

Use of Earth Observation Data within Syndromic Surveillance Systems

CSTE DISASTER EPIDEMIOLOGY SUBCOMMITTEE
AUGUST 19, 2020

JULIA GOHLKE, VIRGINIA TECH
BEN ZAITCHIK, JOHNS HOPKINS UNIVERSITY
MEREDITH JAGGER, CONSULTANT

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)

Contact Info



Julia M. Gohlke, PhD
jgohlke@vt.edu



Benjamin Zaitchik, PhD
zaitchik@jhu.edu



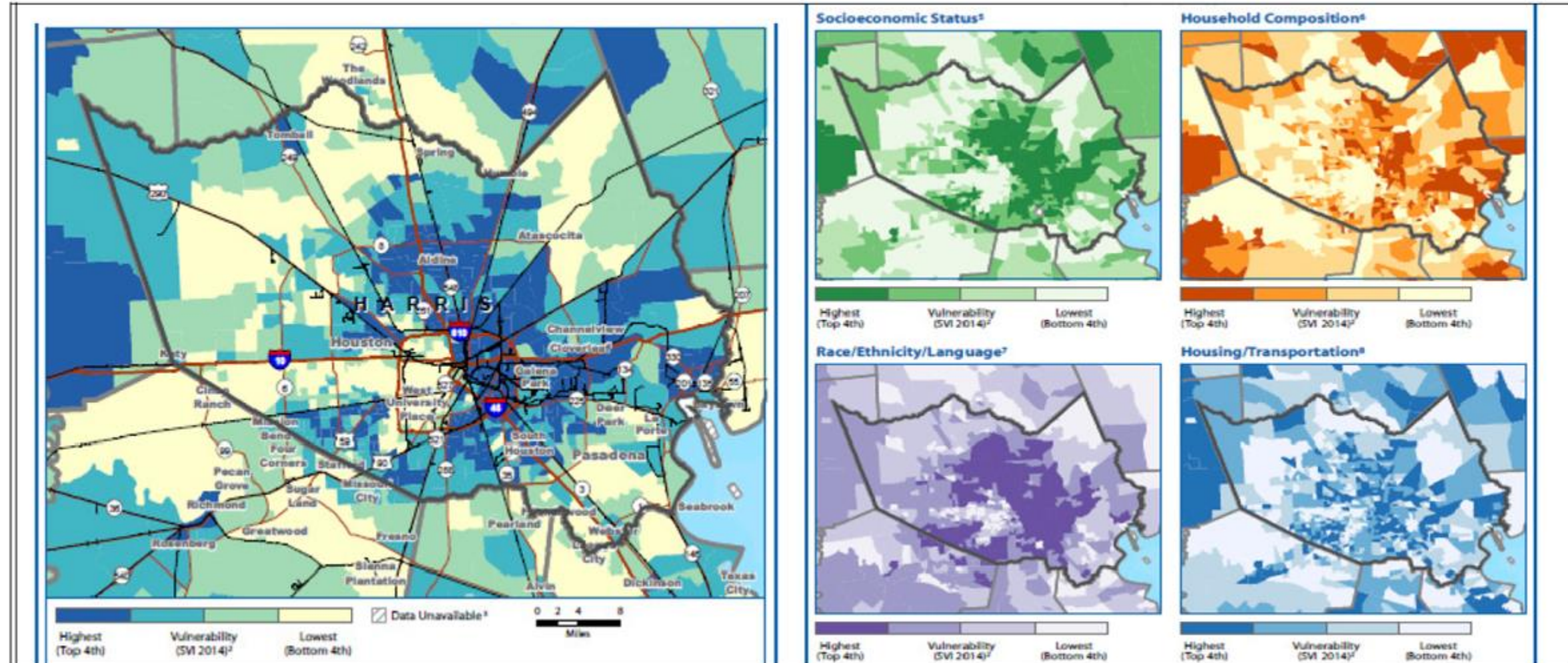
Meredith Jagger
mph. jagger@use.startmail.com

