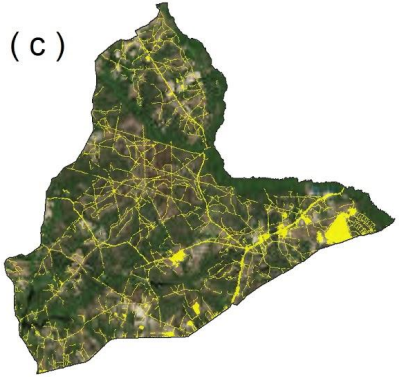
(a)

Shape Index: 3.24
Aggregation Index: 97.62

(b)

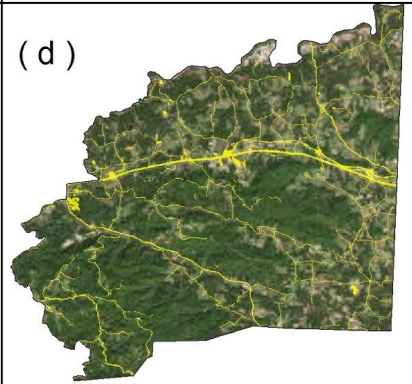
Shape Index: 6.25
Aggregation Index: 82.53

(c)



Shape Index: 10.85
Aggregation Index: 55.15

(d)



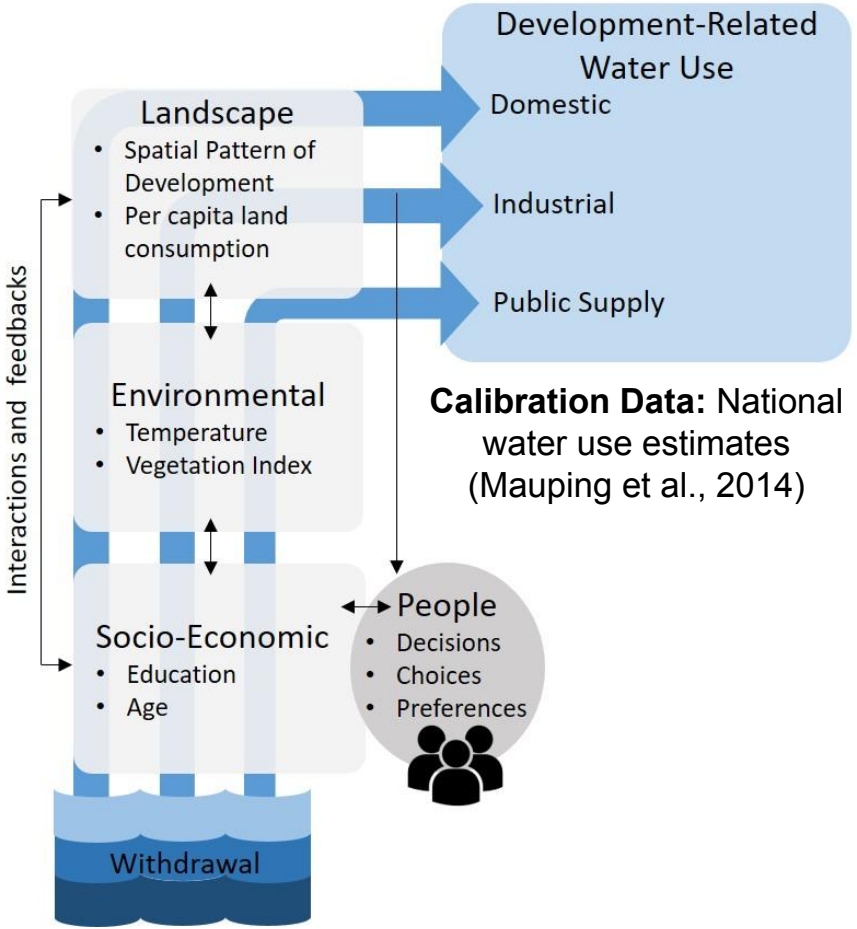
Shape Index: 12.25
Aggregation Index: 57.13

(e)

Shape Index: 16.99
Aggregation Index: 71.92

Conceptual framework

We developed an integrated land- and water-use modeling approach to inform water-efficient development patterns.



Calibration Data: National water use estimates (Mauping et al., 2014)

Sanchez et al., 2018
(Water Resources Research)

Water demand model

- To capture local variation we implemented a Geographically Weighted Regression modeling technique.
- We constructed a holistic modeling framework with landscape, socio-economic and environmental variables.

Development-Related Water Demand

Intercept***
Median Age***
Education*
NDVI***
Temperature***
Shape Index***
Per capita development***

