Groundwater Levels and Coastal Stream Salinization Processes

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Introduction

- In coastal watersheds, migration of saltwater upstream is major water quality concern.
- The salinity of coastal streams depends on the balance between freshwater discharge to the sea and seawater forcing inland.
- Groundwater pumping has been linked to a decrease in stream baseflow, which could disrupt this balance[1].
- There is a gap in the literature around the connection between groundwater pumping and coastal stream salinity (Fig. 1).
- We hypothesized that in many coastal areas, changes in groundwater level can affect coastal stream discharge and salinity.
- The main objective of this research was to test this hypothesis and better understand the relationship between groundwater pumping, streamflow, and stream salinity in coastal watersheds (Fig 2).

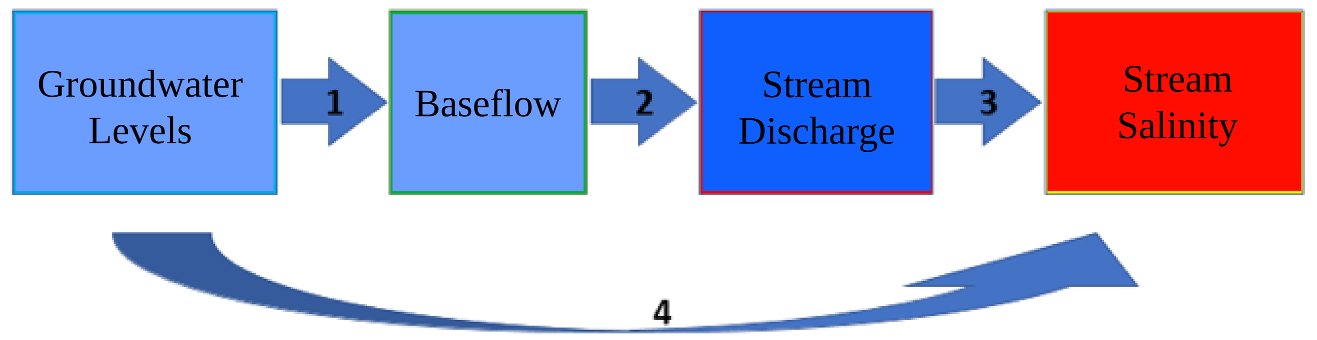

Fig. 1. Conceptual model explaining the relationships that are hypothesized to exist between groundwater levels and stream salinity.