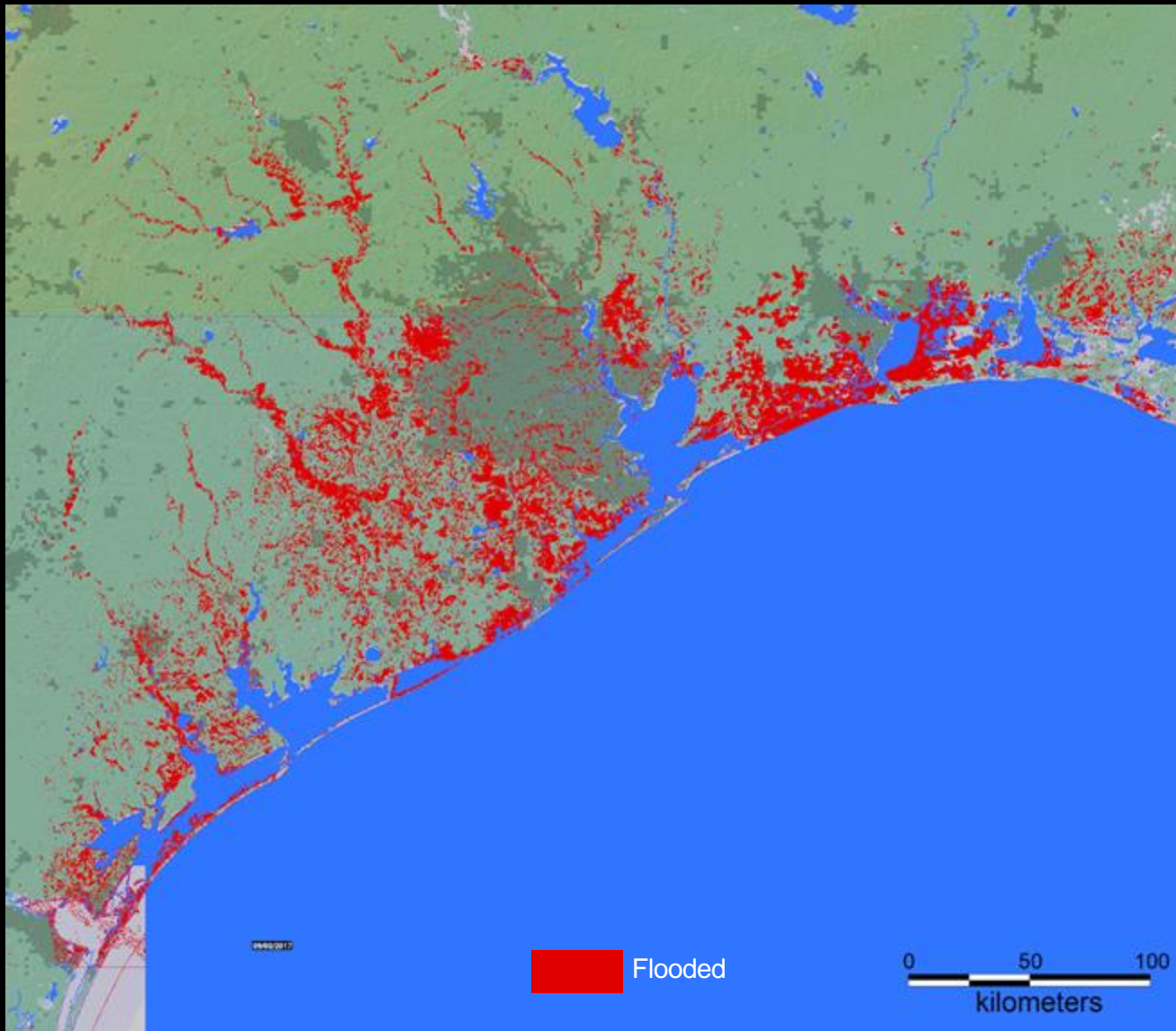
Project Goal and Objectives:

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





Hurricane Harvey

Maximum Observed Flooding

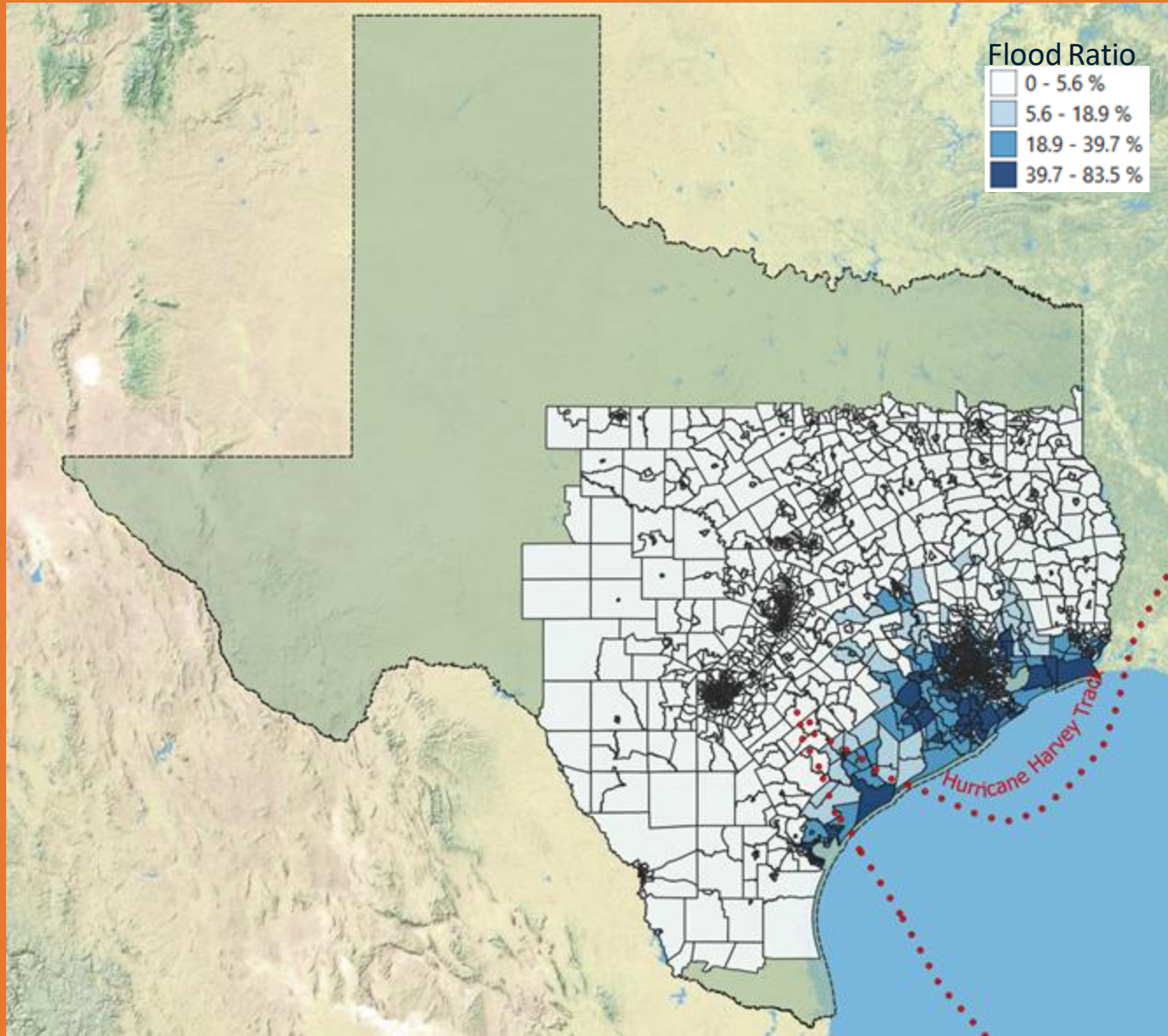
Spatial resolution : 200 m

Inundation Data

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)



