

Introduction

Over 400 million gallons of water are withdrawn per day in the United States. The four sectors which account for over 90 percent of the withdrawals are: industrial, thermoelectric power, domestic, and agricultural irrigation. While water supply and demand are largely managed along governmental boundaries, its distribution within is uneven. Providing a detailed spatial evaluation at a finer resolution can help determine potential imbalances between supply and demand today and into the future.

Water Supply

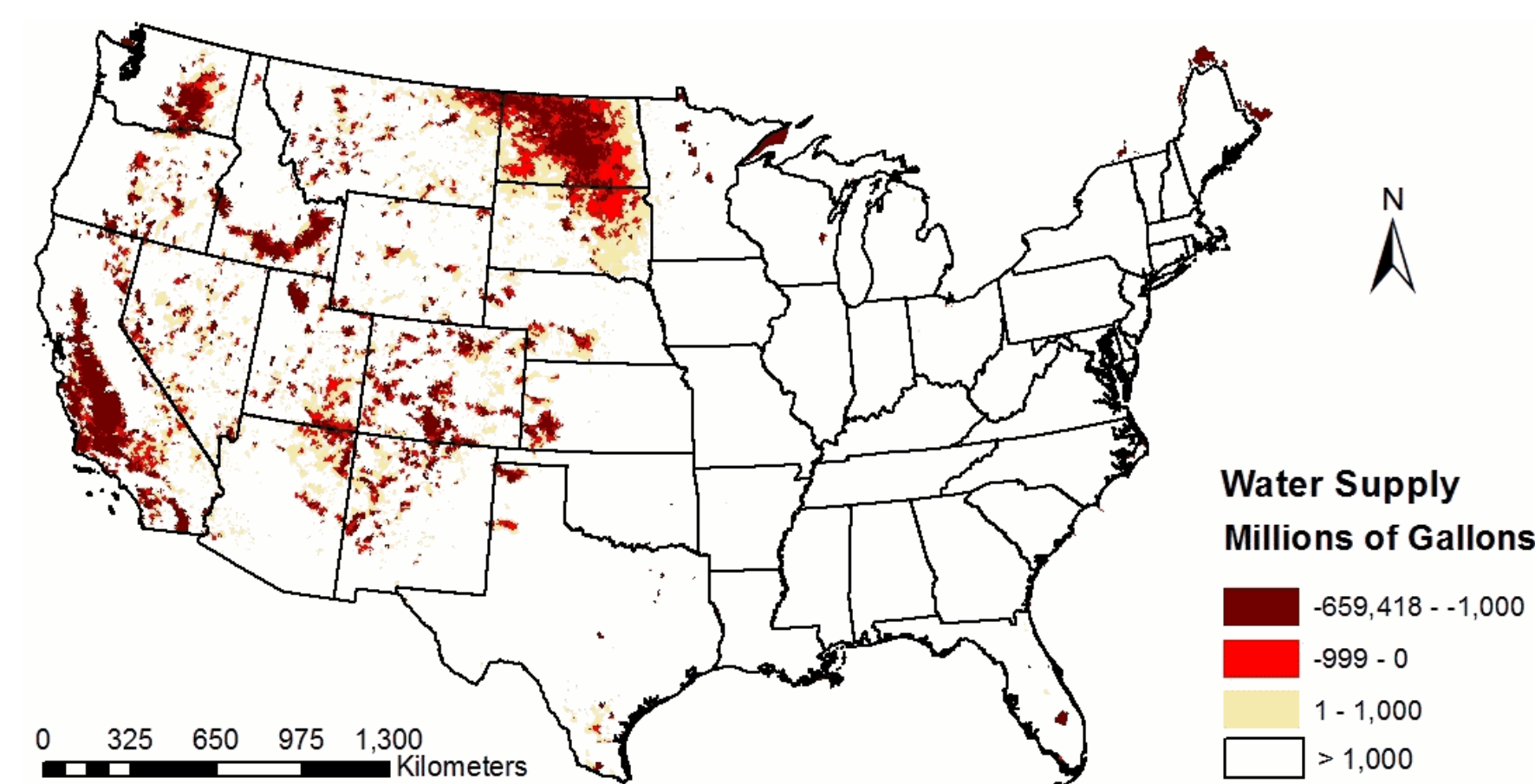
A gross estimate of water supply can be determined by subtracting average annual evapotranspiration, the estimated amount of rainfall that either evaporates from the surface or is transpired by plants, from precipitation. While this type of estimation does not take into account other supply sources, such as groundwater, snow melt, or inter-basin transfers, it does provide a spatial representation of where water supply may be limited.

