Measurements of lateral flow from the Mississippi River at Mardi Gras Pass and flow distribution within the Bohemia Spillway using synoptic and tripod ADCP observations

A field report

Submitted to

The Lake Pontchartrain Basin Foundation

By

Ioannis Y. Georgiou, Ph.D.

Tara Yocum, Mike Brown

Coastal and Environmental Hydrodynamics Laboratory

Pontchartrain Institute for Environmental Sciences

University of New Orleans

October 27, 2017

Introduction

The Coastal Hydrodynamics and Sediment Transport Laboratory at the Pontchartrain Institute for Environmental Sciences conducted synoptic ADCP surveys and tripod deployments at Mardi Gras Pass (MGP), which is a Pass connected to the Mississippi River near the Bohemia Spillway. The survey was conducted on October 27, 2017.

Objective

The objective of the survey was to measure the discharge (flow) at MGP to continue the construction of a stage-discharge curve over time, by adding additional measurements during flood conditions, intermediate and low flow conditions and to assess the flow distribution in the receiving basin (Figure 2). A second objective was to establish hydrodynamic controls within the receiving basin governing flow distribution during flood and non-flood conditions and document the role of tides in modulating receiving basin flow distribution and establish sediment fluxes within the system.

Methods

We used a vessel-mounted Teledyne Acoustic Doppler Current Profiler (ADCP) in tandem with a differential global positioning system (DGPS). The surveys followed a pre-determined schedule of transects, targeted to establish a flow balance within reach four of MGP. Additional synoptic ADCP measurements were conducted to establish a flow distribution within the receiving basin. The junction at MGP with the Back Levee Canal (BLC) and the junction of John Bayou with the BLC were the focus of this survey. Three Nortek Aquadopp Profilers with RBR's tide gauges were mounted on deployment rigs in John Bayou and the BLC (Figure 1). Aquadopp Profilers recorded flow and water level measurements at 2 Hz for two minutes, with a ten-minute interval between measurements. RBR's recorded water level measurements at 2 Hz for five minutes, with a ten-minute interval between measurements. Instruments were deployed for one hundred twenty one days from June 29, 2017 - October 27, 2017.

Figure 1. Locations of synoptic ADCP measurements (yellow lines) and instrument deployments (stars).

Results

Stage Discharge ta MGP

The average flow in Mardi Gras Pass on October 27, 2017 was approximately 132.7 m^3/s or 4,660.7 cfs. Using a standard deviation derived from the field measurements, the average flow at the time of measurement was 132.7 ± 7.7 m^3/s, or 4,660.7 ± 270.5 cfs. Figure 2 shows the updated rating curve for MGP using only ADCP flow data, and Table 1 provides a summary of all flows measured in MGP from each survey conducted throughout the monitoring period.