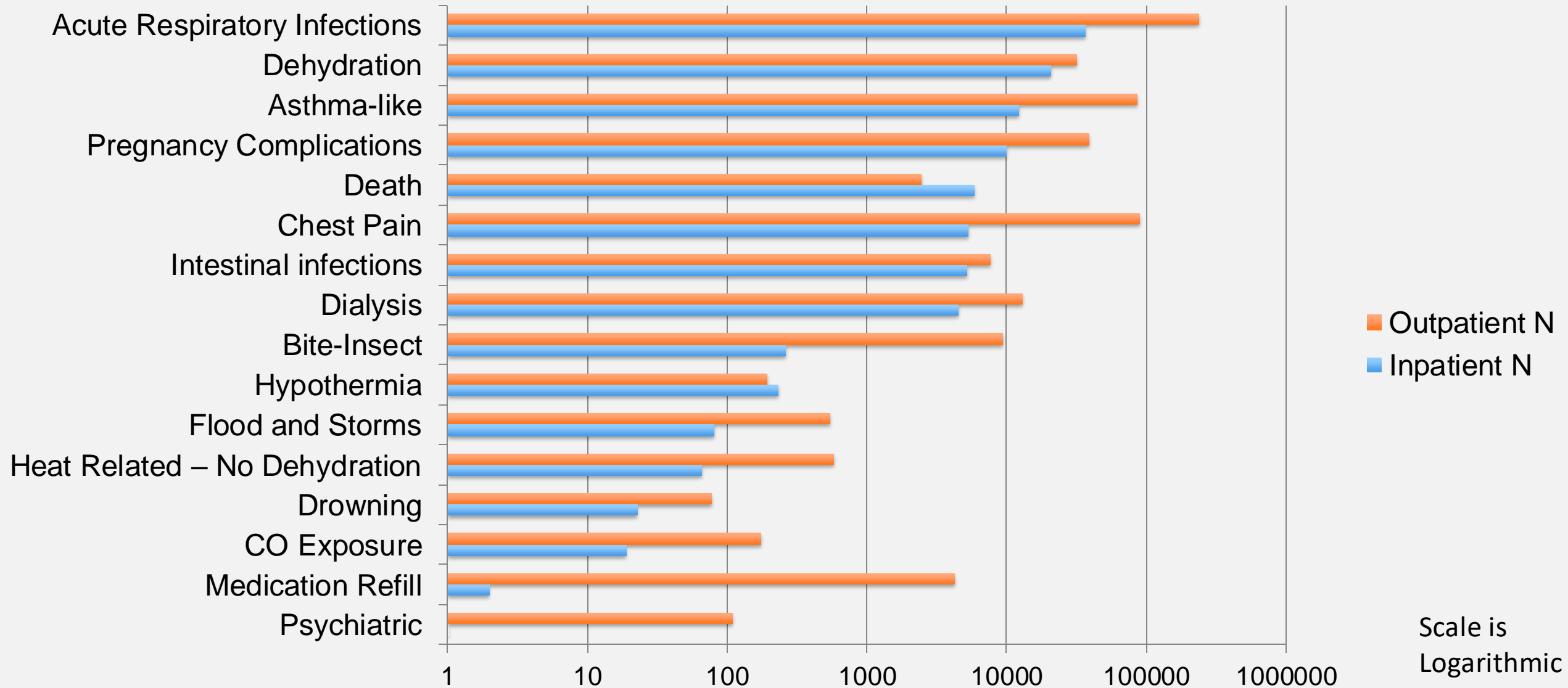
Emergency Department (ED) Visit Data

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

Variables

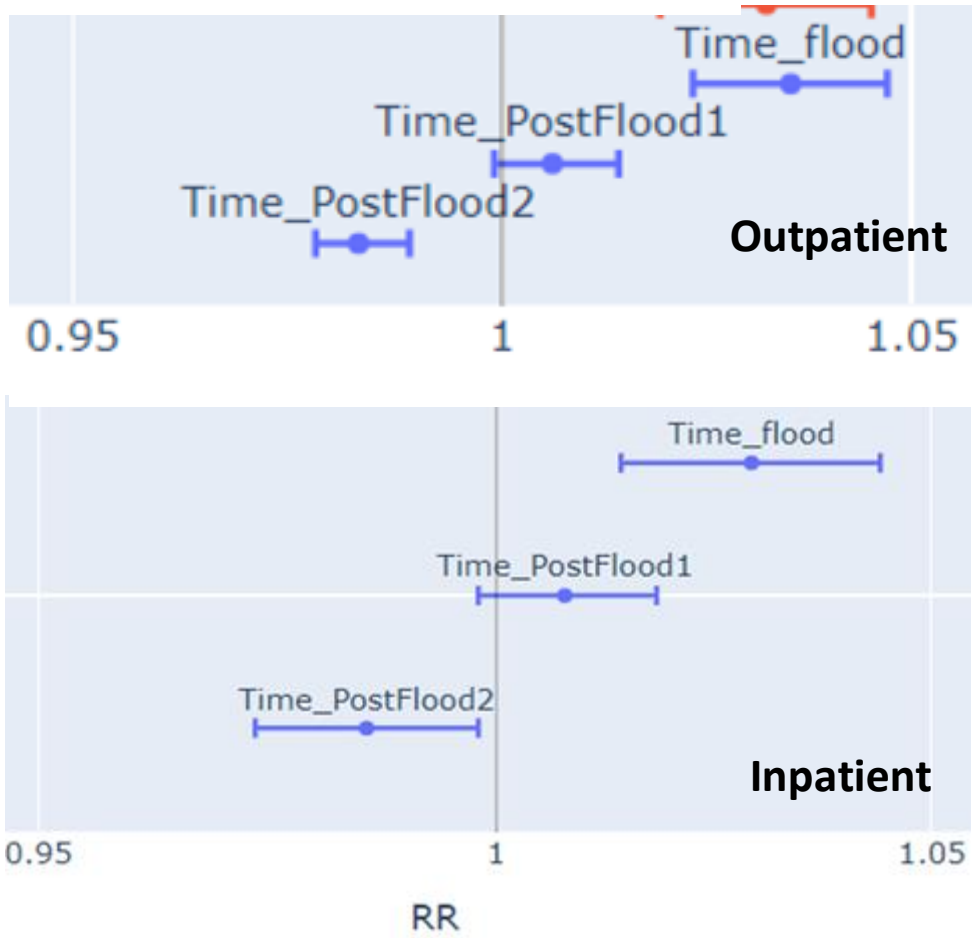
- Patient Zip and Census Block
- Sex, Age, Race, Ethnicity
- Diagnostic Codes
- Condition Codes
- Patient Status
- Statement Start Date
- Admission Date (IP)

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.

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

<i>Post Flood Period 1</i>	<i>RR</i>	<i>95% Conf. Int</i>	
ARI (OP)	2.02	1.36	3.00

<i>Post Flood Period 2</i>	<i>RR</i>	<i>95% Conf. Int</i>	
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?

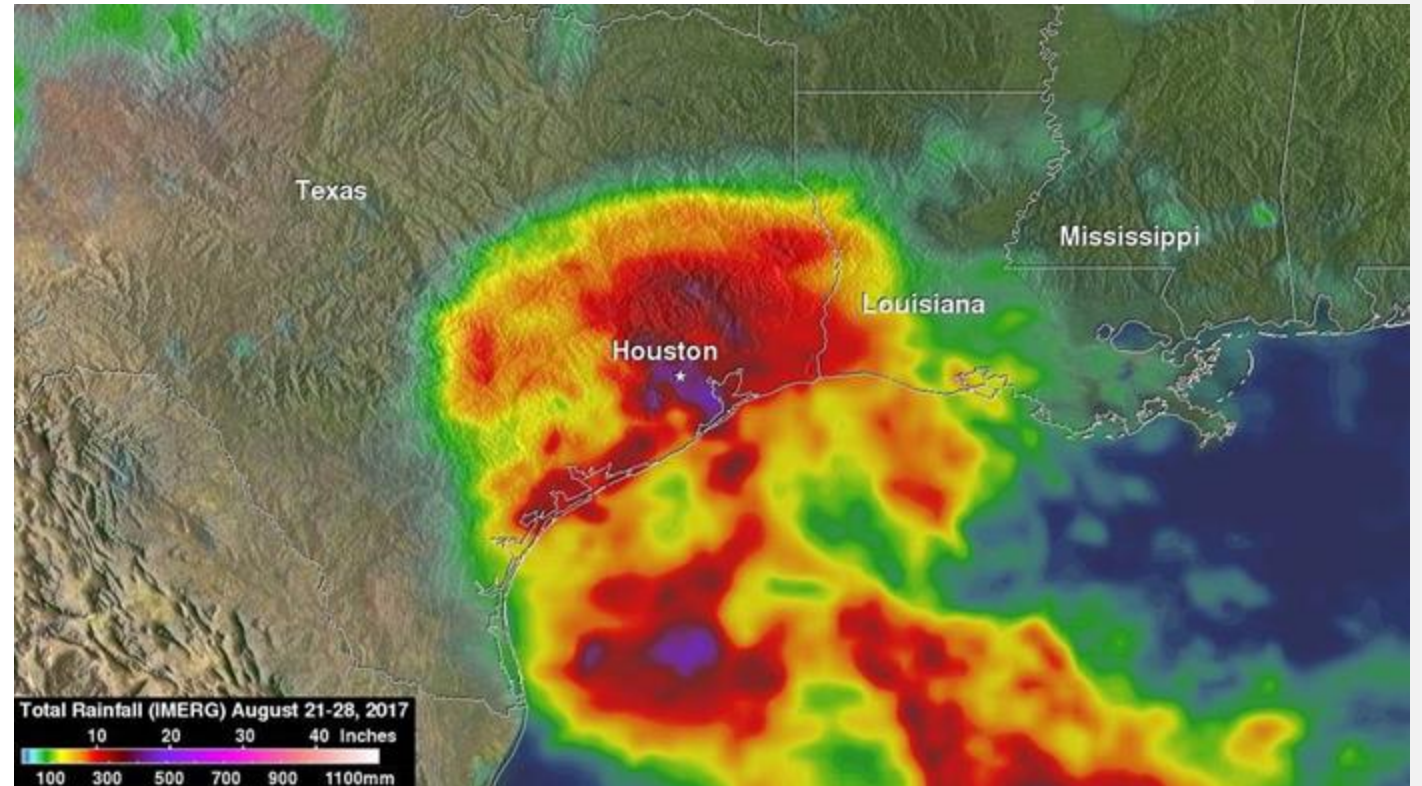
Earth Observations (“EO”) refer to remote observations, *in situ* observations, data-informed computer models, and data assimilation systems.

