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Potsdam, NY & Edinburg, TX

Overview of Hydrologic Monitoring Programs

Presented to:
Lake Champlain Basin Program
NY Citizens Advisory Committee

Presented by:
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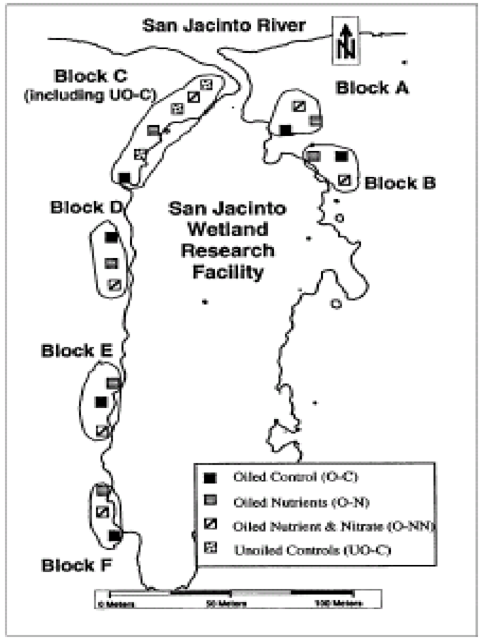
February 22, 2021

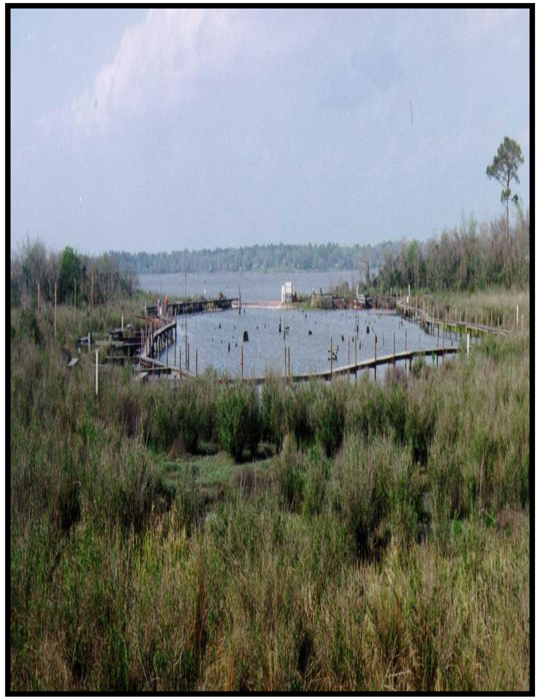
RATES History

- Founded by Dr. James S. Bonner
  - Ph.D. alumni or Clarkson University
  - Professor at Texas A&M, Dept. Civil Engineering
  - Professor at Clarkson University, Dept. Civil and Environmental Engineering
    - 2008-2018
- Mission
  - Democratization of water and environmental data
    - Recognize importance of continuous environmental data and need to lower data collection costs
- Current leadership
  - Dr. Andrew Ernest-CEO
    - Dr. Bonner's 1st doctoral graduate
    - Professor-Civil Engineering at University of Texas Rio Grande Valley
  - Chris Fuller-Chief of Operations
    - Dr. Bonner's last doctoral graduate from Texas A&M (2011)
    - Earned MS Environmental Engineering from Dr. Ernest at TAMU-Kingsville

EVOLUTION OF RATES ENVIRONMENTAL MONITORING

Controlled-Field Studies
San Jacinto Wetland Research Facility, (circa 1995-1998)

