BIG STORM EVENTS AND EXTENT OF WATER LEVEL CHANGES IN MONITORING WELLS, ROBESON COUNTY, NC.

Madan Maharjan and Cody Gless

University of North Carolina at Pembroke

ABSTRACT

Coastal regions of the southeastern Carolinas rely on the Cretaceous aquifers for municipalities, industries, and agricultural water usage. This groundwater is deemed safe and a reliable source of water in this region given the fact that these aquifers are confined. However, it is not necessary that the aquifers have the same level of confinement everywhere, especially under the streams that have vertical incised the confining layer or where the confining layer is thin/missing. It is also noteworthy that this region is experiencing higher frequency and larger magnitude of storm events recently causing more frequent floods for extended periods that could exacerbate groundwater. I have been monitoring groundwater levels and barometric pressure in Robeson County since December 2017 using a network of 13 monitoring wells (county wells) that are tapped into the Black Creek Aquifer. Well hydrographs show a similar trend to the Lumber River following Hurricane Florence for several days. These findings raise the question of whether the Black Creek Aquifer has a significant level of confinement. I have analyzed groundwater level and barometric pressure data from the county wells and state wells to study the characteristics of the aquifer. It is interesting to see the influence of big storms on the groundwater levels in the Black Creek Aquifer. The objective of this study is to find the degree of confinement to the Black Creek Aquifer. There are implications for the public health, the environment, and the economy of the region upon the aquifer having lesser confinement than expected.
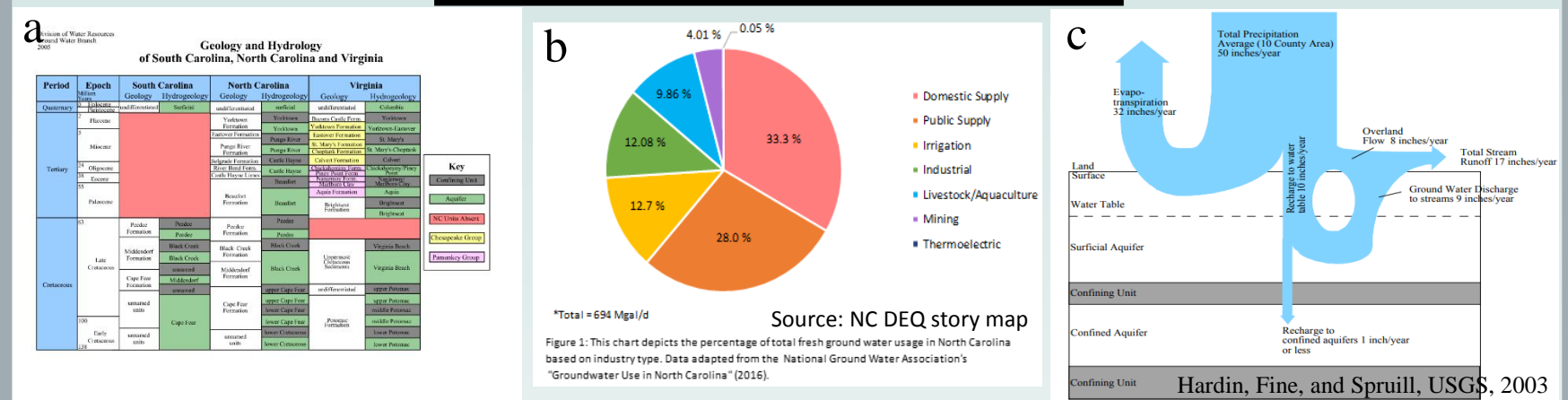
INTRODUCTION