Data Sources:

- 1981-2010 800-meter precipitation, PRISM Climate Group, Oregon State University, <http://prism.oregonstate.edu>, created 4 Feb 2004
- 1983-2006 Land Surface Evapotranspiration, University of Montana

Processing Overview:

Prepared and aligned rasters into inches. Summarized by watershed (12-digit HUC). Subtracted evapotranspiration from precipitation. Converted to millions of gallons.



Water Demand - Industrial

Industrial water demand includes the amount of water used for manufacturing and production of commodities. For the purposes of this metric, industrial water use includes chemical, food, paper, wood, and metal production. Industrial water comes from self-supplied surface and groundwater (e.g., private wells and reservoirs).

Data Sources:

- 2005 County level USGS Water Use Program data
- 2009/2010 Dun and Bradstreet source data

Processing Overview:

Aggregated facility point files. Joined facility point files to county polygons. Created IDW raster. Assigned IDW raster value to points with no county data. Joined points to HUC12s. Summarized by 12-digit HUC.

Water Demand - Thermoelectric

Thermoelectric power through steam powered turbines demand is based on water withdrawn for electrical generation, but does not account for water that is returned to the watershed after use.

Data Sources:

- 2009 EPA Emission and Generation Resource Integrated Database (eGRID)

Processing Overview:

Selected those sites that had fossil fuel or nuclear energy power sources. Created point layer using latitude and longitude from data file. Used coefficients of water consumption by kWhr energy to calculate plant consumption. Summarized by 12-digit HUC.

Water Demand - Domestic

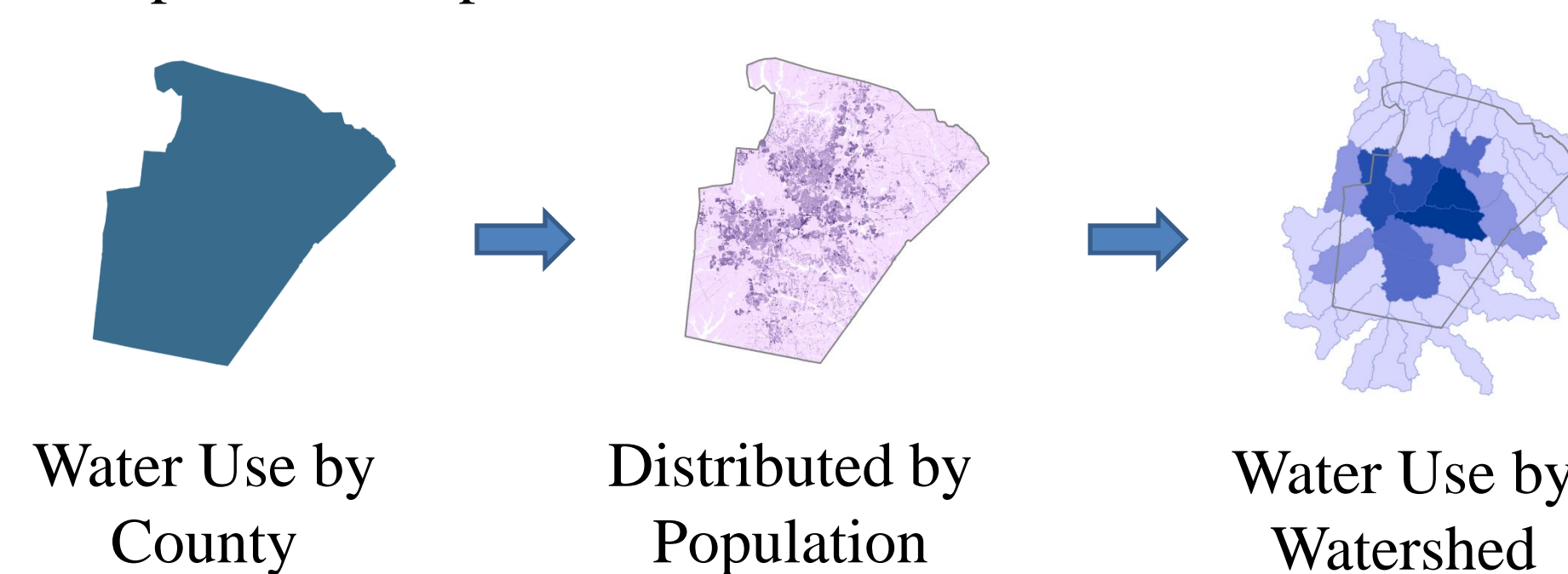
Domestic water demand is the amount of water used for indoor and outdoor residential purposes. It includes self-supplied private wells and publicly-supplied by municipalities. It includes surface and groundwater. Estimates are for primary residences only (i.e., excluding second homes and tourism rentals).