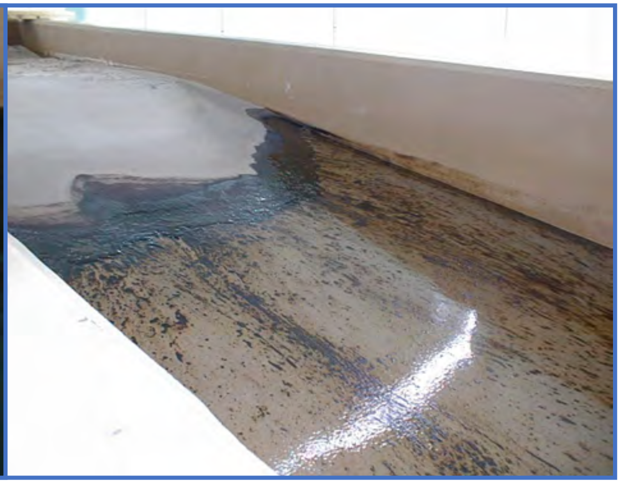




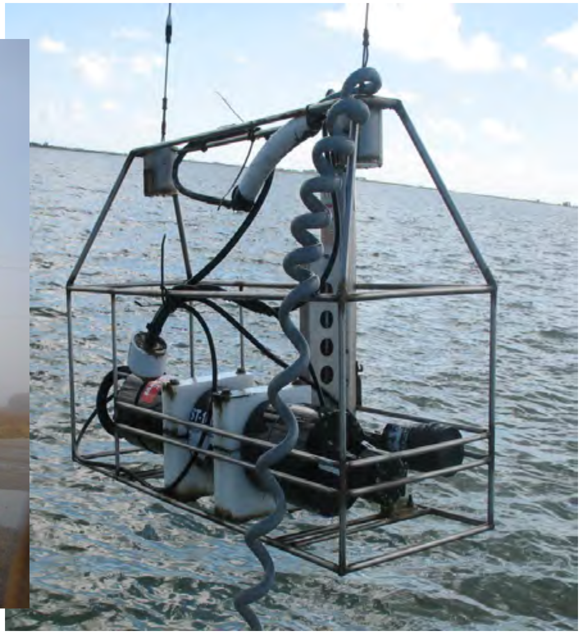
- Oil Spill Fate and Effects Studies
  - Intrinsic recovery of wetland impacted by oil spill
  - Controlled application of oil: to evaluate the behavior and effects of chemically-dispersed oil (CDO) in a wetland setting
    - Monitored sediment petroleum chemistry; toxicity; microbial numbers; nutrients………

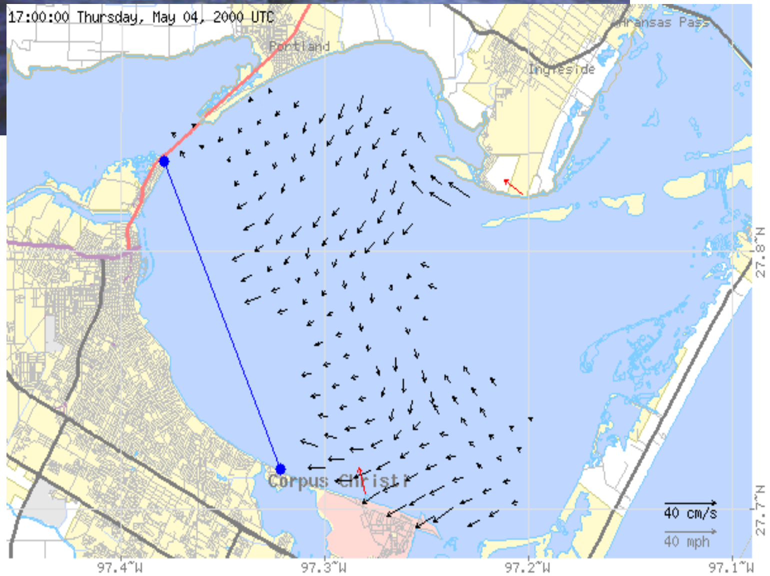
Meso-scale (SERF)

