GEOSPATIAL ANALYSIS OF AGRICULTURAL WATER-METER DATA IN SOUTH GEORGIA

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REFERENCE: *Proceedings of the 2011 Georgia Water Resources Conference*, held April 11–13, 2011, at the University of Georgia.

Abstract. Since November 2008, the U.S. Geological Survey, in cooperation with the Georgia Soil and Water Conservation Commission, has been researching methods for estimating agricultural water use and growing-season pumping rates through the analysis of water-meter data. A geographic information system has been used for geospatial analyses of the data and has yielded promising results for identifying seasonal pumping patterns. For example, cluster and hot-spot analyses of annually read meter data indicate a northwest-to-southeast trend of low-to-high agricultural-irrigation volume, respectively, which could signal relations between water availability, precipitation, soil type, and crop choice among farmers.

INTRODUCTION

By the end of 2009, agricultural water withdrawals in South Georgia were being monitored from a network of 6,985 annually read flow meters and 148 daily reporting, satellite-transmitted, telemetry sites. The monitoring is a result of the enactment of House Bill 579 by the Georgia General Assembly on June 4, 2003, which granted jurisdiction to the Georgia Soil and Water Conservation Commission (Commission) to "[implement] a program of measuring farm uses of water in order to obtain clear and accurate information on the patterns and amounts of such use, which information is essential to proper management of water resources by the state and useful to farms for improving the efficiency and effectiveness of their use of water, …, and [for] improving water conservation" (Georgia General Assembly, 2003).

Since November 2008, the U.S. Geological Survey, in cooperation with the Commission, has been researching methods for estimating agricultural water use and growing-season pumping rates through the analysis of water-meter data. A geographic information system (GIS) has been used for geospatial analyses of the data and has yielded promising results for identifying seasonal pumping patterns.

OBJECTIVES

Objectives of the analysis were to (1) develop a quality-assurance program to ensure completeness and internal consistency of water-meter data, (2) calculate descriptive statistics of aggregated water-use data, (3) evaluate the potential to relate daily water-use telemetry to annually reported water use through a descriptive statistical model, and (4) identify spatial and temporal distributions of agricultural-irrigation pumpage.

PROGRESS AND SIGNIFICANT RESULTS

A GIS-compatible relational database was developed consisting of all annually reported and satellite-transmitted telemetry of agricultural water use for aggregated statistical evaluation and comparison by source (groundwater, surface-water, and well-to-pond irrigation systems). Quality-assurance checks indicated water-meter "rollback" or "roll forward" during periods of non-irrigation, and zero water use at some meter sites since the inception of the metering program in 2003; zero water use significantly affected calculations of mean annual water use. On average, irrigation volume supplied by groundwater exceeded the volume supplied by surface water by about one-third. Comparison of mean irrigation volumes by source indicated that groundwater- and surface-water use represent two distinct data populations that require independent statistical analyses.

Analyses of 81 telemetered and 4,357 annually reported water-use sites, which constitute the metering program in the Chattahoochee–Flint River watershed, were conducted to evaluate the randomness of the two datasets (groundwater and surface water)—a prerequisite for subsequent geospatial analyses—and to assess the spatial distribution of meter locations. The analyses indicated

- Possible outliers or "hot spots" (clusters of high or low water-use values) that may relate to variations in aquifer yield, streamflow availability, soil type, crop patterns, rainfall and topography, requiring further identification and study (Fig. 1). Separate hot-spot analyses for surface water (Fig. 1*B*) and groundwater (Fig. 1*C*) indicated geographic bands trending northwest to southeast of low-to-high agricultural water-use volume.
- Concentrated distributions (clustering) of telemetry sites in areas containing low-irrigation volumes, which resulted in underestimating annually reported mean water use with the telemetry network.
- A wide range of applied irrigation volumes among meter sites, which required data conversion to per-acre application rates by dividing irrigation volume by field acres.

