

# Applying GIS to Evaluate Hydrodynamic Model Performance in Predicting Inundation

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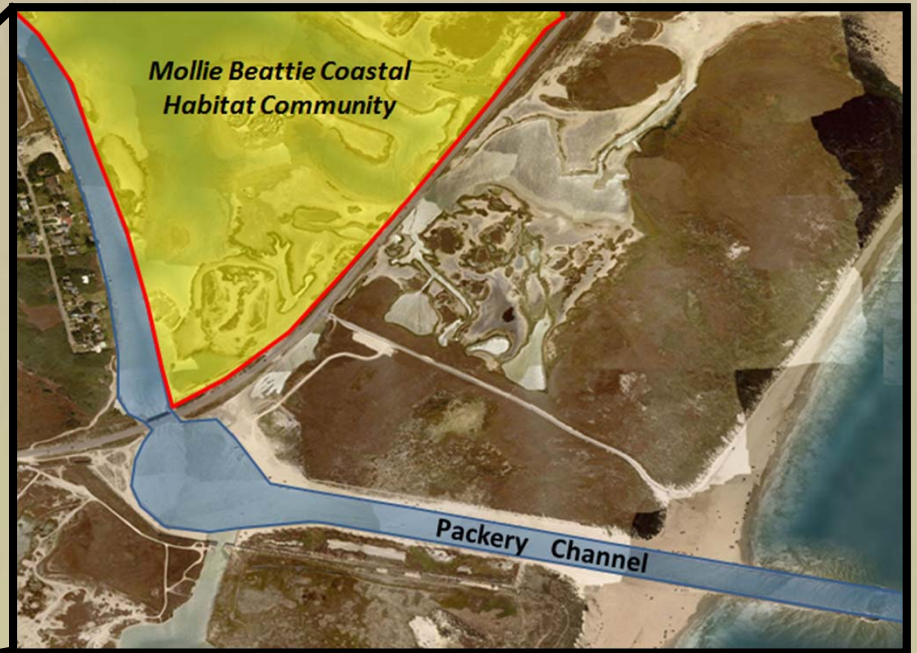


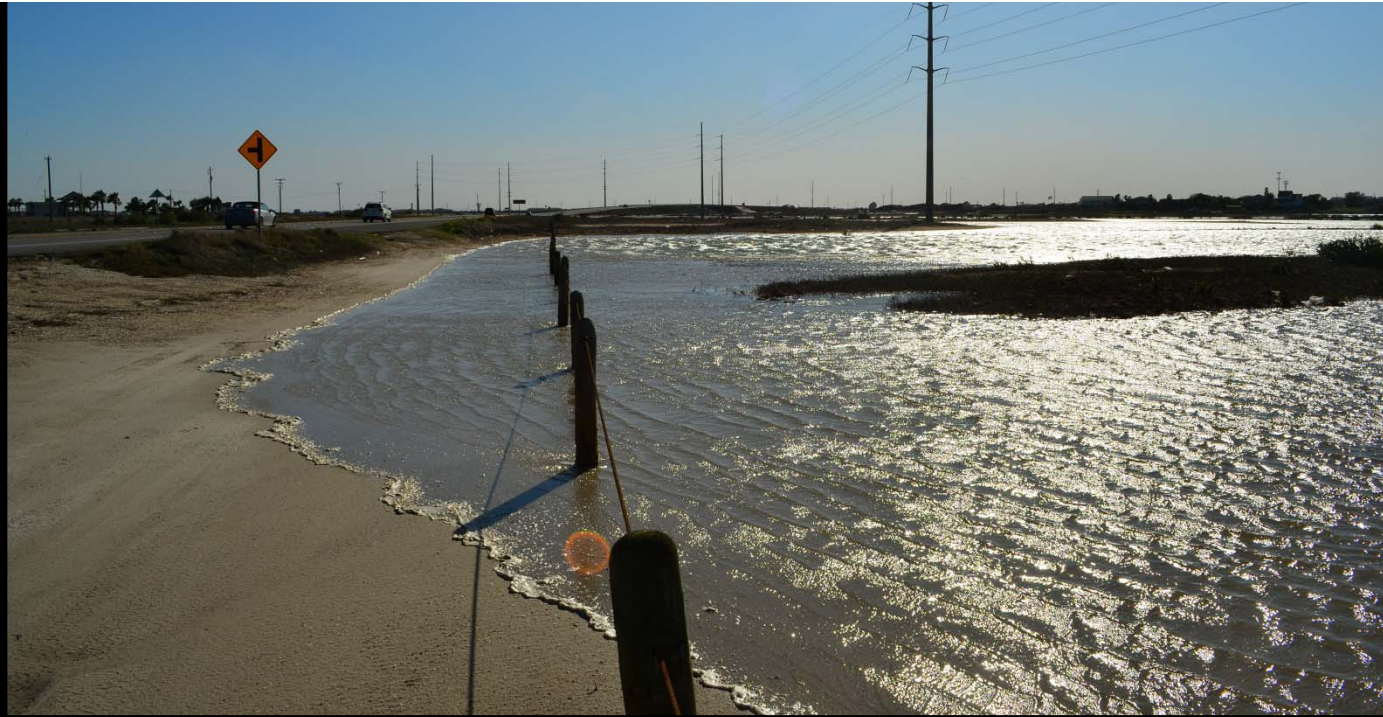
Texas Water Forum III  
October 15, 2013

# Project Overview

- implement a hydrodynamic model, Coastal Modeling System (CMS) for the study area using available water level, wind and bathymetry data
- develop a methodology to quantify the accuracy of the model inundation predictions through the use of geospatial techniques (GPS, aerial and satellite imagery)
- if the model predicts inundation accurately, the method can be applied to predict present and future tidal flat inundation including shorebird habitat

# Mollie Beattie and Packery Channel Area





**Friday  
(1/27/12)**  
flooding occurs  
during a cold  
front  
(strong NW winds)



**Saturday  
(1/28/12)**  
water recedes

# Acquired Data

– GPS elevation surveys to define the model bathymetry

- collected in respect to NAVD 88 and NAD 83 State Plane Texas South (January 2012)
- additional elevation data acquired from the Packery Channel Monitoring Project

– Water level and wind data to define the model forcings

- acquired from the Texas Coastal Ocean Observation Network (TCOON)

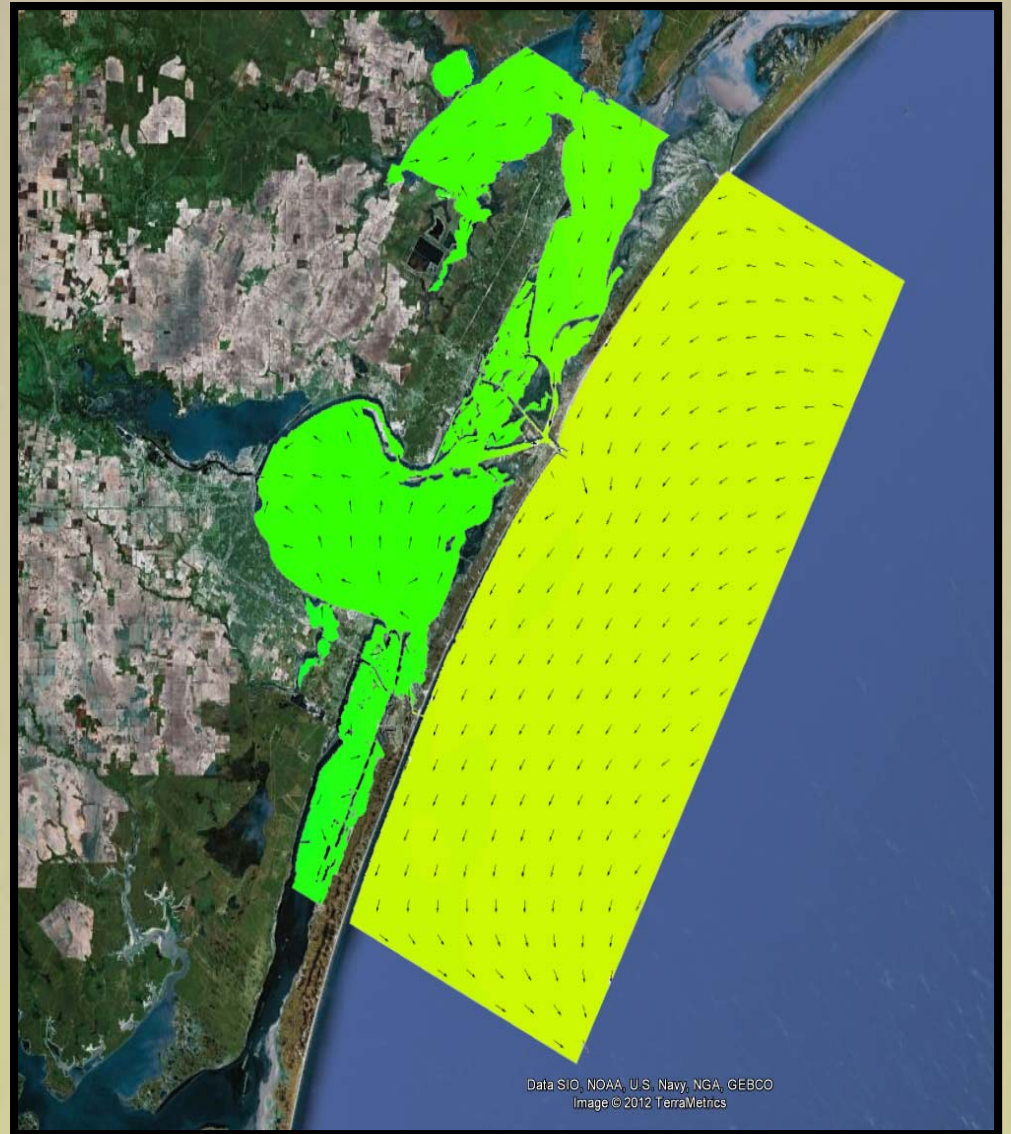
– Aerial and Satellite Imagery

- acquired from DigitalGlobe (GeoEye) Inc., Texas Natural Resources Information System (TNRIS) and Lanmon Aerial Photography Inc.