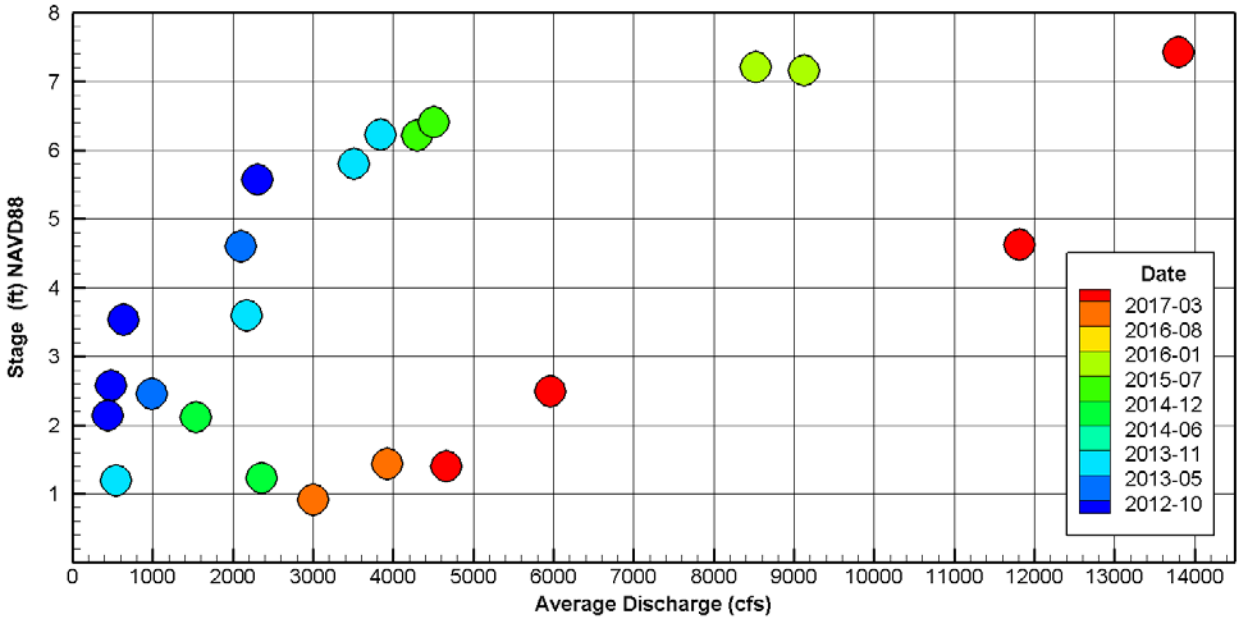


Figure 2. Evolving Stage Discharge curve for Mardi Gras Pass showing all flow measurements since 2012.

Table 1. Discharge details from each survey (1-21) with statistics and corresponding River Stage (ft NAVD88) at West point a la Hache (from rivergauges.com)

Survey number	Date	Average Velocity (ft/s)	Average Discharge (cfs)	Average Discharge (cms)	Standard Deviation (cfs)	Standard Error (cfs)	Standard Deviation (cms)	Standard Error (cms)	Stage (ft) NAVD88
MGP 01	3/28/2012	4.2	2,303.0	65.2	59.4	24.3	1.7	0.7	5.6
MGP 02	4/18/2012	1.2	630.3	17.8	10.8	5.4	0.3	0.2	3.5
MGP 03	5/3/2012	0.9	479.9	13.6	23.3	10.4	0.7	0.3	2.6
MGP 04	7/3/2012	0.8	436.1	12.3	13.5	6.0	0.4	0.2	2.1
MGP 05	1/16/2013	2.0	981.9	27.8	24.7	12.4	0.7	0.3	2.5
MGP 06	2/1/2013	4.0	2,097.2	59.4	16.6	6.8	0.5	0.2	4.6
MGP 07	5/14/2013	2.9	3,840.5	108.8	194.2	97.1	5.5	2.8	6.2
MGP 08	6/23/2013		3,510.3	99.4	40.0	28.2	1.1	0.8	5.8
MGP 09	7/31/2013	2.3	2,167.2	61.4	31.0	17.8	0.9	0.5	3.6
MGP 10	11/11/2013	0.5	537.8	15.2	37.2	21.5	1.1	0.6	1.2
MGP 11	6/11/2014	1.9	2,353.6	66.6	46.2	26.7	1.3	0.8	1.2
MGP 12	8/6/2014	1.2	1,535.1	43.5	40.4	20.2	1.1	0.6	2.1
MGP 13	4/17/2015	2.9	4,300.4	121.8	115.6	81.8	3.3	2.3	6.2
MGP 14	5/8/2015	3.2	4,508.6	127.7	193.1	136.6	5.5	3.9	6.4
MGP 15	1/19/2016	5.2	9,123.1	258.3	115.7	81.8	3.3	2.3	7.2
MGP 15	1/19/2016	4.7	8,517.5	241.2	268.9	134.5	7.6	6.6	7.2
MGP 16	11/14/2016	1.7	3,925.0	111.1	52.1	30.1	1.5	1.2	1.4
MGP 17	12/15/2016	1.3	3,004.2	85.1	165.6	95.6	4.7	3.8	0.9
MGP 18	5/25/2017	5.0	13,793.6	390.6	70.9	50.2	2.0	1.4	7.4
MGP 19	6/29/2017	3.9	11,810.1	334.4	358.6	253.6	10.2	7.2	4.6
MGP 20	8/2/2017	2.1	5,953.5	168.6	119.8	69.2	3.4	2.8	2.5
MGP 21	10/27/2017	1.7	4,660.7	132.7	270.5	156.2	7.7	6.3	1.4

Flow Distribution in the receiving basin

The flow distribution at the time of the survey is shown in Figure 4. The surveys were completed over the course of 3 - 4 hours during which time the water surface elevation at the West Point A La Hache river station operated by the US Army Corps of Engineers was falling (Figure 3) and experienced change of the order of centimeters. The flow distribution in the receiving basin is shown in Figure 4 with approximately 32.5% of the flow from MGP moving northwest (inland) in the BLC and the remaining 67.5% of the flow moving seaward. When the flow in the BLC arrives at the junction with John Bayou, approximately 51% of the flow enters John Bayou while the remaining 49% of the flow continues in the BLC southeast.

