EARTH SCIENCE
APPLIED SCIENCES

EARTH SCIENCE APPLICATIONS WEEK 2022

Day 3: Disasters

August 9, 2022

EARTH SCIENCE APPLICATIONS WEEK 2022

WELCOME!

DAY 3 – AUGUST 11th: DISASTERS

<u>Event Attendance Guidelines</u>

1. Please stay muted with cameras off
2. Post questions for speakers in the chat & they will be answered there

DISASTERS PROGRAM INTRODUCTION

Dr. Shanna McClain
Program Manager
Disasters Program

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What we do

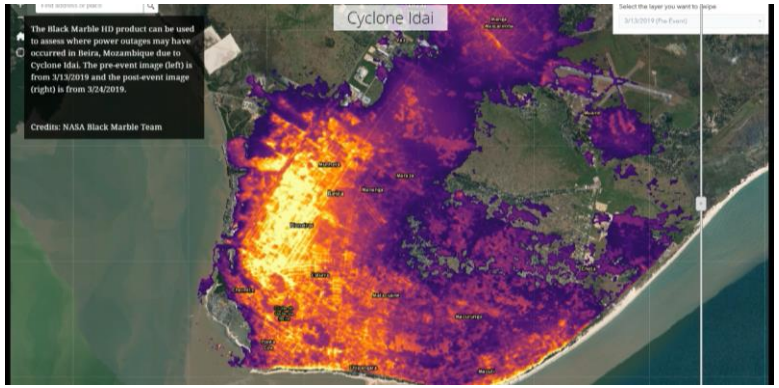
- **Disaster Science Applications**– co-production of comprehensive capabilities for understanding hazards, exposure, vulnerability, damage, and loss contributing to effective disaster management

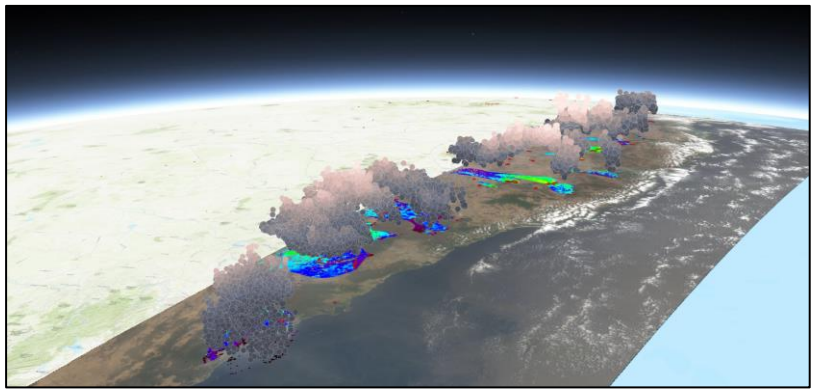
- **Disaster Response Coordination**–active disaster response coordination and technical support for integrating data and products into operational decisions and response efforts

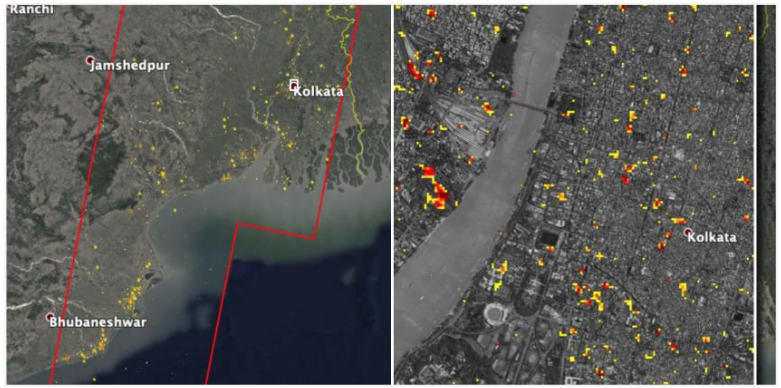
- **Partnerships & Open Science** – working across domestic and international organizations and agencies across multiple levels of disaster management and facilitating open disaster science across these communities

Disaster Applications for Risk Reduction

- Global Flood Modeling for Decision Making
- Critical Infrastructure Exposure for Disaster Mitigation
- Landslide Risk Reduction
- Volcanic Ash Monitoring
- Forecasting of Fire Behavior and Smoke Impact
- SAR Data for Weather-related Disasters
- Oil Spill Monitoring and Storm Damage Assessment
- Hailstorm Risk Assessment
- SAR Rapid Damage Assessments
- Tsunami Warning through Earthquake Products



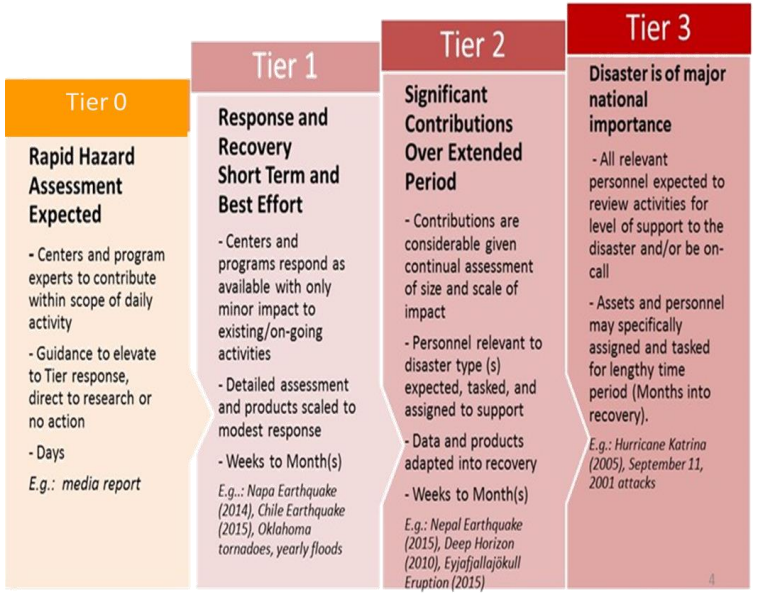




Disaster Response Coordination

2021 marked an intense year for NASA support to disaster events, with increased focus on partnership building.

2021: 43 Total Activations
12 Domestic & 31 International

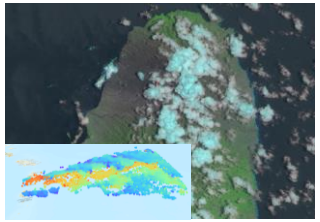


18 **19** **6** **0**

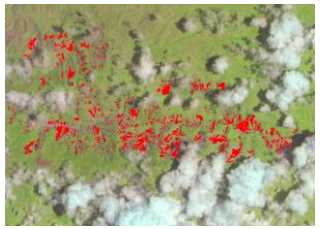
Major Disaster Events Supported in 2021

Tropical Cyclones: 9 Events
Volcanoes: 9 Events
Flooding: 8 Events
Fires: 5 Events

12 other events including Earthquakes, Landslides, Severe Weather, Oil Spills, Tsunamis, Severe Weather, and others



APRIL – TIER 2
La Soufriere
Damage proxy maps, OMPS, MISR, Imagery



AUGUST – TIER 2
Haiti Earthquake
Damage proxy maps, ASTER Imagery, Landslides, Surface Dsp.

AUGUST – TIER 2
Hurricane Ida
Damage proxy maps, Black Marble NRT&HD, UAVSAR, Water Extents

DECEMBER – TIER 2
Tornado Outbreak
Damage proxy maps, Sentinel-2, Planet

Partnerships & Open Disaster Science

Supporting open science, collaboration, and exchange through the Disasters Portal
www.maps.disasters.nasa.gov

NASA Products for Hurricane Laura 2020

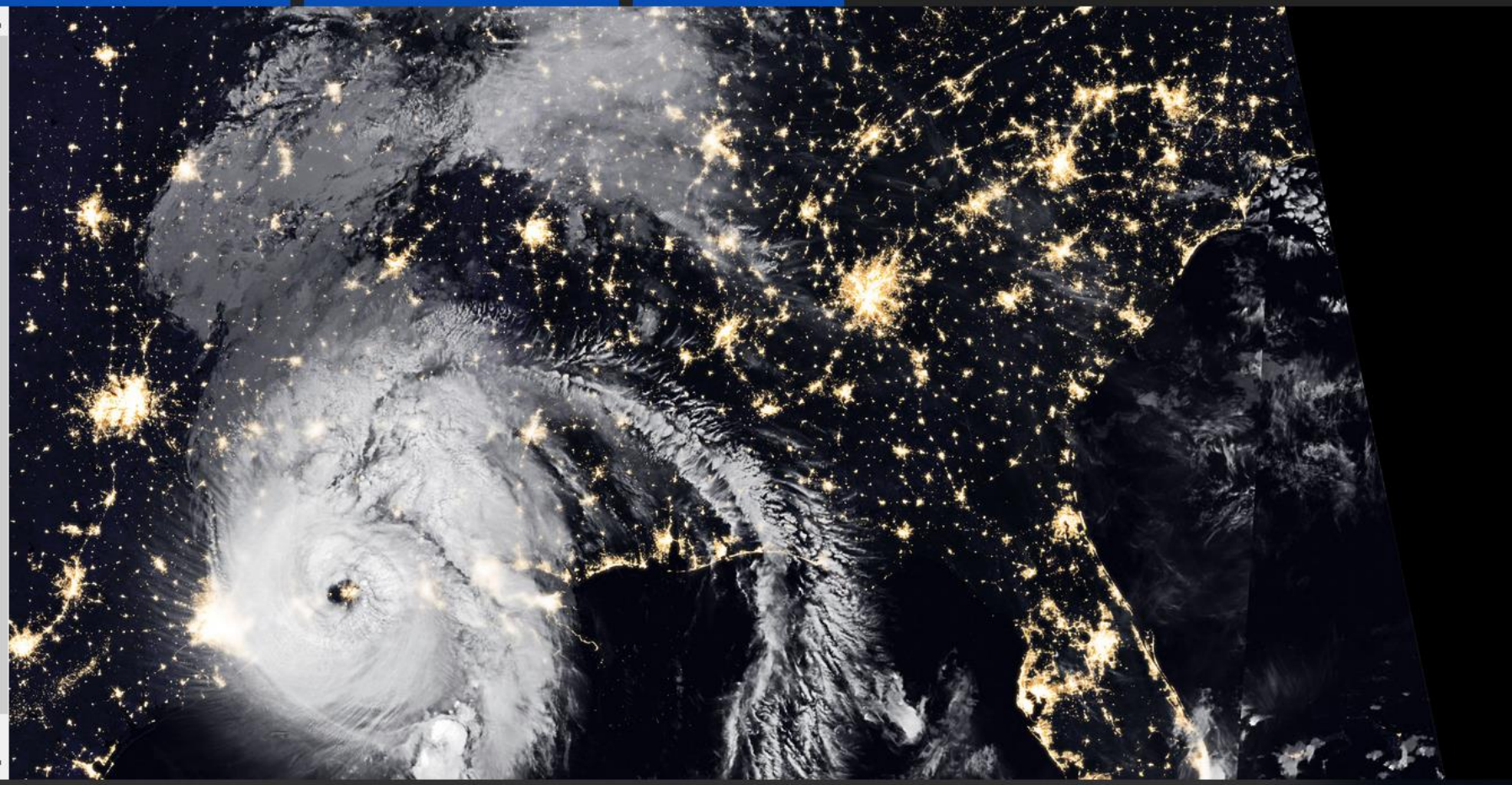
Home | ISS Imagery | SAR Imagery | Sentinel-2 Natural Color Imagery | ARIA Damage Proxy Map | Product Gallery

After making landfall near Cameron, Louisiana, as a category 4 storm, Hurricane Laura continued to move northward over western Louisiana. The Visible Infrared Imaging Radiometer Suite (VIIRS) on NOAA-20 acquired this image of Hurricane Laura at 2:50 a.m. Central Daylight Time on August 27, 2020, about two hours after the storm made landfall. Clouds are shown in infrared using brightness temperature data, which is useful for distinguishing cooler cloud structures from the warmer surface below. That data is overlaid on composite imagery of city lights from NASA's Black Marble dataset.

NASA Earth Observatory image by Joshua Stevens, using VIIRS data from NASA EOSDIS/LANCE and GIBS/Worldview and the Suomi National Polar-orbiting Partnership, and Black Marble data from NASA/GSFC. Caption by Adam Voiland.

Text and Image Source:

https://earthobservatory.nasa.gov/images/147180/laura-makes-landfall



Landslides: Susceptibility & Exposure

Robert Emberson

Associate Program Manager, NASA Disasters

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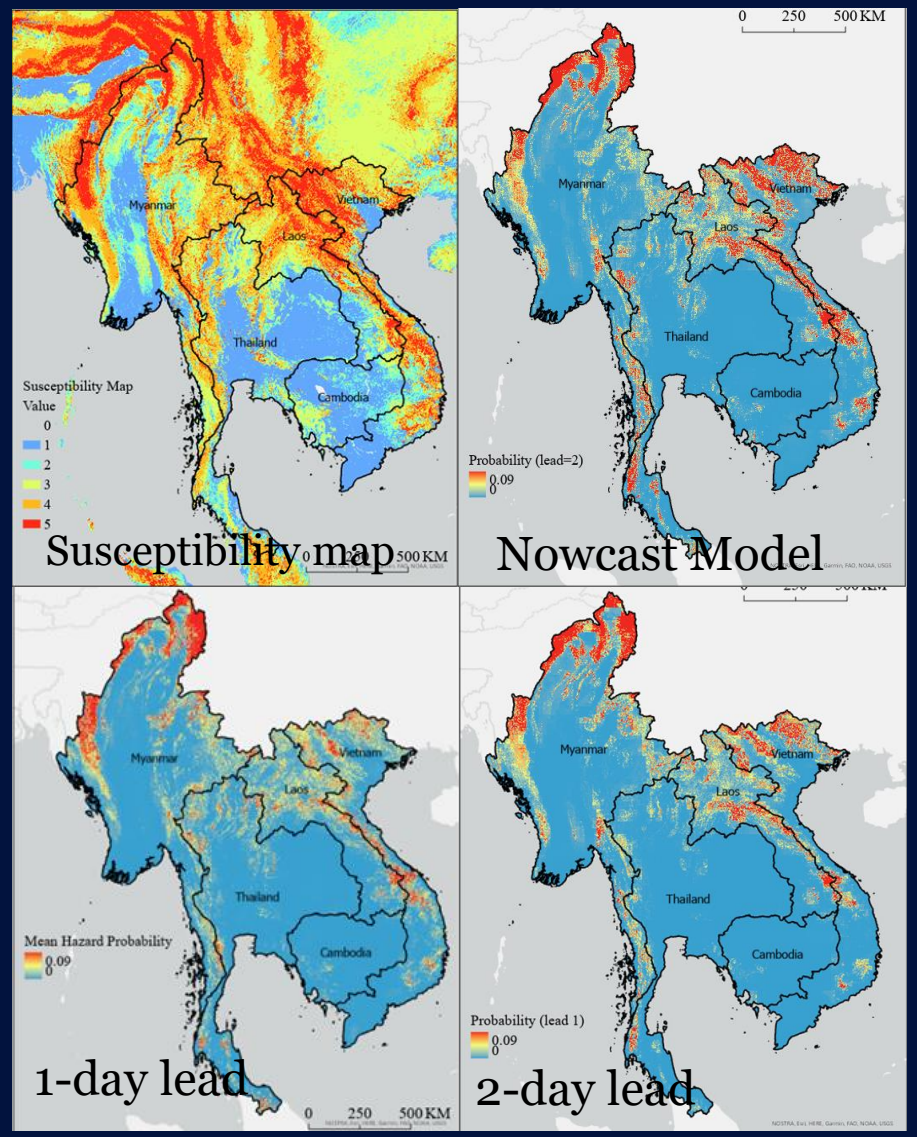
From Susceptibility to Risk

- Ward et al. (2020): “exposure refers to the location of economic assets or people in a hazard-prone area”

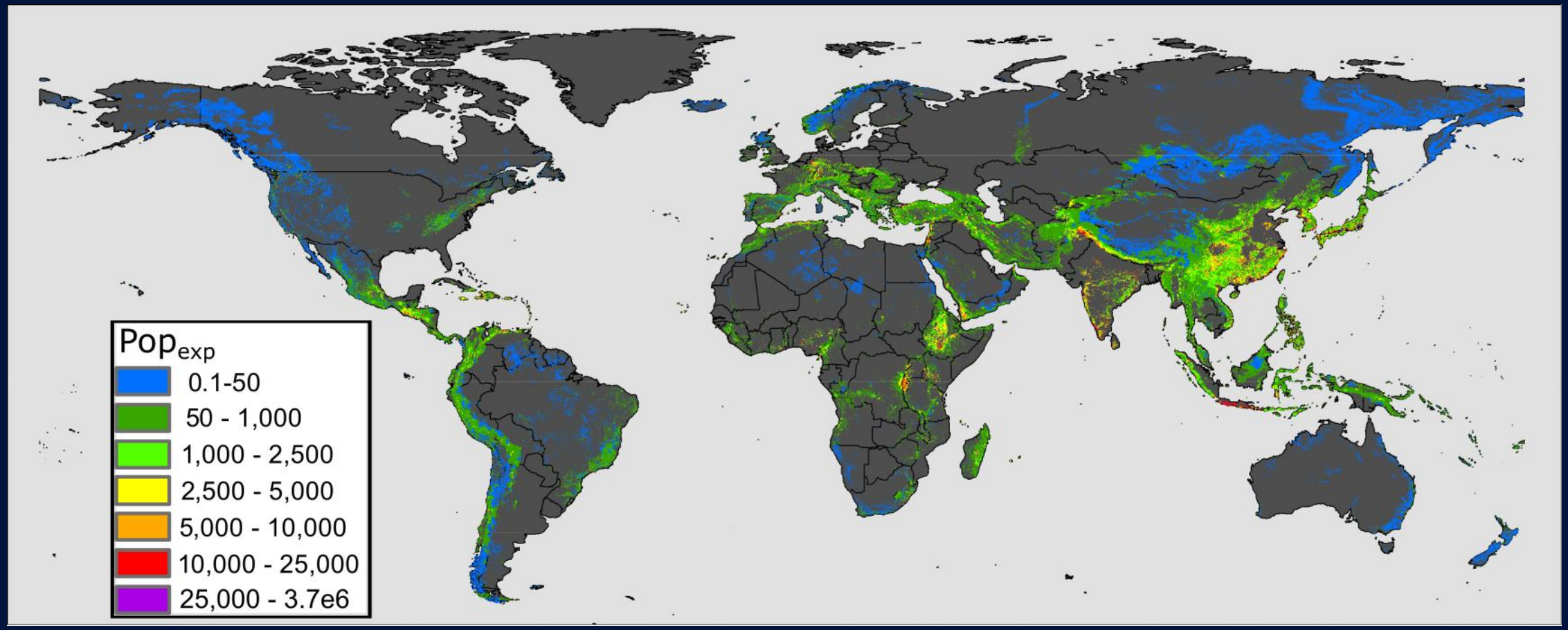
SUSCEPTIBILITY:	HAZARD:	EXPOSURE:	VULNERABILITY:	RISK:
Where is the landslide likely?	Where and when is the landslide likely?	Who / what is in the hazard zone?	How likely is damage / injury for exposure level?	Hazard x exposure x vulnerability



