# Listening to the Land and Lived Experiences of Disasters

Leveraging NASA Earth Observations to Support Community Disaster Management and Advance Environmental Justice

NASA DEVELOP - Virtual EJ | Julianne Liu | Emma Cooper | Keegan Kessler | Natasha Johnson-Griffin

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## Welcome!

Welcome to the **DEVELOP Environmental Justice Disasters Team StoryMap**!

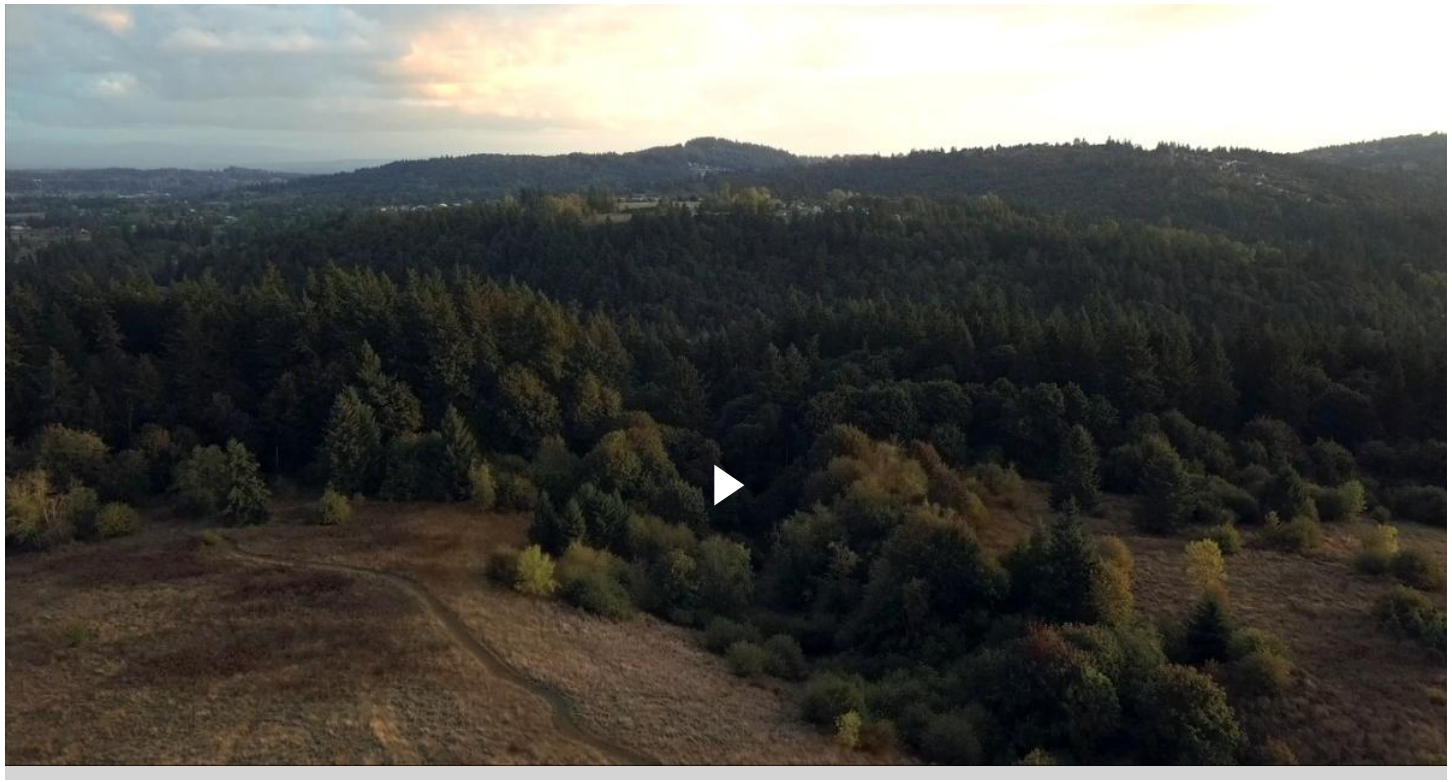
This is one of the culminating products of our 10-week project in which we explored **how NASA Earth observations and geospatial analyses** could **support organizations working towards environmental justice** as well as **equitable disaster management and risk reduction**. We learned about the **intersections of environmental justice, disasters, and remote sensing** from an

extensive literature review and interviews with organizations who shared their priorities, needs, challenges, and dreams with us – **all of which are synthesized here**.

**Scroll down** to get started with our disaster-scape, or **navigate** to a certain section by **selecting a tab** right above this Welcome!

## Introduction

As you scroll down, please click the "**Unmute background audio**" and **make sure your sound is turned on** to be immersed in the disaster-scape through sound.



The geography of the United States lends itself to a beautiful range of landscapes, but this vastness is also presented with a diversity of **disasters**. Climate change is increasing the severity, frequency, and unpredictability of these disasters.

**Wildfires** and **drought** are ravaging the **West Coast**.

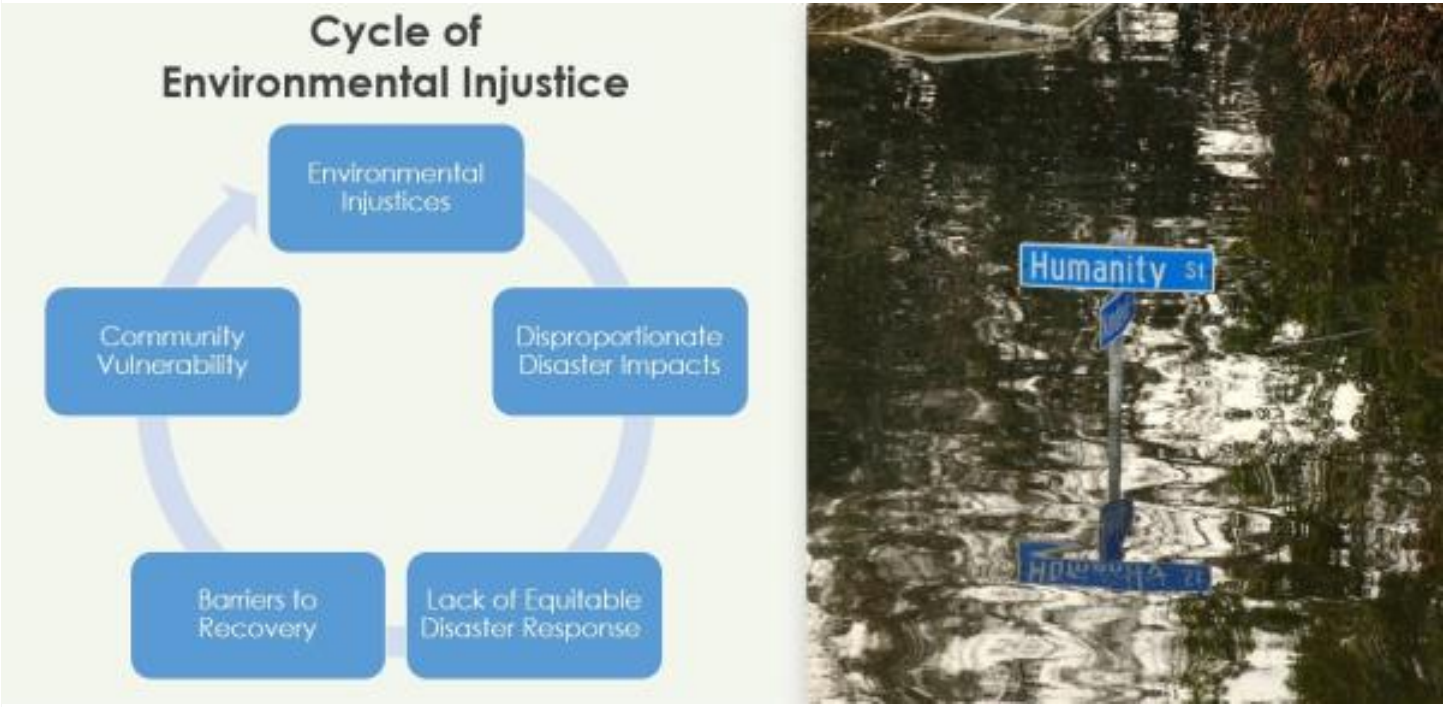
**Tornadoes** and **severe storms** are tearing through the **Midwest**.