AIC	4779
Quasi-global R-squared	0.49

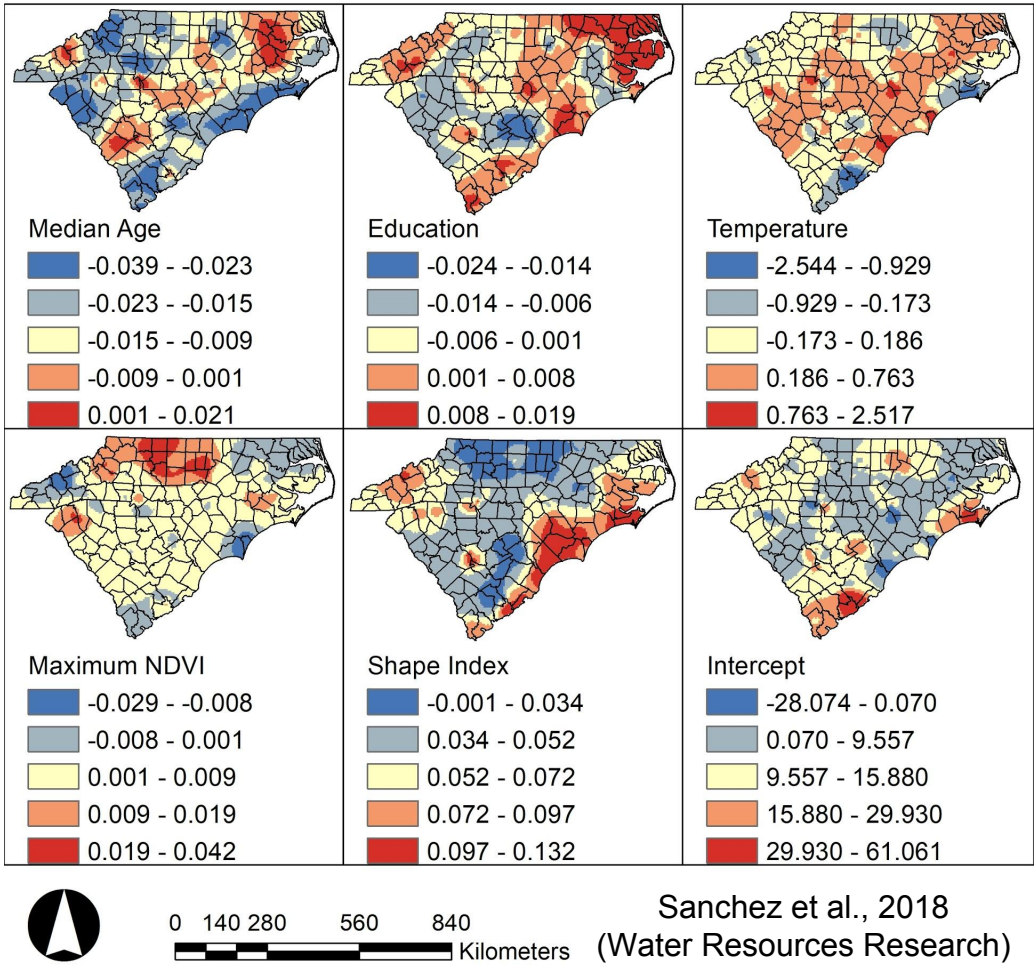
Water demand model

- Median age, education, and NDVI are assumed as temporally static parameters.
- Temperature, shape index, and per capita development are assumed as temporally dynamic parameters.

Development-Related Water Demand	
Intercept***	
Median Age***	
Education*	
NDVI***	
Temperature* **	
Shape Index* **	
Per capita development* **	
AIC	4779
Quasi-global R-squared	0.49

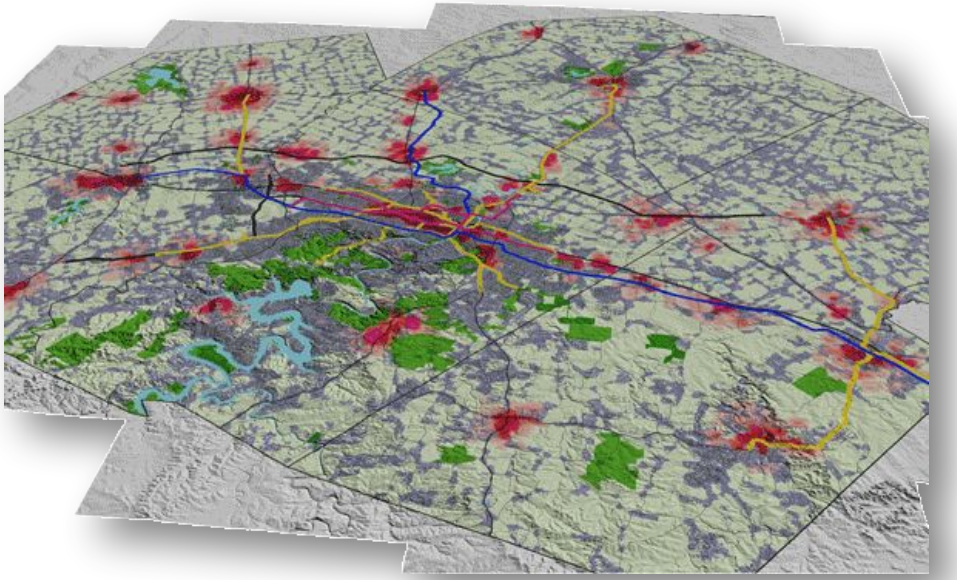
Spatial distribution of geographically weighted regression coefficients

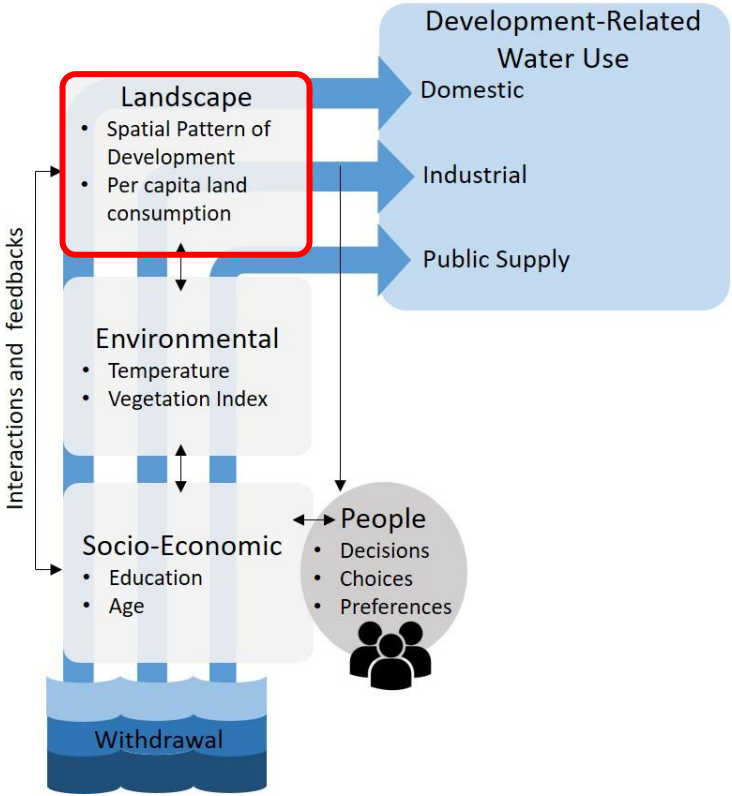
Higher coefficients indicate a greater relationship between explanatory variables and development-related water use.



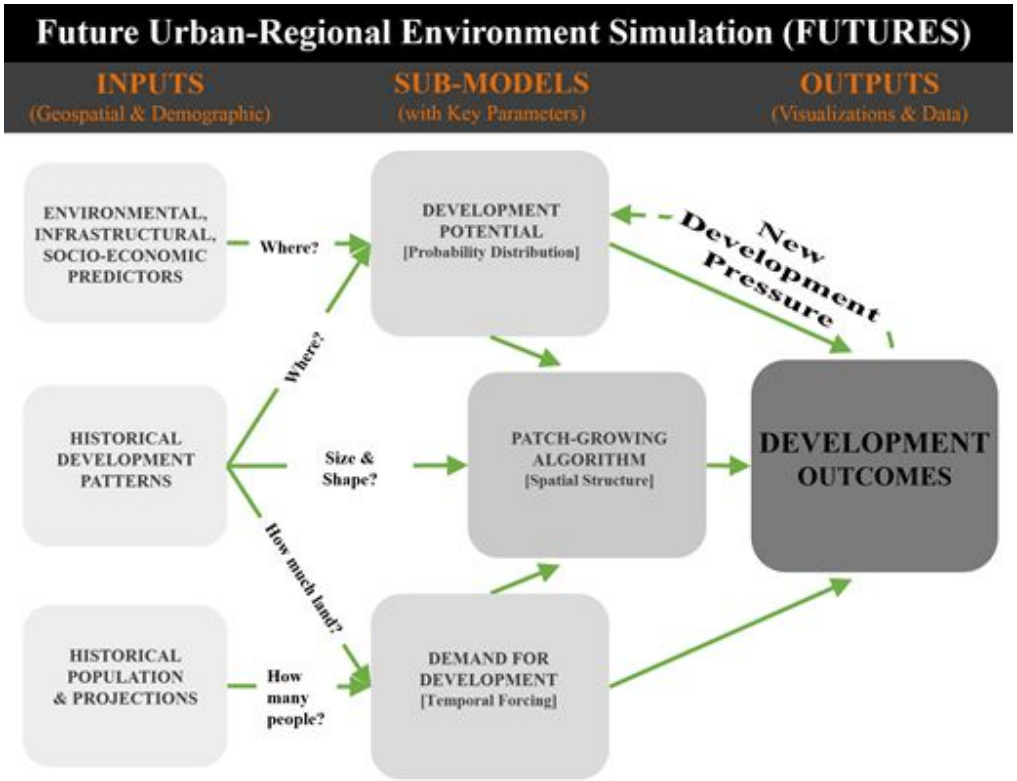
Sanchez et al., 2018
(Water Resources Research)

