

# The Convergence of IoT, Machine Learning, and Big Data for Advancing Flood Analytics Knowledge



Credit: Unknown

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**(on behalf of many collaborators and students)**

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# The Hydrosystem and Hydroinformatics Research (HHR) Team Welcomes You!

Our focus is on Flood Computational Modeling and Forecasting and Impacts of Flooding on Critical Infrastructure.



**HHR@Clemson**  
78 Tweets



**#WeareHHR**

Edit profile

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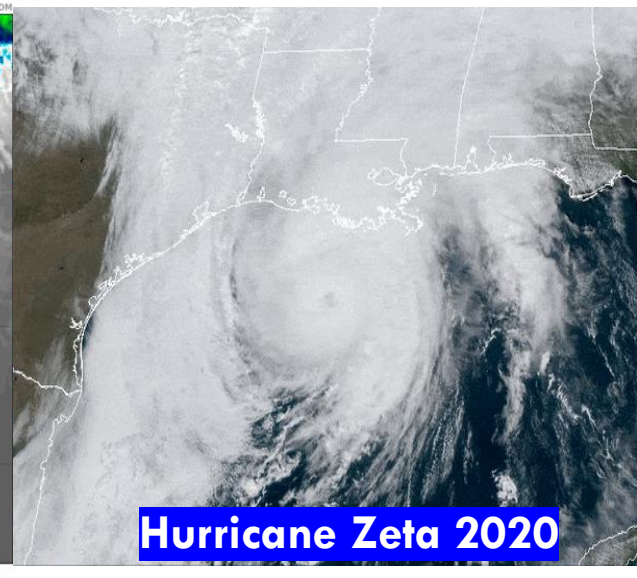
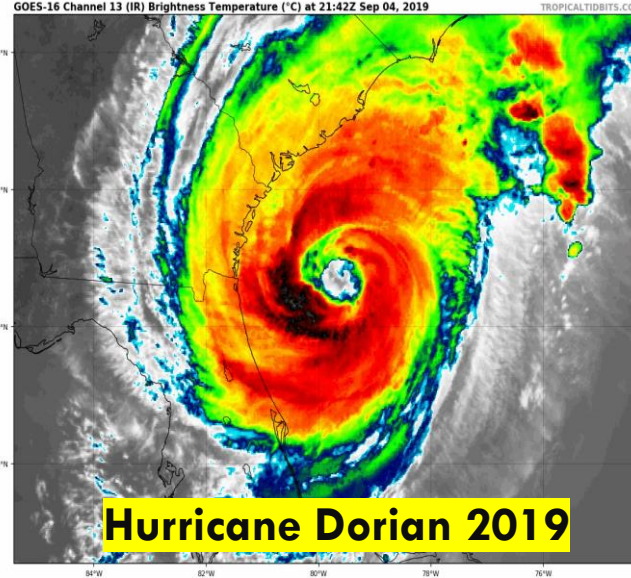
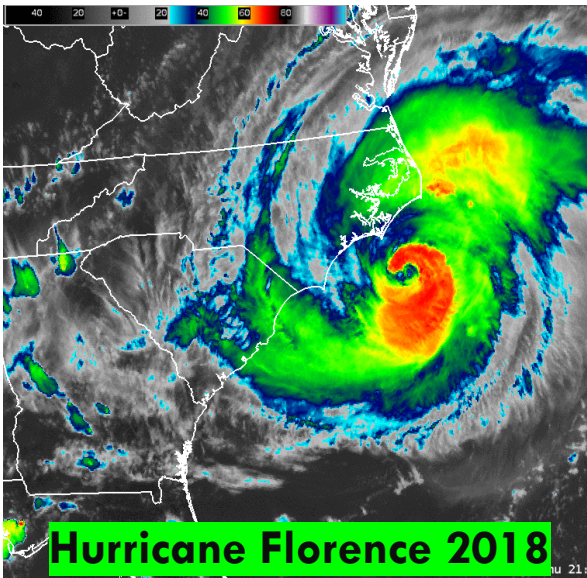
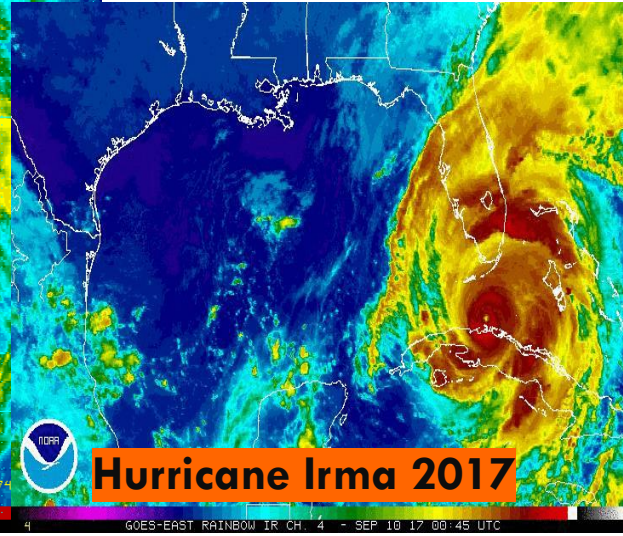
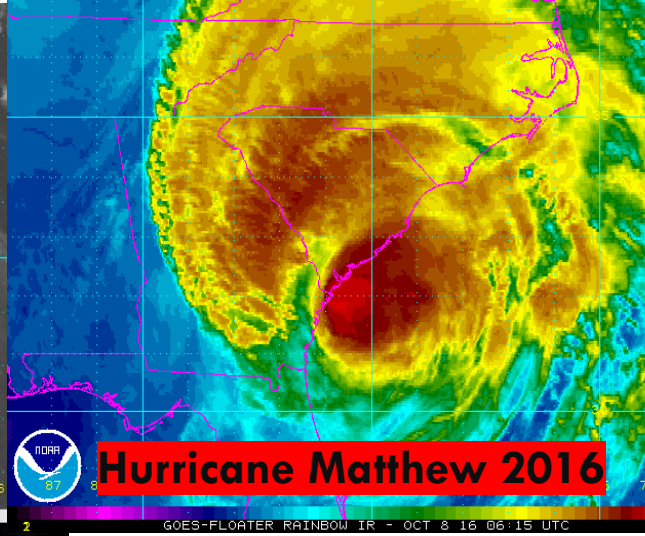
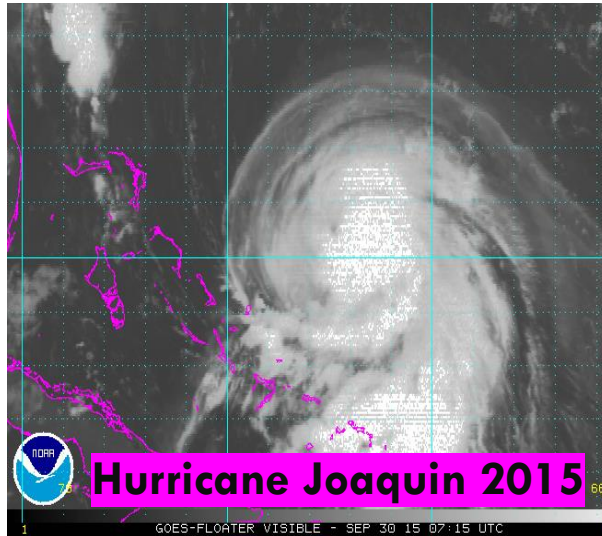
Hydrosystem and Hydroinformatics Research (HHR) group at Clemson University  
[#weareHHR](#) @ClemsonUniv

