

OGC Disasters Resilience Pilot User
Guide
*Health SDI - Facilitating Public Health During a
Disaster*

by Health Solutions Research, Inc.

Table of Contents

1. Introduction	2
1.1. Disaster Response Planning	2
1.2. Use Case:	2
1.3. User Guide Organization:	3
2. Simple Architecture	4
2.1. Data Providers	4
2.2. Catalog Providers	5
2.3. Data Consumers	5
2.3.1. Data Consumers' Questions	5
2.3.2. Secondary Consumers	6
3. General Use Cases by User Activity	7
3.1. Publication of data	7
3.2. Registration of data	7
3.3. Discovering of data	7
3.4. Downloading of data	7
3.5. Data Integration	8
3.6. Republication of data	11
3.7. Displaying of the data with proper symbology	11
3.8. References	12
4. Special Topics	14
4.1. The Right Data for the Right People at the Right Time	14
4.2. Semantic Mediation	14
4.3. Health Data	14
4.4. Social Data	15
4.5. Smart Cities	15
4.6. Post-Disaster Recovery Needs	16
5. Scenarios and Tools Demonstration	17
5.1. Health Risk Index	18
5.1.1. Audience	19
5.1.2. Publication of data	20
5.1.2.1. In-situ Data	20
5.1.2.2. Model Data	20
5.1.2.3. Remote Sensing Data	20
5.1.3. Registration of data	20
5.1.4. Discovering of data	20
5.1.5. Downloading of data	22
5.1.6. Data Integration	22
5.1.7. Republication of data	22

5.1.8. Displaying of the data with proper symbology	23
6. Conclusion and Way Forward	24
6.1. Phase I of the Disaster Resilience Pilot	24
6.1.1. Lessons Learned:	24
6.2. Way Forward	27
6.2.1. Smart Cities	28
6.2.2. Post-Disaster Recovery Needs	28

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NOTE

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Chapter 1. Introduction

Health Solutions Research (HSR) is a GeoHealth company that merges, publishes, and analyzes data on social determinants of health with health outcomes & costs, ultimately providing point-of-care decision support at multiple geographic levels.

HSR staff and management include clinicians, public health analysts, data analysts, as well as geospatial analysts.

For the Open Geospatial Consortium (OGC) Disaster Resilience Pilot, HSR's philosophy of providing health-related insights at the point-of-care is being leveraged to design and deliver solutions to bring health data into the emergency or disaster response planning effort.

1.1. Disaster Response Planning

According to the United Nations (UN) Office for Disaster Risk Reduction, financial damages and the cost in human lives due to natural disasters are tremendous:

United Nations Statistics on Disasters, 2005-2014

\$1.4 Trillion	1.7 Billion	0.7 Million
Damages	People Impacted	Lives Lost

The statistics pre-date the 2017 Atlantic Hurricane Season which was one of the most active in history with 17 named Hurricanes [Federal Emergency Management Agency 2018] and with just three storms - Hurricanes Harvey, Irma, and Maria - causing \$265 billion in damages. Hurricane Maria, which made landfall in Puerto Rico on September 20, 2017 as a Category 4 hurricane caused \$90 billion in damages, crippled the power grid for months, impacted 100% of the island's 3.8 million population and caused 2,975 deaths [Milken Institute School of Public Health 2018].

In the Response to Hurricane Maria, there is anecdotal evidence that the lack of medical personnel early on in the response contributed heavily to storm-related fatalities. These are lives that could have been saved if medical personnel were dispatched to the disaster impacted area sooner.

The scope of the geospatial need for medical personnel wasn't known by Emergency Operations Managers until the response was underway. HSR's system provides the foresight to ensure the medical and health needs of the impacted population are known to both Emergency Operations Managers and Emergency Medical Responders in advance and can be addressed.

1.2. Use Case:

To provide this foresight, HSR is creating a revolutionary Health Geo Platform – a Health-focused Spatial Data Infrastructure (SDI), as a National Health SDI, with an initial application to allow for the inclusion of health information in emergency or disaster response planning and execution processes. This application is named a Health Risk Index and merges data on social determinants of health as well as health data to identify an impacted population's risk – health risk – from a natural

disaster. This information can be utilized by Emergency Operations Managers and the boots-on-the-ground Emergency Medical Responders to ensure their efforts address the unique health challenges caused by experiencing a natural disaster.

