# Spatially explicit flood warning system for the
Meadowlands District of New Jersey

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Tuesday, March 3rd, 2009
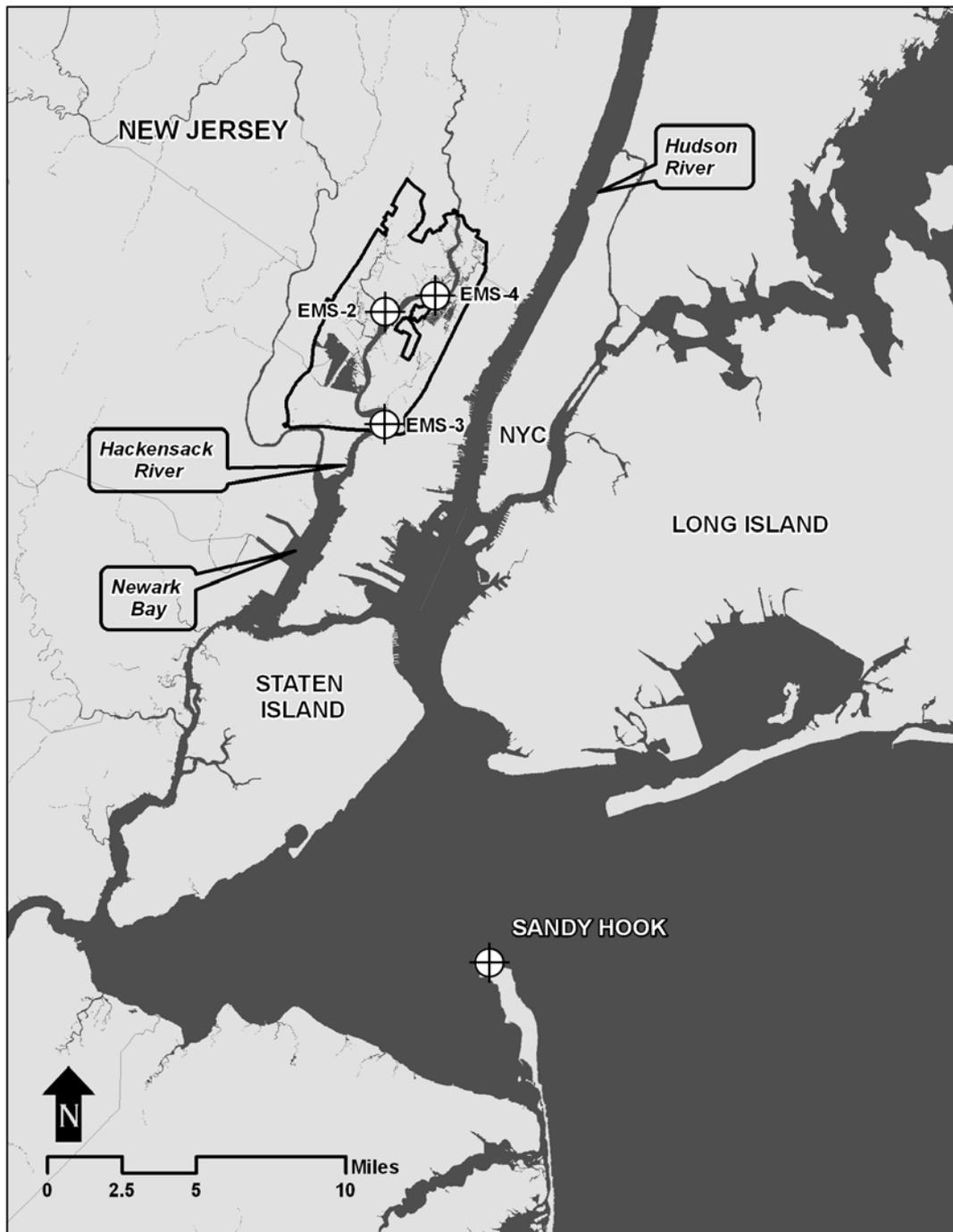
The New Jersey Meadowlands District (District) is located in a low lying flat glacial valley of the lower Hackensack River where the average elevation is 1 foot above the high water mark
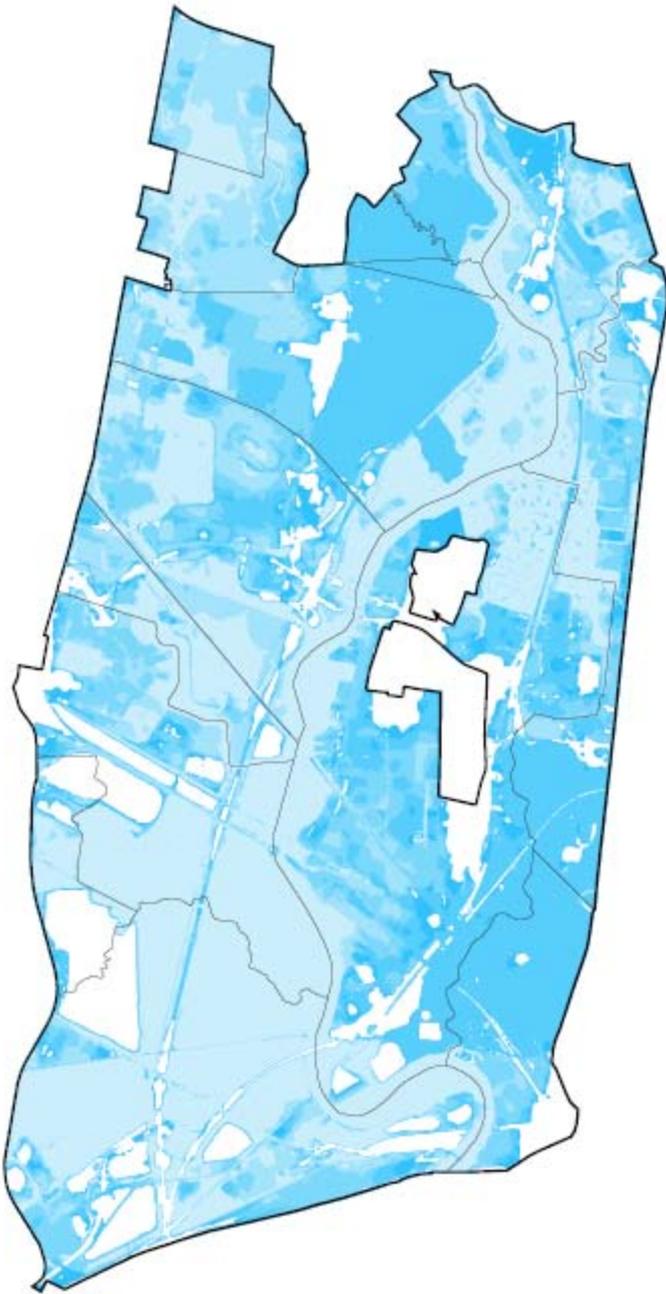
According to the Federal Emergency Management Agency (FEMA 2006), there are 5,100 homes and 2,100 commercial and industrial buildings in the 100 year flood plain.

