Use of Earth Observation Data within Syndromic Surveillance Systems

CSTE DISASTER EPIDEMIOLOGY SUBCOMMITTEE
AUGUST 19, 2020

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OVERVIEW

- Project Overview (Julia)
- Discussion: Experience Using Environmental and SyS Data Together (Meredith, Group)
- Earth Observation Data: Options, Resolution, Limitations (Ben)
- Discussion: Adding Data Sources to ESSENCE (Meredith, Group)

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Project Goal and Objectives:

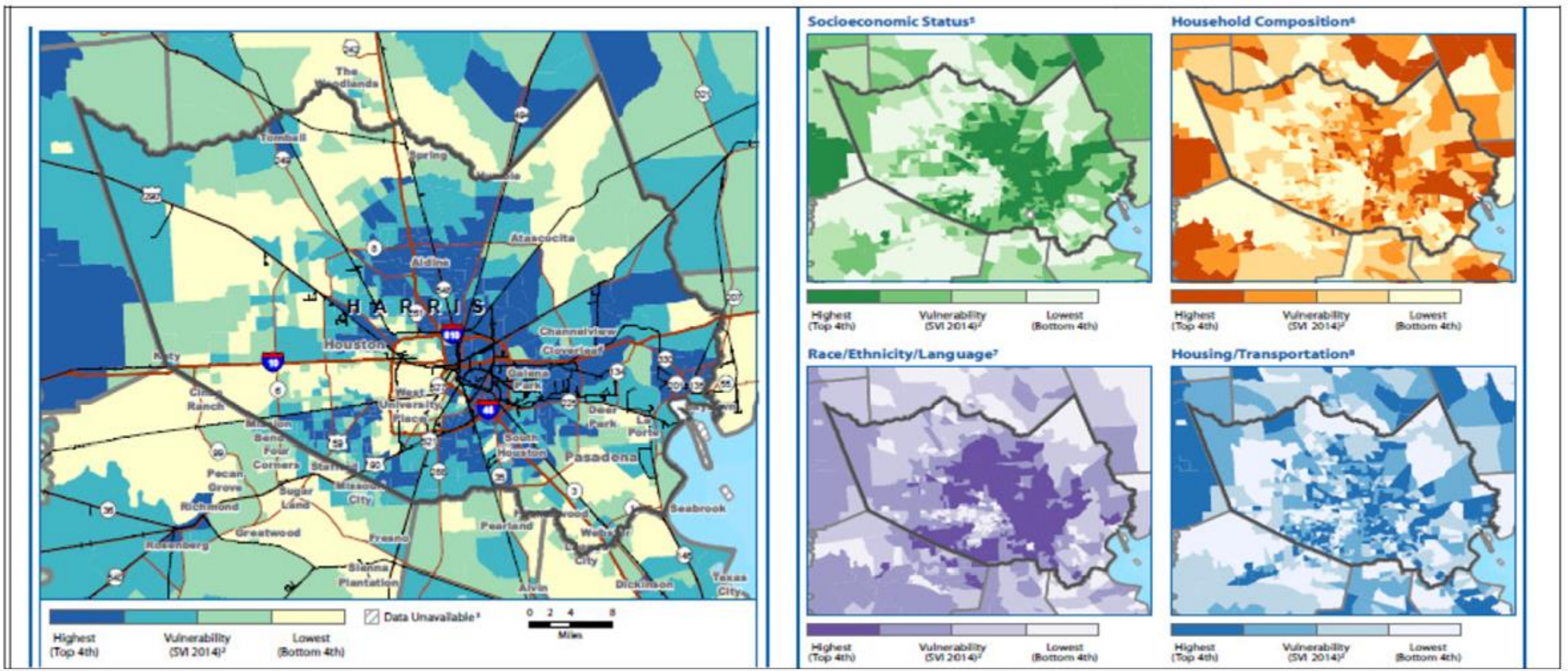
Enhance the CDC Social Vulnerability Index (CDC SVI) by adding exposure estimates, using Hurricane Harvey as case study:

1. Incorporating Earth Observations (EO) datasets on flooding, heat, power outages, and chemical emissions from industrial facilities.

