Hurricane Dorian on Johns Island: September 2019
QUICKLOOK September 24, 2019

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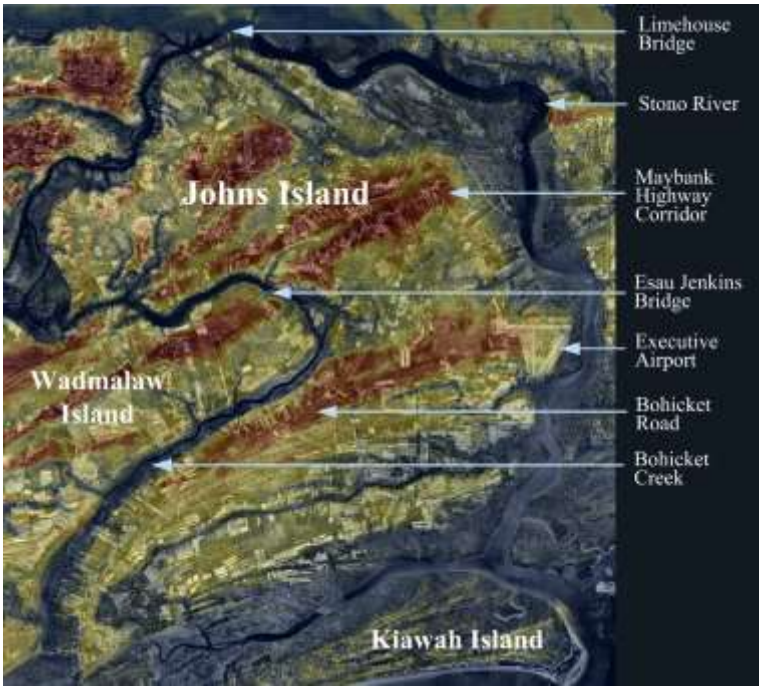
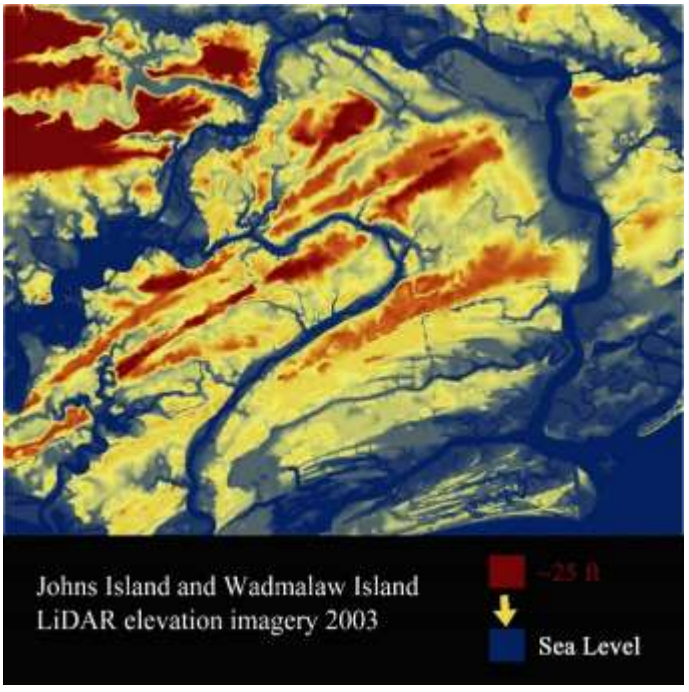
Lowcountry Flooded States of America

Introduction

This is a very preliminary report on the impact of Hurricane Dorian on the Johns Island watershed known as the Burden Creek Basin, a low-lying area which traverses the middle of Johns Island between two large ancient dune systems. This area is being developed with Fill-and-Build developments, which clear-cut forested areas, decrease the permeability of the ground, negatively affect surface and subsurface hydrology, and contribute to a much higher runoff rate of degraded-quality water to the watershed. While the storm stayed offshore, Johns Island, SC experienced high winds and received approximately 6 inches of rain in a nine-hour period. A recording weather station and seven recording instruments positioned at six observation points captured the qualitative differences in the behavior of five sub-watersheds of the Basin.