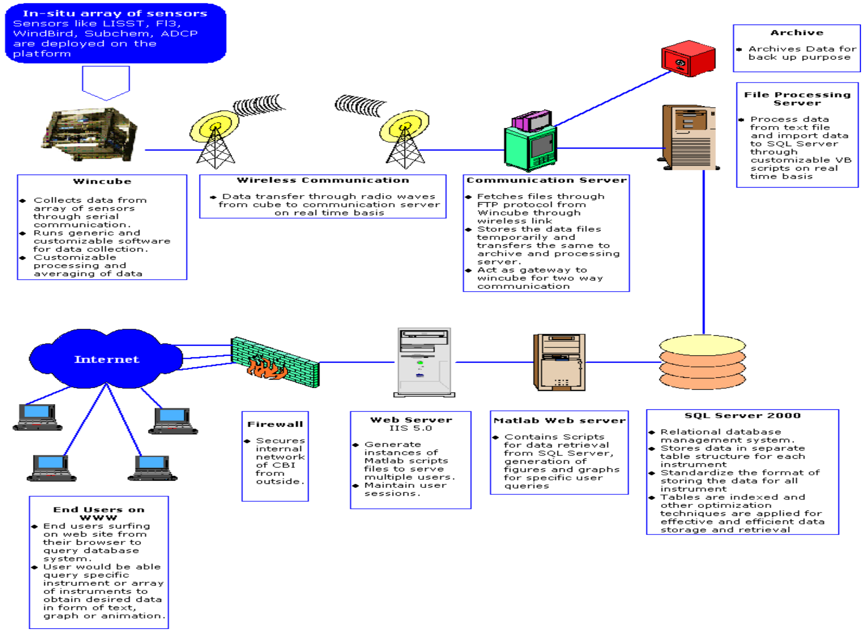
(**S**horeline
Environmental
Research
Facility)



NSF Waters: Corpus Christi Bay Test Bed





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Integrated real-time monitoring system to investigate the hypoxia in a shallow wind-driven bay

Mohammad Shahidul Islam · James S. Bonner · Cheryl Page · Temitope O. Ojo

Received: 6 August 2009 / Accepted: 15 January 2010

Abstract Corpus Christi Bay (Texas, USA) is a shallow wind-driven bay which experiences hypoxia (dissolved oxygen < 2 mg/L) during the summer. Since this bay is a very dynamic system, the processes that control the hypoxia can last on the order of hours to days. Monitoring systems installed on a single type of platform cannot fully capture these processes at the spatial and temporal scales of interest. Therefore, we have integrated monitoring systems installed on three different platform types: (1) fixed robotic, (2) mobile, and (3) remote. On the fixed robotic platform, an automated profiler system vertically moves a suite of water quality measuring sensors within the water column for continuous measurements. An integrated data acquisition, communication and control system has been configured on our mobile platform (research vessel) for synchronized measurements of hydrodynamic and water quality parameters at greater spatial resolution. In addition, a high-frequency radar system has been installed on remote platforms to generate surface current maps for the bay. With our integrated system, we were able to capture evidence of a hypoxic event in summer 2007; moreover, we detected low dissolved oxygen conditions in a part of the bay with no previously reported history of hypoxia.

Keywords Monitoring systems · Sensors · Hypoxia · Stratification · Corpus Christi Bay

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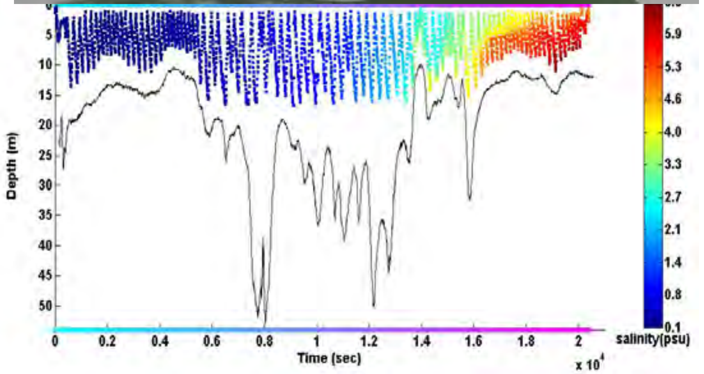
Introduction

Corpus Christi Bay in the state of Texas in the USA harbors the nation's seventh largest port and a large complex of petroleum facilities. In 1992, the National Estuary Program designated Corpus Christi (CC) Bay as a National Estuary and created the Corpus Christi Bay National Estuary Program to protect the health of this bay while supporting its economic growth. This shallow bay has an average depth of 3.6 m (Ward 1997) and is connected to the Gulf of Mexico through two narrow inlets. Therefore, the hydrodynamic conditions of the bay are primarily wind-driven as

Rivers and Estuaries Observatory Network (REON) Beacon, New York (circa 2009)