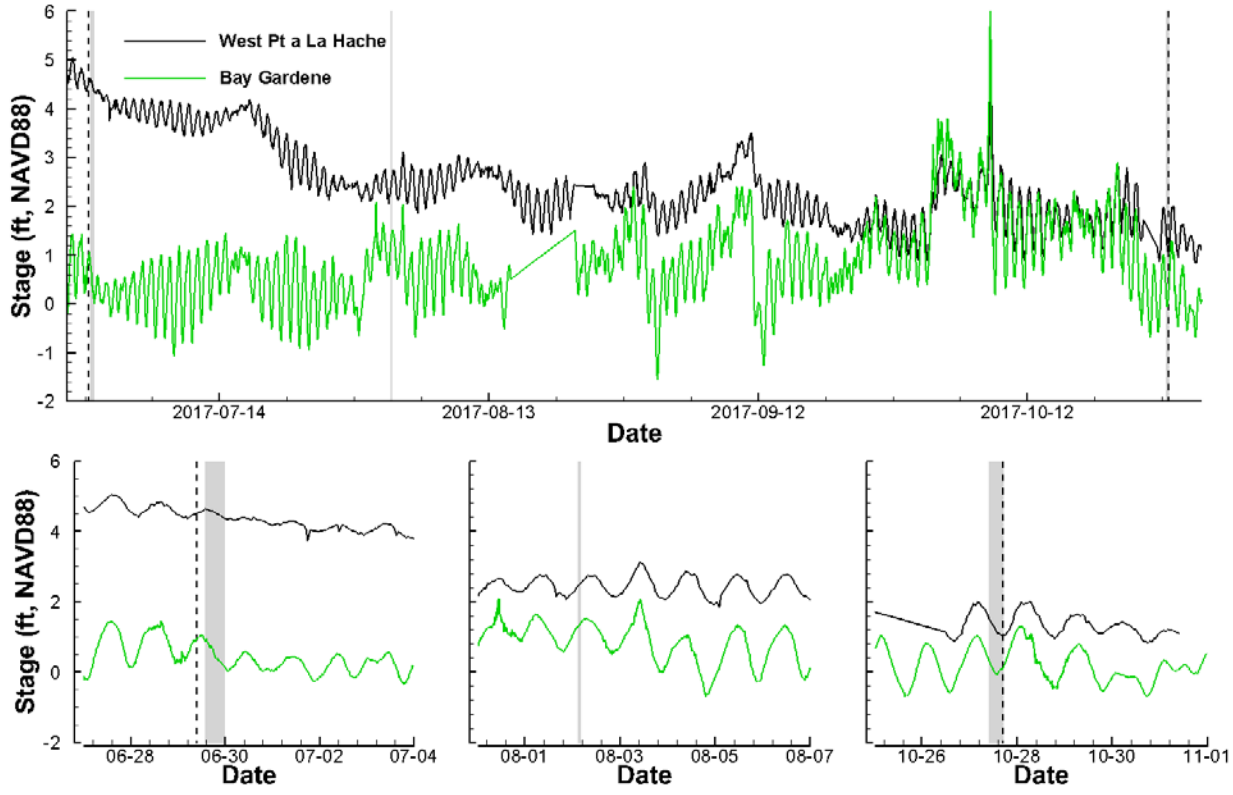


Figure 3. Stage at West Point A La Hache from June 27, 2017 to October 31, 2017. The gray bars indicate when the surveys took place.

Figure 4. Mardi Gras Pass flow and flow distribution in the receiving basin at key junctions in the back levee canal and John Bayou.