Forested and marsh-dominated watersheds experienced the least storm-related runoff while the area where there has been extensive Fill-and-Build development exhibited the greatest amount of degraded-quality flash runoff closely followed the rainfall in developed areas whereas, the less-developed areas showed retention and slower release. Water quality monitoring in Burden Creek before and after the storm detected a severe drop in oxygen that lasted for many days after the storm. Such oxygen depletion events from densely developed watersheds are consistent with the ecological damage to marshlands found by the Charleston Harbor Project of the mid-1990's. These data document the effects of Fill-and-Build developments to stormwater flooding and the ecological degradation of wetland water quality. As Charleston continues to grow, it must realize that large-scale Fill-and-Build development projects will degrade water quality of our wetlands, exacerbate the destructive forces of climate change, and reduce the resiliency of natural buffers. This is especially true for developments now approved or planned for Johns Island, Cainhoy, and West Ashley.





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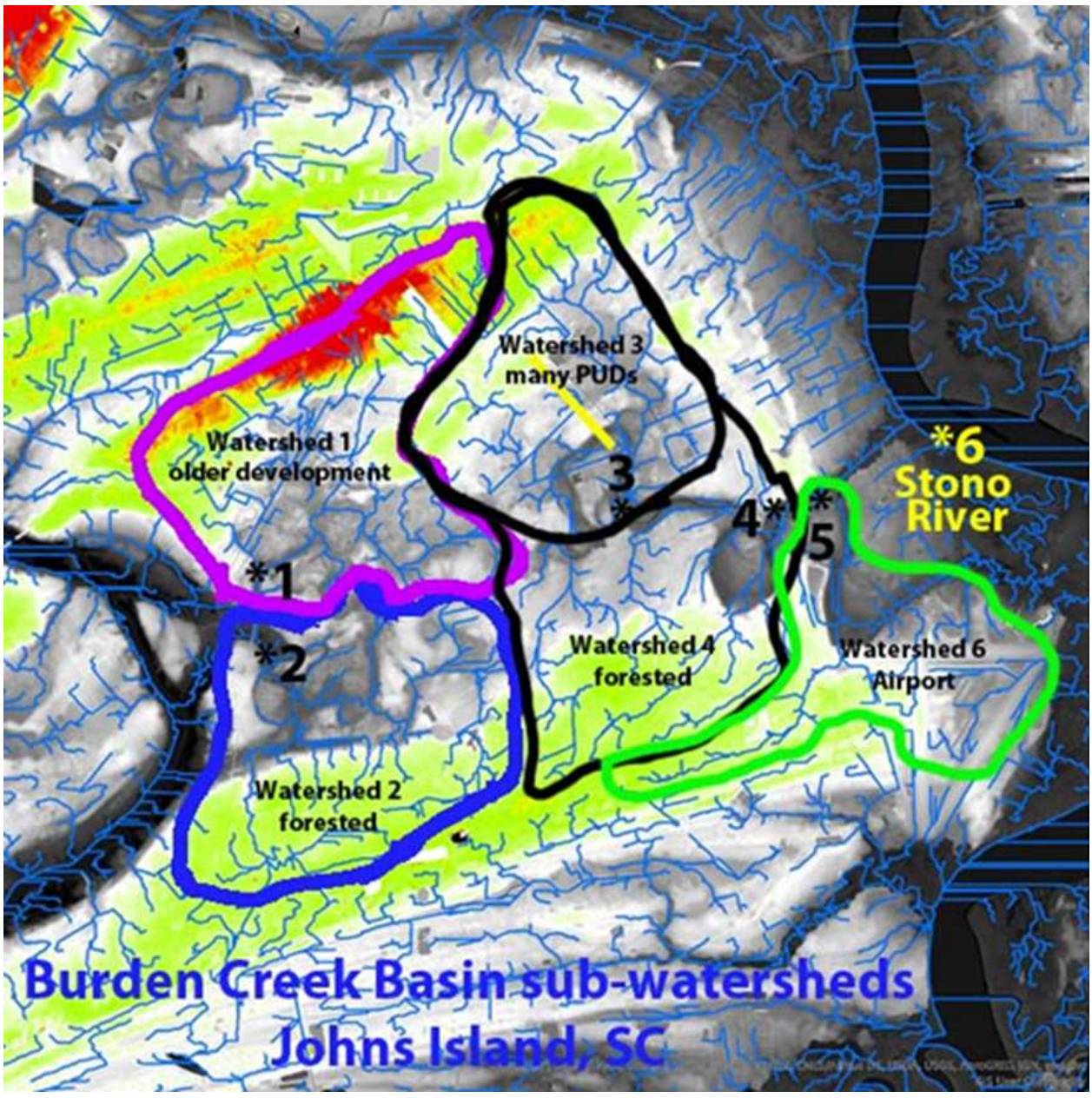
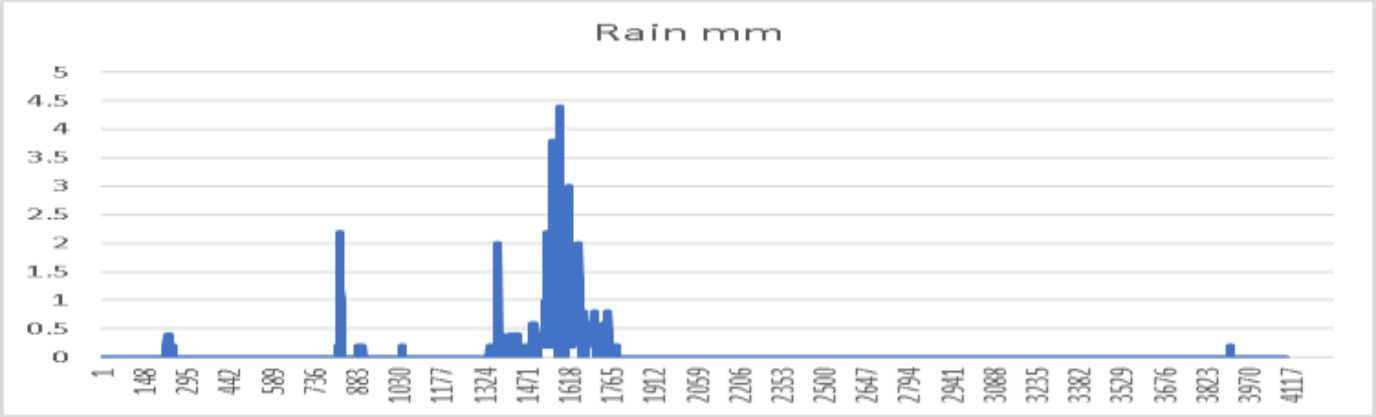
Watersheds:

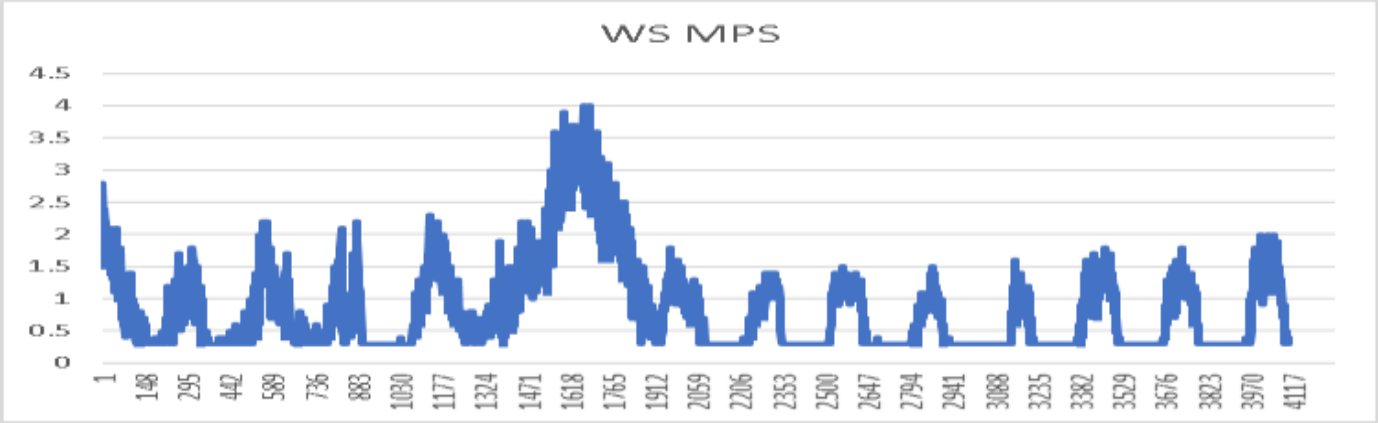
The outlines of the sub-watersheds above were determined from flow path analysis of the surface topography provided by high resolution LiDAR imagery. Therefore, the outlines are approximate but show that the area between the two high grounds (Maybank and Airport Dunes) define a large watershed that can be subdivided, each with its own history of land use. Watershed 2 and 4 are heavily forested while watersheds 1 and 3 are developed; 2 is mostly older more traditional developments with lots of vegetation and Watershed 3 is principally newer Planned Unit Developments (PUDs), some not even finished. Watershed 6 primarily drains the Johns Island Airport.
The asterisks show the location of instruments that recorded water level, temperature, and in some location salinity and other water quality parameters. Their placements were chosen to track the flow of water from each watershed as best as possible during the passage of Hurricane Dorian on September 4-5, 2019. Water level sensors measure the height of water above the sensor in millimeters. They can be calibrated to tidal height through comparisons of nearby tidal gauges after the passage of the storm's impact.

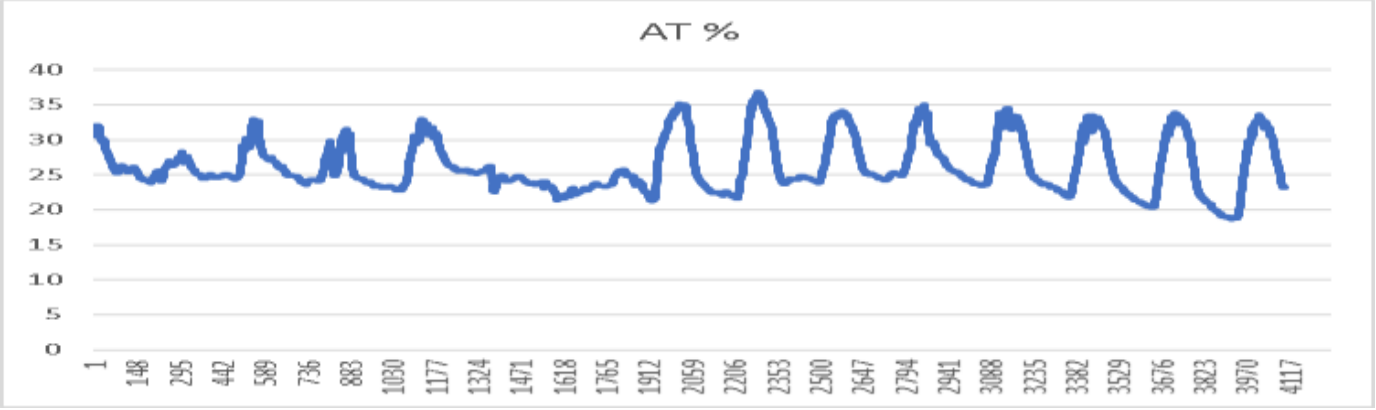


Weather Station Data

The weather station recording from (08:30 Aug 30 to 08:25 Sept 7) revealed Hurricane Dorian brought approximately 6 inches of rainfall to Johns Island over approximately 9 hours (03:15hrs 9/4/2019 to 12:00hrs 9/5/2019). It acted like a pulse-chase experiment where the rainfall pulse was chased by a long drying out period. Thus, the rainfall provided a very "clean" signal. This can be seen in the first data set of plots which show Dorian's drop in barometric pressure, rainfall, windspeed, and air temperature.