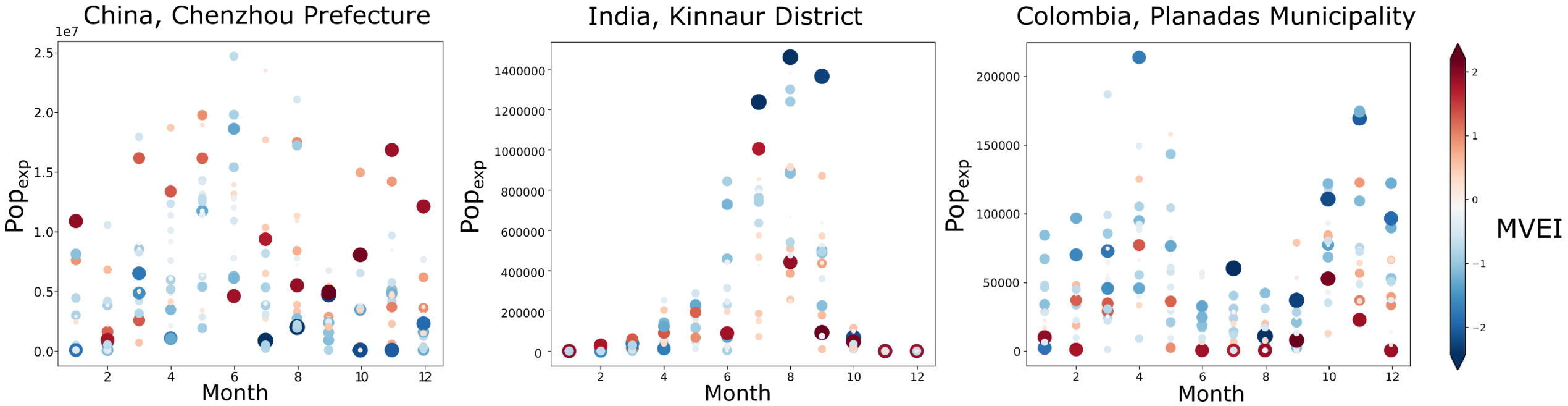
- Global and regional models can estimate where landslides are likely to occur due to heavy rainfall.
- Newly implemented in Google Earth Engine to enable reproducibility and reuse.
- But what about people and infrastructure?

Global Exposure

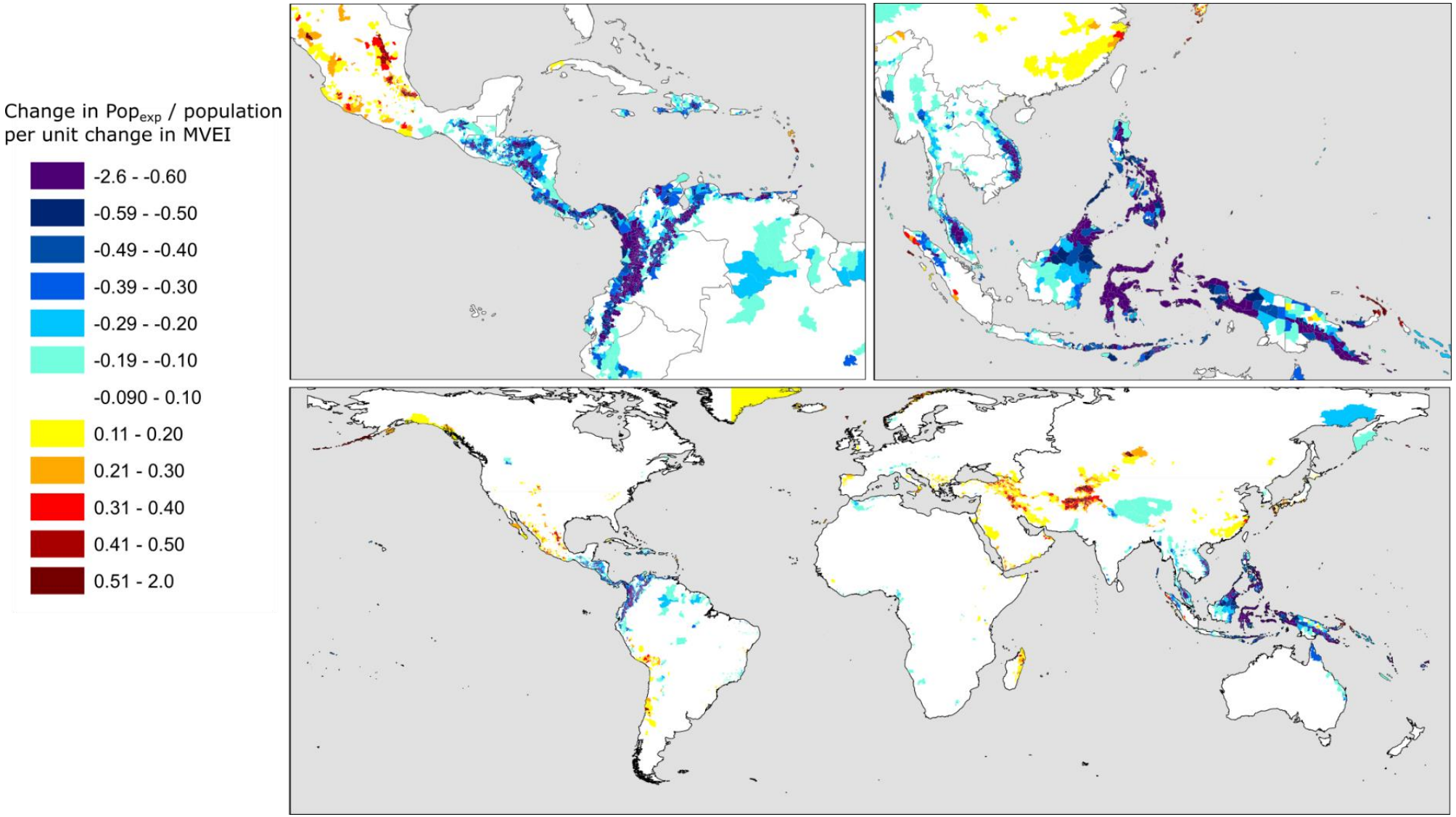
Using global datasets, we can fill in gaps in exposure estimates



Monthly exposure estimates highlight variability linked to ENSO

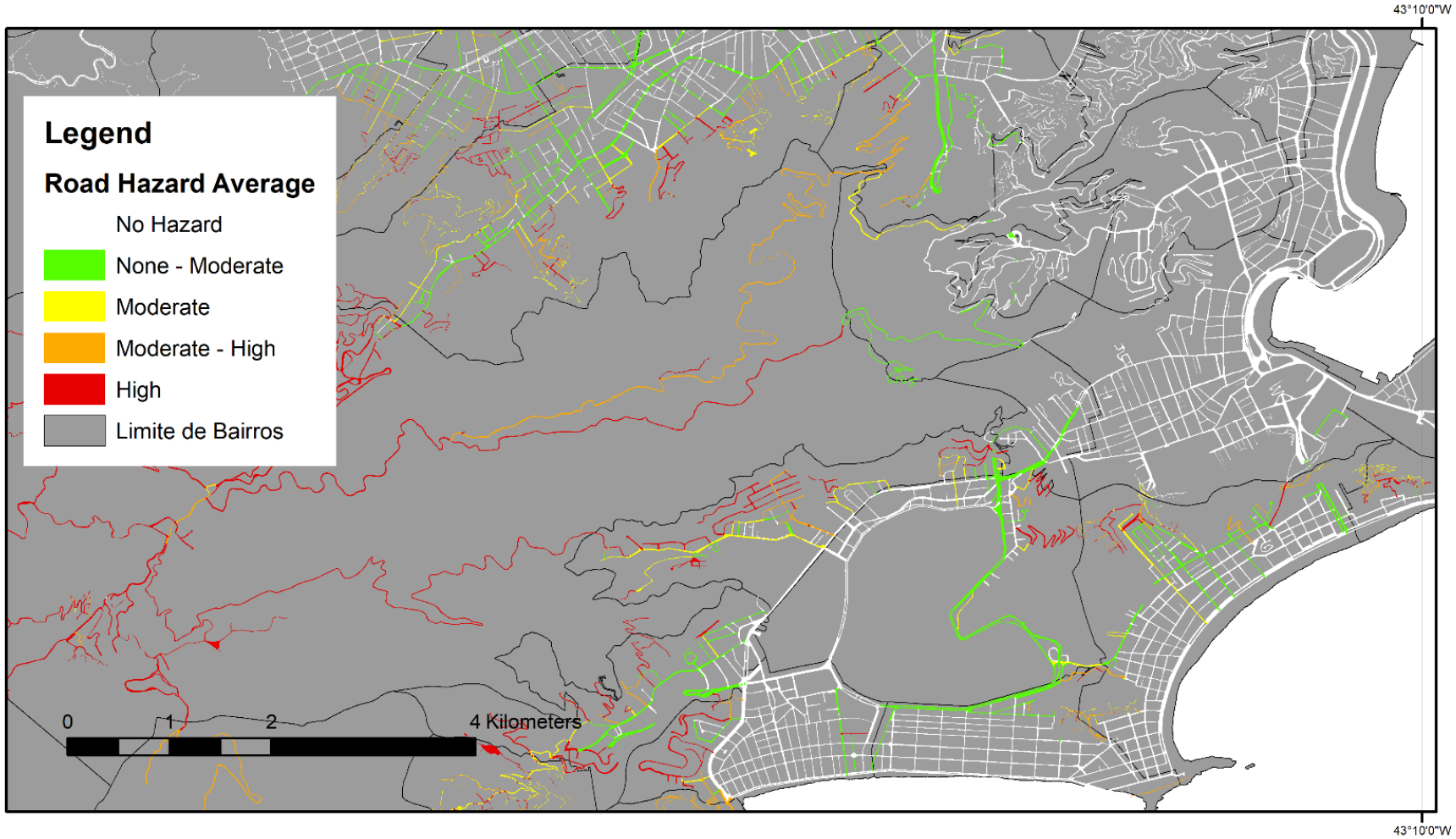


Seasonal Exposure Modelling



Highlighting areas where we can provide seasonal predictions for changes in exposure

From global to local scale



Collaborative work with Rio de Janeiro to estimate where roads are most exposed to landsliding

Multihazard Risk Analysis and Game Engine Immersive Data Visualization

Shayna Solis sss@navteca.com shayna.s.skolnik@nasa.gov

Ricardo Quiroga ricardo.quirogavanegas@nasa.gov

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A Guatemala City Case Study

Pilot Project Partner Organizations

Muni Guate

CEPREDENAC
CENTRO DE COORDINACIÓN PARA LA PREVENCIÓN DE LOS DESASTRES EN AMÉRICA CENTRAL Y REPÚBLICA DOMINICANA

SICA
Sistema de la Integración Centroamericana

Navteca

SALVETERRA

CONRED
COORDINADORA NACIONAL PARA LA REDUCCIÓN DE DESASTRES
GUATEMALA, C.A.

UNDRR
UN Office for Disaster Risk Reduction

AVE

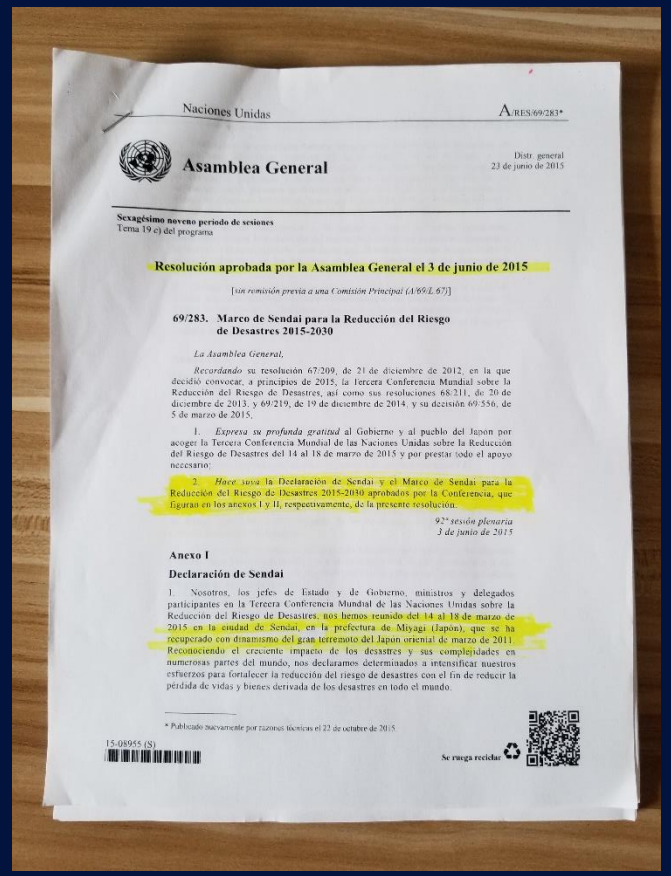
NASA

NASA Earth Science
DISASTERS PROGRAM

Make data relevant and understandable and ACTIONABLE

Building on Navteca's success ingesting data in near real time from the NASA Disaster Applications portal

Multi-hazard Risk Analysis



Naciones Unidas A/RES/69/283*

Asamblea General

Distr. general
23 de junio de 2015

Sexagésimo noveno período de sesiones
Tema 19 c) del programa

Resolución aprobada por la Asamblea General el 3 de junio de 2015

[*sin remisión previa a una Comisión Principal (A/69/L.67)*]

69/283. Marco de Sendai para la Reducción del Riesgo de Desastres 2015-2030

La Asamblea General,

Recordando su resolución 67/209, de 21 de diciembre de 2012, en la que decidió convocar, a principios de 2015, la Tercera Conferencia Mundial sobre la Reducción del Riesgo de Desastres, así como sus resoluciones 68/211, de 20 de diciembre de 2013, y 69/219, de 19 de diciembre de 2014, y su decisión 69/556, de 5 de marzo de 2015,

1. *Expresa su profunda gratitud* al Gobierno y al pueblo del Japón por acoger la Tercera Conferencia Mundial de las Naciones Unidas sobre la Reducción del Riesgo de Desastres del 14 al 18 de marzo de 2015 y por prestar todo el apoyo necesario;

2. *Hace suya* la Declaración de Sendai y el Marco de Sendai para la Reducción del Riesgo de Desastres 2015-2030 aprobados por la Conferencia, que figuran en los anexos I y II, respectivamente, de la presente resolución.

92ª sesión plenaria
3 de junio de 2015

Anexo I

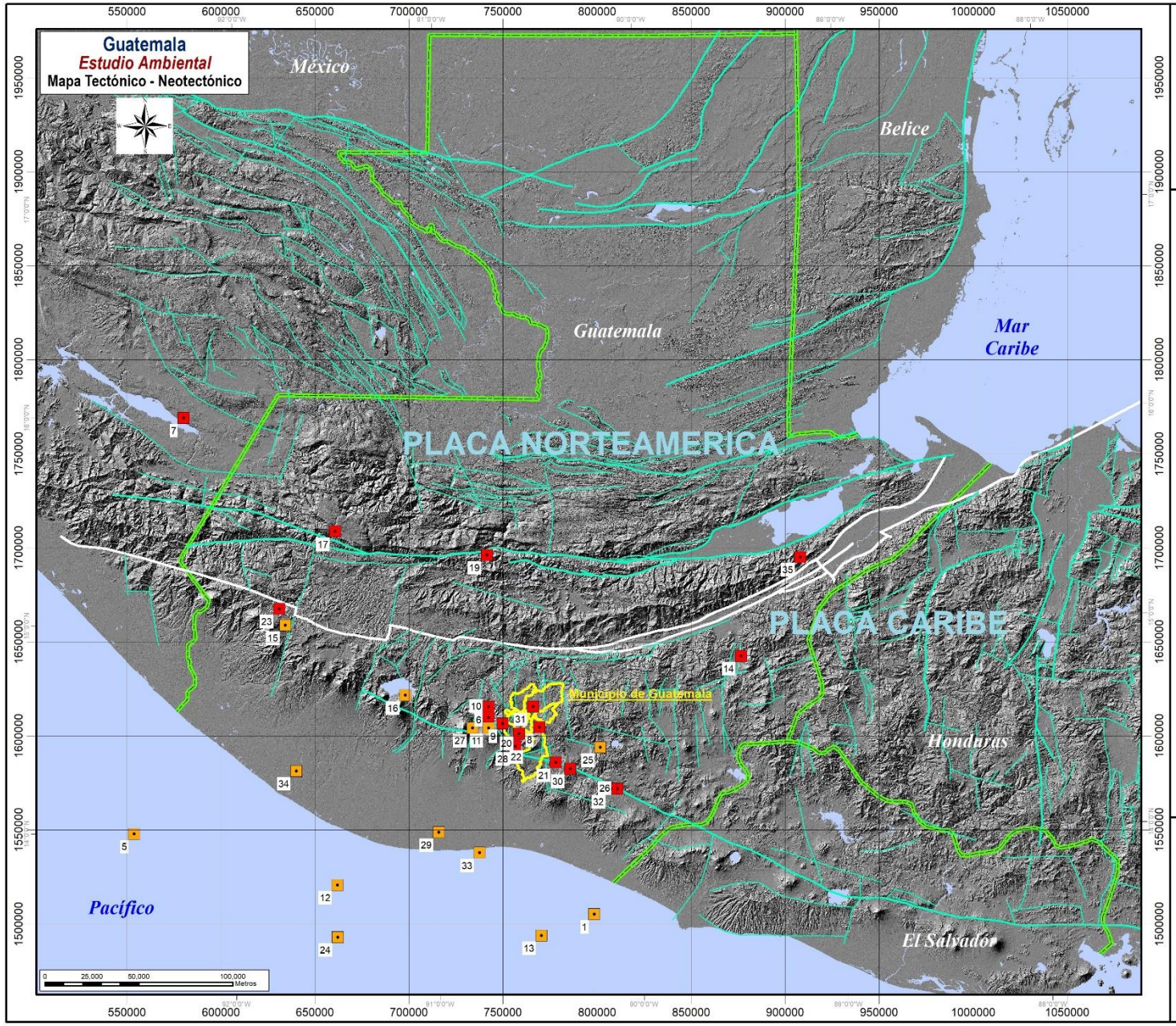
Declaración de Sendai

1. Nosotros, los jefes de Estado y de Gobierno, ministros y delegados participantes en la Tercera Conferencia Mundial de las Naciones Unidas sobre la Reducción del Riesgo de Desastres, nos hemos reunido del 14 al 18 de marzo de 2015 en la ciudad de Sendai, en la prefectura de Miyagi (Japón), que se ha recuperado con dinamismo del gran terremoto del Japón oriental de marzo de 2011. Reconociendo el creciente impacto de los desastres y sus complejidades en numerosas partes del mundo, nos declaramos determinados a intensificar nuestros esfuerzos para fortalecer la reducción del riesgo de desastres con el fin de reducir la pérdida de vidas y bienes derivada de los desastres en todo el mundo.