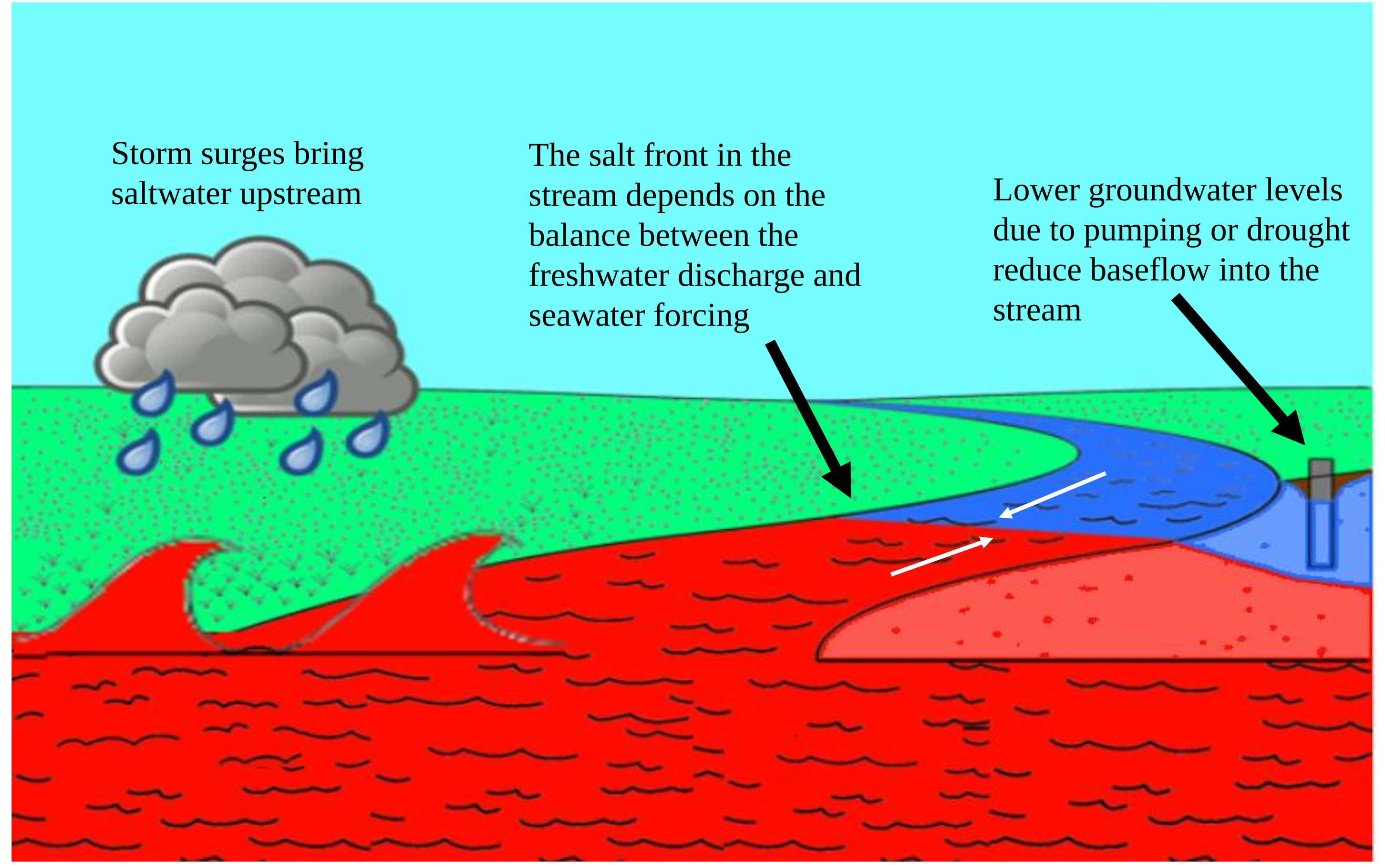

Fig. 2. Conceptual model illustrating the different salinization processes that can affect coastal streams, through both freshwater discharge and seawater forcing.

Data

- Data was obtained from the United States Geological Survey National Water Information System Web Interface, the National Oceanic and Atmospheric Administration, and the Florida Fish and Wildlife Conservation.

Results: Suwannee River

- The spikes in specific conductance in the Suwannee River Watershed (Fig. 3) represent fast salinization processes related to storm events and tides.
- One salinization process is caused by large storm surges bringing seawater upstream (Fig. 4).
- Another salinization process is caused by a decrease in freshwater discharge, allowing specific conductance to spike more easily (Fig. 5).

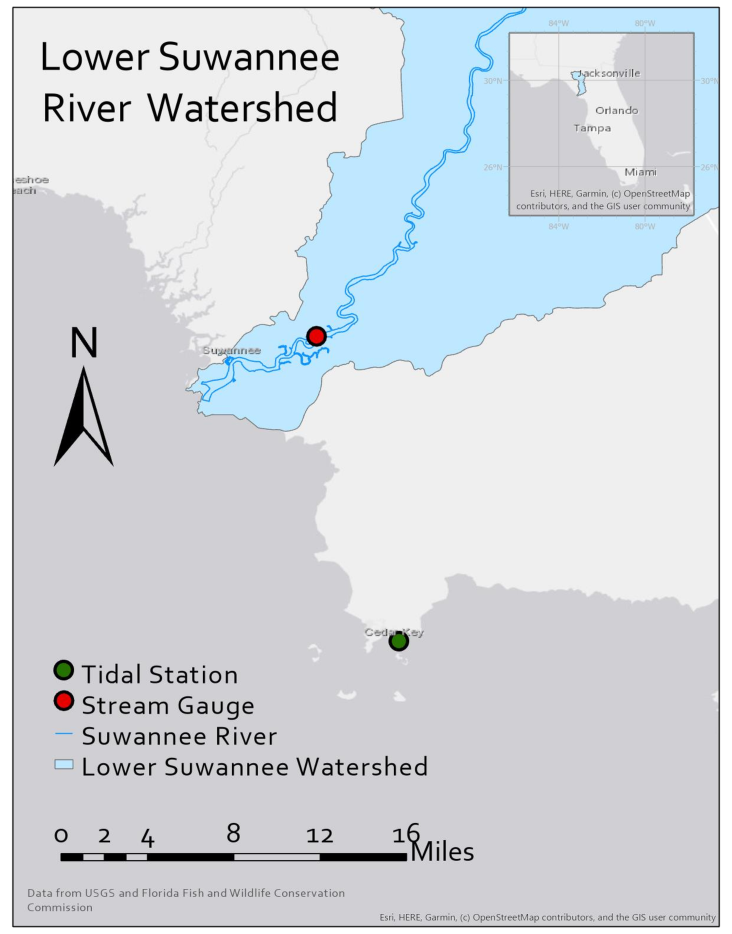

Fig. 3. Lower Suwannee River Watershed, showing stream gauge and tidal station.