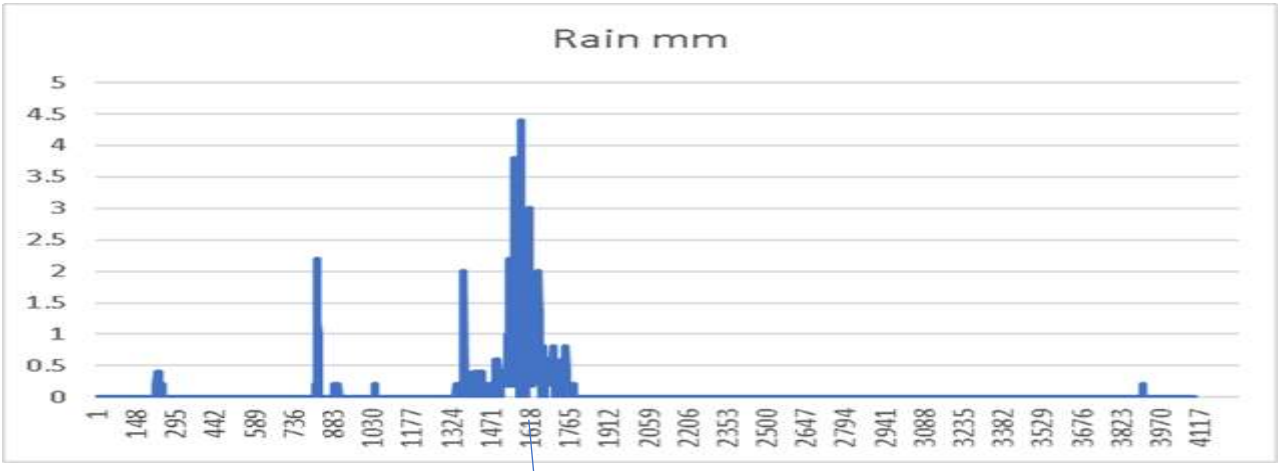


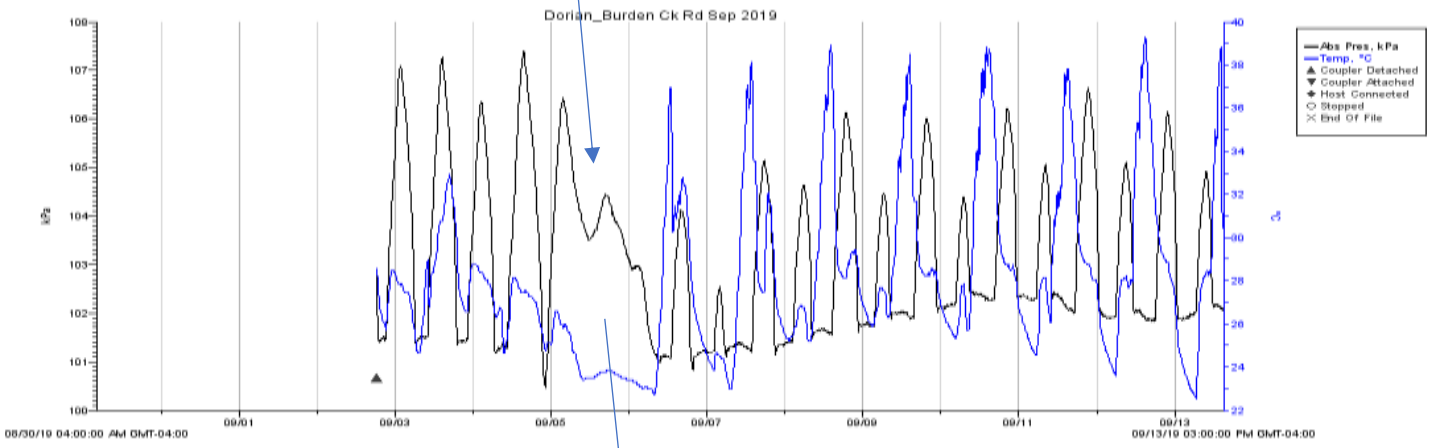


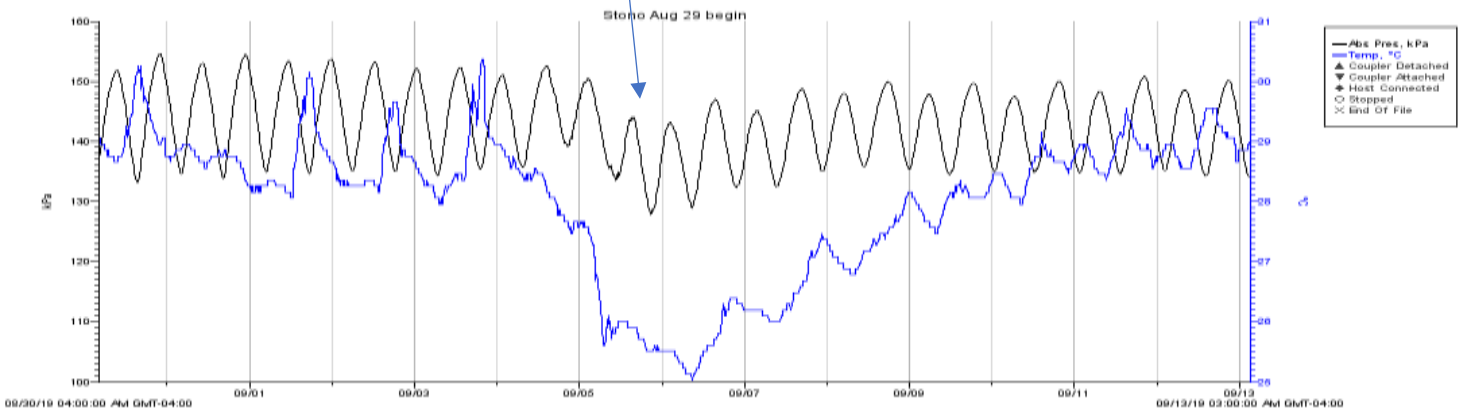


Airport Sub-watershed

Comparison of Burden Creek (Station 5) and Stono River (Station 6) shows water holding in the marsh during heavy rains (temp drop). There was no storm surge, in fact, water levels in the Stono River dropped as the storm passed by offshore. On these plots blue represents temperature and black water height above the instrument. The increased water level at Station 5 is from rainfall runoff from the airport watershed. The Stono River (Station6) revealed that water levels fell during the same period, strongly suggesting that the Burden Creek marsh is sensitive to rainfall runoff and "holds" runoff. Decreased water temperatures are caused by rainfall dilution which has been noted during previous large rainfall events. This area flooded during Hurricanes Matthew and Irma making Burden Creek Road impassable.