**Hurricanes** and **flooding** are devastating the **Gulf Coast**.

**Unprecedented storms** and **extreme weather** are afflicting the **East Coast** and **Alaska**.

**Storm surges**, **landslides**, and **tsunamis** are affecting **coastal areas**, especially **Hawai'i**.

Notably, though, **people are not equally impacted** by these disasters.




**Communities of color, low-income communities,** and **linguistically-isolated communities** often experience a disproportionate burden of a disaster's impact, in addition to facing challenges and discrimination in disaster preparation and recovery (Flores et al., 2021; Davies et al., 2018; United Church of Christ, 1987). Furthermore, marginalized communities have historically been, and continue to be, excluded from decision-making processes.

These disparities have been created and reinforced by **disenfranchisement**, **disinvestment**, **discriminatory policies**, and other sources of **systemic inequality**.

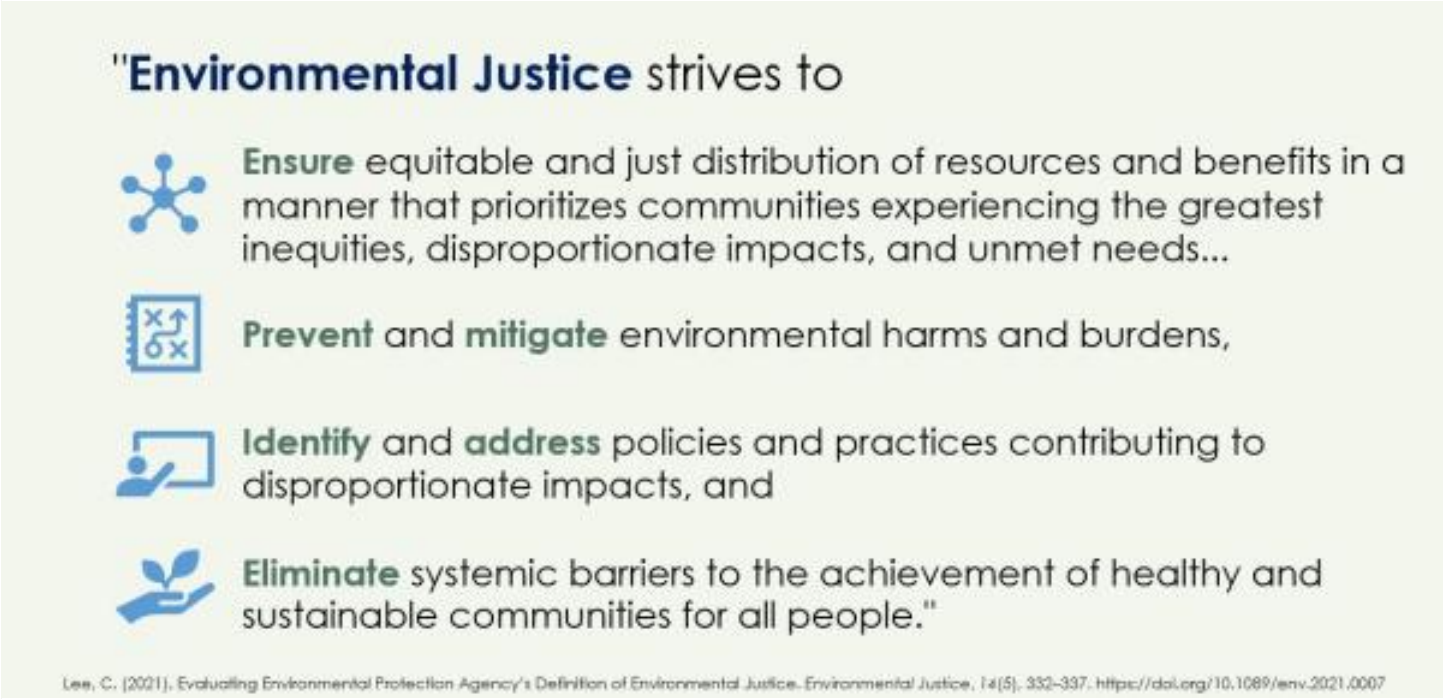

Inequities are not limited to disasters and are instead part of the overarching fabric of **Environmental Justice (EJ).**

EJ carries **many definitions and interpretations.** One of the most commonly cited is the U.S. Environmental Protection Agency (EPA)'s

definition, but, written over thirty years ago by the EPA's Office of Environmental Equity, it focuses on equity, rather than justice.

EJ trailblazer Charles Lee* recently proposed an **enhanced version of the EPA's definition** of EJ to center justice and emphasize the need for an **interdisciplinary, holistic approach to EJ**, featured on the right.

*Lee was active in EJ organizing at the nonviolent Warren County protests, among other key events in EJ, and is also the principal author of the United Church of Christ's groundbreaking "Toxic Wastes and Race in the United States" report (1987), coordinator of the first People of Color Environmental Leadership Summit, and contributor to Executive Order 12898. He is currently a lead policy advisor at the EPA.




Lee also proposes these additions to the EPA's definition of EJ to **more concretely outline** what EJ should look like.

**EJ centers,** and **is championed by, marginalized communities** seeking to regain autonomy over their health and environment.

It recognizes the **joint exploitation** of people and land, linking systemic economic, social, and political discrimination with disproportionate exposure to environmental hazards.

These hazards include, but are not limited to, the **proximity** and **experience** of natural disasters, **siting** of toxic waste facilities or

undesirable land uses, occupational **exposures** to chemicals and unsafe conditions, and **access** to green space and healthy, culturally appropriate food.