Simulate Land Change





Land Change Model: FUTURES

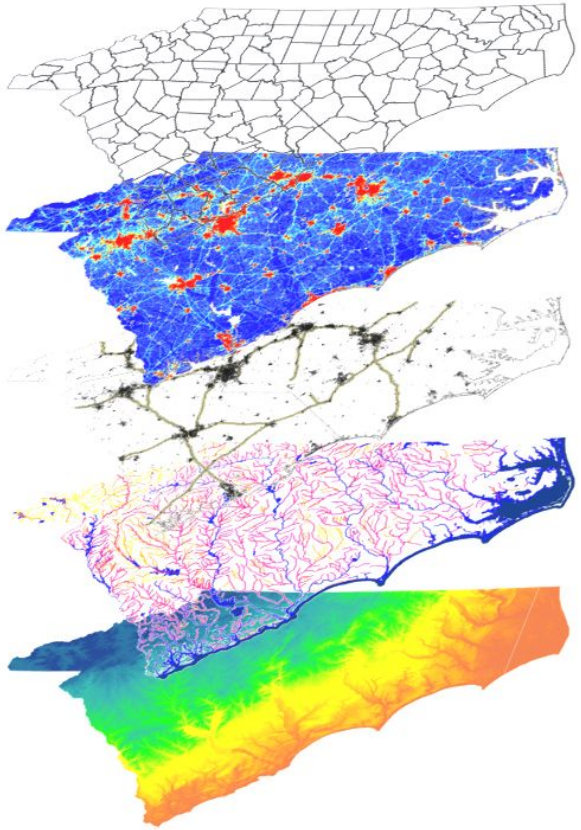


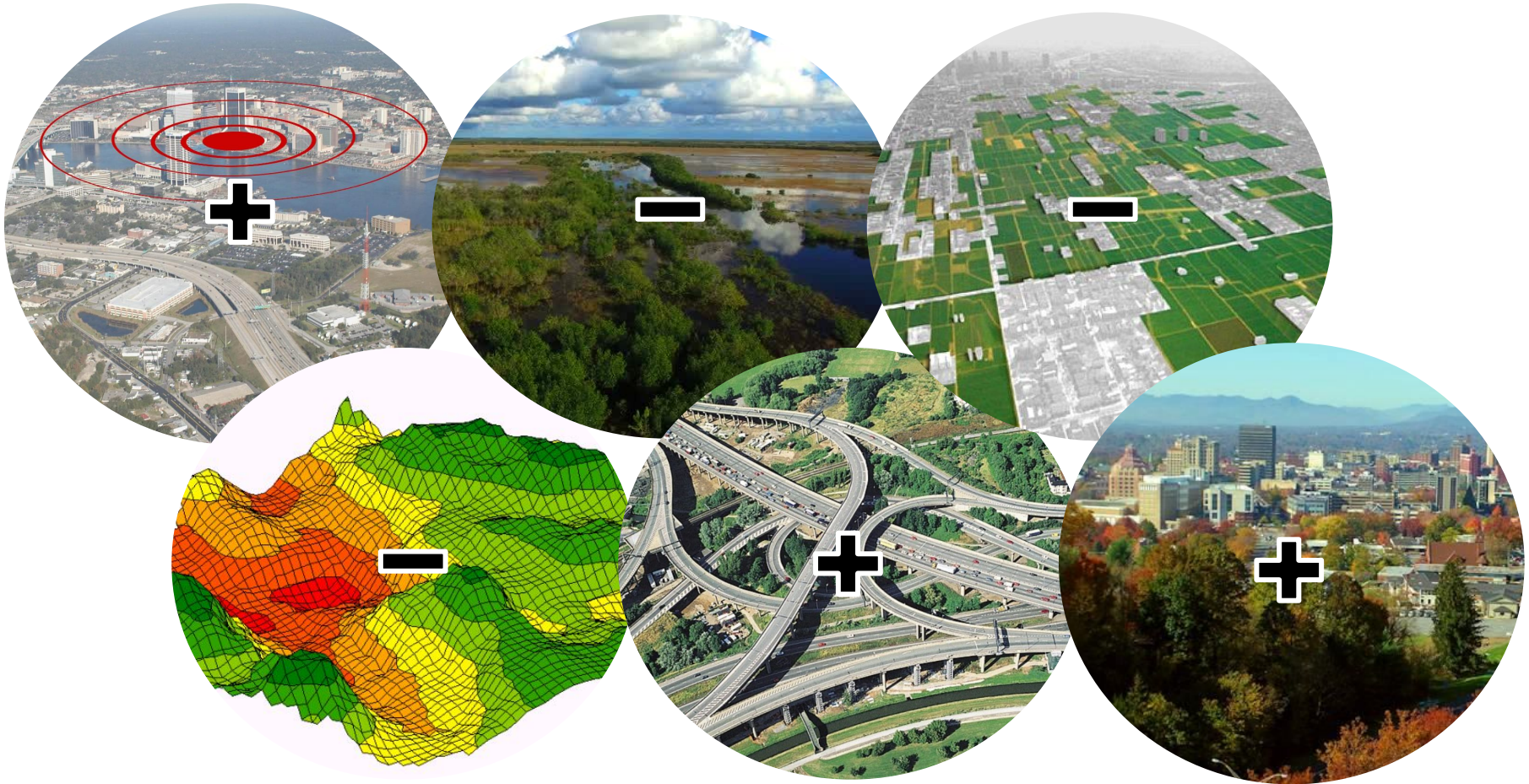
[Meentemeyer et al., 2013]

- Simulates spatial patterns of land-use change driven by urbanization.
- Population demand and development suitability interact to simulate urban growth.
- Realistics patches of growth.

Land Change Model: FUTURES

- Projections are based on historical patterns of grow and their relationship to socio-economic, infrastructural and environmental predictors.