Currently, emergency response operations conducted by the Federal Emergency Management Agency (FEMA) and their peers at State and Local levels have limited visibility into the health needs of the disaster-impacted populations they serve. Therefore, emergency operations managers and emergency medical responders may develop response & evacuation plans, or may enter disaster struck areas unaware of the overall health and medical needs among civilians.

The Health SDI and its Health Risk Index application will provide the necessary, geocoded public health information that may prove vital to the success of emergency response efforts and will align smoothly with the global emergency response systems. The Health SDI and the Health Risk Index are revolutionary decision support tools that hold unlimited capabilities.

1.3. User Guide Organization:

Chapter 2 provides a high-level description of the architecture of the Health SDI and the data sources behind the Health Risk Index.

Chapter 3 provides additional details on the symbology and specific data sets used and published in this effort.

Chapter 4 provides discussion on key special topics that may be relevant and related to this effort going forward.

Chapter 5 details how the SDI works describing how actionable information is put into the hands of the two primary end users (emergency operations managers and emergency medical response personnel) in a way that they can use during disaster response scenarios.

Chapter 6 will present a Conclusion of this specific effort - which is Phase 1 of a longer effort to ensure emergency response personnel have the health and medical information they need, when they need it, and within their existing workflow to best serve the impacted population.

This chapter will also discuss viable future applications of the Health SDI. The utility of a SDI progresses is limited only by imagination. For example, the SDI can provide focus on the greatest health needs in the world and streamline medical and pharmaceutical research to address those needs.

Chapter 2. Simple Architecture

The current data workflow for the Health SDI supporting generation of the Health Risk Index is shown in Figure 1. This will continue to be refined throughout all phases of this effort.

Health SDI Process Flow

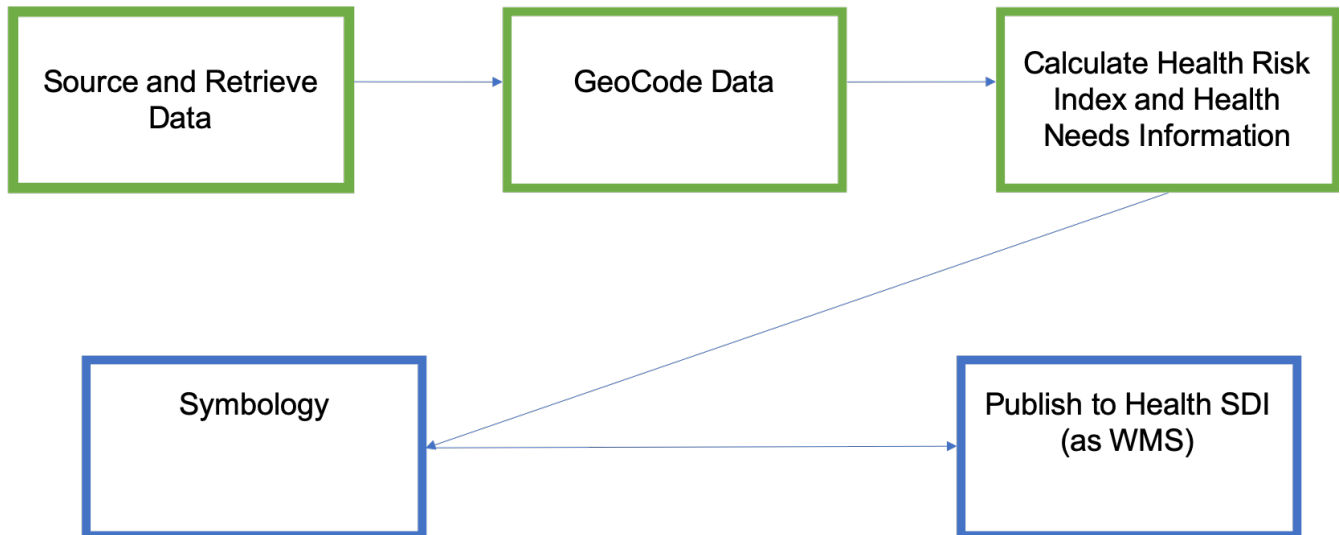


Figure 1. Health SDI Process Flow

The first step is to identify and retrieve relevant health and social data. Following data retrieval, the data is geocoded and prepared for analysis. The analysis of the data includes calculating the Health Risk Index as well as displaying the health needs information of relevance to the end users and data consumers, discussed in Section 2.3 below.