Clemson, SC <https://t.co/Rn6FnMOPD3> Joined May 2018





# Successive hurricane events have brought new challenges to human life in US





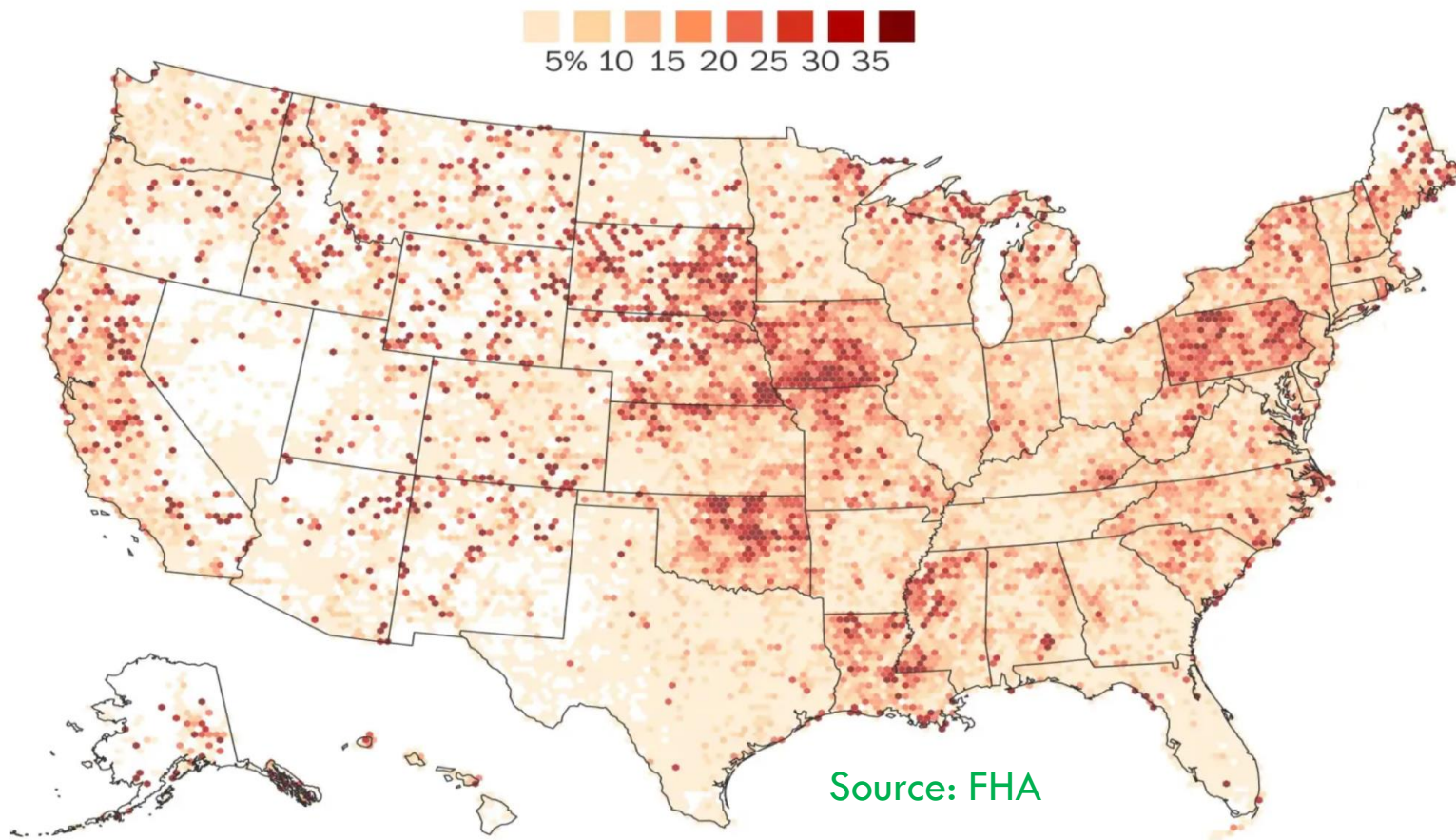
# Planning ahead is essential for flood evacuations



# Regions in the U.S. with the highest percentage of bridges deemed by the Federal Highway Administration as "structurally deficient"

## America's most dangerous bridges

Percent of bridges rated "structurally deficient"



[https://www.washingtonpost.com/news/wonk/wp/2015/02/04/mapping-americas-most-dangerous-bridges/?noredirect=on&utm\\_term=.98ca55d99c9b](https://www.washingtonpost.com/news/wonk/wp/2015/02/04/mapping-americas-most-dangerous-bridges/?noredirect=on&utm_term=.98ca55d99c9b)

# South Carolina has >1000 deficient bridges



State	Total bridges	Deficient bridges	Obsolete bridges	Percent deficient	Percent obsolete
FLORIDA	12,137	243	1,760	2.00	14.50
GEORGIA	14,795	785	1,623	5.31	10.97
MARYLAND	5,305	317	1,104	5.98	20.81
NORTH CAROLINA	18,117	2,199	3,135	12.14	17.30
SOUTH CAROLINA	9,338	1,031	891	11.04	9.54
VIRGINIA	13,800	1,120	2,454	8.12	17.78