75% of the District is within the 100 year floodplain

Ditch network (elevation) and their proximity to buildings and populated areas.

Drainage ditches constructed during the 1930's for mosquito control

Areas that have reported flooding since 2005 are highlighted in yellow

Tropical storms

- Tropical storms can occur in any month of the year, most recorded threats occurred from June through November with August and September being the peak threat months

- In September 1960, Hurricane Donna produced a water level of 10.5 feet above Mean Lower Low Water (MLLW).

- Severe tidal flooding begins at 8.7 feet and moderate and minor tidal flooding begins at 7.7 feet and 6.7 feet above MLLW.

Hackensack River

Elevation NADV88 feet

-0.5	3.5	7.5
0	4	8
0.5	4.5	8.5
1	5	9
1.5	5.5	9.5
2	6	10
2.5	6.5	10.5
3	7	

0   100   200   300   400   500 Feet
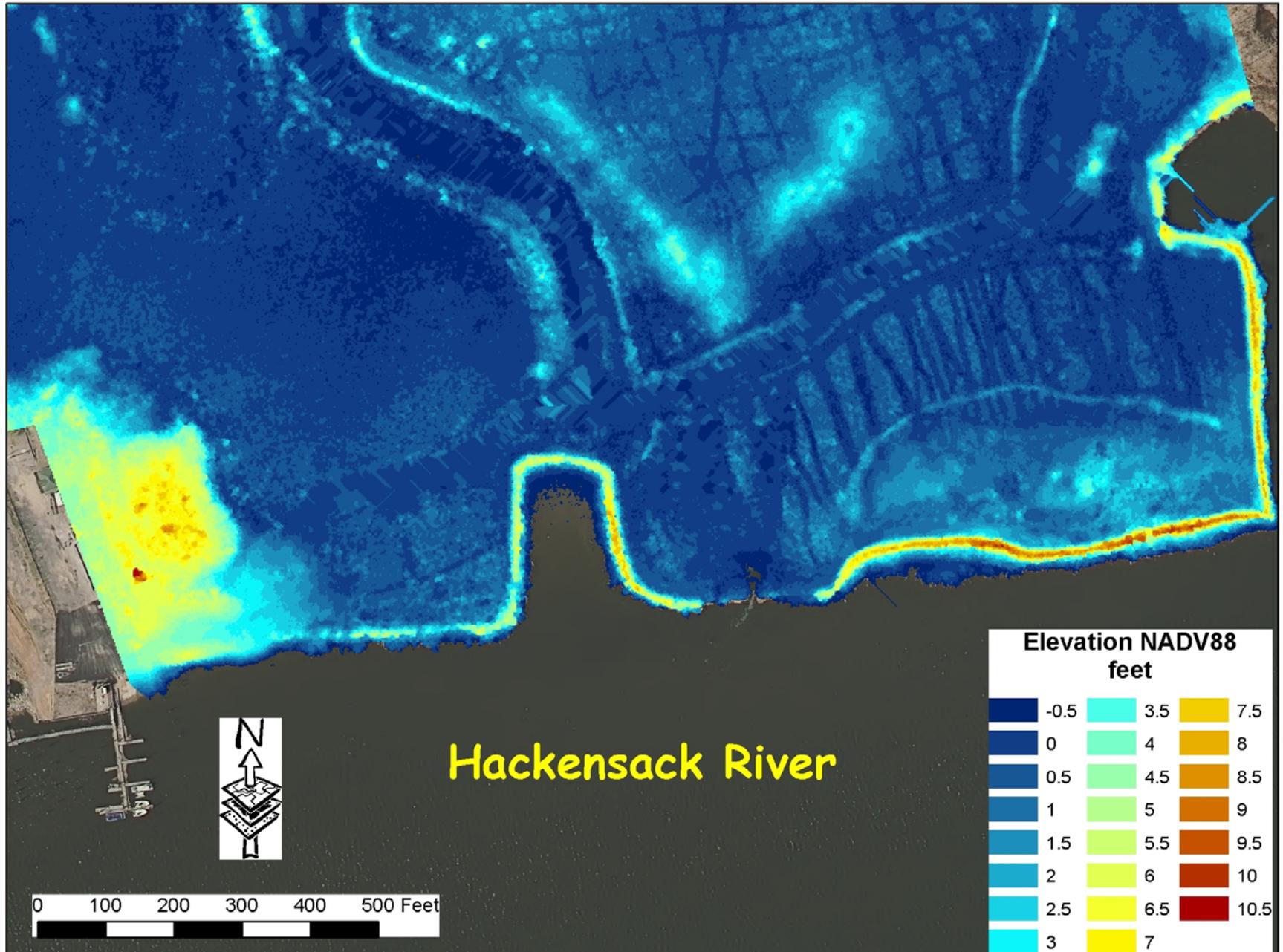
Objective

