# Machine Learning Applied to Sewer Overflows and Sea Level Rise

(Compound Flooding – extreme weather)

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### <u>Outline</u>

- 1. Pinellas County
- 2. Changing climate
- 3. Logistic Regression
- 4. Future SLR
- 5. Past SLR
- 6. Conclusions





Pinellas County low-lying shoreline

surge can block runoff

Infrastructure failure



#### LIDAR

Florida International University Int'l Hurricane Research Center

http://www.ihrc.fiu.edu/research/ projects/storm-surge-broward/ How will climate change impact SSO?

Statistical model: logistic regression

Compound flooding + saturated soil -> SSO

- 1. Water Level Tide Gauge
- 2. Precipitation NEXRAD
- 3. Static infrastructure



Pinellas County (southern) 2000-2017

5 WWTP had ~900 SSO days total 200,000,000+ g surface and deep-well

Median: 200 g 176 released >1000 g 62 released > 10,000 g

6 <u>non-mechanical</u> identified w/CF: 51% of total discharge Self-selects precip > 5 $\sigma$  above mean



#### Logistic Regression Model (Binary Classifier)

Probability  $\pi$  of an event is given by:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \sum_i \beta_i X_i + c_0$$

 $\beta$ : fitting coefficients X: independent variables  $c_0$ : constant

**Guided choice of Predictors** 

Previously used in flooding and precip-only SSO, not CF



#### LRM Yields Probability of Overflow

Events match high model probability...threshold?



#### Increased Probability with SLR # days/yr above probability threshold

$$W_2 \rightarrow W_2 + \xi$$

 $\xi$  = 0 to 0.5 m

Doubles every 0.09-0.1 m

One sequence (historical).



#### Monte Carlo

## Based on empirical probability distributions

 $\xi$  = 0 to 0.5 m 200 yrs each



#### **Question:**

Has sea level rise already had an impact on the rate of SSOs in Pinellas County?

Remove SLR and reapply LRM

 $W_2 \rightarrow W_2 - (\alpha t - \gamma)$   $\alpha$ : rate of SLR (2.7 mm/yr)  $\gamma = -\alpha T$ : SLR prior to study

#### Prior SLR:



 $W_2 \rightarrow W_2 - (\alpha t - \gamma)$   $\alpha$ : rate of SLR (2.7 mm/yr)  $\gamma = -\alpha T$ : SLR prior to study

#### <u>Conclusions</u>

- LRMs can be developed to model infrastructure failure due to CF
- Doubling every ~0.1 m of rise
- Rare -> common
- SSOs already triggered by SLR
- Tie to NOAA weather & climate forecasts



Interactive modules: http://shiny.tbeptech.org/sso-dash/ https://shiny.tbep.org/sso-dash/future-risk.Rmd

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