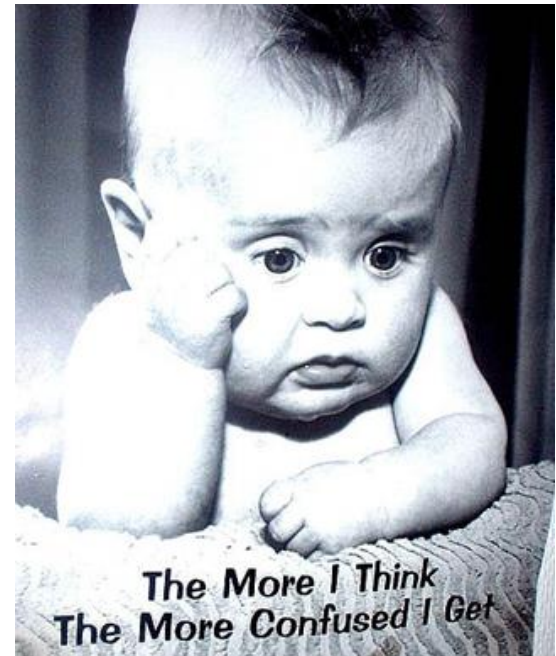
Source: FHA [https://www.washingtonpost.com/news/wonk/wp/2015/02/04/mapping-americas-most-dangerous-bridges/?noredirect=on&utm\\_term=.98ca55d99c9b](https://www.washingtonpost.com/news/wonk/wp/2015/02/04/mapping-americas-most-dangerous-bridges/?noredirect=on&utm_term=.98ca55d99c9b)