**The formal EJ movement** was organically and gradually grown over the second half of the 20th century by **grassroots activism** across the United States. EJ activists came from, and were inspired by, groups such as the Civil Rights, Anti-Toxics, and Labor movements; indigenous struggles; and academia (Cole and Foster, 2001).

Together, they fought for the guarantee of **healthy people and place**, fair and accurate **representation in decision making**, and the **right to self-determination**.


**The EJ movement continues today** as activists still work towards these goals, and many are **pushing forward action** in the realm of **disasters**.

## NASA DEVELOP


**NASA DEVELOP** is committed to supporting work in both EJ and disasters. This **applied science, capacity building program** collaborates with partners to identify how Earth observations (satellite-sourced data and imagery) can support their missions and address broader **environmental and public policy issues.** Teams provide geographic analyses and create tools to **empower partner**

**decision making** and **increase awareness** about how **Earth observations** can be used.

DEVELOP recently launched an initiative to **strengthen their EJ involvement** and **established the Virtual Environmental Justice office**. This led to the creation of the Environmental Justice - Disasters Needs Assessment project which has the goal to **understand the inequitable experience of disasters** in the US and

identify how Earth observations could **support organizations working towards equitable disaster management and EJ**.


*To achieve this, **the DEVELOP EJ Disasters team** connected with EJ and disaster organizations across the country and interviewed them to assess their needs and explore how DEVELOP can leverage geospatial science to advance EJ.*

## Disaster and EJ Organizations

In our landscape analysis, we identified **82 organizations whose work addresses disaster and/or EJ issues** (shown in Map 1 below). This revealed a spatial pattern in the distribution of organization types, as organizations at the cross-section of disaster and EJ tend to emerge from areas exposed to constant natural disasters. Thus, research at the intersection of disasters and EJ is imperative to address the needs of communities impacted by disasters.

**Move around** by clicking and dragging your cursor. **Zoom in** with the plus sign in the bottom right corner, and **zoom out** with the minus sign. Make sure you view Alaska and Hawai'i. **Open the legend** by clicking the menu circle in the bottom left corner. **Expand the map** with the diverging arrows in the top right corner.


Map 1: 82 disaster and/or EJ organizations identified through our landscape analysis. **Blue** dots show organizations that were interviewed, **orange** dots were contacted, and **gray** were identified but not contacted.

We then contacted **37** of these organizations, and **11** agreed to an interview (shown in Map 2 below). These organizations' work ranges from mitigating urban heat island and stormwater runoff, to efficient disaster response in underserved communities, and to organizing community mapping efforts to inform climate adaptation.

**Click** on an organization marker on the map below to learn about each organization and their work.

Esri, USGS

Powered by Esri

### Alaska Institute for Justice

Alaska Institute for Justice works alongside Native Alaskan communities to combine traditional

### Depave

Depave engages in “constructive destruction” in Portland, Oregon and transforms over-paved places. They focus on empowering “disenfranchised communities to overcome social and...

### Save Our Great Salt Lake

Save Our Great Salt Lake engages residents in advocacy and policy, while also increasing education about the lake and water issues.

### Valle de Oro National Wildlife Refuge

Valle de Oro is an urban wildlife refuge built from grassroots community movements in Mountain View, New Mexico. In addition to a strong focus on wildlife conservation, Valle de Or...

### SBP

SBP was founded in March 2006 following Hurricane Katrina. St. Bernard Parish is located just outside of New Orleans and was made 100% uninhabitable by Katrina's floodwaters. Inspired...

### Imagine Water Works

Imagine Water Works' main focus areas are climate justice, water management, and disaster readiness and response. They support community efforts by providing resources, creating...

### Florida Housing Coalition

The Florida Housing Coalition focuses on providing resources to housing advocates to promote affordable housing and quality living environments for Florida residents.

### Seeds of Resistance (AFSC)

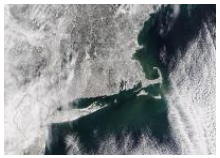
Seeds of Resistance is a grassroots and youth-led resistance under the American Friends Service Committee (AFSC) Florida that strives to "defend their communities from catastrophi...

### NC Climate Justice Collective

The North Carolina Climate Justice Collective works to bring a just recovery to ensure all people and the planet thrive by engaging with communities, developing movement infrastructure, an...

### Anonymous Organization

An organization that helps communities prepare for, respond to, and recover from disasters. With a focus on health, this organization helps improve and save lives impacted by poverty or...



### All Hands and Hearts

All Hands and Hearts is committed to addressing the immediate and long-term needs of communities around the world who have been impacted by disasters. Their response include...

**Disclaimer:** NASA and DEVELOP do not endorse these organizations. The groups featured in this map were contacted because of their contributions to EJ and disasters work. The scope of this project was to learn more about the needs of such organizations, as well as how geospatial tools can be utilized to support EJ and disasters work, and we looked to these organizations' experiences and expertise. Moreover, a few groups were interviewed at a later date. Due to deadlines, we were not able to include them in this StoryMap, but we still thank them for their participation in our project.

## Emerging Themes

Our conversations with organizations revealed the following themes in their priorities, challenges, and geospatial needs.

### Priorities

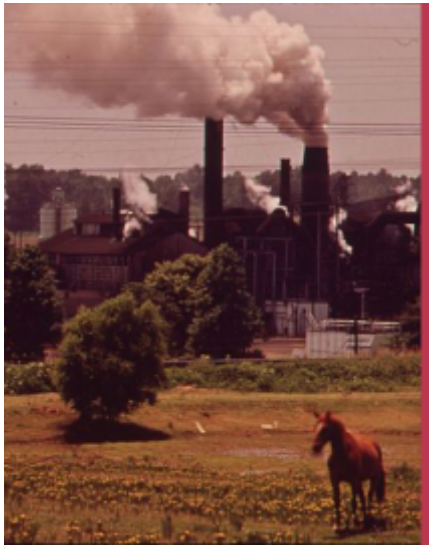
We were interested in learning more about organizations' **priorities** to better understand their **most important considerations** and **most pressing issues**.

These groups who advocate for communities grappling with EJ and/or disasters prioritized **community involvement**, **sustainable workloads** and **project impact**, and **approaching justice holistically** to direct attention to social and economic justice alongside EJ.

**Click** on the individual images to **expand these important quotes** from organizations.

"If an organization is an **expert** in something..., it's best to **collaborate** with them and let them take the lead on that part of the project... **Everybody** has their own **niche** and **gifts** to **contribute** to a project. Projects come out **stronger when we work together**."