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



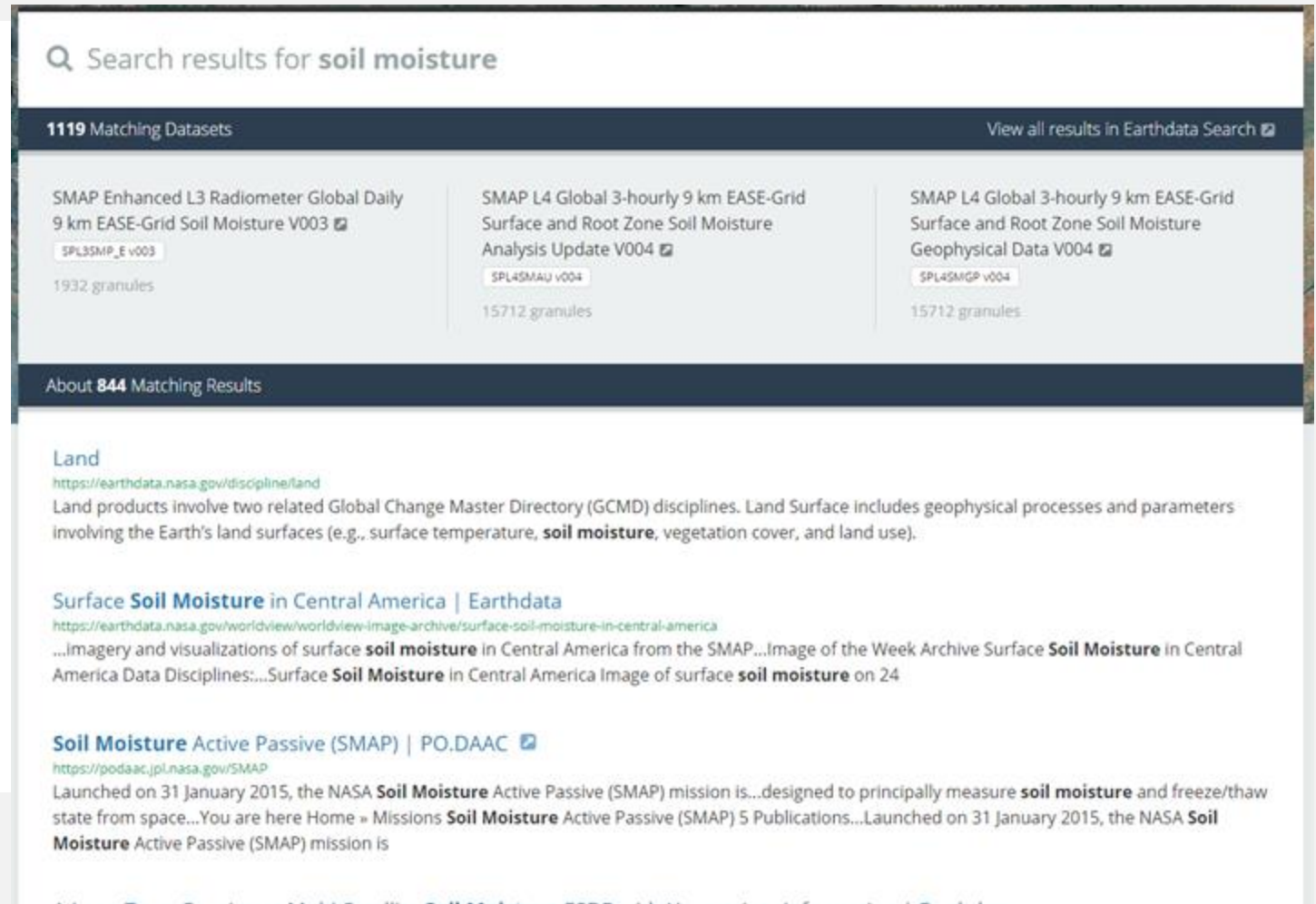
Why use remotely acquired EO?