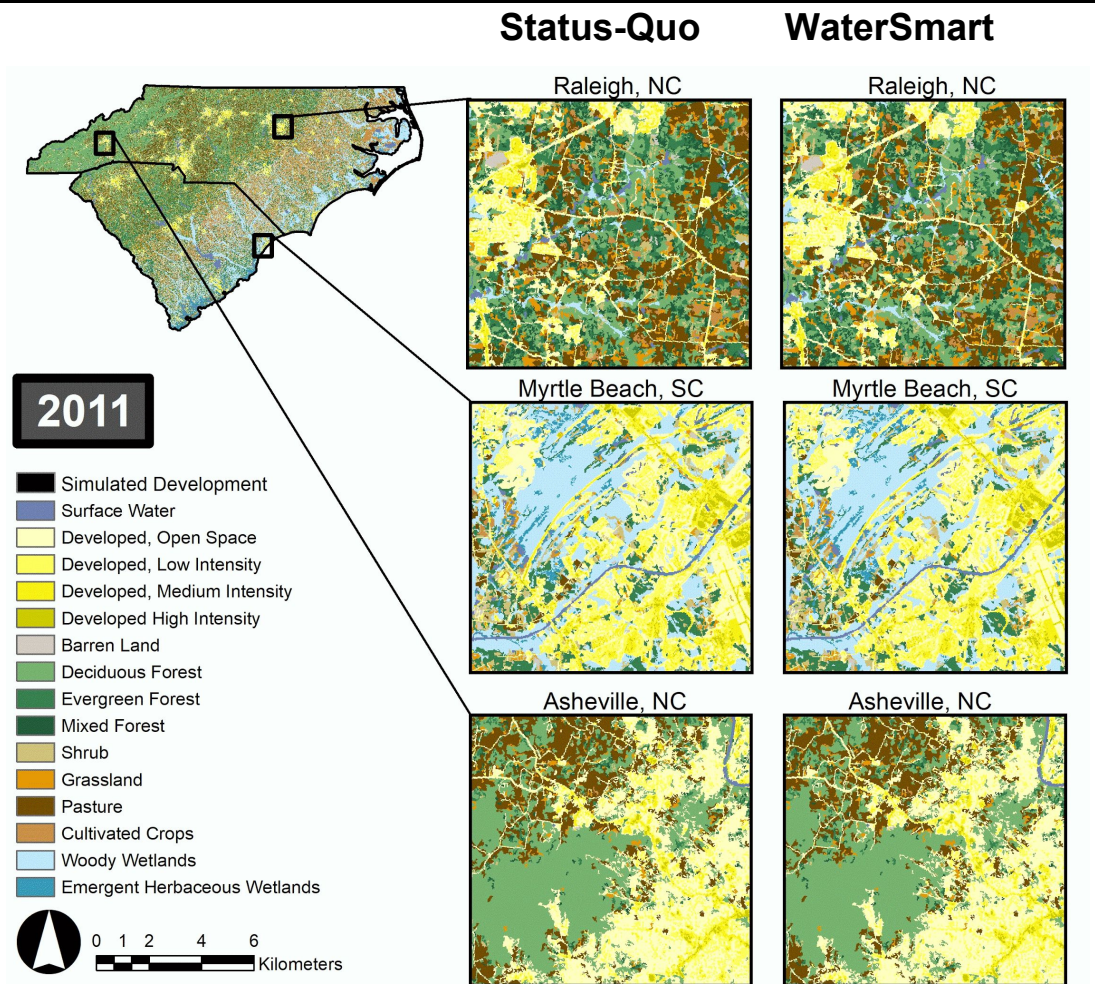


Land change scenarios

Projected year: 2065

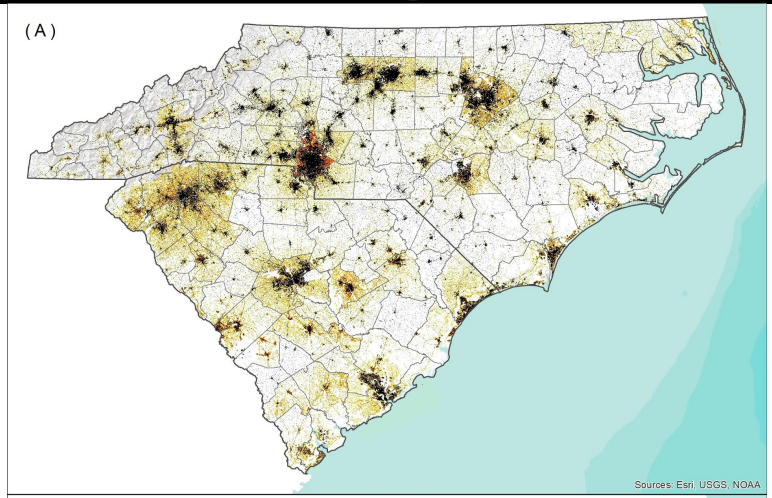
	Status-Quo
Population	24 M
Per capita land consumption	2.5 people/unit
Spatial patterns of development	historical pattern of growth
Protected areas	under current protection

	WaterSmart
Population	24 M
Per capita land consumption	3 people/unit
Spatial patterns of development	infill (simple, cohesive patches)
Additional conservation measures	riparian buffers, wetlands

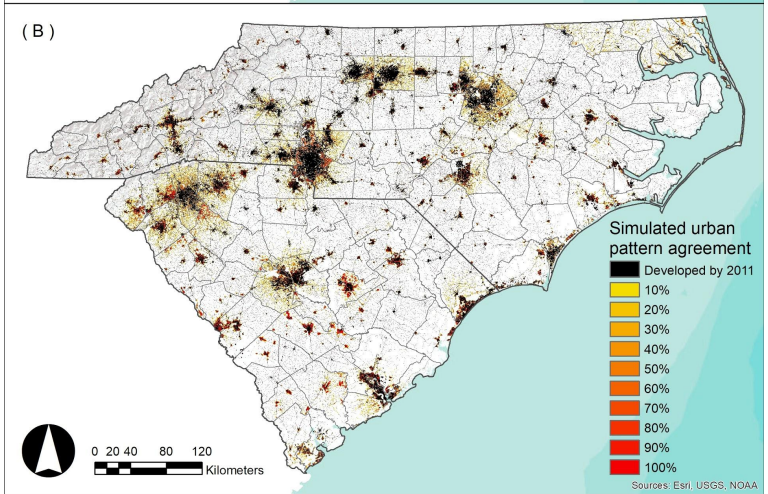

Status-Quo
WaterSmart
Raleigh, NC
Raleigh, NC
Myrtle Beach, SC
Myrtle Beach, SC
Asheville, NC
Asheville, NC
2011
Simulated Development
Surface Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed High Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub
Grassland
Pasture
Cultivated Crops
Woody Wetlands
Emergent Herbaceous Wetlands
0 1 2 4 6
Kilometers