* Publicado nuevamente por razones técnicas el 22 de octubre de 2015.

15-08955 (S)

Se ruega reciclar



SALVETERRA

Terremotos y sismos fuertes sentidos en Guatemala desde 1.500 D.C.

Eventos sismicos mayores de los últimos 500 años (Profundidad)

- Subducción - profundo
- Cortical - somero

- Límite Estructural entre la Placa del Caribe y la Placa de America del Norte
- Fallas geológicas - escala regional
- Fallas geológicas - escala local

- Fronteras Nacionales
- Limites de los Municipios de la Gran Ciudad del Sur del Departamento de Guatemala

Fuente: Benito & Torres (Eds., 2009): Amenaza Sísmica de América Central

Base Topográfica: Modelo Digital de Terreno (MDT) del Proyecto SRTM; resolucón: 30 m.

Profesionales Responsables:
Dr. Andreas Mende y Dr. Allan Astorga

Especialista en Sistemas de Información Geográfica (Procesamiento de Datos, Cartografía y Diseño):
Dr. Andreas Mende

Fuente de Datos: Datos proprios y Información publicada previamente (detalles compare informe técnico)

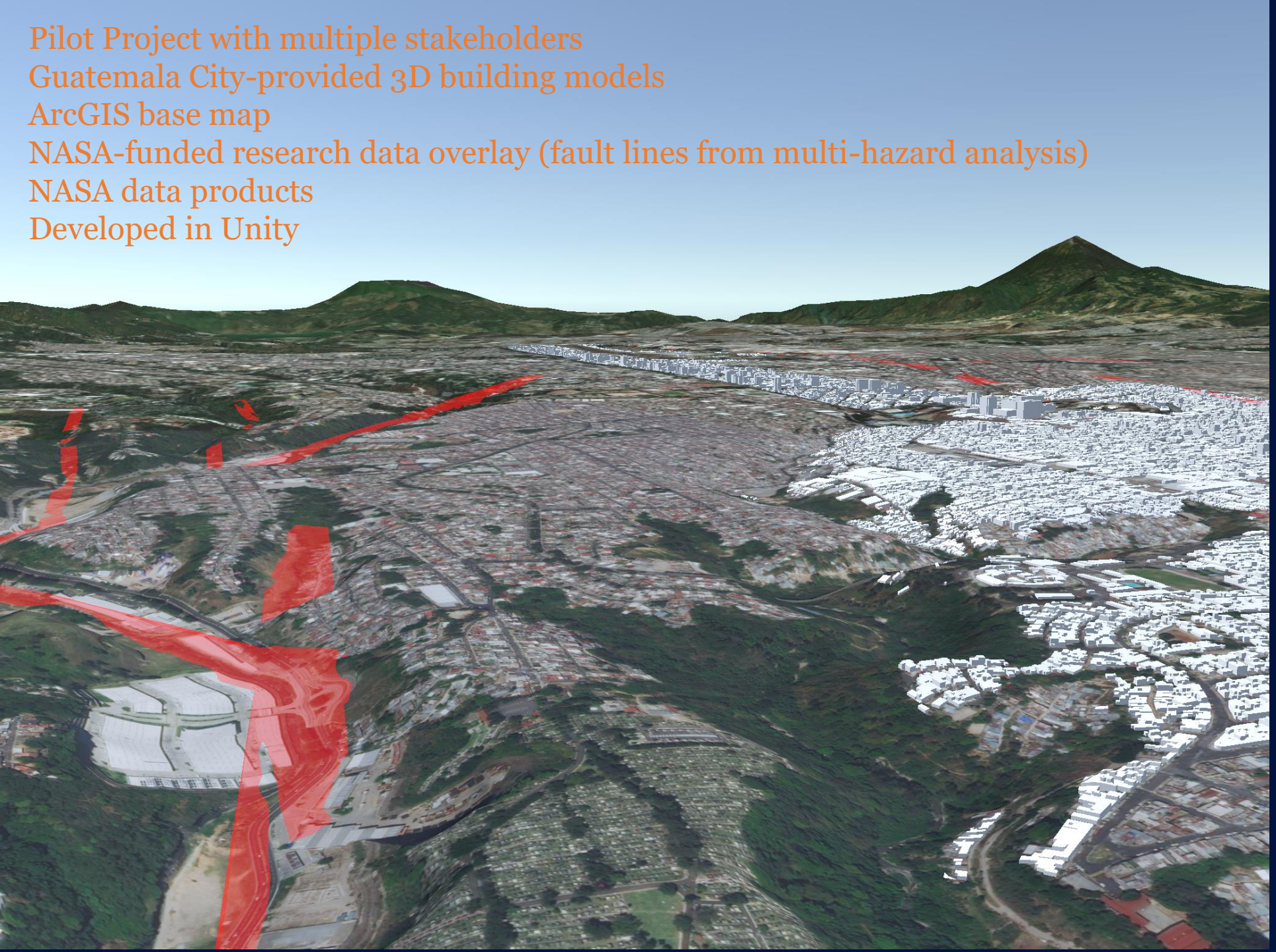
Proyección Cartográfica: Grados Geográficos, basado en el sistema de coordenadas WGS84

Fecha: 23.07.2020

Guatemala City

NOVEX

Pilot Project with multiple stakeholders
Guatemala City-provided 3D building models
ArcGIS base map
NASA-funded research data overlay (fault lines from multi-hazard analysis)
NASA data products
Developed in Unity



3D TERRAIN + “CATASTRO” BUILDING MODELS

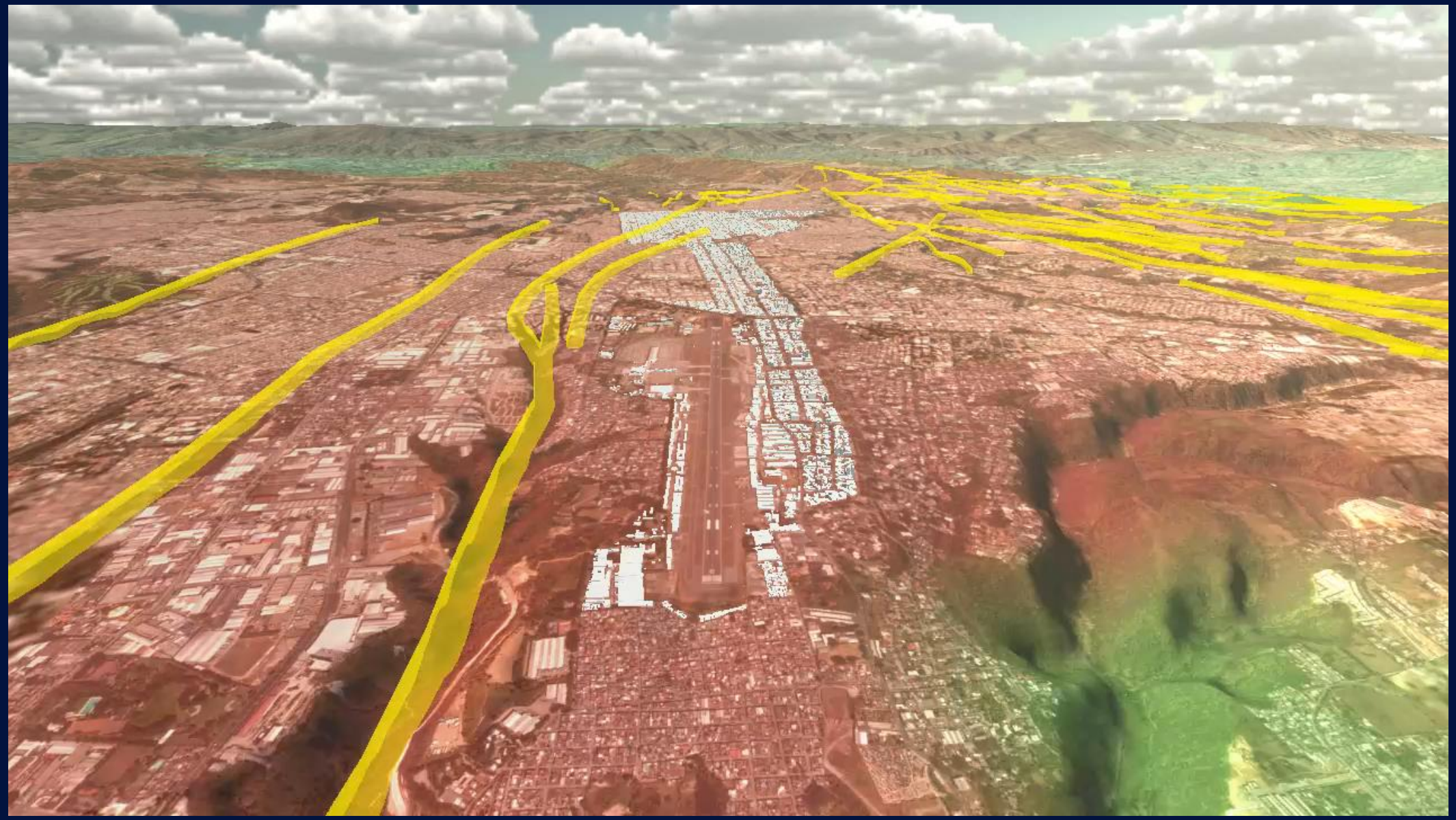
VISUALIZING THE INVISIBLE: FAULTS

Data source: Salveterra multihazard risk analysis report

It’s about the impact on people

NASA SEDAC Data Adds Additional Context to Risk

Data Source: Socio Economic Data and Applications Center (SEDAC)
https://sedac.ciesin.columbia.edu/



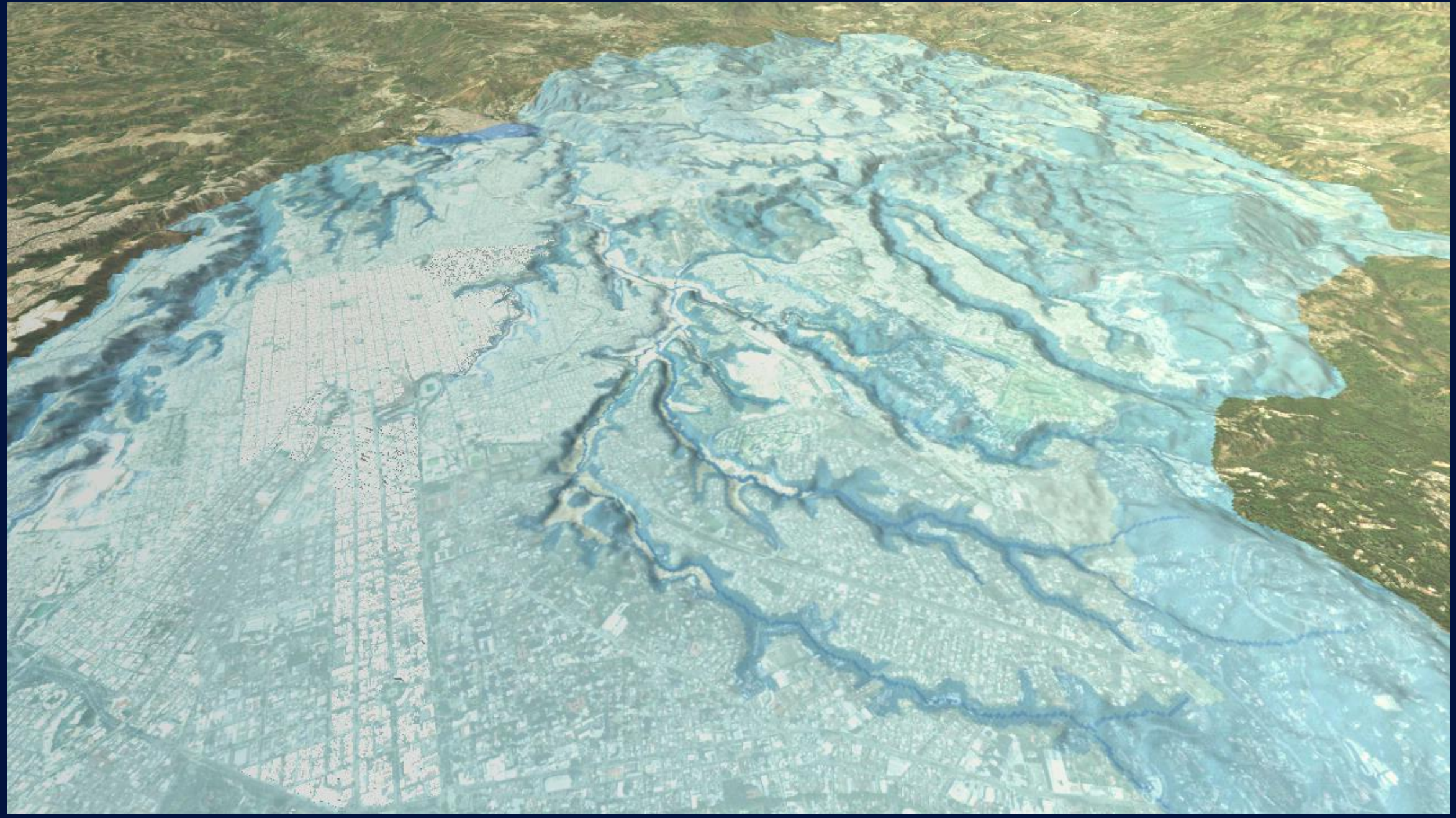
THE SEISMIC RISK BECOMES CLEARER WITH NASA SEDAC DATA AND 3D MODELS OF THE CENTRAL CORRIDOR

Landslides

VISUALIZING LANDSLIDE RISK WITH NEAR-REAL TIME NASA DATA PRODUCTS: GLOBAL LANDSLIDE NOWCAST

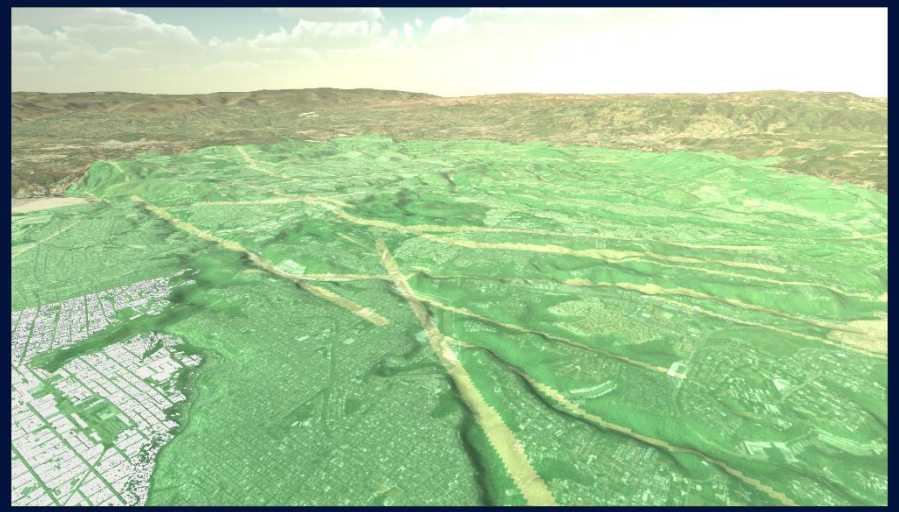
Global Landslide Nowcast, "Nowcast" is created by comparing GPM data from the last seven days to the long-term precipitation record, updated every 3 hours.