Figure 1. (a) General hydrogeology, (b) water usages, and (c) Water balance

CONCEPTUAL MODEL

Figure 2. Cross section of the Black Creek aquifer showing breach of the confining layer and potential pathways of water movement in the aquifer.
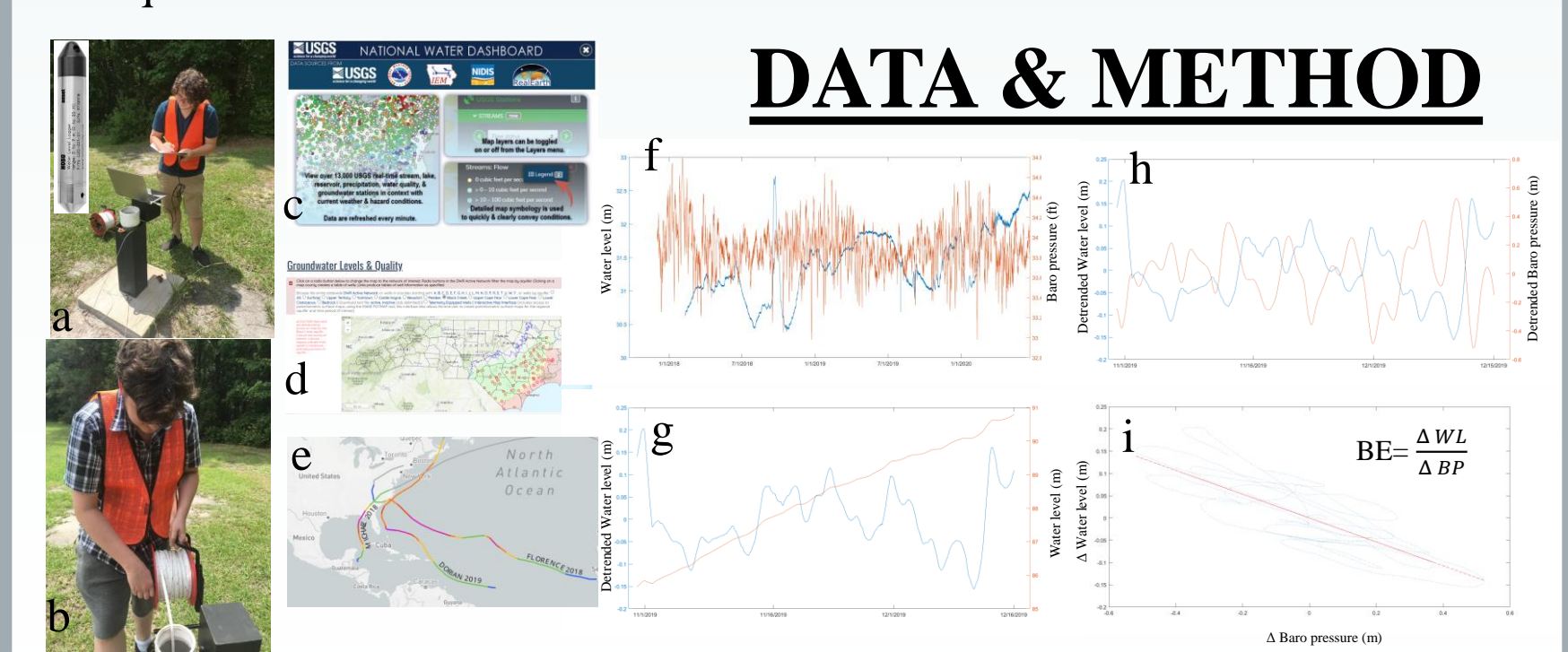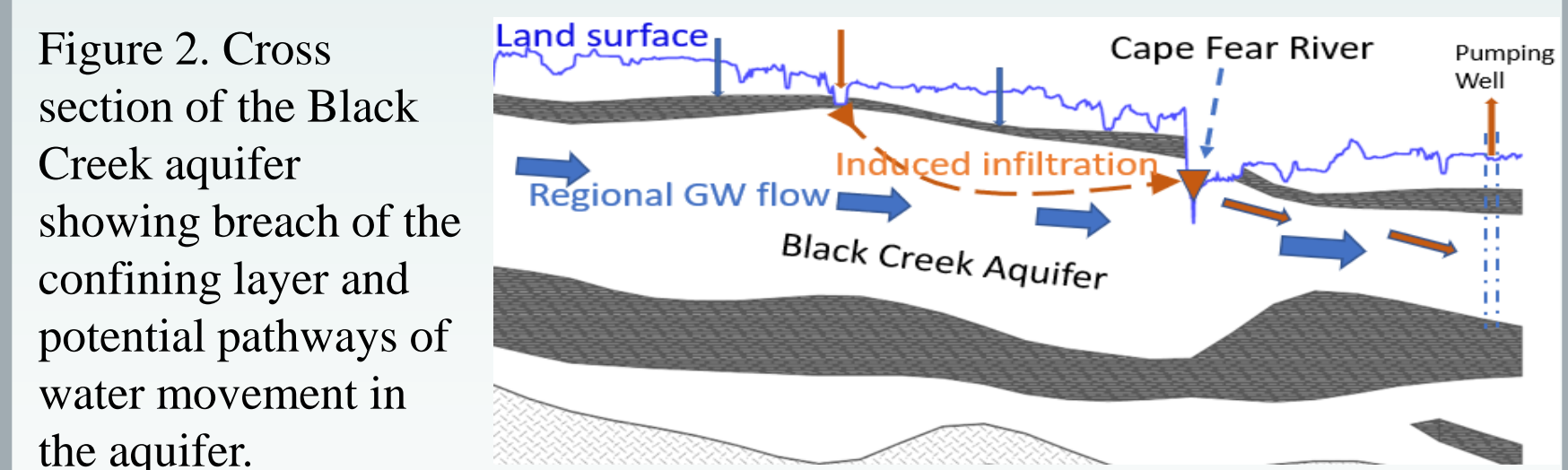
DATA & METHOD