- Develop a local sea surge warning system that can be easily installed and maintained and can inform emergency managers about specific properties and infrastructure at risk of flooding at least three to six hours in advance.

Strategy

- Utilize existing warning systems based on NOAA models as a trigger for releasing pre-calculated flood maps.

- Utilize existing land use inventories, terrain elevation models and ditch elevation and network layout to build flood maps for different water depths.

- Build a distributed tide-gate sensor network with telemetry capabilities to inform the system of tide-gate functioning and status

- Disseminate flood maps of the 14 District municipalities to a subscriber list of emergency managers

NOAA Flood warning

Sent by: flooding_alert@stevens.edu

- Sandy Hook, NJ (N021): Severe Tidal Flooding Possible in 2 hours (Anticipated water elevation in 2 hrs = 11 ft 1 inches) Please go to http://hudson.dl.stevens-tech.edu/SSWS to see the predictions/water levels.

Storm Surge Warning System

Station: Sandy Hook NJ

Start date: 2009-02-23

End date: 2009-02-25

Datum: MLLW

Units: English

Time: Eastern Time

Query Data   **Plot**

Subscribe for Storm Surge email alerts here

Sandy Hook NJ - elevation relative to MLLW (ft)

Major flood level: 8.69
Moderate flood level: 8.1
Minor flood level: 6.69
Blowout level: -1.8

— Astron. predictions
· Observations
— Forecast model
— Extrapolation model

Sandy Hook NJ - Water elevation difference (ft)

· (observed - astron. prediction)
· (observed - forecast model)
· (observed - extrapolation model)
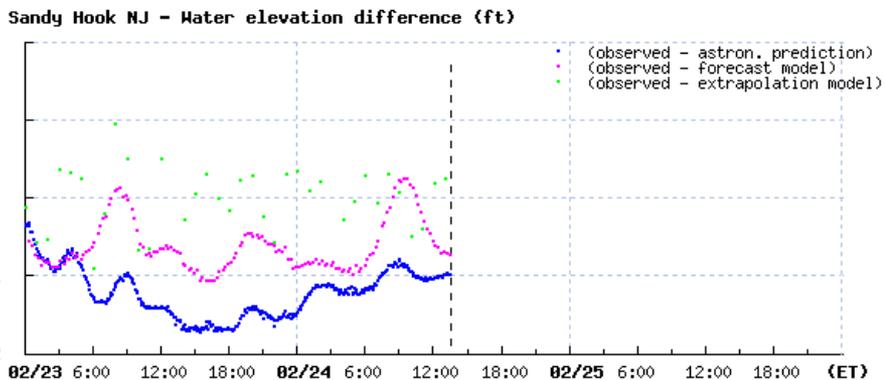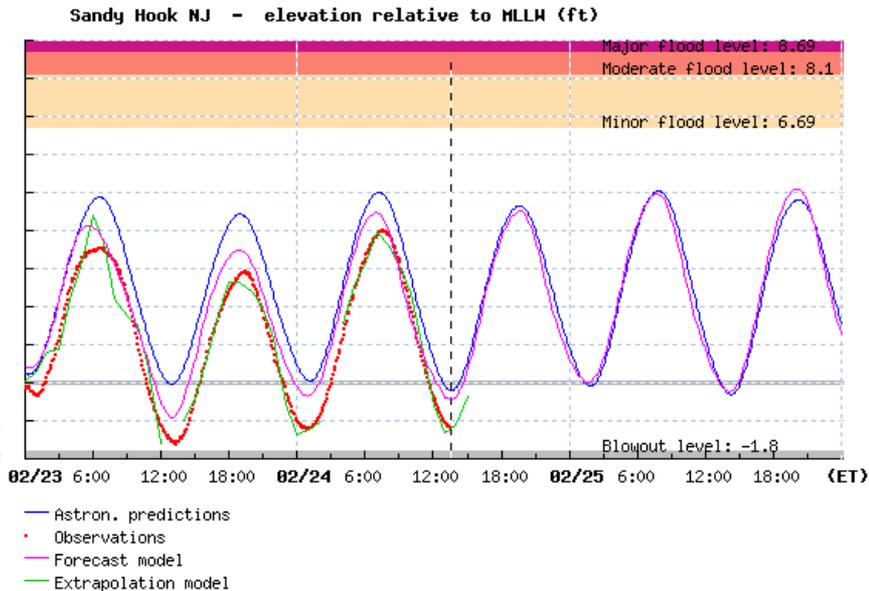
Real-Time - 1 Kearny (EMS3): EMS3