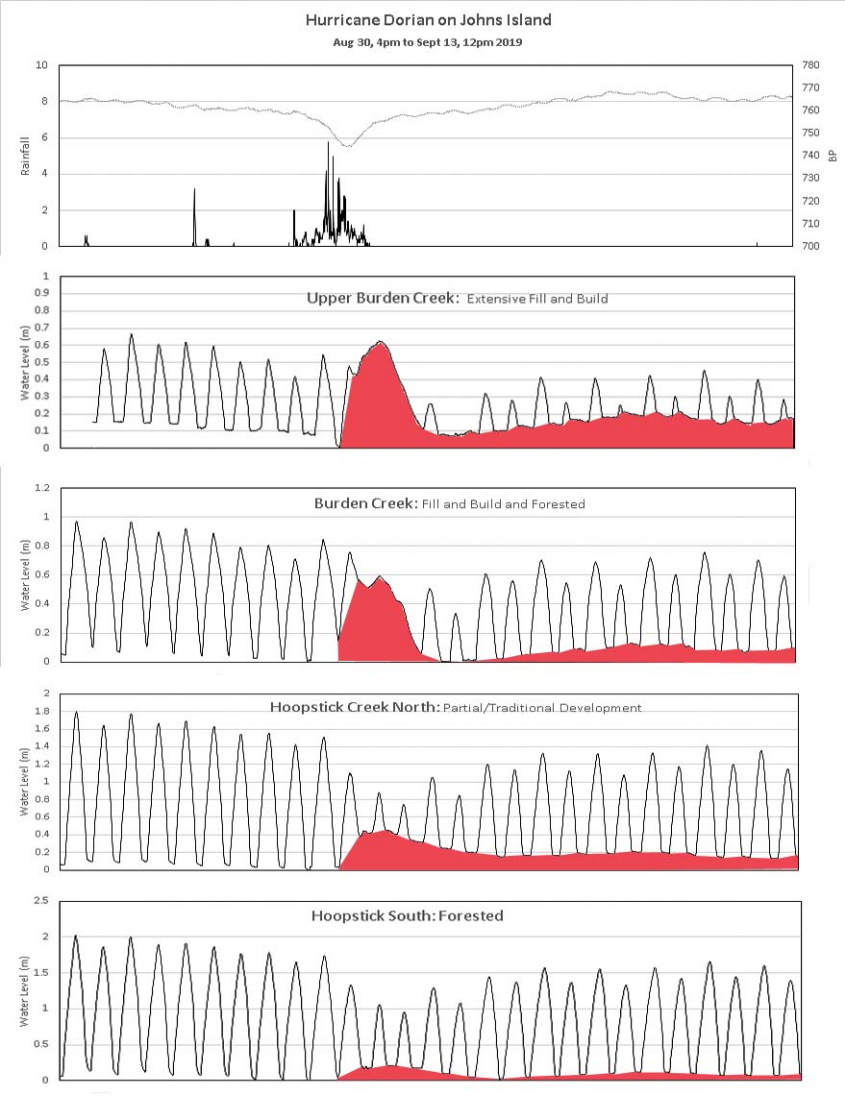






Hurricane Dorian and Burden Creek Basin Watershed drainage patterns

The sharp rainfall from Dorian ran into storm channels and into the marsh quickly (see data plots on next page). This sharp bolus of water can be seen at Station 3 which is downstream of a large drainage canal (yellow line on map)) which drains large areas of new and under construction Fill-and-Build PUDs (Planned Unit Developments) in the vicinity of Cain Slash Road into Burden Creek. The flash runoff appears at Burden Creek (Station 4) one or two tidal cycles later. Salinity monitoring at Burden Creek (Station 4) revealed that fresh water runoff completely dominated the creek for 3 tidal cycles and at low tide until the end out our monitoring more than a week later. Watersheds 1 and 2 showed increased levels during low tide, but the stormwater peaks were evident only as increased water levels during low tide. In other words, there was no bolus of water emanating off the watershed as was the case for Watershed 3. These data indicate that widespread PUD developments in the Burden Creek Basin watershed have increased the amount and patterning of stormwater runoff, their Fill-and-Build construction having severely curtailed the water capacity of the forest trees and soils that predated their construction.


Hurricane Dorian on Johns Island
Aug 30, 4pm to Sept 13, 12pm 2019
Rainfall
BP
Upper Burden Creek: Extensive Fill and Build
Burden Creek: Fill and Build and Forested
Hoopstick Creek North: Partial/Traditional Development
Hoopstick South: Forested
Water Level (m)