Figure 3. Data collection methods employed in the field (a & b) and lab (c, d, & e) and data processing for calculation of Barometric Efficiency (f, g, h, & i).
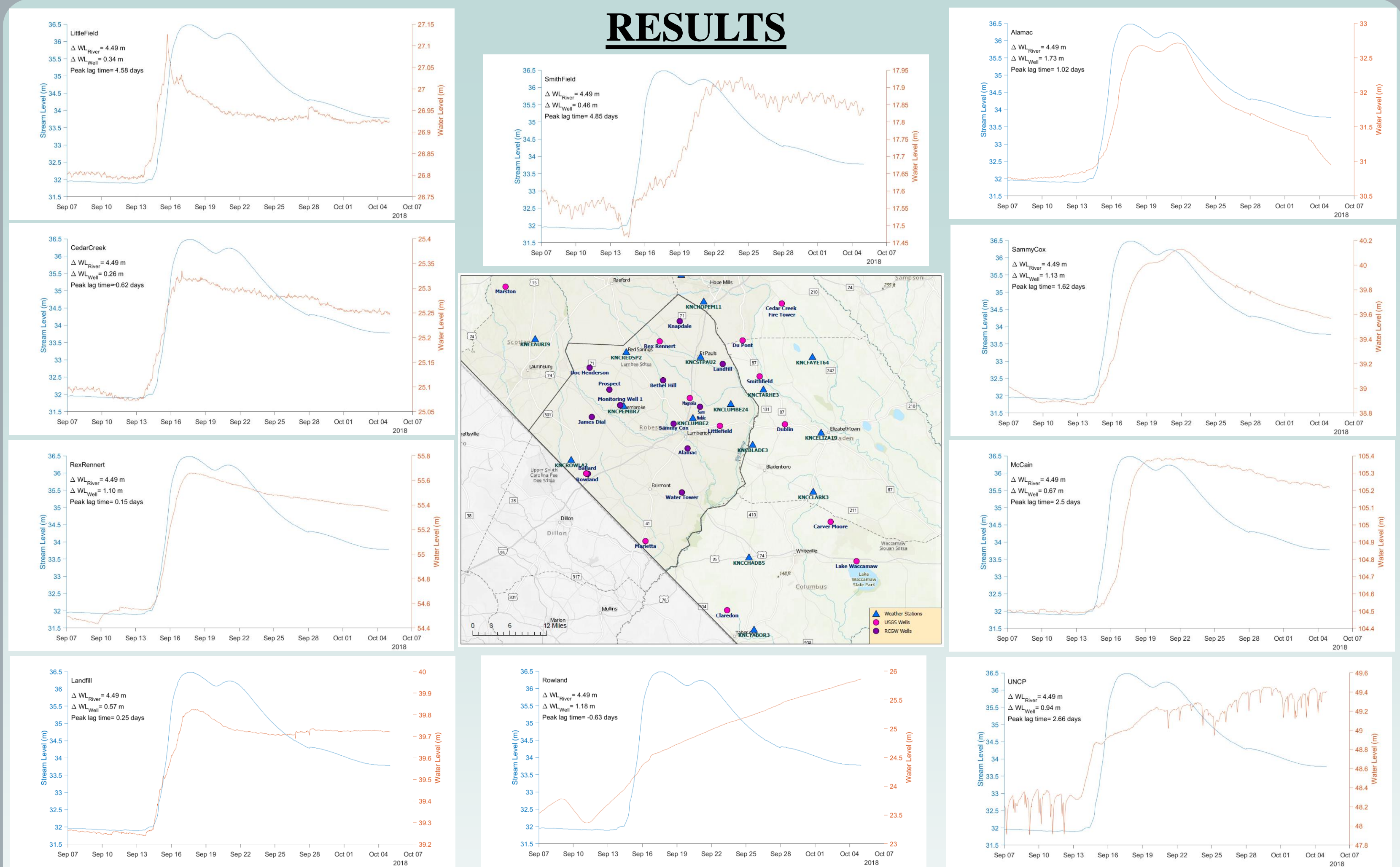
RESULTS

Figure 4. Comparison of stream hydrograph (Lumber River) with surficial and confined aquifers' well hydrographs after major hurricanes.