Urbanization Probability by 2065

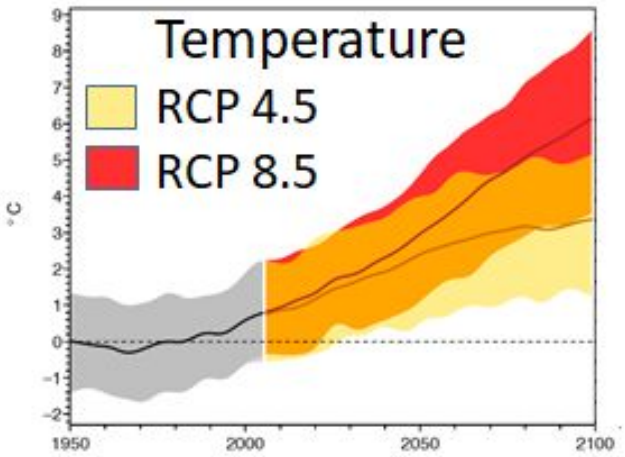
Status-Quo

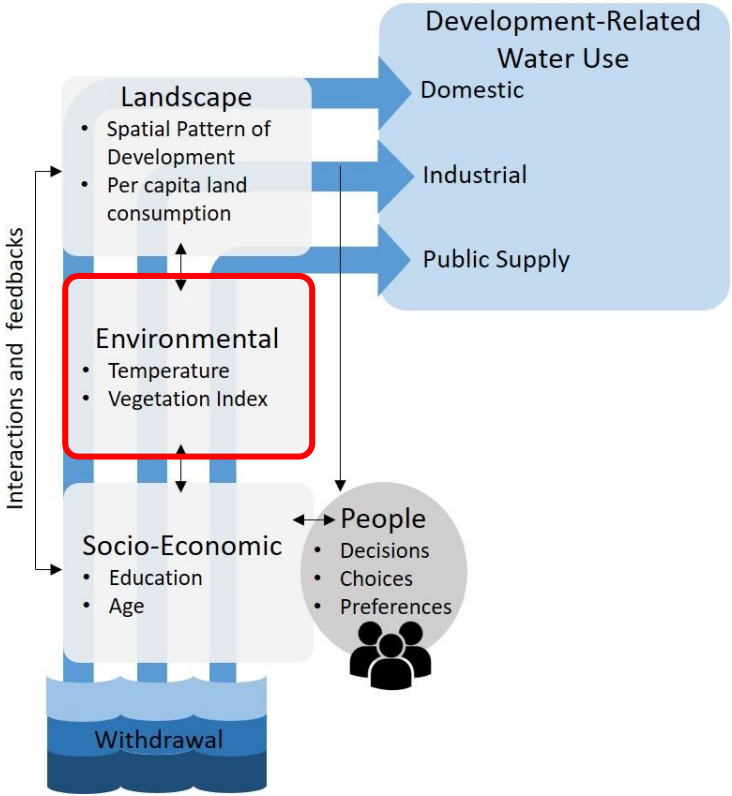


WaterSmart

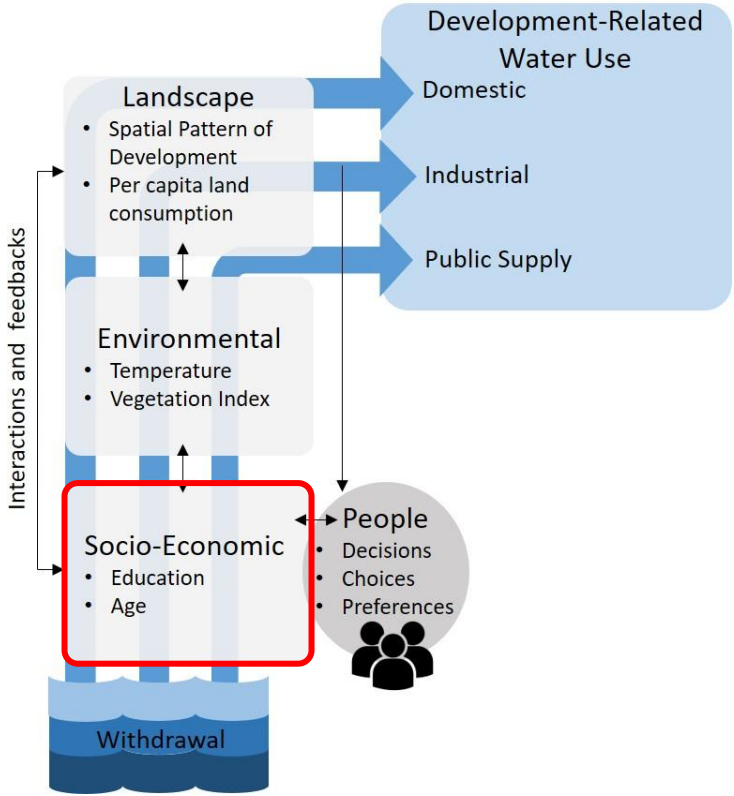


Climate Change

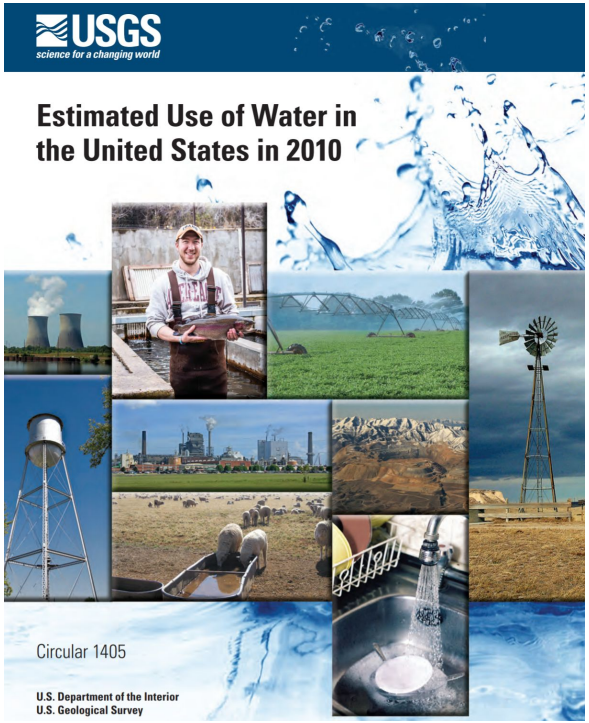