# The way that data is organized can enhance or inhibit the analysis and action that can be done



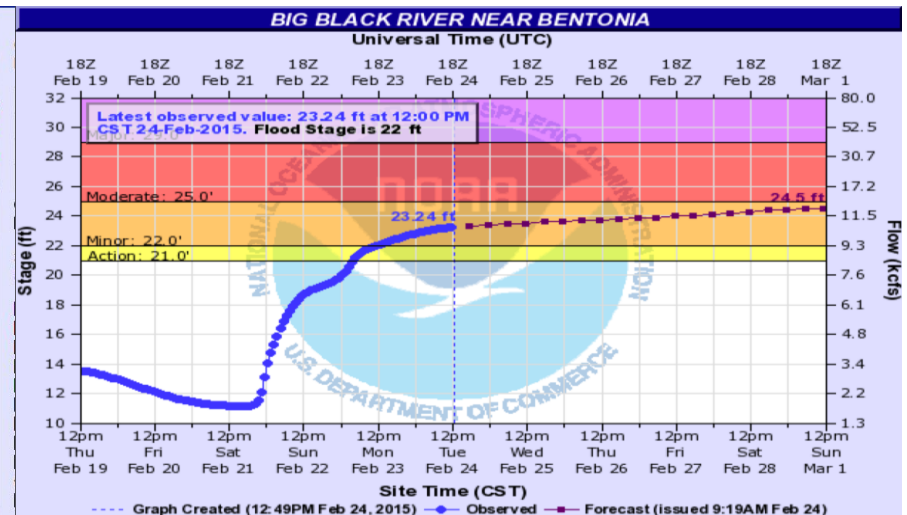
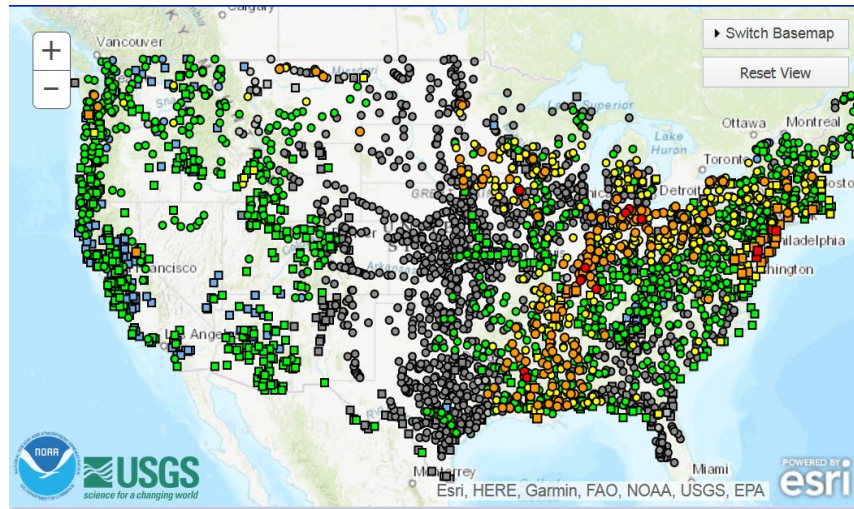
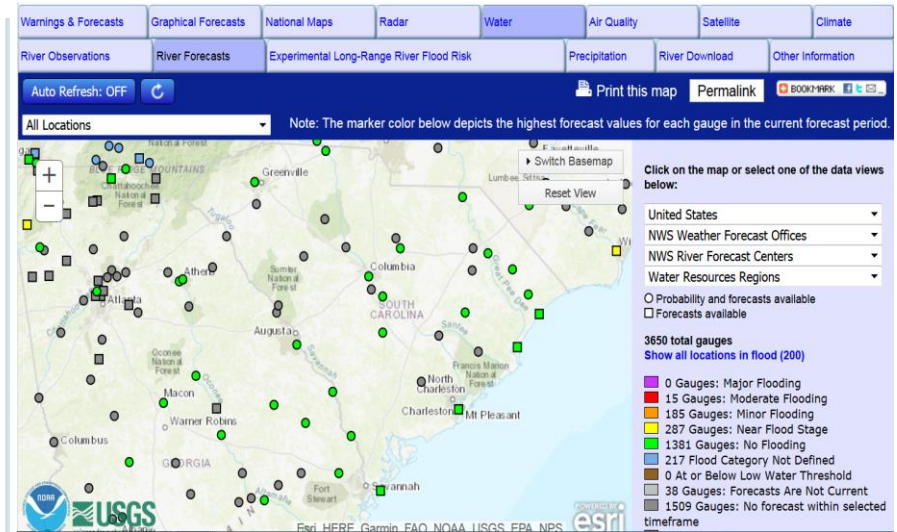
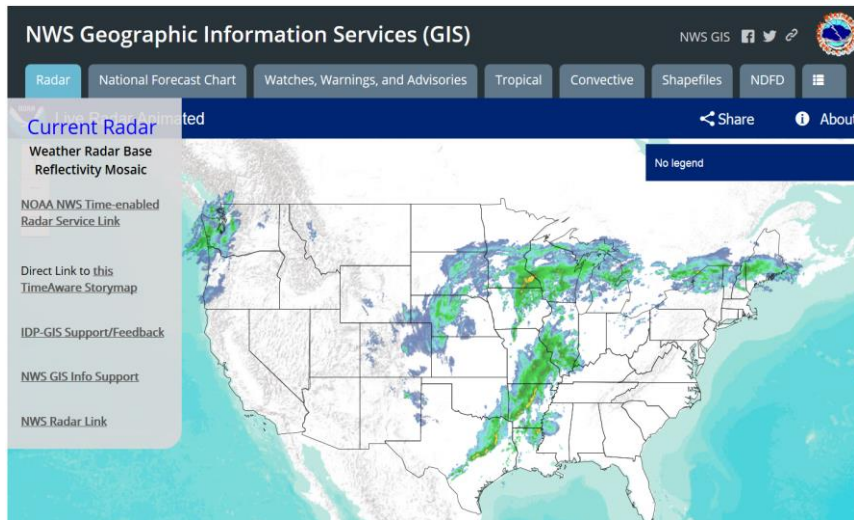
I have your information  
right here ...



# What are we doing now?

No interface to collect floods data—We have many ungagged catchments

Plan with confidence and efficiency--Better meet the needs of decision makers





... and what we have developed!

## FLOOD ANALYTICS INFORMATION SYSTEM (FAIS)

FAIS application helps researchers, scientists, and decision makers gather Big data and assess flood emergency situations in a more intelligent and user friendly way.