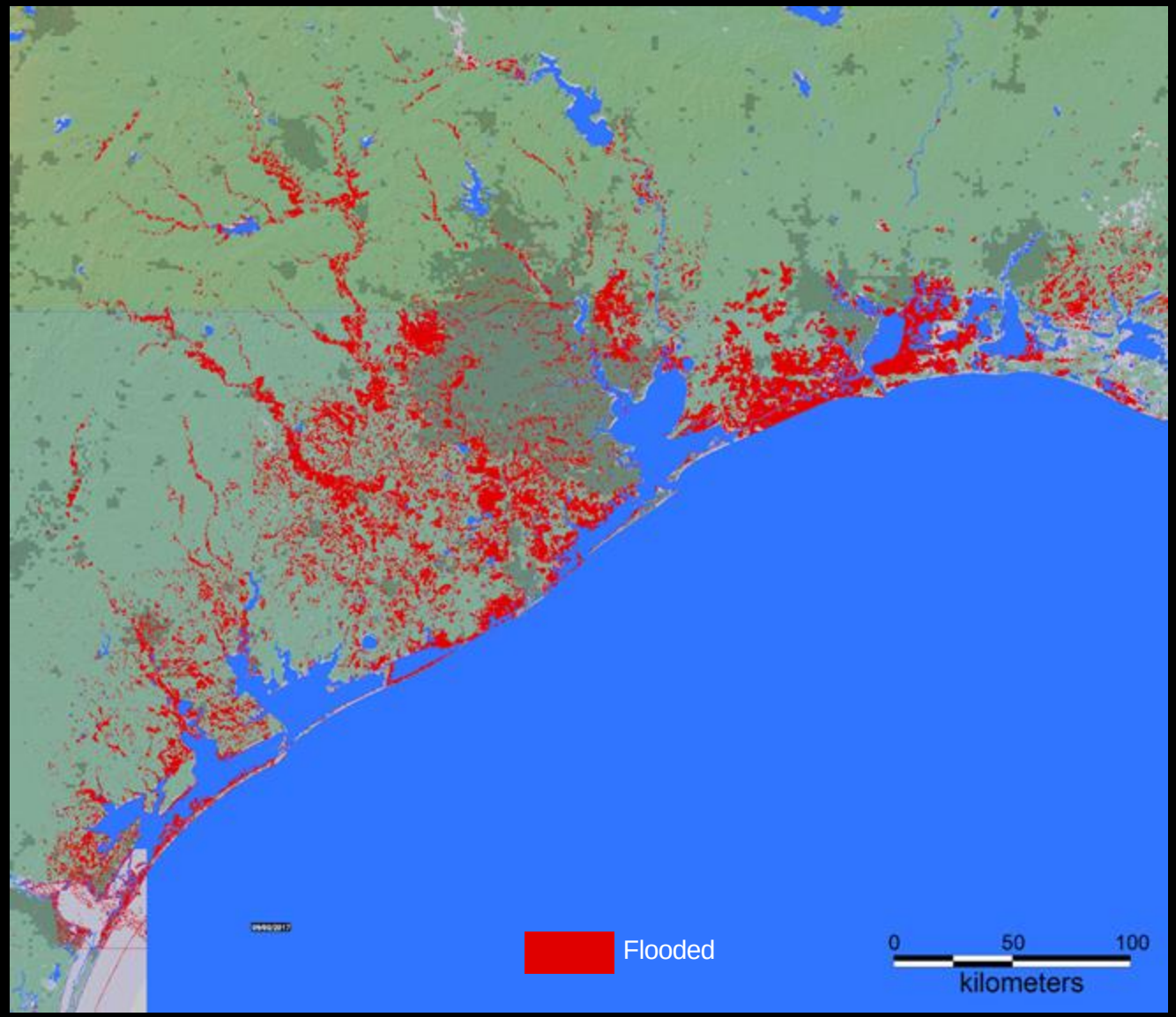
2. Incorporating a synthetic population model of movement of people pre, during and post disaster.

3. Evaluating the utility of these enhancements through analysis of healthcare visit data collected pre, during, and post Hurricane Harvey.

The CDC SVI is used to estimate the amount of needed supplies, locations of emergency shelters, assisted evacuations, support response