- Katya Reyna, Program Director, Depave



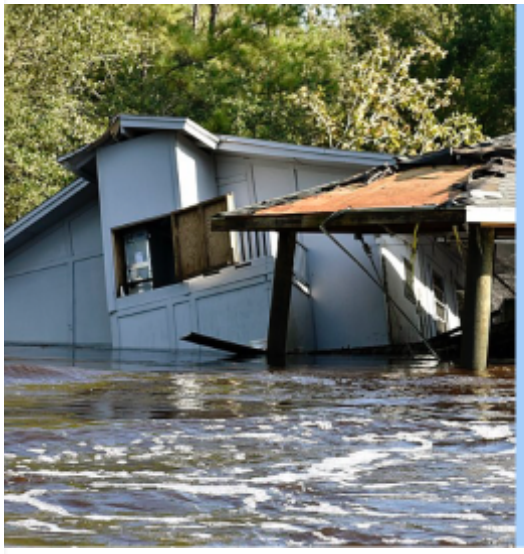
"When we talk about **who's first and worst impacted** by **climate issues**, we are also looking at **who's first and worst** impacted by **social issues**... environmental justice as an understanding of **cumulative** and **disproportionate** impact **isn't just looking at where** pollution is, **it's looking at why** certain pollution is happening in communities..."

- Jodi Lasseter, Founder and Co-Director, NC Climate Justice Coalition

"Multiple members from our neighborhood were at [the **First National People of Color Environmental Leadership Summit**] and helped craft the principles of environmental

"The way those big cities developed is people with money bought all the land that was worth having and **people without money** were forced to live in the places that weren't worth having, and **the places that weren't worth having** were pretty plain to see. If you go to any of their low-lying areas, they **flood all the time**."

- Reese May, Chief Strategy and Innovation Officer, SBP



"Today with **sea level rise**, a lot of folks are concerned about being **right there on the coast**. These more affluent folks want to take over the area where the **low-income people have been displaced** to, which is the highest area of Miami Dade County. And so that's a **climate change issue** and it's a **justice issue**, and more specifically **climate justice**, this idea that **the poor get pushed aside**."

- Michael Chaney, Technical Advisor, Florida Housing Coalition


## Organizational Challenges

Work towards the aforementioned priorities may be difficult at times due to **organizational challenges**.

Our conversations illuminated the following challenges that should be considered and addressed during any collaborations: **staff** and **volunteer capacity**, **time constraints**, and **funding**.

"We can't wait for perfect. We've got to get people on the ground and just get them working [in the aftermath of a disaster]."

- George Hernandez Mejia, U.S. Disaster Response Manager, All Hands and Hearts

"Our work is what it is because we do work at the full cycle and because we do it very intentionally. And the realities are that that requires staffing more than what we've had..."

- Klie Kliebert, Executive Director, Imagine Water Works


**Click** on the individual images to **expand quotes.**

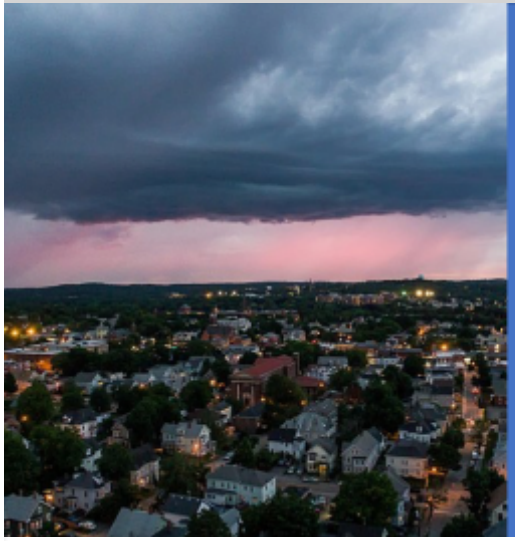
## Geospatial Needs

Organizational priorities and needs directly inform the **geospatial tools** that could support them.

We found that organizations are looking to leverage mapping technology to support **decision making**, **grant writing**, **resource distribution**, and **policy work**. We saw interest in maps that show change in environmental conditions and disparities over time, as well as geospatial tools that contribute to seeking funding opportunities by quantifying and visualizing an organization's impact.

"It speaks volumes when you can have data like [the temperature impact of depaving]. Grants often ask for figures like how many trees were planted or how much carbon was sequestered... having better data and visuals depicting our project elements would be really helpful in quantifying our project impact."

- Katya Reyna, Program Director, Depave



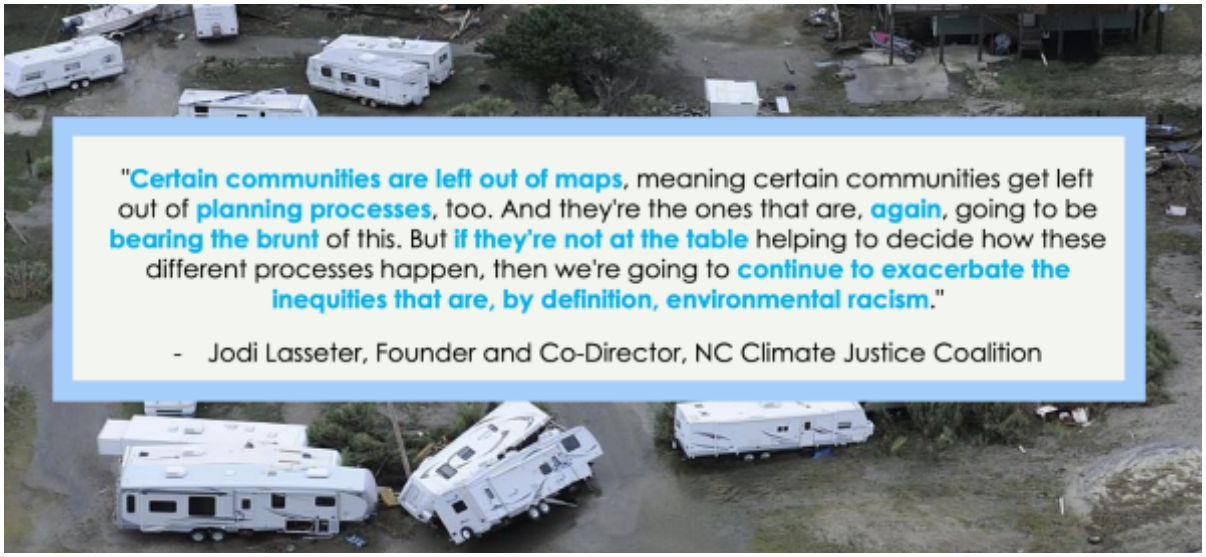
"It's hard to get consistent disaster data of weather impacts, like knowing where the storm surge was high, where the most rainfall was, where the highest gusts of winds were..."

- George Hernandez Mejia,
U.S. Disaster Response Manager,
All Hands and Hearts

"...More emphasis on the impacts on community members due to hurricanes... even showing the vulnerability in certain areas... through mapping and looking at some of the mapping [that has] already done, it's very impactful and powerful to have those types of resources available to community members."

- Guadalupe De La Cruz,

Program Director, Seeds of Resistance,
American Friends Service Committee (Florida)




"[It is important to] gath[er] the **data** and mak[e] it **accessible** in a format that folks are able to use because, so much of the time, the **data might be there**, but it **takes six months to figure out** what it actually means. And **we don't get that kind of time**."