# Overall, we developed 12 python modules for the FIAS development.



Home

## FLOOD DATA

USGS Real Time Data >

USGS Historical Data

511 Traffic Camera

## SOCIAL MEDIA

Twitter

Twitter Streamer

## FLOOD ANALYSIS

Data Analytics

Flood Frequency Analysis

Field Data Collection

## Flood Analytics Information System (FAIS)

FAIS is a National Scale Analytics Pipeline for Data Gathering and Computing



FAIS is funded by NSF grand # 1901646  
Contact [samadi@clemson.edu](mailto:samadi@clemson.edu)







# Real-time and historical USGS data gathering and analysis



**RealTime Flood Information** [Generate CSV Report](#)

States: **Florida**

Table View Map View

Show: 10 Search:

Station	ID	Latitude	Longitude	Flow (cubic ft)	Stage	Url
10B BLACK CR CANAL AT OLD CUTLER RD NR GOU	02290709	25.5599	-80.3596	0.0	0.79	<a href="#">link</a>
10B LATERAL 405 AB S-405 NEAR VINELAND, FLA	02266293	28.3947	-81.5844	12.0	89.44	<a href="#">link</a>
10B LATERAL 405 BL S-405 NEAR VINELAND FLA	02266294	28.3946	-81.5844	0.0	81.26	<a href="#">link</a>
10B REEDY CREEK BELOW S-46 NR VINELAND FLA	02266026	28.4042	-81.6115	0.0	86.62	<a href="#">link</a>
ALAFIA RIVER AT BELL SHOALS NEAR RIVERVIEW FL	02301638	27.8589	-82.2737	0.0	1.0	<a href="#">link</a>
ALAFIA RIVER AT GIBSONTON FL	02301721	27.8597	-82.3843	0.0	1.32	<a href="#">link</a>

**RealTime Flood Information** [Generate CSV Report](#)

States: **Florida**

Table View Map View

**Rakshit Pally**  
Pally and Samadi, 2021

**Search Criteria**

States: **Florida**

Station: **02228500 : NORTH PRONG ST. MARYS RIVER AT MONIAC, GA**

Start Date: **2019-10-01** End Date: **2019-12-04**

[Search](#)

**Gage Height Average**

**Flood Data**

Show: 10 entries Search:

Date Time	Discharge (ft <sup>3</sup> /s)	Gage Height (ft)
2019-10-01 00:00	0.01	4.26
2019-10-01 00:15	0.01	4.26
2019-10-01 00:30	0.01	4.26
2019-10-01 00:45	0.01	4.26