Depth NAVD
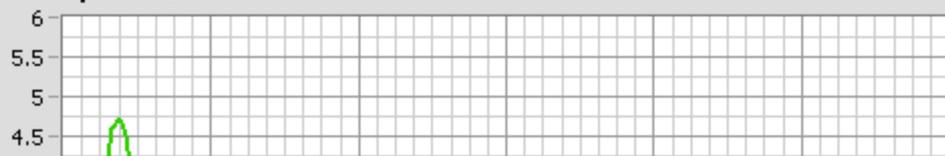
Latest time: 1:00:00 PM 2/24/2009

Plot	Latest	Unit
☑ Depth NAVD: Real-Time - 1 Kearny	-2.096	feet

Y-axis: 6, 5.5, 5, 4.5, 4, 3.5, 3, 2.5, 2, 1.5, 1, 0.5, 0, -0.5, -1, -1.5, -2, -2.5, -3, -3.5, -4

7:00:00 PM 2/18/2009

Real-Time - 2 Berrys Creek (EMS2): EMS 2

NAVD Depth
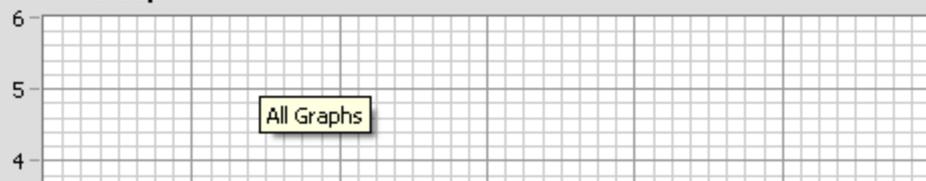
Latest time: 1:00:00 PM 2/24/2009