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Impacts of an Extreme Weather-Related Episodic Event on the Hudson River and Estuary

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Abstract

The frequency and severity of extreme weather-related episodic events have increased in recent years. These ephemeral events have been shown to dramatically change water column conditions in affected aquatic systems. Impacts of a representative storm event in New York's Hudson River (HR) and Estuary (HRE) are evaluated. Hurricane Irene struck the United States Atlantic Coast in August 2011 with heavy rainfall throughout the HR watershed as it moved inland. Using automated sensor systems, the River and Estuary Observatory Network characterized the watershed impacts of this event on hydrodynamics, and sediment transport in the HRE. Recorded data showed dramatic increases in stream discharge (e.g., from 110 to 3300 m^3/s at Cohoes, NY), especially in the upper HR, and changes in hydrodynamic conditions throughout the HRE (e.g., an order of magnitude increase in water current velocities, continuous downstream flow irrespective of tidal stages). Storm-related sediment load represented a major portion of the estimated total annual load. Contribution of episodic events to mobilization and transport of sediment-bound contaminants (e.g., polychlorinated biphenyl) from the HR superfund site was demonstrated through observed changes in suspended sediment size distribution and rapid increases in bed shear stress (e.g., from 0.2 to 4.4 N/m^2 at Fort Edward, NY). Strong, Irene-induced flood currents prevented sediment resuspension normally associated with flood tides in estuarine river reaches. This study provided critical insight with respect to hydrodynamic and sediment dynamic variability during episodic events for improved transport modeling and impact evaluation of the HRE.

Key words: extreme episodic events; sediment transport; Hudson River and Estuary; *in situ* monitoring; hydrodynamics

Introduction

INTENSITY, FREQUENCY, and duration of extreme weather-related episodic events continue to increase (Kunkel *et al.*, 1999; Klein Tank and Konnen, 2003; Emanuel *et al.*, 2005; Jennings *et al.*, 2012). Bender *et al.* (2010) predicts hurricane intensity and frequency in the eastern United States to increase by as much as a factor of 2 in the near future. These weather-related episodic events pose a greater threat to organisms and populations than that of anticipated gradual climate changes (Cotner *et al.*, 2000; Drakare *et al.*, 2002; Lohrenz *et al.*, 2004; Gutschick and BassiriRad, 2010; Jennings *et al.*, 2012). One study by Oeurng *et al.* (2011) in a large agricultural catchment to the Save River, France shows that short episodic events lasting 10–20% of the study duration are responsible for >80% of particulate organic carbon and >70% of dissolved organic carbon loads into the river. Schubel and Hirschberg (1978) also report that sediment loading in Chesapeake Bay from two major storms is comparable to the total sediment input to the waterbody between 1900 and 1975. Therefore, it is important to quantify the effects of these types of episodic events on waterbodies for both of their short and long-term management.

Tropical storm Irene, ranked as one of the costliest storms in U.S. history, passed along the Northeast coast of the United States on August 28–29, 2011 (*NOAA*, 2012) and produced intense precipitation and flooding in the Hudson River watershed (Ralston *et al.*, 2013). Irene first struck the United States as a category 1 hurricane in eastern North Carolina, then moved northward along the Mid-Atlantic Coast before making final landfall as a tropical storm in the New York City area. Irene-associated precipitation events equaled a 200-year flood event in some parts of the watershed (Yoon and Raymond, 2012). In this article, we evaluated impacts of this event on changing hydrodynamics and sediment transport throughout the Hudson River and Estuary (HRE).

The HRE is separated at the Troy Dam into two hydrodynamically distinct regions (Fig. 1) including the Lower Hudson River (LHR), a tidally influenced reach extending