Water Level in the receiving basin

The measured water level anomaly for the entire deployment window is shown in Figure 5. The early period of deployment when the river was in flood, the data shows that tidal range was attenuated compared to the later window when flood level subsided. For instance, through 7-29 the BLC experiences a spring tidal range of ~0.2 m, while for the remaining pwriod through 10-27 the spring tidal range is ~0.3. Also significant is the sub-tidal response; for instance, sub-tidal variations during flood are suppressed with the exception of an event post 7-29, compared to the remaining period where sub-tidal variations are more widespread. The effect of storms is also obvious in this record, where water level peaks are obvious on 9-12 and 10-3 where levels were 0.4-0.6 above normal, and lastly we see the effect of Hurricane Nate, which elevated water levels by approximately 1.2 m above normal..

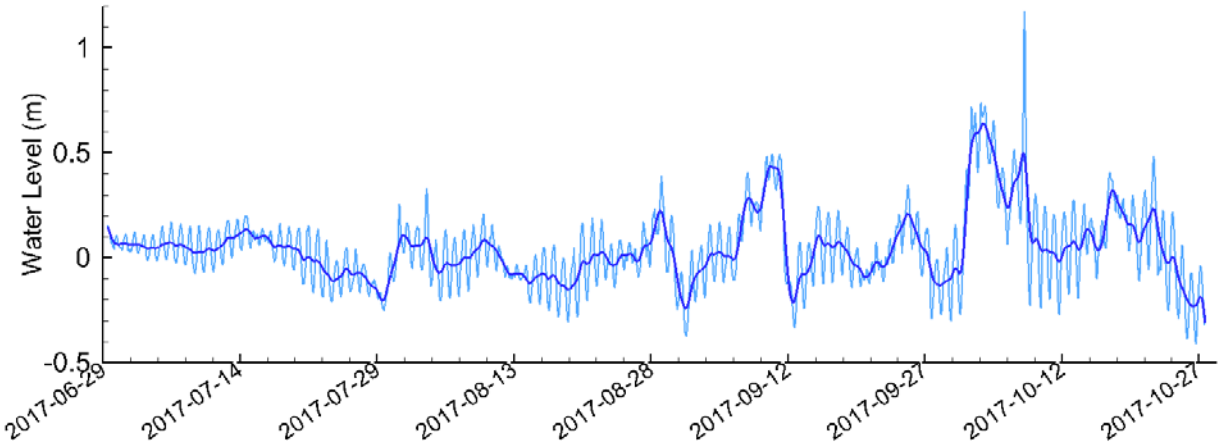
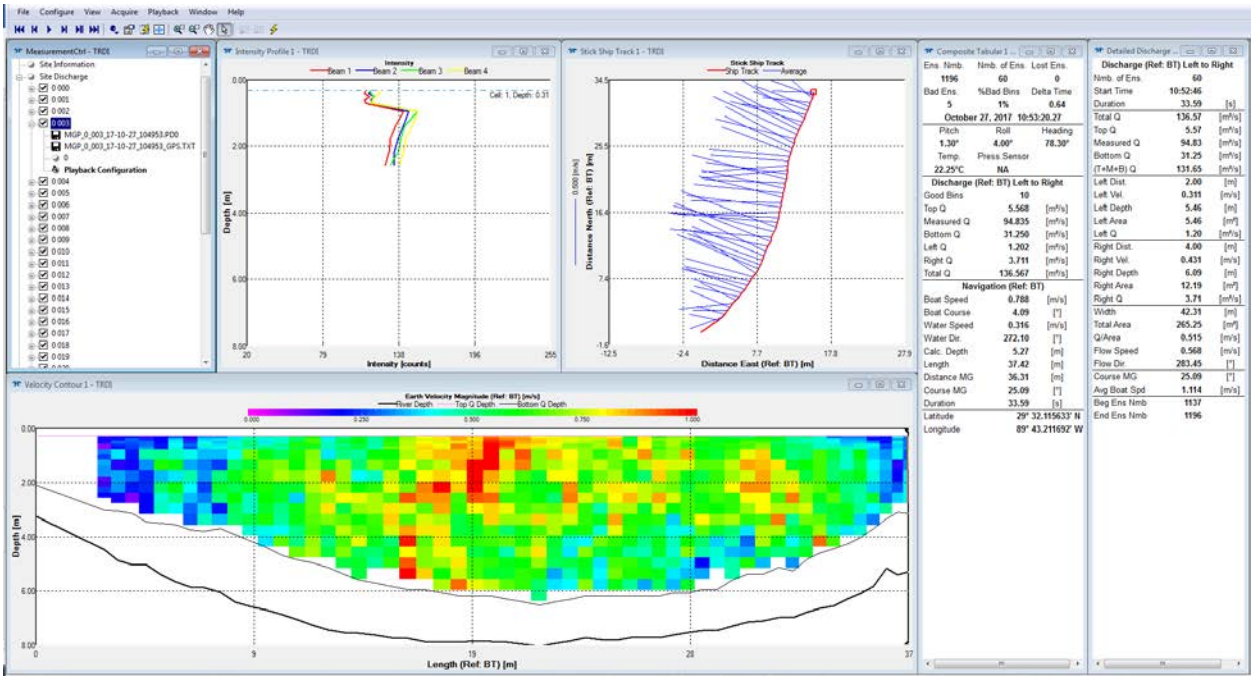