Symbology is addressed following the National Alliance for Public Safety GIS Foundation guidelines, and the shapefile is published to the Health SDI, is available as a direct download, and exposed through Open Standards.

2.1. Data Providers

The Health Risk Index leverages both data on social determinants of health as well as health outcomes and costs from a broad variety of sources. These include global non-governmental organizations, such as the UN and World Health Organization, national government organizations, such as the Centers for Disease Control and Prevention (CDC) and the Homeland Infrastructure Foundation-Level Data (HIFLD) produced by the Department of Homeland Security (DHS) within the U.S., as well as U.S. State, and Local government agencies. Health Registries, disease-specific healthcare organizations, university and non-profit research organizations and other sources of data are also considered.

HSR continues to seek data from new sources, including US-sources at the National, State, and Local levels, non-governmental organizations, educational organizations, as well as international sources that make health and health-related data available for public consumption.

2.2. Catalog Providers

HSR is working towards building an SDI that can serve as a National SDI as well as an international SDI for health issues and therefore are working to integrate and collaborate with existing SDIs and catalog providers, including GeoPlatform.gov, AmeriGEOSS, and NextGEOSS.

2.3. Data Consumers

As the near-term output of the Health Risk Index relates to disaster response efforts, the primary data consumers, or end users, include:

- Emergency Operations Managers, and
- Emergency Medical Responders.

Emergency Operations Managers are those individuals who plan and oversee the overall disaster response effort. Emergency Medical Responders are the “boots-on-the-ground” who go into disaster-impacted areas and provide disaster relief services including needed medical care. The needs of these users are certainly related and both users can have visibility into the data provided to each other.

2.3.1. Data Consumers' Questions

The questions these consumers ask that the Health Risk Index provides include:

1. What are the high-risk areas for medical evacuation?

Emergency Operations Managers develop evacuation plans responsive to specific nuances of each disaster event. The Health Risk Index provides information on the risk of adverse health impact due to the disaster. Emergency Operations Managers can use this information to design evacuation plans that best meet the impacted populations' health needs and limit the likelihood of adverse and life-threatening health events, including fatalities.

- 2a. What healthcare assistance is needed, where, and for whom?

To identify this information the Health Risk Index includes data on pre-existing conditions; health conditions that may be worsened by or flair up during disasters such as allergies, asthma, heart disease; and health conditions that are caused by the disaster such as illnesses or trauma.

In addition to Emergency Operations Managers and Emergency Medical Responders, this information is relevant to hospitals, healthcare providers, as well as pharmacy distribution personnel serving the disaster impacted area. The CDC may also be interested in this information for the purposes of disease outbreak monitoring and containment.

- 2b. What health conditions are patients likely to present with?

Related to 2a, this will identify the medical equipment, medical supplies, and pharmaceutical medication first responders should bring to a disaster-impacted area.

In addition to Emergency Operations Managers and Emergency Medical Responders, this

information is relevant to hospitals, healthcare providers, as well as pharmacy distribution personnel serving the disaster impacted area.

All information will be provided in seamlessly and within the first responders current workflow.

2.3.2. Secondary Consumers

Secondary consumers of the Health Risk Index include partners to whom the Index is exported and include:

- Esri
- Compusult

These partners receive an export of the Health Risk Index following OGC standards for display in their platforms. In the interest of public health, HSR is open to working with other interested partners as well.

In the long-term, the Health Risk Index can be used to track post-disaster recovery as well, and additional consumers can include providers (e.g., hospitals and health systems), as well as departments and ministries of health at the national and local levels who are charged with ensuring the long-term health of populations.

Chapter 3. General Use Cases by User Activity

This section will provide details on the use case and data consumers, or end users, of the Health Risk Index and health needs data.

3.1. Publication of data

The Health Risk Index is published to the Health SDI. Effort to publish the Health Risk Index to GeoPlatform.Gov are underway.