- Katie McVey, Deputy Refuge Manager,
Valle de Oro National Wildlife Refuge

**Click** on the individual images to **expand quotes**.

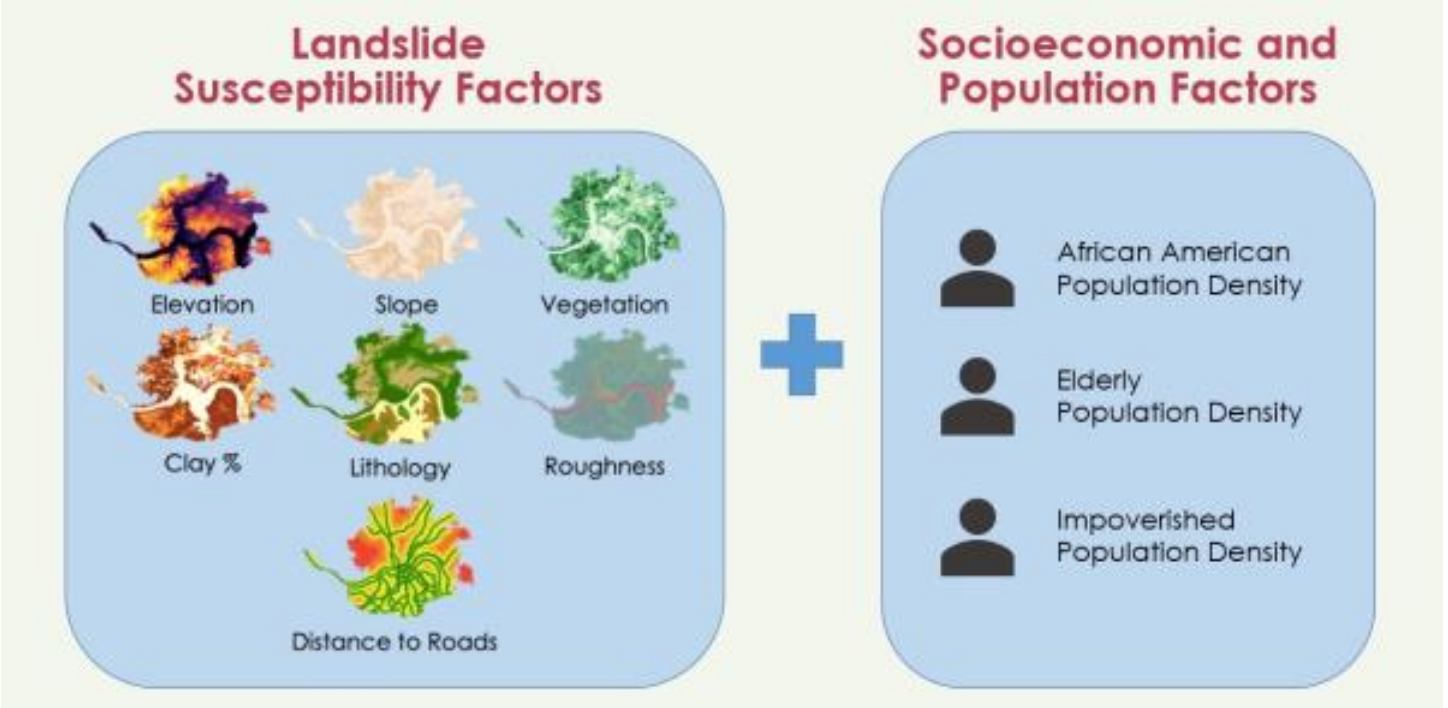
## EJ, Disasters, and Remote Sensing

While remote sensing alone cannot address the needs and concerns of these organizations and others, it is still a helpful tool that can support them in their missions and decision making. The **coming together of experts in EJ, disasters, and geospatial analyses** can further support communities and organizations, as well as strengthen their respective areas of work.

The following examples illustrate how previous DEVELOP projects and other remote sensing work have leveraged satellite data, including NASA Earth observations, to address issues relating to EJ and disasters.

### DEVELOP's Cincinnati & Covington Urban Development II Project

DEVELOP's **Cincinnati & Covington Urban Development II** Project (Summer 2021) applied data from the **Landsat 8** and **Global Precipitation Measurement** (GPM) satellites to calculate the **landslide susceptibility** of different areas around Cincinnati, Ohio and Covington, Kentucky.

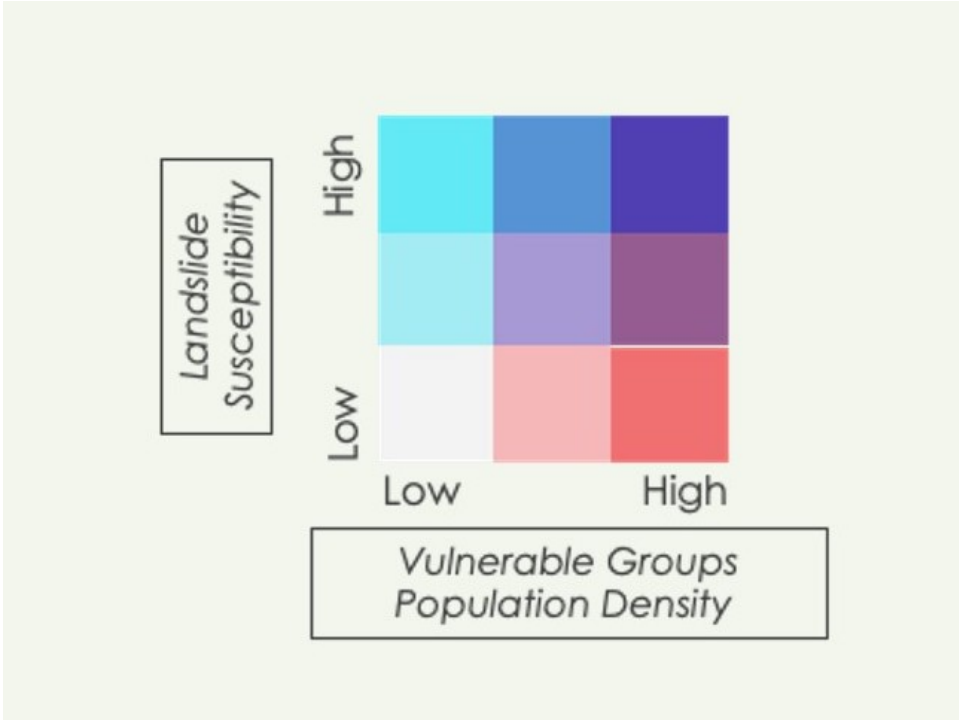



They combined environmental landslide susceptibility data with socioeconomic and population data to illustrate the **intersections of environmental injustice** and **landslide risk.**

Powered by Esri

Groundwork USA and Groundwork Ohio River Valley use the interactive map to the right to **alert communities at heightened landslide risk.**

**Move around** by clicking and dragging your cursor and **zoom in** with the plus sign in the bottom right corner. **Expand** the map with the diverging arrows in the top right corner.




Learn more about their project in this StoryMap: Flood and Landslide Vulnerability in the Ohio River Valley .