Data Sources:

- 2005 County level USGS Water Use Program data
- 2010 30-meter U.S. EPA EnviroAtlas Dasymetric Population Map

Processing Overview:

Calculated domestic water use, resulting in gallons per person per day per county. Converted to raster. Calculated median use by state for normalization. To weight by population, multiplied state medians by the dasymetric data. Summarized by 12-digit HUC.



Water Demand - Agricultural

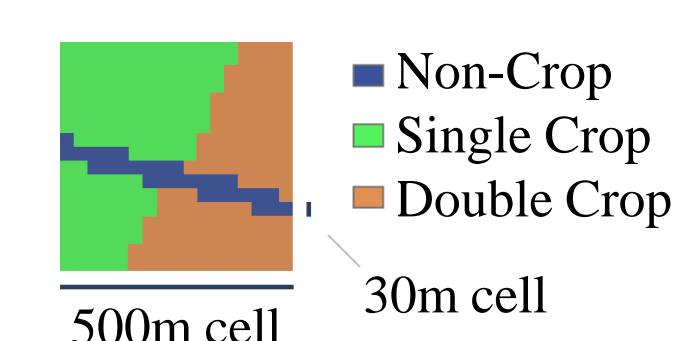
Agricultural water demand provides an estimate of the water used for irrigation. Agricultural water use, as defined in this case, meets a variety of needs before, during, and after growing seasons (e.g., dust suppression, field preparation, chemical application, weed control, salt removal, frost protection, cooling, and harvesting). Sources include self-supplied surface and groundwater, as well as public and private, irrigation-specific organizations.

Data Sources:

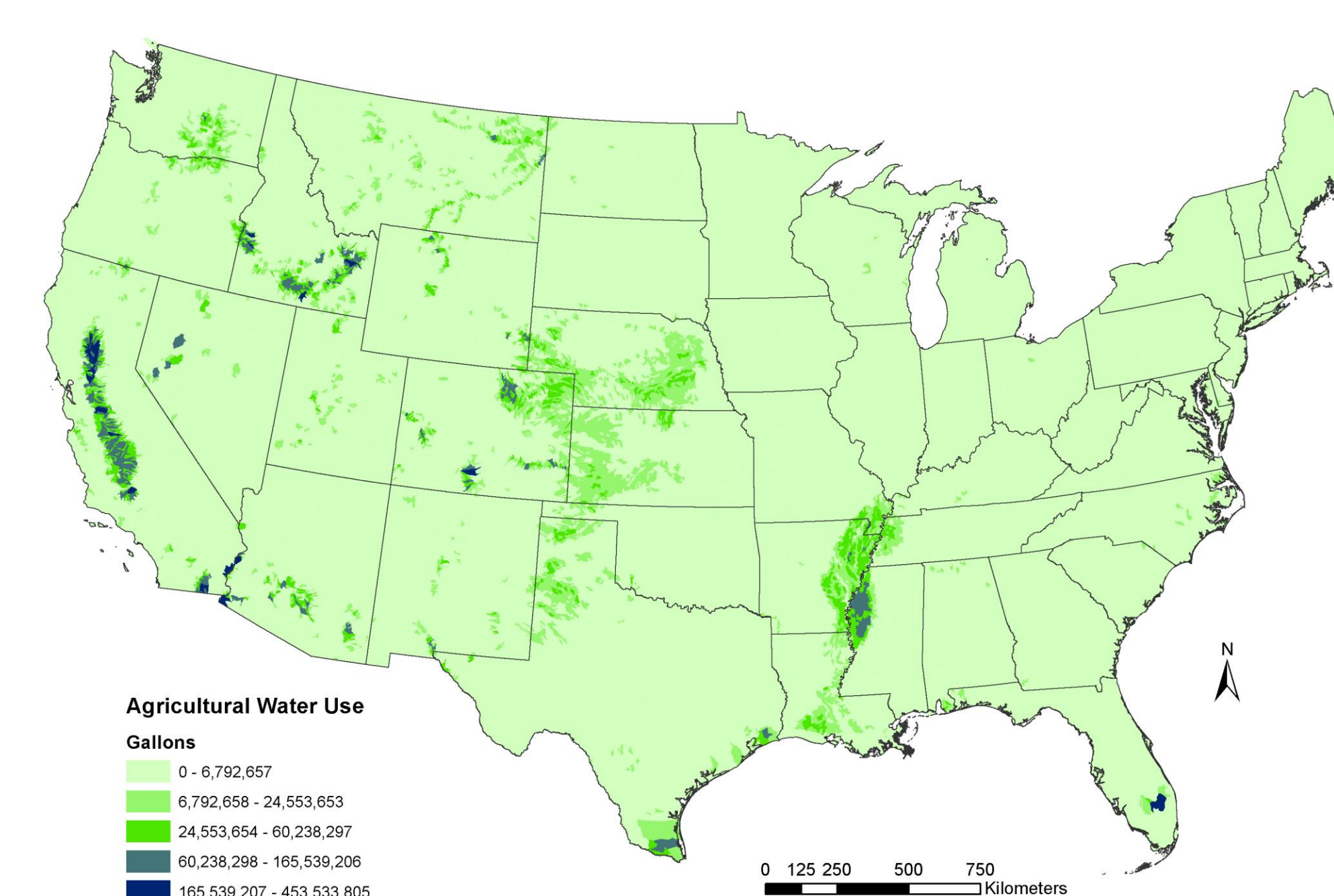
- 2005 County level USGS Water Use Program data
- 2001 500-meter Irrigated Lands from Remote Sensing, University of Wisconsin
- 2010/2006 30-meter U.S. EPA EnviroAtlas Combined USDA Crop Data Layer-MRLC National Land Cover Data

Processing Overview:

Prepared water use data. Where available, removed golf water use. Calculated Agricultural water use per Acre per day per county. Counties with Ag per Acre greater than zero were converted to raster and evaluated. Counties with no Ag per Acre were assigned the state mean or median, whichever was closer to the majority. Converted to Ag per 30m Cell. *Prepared UW remotely sensed irrigation data.* Reclassified 0% to NoData. *Prepared CDL-NLCD.* Reclassified data to 2 (potentially irrigated double crops), 1 (potentially irrigated single crops), and 0 (all others/unlikely crop irrigation). *Created combined UW-CDL-NLCD (UCN) layer.* Extracted from CDL-NLCD using UW as a mask (see below). *Distributed and weighted water use.* Multiplied the UCN by the final Ag per Cell raster. *Summarized results by 12-digit HUC.*