3.2. Registration of data

At present, the Health Risk Index uses the most currently available data for the identified datasets that are in the public domain. Later phases of this effort will include discussion of licensing these data sets from providers to have access to either (or both where available) more regularly updated data and current data as well as access to data at the Census tract level. These discussions will involve addressing and documenting policy and procedure issues, security and privacy issues, as well as the republication of data.

3.3. Discovering of data

To produce the Health Risk Index, HSR sought health and social data that, when considered together, stratify the health risks facing an impacted population due to a natural disaster.

Additionally, boundary layers were discovered through searching the U.S. Census Bureau (Census), guidance on symbology was taken from the National Alliance for Public Safety GIS Foundation, and address data was discovered from the U.S. Department of Transportation's National Address Database (NAD).

3.4. Downloading of data

The following data tables are used in the construction of the Health Risk Index:

Table 1. Resource Table

Data Provider	Data Catalogue	Name	Use	Retrieval Method
Homeland Infrastructure Foundation-Level Data	GeoPlatform	Health / Emergency Response Facilities	Geographic Layers	Direct Download (GeoPlatform 2017)
National Alliance for Public Safety GIS	Symbol Library	Symbology Guidelines	Symbology	Reference (NAPSG Foundation 2019)

National Oceanic and Atmospheric Administration	National Hurricane Center Data Archive	Storm Paths	Geographic Layers	Direct Download (NOAA 2019)
U.S. Census Bureau	American Fact Finder	American Community Survey 5 year Data Tables	Social Determinants	Python Census API (Python Software Foundations 2019) (U.S. Census Bureau 2019)
U.S. Census Bureau	U.S. Census Bureau	TIGER Line U.S. Boundary Layer	Geographic Boundaries	Direct Download (U.S. Census Bureau 2019)
U.S. Centers for Disease Control	Agency for Toxic Substances and Disease Registry	Social Vulnerability Index	Social Determinants	Direct Download (ATSDR 2018)
U.S. Centers for Medicare and Medicaid Services	AmeriGEOSS	Chronic Conditions	Health Dataset	Direct Download (CMS.gov 2019)
U.S. Department of Health and Human Services	GeoPlatform	Empower Map	Health Dataset	Direct Download/API (HHS.gov 2019)
U.S. Department of Housing and Urban Development	HUD User Portal	HUD USPS ZIP Code Crosswalk Files	Geographic Scale Mobility	Direct Download (HUD User 2019)
U.S. Department of Transportation	U.S. Department of Transportation	National Address Database	Address Data and Attributes	Direct Download (Transportation.gov 2019)
The Dartmouth Institute for Health Policy and Clinical Practice	Dartmouth Atlas Data	Our Parents, Ourselves: Health Care for an Aging Population Appendix Table 4	Health Dataset	Direct Download (Dartmouth Data Atlas 2012)

3.5. Data Integration

The health and social data inputs are joined to crosswalk files which allows for the information to be displayed at multiple geographic levels. Data from the health and social datasets are then used to calculate the Health Risk Index at each geographic level. Additionally, the health needs information relevant to the on-the-ground Emergency Medical Responders is displayed and exported. After the Health Risk Index is calculated for each geographic level the table is joined to the geographic boundary files from the Census, where symbology is then established and the layer is published to the Health SDI. The layers available on the Health SDI can be retrieved using OGC standards. This allows our partners, such as Esri and Compusult to import and utilize the data in their platforms, allowing for wide use of the information by the First Responder community overall.