https://svi.cdc.gov/



Spatial resolution : 200 m

Inundation Data

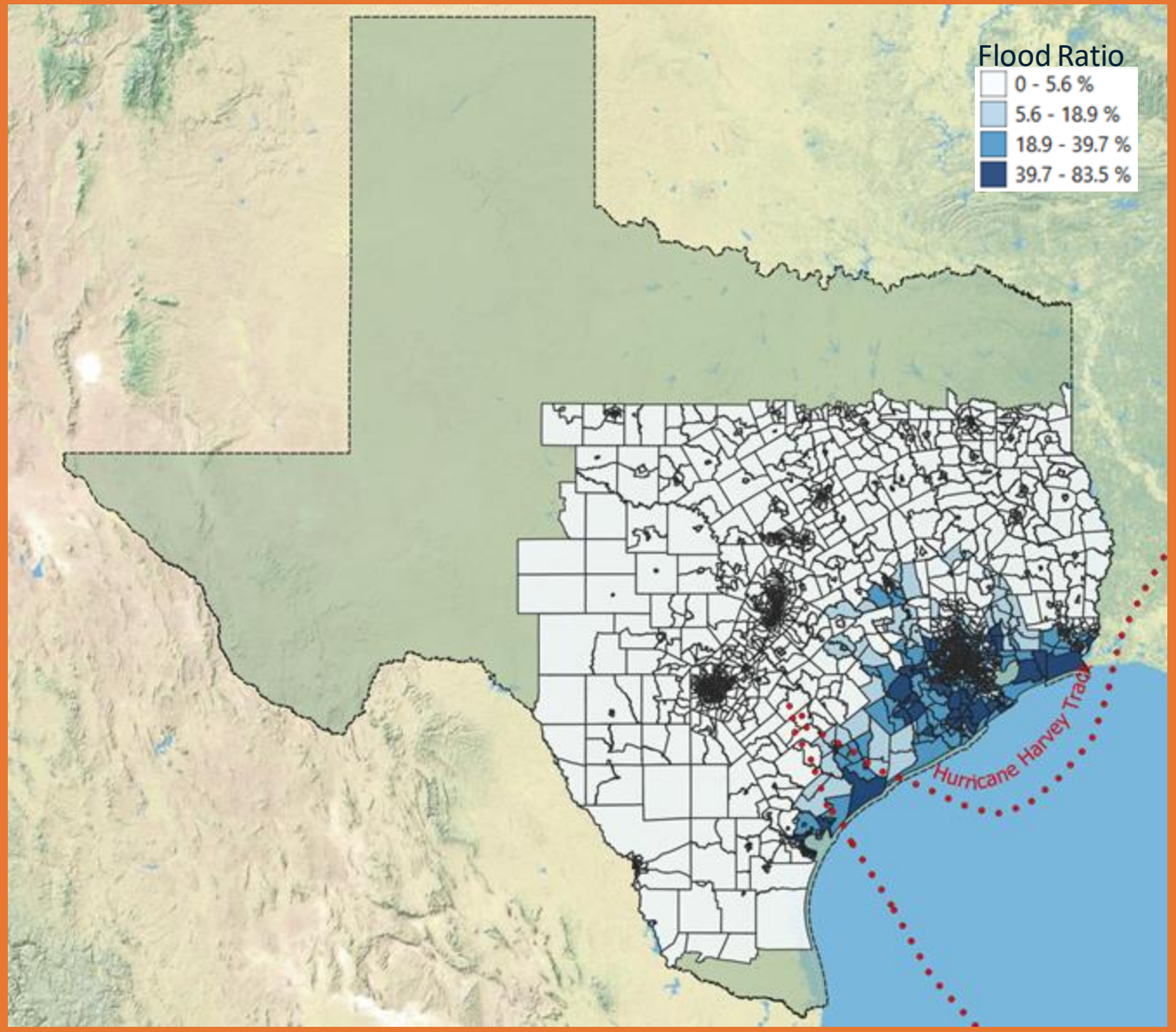
Hurricane Harvey

Maximum Observed Flooding

Brakenridge, G.R. and Kettner, A. J., 02-02-2020, "DFO Flood Event 4510", Dartmouth Flood Observatory, University of Colorado, Boulder, Colorado, USA, http://floodobservatory.colorado.edu/Events/2017USA4510/2017USA4510.html.

Health Outcome Datasets

- Texas Flood Registry, collaboration between Rice University and several organizations
- Inpatient and Outpatient visits from the Texas Department of State Health Services (2016, 2017, 2018)
- Syndromic surveillance data from Houston Health Department (2017, 2019)



Study Area and Data Description

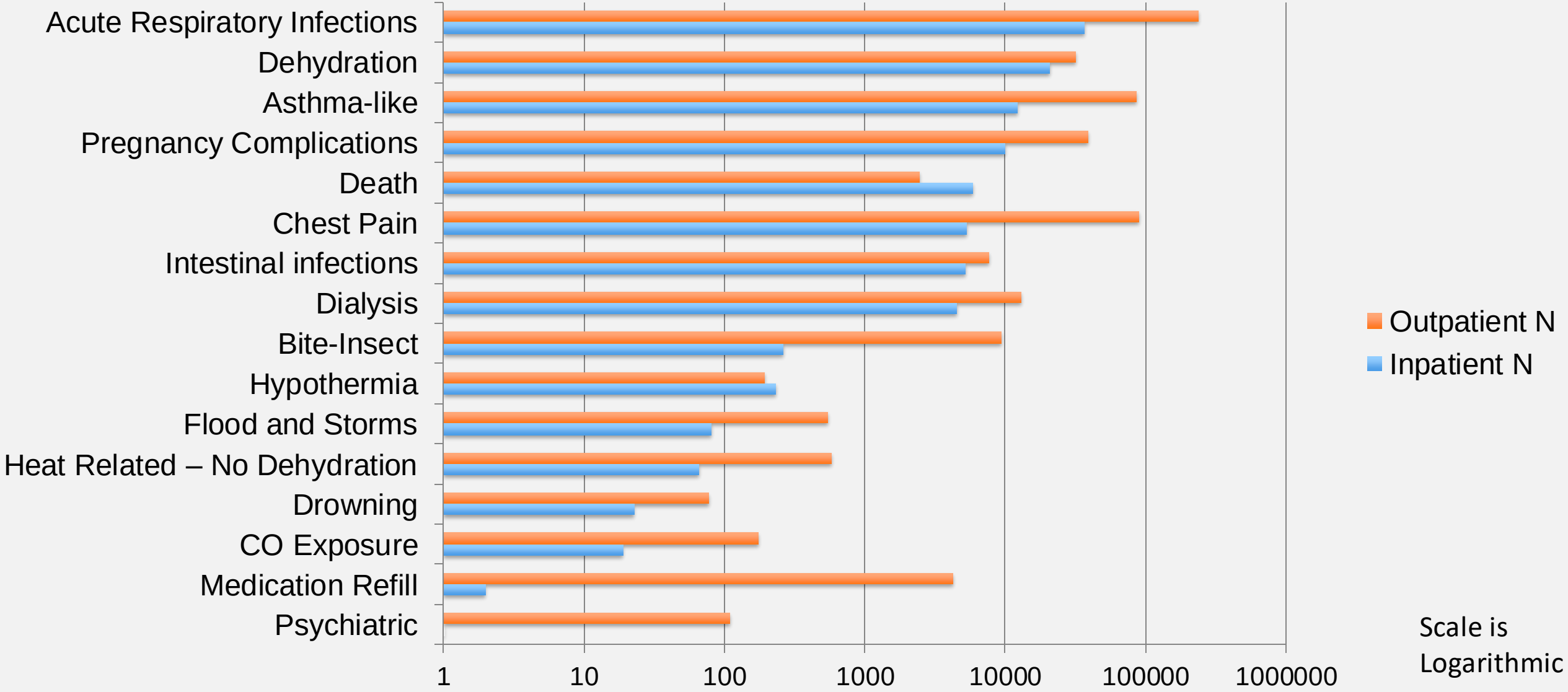
Emergency Department (ED) Visit Data

- 1.2 Million Inpatient Records
- 7.9 Million Outpatient Records
- Geocoded to 2883 Census Tracts
- 117 Counties in Study Area