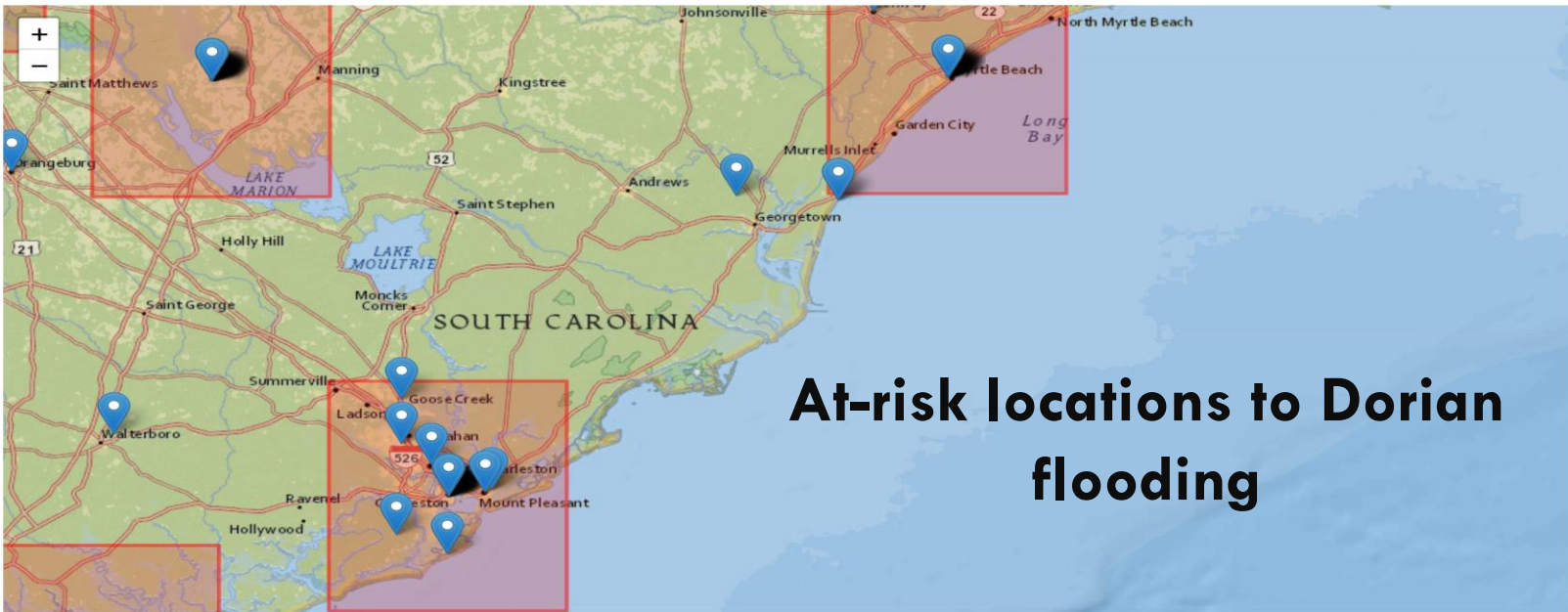


# Crowdsourced Processing of Tweets

Tweets	Date	Source	Image	Sentiment
# Dorian timeline & impacts in a nutshell: Tues-Wed: close to the Florida east coast Wed-Thurs: close to the Georgia and South Carolina coasts Potential impacts: life-threatening storm surge, dangerous winds, flash floods, isolated tornadoes <a href="http://noaa.gov/dorian">http://noaa.gov/dorian</a> <a href="http://noaa.gov/dorian">pic.twitter.com/JsTg9PD3PG</a>	2019-09-03 01:11:55	<a href="#">Source</a>	<a href="#">Image</a>	-1
A Flash Flood Emergency continues for New Orleans, LA this morning. These emergencies are issued for exceedingly rare situations when a severe threat to human life and catastrophic damage from a flash flood is happening. <a href="https://twitter.com/NWSFlashFlood/status/1148955662837137409">https://twitter.com/NWSFlashFlood/status/1148955662837137409</a> ...	2019-07-10 14:36:55	<a href="#">Source</a>	<a href="#">Image</a>	1
Don't let your little ones, furry and human, go into flood waters. There's a lot of dangerous stuff in there - some of which you can't see! <a href="http://pic.twitter.com/KqOecNP2kl">pic.twitter.com/KqOecNP2kl</a>	2019-07-13 18:39:08	<a href="#">Source</a>	<a href="#">Image</a>	-1
During a flood, water levels and the rate at which the water is flowing can quickly change. Get to higher ground. Do not drive or walk into water. It only takes 6 inches of water to knock you off your feet. <a href="http://weather.gov/safety/flood">http://weather.gov/safety/flood</a> #WeatherReadypic.twitter.com/VhE5F7rQjg	2019-09-19 14:50:26	<a href="#">Source</a>	<a href="#">Image</a>	1
Here's the distinction between a Flash Flood Emergency and a Flash Flood Warning... <a href="http://pic.twitter.com/k9zmwGxf2b">pic.twitter.com/k9zmwGxf2b</a>	2019-07-10 14:38:51	<a href="#">Source</a>	<a href="#">Image</a>	0

Table View

Map View







On the hunt for a webcam that shoots high resolution photos...

## Real-Time River Webcam Image/ 511 Traffic Cameras Image Collection

### 511 Cams North Carolina

I77 SB @ MM30.8



US 70 (Arendell St) @ 23rd Street



US 74 @ mm 255.3



US 17 Bus (Market St) at US 74 (MLK Pkwy / Eastwood Rd)



# Image Processing- 4 new python modules

Upload Image

Drop files here to upload



Label and Score

Flood : 0.91

Water : 0.81

Residential area : 0.8

Suburb : 0.71

Floodplain : 0.68

Event : 0.63

Photography : 0.62

Road : 0.58

Thoroughfare : 0.58

Tsunami : 0.54



Label and Score

Flood : 0.94

Vehicle : 0.83

River : 0.83

Waterway : 0.82

Water : 0.81

Event : 0.72

Car : 0.71

Tree : 0.69

Watercourse : 0.66

Geological phenomenon : 0.62



# Flood Frequency Analysis (FFA)

FAIS computes design flow values corresponding to specific return periods that can help engineers in designing safe structures and in protection against economic losses due to maintenance of civil infrastructure.