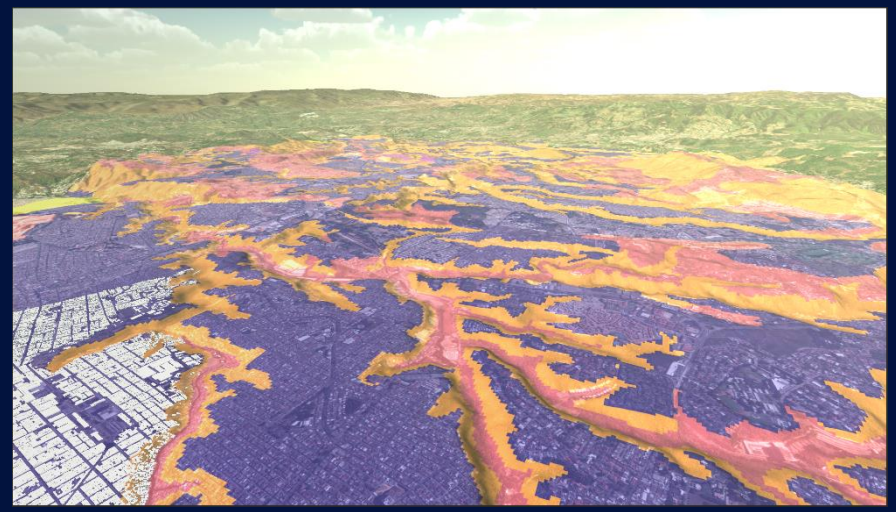
Floods

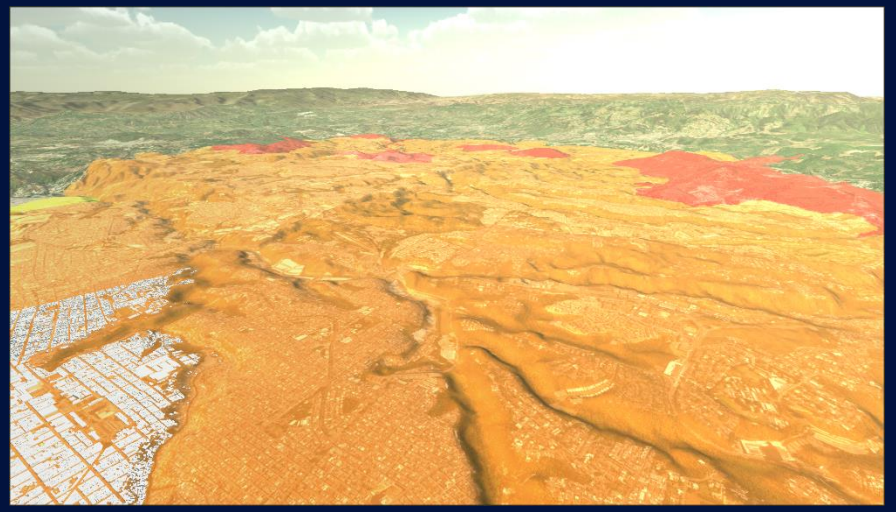


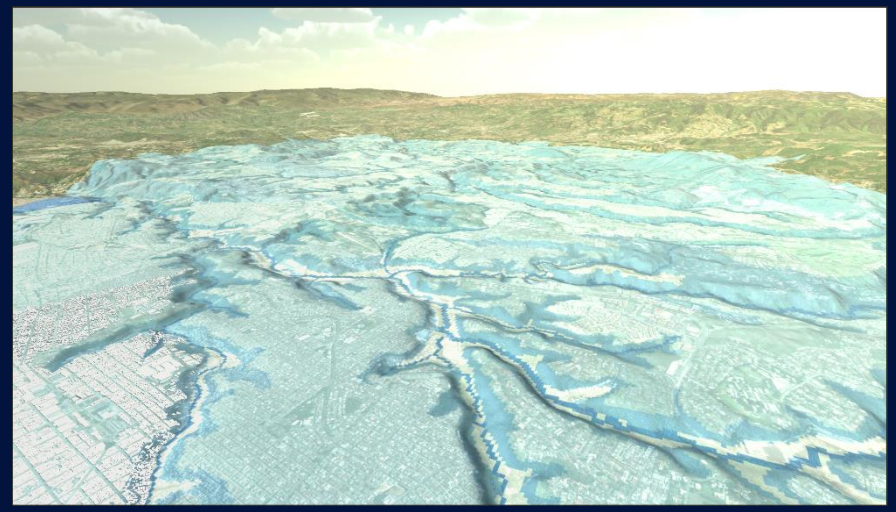
Flood risk in the region interpreted from the multihazard report (Salveterra)

From data to data-driven decision…





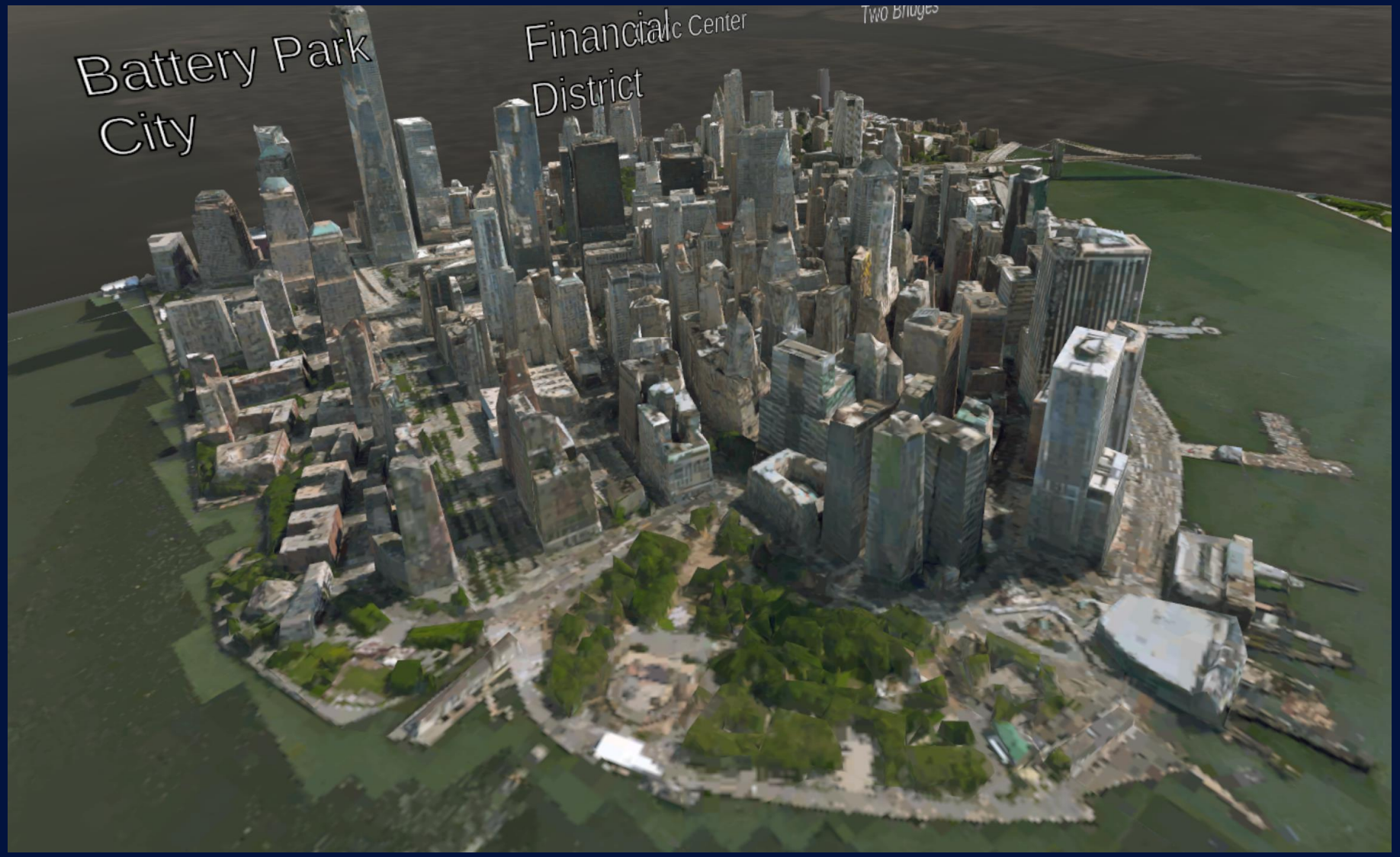




We can improve readiness and resilience with scientific data and information

Central American Earthquake Simulation Drill, 7.2, February 4, 2022, Guatemala City EOC

VR/AR AND GAMING ENGINE TECHNOLOGY CAN INCREASE RESILIENCE BY HELPING VISUALIZE AND PLAN FOR EXTREME WEATHER, DISASTERS, AND CLIMATE CHANGE



Active Fires: Fire Directionality & Impact

Kyle Hilburn

Cooperative Institute for Research in the Atmosphere (CIRA/CSU)

Acknowledgements: Adam Kochanski (SJSU), Jan Mandel (CU-Denver)

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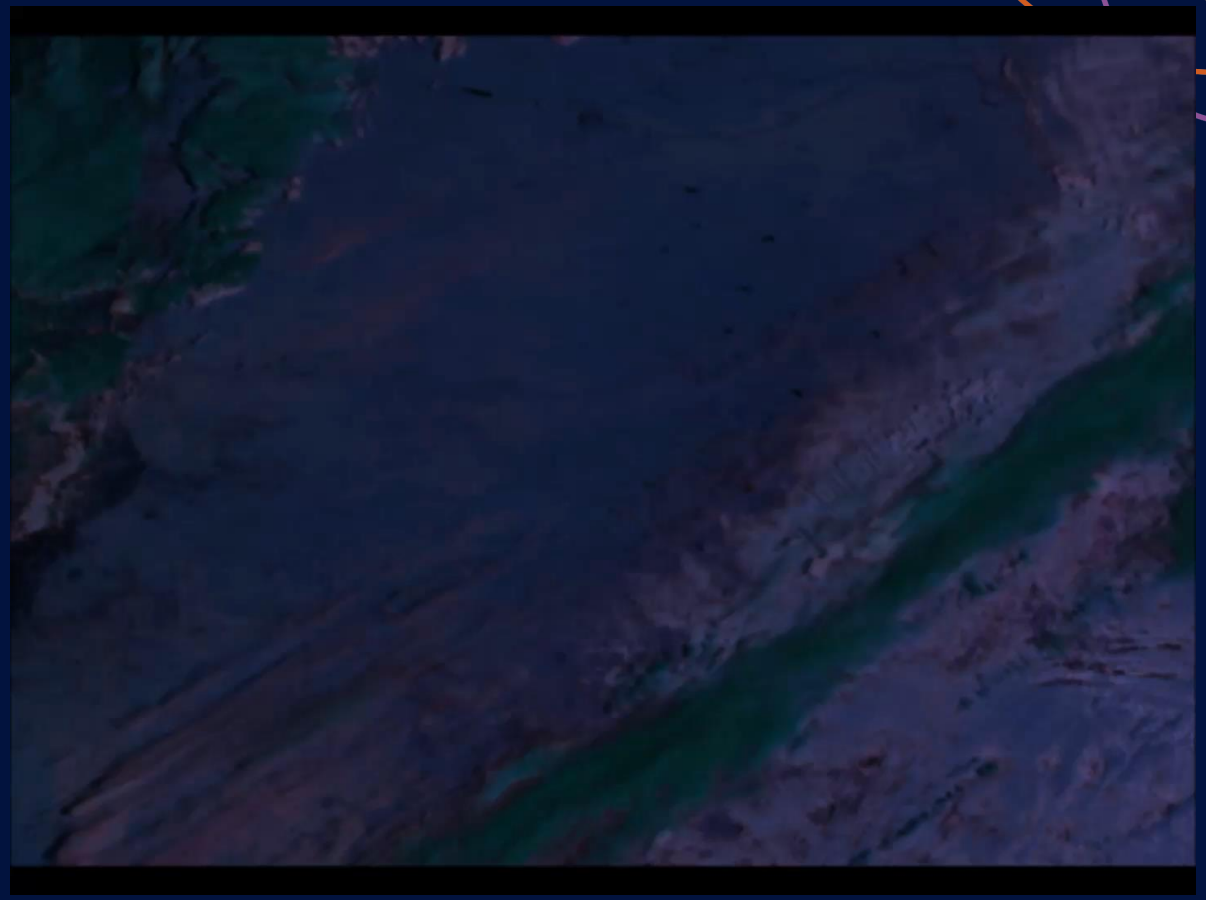
Motivation

- We are living in the era of million-acre wildfires
  - August Complex (2020) 1.0M acres
  - Dixie Fire (2021) 0.96M acres
- Fires are large and hot enough to create their own weather
  - Extreme fire behavior
- Drought is creating a landscape that is more fire-prone
- Population growth across the Wildland-Urban Interface
  - Marshall Fire (2021)
- Need for high-resolution weather, fire, and smoke information

Oak Fire (Image credit: AP/Noah Berger)

Fire Behavior

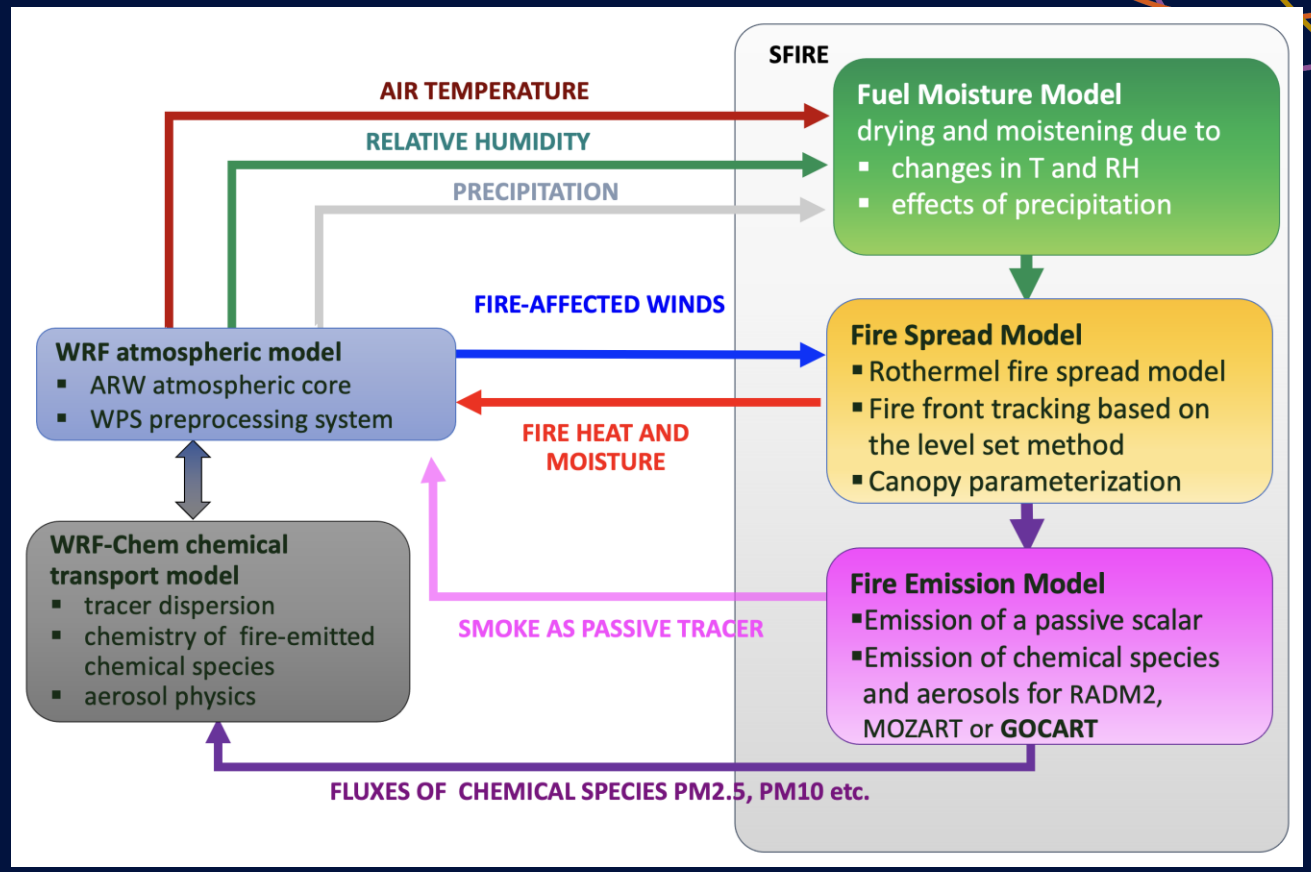
- Fuels
  - Fine fuels (grass, brush) can dry out very quickly
- Weather
  - Winds: Santa Ana, Diablo, Upslope, Downslope, Fronts, Convective Outflow
  - Temperature, Humidity, Precipitation
- Topography
  - Faster spread uphill - flames closer to fuels, and fuels preheated by fire



GOES-16 Fire Temperature RGB (Image credit: CIRA)

Coupled Modeling

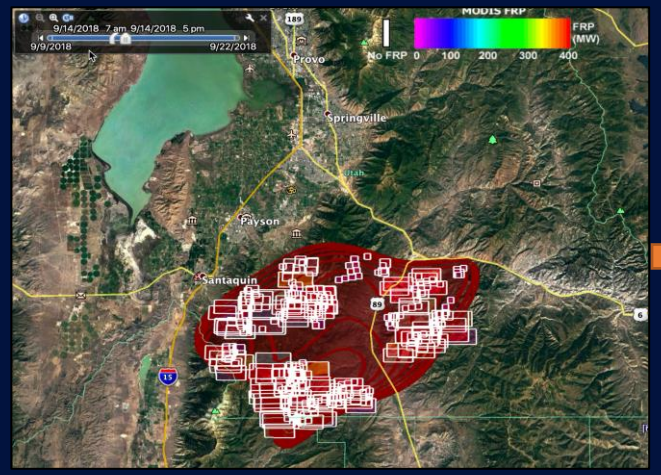
- Heat released from fire induces winds and updrafts, which in turn impact fire behavior
  - Rate of spread
  - Pyro-convection, fire whirls
- Fire-modified weather alters fuel moisture
  - Fuel drying, wetting
- Resolved plume rise dynamics
- Fuels converted to smoke emissions