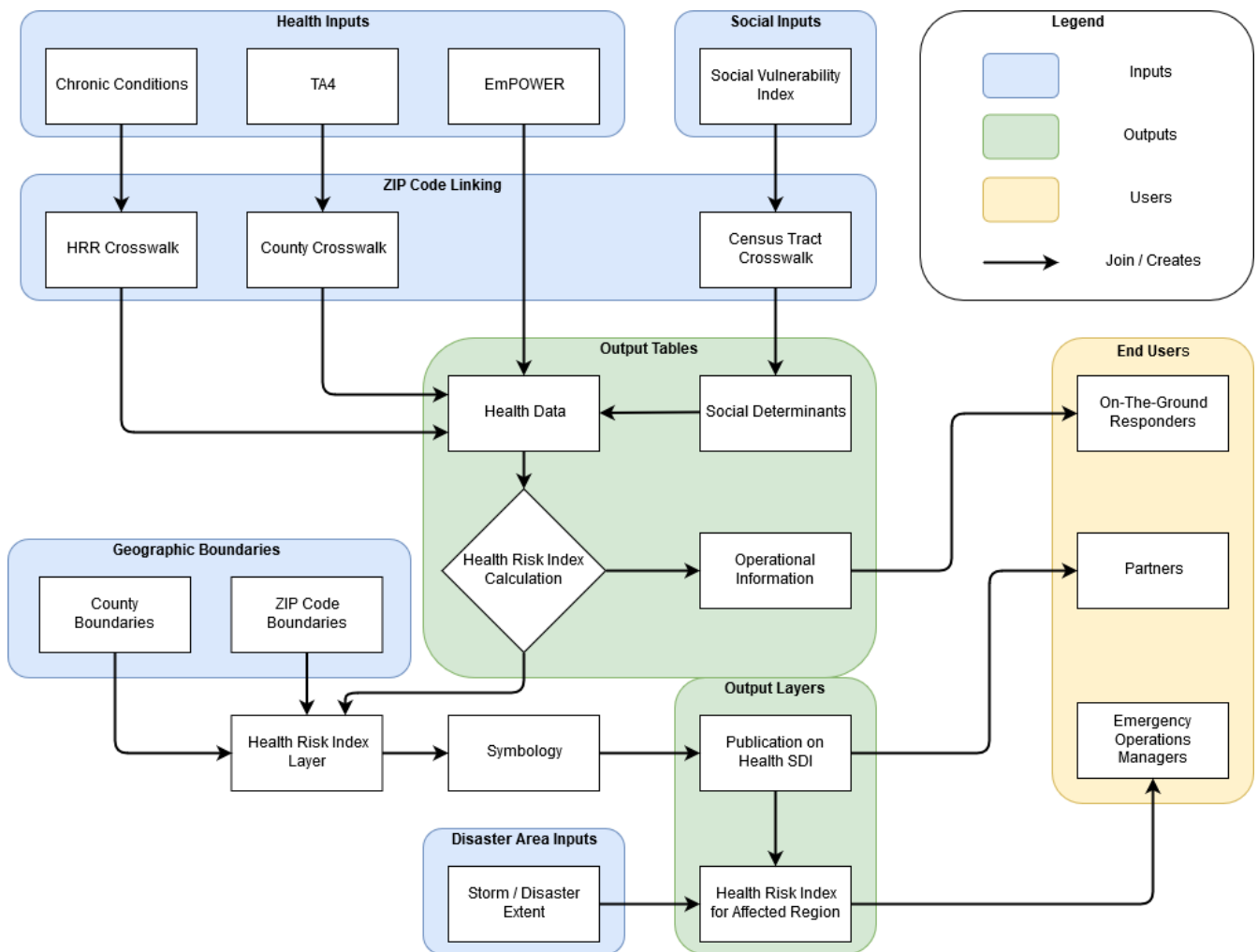


Figure 2. Data Integration Workflow

Finally, predicted storm paths from the U.S. National Oceanic and Atmospheric Administration (NOAA) or other sources of disaster impact information can be overlaid onto the Health Risk Index to retrieve the index at all geographic levels as shown in Figure 2 for the National Level.