Variables

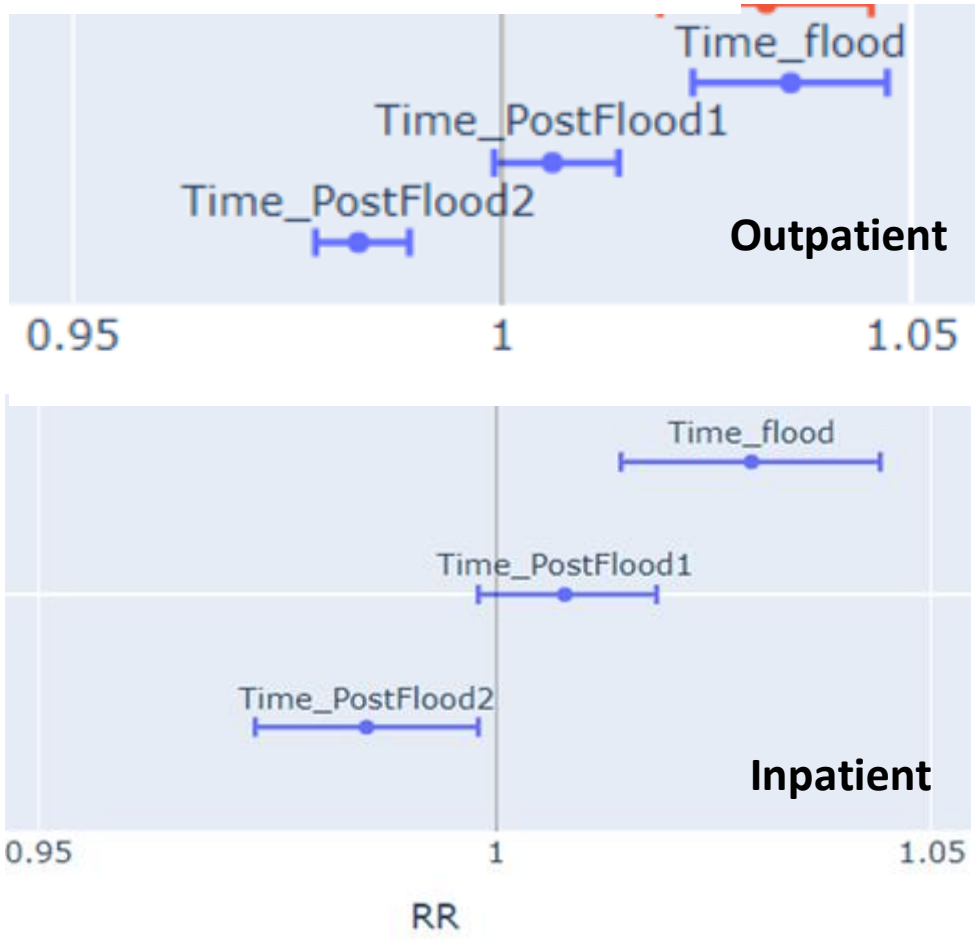
- Patient Zip and Census Block
- Sex, Age, Race, Ethnicity
- Diagnostic Codes
- Condition Codes
- Patient Status
- Statement Start Date
- Admission Date (IP)

Heath Outcome Categories and Number of Visits During Flood and Post Flood Periods



Total visits increased by 4% during the flood impact period, with increases in several categories

Total Visits



Flood Period	RR	95% Conf. Int	
Flood Storms (OP)	11.25	7.30	17.34
Drowning (IP)	9.23	1.07	79.44
Hypothermia (IP)	3.24	1.58	6.62
CO Exposure (OP)	2.75	1.09	6.92
Medication Refill (OP)	2.00	1.73	2.31
Intestinal Infectious (OP)	1.41	1.23	1.63
Dialysis (OP)	1.41	1.28	1.55
Bite-Insect (OP)	1.23	1.12	1.35
Pregnancy Comp (OP)	1.13	1.06	1.20

* Decreases in ED visits for chest pain and acute respiratory illnesses during impact period

CDC Social Vulnerability Index of patient census tract and visits during the flood and post flood periods

- A 10% increase in the CDC SVI was associated with increased relative risks for intestinal infectious diseases and acute respiratory illness during the flood impact periods.
- A 10% increase in the CDC SVI was associated with increased relative risks for outpatient visits for acute respiratory illness and dialysis in post flood periods.

Flood Period	*RR*	*95% Conf. Int*	
Intestinal infectious diseases (IP)	14.27	1.13	181.27
ARI (OP)	2.94	1.66	5.19

Post Flood Period 1	*RR*	*95% Conf. Int*	
ARI (OP)	2.02	1.36	3.00

Post Flood Period 2	*RR*	*95% Conf. Int*	
Dialysis (OP)	7.07	1.91	26.35

Health Outcome Next Step – Syndromic Surveillance Data

- Similar Poisson Modeling
- Definitions from chief complaint/discharge diagnosis queries and approximations of syndromes and subsyndromes
- 4 Million Records
  - June 2017 – December 2017
  - June 2019 – December 2019

Variables

- Date
- Time
- Zip code
- Age
- Sex
- Chief Complaint Orig
- Discharge Diagnosis
- Provider Diagnosis
- Race
- Ethnicity
- Hospital Name
- Hospital Zip Code

The Team

Ben Zaitchik and Lauren Deanes, Johns Hopkins University

Samarth Swarup, Anna Brower, and Sanchit Sinha, University of Virginia

Julia Gohlke, Suwei Wang, and Balaji Ramesh, Virginia Tech

Biru Yang and John Fleming, Houston Health Department

Elaine Hallisey, Barry Flanagan, and Caitlin Mertzlufft at CDC GRASP

Meredith Jagger, Independent Consultant

Discussion Questions

- What is your experience or familiarity with using environmental data in combination with syndromic surveillance?
  - What type(s) of environmental data, events, and health outcomes?
  - What resolutions (temporal, geographic)?
  - Was the analysis conducted during or after a disaster response? How fast do you need it?
  - Was the work done within or outside of SyS platform?