Plot	Latest	Unit
☑ Depth NAVD: Real-Time - 2 Berrys C	-3.315	feet

All Graphs

Y-axis: 6, 5, 4, 3, 2, 1, 0, -1, -2, -3, -4, -5

7:00:00 PM 2/18/2009

Real-Time - 3 Mill Creek(EMS4): EMS4

Depth NAVD
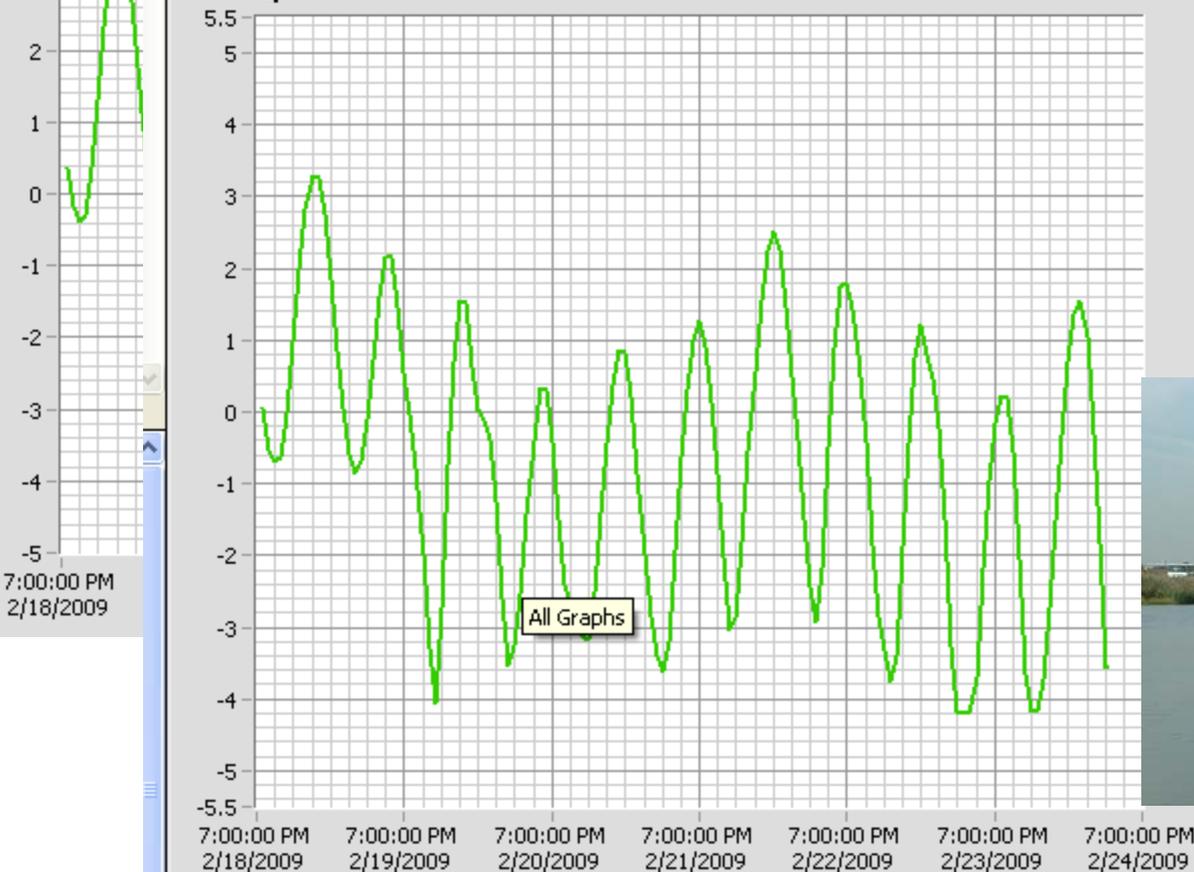
Latest time: 1:00:00 PM 2/24/2009

Plot	Latest	Unit
☑ Depth NAVD: Real-Time - 3 Mill Cree	-3.568	feet

Depth NAVD: Real-Time - 3 Mill Creek(EMS4)

Max	Average	Min	
3.3000000191	-0.732	-4.212000005	

All Graphs

Y-axis: 5.5, 5, 4.5, 4, 3.5, 3, 2.5, 2, 1.5, 1, 0.5, 0, -0.5, -1, -1.5, -2, -2.5, -3, -3.5, -4, -4.5, -5, -5.5

X-axis: 7:00:00 PM 2/18/2009, 7:00:00 PM 2/19/2009, 7:00:00 PM 2/20/2009, 7:00:00 PM 2/21/2009, 7:00:00 PM 2/22/2009, 7:00:00 PM 2/23/2009, 7:00:00 PM 2/24/2009

Tidal Predictions: Time

$y = -4E\text{-}10x^2 + 8E\text{-}05x - 0.472$

$R^2 = 1$

2.12

2.8

2.92

Elapsed Time from S.Hook (hours

Distance Upstream (Feet)
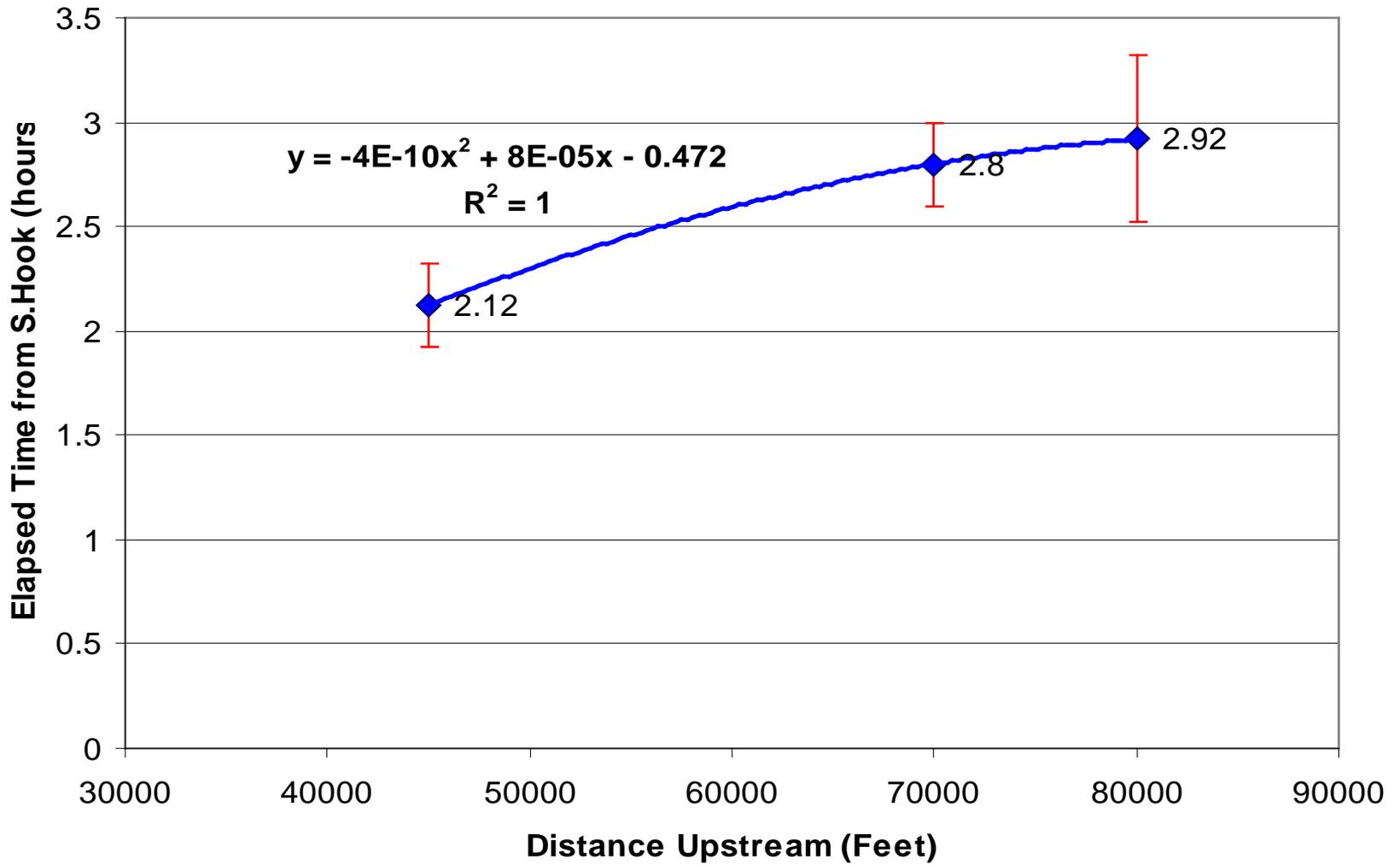
◆ Elaspsed Time Predicted