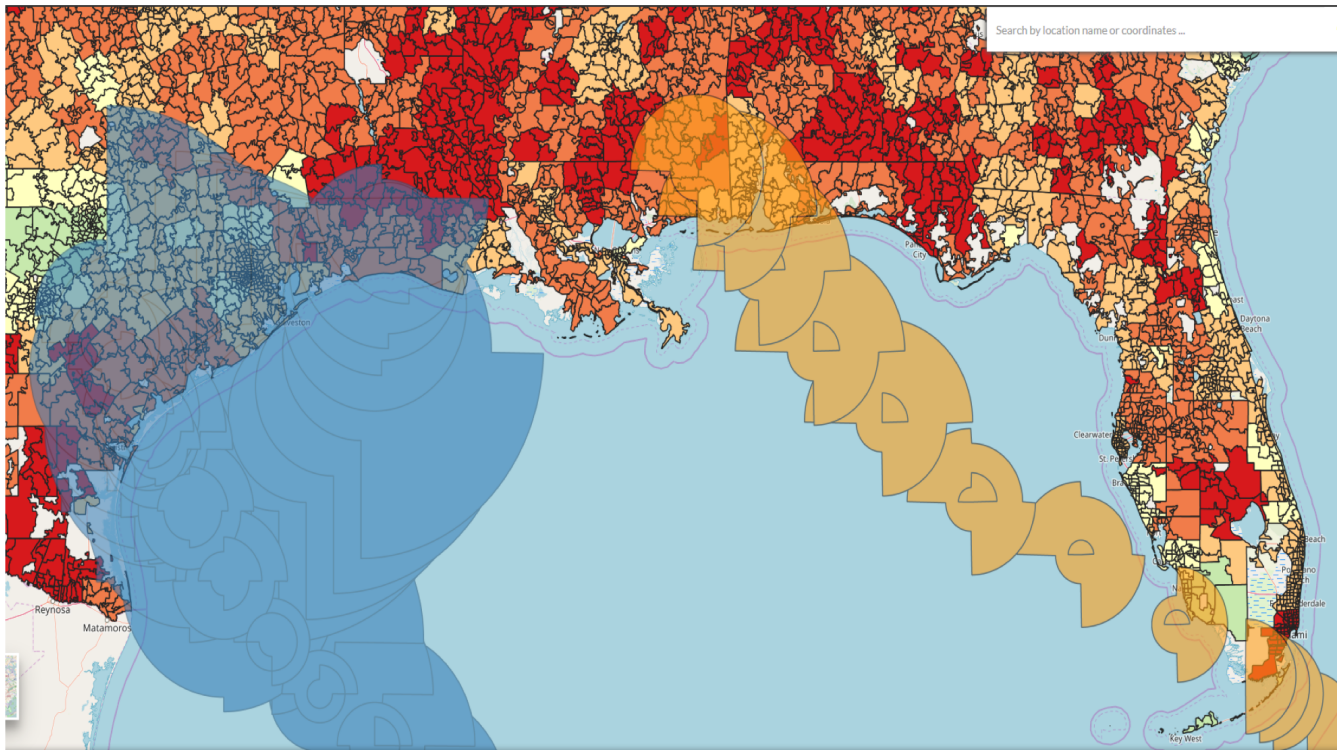


Figure 3. Health Risk Index Storm Overlay

Emergency Operations Managers can isolate the index for the impact region as shown in Figure 3.