# Coastal Modeling System (CMS)

- hydrodynamic predictive model developed by the USACE, simulates water levels, currents, sediment transport and salinity
- previously implemented for the Coastal Bend, used to predict water levels
- provides vertical water level change in respect to a defined vertical datum
- provides prediction outputs with coordinates assigned to the centroid of each computation cell based on a defined horizontal reference frame





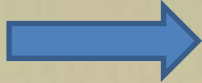
Bay Forcing

Flooding / Drying  
Analysis Area

Current  
Meter

Gulf Forcing

# Model Simulation: July 2008

Model Input 

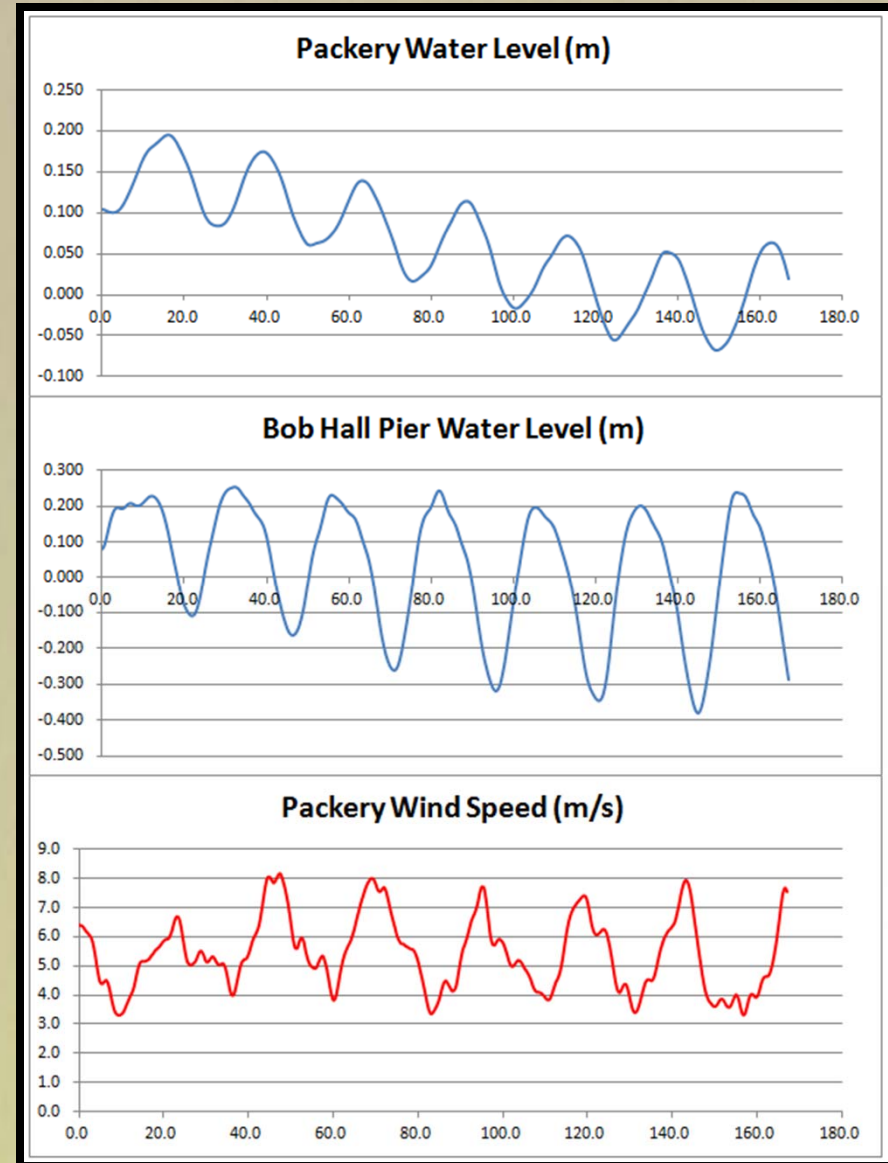
## Simulation Info

Run Date: 7/10/08 – 7/20/08