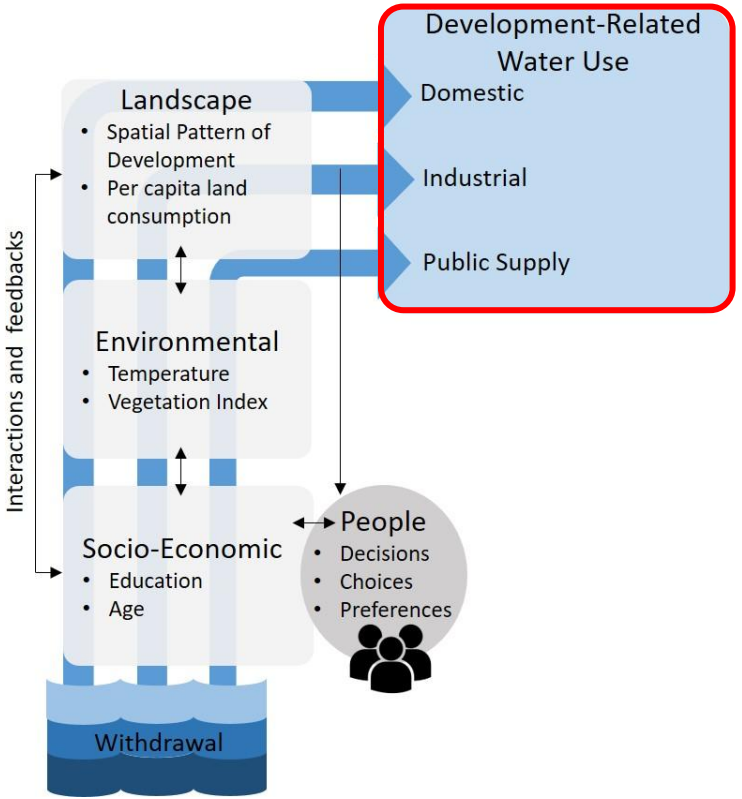


Estimated Population Growth

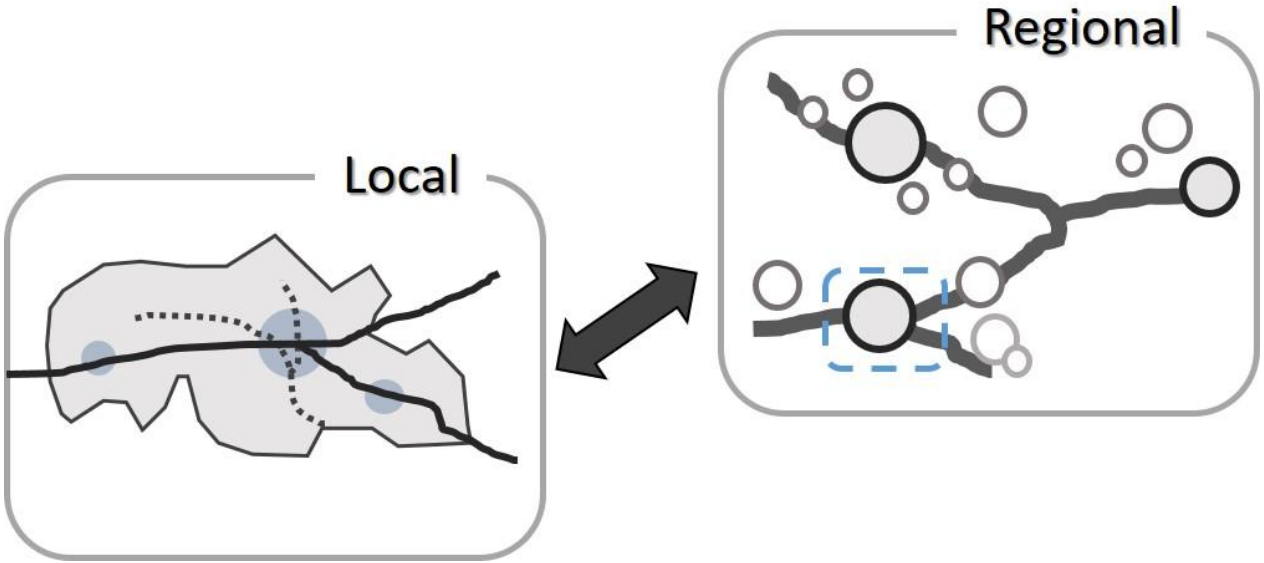


Future Water Demand



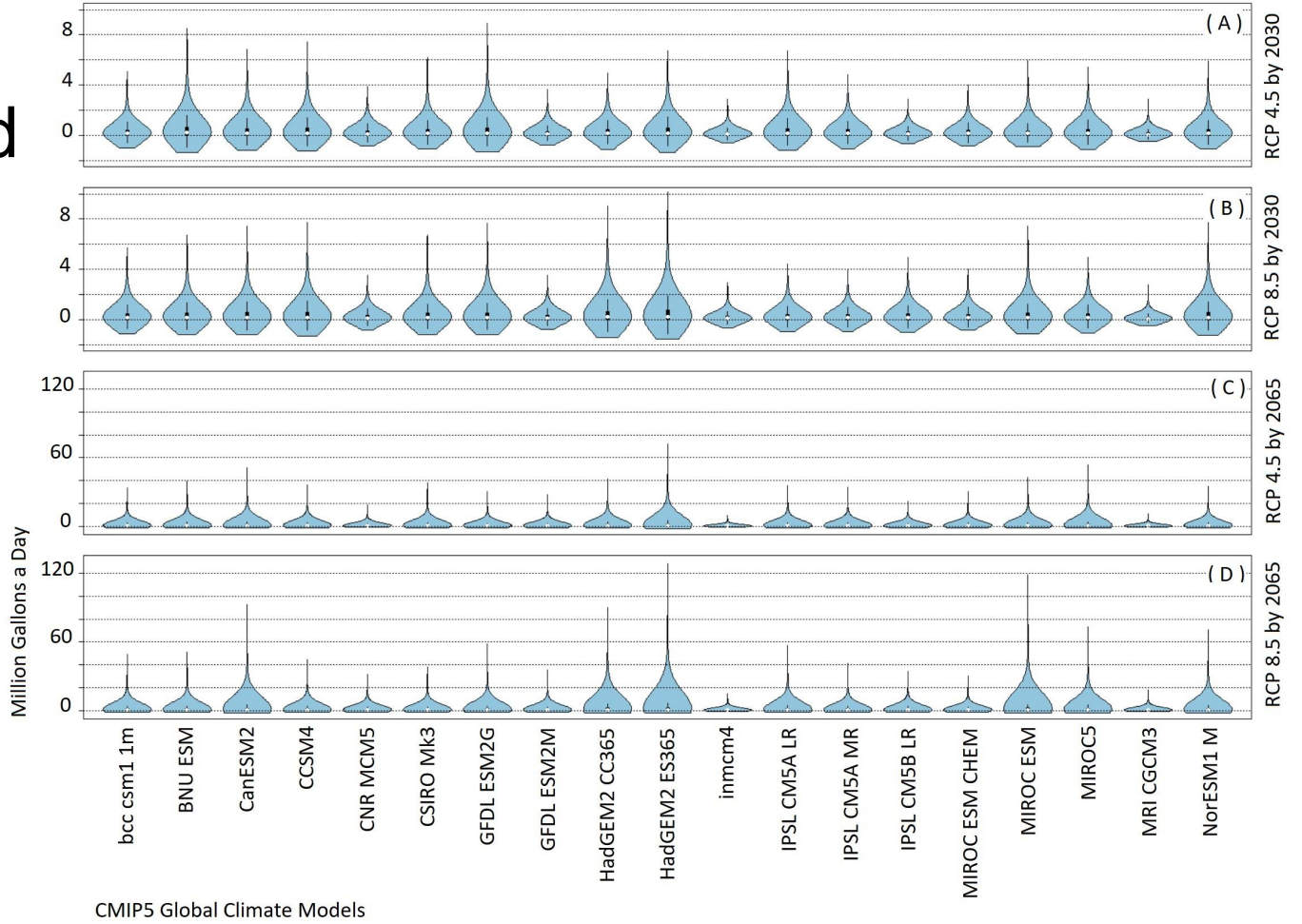


Scalability and Replicability

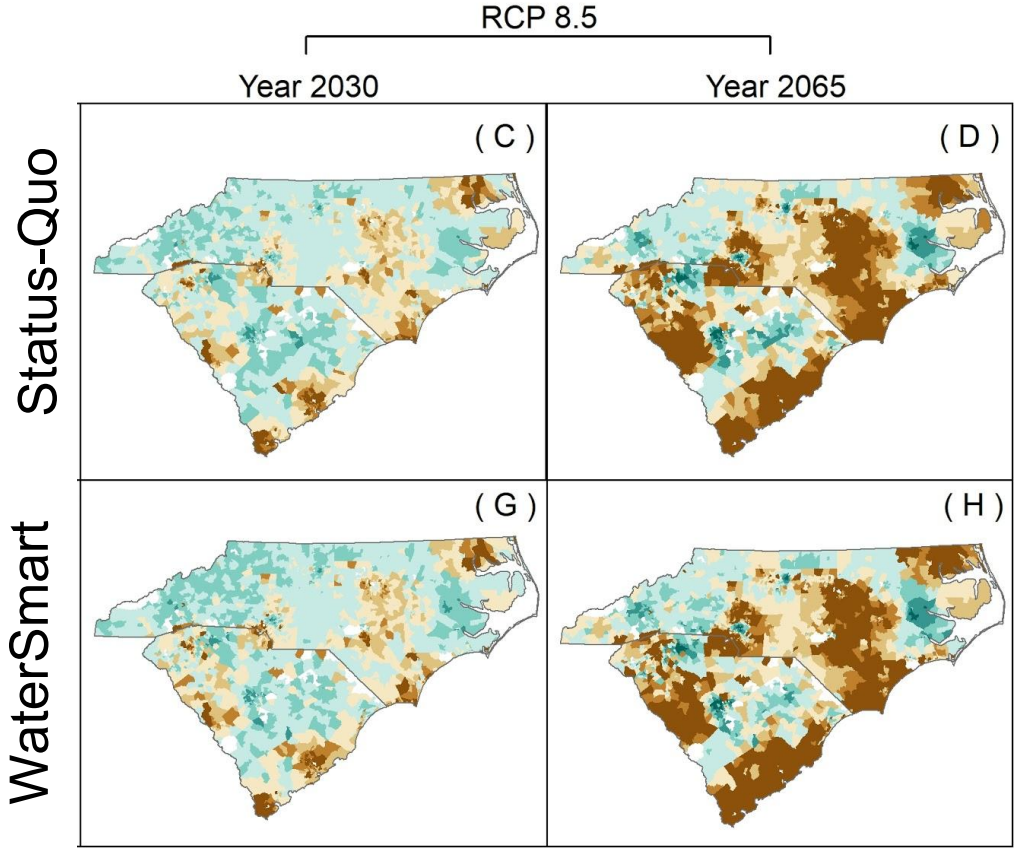