## USGS 02155500 PACOLET RIVER NEAR FINGERVILLE, SC

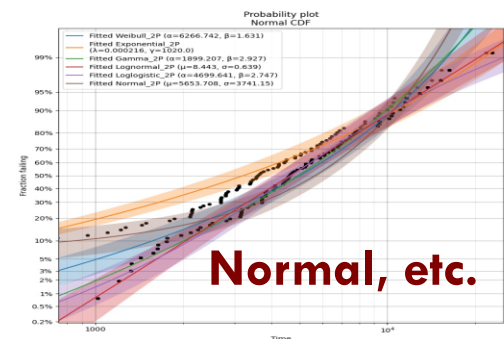
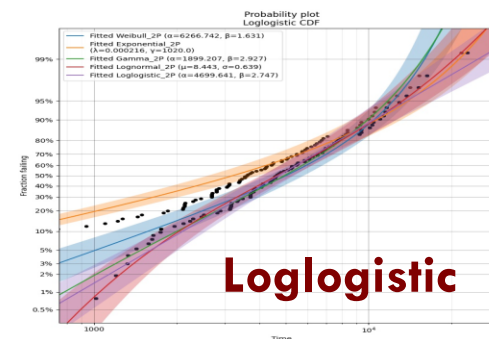
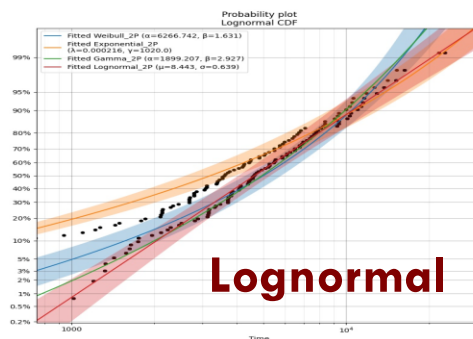
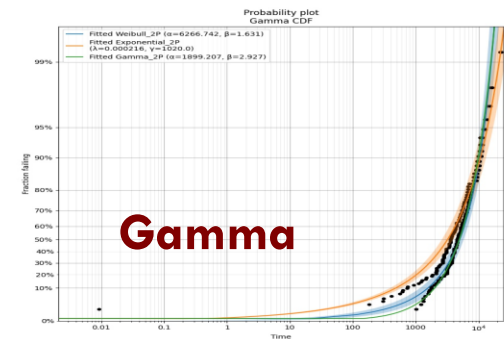
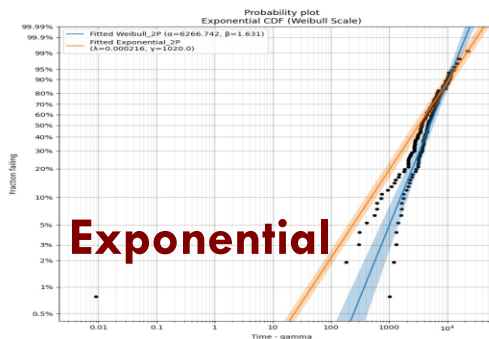
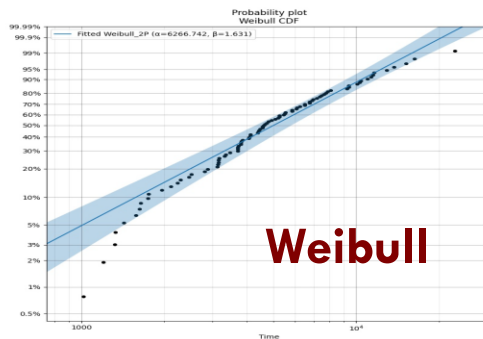
### Flood Frequency Analysis

#### USGS Peak Flow Rate Analysis

Flood Station 02155500

Search

Date Time	Peak Value (cfs)
1903-06-00	
1930-12-06	1020
1931-12-15	3810
1932-10-17	11000
1934-03-04	3810



The best fitting distribution was Lognormal\_2P with which had parameters [8.44:

# Flood Data Collection

First Name First Name

Last Name Last Name

Email ID Email Address

Location Location

Latitude Latitude

Longitude Longitude

Time Stamp --:-- --



Date mm/dd/yyyy



Flood Depth (in ft) Flood Depth

Additional Info



Mobile Application Development

✓ Submit

Upload Media

Choose File No file chosen

Upload Documents





**Next Step**

**Flood Depth &  
Inundation Mapping**