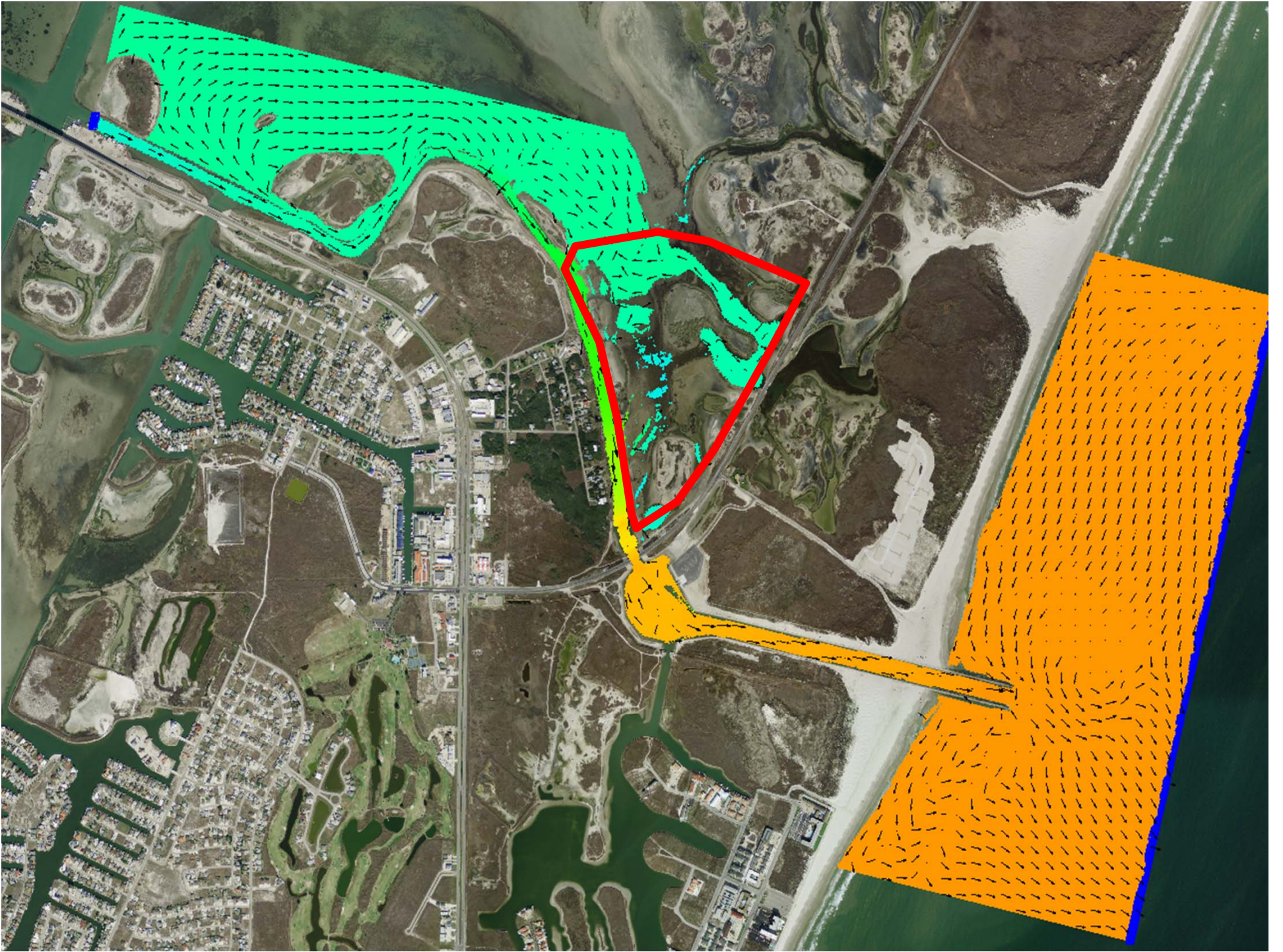
Simulation Time: 260 hours

Image Taken: 6 pm on 7/20/08

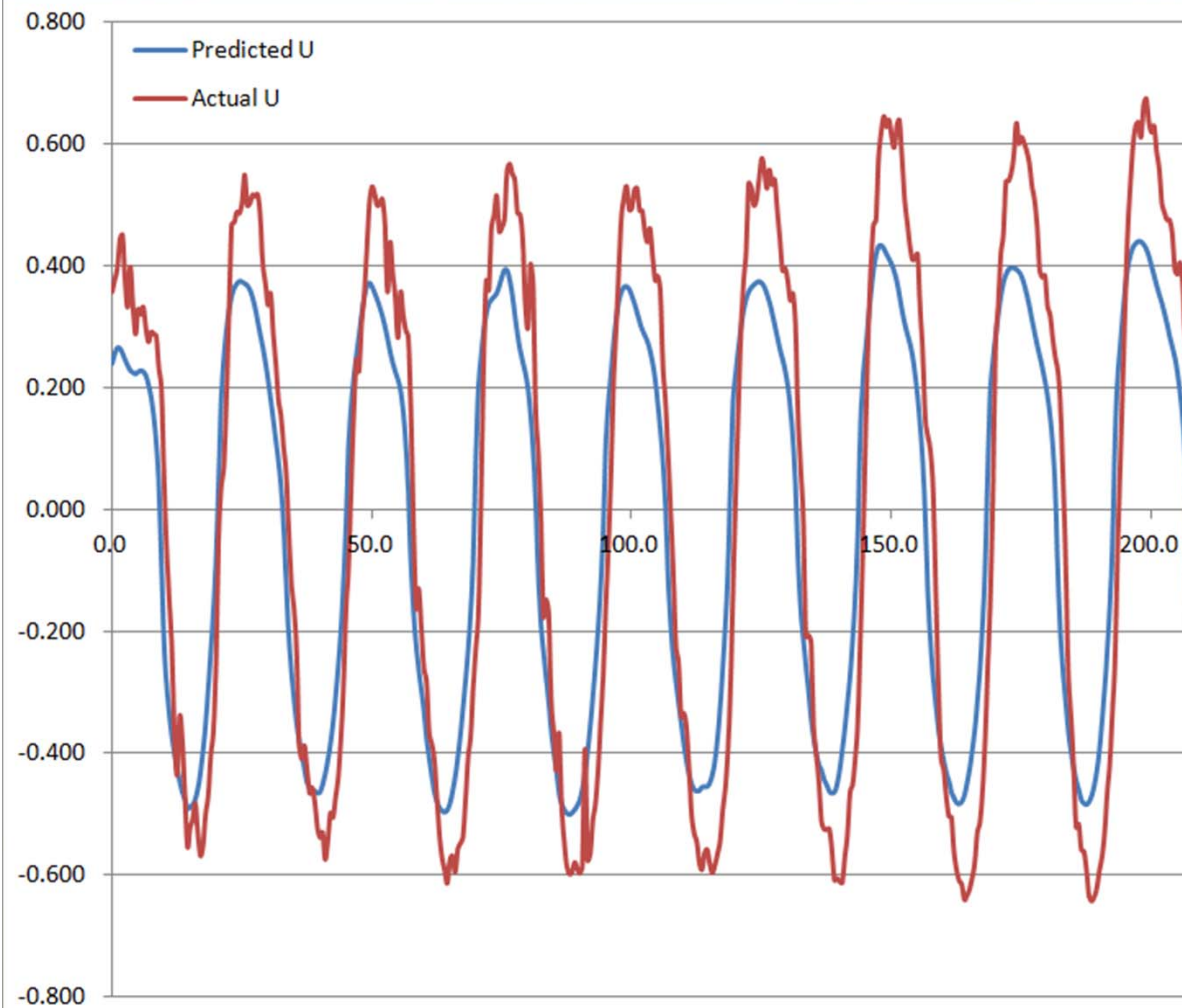
Number of Cells: 377, 762







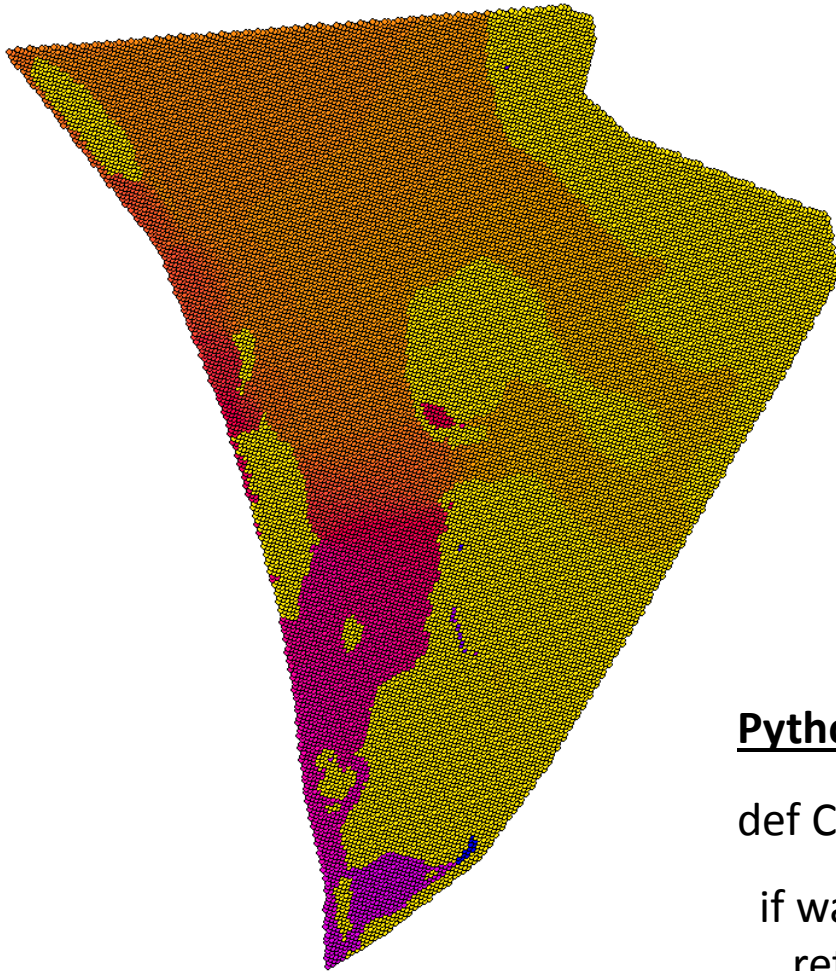
# Current Velocity Analysis



**Graph – July 2008**

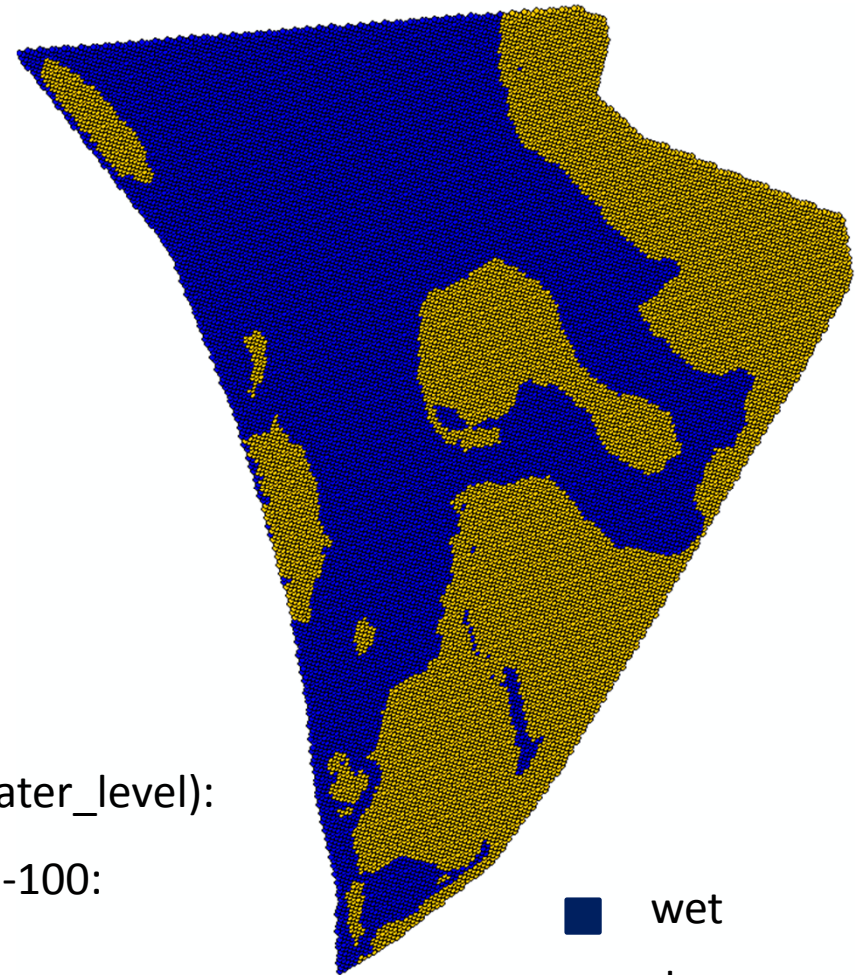
Case	AAE (m/s)	Type
7/20/2008	0.034	Image
9/30/2008	0.053	Image
12/29/2008	0.061	Image
1/12/2009	0.061	Image
8/4/2009	0.026	Image
2/15/2010	0.082	Image
4/24/2010	0.116	Image
3/12/2011	0.069	Image
11/4/2011	0.107	Image
4/23/2012	0.089	Image
8/12/2012	0.070	Image
12/20/2012	0.123	GPS
2/25/2013	0.036	GPS
3/24/2013	0.116	GPS
4/20/2013	0.120	GPS
4/21/2013	0.125	GPS