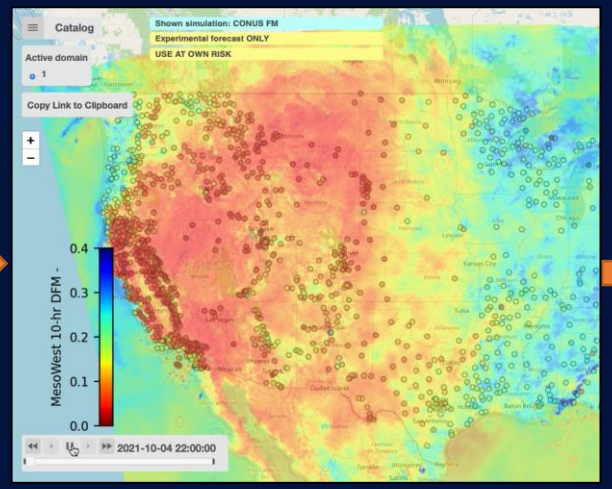
WRF-SFIRE Modeling System

Satellite Observations

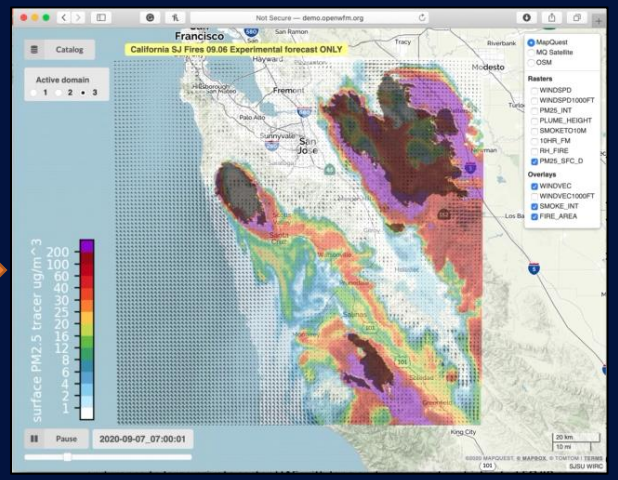
- Satellite observations are often the only information in the early critical hours of a new fire
- WRF-SFIRE automated workflow ingests VIIRS, MODIS, and GOES active fire detections for initializing forecasts



Satellite Fire Detections



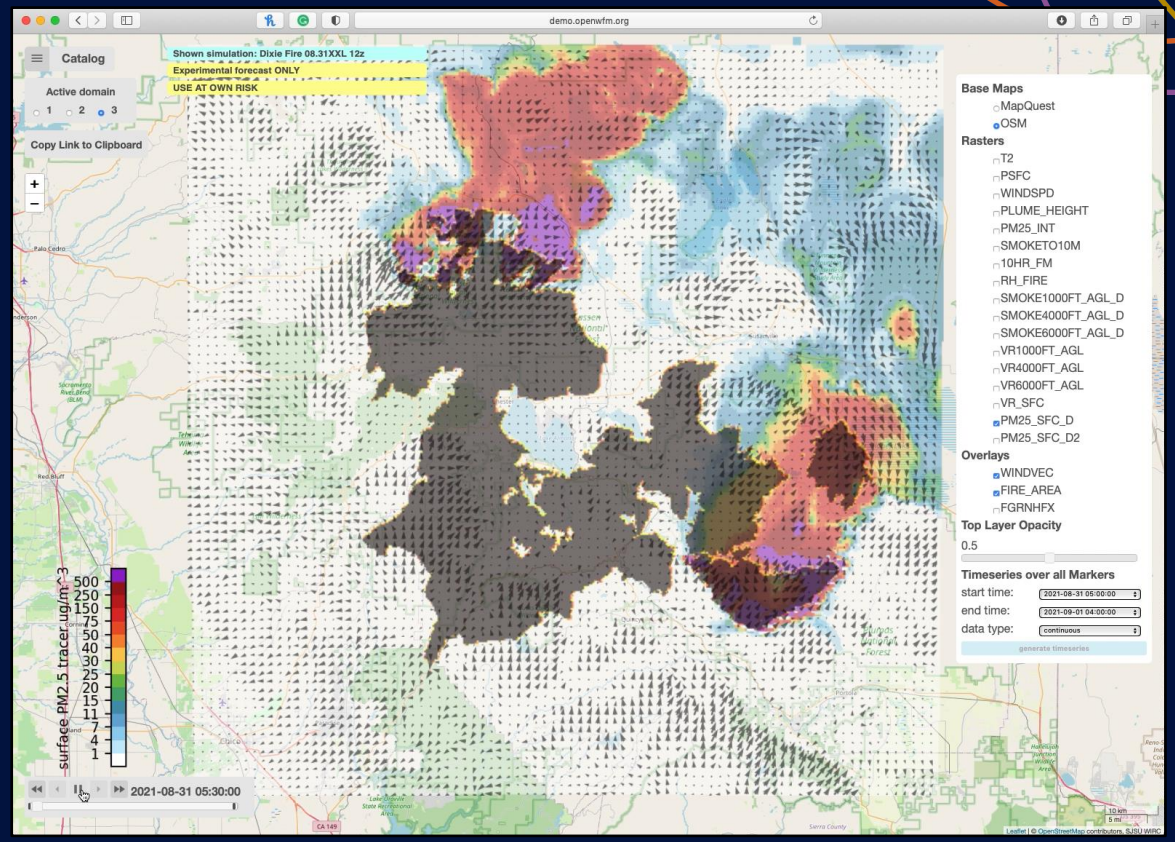
Fuel Moisture Estimates



Fire and Smoke Forecasts

Fire and Smoke Forecasts

- Delivery mechanisms
  - Web-based interface
  - NASA Disasters Portal
  - ArcGIS integration
  - Technosylva Fire Analyst
- End users and partners
  - U.S. Forest Service
  - Fire agencies (CAL FIRE)
  - CA National Guard
  - Air Resource Advisors
  - Incident Meteorologists



Dixie Fire Forecast, August 2021

Conclusions

- There is an increasing need for high-resolution fire, smoke, and weather information
- Coupled fire-atmosphere-fuel-smoke models will be essential to meeting those needs
- The WRF-SFIRE system demonstrates the possibilities for the next generation of operational modeling systems

CIRA Connecting Models and Observations

SJSU SAN JOSÉ STATE UNIVERSITY

University of Colorado Denver CU IN THE CITY

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

Global Economic Disruption Index (GEDI)

Charles K. Huyck & team, ImageCat

CIESIN

GEO GROUP ON EARTH OBSERVATIONS

ImageCat

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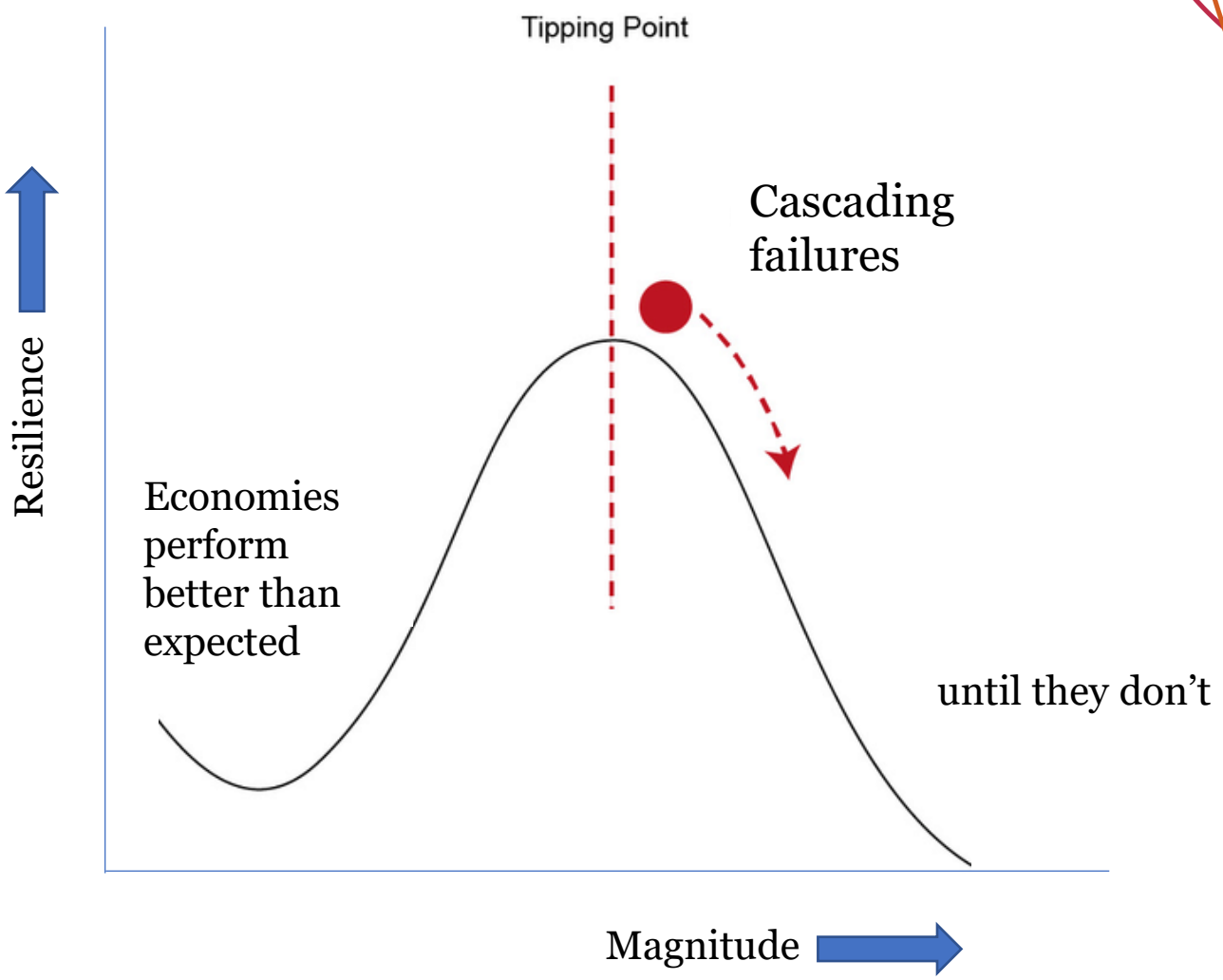
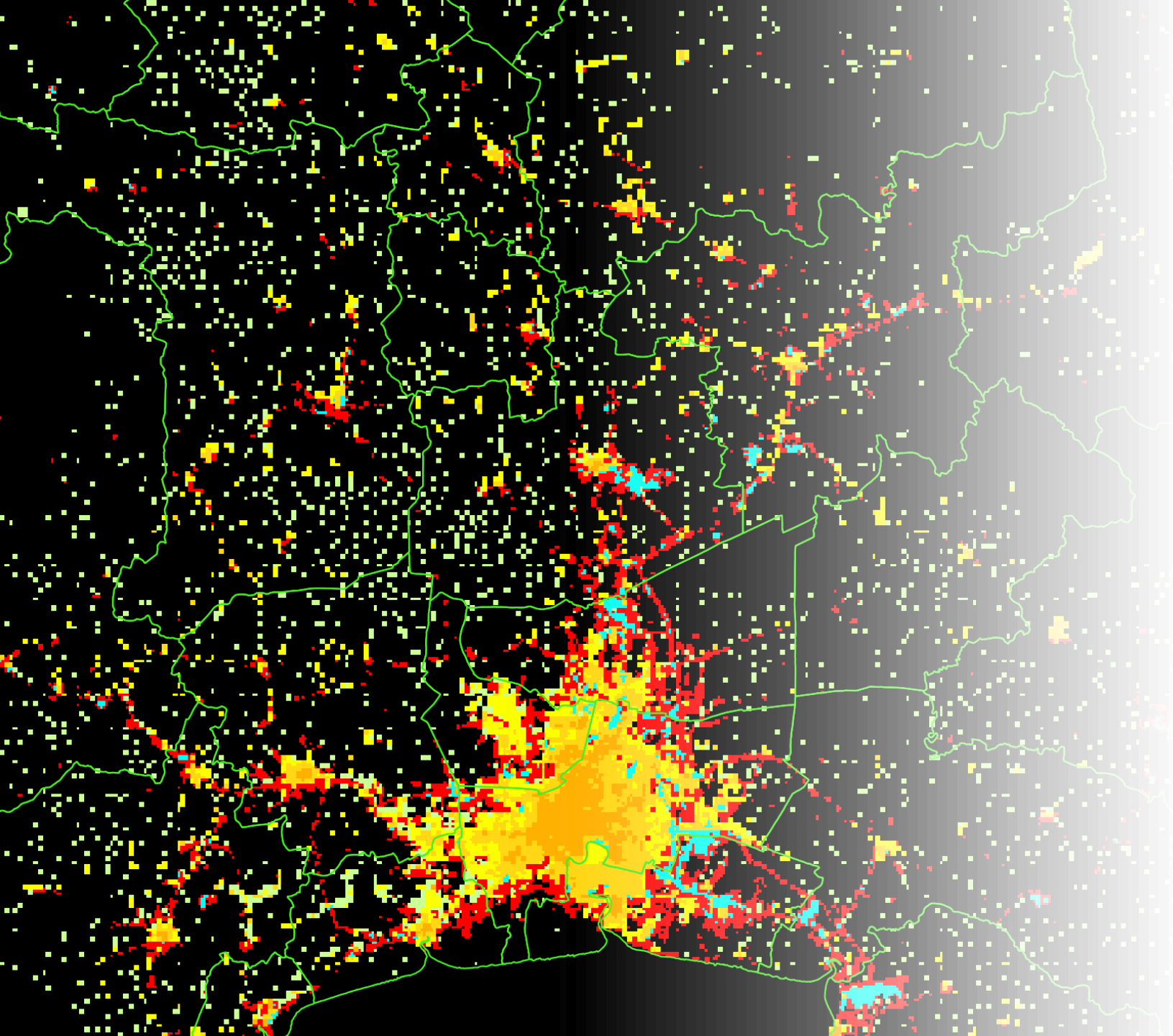
Disasters have a "tipping point"



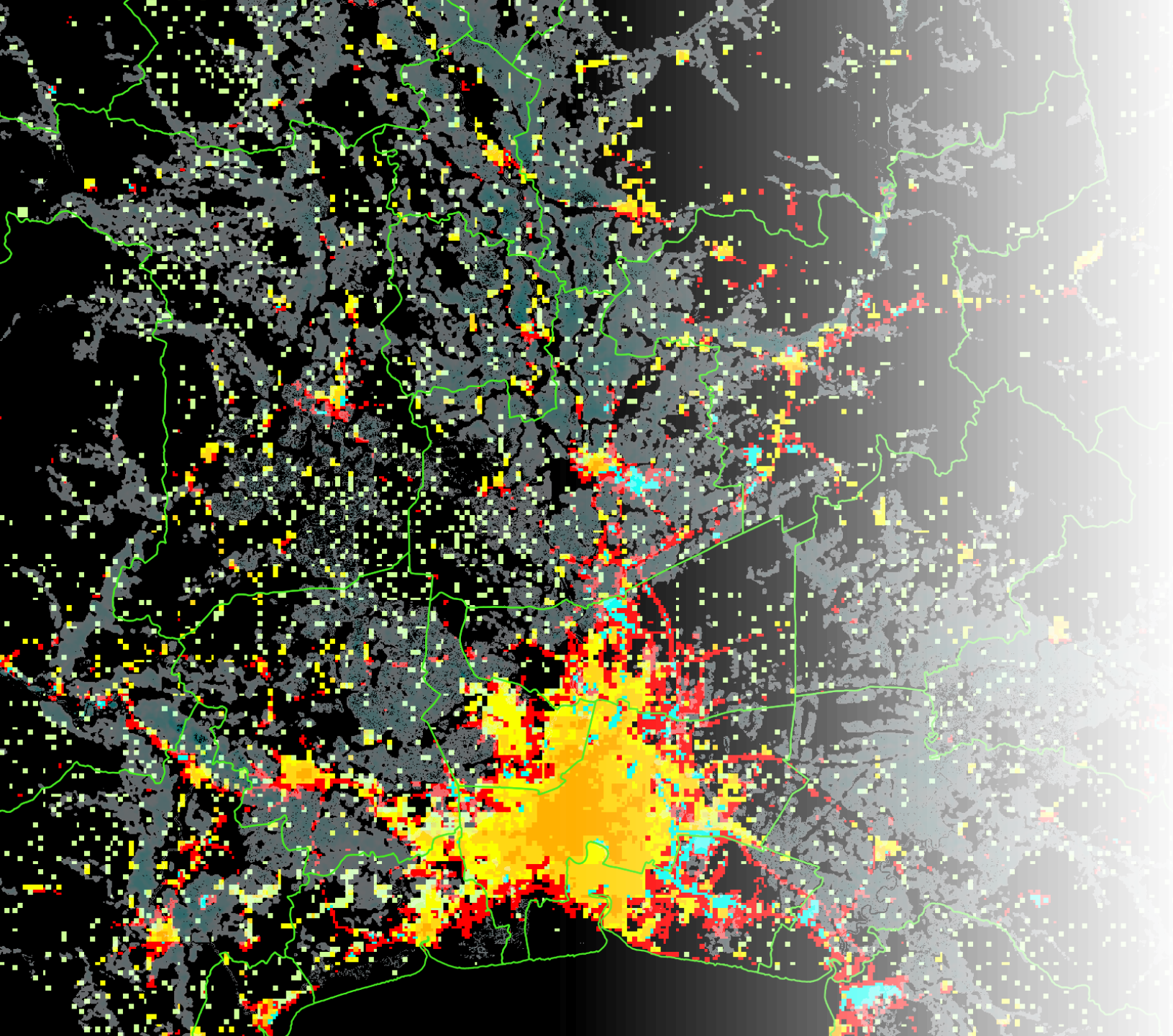
Can EO be used to characterize the potential for long term economic disruption?