Figure 5. Calculated water level rise in the Black Creek aquifer (bottom), correlation between the Lumber River and well hydrographs (middle), and peak lag times between surface water levels and groundwater level (top) recorded after Hurricanes Florence, Michael, and Dorian in the study area.
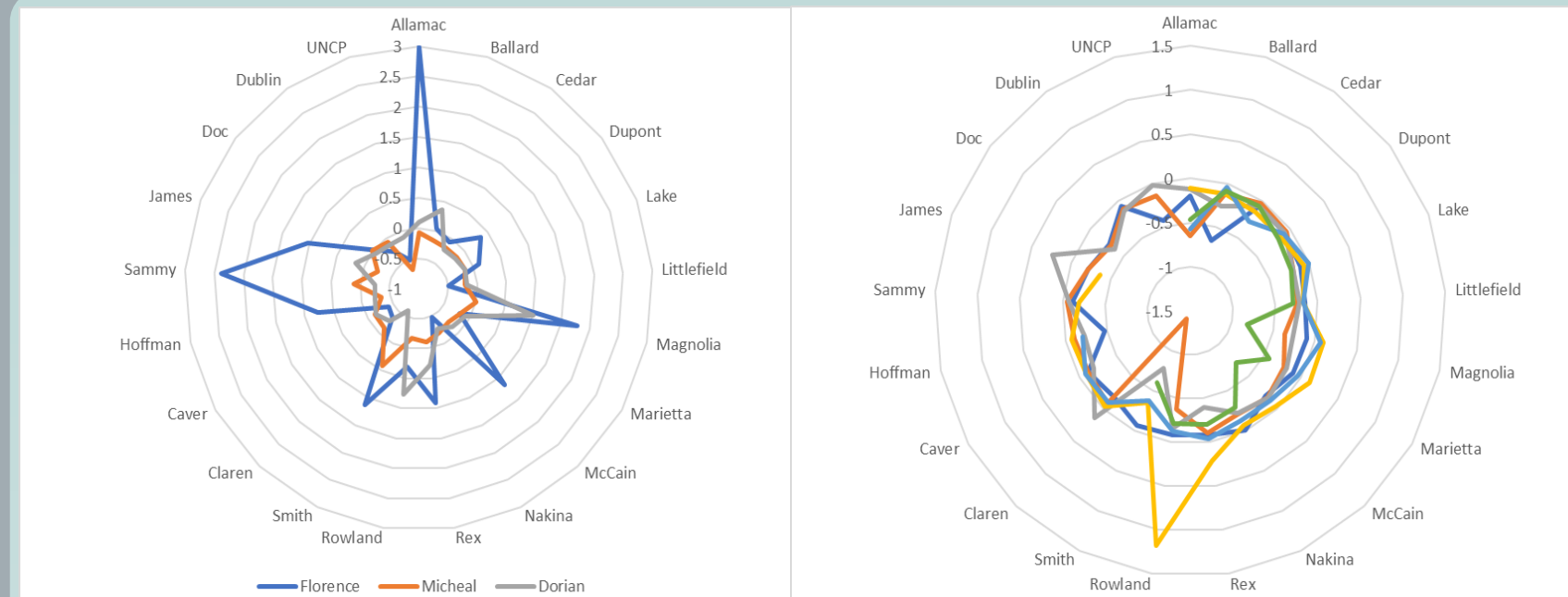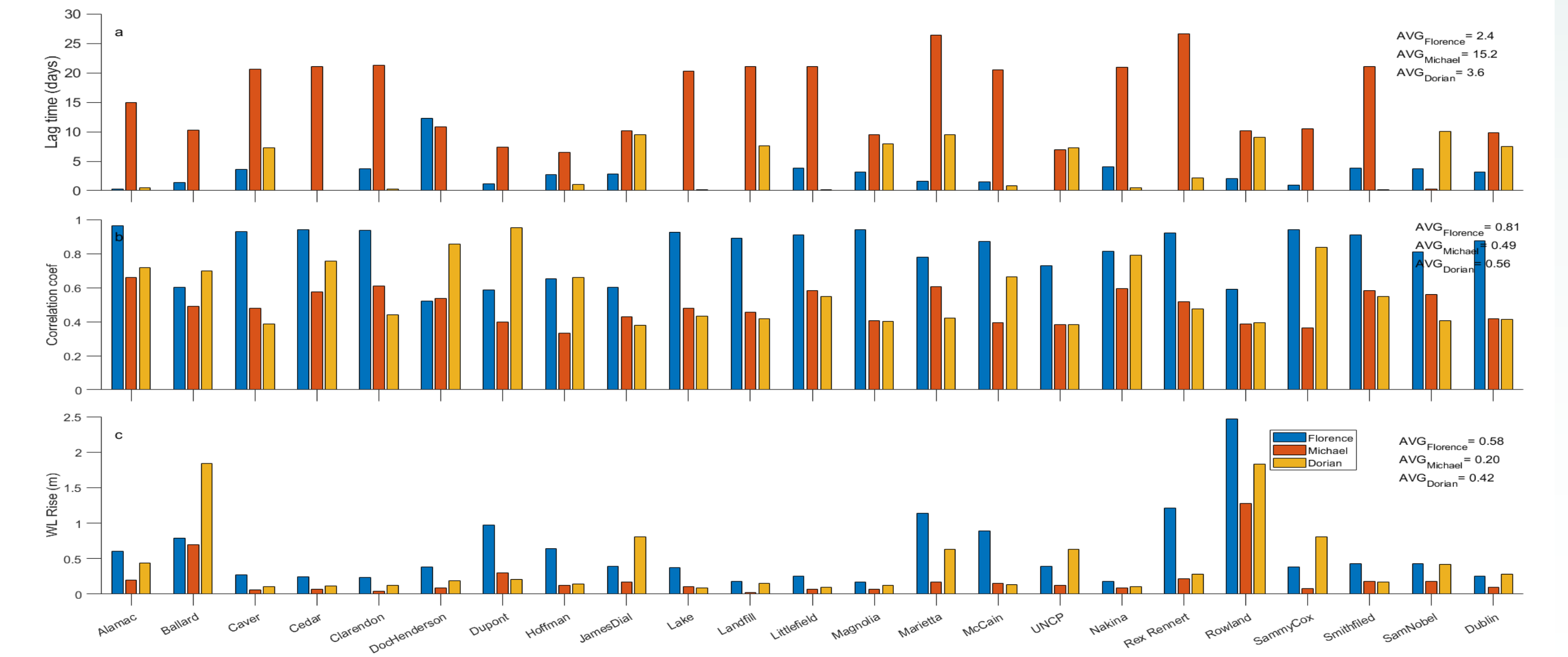
Figure 6. Comparison between event-specific (left, three hurricanes) and seasonal (right) barometric efficiency for the Black Creek aquifer.