Actual and predicted water elevations in the upper (EMS4), middle (EMS2) and lower reaches (EMS3) of the New Jersey Meadowlands estuary according to eight events that took place between January and May of 2008.

DATE & TIME		ELEVATION NAVD 88 (FT)											
Event Date (2008)	Event Time (24h)	Predicted SH	Actual SH	Prediction Error	Predicted EMS 3	Actual EMS 3	Prediction Error	Predicted EMS 2	Actual EMS 2	Prediction Error	Predicted EMS 4	Actual EMS 4	Prediction Error
5/12	12:32	4.60	4.52	0.08	6.00	5.72	0.28	5.20	4.18	1.02	4.90	3.63	1.27
5/9	23:32	3.85	3.35	0.50	5.25	5.45	-0.20	4.45	4.64	-0.19	4.15	4.13	0.02
5/7	21:32	3.93	3.44	0.49	5.33	5.50	-0.17	4.53	4.70	-0.17	4.23	4.18	0.05
5/5	18:32	3.93	4.02	-0.09	5.33	5.31	0.02	4.53	3.96	0.57	4.23	3.44	0.79
5/4	17:32	3.85	3.78	0.07	5.25	4.79	0.46	4.45	3.81	0.64	4.15	3.30	0.85
5/3	17:32	3.93	4.16	-0.23	5.33	4.47	0.86	4.53	4.57	-0.04	4.23	4.07	0.16
2/8	6:32	3.85	3.61	0.24	5.25	4.71	0.54	4.45	3.02	1.43	4.15	2.66	1.49
1/18	1:32	4.34	3.15	1.19	5.74	4.89	0.85	4.94	3.58	1.36	4.64	3.27	1.37
Average Prediction Error				0.28			0.33			0.58			0.75

West Riser Tide Gates

KNICKERBOCKER RD

W COMMERCIAL AVE

New Jersey
Meadowlands Commission
Geographic Information Systems

Borough of Moonachie

UNIVERSAL PL

ASIA PL

127

AMOR AVE

84

East Riser Tide Gates

123

GOTHAM PKWY

COMMERCIAL AVE

COMMERCE BLVD

91

16TH ST

92

DELL RD

126

KERO RD

101

Waitex Tide Gate

BROAD ST

102

103

104

Dell Road Tide Gate

GRAND ST

JONY DR

...feet Tide Gate

116

118

119

120.01

120

14.01

14.02

123.01

121

8.01

7.01

9.03

9.02

9.05

9.01

TRIANGLE BLVD

125

VETERANS BLVD

PALMER TERR

Peach Island Creek Tide Gates

Borough of East Rutherford

NJ 120

122

124

MURRAY HILL PKWY SECONDARY

KWY

NJ 120 SECONDARY

ROUTE 503

128

124.01

128.01

12.01

0   250   500
Feet

1 inch = 1,500 feet

From: Meadowlands Commission   **To:** 40.839, -74.071

Language: English ▼   Get Directions!