Bangkok, Thailand

Regions of production are generally visible



are detectable through image segmentation

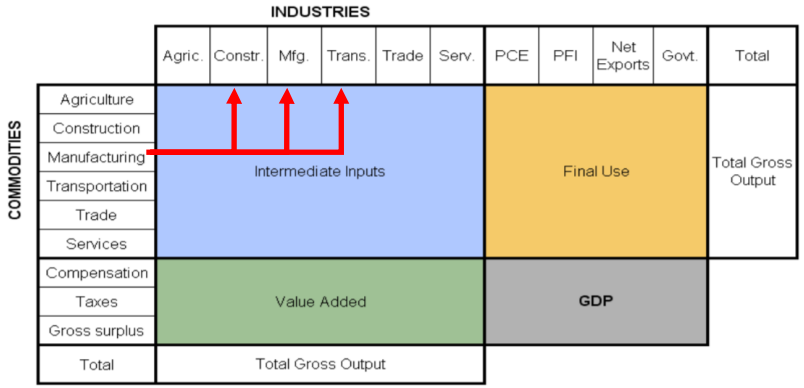


can then be overlaid

with global hazard datasets to identify problematic areas

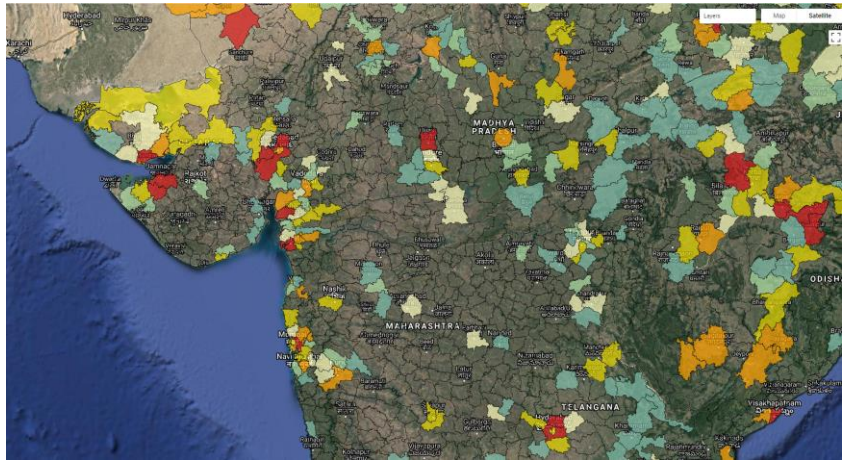
and combined with regional vulnerability and hazard to indicate risk, potential supply chain impacts

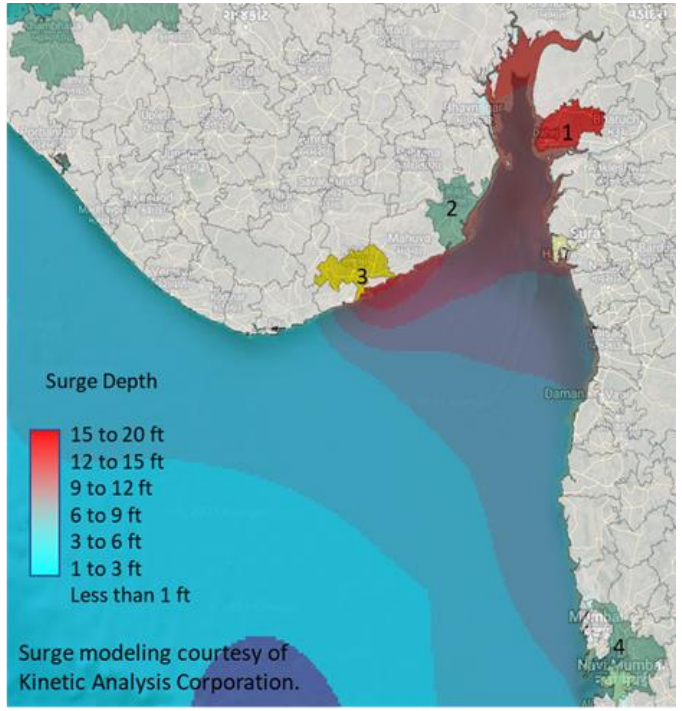
Reduced production can be fed into regional economic models to identify where localized losses may trigger cascading impacts.



India pilot

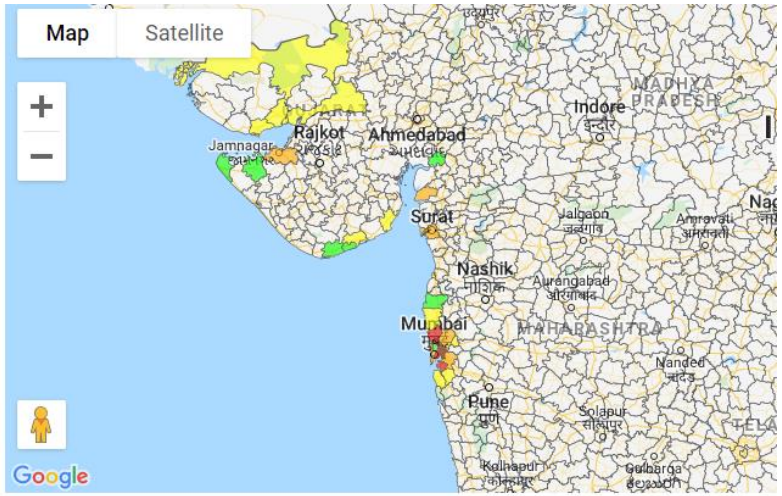
Probabilistic (flooding)





Impending events (typhoon)

Climate conditioned (coastal surge)



Global Economic Disruption Index (GEDI)

Rank	*Description*	*Restoration*
I	Slight	Rapid restoration on the order of a few hours to a few days expected
II	Moderate	Economic activities typically resume in less than a week
III	Major	Economic activities are likely to rebound on the order of weeks.
IV	Severe	Economic rebound expected after months of restoration.
V	Catastrophic	Major disruption in economic activity requires years of recovery.

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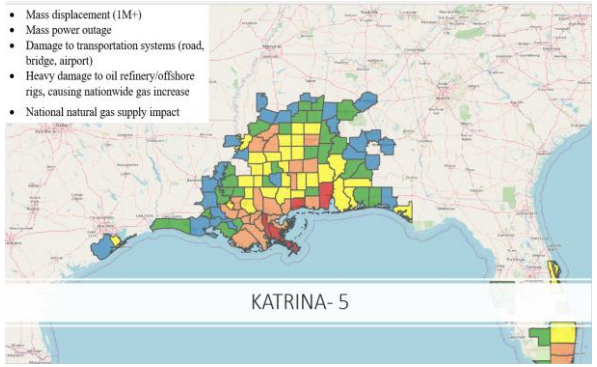

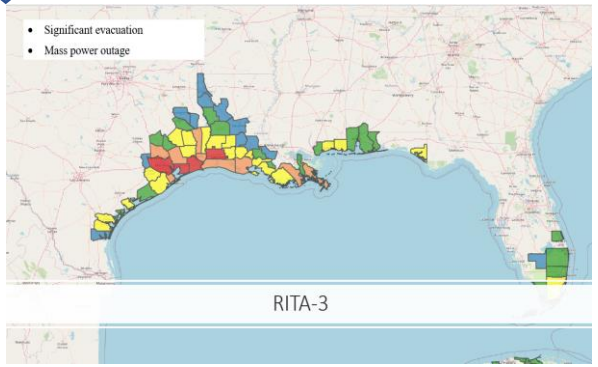

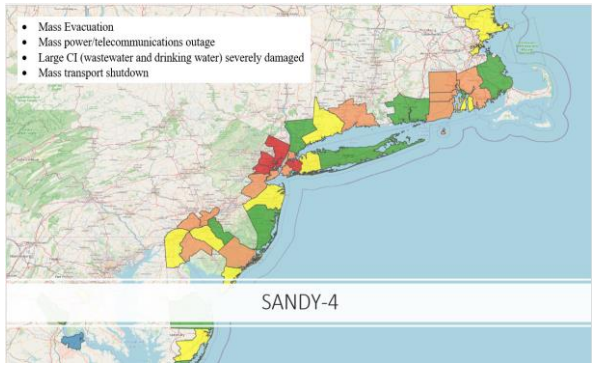

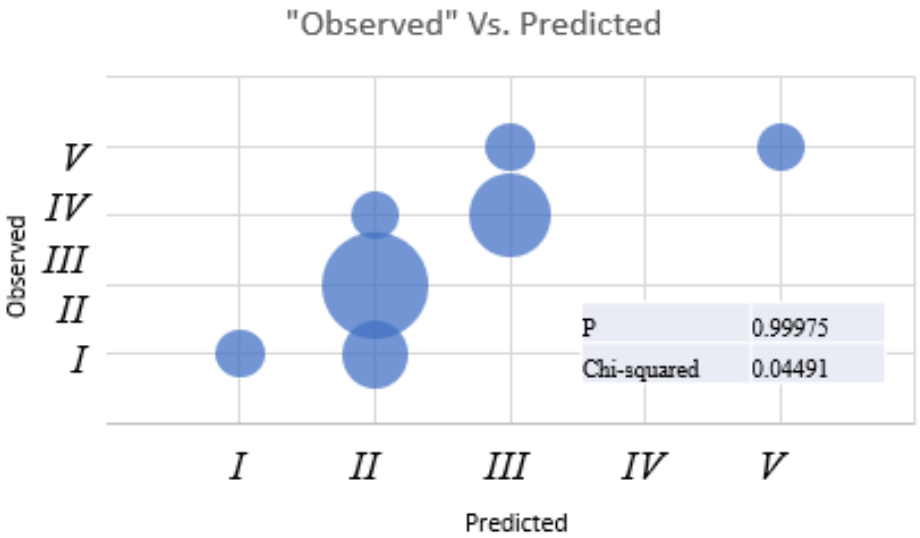

Applications

- Real time advisories (i.e. USGS Shakecast)
- Global corporate risk- CRE, investment portfolios
- Extension of CAT modeling tools
- Prioritization of infrastructure hardening and development projects

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Tornadoes: Damage and Impact

Eric Fielding

Jet Propulsion Laboratory
California Institute of Technology

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APPLICATIONS WEEK 2022

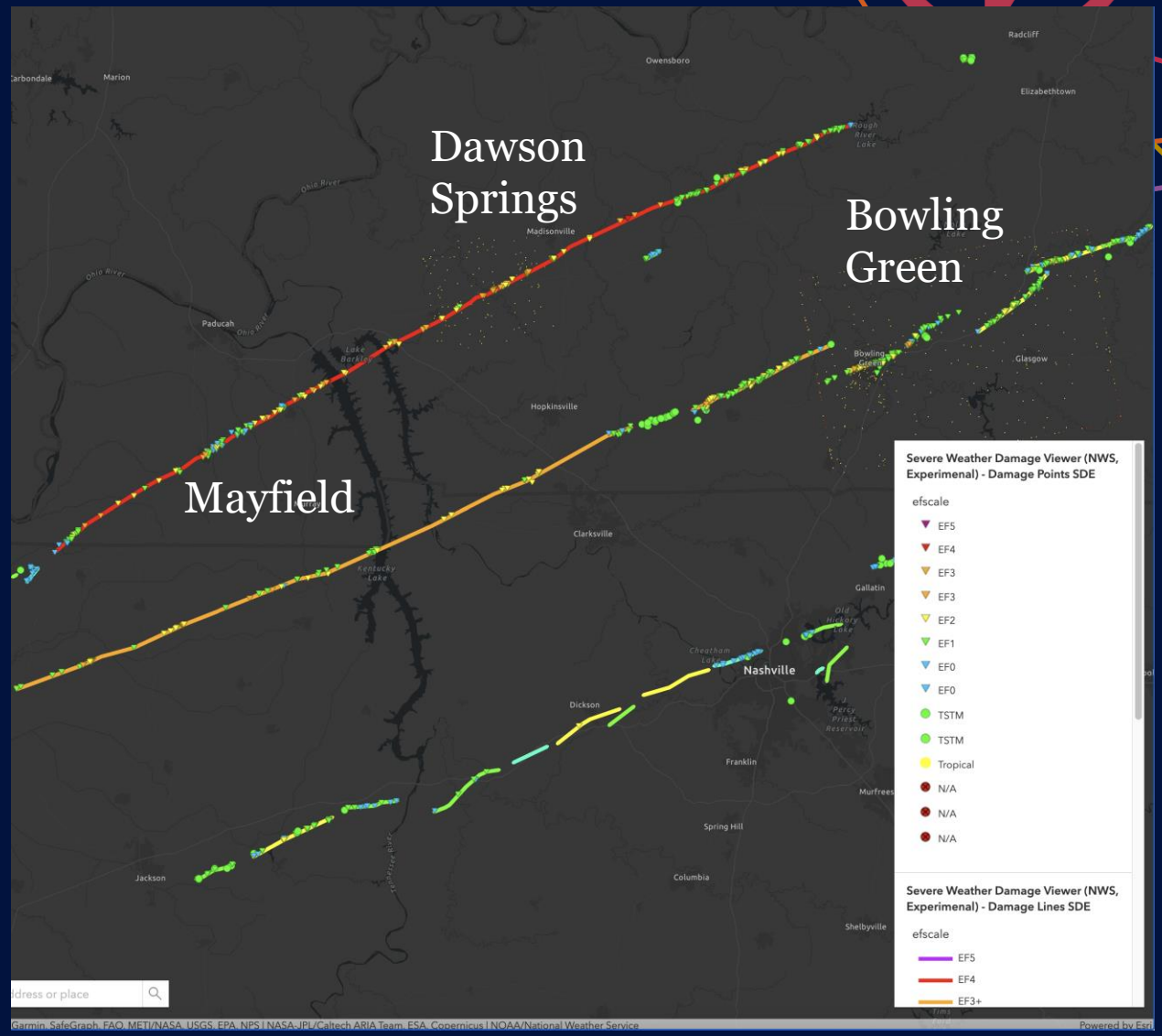
Damage Proxy Maps from Radar

- Estimated from satellite radar images
- Radar reflects strongly from buildings and other infrastructure
- Change in reflection coherence is likely damage
- Wide variety of damage causes: earthquakes, wind, explosions

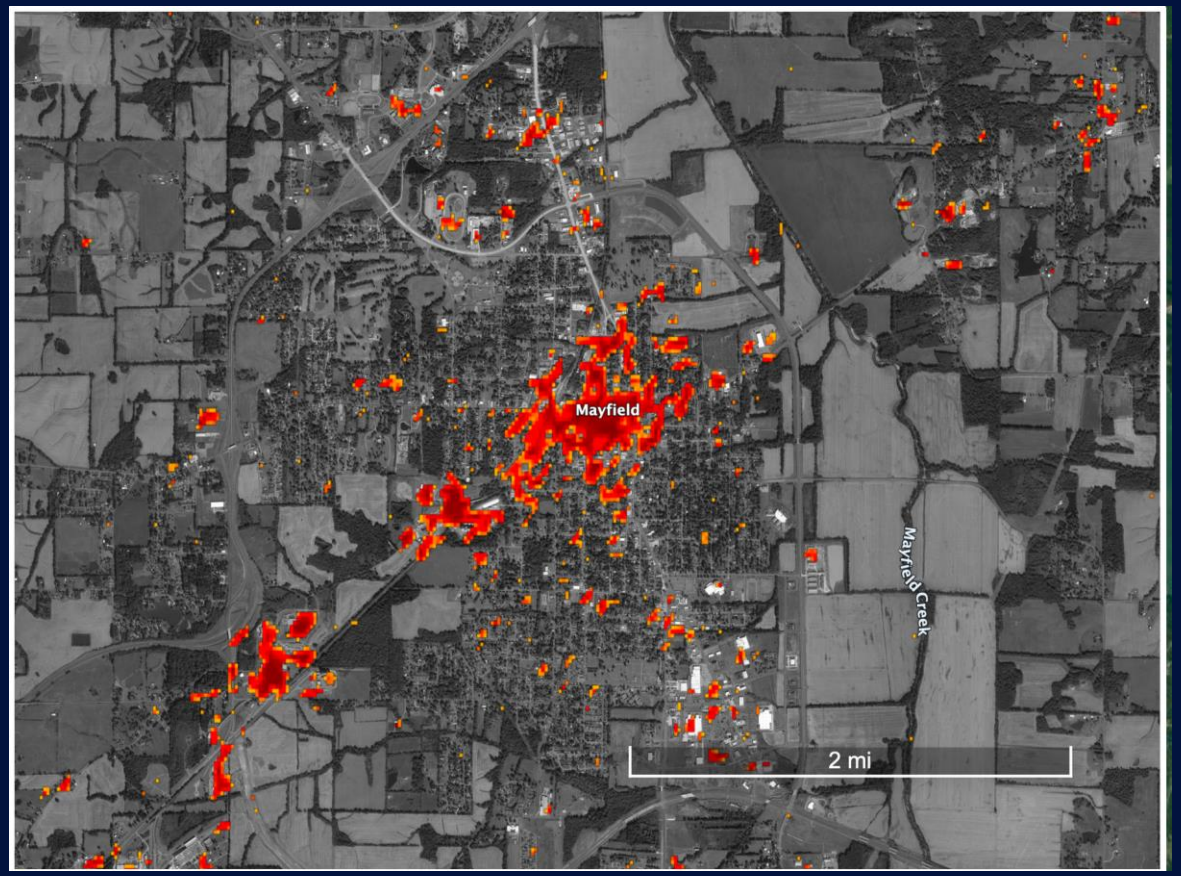
- European Copernicus Sentinel-1 covers most areas every 12 days
- NISAR will provide even better coherent radar coverage