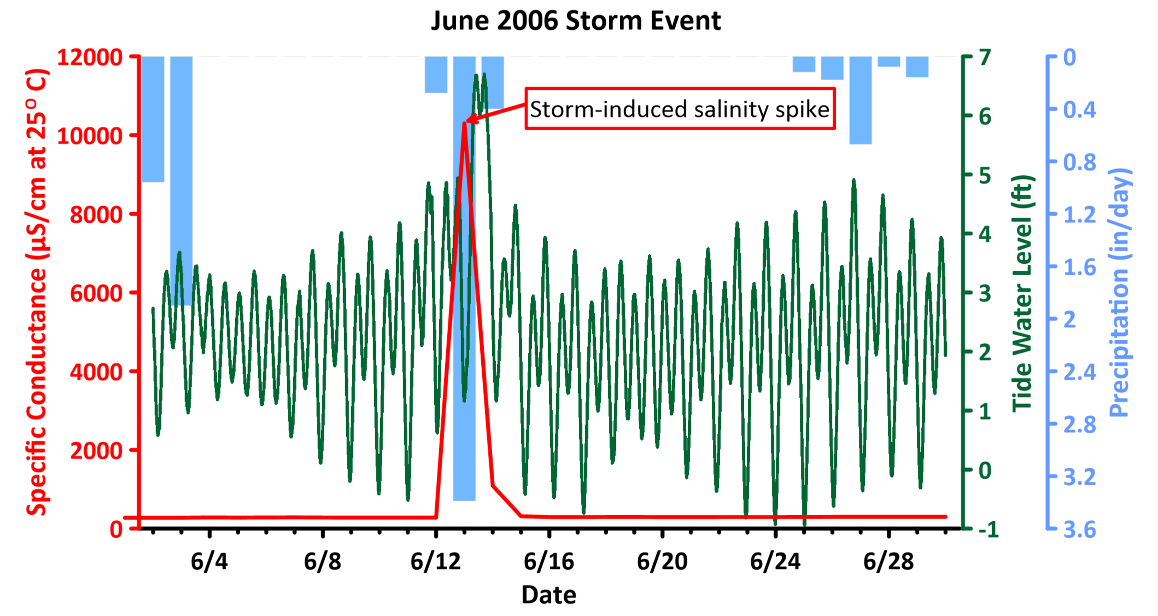

Fig. 4. A tropical storm in June 2006 created a storm surge that brought seawater up the Suwannee River, causing a spike in specific conductance.

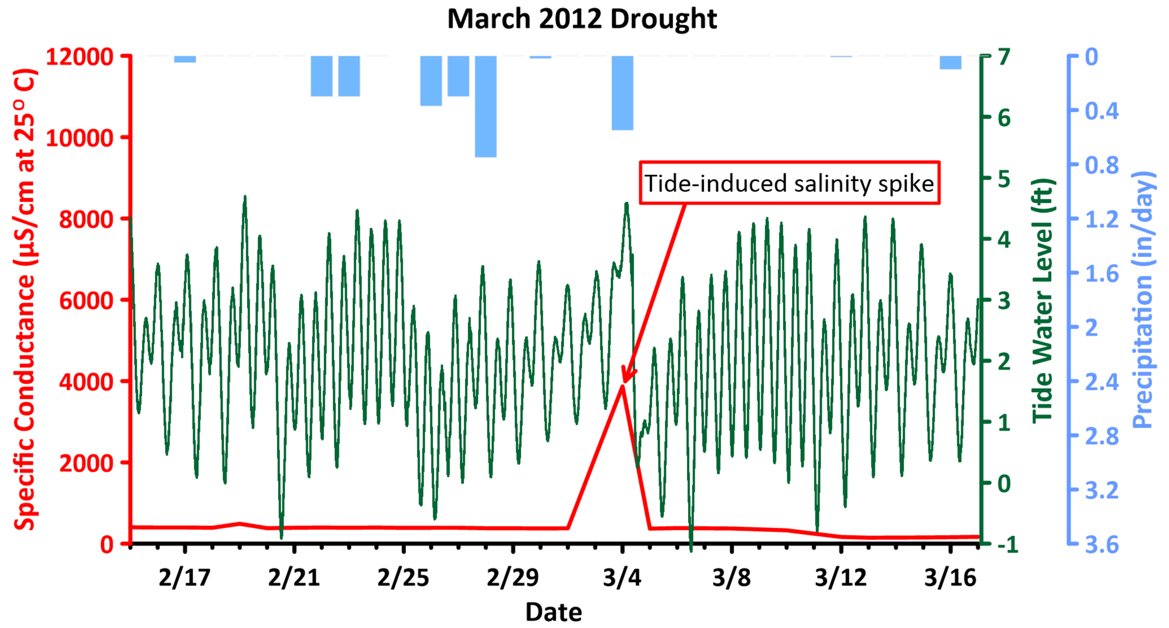

Fig. 5. A drought period in March 2012 decreased the amount of freshwater that was balancing the seawater forcing, allowing the specific conductance to spike during a high tide.