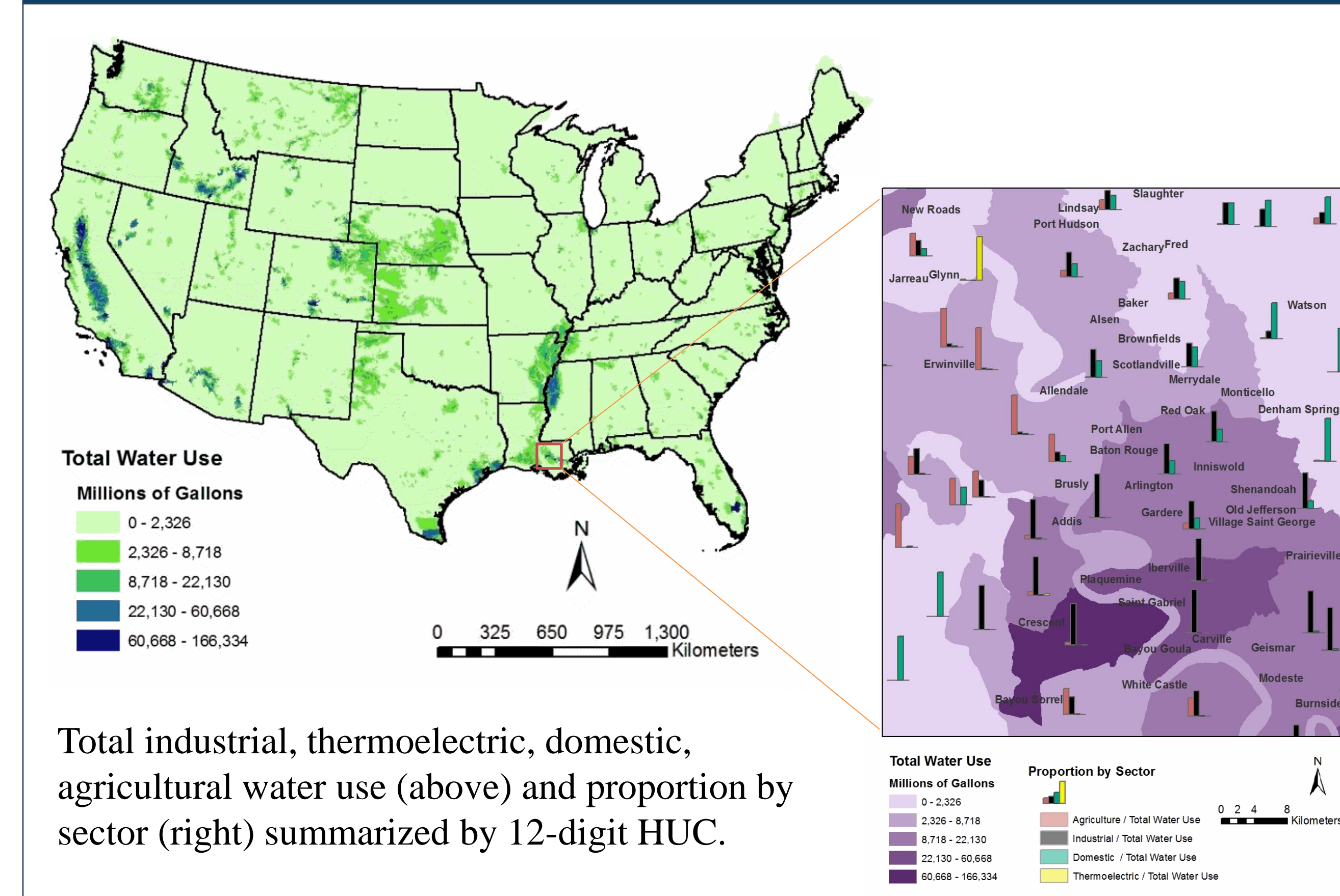
The Irrigated Lands from Remote Sensing data layer shows the estimated percentage per 500-meter cell that is irrigated. The combined usage of the land cover, crop distribution, and crop type at 30-meter resolution helps identify where within the 500-meter cell the irrigation would likely take place.



Spatial Distribution of Irrigation

Agriculture production is the second largest consumer of fresh water in the United States. The fertile river valleys of California, Idaho, and Mississippi all support extensive fruit, vegetable and row crop from above ground water resources. The prairie states of Nebraska, Colorado and Kansas depend on underground pumping and center pivot irrigation for grain production.