December 2021 Tornado Outbreak

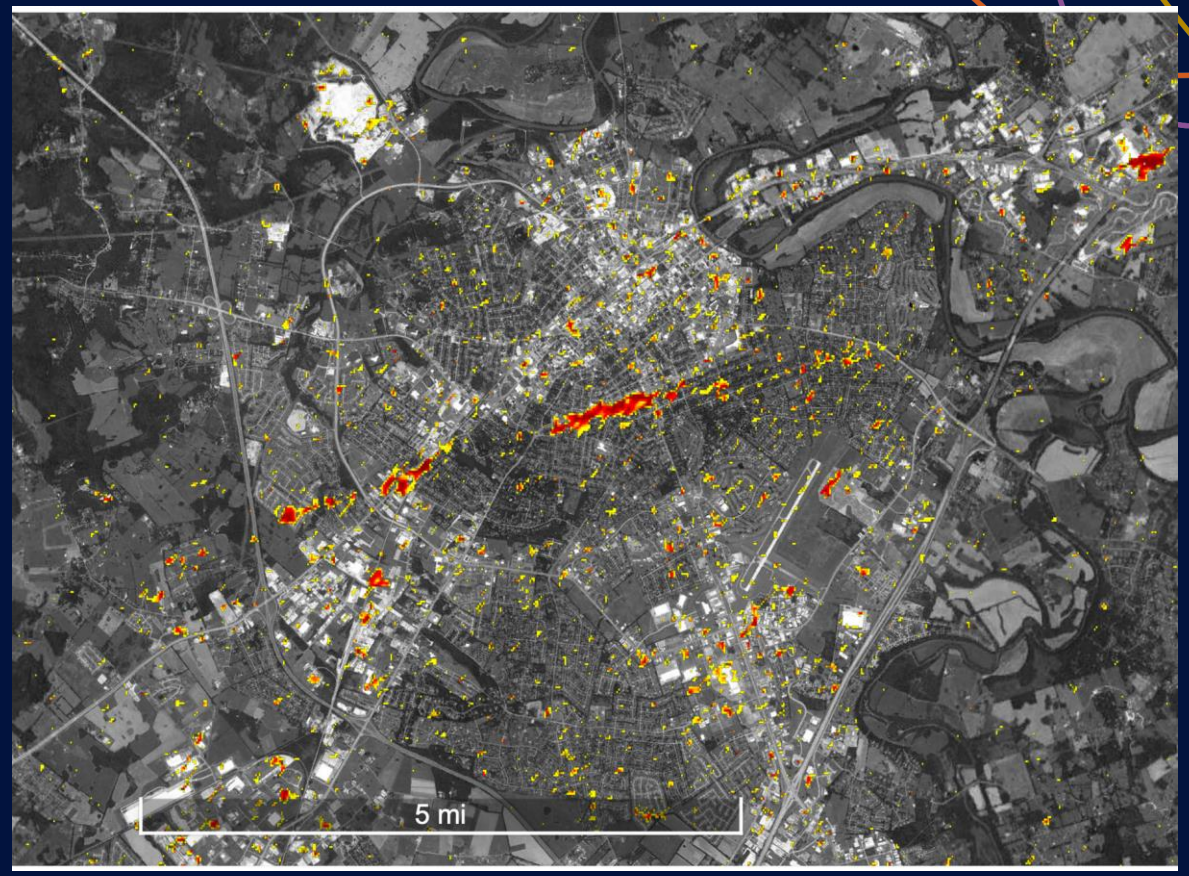
- Night December 10–11, 2021
- Tornadoes reported in 9 states
- Heavy damage western Kentucky
- Tornado track 165 miles long mostly EF4
- Many other tornadoes



Tornado Damage Proxy Maps



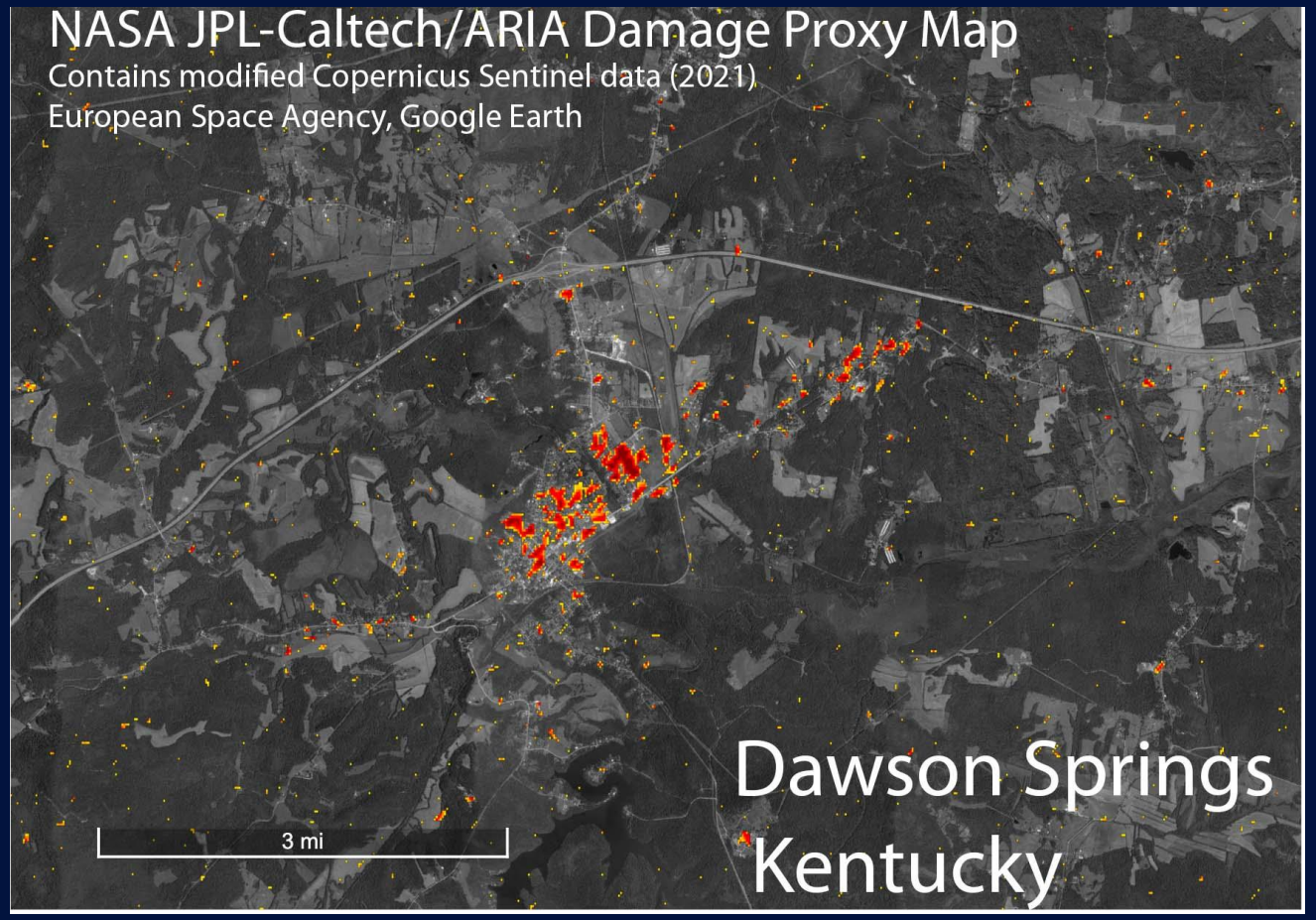
Mayfield, Kentucky

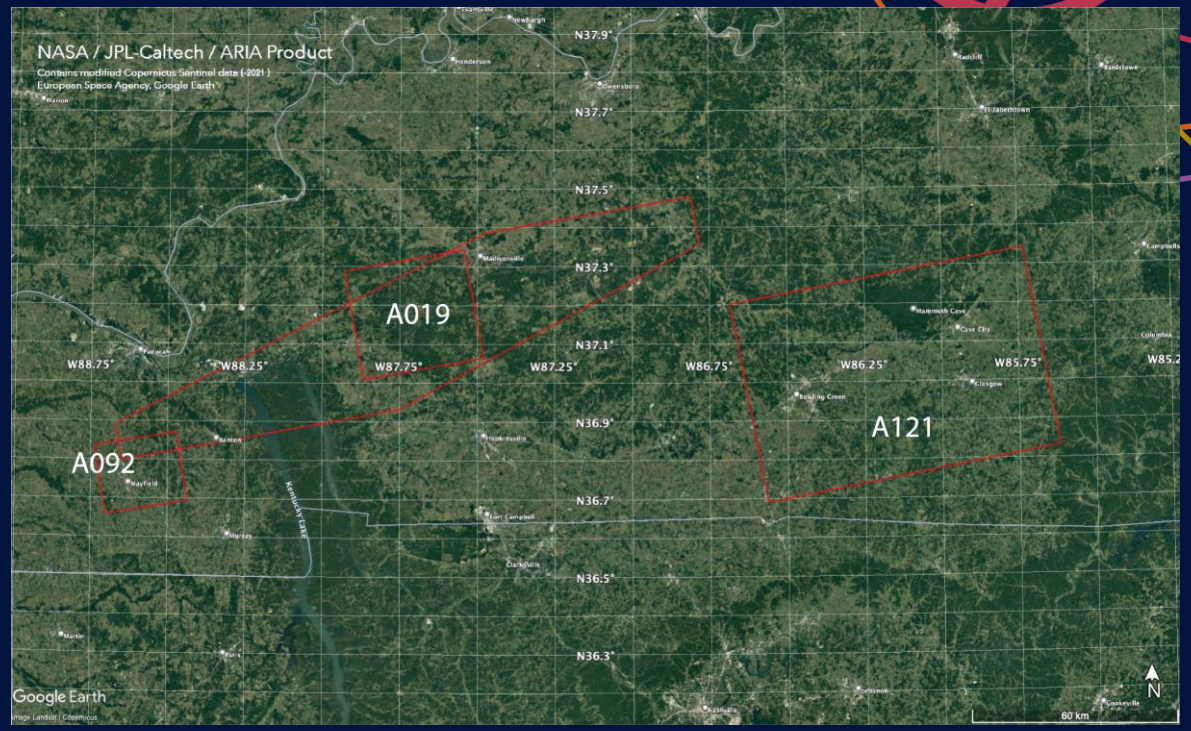


Bowling Green

Contains modified Copernicus Sentinel-1 data (2021)

Tornado Damage Proxy Maps





Large area affected required 3 tracks of Sentinel-1 data

Applied Remote Sensing Training (ARSET)

Humanitarian Applications Using NASA Earth Observations

Sean McCartney

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APPLICATIONS WEEK 2022

Why do we need a training on remote sensing applications in humanitarian settings?

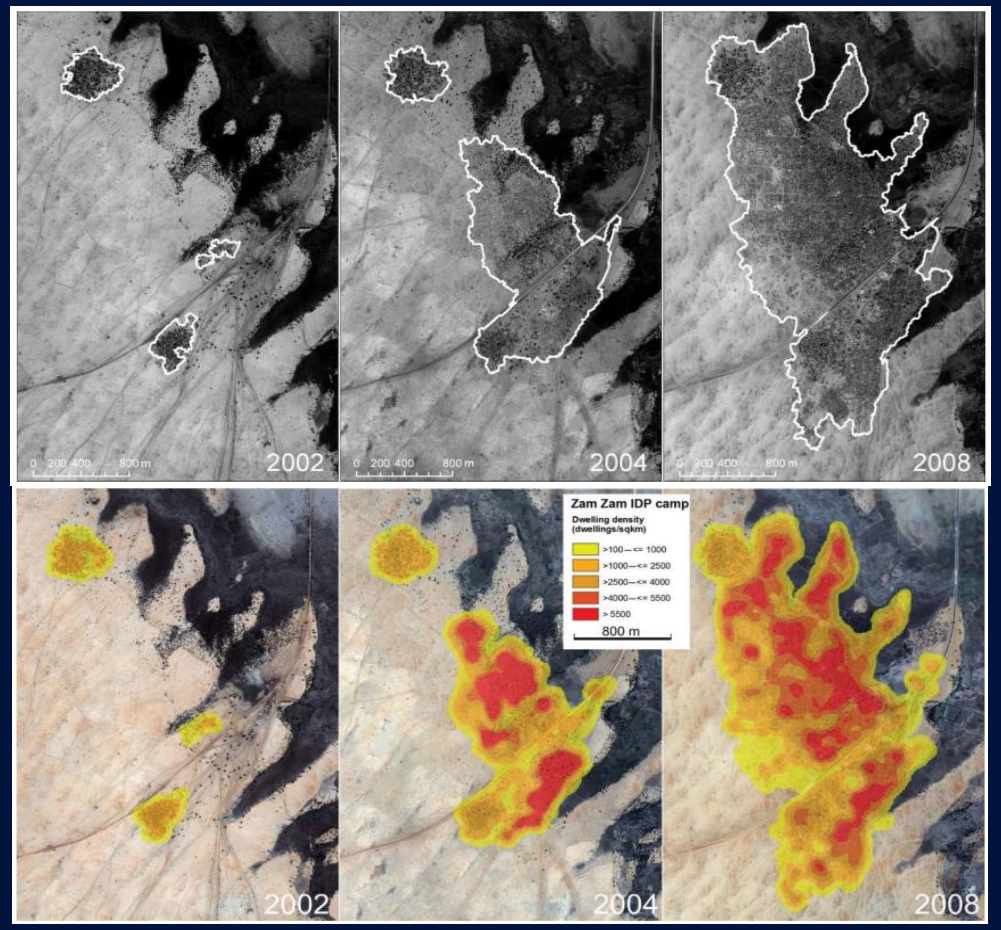
- Any remote sensing approach that is effective for mapping environmental condition or change outside of a humanitarian setting should still be effective (to some extent) in a humanitarian setting.

Mapping Refugee Settlement Growth and Population Change

- 73% of refugees seek asylum in neighboring countries.

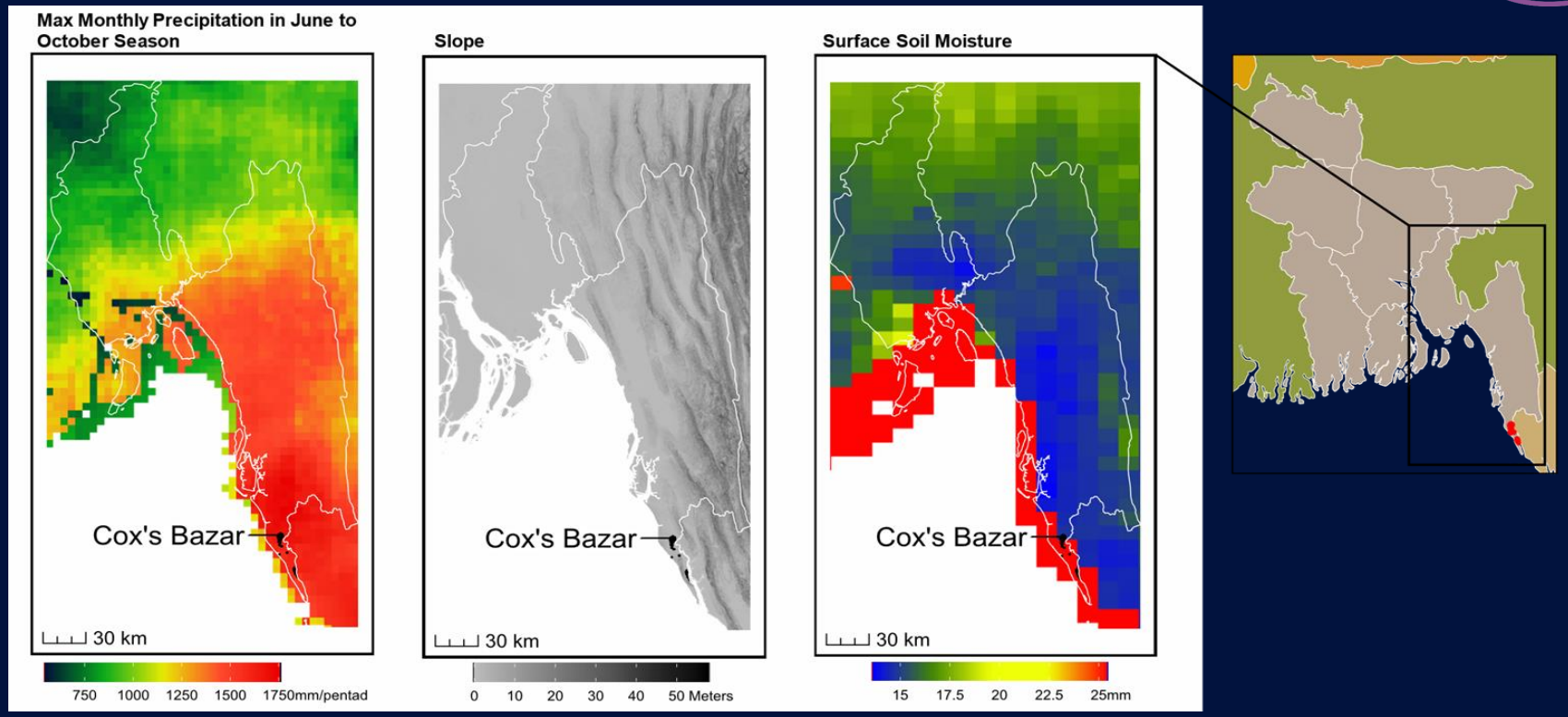
Satellite remote sensing data are uniquely valuable for monitoring humanitarian conditions at refugee settlements.

- Satellites are not inhibited by the limited physical access to or remote locations that typify many refugee settlements.
- Geographically expansive coverage means that we can contextualize conditions in refugee settlements within the region.



Gauging climate disaster risk in refugee settings means understanding how exposure, social vulnerability, and weather and climate events interact.

- Calculate the relative exposure of study refugee camps using a uniform weighting scheme.



Gauging climate disaster risk in refugee settings means understanding how exposure, social vulnerability, and weather and climate events interact.

- Action can be taken if risk is understood – and if there are standard operating procedures to act if a shift (increase) of that risk is identified in forecasts.