Results: Savannah River

- The Savannah River Watershed (Fig. 6) possibly represents a slow salinization process related to changes in groundwater levels and streamflow.
- Stream gauge data from this site exhibits a relationship between lower discharge and higher specific conductance[2] (Fig. 7).
- The city of Savannah began to extensively pump groundwater from the confined Upper Floridan Aquifer in the mid 20th century, drawing down the water levels in the aquifer[3] (Fig. 8).

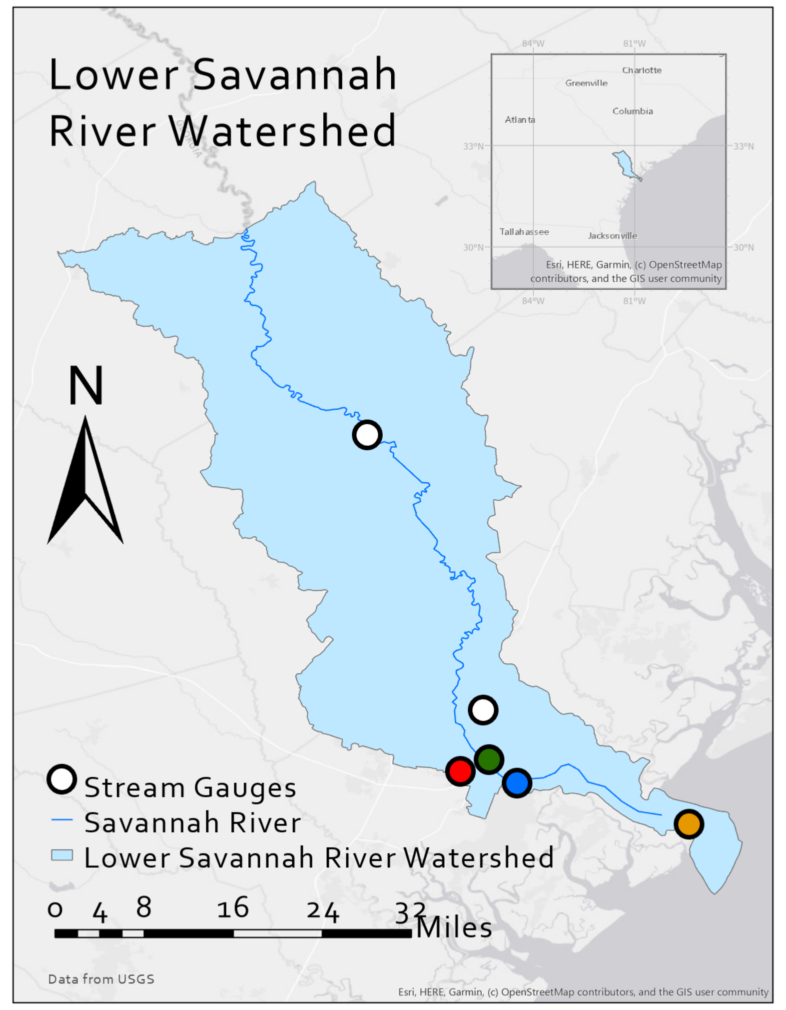

Fig. 6. Lower Savannah River Watershed, showing stream gauges and wells that provided data.