Formatted Directions	Map

Ⓐ Valley Brook Ave

5.6 mi (about 11 mins)

1. Head **northeast** on **Valley Brook Ave** toward **Woods Ct** — 0.9 mi
2. Turn **right** at **Chubb Ave** — 0.6 mi
3. Turn **right** at **Wall St W** — 0.2 mi
4. Turn **left** at **Rutherford Ave** — 0.1 mi
5. Take the ramp to **11th St/ Meadow Rd/RT-17** — 0.1 mi
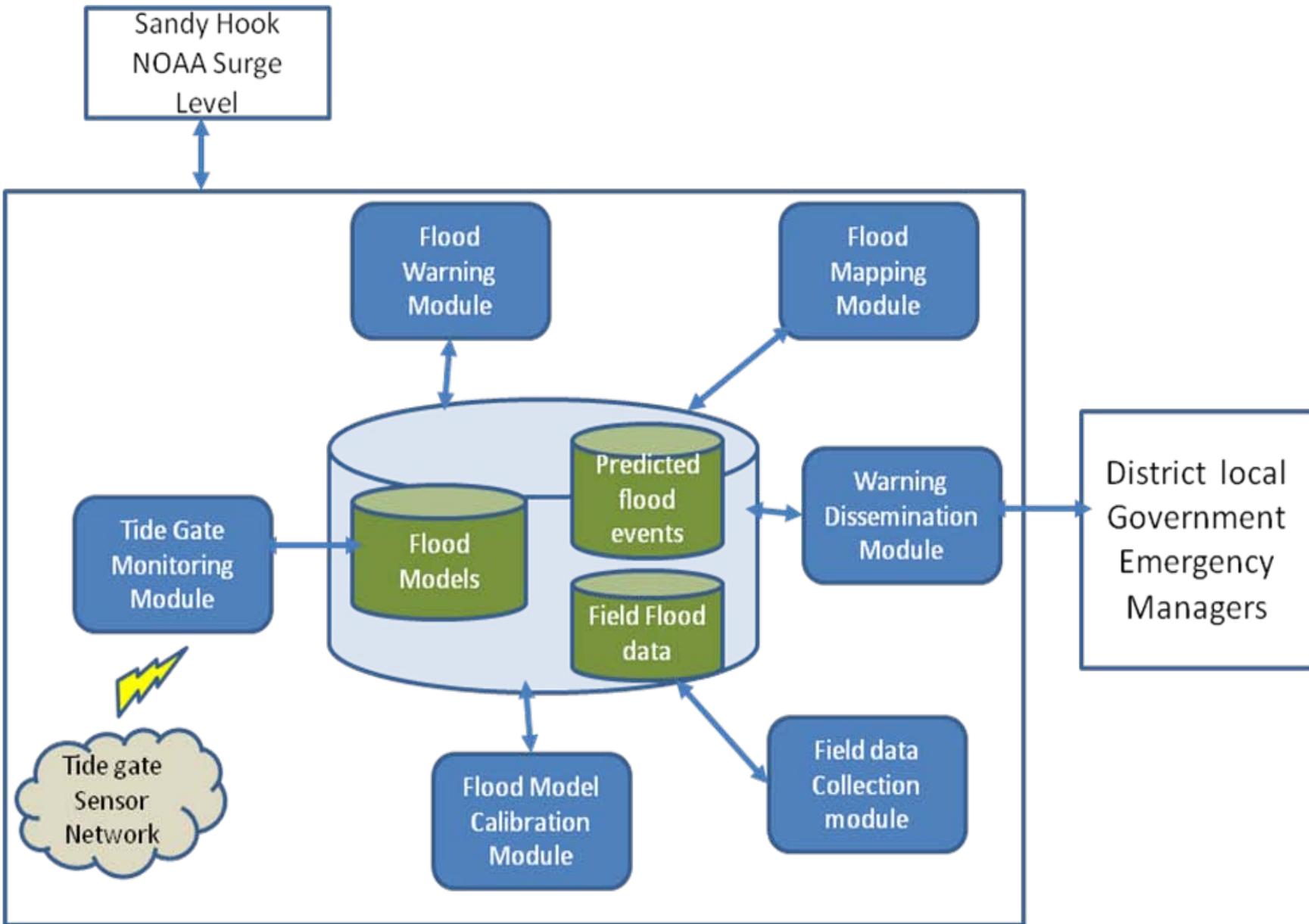
Data dissemination

- The system generates a flood warning message and sends an email or text message (SMS) notification to subscription members.   The recipients are alerted to view maps of their towns showing flooded areas according to sea surge warnings.

- Hard copies of the flood maps along with tables with property information of the affected areas are made available to emergency managers ahead of time.

Results

- The most common flood events (nuisance flooding) which cause traffic to be temporarily disrupted and properties to suffer minor flood damage can be predicted and prepared for.

- Continued flood validation, is allowing for more precise warnings - to a point where specific road intersections and properties at risk are being identified in advance.

Results continued

- Awareness is increased of the often complex local drainage systems. As such, newer local officials and emergency officials from outside the District, can quickly develop an understanding of an area at risk during an emergency.

- In the event of power loss, flood projections can be completed by hand, based on established regressions, and communicated to appropriate officials by various methods.