# CMS Output to Binary (Wet/Dry)



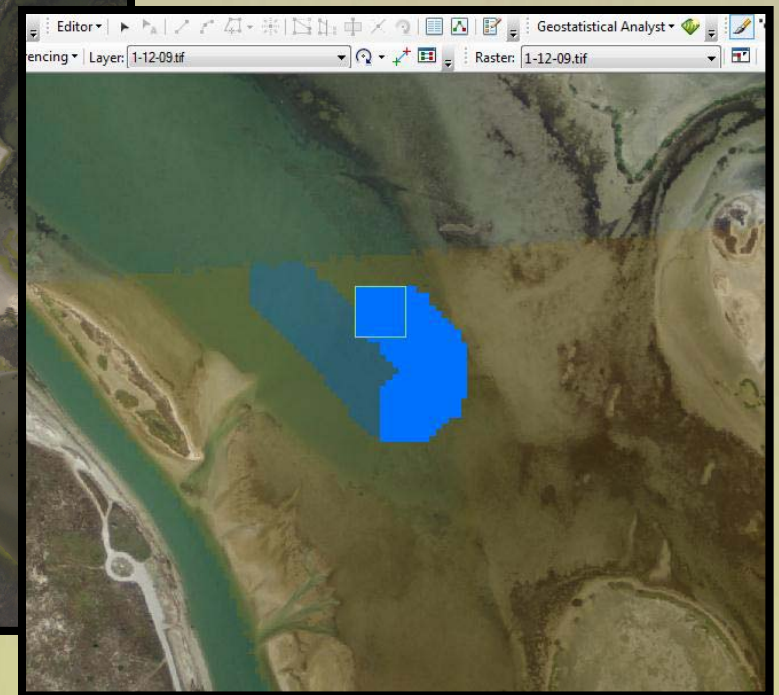
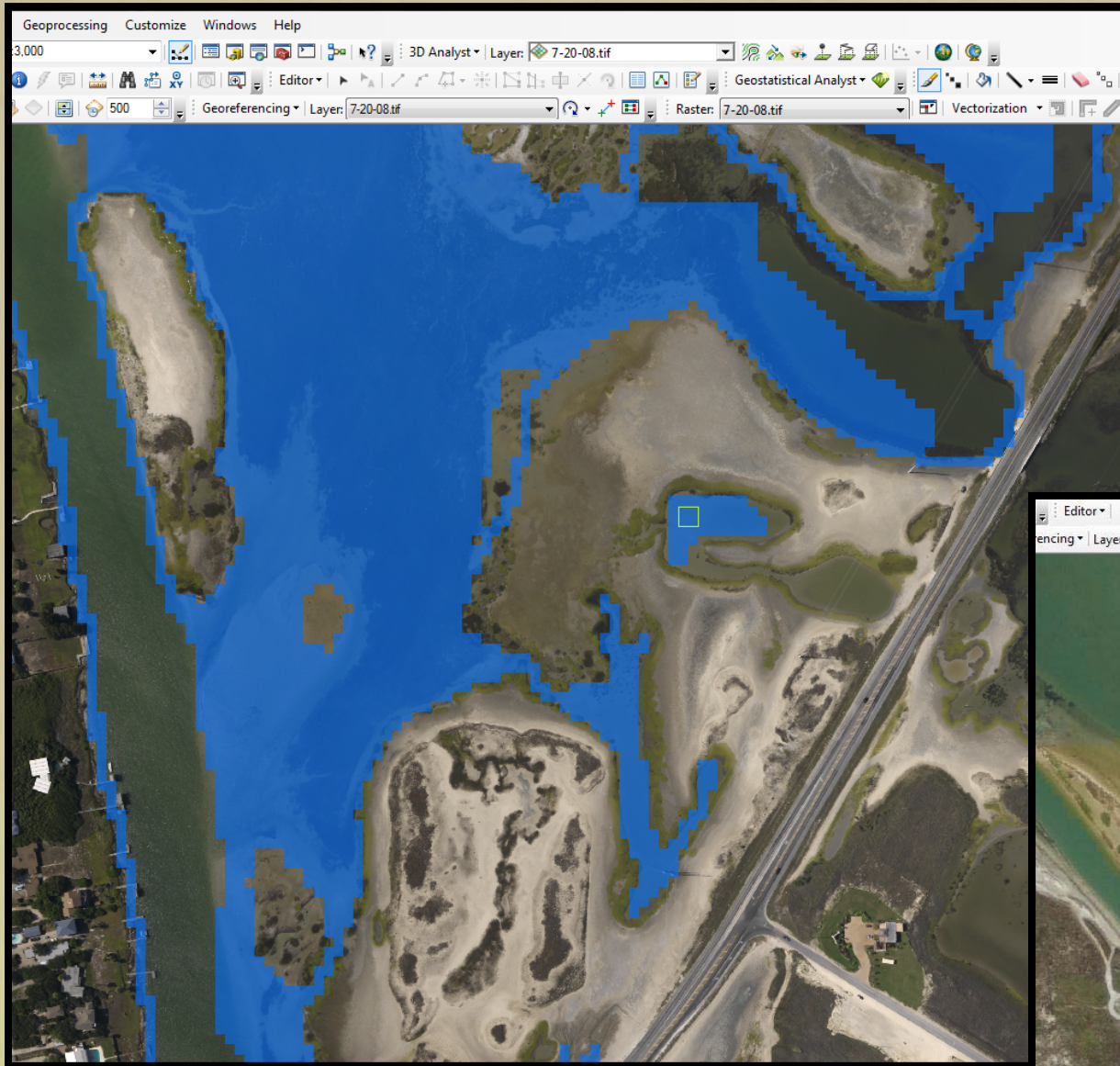
## Python Script

```
def Condition (water_level):  
    if water_level < -100:  
        return 0  
    else:  
        return 1
```