Future Local Water Demand

Estimates at census tract spatial unit by 2030 and 2065.



Spatial Distribution of Projected Change



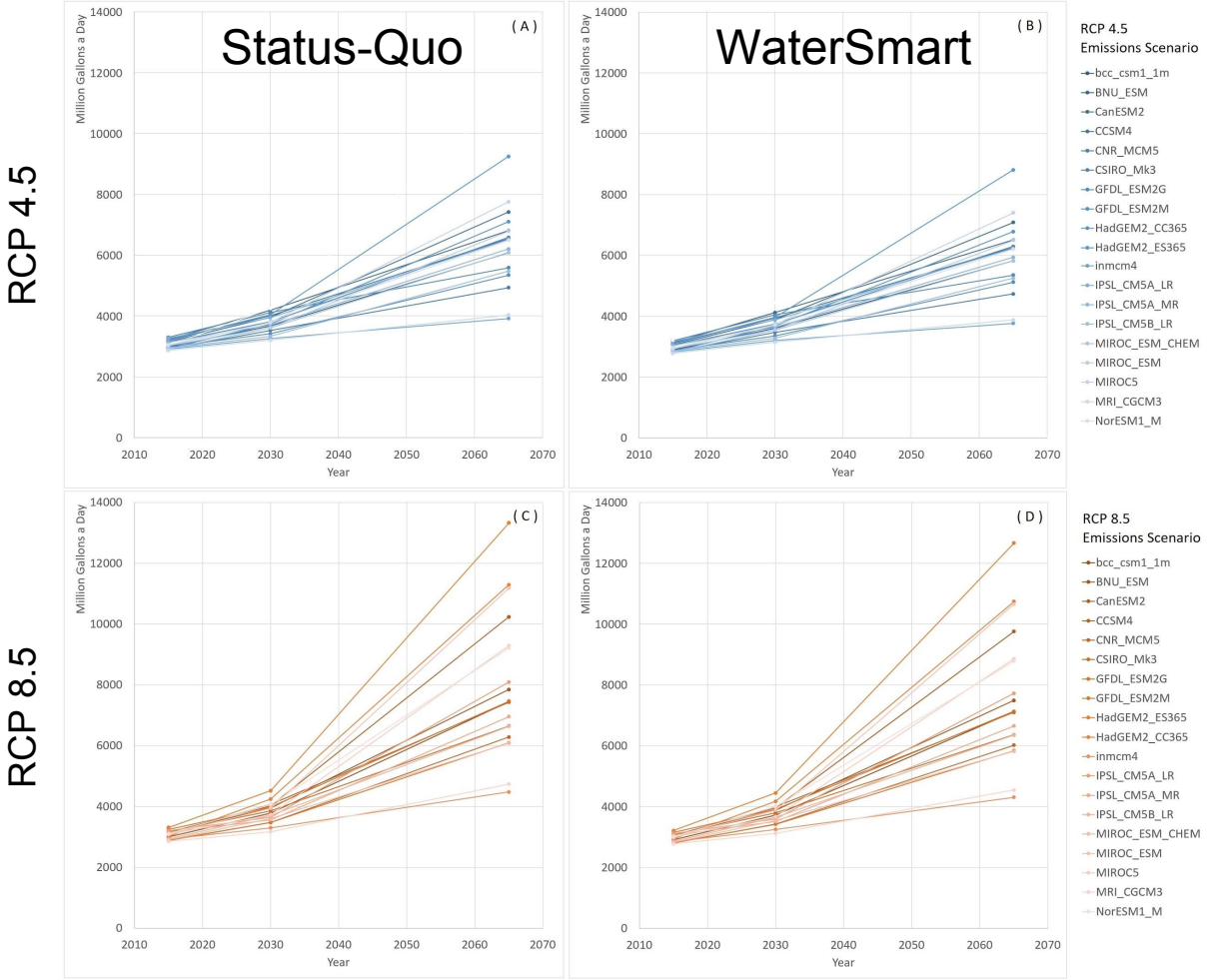
Estimates at census tract spatial unit by 2030 and 2065.