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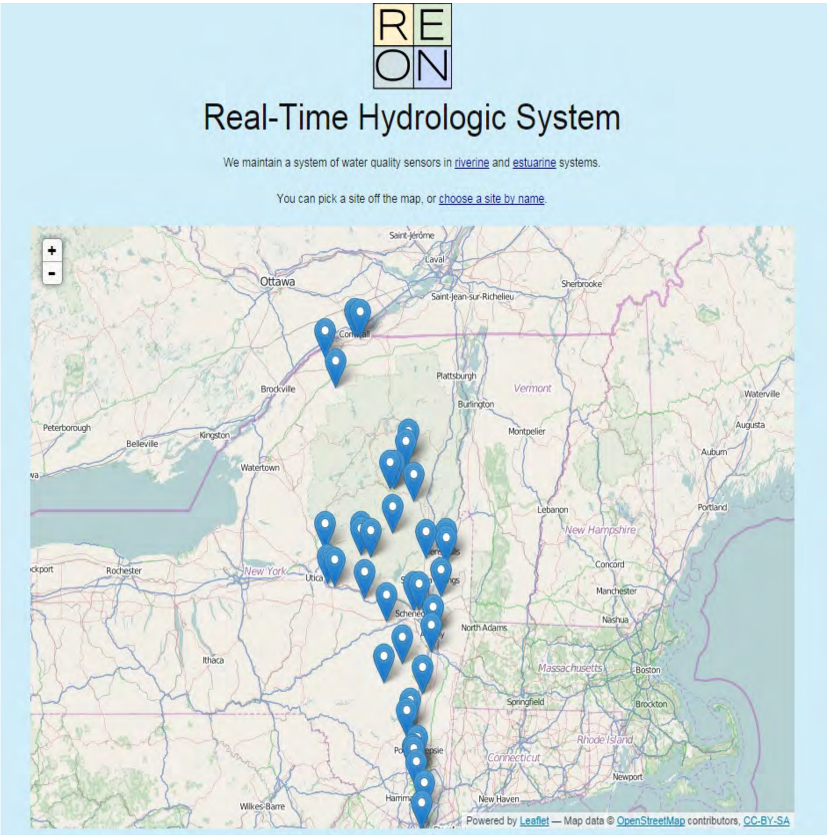
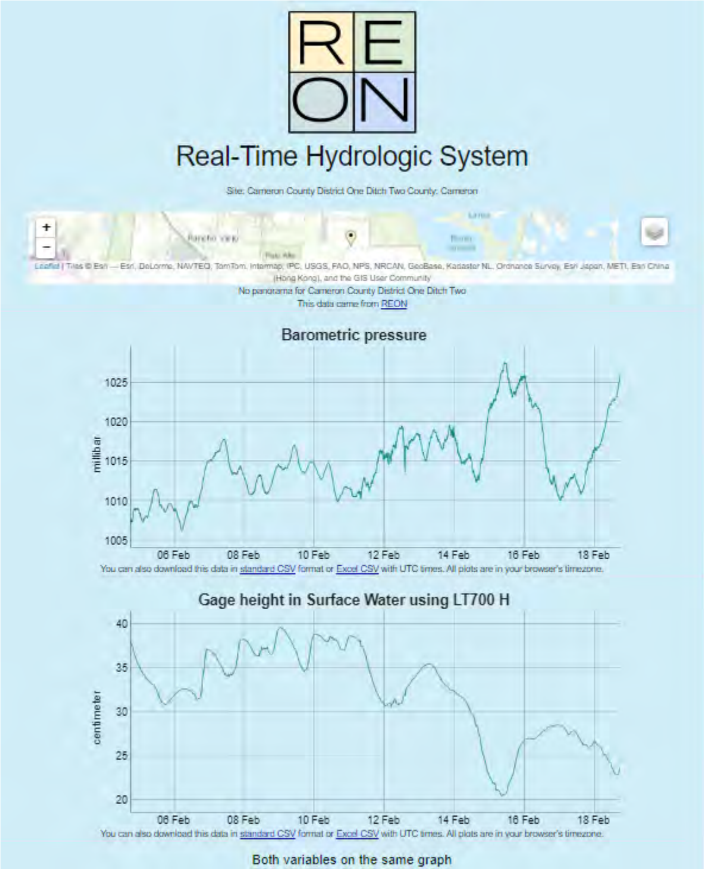
River and Estuary Observation Network (REON-2) (Summit to the Sea)

- Providing high resolution Spatial and Temporal data For: Environmental Decision Support , Resource Management, Enforcement/Compliance, and Environmental Science and Engineering Research Transformation
- Real time access to data