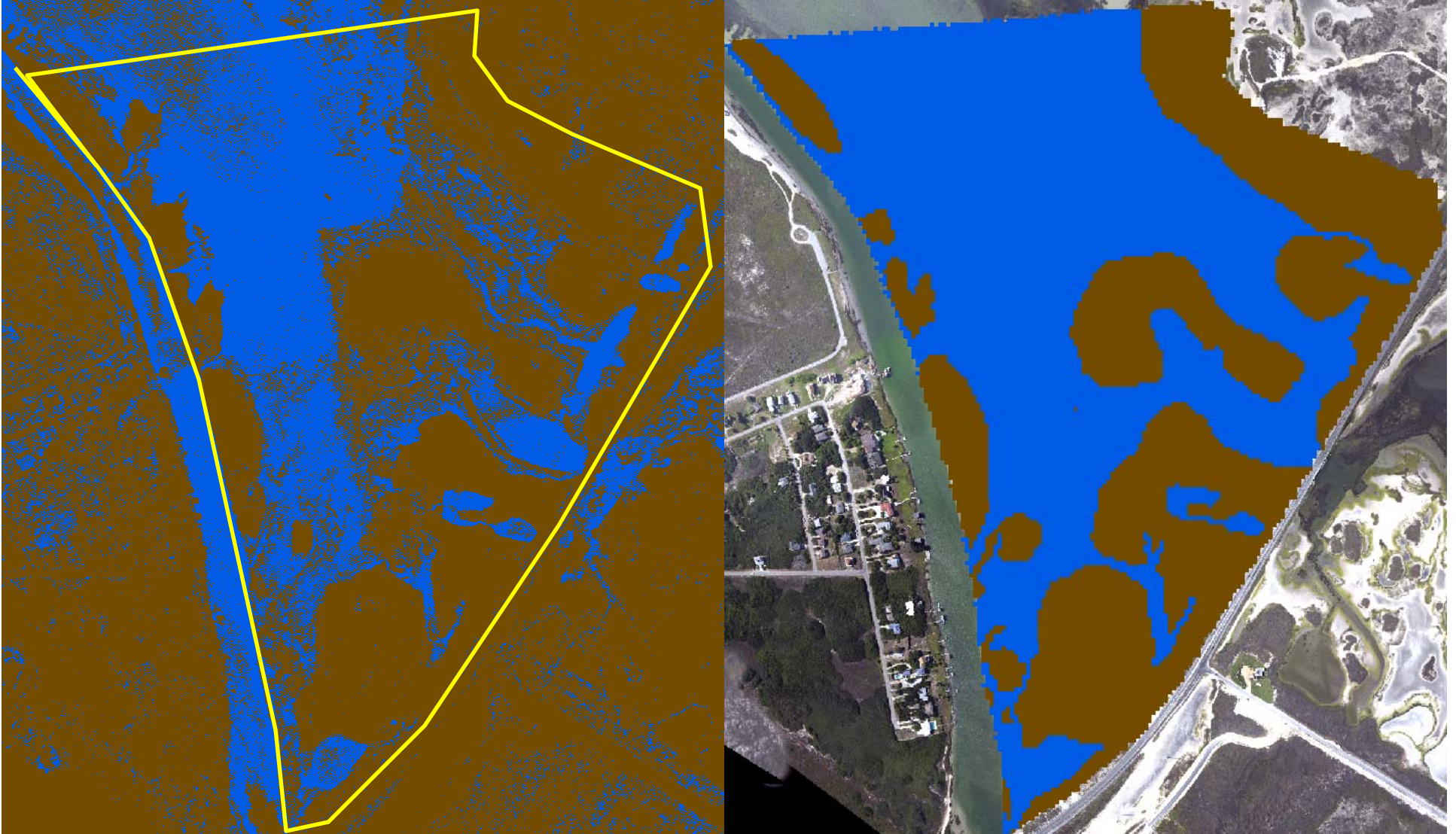


■ wet  
■ dry

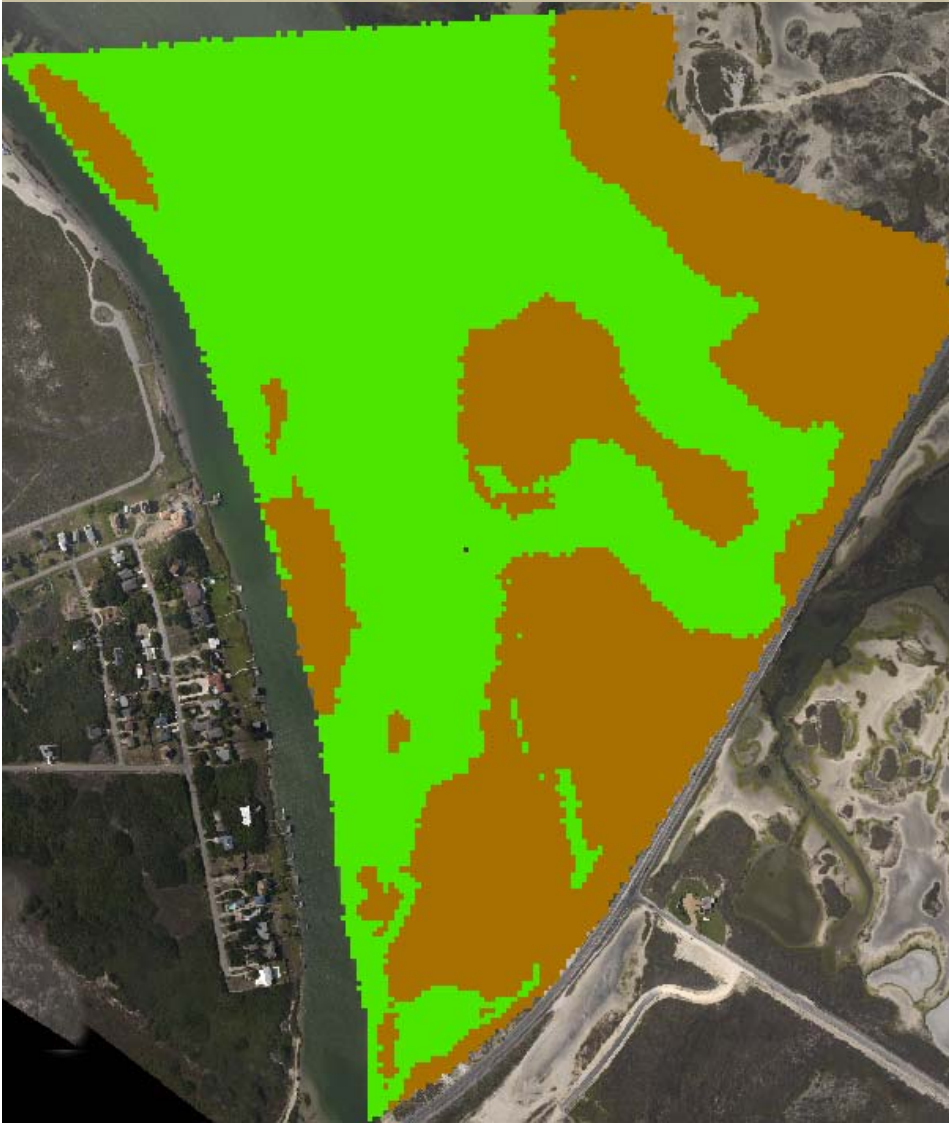
# Manual Image Classification (ArcMap)



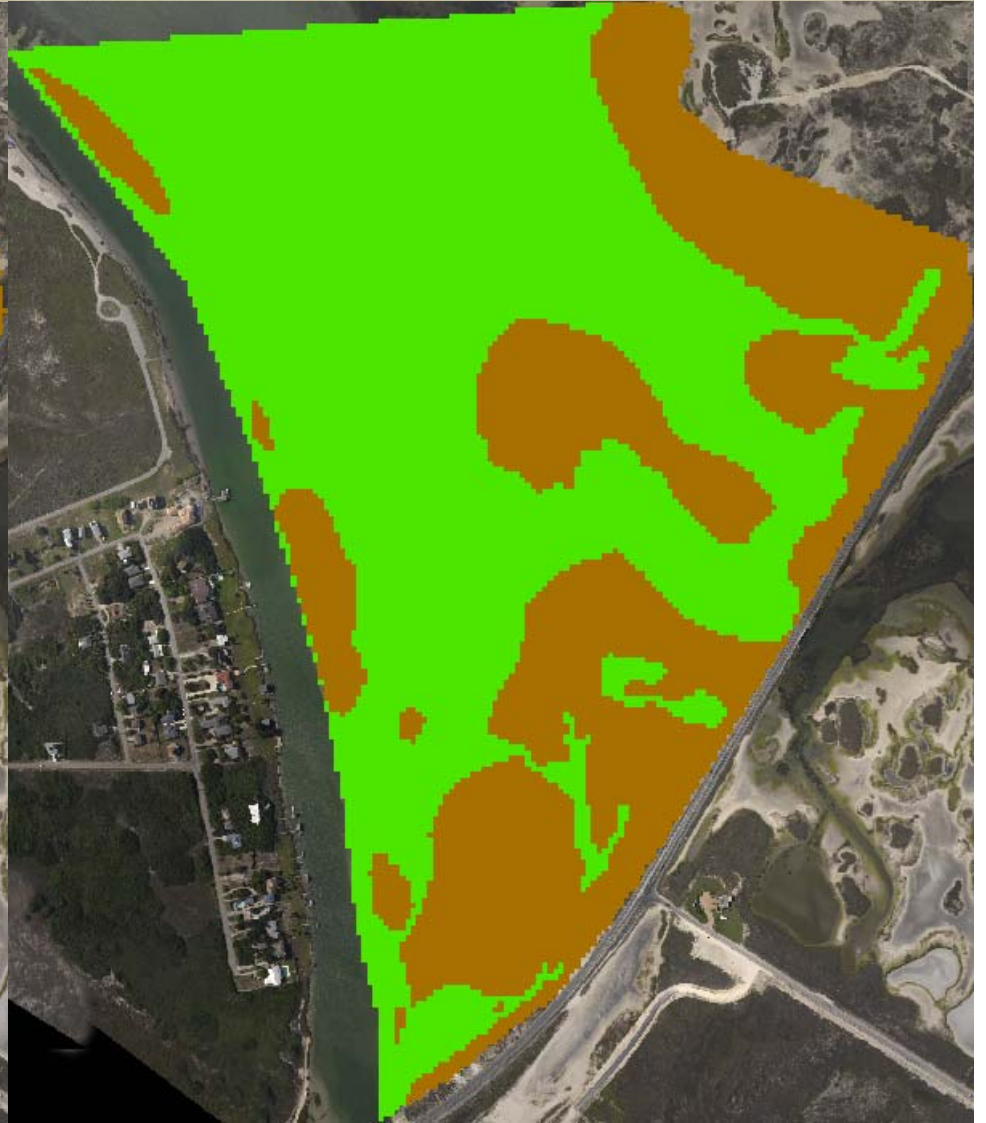
# Supervised Image Classification (~10 training samples)