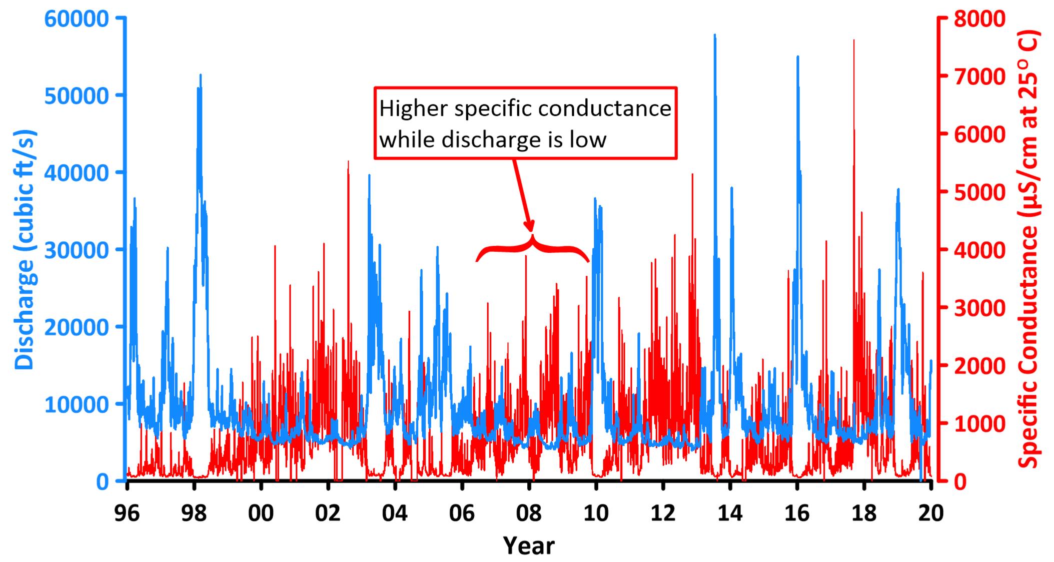

Fig. 7. Discharge and specific conductance in the Savannah River, with periods of low discharge associated with higher specific conductance. The upstream gauge was used for discharge data due to tidal influence on downstream gauges.

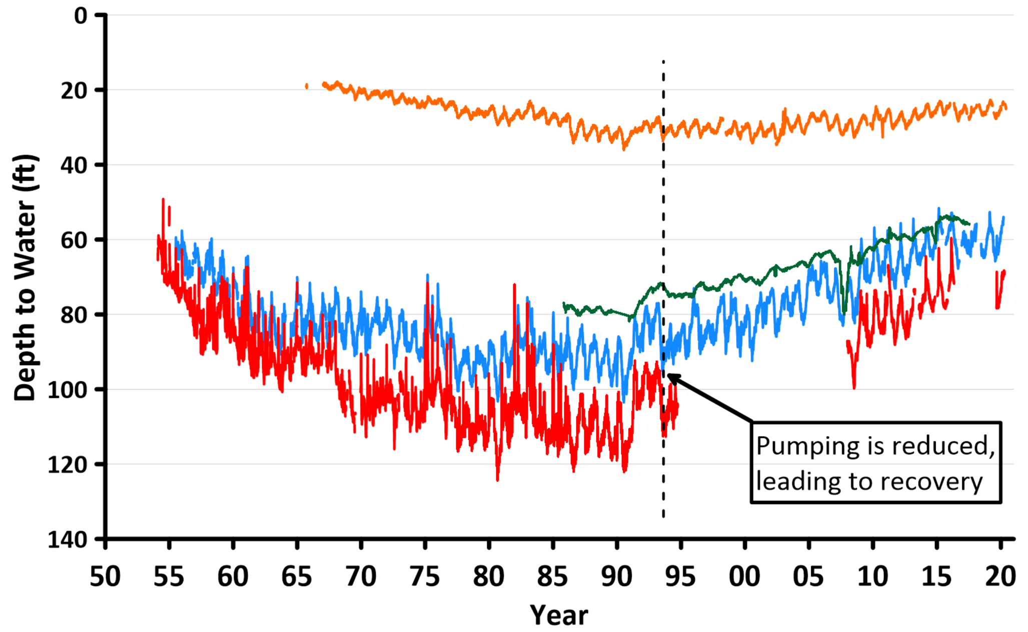

Fig. 8. Groundwater levels in the Upper Floridan Aquifer reflect drawdown due to pumping and subsequent recovery due to a decrease in pumping from saltwater intrusion concerns. Colors correspond to Fig. 6.

Conclusions

- Trends in the Suwannee River represent a fast salinization process, in which storms events and high tides cause salt water to migrate farther upstream than normal.
- Trends in the Savannah River could represent a much slower salinization process, in which long-term changes in streamflow and in groundwater levels affect the salinity of the stream.
- Both watersheds demonstrate coastal salinization processes that should be further investigated to fully understand water resource implications.

References

[1] Killian, C.D. et al., 2019, https://doi.org/10.1007/s10040-019-01981-6.
[2] Conrads, P.A. et al., 2006, https://pubs.usgs.gov/sir/2006/5187/pdf/sir20065187.pdf
[3] Provost, A.M. et al., 2006, https://pubs.usgs.gov/sir/2006/5058/pdf/sir06-5058.pdf.

Acknowledgements

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