CONCLUSIONS

- The Black Creek aquifer has spatially and temporally varying water levels, peak lag times, and rise in water levels during three hurricanes.
- The Black Creek aquifer has noticeably different values of barometric efficiency during the three hurricanes.
- Bigger the storm larger the impact on the aquifer in terms of change in water level and barometric efficiency.
- Barometric efficiency exceeds its range indicating that the aquifer was under higher influence of both natural and anthropogenic activities.
- A short gap between two hurricanes means a lesser impact on the aquifer.
- Both natural (storms) and anthropogenic (pumping) activities have substantially influenced the groundwater levels.

FUTURE WORK

- Tease out natural vs anthropogenic signals from water level data;
- Process water level data to filter out barometric pressure independent water level changes;
- Further analysis of Barometric efficiency;
- Estimate error in calculation of barometric efficiency;
- Identify aquifer responses to storms; and
- Estimate the degree of confinement of the aquifer.

REFERENCES

- Division of Water Resources, Aquifer Characteristics, North Carolina Department of Environment and Natural Resources, https://geodata.lib.ncsu.edu/stategov/gws/2010/Aquifer%20Characteristics.htm.
- Harden, S. L., Fine, J. M., & Spruill, T. B. (2003). Hydrogeology and ground-water quality of Brunswick County, North Carolina (Vol. 3, No. 4051). US Department of the Interior, US Geological Survey.
- Gonthier, G. J. (2007). Estimating Barometric Efficiency Using a Graphical Method on Nearly Continuous Data. Georgia Institute of Technology.
- NCGWA, 2016, Groundwater-Use-in-NC.pdf, ncgwa.org, https://ncgwa.org/contento/uploads/2016/08/Groundwater-Use-in-NC.pdf
- Strickland, A. G. (2000). Water-level Conditions in the Black Creek Aquifer, 1992-98, in Parts of Bladen, Hoke, Robeson, and Scotland Counties, North Carolina (No. 4138). US Department of the Interior, US Geological Survey.

ACKNOWLEDGEMENTS