# Binary (Wet/Dry) Rasters (July 2008)



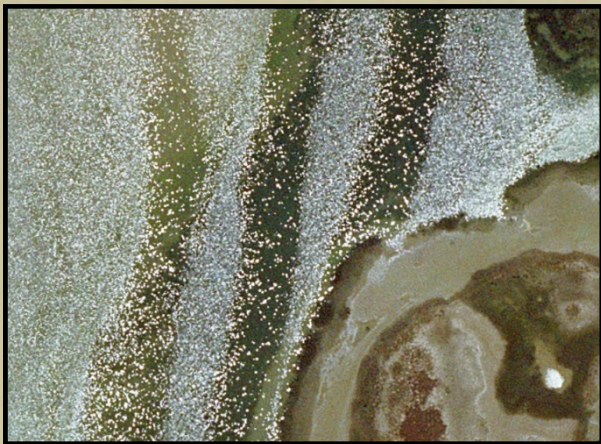

**CMS**



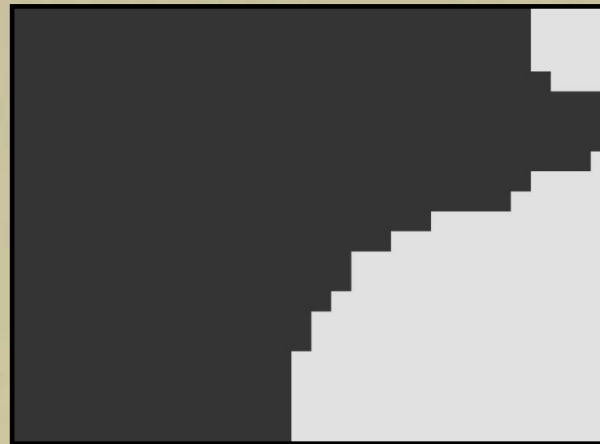
**Aerial Image**

# Comparing Classification Methods

Sunlight Glare



**Aerial  
Image**



**Manual  
Classification**



**Supervised  
Classification**

# “First Glance” CMS Inundation Accuracy (July ‘08)

RASTER ADDITION:

1	1	1	1
0	0	1	1



1	0	1	0
1	0	0	0

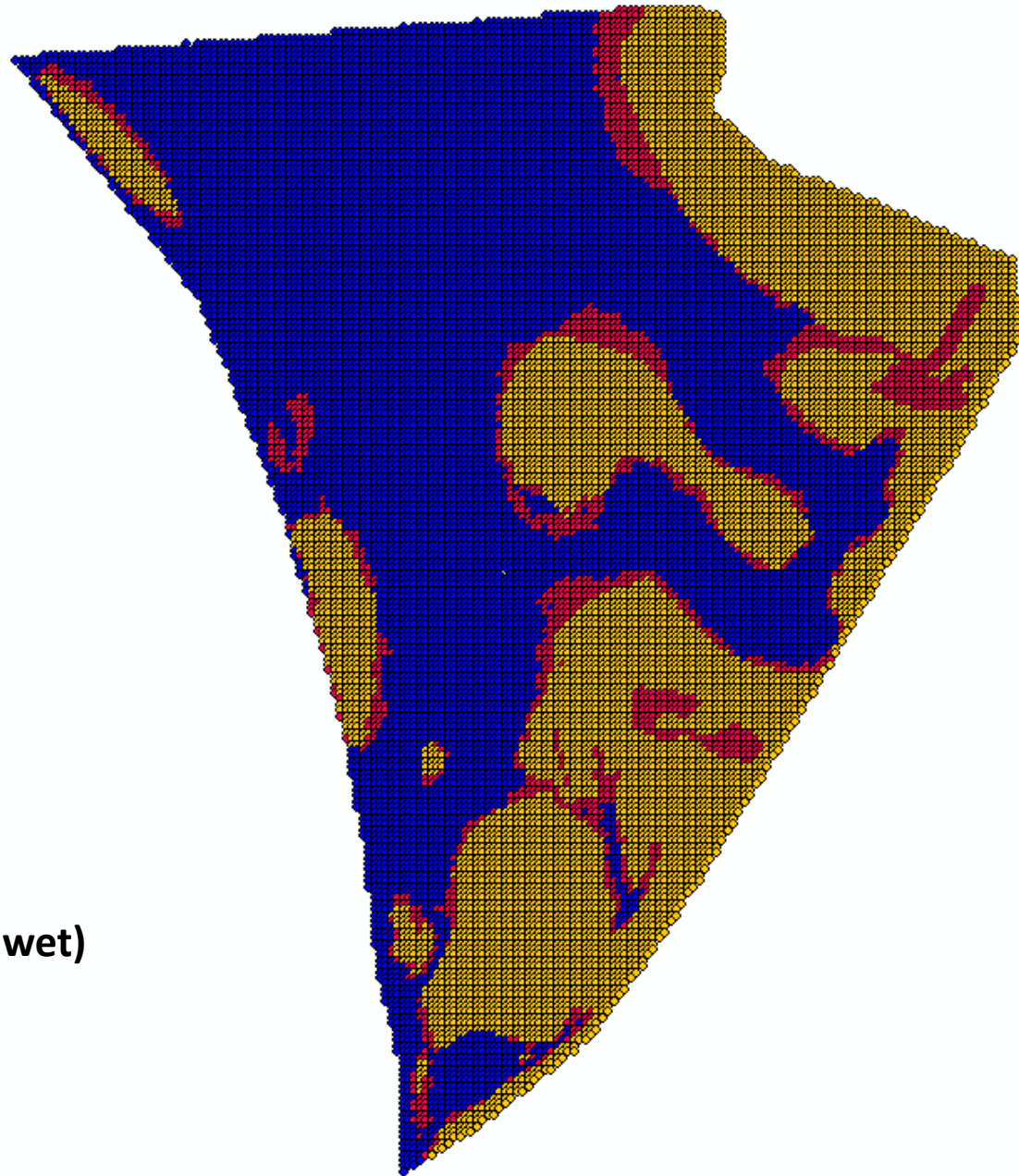


2	1	2	1
1	0	1	1



GRID\_CODE

- 0 Accurate (both dry)
- 1 Error (one dry, other wet)
- 2 Accurate (both wet)