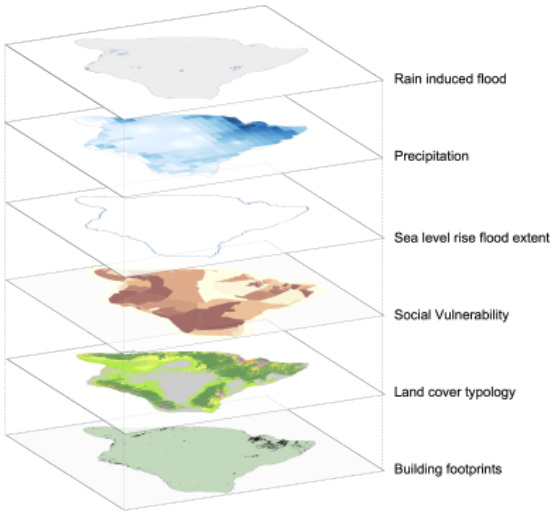
## DEVELOP's Hawai'i Island Disasters Project

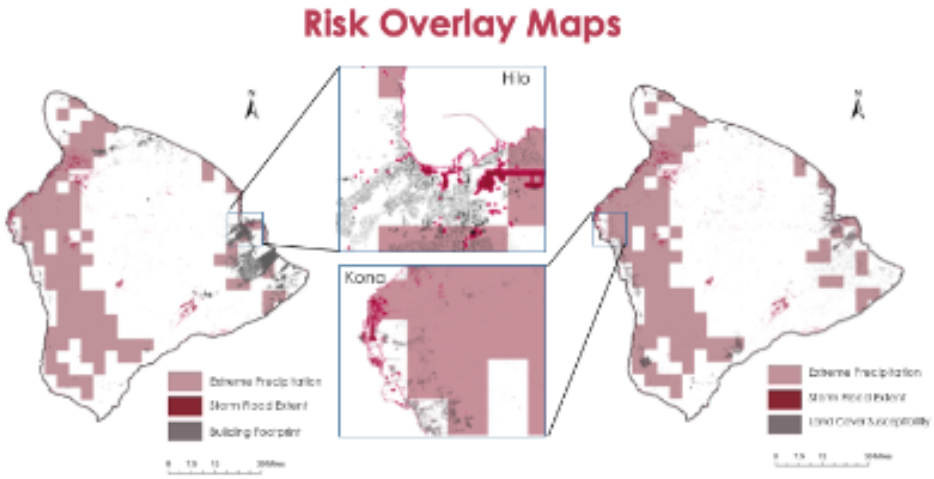
DEVELOP's **Hawai'i Island Disasters** Project (Fall 2021) used the **Landsat 5** and **Landsat 8** satellites, along with other remote sensing data, to identify **land cover** and **flood extent** on the island of Hawai'i and inform future **disaster mitigation** and **preparation**.

They layered various land cover, storm, and social data maps to visualize **infrastructure** and **land susceptibility** to **flood risk**.

The methodology and mapping developed in this project ultimately allowed the County of Hawai'i to establish a **protocol** and **standard framework** for **addressing issues in at-risk areas**.

Learn more about their project in this StoryMap: Hawai'i Island Disasters




These risk overlay maps feature extreme precipitation and storm flood extent in relation to building footprint and land cover susceptibility, looking especially at Hilo and Kona.

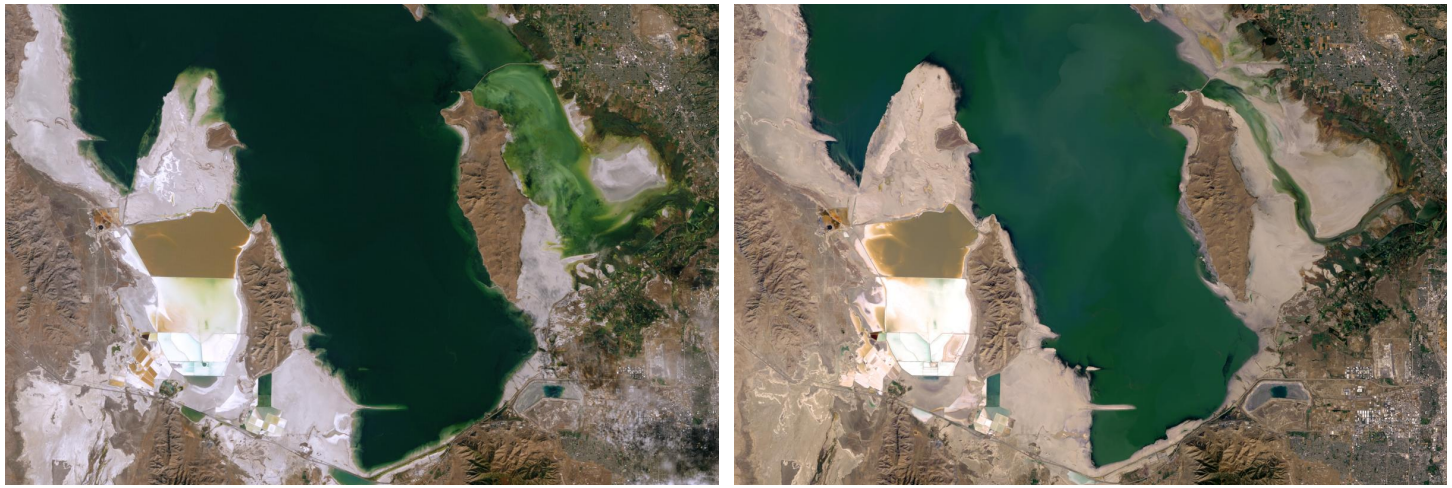
## NASA Earth Observatory: Drought and the Great Salt Lake

Located in Northern Utah, **the Great Salt Lake** is a remnant of the prehistoric Lake Bonneville. It is three to five times saltier than the ocean, and the ecosystem is home to a diversity of species (Carlowicz, 2016). The lake also holds great cultural significance to many indigenous groups in the area. However, due to **anthropogenic lake uses and diversions**, alongside a **record drought**, the Great Salt Lake **reached its lowest water level on record in July 2021** (Carlowicz, 2016). Water levels have since **continued to drop**. Satellite imagery helps **monitor these changes** and could **direct environmental action and policy**.

The NASA Earth Observatory used **Landsat 8** satellite's Operational Land Imager (OLI) sensor, a collaboration between NASA and USGS, to capture these changes in the water level of the **north end** of the Great Salt Lake between **2017** and **2021**.

The image on the **left** shows **2017** and the image on the **right** shows **2021**. **Drag the bar** to see the changes in water level in the north end of the Great Salt Lake.

From **2011** to **2016**, **Farmington Bay** experienced drastic water loss. **Landsat 5**'s Thematic Mapper (TM) sensor captured the 2011 image and **Landsat 8**'s Operational Land Imager (OLI) sensor captured the 2016 image.