- Coverage
- Consistency
- Completeness
- Capabilities



Why not use remotely acquired EO?

- Uncertainties
- Unfamiliarity
- Unavailability
- Unwieldiness



The screenshot displays the Earthdata Search interface for the query "soil moisture". At the top, a search bar shows the query and a magnifying glass icon. Below the search bar, a dark blue header bar indicates "1119 Matching Datasets" and provides a link to "View all results in Earthdata Search". The main content area is divided into three columns, each displaying a dataset card. The first card is for "SMAP Enhanced L3 Radiometer Global Daily 9 km EASE-Grid Soil Moisture V003" with identifier "SPL3SMP_E v003" and "1932 granules". The second card is for "SMAP L4 Global 3-hourly 9 km EASE-Grid Surface and Root Zone Soil Moisture Analysis Update V004" with identifier "SPL4SMAU v004" and "15712 granules". The third card is for "SMAP L4 Global 3-hourly 9 km EASE-Grid Surface and Root Zone Soil Moisture Geophysical Data V004" with identifier "SPL4SMGP v004" and "15712 granules". Below the dataset cards, a dark blue bar states "About 844 Matching Results". The page then lists several related links and descriptions. The first link is "Land" with the URL "https://earthdata.nasa.gov/discipline/land", followed by a paragraph about Land products. The second link is "Surface Soil Moisture in Central America | Earthdata" with the URL "https://earthdata.nasa.gov/worldview/worldview-image-archive/surface-soil-moisture-in-central-america", followed by a paragraph about imagery and visualizations. The third link is "Soil Moisture Active Passive (SMAP) | PO.DAAC" with the URL "https://podaac.jpl.nasa.gov/SMAP", followed by a paragraph about the SMAP mission launched on 31 January 2015.

Search results for **soil moisture**

1119 Matching Datasets [View all results in Earthdata Search](#)

Dataset Name	Identifier	Granules
SMAP Enhanced L3 Radiometer Global Daily 9 km EASE-Grid Soil Moisture V003	SPL3SMP_E v003	1932 granules
SMAP L4 Global 3-hourly 9 km EASE-Grid Surface and Root Zone Soil Moisture Analysis Update V004	SPL4SMAU v004	15712 granules
SMAP L4 Global 3-hourly 9 km EASE-Grid Surface and Root Zone Soil Moisture Geophysical Data V004	SPL4SMGP v004	15712 granules

About 844 Matching Results

Land
<https://earthdata.nasa.gov/discipline/land>
Land products involve two related Global Change Master Directory (GCMD) disciplines. Land Surface includes geophysical processes and parameters involving the Earth's land surfaces (e.g., surface temperature, **soil moisture**, vegetation cover, and land use).

Surface Soil Moisture in Central America | Earthdata
<https://earthdata.nasa.gov/worldview/worldview-image-archive/surface-soil-moisture-in-central-america>
...imagery and visualizations of surface **soil moisture** in Central America from the SMAP...Image of the Week Archive Surface **Soil Moisture** in Central America Data Disciplines:...Surface **Soil Moisture** in Central America Image of surface **soil moisture** on 24

Soil Moisture Active Passive (SMAP) | PO.DAAC
<https://podaac.jpl.nasa.gov/SMAP>
Launched on 31 January 2015, the NASA **Soil Moisture** Active Passive (SMAP) mission is...designed to principally measure **soil moisture** and freeze/thaw state from space...You are here Home » Missions **Soil Moisture** Active Passive (SMAP) 5 Publications...Launched on 31 January 2015, the NASA **Soil Moisture** Active Passive (SMAP) mission is

EO in our project

NLDAS:

- surface meteorology
- hydrological states

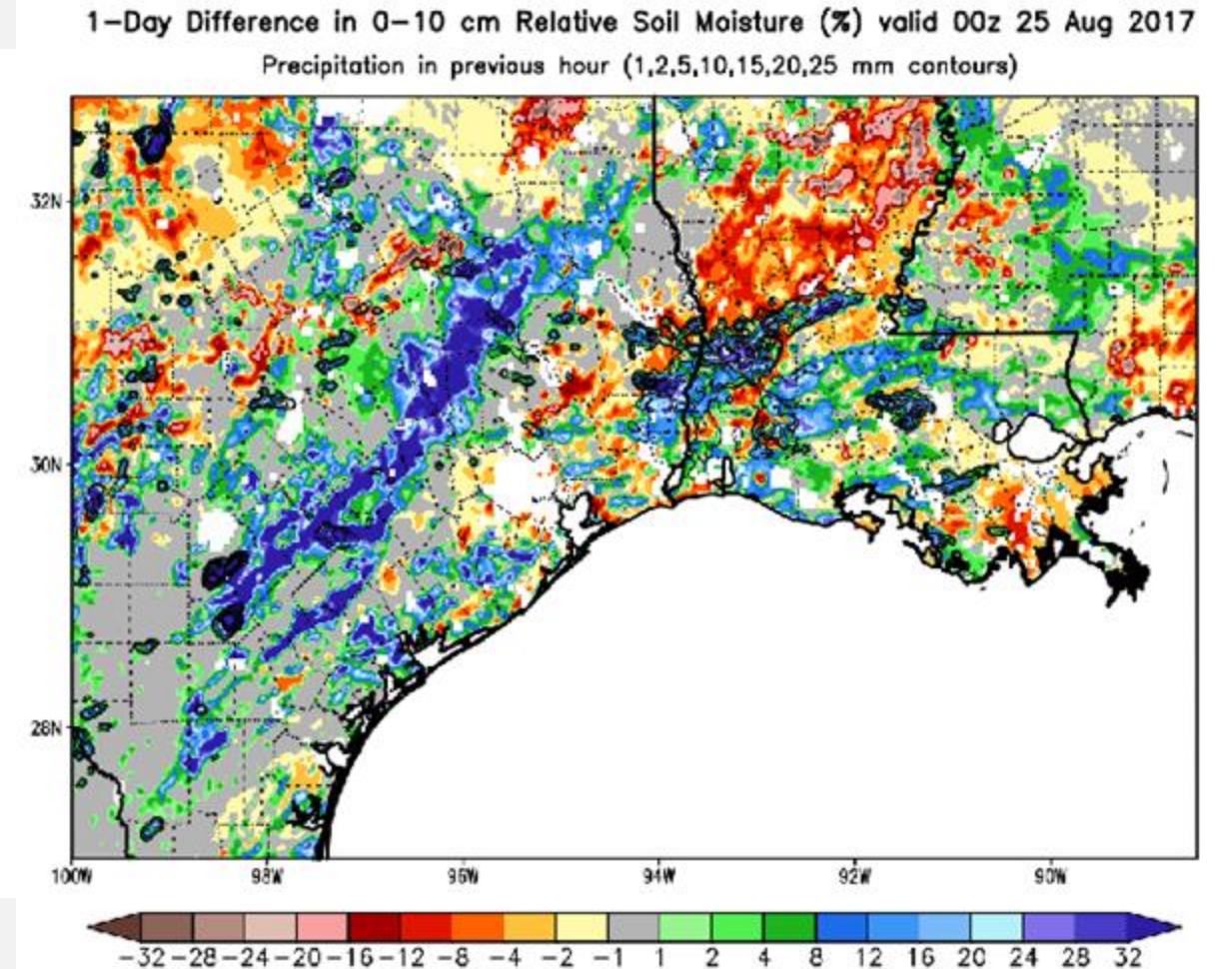


Image: NASA SPoRT

EO in our project

The Dartmouth Flood Observatory:

- Inundated area

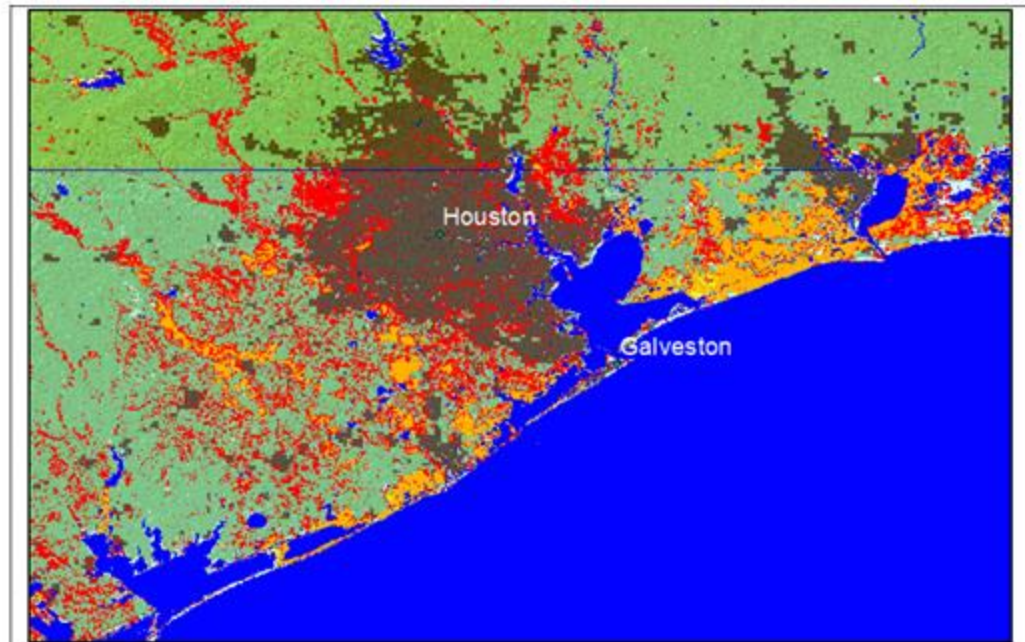


Figure 1: Post-Harvey flooding detected in September 1 products by NASA MODIS NRT (yellow), DFO (red), and both products (orange).