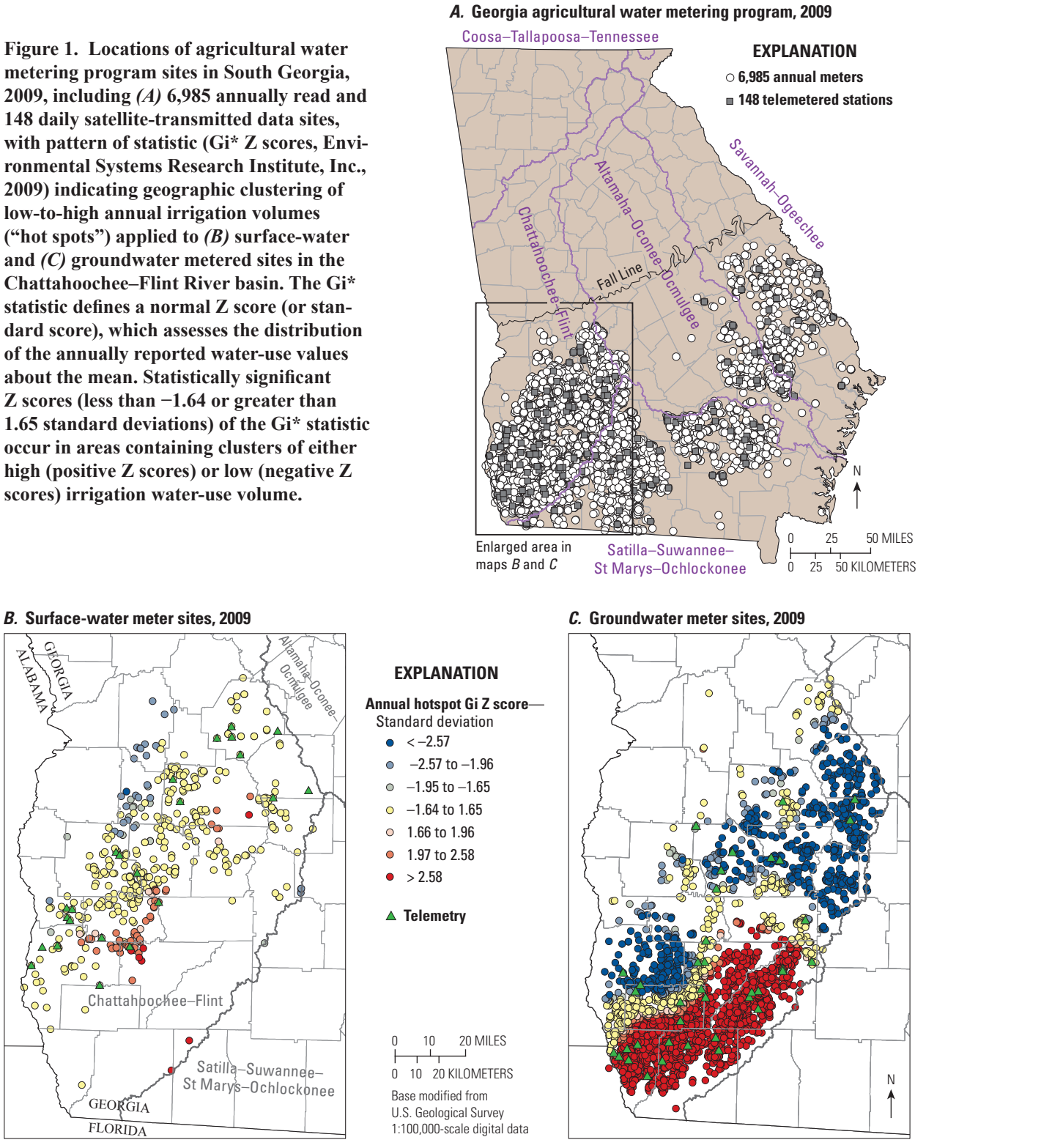

Figure 1. Locations of agricultural water metering program sites in South Georgia, 2009, including *(A)* 6,985 annually read and 148 daily satellite-transmitted data sites, with pattern of statistic (Gi* Z scores, Environmental Systems Research Institute, Inc., 2009) indicating geographic clustering of low-to-high annual irrigation volumes ("hot spots") applied to *(B)* surface-water and *(C)* groundwater metered sites in the Chattahoochee–Flint River basin. The Gi* statistic defines a normal Z score (or standard score), which assesses the distribution of the annually reported water-use values about the mean. Statistically significant Z scores (less than −1.64 or greater than 1.65 standard deviations) of the Gi* statistic occur in areas containing clusters of either high (positive Z scores) or low (negative Z scores) irrigation water-use volume.

REFERENCES

Environmental Systems Research Institute, Inc., 2009, How hot spot analysis: Getis-Ord Gi* (Spatial Statistics) works: Environmental Systems Research Institute, Inc., release 9.2, accessed March 24, 2010, at *http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=How%20Hot%20Spot%20Analysis:%20Getis-Ord%20Gi*%20(Spatial%20Statistics)%20works*.

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