Open Science: Disasters Mapping Portal

NASA Earth Applied Sciences Disasters Program

Garrett Layne

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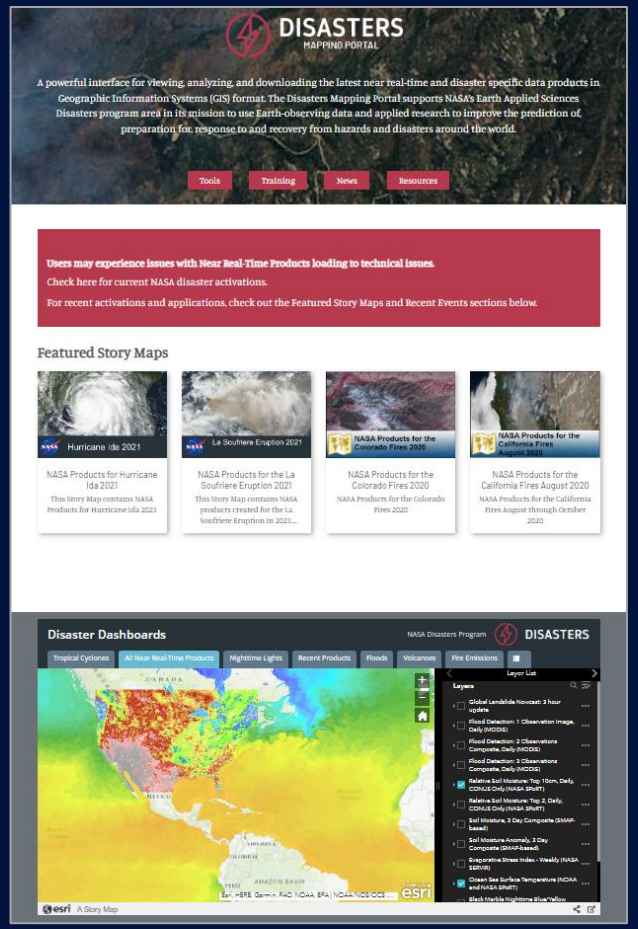
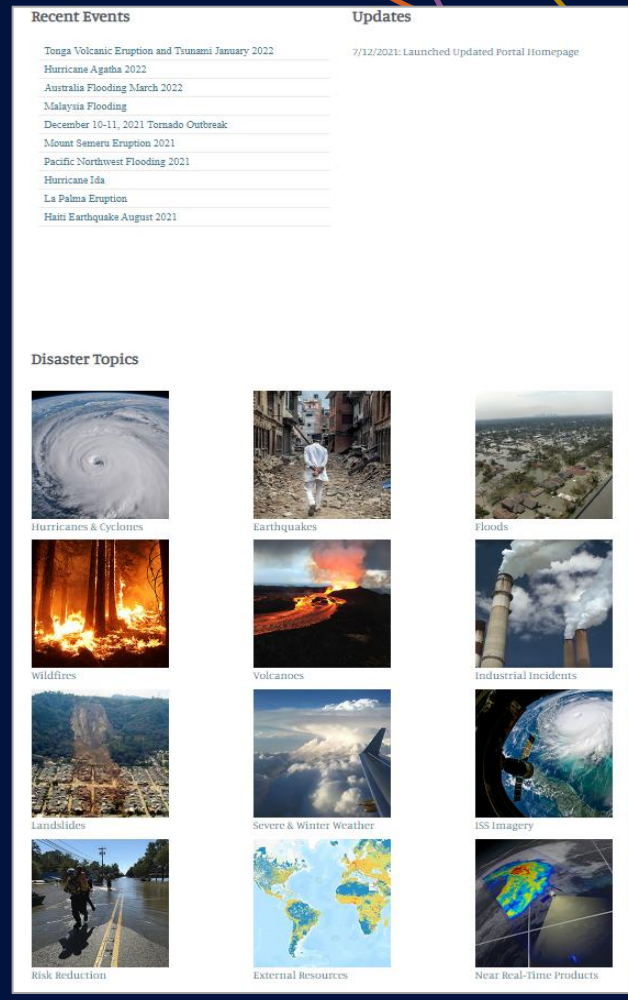
What is the NASA Disasters Mapping Portal?

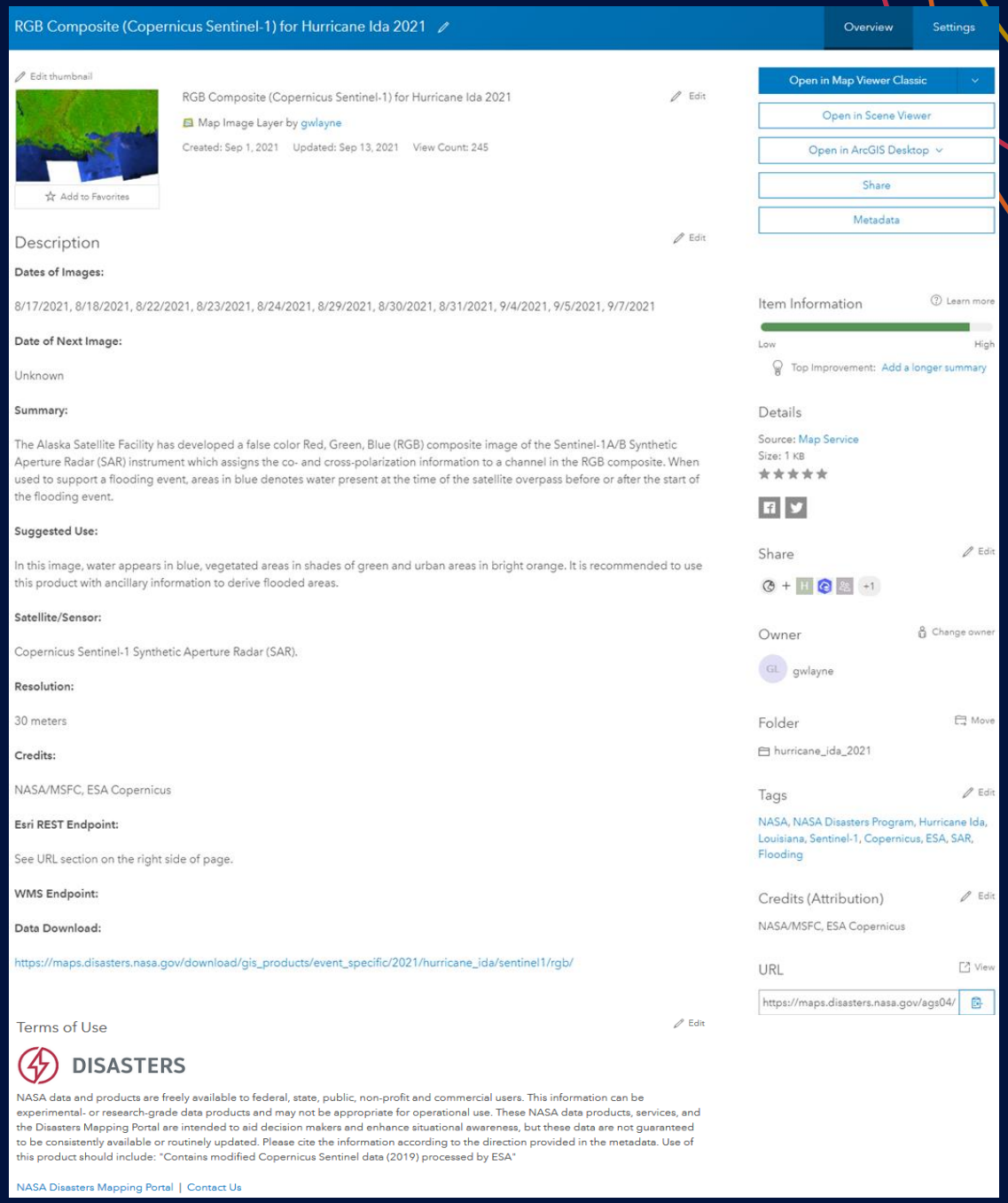
- **The hub of geospatially enabled NASA disaster products**
  - Event-based and Near-real time products
- **The proving ground to make NASA Earth Science data accessible and discoverable to non-science users and experienced practitioners**
  - All data is free and openly available without any login requirements – promoting open science and innovation
- **An interoperable platform where uniform format allows easy ingestion by disaster managers, humanitarian relief, other stakeholders, and the public**
- **The collaboration environment where Story Maps and Applications to demonstrate how products can be synthesized and used for decision support**
  - Every product has REST and WMS endpoints





Accessible Data Descriptions

- Date of Image(s)
- Summary
- Suggested Usage
- Satellite/Sensor
- Credits
- REST Endpoint
- WMS Endpoint
- Data Download Link
- Terms of Use
  - 100% Free To Access
  - Open To All Users
- Contact Us link



RGB Composite (Copernicus Sentinel-1) for Hurricane Ida 2021

Overview | Settings

Edit thumbnail

Add to Favorites

RGB Composite (Copernicus Sentinel-1) for Hurricane Ida 2021

Map Image Layer by gwlayne

Created: Sep 1, 2021 Updated: Sep 13, 2021 View Count: 245

Open in Map Viewer Classic

Open in Scene Viewer

Open in ArcGIS Desktop

Share

Metadata

Description

Dates of Images:

8/17/2021, 8/18/2021, 8/22/2021, 8/23/2021, 8/24/2021, 8/29/2021, 8/30/2021, 8/31/2021, 9/4/2021, 9/5/2021, 9/7/2021

Date of Next Image:

Unknown

Summary:

The Alaska Satellite Facility has developed a false color Red, Green, Blue (RGB) composite image of the Sentinel-1A/B Synthetic Aperture Radar (SAR) instrument which assigns the co- and cross-polarization information to a channel in the RGB composite. When used to support a flooding event, areas in blue denotes water present at the time of the satellite overpass before or after the start of the flooding event.

Suggested Use:

In this image, water appears in blue, vegetated areas in shades of green and urban areas in bright orange. It is recommended to use this product with ancillary information to derive flooded areas.

Satellite/Sensor:

Copernicus Sentinel-1 Synthetic Aperture Radar (SAR).

Resolution:

30 meters

Credits:

NASA/MSFC, ESA Copernicus

Esri REST Endpoint:

See URL section on the right side of page.

WMS Endpoint:

Data Download:

https://maps.disasters.nasa.gov/download/gis_products/event_specific/2021/hurricane_ida/sentinel1/rgb/

Terms of Use

DISASTERS

NASA data and products are freely available to federal, state, public, non-profit and commercial users. This information can be experimental- or research-grade data products and may not be appropriate for operational use. These NASA data products, services, and the Disasters Mapping Portal are intended to aid decision makers and enhance situational awareness, but these data are not guaranteed to be consistently available or routinely updated. Please cite the information according to the direction provided in the metadata. Use of this product should include: "Contains modified Copernicus Sentinel data (2019) processed by ESA"

NASA Disasters Mapping Portal | Contact Us

Item Information

Low High

Top Improvement: Add a longer summary

Details

Source: Map Service

Size: 1 KB

Share

Owner

gwlayne

Folder

hurricane_ida_2021

Tags

NASA, NASA Disasters Program, Hurricane Ida, Louisiana, Sentinel-1, Copernicus, ESA, SAR, Flooding

Credits (Attribution)

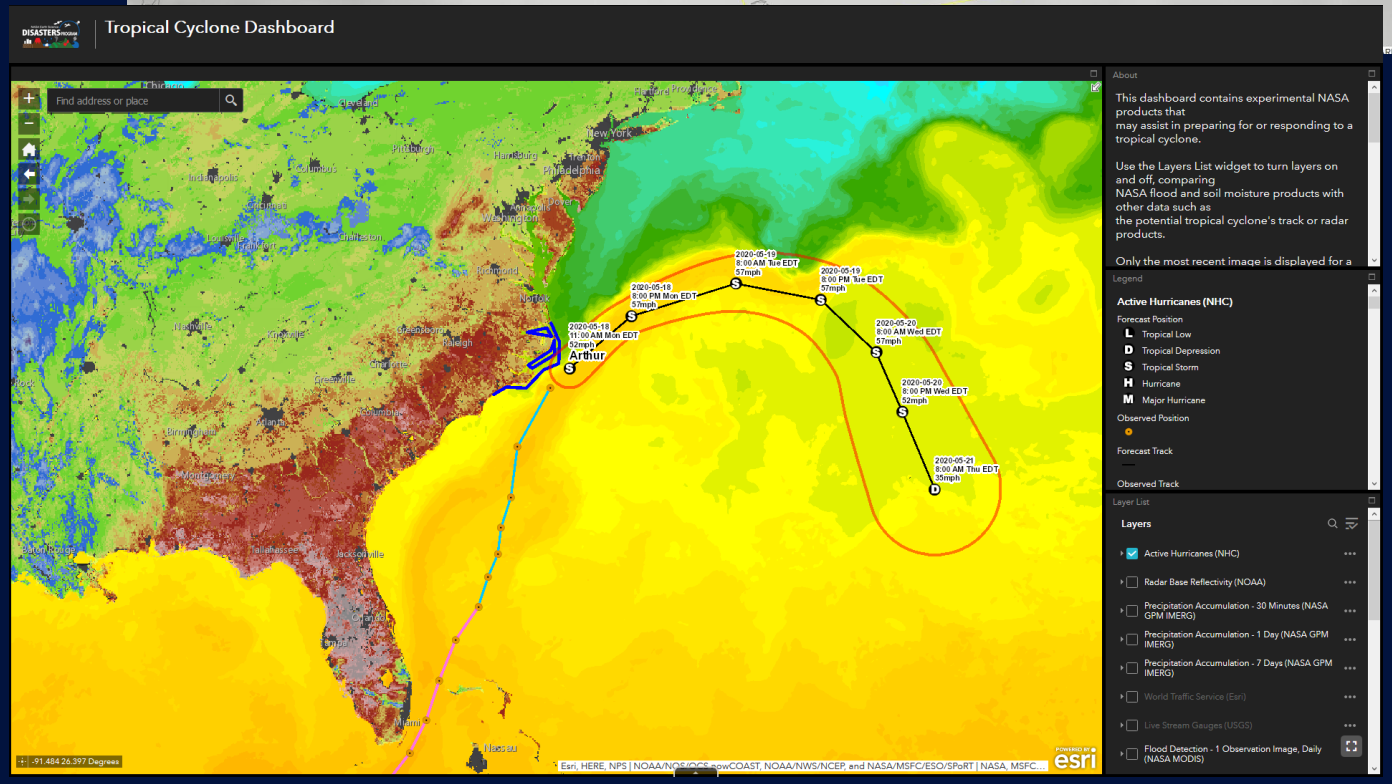
NASA/MSFC, ESA Copernicus

URL

https://maps.disasters.nasa.gov/ags04/

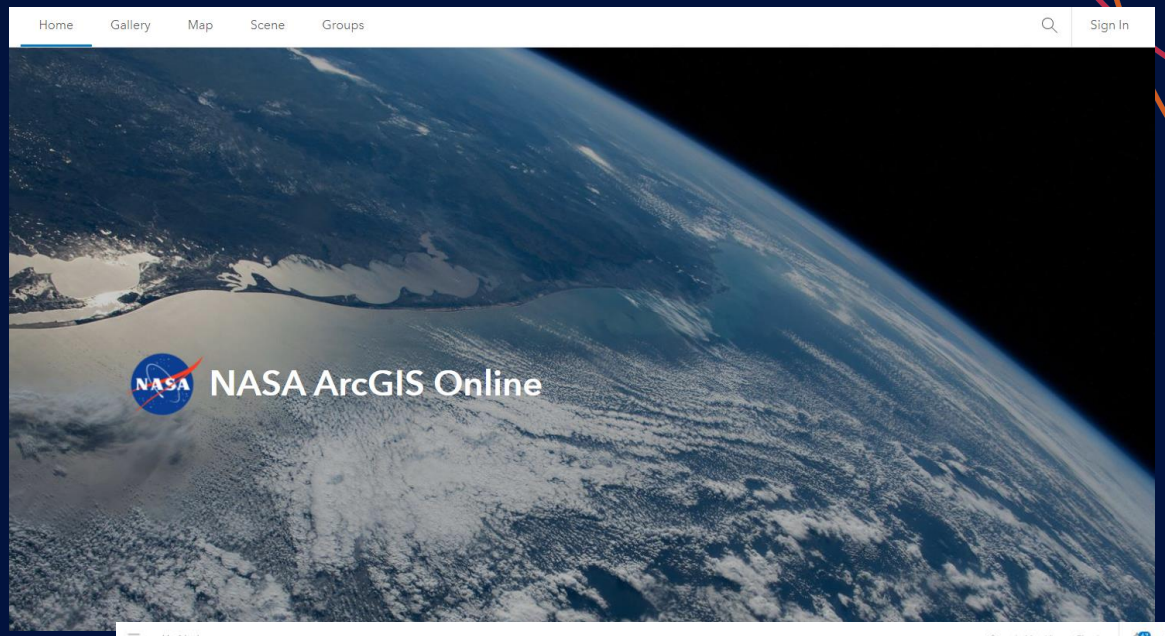
Interactive Web Applications and Dashboards

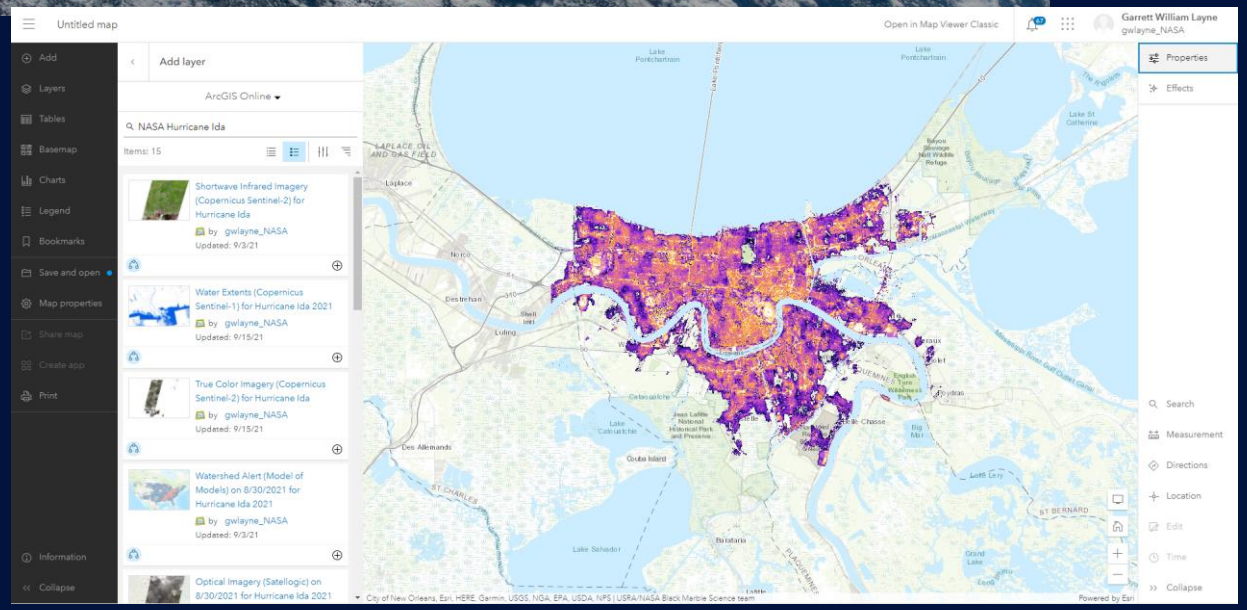
- Introduce less familiar satellite data
- Help explain more complex products
- Show ways to use NASA data
- Demonstrate ways to combine NASA data with other sources
  - Layers from NASA, NOAA, USGS



ArcGIS Online and Open Data

- Most data on the Disasters Portal is available through NASA's ArcGIS Online (AGOL)
  - https://nasa.maps.arcgis.com
- Discoverable through Open Data search engines





Thank you

Up Next: Getting Involved