EO in our project

NASA VIIRS:

- Nighttime lights

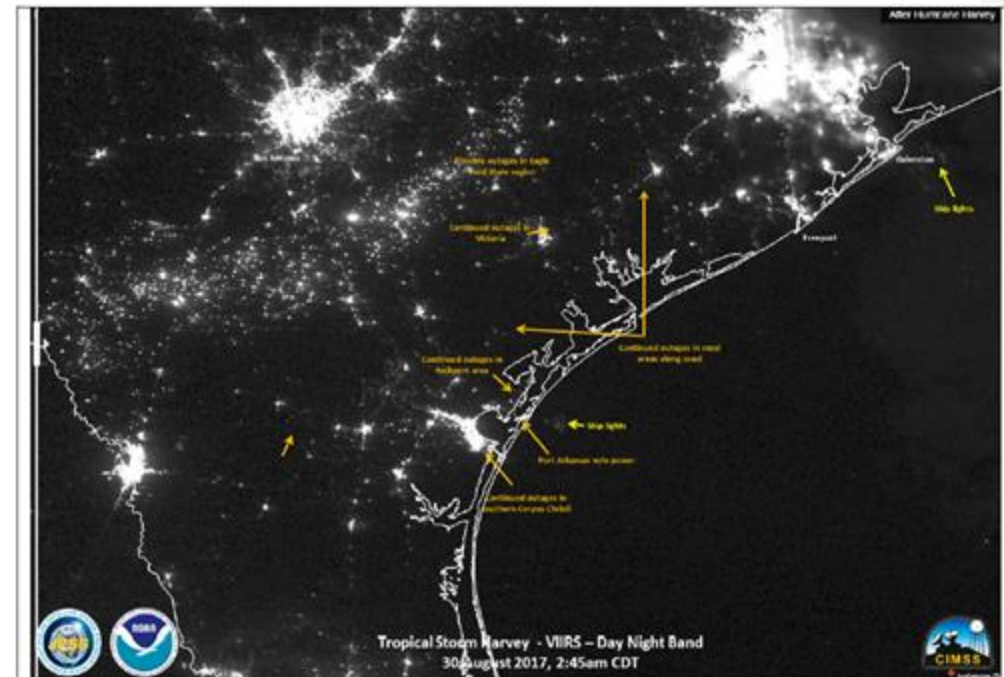
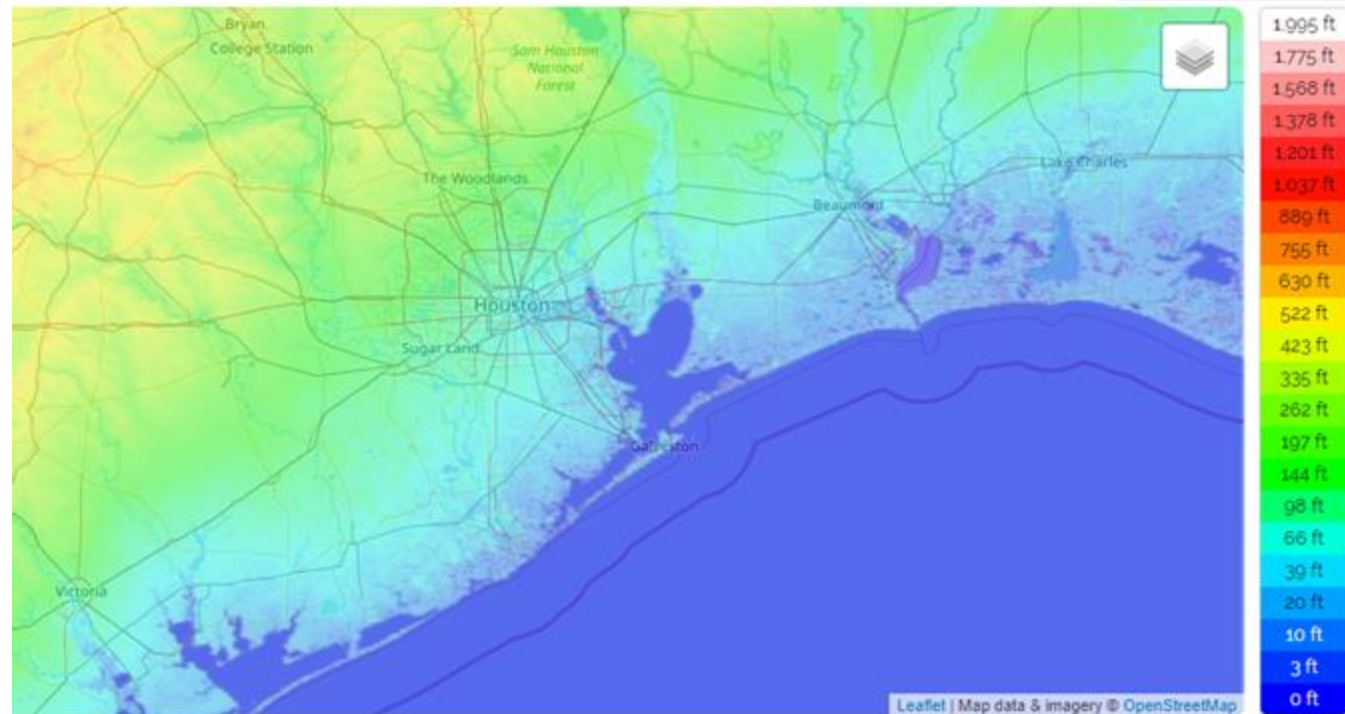


Figure 2: VIIRS DNB image collected on August 30, 2017, with annotation of identified outage areas performed by CIMSS (image produced by William Straka, SSEC/CIMSS).

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