Earth Observations

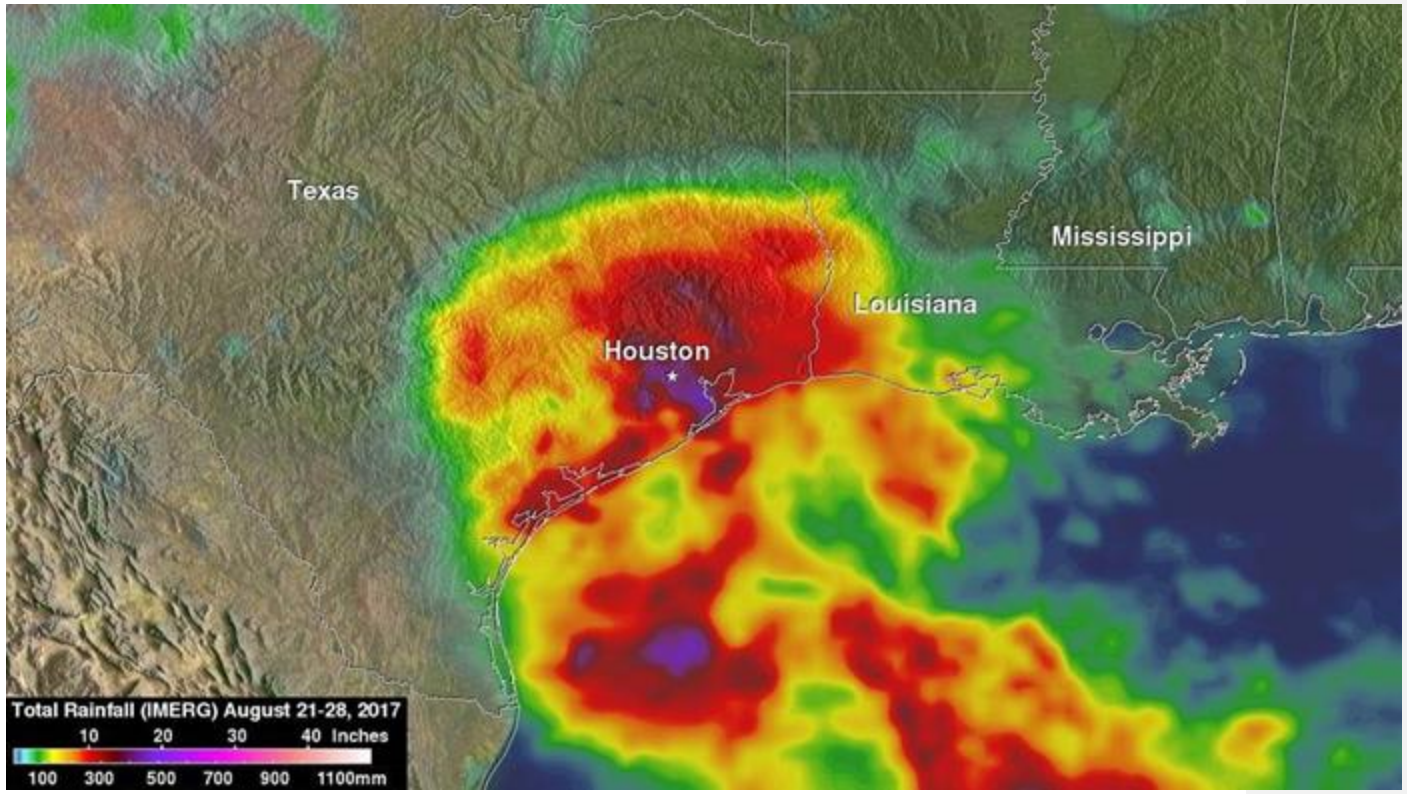
What are Earth Observations?

Earth Observations (“EO”) refer to remote observations, *in situ* observations, data-informed computer models, and data assimilation systems.

This is a powerful set of tools for observations across space and time, but each EO has its own limitations in resolution, temporal coverage, latency, precision, and accuracy