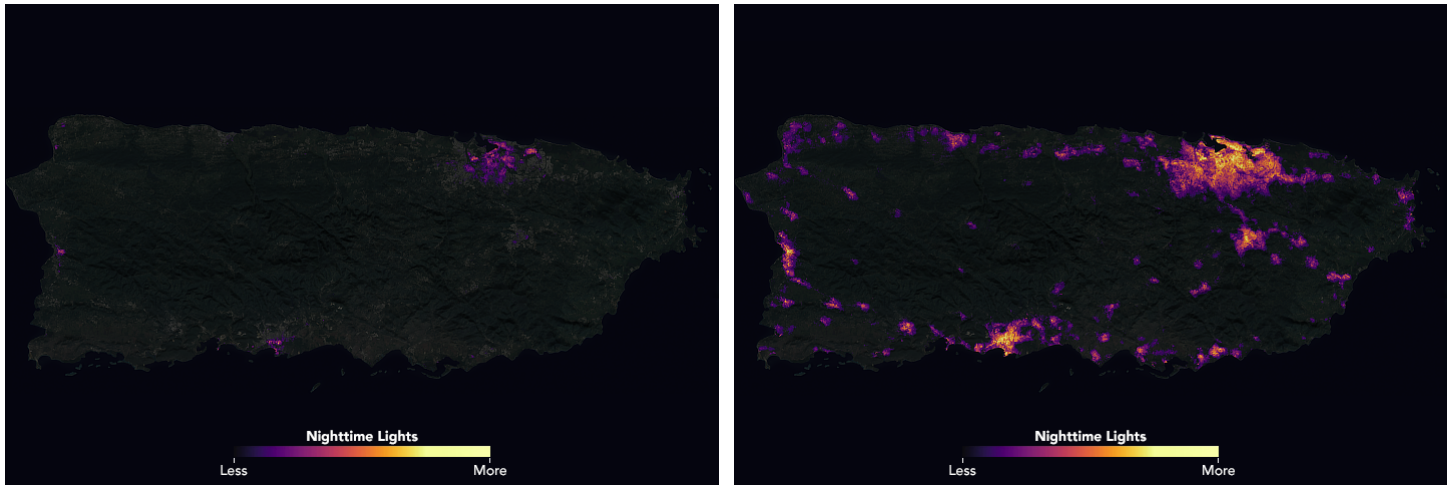
The image on the **left** shows **2011** and the image on the **right** shows **2016**. **Drag the bar** to see the changes in water level in Farmington Bay (top right).

Learn more about this NASA Earth Observatory application of remote sensing: Salt Lake Water Woes

## NASA Earth Observatory: Hurricane Maria and Recovery Mapping in Puerto Rico

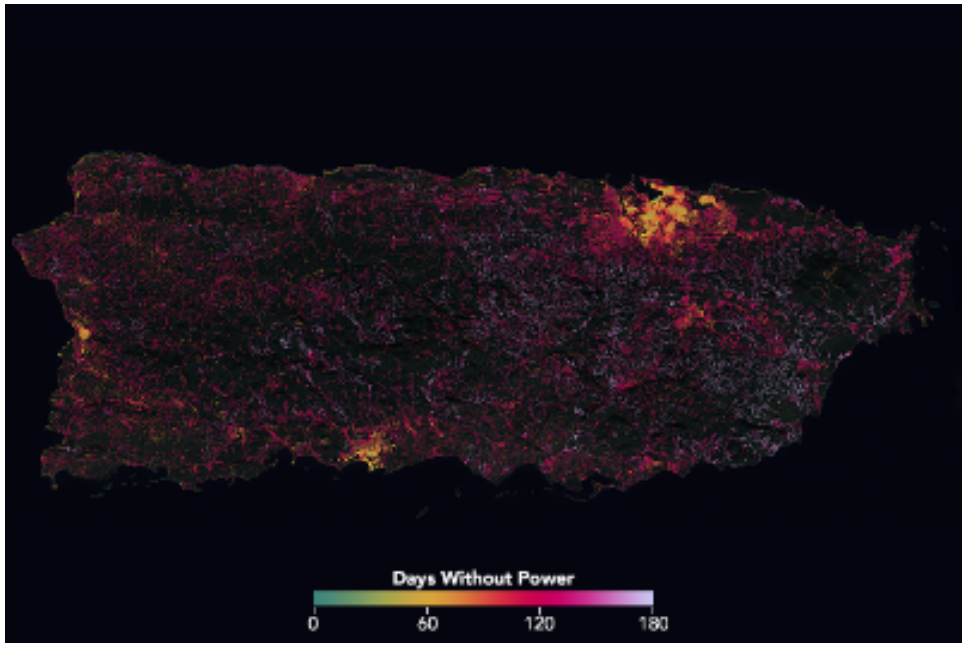
In **September 2017**, **Hurricane Maria** pushed through the northeastern Caribbean. Classified as a Category-4 when it made landfall in **Puerto Rico**, the hurricane had a **devastating impact** on **human life**, **infrastructural** and **environmental amenities**, and the island's **economy** (Gray and Carlowicz, 2018).

Using data acquired by the Visible Infrared Imaging Radiometer Suite (VIIRS) on NASA's **Suomi NPP Satellite**, scientists at the NASA Earth Observatory illustrated the **speed and location of recovery** from Hurricane Maria in Puerto Rico. The majority of **long-term power outages** occurred in **rural areas**, as critical infrastructure repair in cities was prioritized. Visualizations such as this can **illuminate areas in need of recovery support**.




The image on the **left** is from September-November **2017** and the image on the **right** is from January-March **2018**. **Purples** indicate **less** nighttime lights and **yellows** indicate **more** nighttime lights. **Drag the bar** to see which areas had electricity at the point in time.

This information was synthesized into the **composite** map below which shows the **total number of days** an area went **without power**, as calculated in March 2018.




This composite image shows the total number of days an area went without power over September-November 2017 and January-March 2018. **Green** indicates an area went **0 days** without power and **light pink** indicates the other end of the spectrum with **180 days** without power.

Learn more about this NASA Earth Observatory application of remote sensing: Night Lights Show Slow Recovery from Maria

# Conclusions

## EJ takes time.

Building the **strong, trusting relationships** required to work effectively towards justice doesn't happen overnight. Many

organizations stressed the importance of **consistency and time investment** in collaborative project environments.

"We want to incorporate all of these things and continue to do it in a way that continues community trust, that's why we're so intentional. But it actually **requires much more time**."

Klie Kliebert, Executive Director, Imagine Water Works

### Barriers to capacity building must be acknowledged and addressed.

Marginalized groups often cannot dedicate extra time, staff, or other resources towards finding and learning geospatial tools and software. This knowledge can support decision-making within communities, so it is important to **be cognizant of the accessibility of resources** when designing or carrying out projects.

"It's all dependent on each program and what we have in funding... **resilience and sustainability** is something that we want."

George Hernandez Mejia,
U.S. Disaster Response Manager, All Hands and Hearts

### Community-led research is critical to pursuing work at the intersection of EJ, disasters, and remote sensing.

Organizations expressed a lot of interest in collaborating with NASA DEVELOP to leverage spatial data to their community's advantage. As both NASA DEVELOP and NASA Applied Sciences look to address environmental and social issues through remote sensing and geospatial analysis, it is important to ensure the **diversity of voices affected by EJ is meaningfully represented and included**.