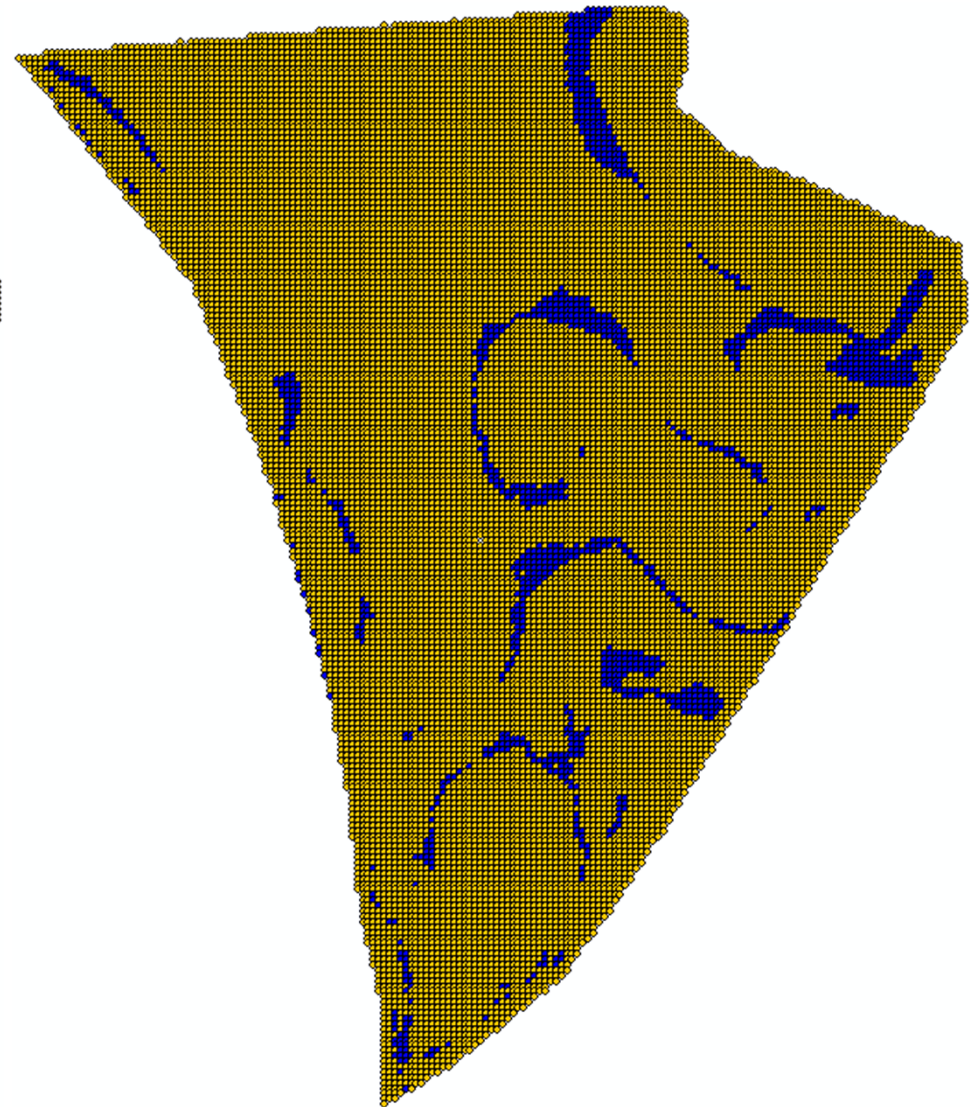
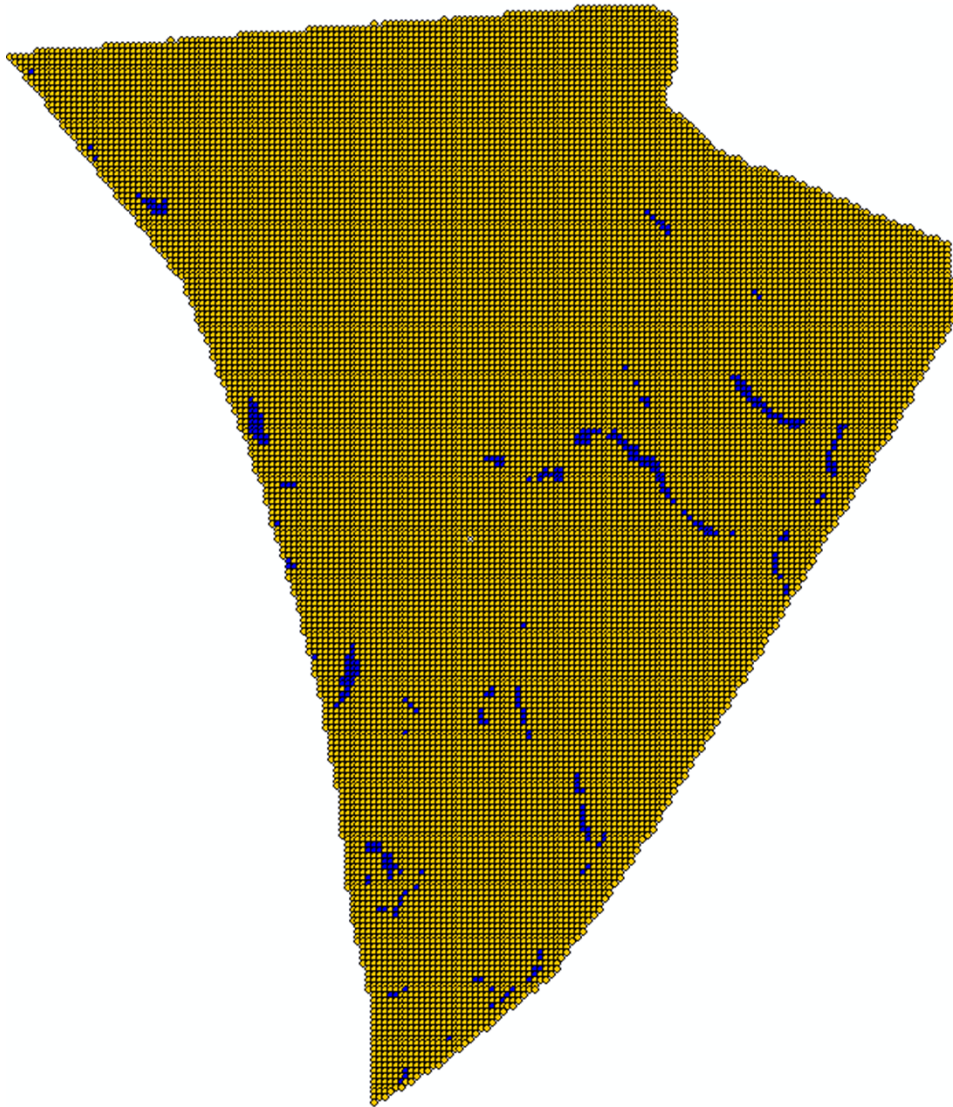




# Error Pattern: CMS is under-predicting (July '08)

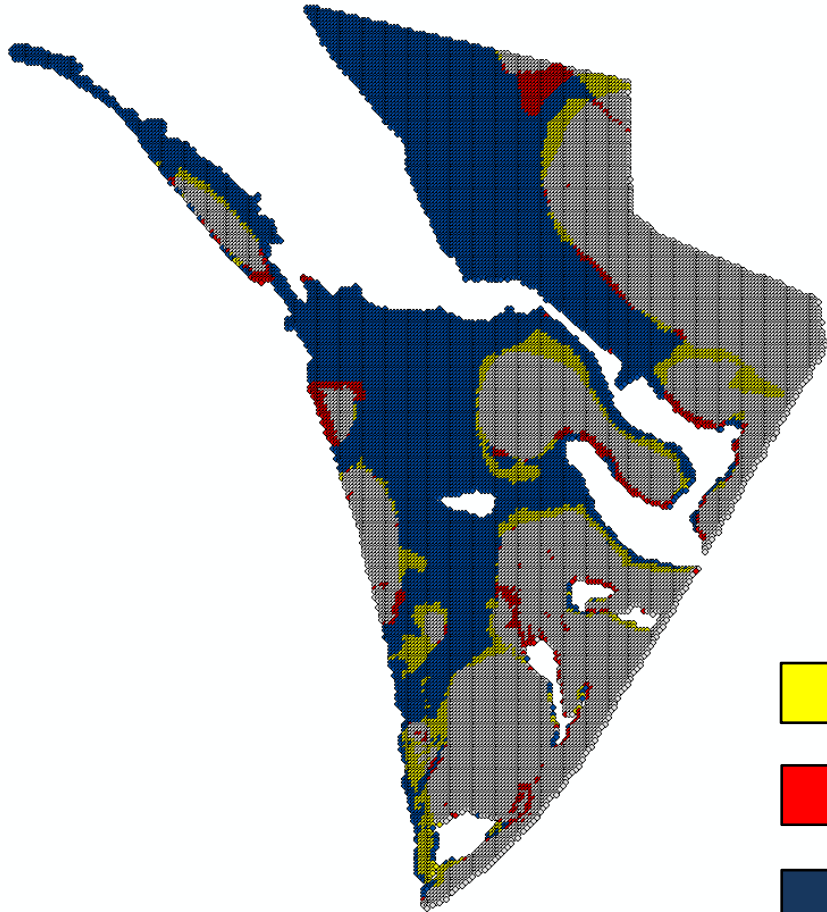
■ CMS predicting flooding where it's actually dry land

■ CMS predicting dry land where It's actually flooding

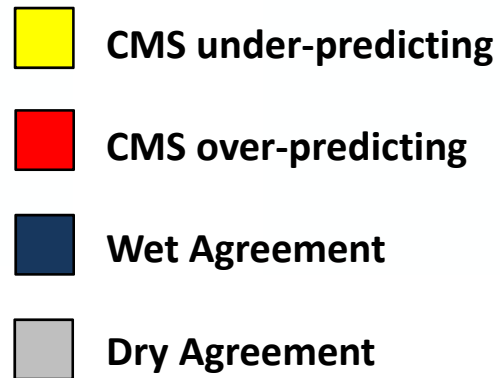
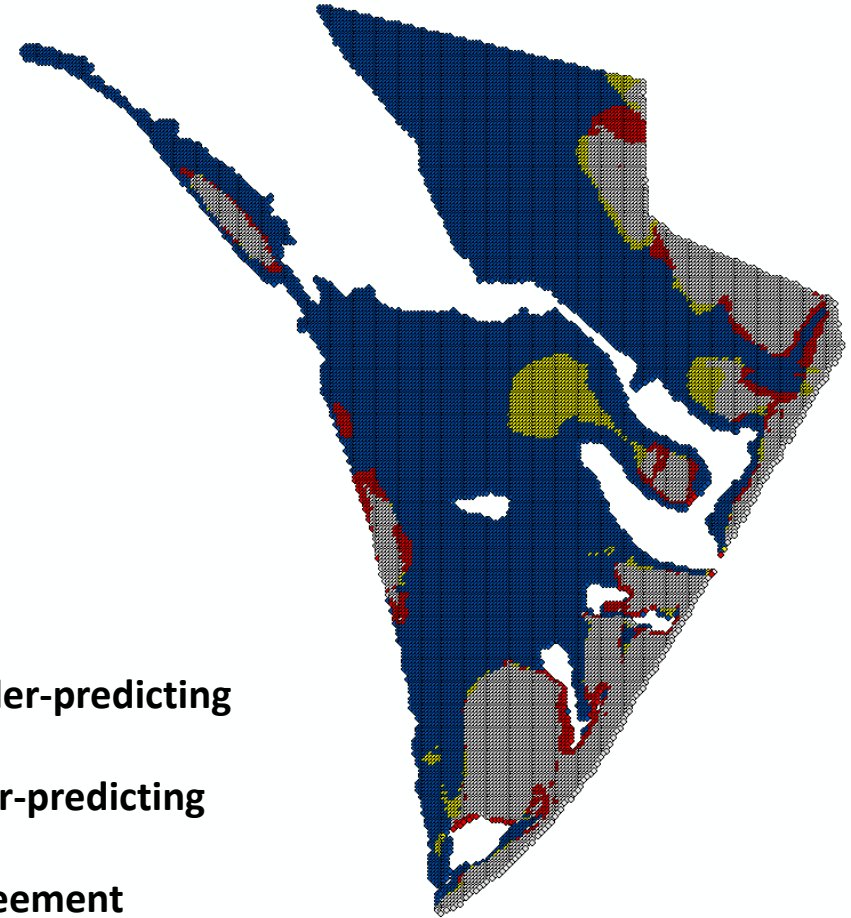