Results

- The system has improved preparedness (e.g. valuable belongings can be moved to high places, traffic can be re-routed, and utilities fortified or disconnected)

- The basic field data provided by the installed sensors on the District tide gates allows for the quick and safe determination of functionality and can focus emergency repairs where most needed, prior to surge/storm events

- Emergency officials can now check the condition of tide gates on-line well in advance of storms, as well as during an event.

- The NJMC/MERI can evaluate the performance of tide gates with collected data, following a storm event.

Conclusions

- As a result of this study, a regional planning agency (NJMC) was able to utilize the real-time sea surge forecasts from NOAA models and translated this information into local flood maps showing properties at risk according to water level. The status of tide gates from telemetry data are taken into account and a warning is disseminated to emergency officials. During each significant flooding event data is collected in order to verify the accuracy of the prediction and re-calibrate the model.

Conclusion

Public agencies can inexpensively develop a system that predicts the extent of a flood hazard with existing technology and available data from reliable sources (NOAA).

The developed system is easily scalable, and can be expanded to monitor the condition and effectiveness of levees, dams, pump stations, and other essential infrastructures.
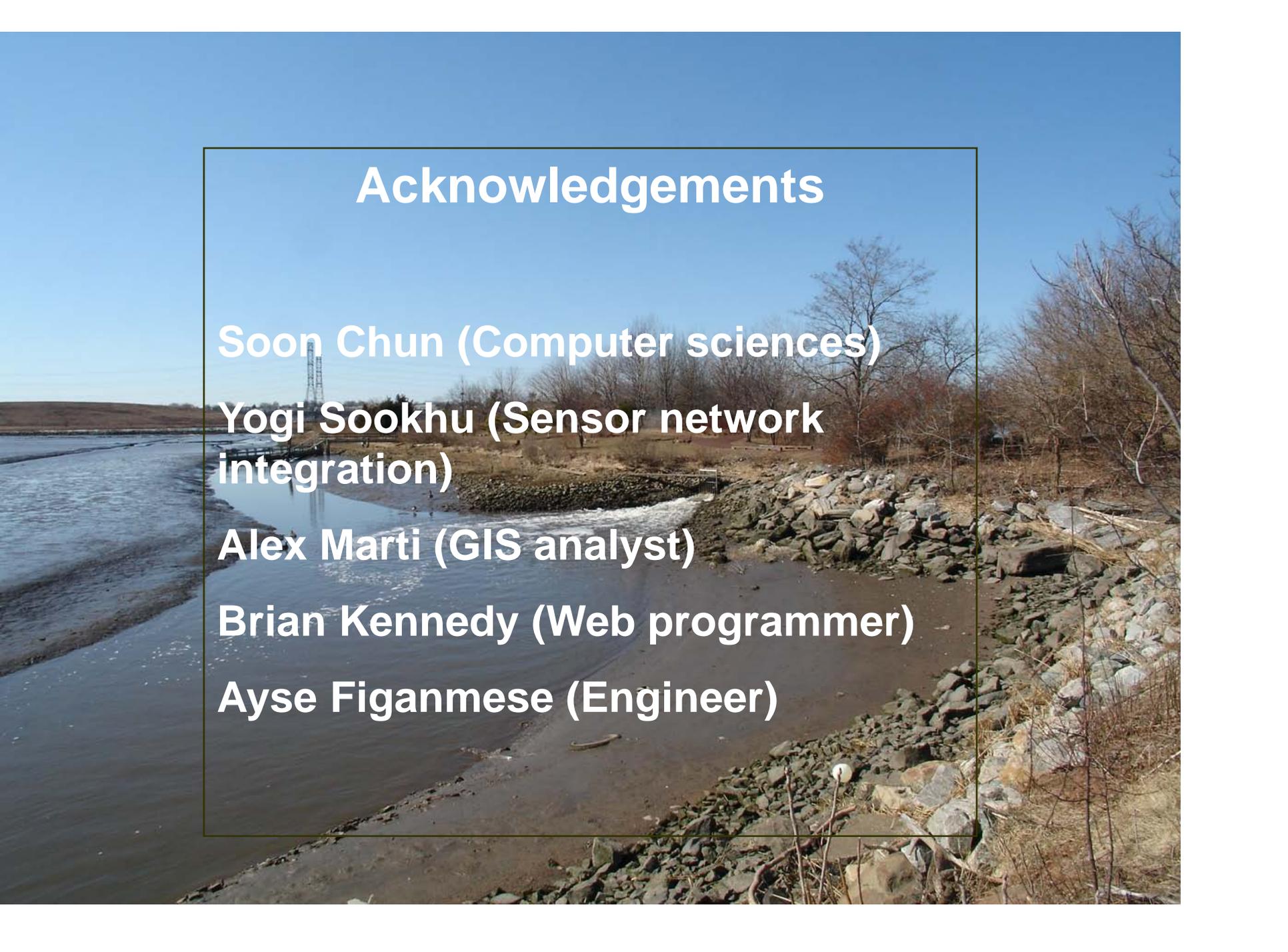
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