South Carolina Spring Water Quality Data in Relation to Land Use and Population Changes: A Preliminary Study

By: Alexis Modzelesky, Nicholas Pinder, C. Luke McDurmon, Kathryn Smith, Hannah Hartley

South Carolina Department of Environmental Services

Introduction

This study updated the water quality data of springs that were previously measured in the 1990s and 2000s, with the purpose of comparing the old and new data within the context of population and land use changes to determine possible effects on spring water quality. This study recorded and updated data on 69 springs that spanned all regions of South Carolina. Parameters studied included temperature, pH, conductivity, dissolved oxygen (DO), alkalinity, ammonia, nitrate, and flow.

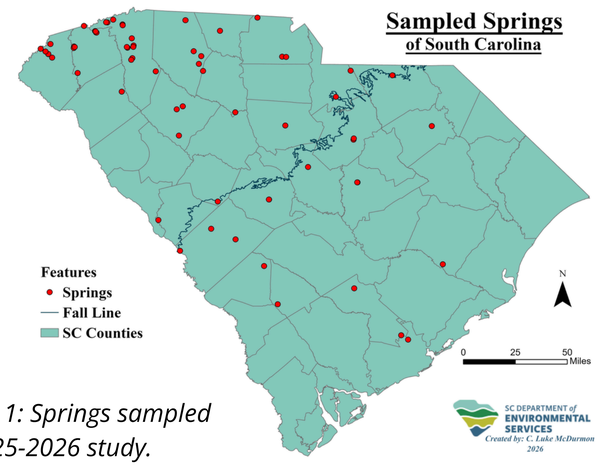


Figure 1: Springs sampled in 2025-2026 study.

Methods

- From the 458 springs identified in the 1990s, a subset of 69 sites were sampled.
- Each site had a minimum of 4 trials performed at randomly selected points around the outflow location to determine the most accurate representation of the springs system.
- Land use figures were converted to rasters and cross-tabulation was applied in R to form a contingency table with the numbers of pixels within each class in order to compare 1996 and 2025 values.
- Population change figures were created using census data and processed within R. Age and race were aggregated and summed on a county level for each year and then percent change was calculated.
- Parameter distributions were constructed based on all recorded trials at each site, and aid in understanding the joined boxplot which demonstrates the regional interquartile range (IQR) and outliers.
- Within ArcGIS spring locations were plotted with their associated parameter values to understand their distribution in relation to regional differences.

Data Analysis

Land Use: Land use change occurred over nearly all class types, with a selection below (*Table 1*).

Class Type 1996	Class Type 2026	Surface Area (km2)
Deciduous Forest	Developed, Low Intensity	102.3
Deciduous Forest	Hay/Pasture	183.31
Evergreen Forest	Developed, Open Space	396.59
Evergreen Forest	Developed, Low Intensity	350.91
Evergreen Forest	Developed, Medium Intensity	182.97
Shrub/Scrub	Evergreen Forest	1074.01
Hay/Pasture	Developed, Open Space	302.64
Hay/Pasture	Developed, Low Intensity	122.73

Table 1: Selected land use change classes from the 2025-26 study.

Population Change: Six counties exceeded 100% increase in population over the last 30 years, and 7 lost more than 10% in total population over the same period.

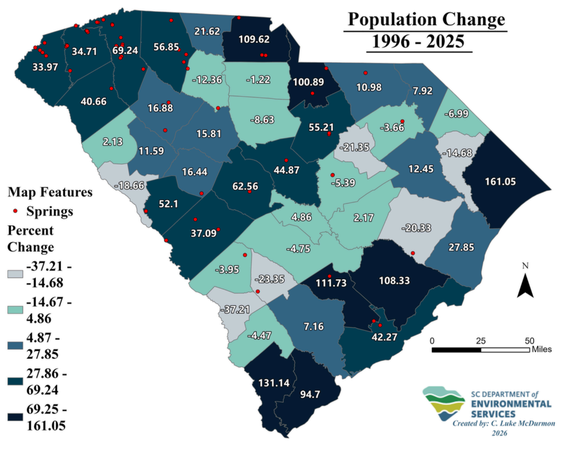


Figure 2: Population percent change by county from 1996 to 2025.

pH: The pH plot illustrates a difference of 0.4 SU between the two regions with the Piedmont having a higher median pH value.

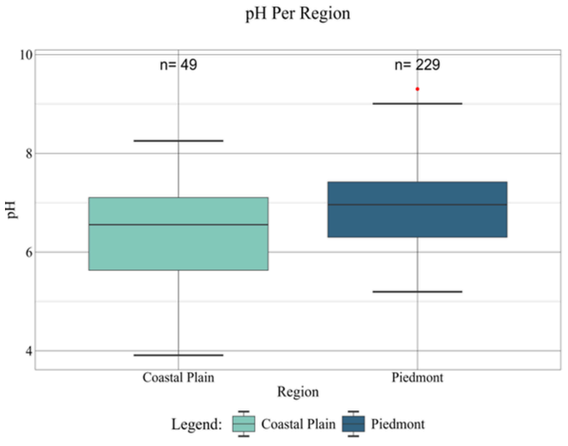


Figure 3: pH box and whisker plot of the Coastal Plain (left) and Piedmont region springs (right).

pH: pH in the Coastal Plain was more acidic compared to the Piedmont (6.56 vs 6.96), however, the Coastal Plain springs were much less represented than those in the Piedmont and Blue Ridges areas.

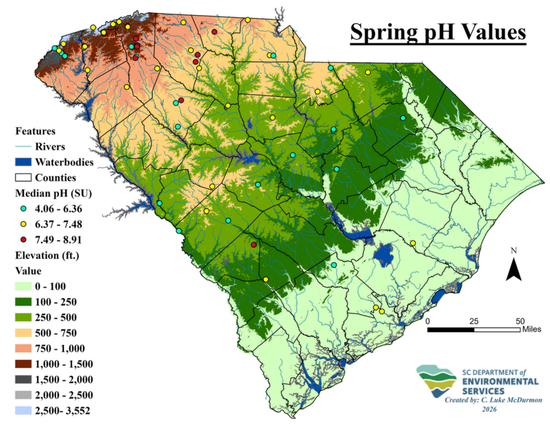


Figure 4: Regional pH values of springs overlaying elevation change.

Discussion

- The springs that were located and sampled appeared to be insulated from the effects of land use and population changes. There were springs that were not located and were therefore unable to be sampled or used in the analysis of this study. More data is required to solidify the connection between these changes and spring chemistry.
- pH values varied across the state possibly due to localized differences in sediment type and geology, but additional sampling would be required to confirm this.
- Areas of the state with the greatest percent increase in population are those in the coastal counties, those centrally located near Columbia and Charlotte, and then those counties near the Blue Ridge. There are some similarities between the parameter data clustering and those areas with population increases, however, this relationship would only be able to be further investigated with additional data recorded over time.
- Exploring land use changes over the last 30 years allows for the examination of how springs are being used, what may be impeding recharge, and the overall water quality being influenced by above ground activities. Although the spatial resolution, 30x30, does generalize areas, the State of South Carolina has undergone extensive land use changes. However, these changes have been isolated to more populous areas and have had little effect on the springs selected in this study. Of the 69 springs where water samples were obtainable, only 6 presented land use changes over time. Of these 6, three were not previously sampled, and three exhibited higher pH.

Data Source

Land use and Population datasets came from Earth Resources Observation and Science (EROS) Center of the USGS and SCORFA (South Carolina Office of Revenue and Fiscal Affairs), respectively. Original data recorded by H. Lee Mitchell of the SCDNR.

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