"**Certain communities are left out** of maps, meaning certain communities get left out of planning processes, too. And they're the ones that are, again, going to be **bearing the brunt** of this. But **if they're not at the table** helping to decide how these different processes happen, then we're going to continue to **exacerbate the inequities that are, by definition, environmental racism.**"

Jodi Lasseter, Founder and Co-Director, NC Climate Justice Collective

## Resources

From **listening to organizations** and **holding dialogues** to better understand their needs and experiences, we identified the following resources that could help **empower** and **equip** them in its work and future goals. **Click** the underlined, hyperlinked text to be directed to the websites.

**Disclaimer:** NASA and DEVELOP do not endorse the resources housed outside of their own programs. These resources from other organizations were included due to their applicability to disasters and EJ.

## GIS and Remote Sensing Resources

**NASA Applied Remote Sensing Trainings (ARSET)**: ARSET offers free online, in-person, and previously recorded trainings at all levels of remote sensing expertise, answering questions from "What is a satellite?" to "How can I make a flood map?" Learn how to use tools, such as Google Earth Engine, which can address issues related to disasters, health and air quality, water resources, and more. Available in English and Spanish.

- Fundamentals of Remote Sensing
- Learn to Use Earth Observations

**Esri Trainings**: Esri offers a variety of free and paid training resources for remote sensing, mapping, and spatial analysis, including free live training seminars, self-paced courses, and certification programs. Some trainings may require access to paid software.

- GIS Basics
- GIS Fundamentals
- ArcGIS Online Basics
- ArcGIS Online Fundamentals

## Disaster Resources

**NASA Applied Sciences Disasters Program:** The NASA Applied Sciences Disasters program shares resources to address how Earth observations and research can improve preparation, response, and recovery for disasters and hazards around the world.

- NASA Applied Science Disasters Homepage

**NASA Applied Sciences Disasters Mapping Portal:** This interface allows users to view, analyze, and download disaster data products for use in Geographic Information Systems (GIS).

- NASA Disasters Mapping Portal

**NASA Applied Sciences Disasters Data Pathfinder:** The data pathfinder can be helpful for identifying data products relevant to a specific disaster interest and conducting one's own analyses.

- NASA Disasters Data Pathfinder

**NASA Applied Remote Sensing Trainings (ARSET) Disaster-Related Trainings:** The following offerings from ARSET could be helpful for organizations interested in disaster mapping.

- Disaster Risk Assessment & Resilience
- Remote Sensing for Disasters Scenarios
- Integrating Population Grids with Remote Sensing Data for Sustainable Development and Disaster Management
- Pre- and Post-Fire Monitoring
- Satellite Observations and Tools for Fire Risk, Detection, and Analysis
- Monitoring Tropical Storms for Emergency Preparedness
- Monitoring Urban Floods

**CONVERGE Trainings:** These free trainings are funded by the National Science Foundation and headquartered at the University of

Colorado Boulder's Natural Hazards Center. Topics include cultural competency, mental health, and social vulnerability as they relate to disaster research.

- CONVERGE Training Modules

**ARIA Disaster Technology:** ARIA is a collaboration between NASA Jet Propulsion Laboratory (JPL) and Caltech and utilizes radar and remote sensing, GPS, and seismic observations for disaster science and response applications. The ARIA website includes tools and open-source data access for disaster urgent response products.

- ARIA - Advanced Rapid Imaging and Analysis


## Environmental Justice (EJ) Resources

**U.S. Environmental Protection Agency (EPA) EJ Homepage:** The EPA EJ Homepage includes resources to learn more about EJ. Scroll to the bottom of the page to see a timeline of EJ's history, which features a link to the seminal 17 principles of EJ written at the first People of Color Environmental Leadership Summit in 1991.

- EPA EJ Homepage

**U.S. EPA EJScreen:** EJScreen is a free online mapping tool that allows users to evaluate the EJ risk of an area by comparing data on pollution, socioeconomic conditions, health disparities, service gaps, and more. These analyses support the EPA's outreach and engagement strategies and can also inform community efforts, grant writing, and educational program.

- EJScreen Homepage (Launch Tool)
- How to Use EJScreen
- How to Understand EJScreen Results
- Tutorial by the Environmental and Energy Study Institute (EESI)

**National Black Environmental Justice Network (NBEJN) Resources and Tool Page:** NBEJN is a coalition of EJ organizations fighting for socioeconomic and environmental equity. They compiled an extensive list of resources relevant to the work of EJ organizations, including grant resources and information on how to use mapping in an EJ context.

- NBEJN Resources and Tools Page

**NASA EJ Backgrounder:** This EJ Backgrounder provides an overview of the ways NASA is addressing EJ. It discusses how NASA data is supporting EJ and climate justice, as well as citizen science.

- NASA EJ Backgrounder Homepage

**NASA Socioeconomic Data and Applications Center (SEDAC):**
SEDAC focuses on human interactions in the environment. With a mission to integrate socioeconomic and Earth science data, resources are available to share information between Earth sciences and social sciences.

- NASA Socioeconomic Data and Applications Center

## Collaboration Opportunities

**NASA DEVELOP Projects:** The NASA DEVELOP program uses NASA Earth observations and mapping techniques to empower decision making and address environmental and public policy issues. A recent initiative is pushing forward EJ-oriented projects which leverage geospatial data to support justice and equity work.

- NASA DEVELOP Homepage
- Project Idea Submission Form
- Contact DEVELOP at **NASA-DL-DEVELOP@mail.nasa.gov**

**Thriving Earth Exchange (TEX):** TEX focuses on community science to help bring together communities, scientists, and partner organizations to collaborate on projects that tackle local issues related to natural hazards, natural resources, and climate change.

- TEX Homepage

**EPIC-N:** EPIC-N works to bring together university resources and community organizations to create and implement creative solutions to local problems. In addition to collaboration opportunities, their website hosts an extensive list of resources aimed at bridging academic resources and community organizations.

- EPIC-N Homepage

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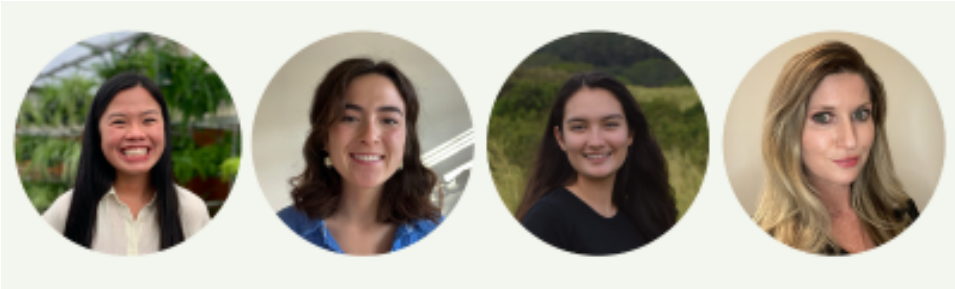

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