# Removing Bias (Intertidal Zone)

7/20/2008



4/24/2010



# July 2008 Case - Contingency Table Analysis

Packery Inundation				
		Aerial Image		
		Wet	Dry	
CMS	Wet	9994	291	10285
	Dry	1322	6535	7857
		11316	6826	18142

		Observed	
		Yes	No
Forecast	Yes	A	B
	No	C	D



Packery Inundation				
		Aerial Image		
		Wet	Dry	
CMS	Wet	55.1%	1.6%	56.7%
	Dry	7.3%	36.0%	43.3%
		62.4%	37.6%	1



Accuracy	
% Correct	91.1%
% Incorrect	8.9%
Bias	
Wet	0.91
Dry	1.15

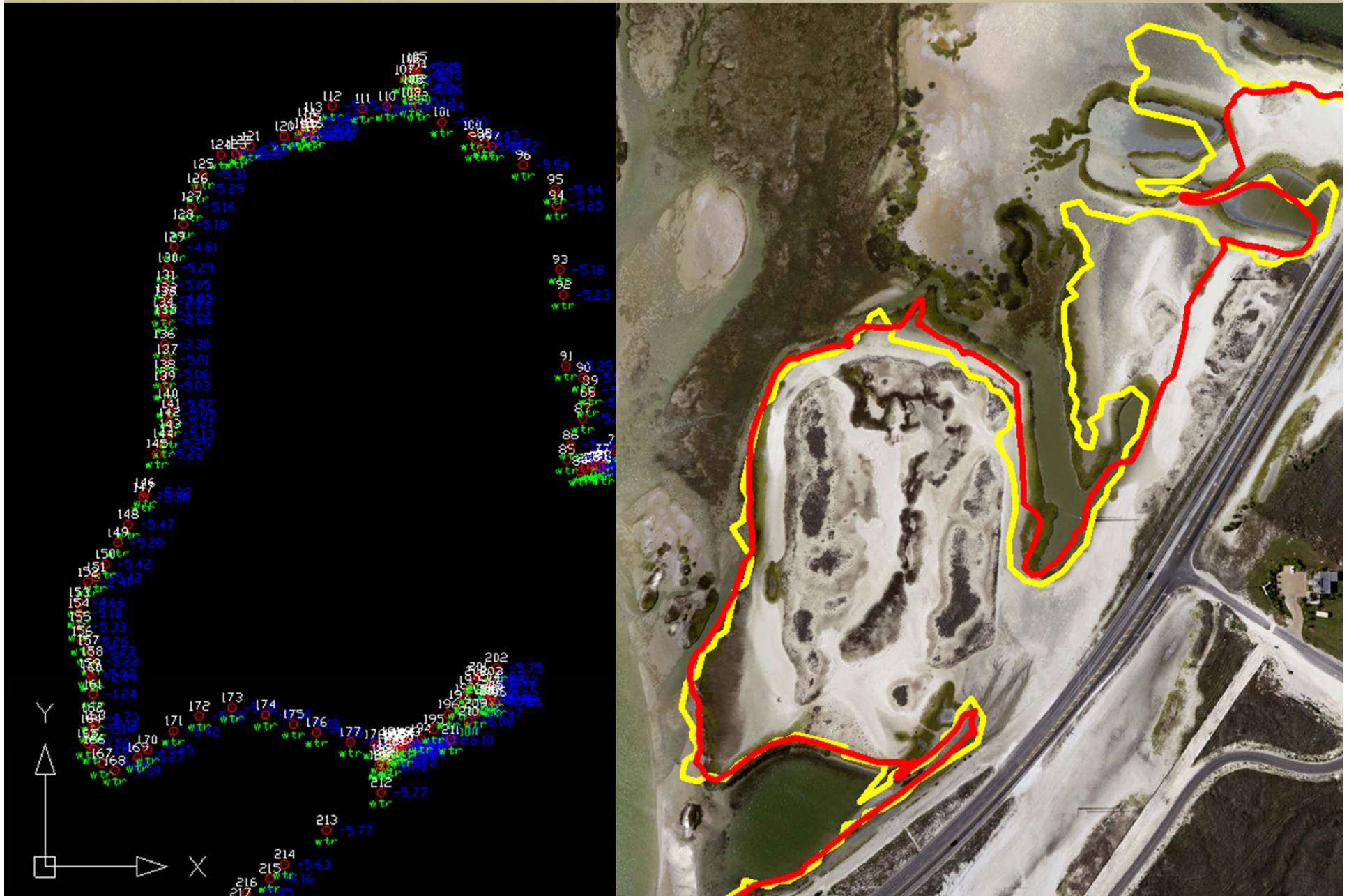
# Contingency Analysis Results

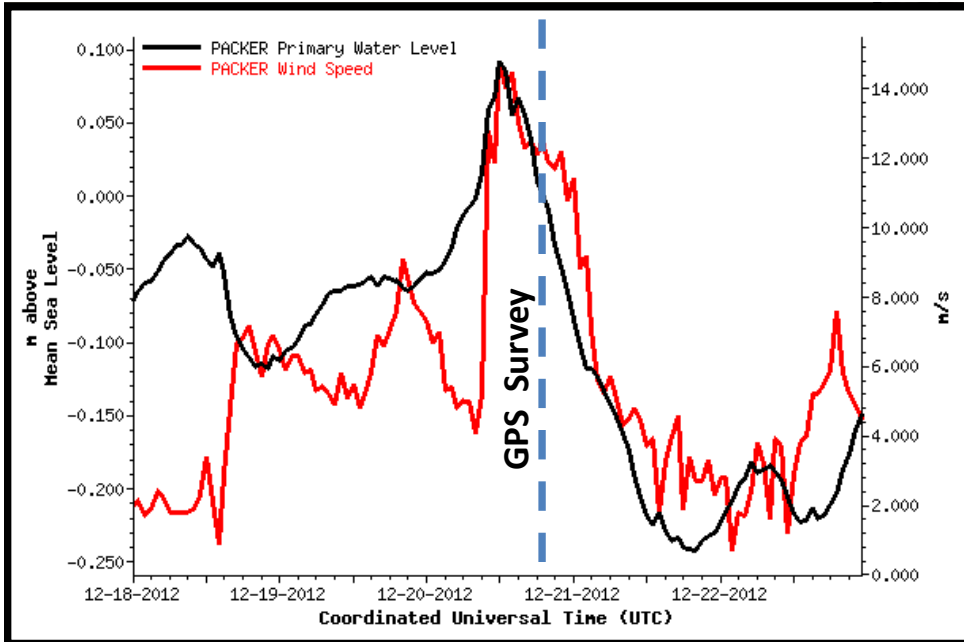
## Manual Classification Method

## Supervised Classification Method

Case	Agreement (%)	Wet Bias	Dry Bias		Accuracy (%)	Wet Bias	Dry Bias
7/20/2008	89.0	0.9	1.1		78.2	0.8	1.3
9/30/2008	89.5	1.0	0.9		68.6	1.4	0.6
12/29/2008	90.1	1.0	1.0		75.0	1.0	1.0
1/12/2009	83.0	1.1	1.0		71.0	0.6	1.3
8/4/2009	84.3	0.9	1.1		75.7	0.8	1.3
2/15/2010	88.0	1.2	0.9		79.2	1.3	0.8
4/24/2010	90.6	1.0	1.0		84.5	1.4	1.0
3/12/2011	89.0	1.1	0.9		78.6	1.2	0.8
11/4/2011	89.9	1.1	1.0		79.6	1.1	0.9
4/23/2012	86.8	1.2	0.8		84.4	1.2	0.7
8/12/2012	85.2	1.2	0.8		88.8	1.0	0.9

# GPS Delineation Analysis





Date: 12/20/2012 ~11 am  
 \*Note: GPS Survey was conducted during a cold front

Error Area: 24.97m<sup>2</sup>  
 Total Study Area: 941.92m<sup>2</sup>  
 Avg GPS Elevation: -.34m (NAVD 88)

# Conclusions

- CMS model optimization and verification
  - currents and water levels
- multiple test cases in various seasonal conditions
  - 11 test cases with agreements ranging ~70% - ~90%
- extend implementation for other coastal areas and more test cases
- sea level rise flooding delineation
- seasonal and extreme weather flooding delineation
- shoreline habitat reduction

**Questions?  
Comments?  
Concerns?**

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