Percentage change

< - 50%	25% - 50%
-50% - -25%	50% - 75%
-25% - 0%	75% - 100%
0% - 25%	> 100%

Future Regional Water Demand

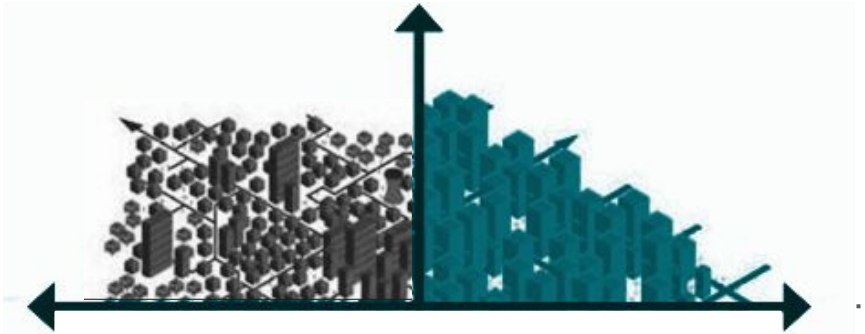
- Calibration year 2010
- Estimated development-related water use: 2758 MGD



Projected Change in Regional Demand: RCP 8.5

Status-Quo	Year 2065
Population	24 M
Water Demand	**7937 MGD 288% Increase**

WaterSmart	Year 2065
Population	24 M
Water Demand	**7576 MDG 275% Increase**

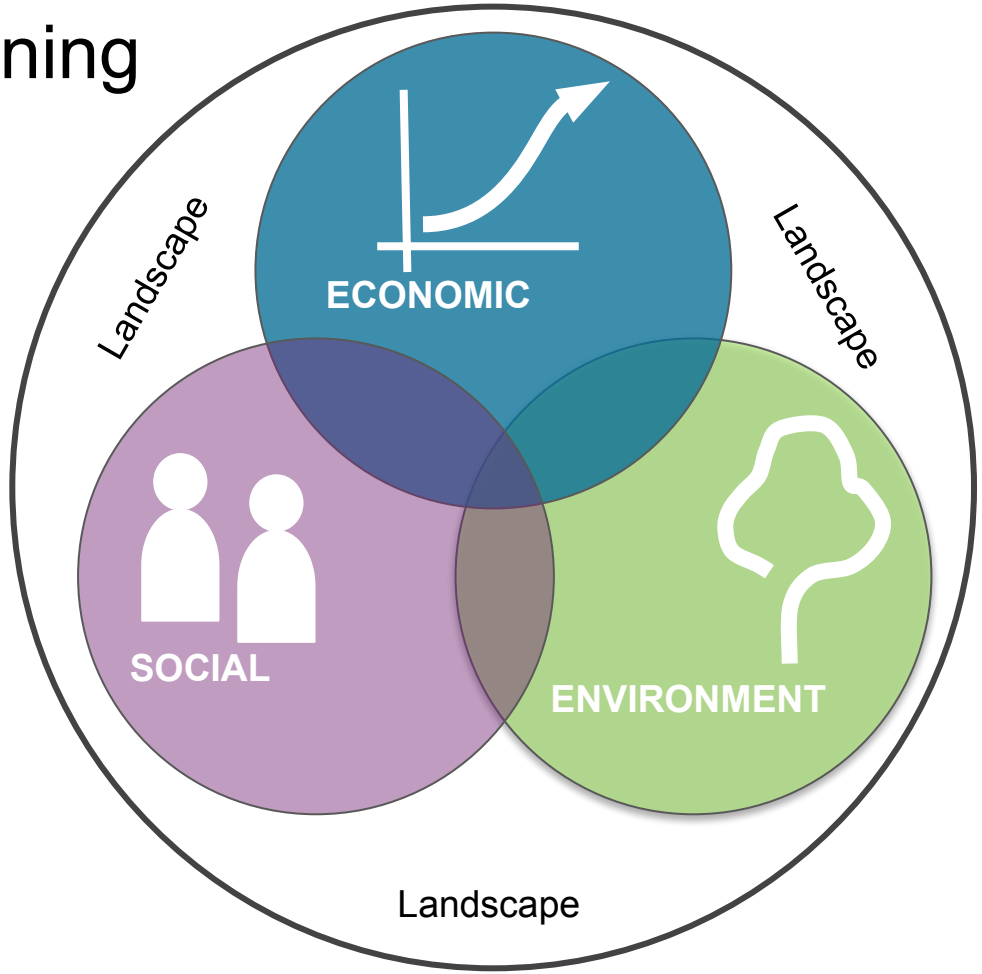


Status-Quo vs WaterSmart

- This represents 13% of 2010's urban water footprint.

Integrated Land Use Planning

To understand the role that urban-suburban development choices play in contributing to future water demand.



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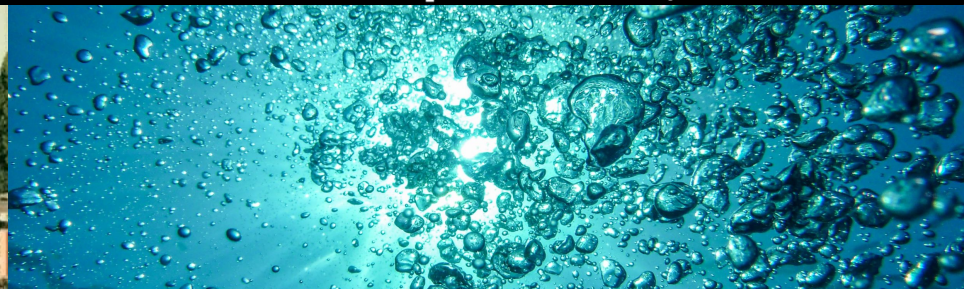

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https://goo.gl/nYpzP6 | https://goo.gl/B9QY9I | https://goo.gl/tlPuc7

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