Characterization of Sturgeon Spawning Habitat on the Grasse and Raquette Rivers (SRMT 13-54)

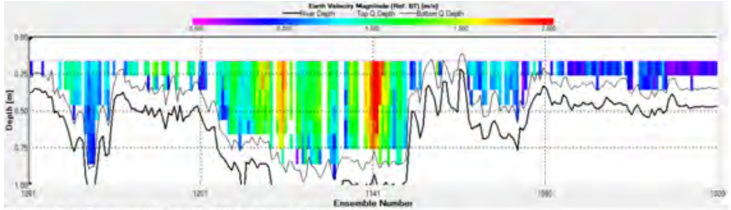
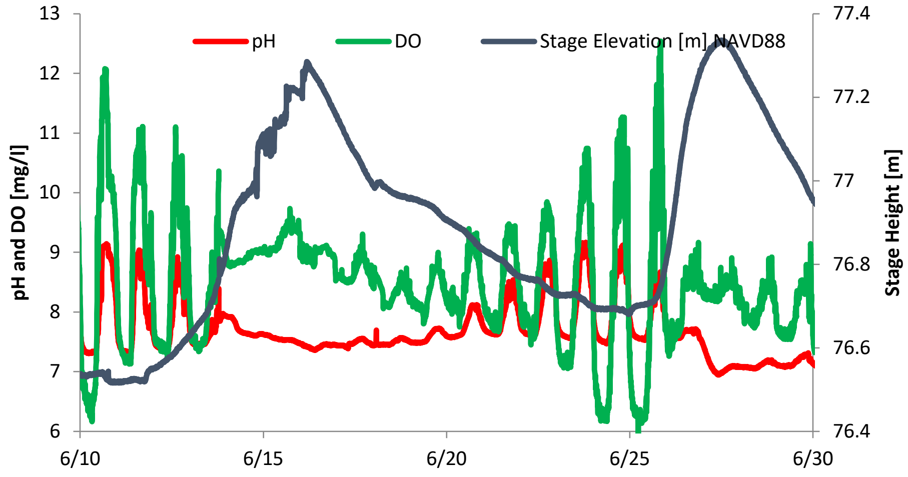
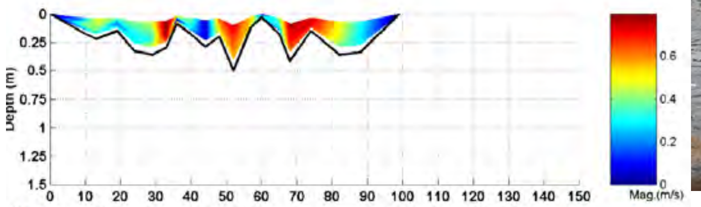


Figure 7A Transect Line B_High Flow (Transect 001)

- Funded by EPA through Saint Regis Mohawk Tribe
  - Stream bed elevation surveys
  - Hydrodynamic characterizations
    - Discharge measurements
    - Velocity profiles
  - Continuous monitoring with REON RTHS
    - Weather
    - Stage height
    - Water quality