Water Demand - Total

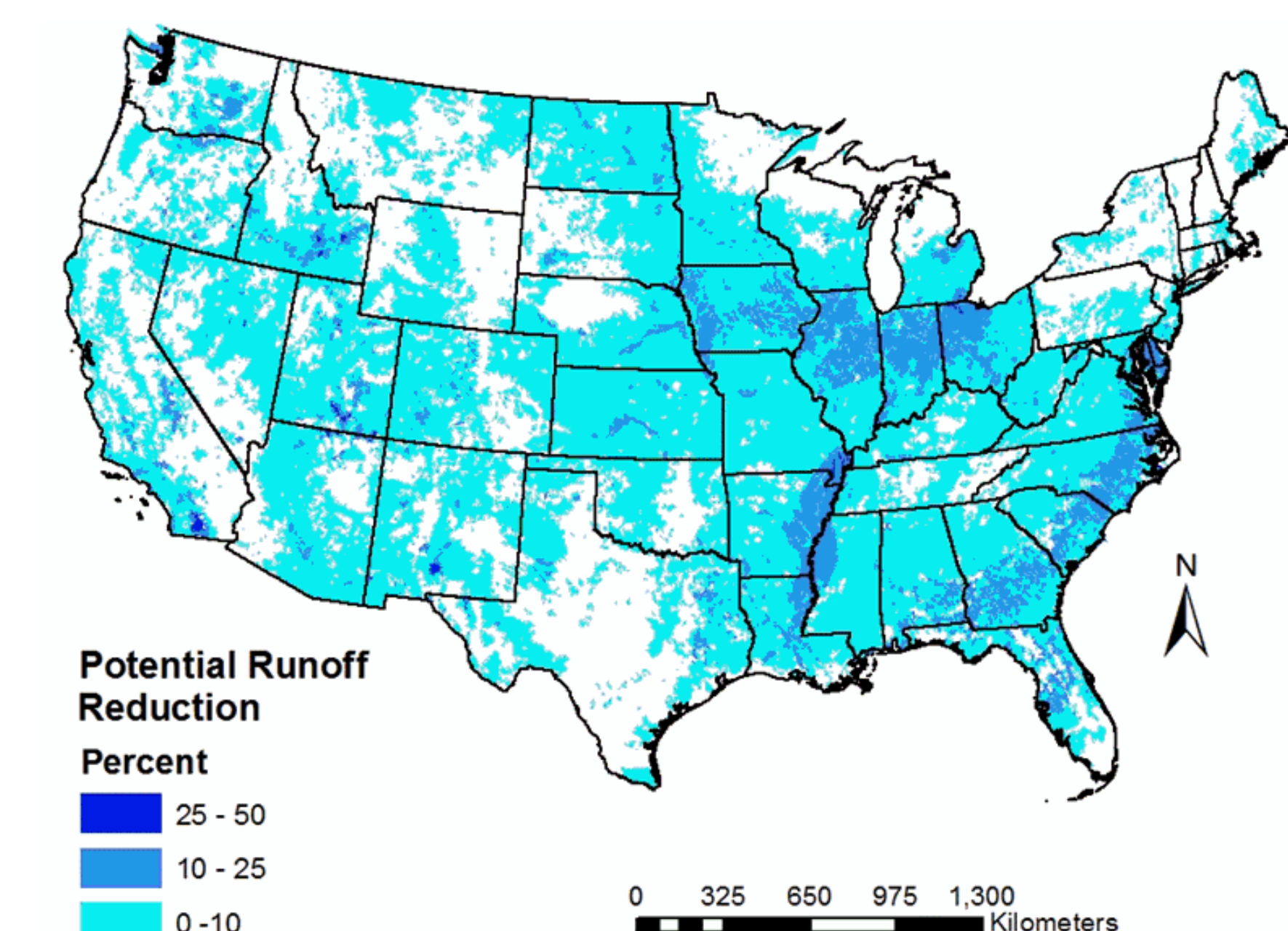


Total industrial, thermoelectric, domestic, agricultural water use (above) and proportion by sector (right) summarized by 12-digit HUC.

Conclusion

While the total water supply from precipitation in the United States is substantially greater than demand, the distribution is uneven. Many of the states west of the Mississippi river are vulnerable to drought and water shortages. Water consumption has steadily increased and remained high in these states with agriculture being the largest user, resulting in the depletion of groundwater and stream flow.

One option for reducing the impact from consumption is to incorporate ecosystem services into future land use planning. For example, returning natural vegetation in and around stream and groundwater recharge areas and reducing the proportion of impervious surface area within a watershed can slow runoff, decrease sediment transport, and improve recharge.



Runoff difference between potential natural vegetation (USGS, 2000) and current condition (NLCD, 2006) condition based on curve number values (USDA, NRCS TR-55).

Acknowledgements

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