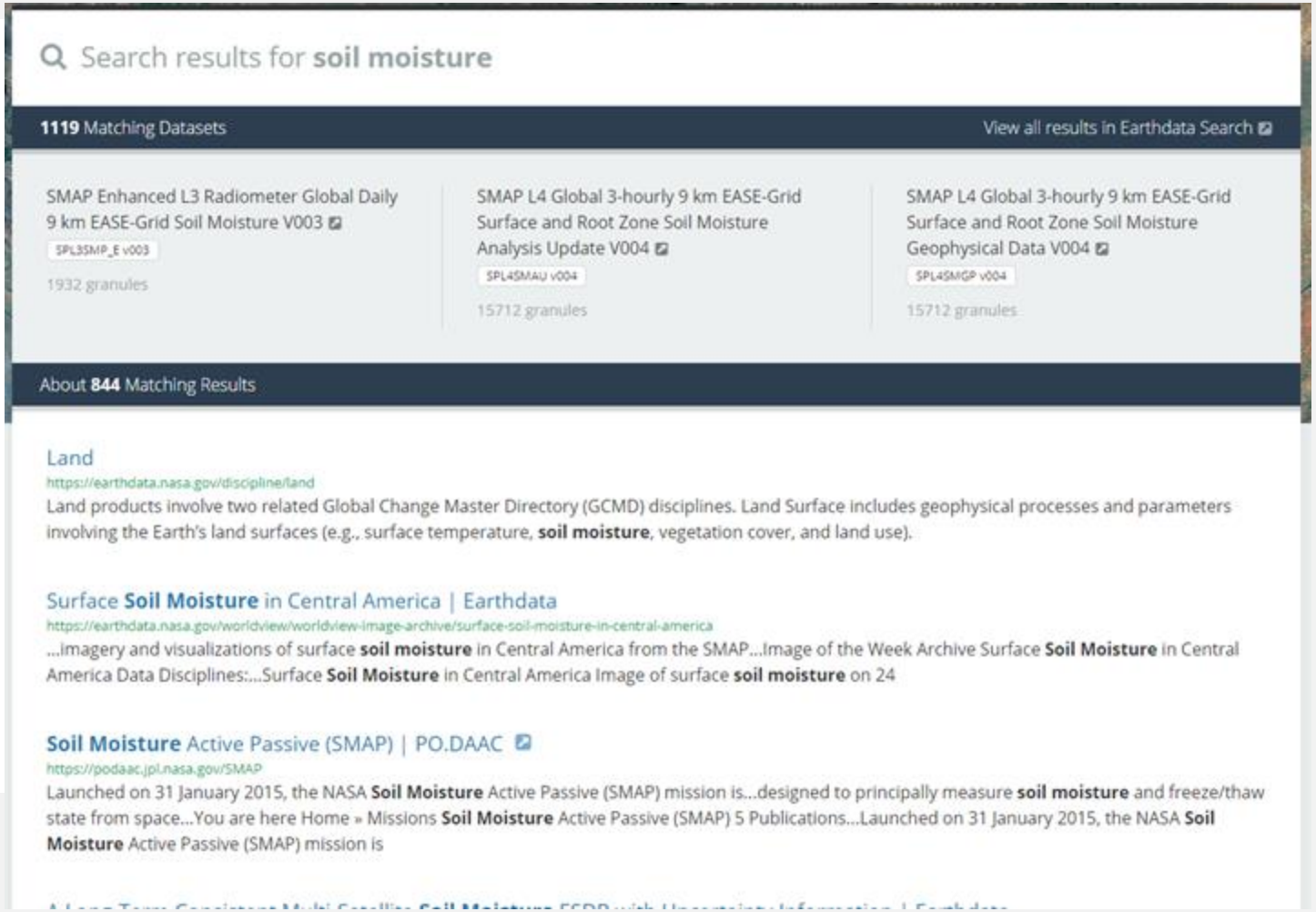
Why use remotely acquired EO?

- Coverage
- Consistency
- Completeness
- Capabilities



Why not use remotely acquired EO?

- Uncertainties
- Unfamiliarity
- Unavailability
- Unwieldiness



EO in our project

NLDAS:

- surface meteorology
- hydrological states

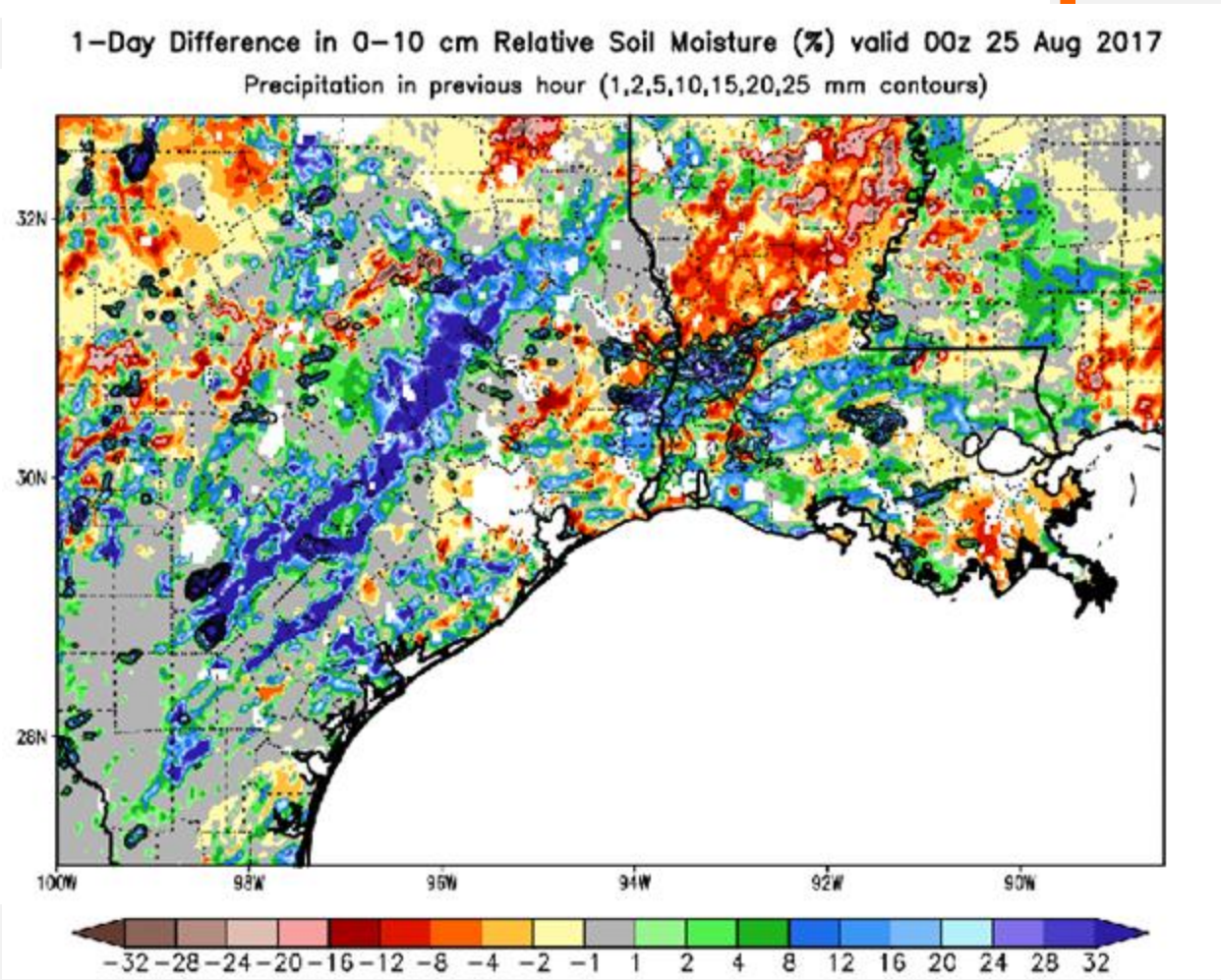


Image: NASA SPoRT

EO in our project

The Dartmouth Flood Observatory:

- Inundated area

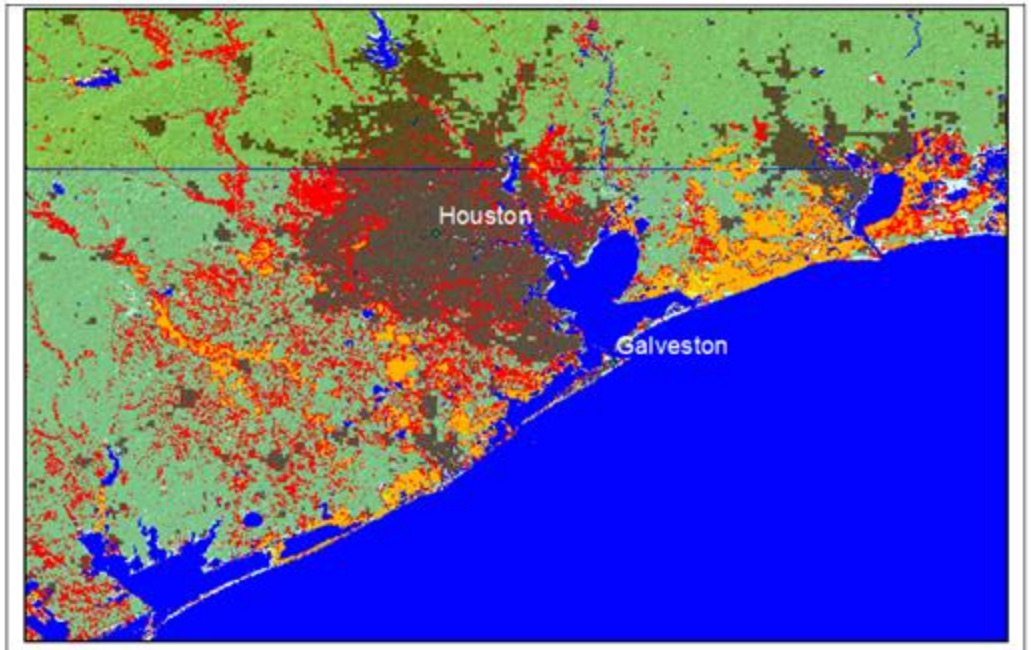


Figure 1: Post-Harvey flooding detected in September 1 products by NASA MODIS NRT (yellow), DFO (red), and both products (orange).

EO in our project

NASA VIIRS:

- Nighttime lights

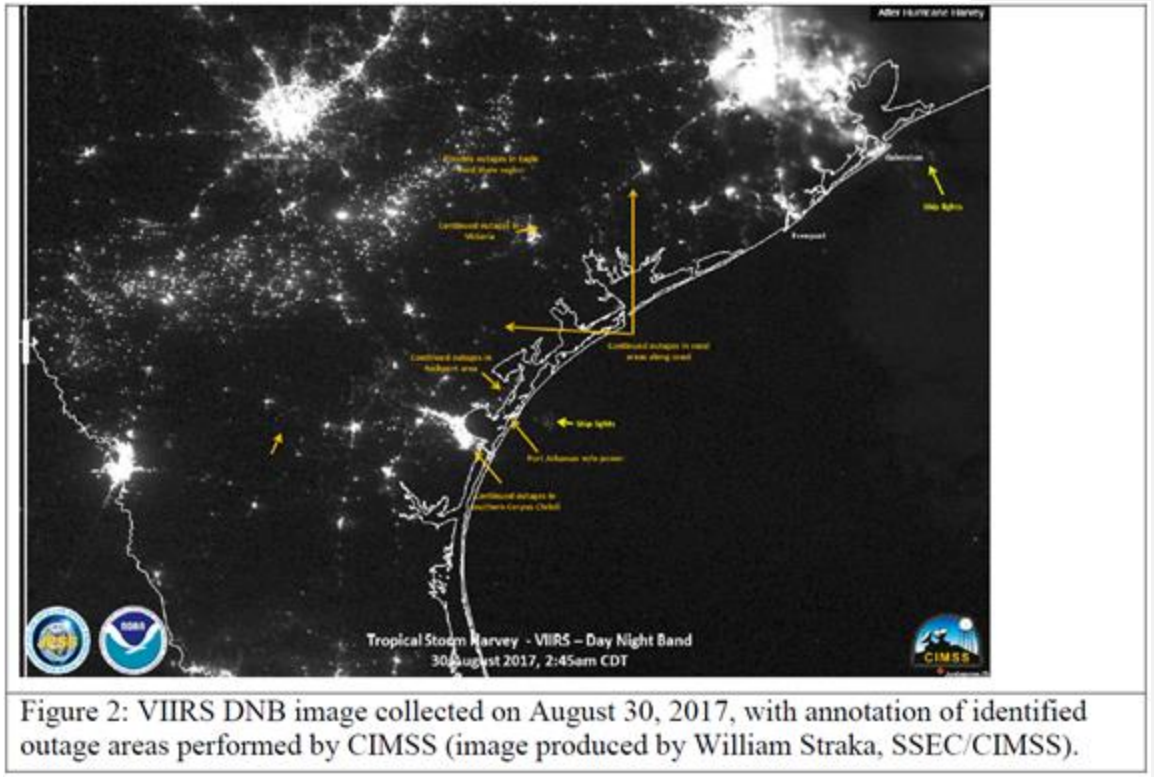
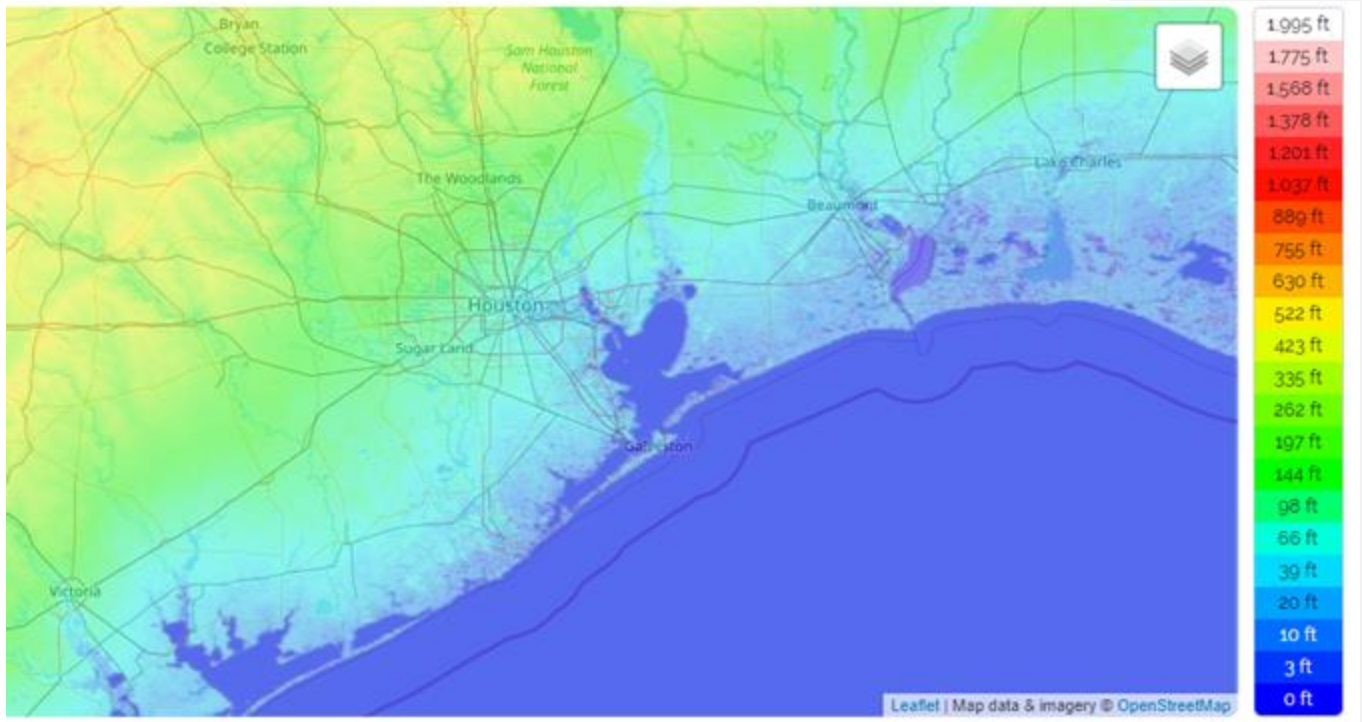


Figure 2: VIIRS DNB image collected on August 30, 2017, with annotation of identified outage areas performed by CIMSS (image produced by William Straka, SSEC/CIMSS).

EO in our project

Multiple static products:

- Elevation
- Distance from coast
- Surface water bodies
- Etc. etc.



EO for ESSENCE?

Some meteorological variables are already present in weather station data in ESSENCE.

- In those cases, would greater spatial coverage or forecast potential be useful?

Other variables are not yet available in ESSENCE.

- Are there environmental variables that would be worth adding?
- What are the applications and the requirements (resolution, latency, etc.) for those observations?

Discussion Questions

- What types of additional environmental or EO data might be useful in your disaster epi work?
- Would an ESSENCE data source be the best way to get you/your ESSENCE users these data?

Research → Real-time → Operational