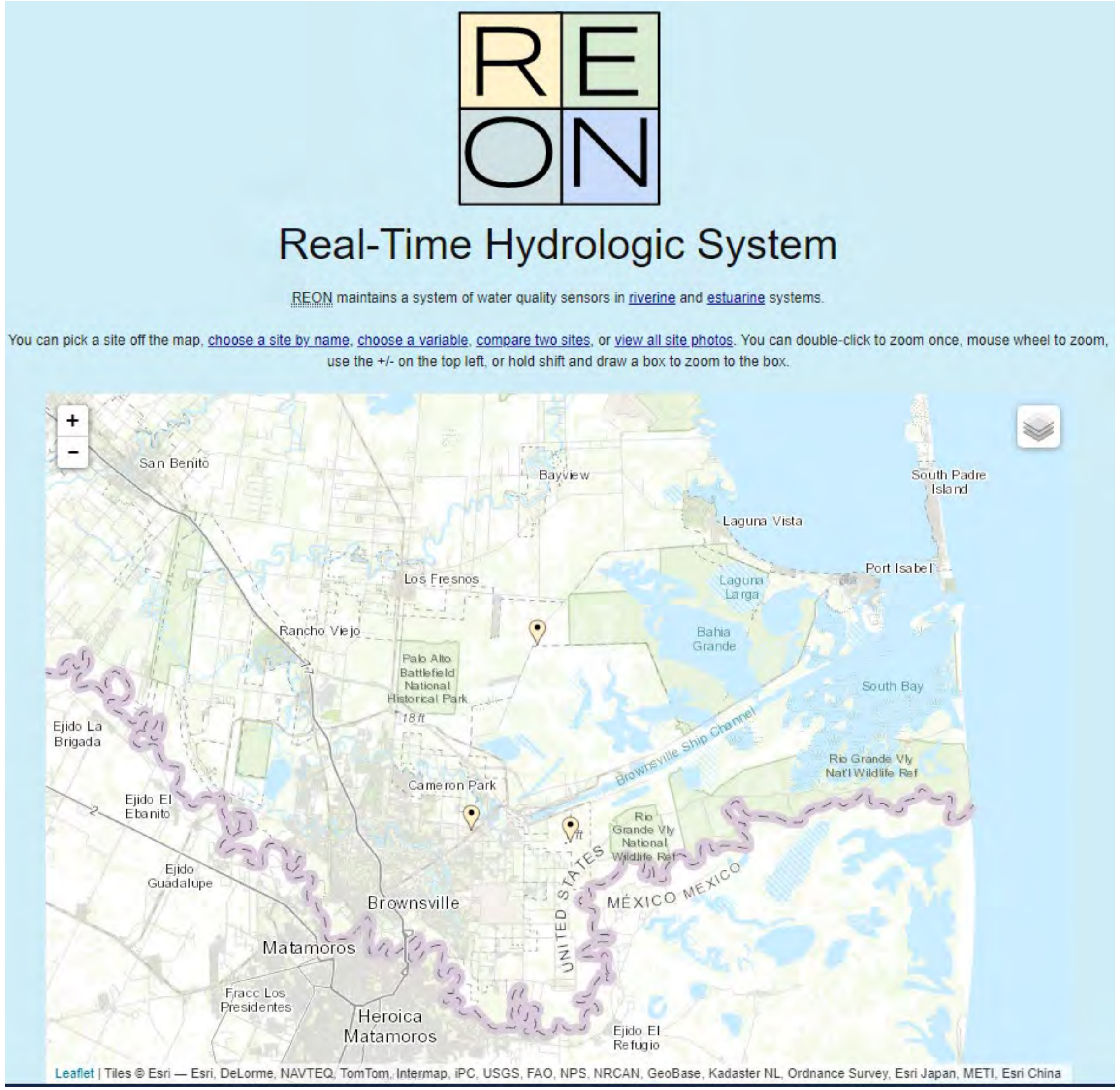




8F Grasse River Low Flow Velocity contour plot (Transect F)

REON today

- Expanded coverage into lower Rio Grande Valley
  - CWA Section 319 (Watershed Protection Plans)
    - EPA approved QAPP
    - 3 active stations
  - Fresh water inflows-TWDB
    - 4 stations contracted
  - Flood Infrastructure Fund- TWDB
    - 50 stations
- Improvement to sensor and system technology
  - Stage height sensor_rev 2
    - Reduce capital cost
    - Improved accuracy
  - IoT communication protocol
    - Reduce operational costs
  - Automated notifications
    - Level thresholds
    - Rate of changes
    - Both text and email notification
  - Expanding services to include modeling applications
    - In development as part of Flood Infrastructure Planning project.
      - Hydrologic models
      - Hydrodynamic models



Stream monitoring program considerations

- Budget
  - Initial capital investment
  - Operational
- Data needs
  - Parameter of interest
  - Observation frequency
  - Measurement objectives
    - Scientific
    - Legal and/or compliance
    - Public service
- Physical considerations
  - Stream segment characteristics
  - Stream bed morphology/geometry
  - Communication options (e.g. cell phone)
  - Accessibility

Monitoring Options

- Event based monitoring
    - Temporally limited
    - Labor intensive
- Continuous logging
    - High temporal resolution
    - Significant lags in data access (Is my logger still working data?)
- Continuous logging with real-time data access
    - High temporal resolution
    - Immediate access to data
    - Automated notification applications