Figure 5. Measured water level anomaly in John Bayou (light blue), with a low-pass filter (dark blue).

Appendix A. Mardi Gras Pass Survey June 29, 2017

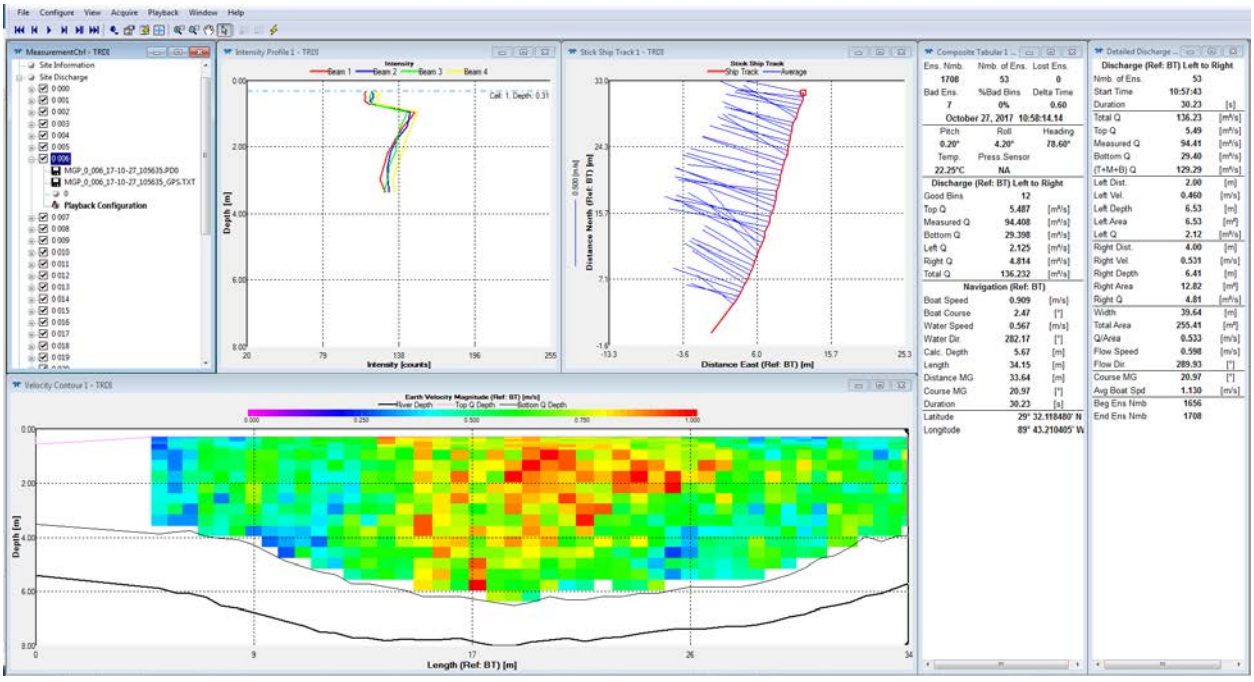
Transect 003

Q ~ 137 m^3/s



Transect 006

Q ~ 136 m^3/s



Transect 007

Q ~ 123 m^3/s