Stage Height Monitoring Options

- Visual staff gages
  - Suggested to address QAQC needs for all deployments QAQC
- Level logger
  - Un-vented require barometric pressure corrections (1 mbar ≈ 1cm water
- Real Time Level Loggers
  - Many options
    - Bubbler system (USGS)
    - Submersible pressure transducer (vented)
    - Submersible pressure transducer non-vented (i.e. absolute pressure)
      - RATES RTHS Sensor
      - Integrated with barometric pressure at each station

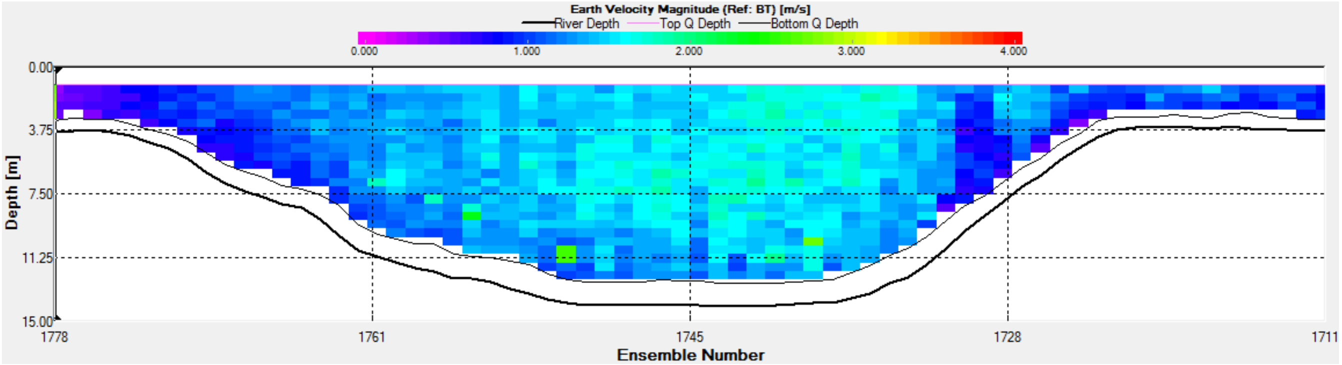
Stage Height Monitoring Considerations

- Sensor vertical control
- Sensor protection (ice, debris, buried)
- Mounting systems- suggest use of stilling well if possible)
- Barometric pressure corrections if necessary
- Sensor QAQC
  - Compare against independent measurements
  - Validate vertical placement
  - Validate measurement time

Flow measurements

- Calibrated flumes
- Wading Rod
  - Applicable to shallow water applications
  - Accuracy dependent on number of velocity measurements collected in stream cross section
  - USGS Methods are available
  - In-expensive instrumentation is available (Cost ?)
    - Possible solution or citizen science groups
  - Included in RATES equipment inventory
- Acoustic Doppler Current Profiler
  - Applicable to measuring to velocities at depths between (12” to 3,000 ft)
    - 2,400 kHz to 38 kHz
  - High resolution (i.e. 30 depth bins)
  - Accurate measurements
  - Included in RATES equipment inventory (2,400 kHz RDI StreamPro to RDI Workhorse 600 kHz)
    - RATES staff has deployed in everything from small streams to the Mississippi

ADCP Discharge Measurements-Big Water



Cross Section	Flow Rate (m^3/sec) (STDEV (n=3))
R. Moses Dam	7,575 (80)
Polly's Gut	5,024 (66)
N. Channel	2,588 (36)

Combined flow of Polly's Gut and N. Channel = 7,612 cms

Water Quality Discussion

- REON RTHS can be configured with multiparameter sonde for continuous water quality monitoring
  - R&D Units designed and built by RATES staff
    - SRMT Project
    - Clarkson PhD Graduate on RATES staff has developed optical sensors for turbidity and D.O.
  - Research and commercial grade instruments (YSI and In-Situ)
    - pH, DO, conductivity, turbidity, nitrate, ammonia, chlorophyll-a
- Alternatively sondes can be used as part of event based monitoring programs

QUESTIONS