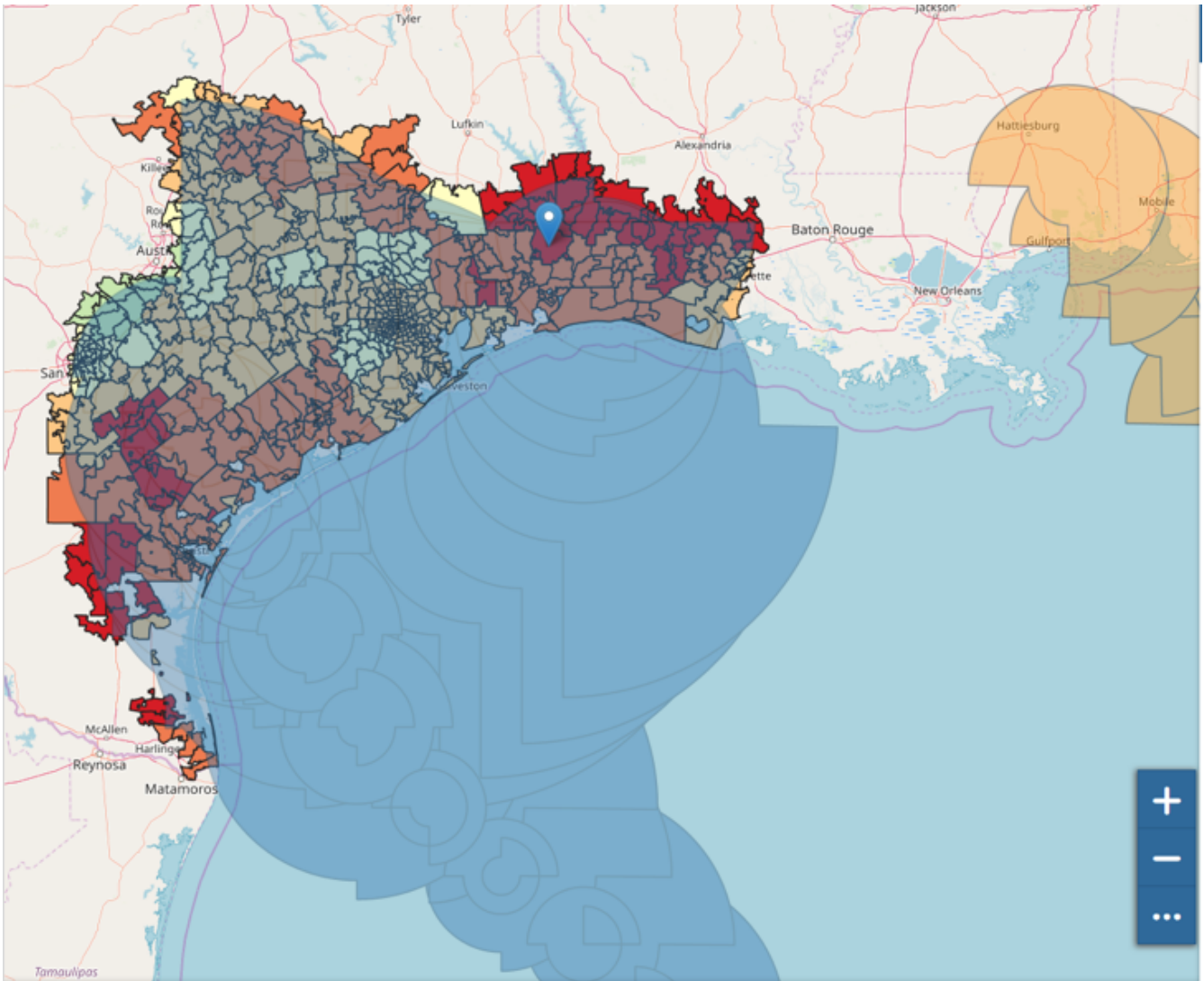


Figure 4. Health Risk Index Storm Overlay

3.6. Republication of data

All of the health data is joined with crosswalk files from the U.S. Department of Housing and Urban Development (HUD) and republished as the HSR Medical Dataset on the Health SDI. Similarly, the social data is joined with HUD crosswalk files (https://www.huduser.gov/portal/datasets/usps_crosswalk.html) and republished as the HSR Social Determinants Dataset on the Health SDI. Joining the health and social data inputs to the crosswalk files allows for the information to be displayed at multiple geographic levels. Additionally, the Health SDI will republish other data and resources related to disaster response efforts, including but not limited to a link to NOAA’s National Hurricane Center data archive and the symbology guidelines of the National Alliance for Public Safety GIS Foundation.

3.7. Displaying of the data with proper symbology

The symbology used in the Health Risk Index is based on the symbology guidelines produced by the National Alliance for Public Safety GIS Foundation. This includes the symbols for hospitals, roads, the thematic coloring, as well as the legend.

The legend is a 7-point scale ranging from very low risk, or a white color on the map, to a extremely

high risk, or purple. The greater the risk, the more urgent the need to provide appropriate medical care and intervention, up to and including potential evacuation to a specific medical facility, to the population within the geographic region.

Description/Examples for Use	Color	RGB	HEX
No severity or risk; Normal Operations/Status	White	255,255,255	#FFFFFF
Low severity or risk; No Damage; Open Status	Green	0,172,58	#00AC3A
Low to medium severity or risk; Alert/Action Notice	Blue	35,122,207	#237ACF
Medium severity or risk; Moderate damage	Yellow	255,215,24	#FFD718
Medium to High severity or risk; Watch Notice;	Orange	255,137,24	#FF8918
High severity or risk; Warning Notice; Severe Damage; Closed Status	Red	255,24,30	#FF181E
Extreme severity or risk; Highest category possible.	Purple	237,26,252	#ED1AFC

Figure 5. NAPSG Symbology Guidelines

3.8. References

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Chapter 4. Special Topics

This section describes special topics, issues, and considerations related to the Use Case.

4.1. The Right Data for the Right People at the Right Time

In emergency situations, time is of the essence. It is critical that decision makers have the right data - accurate & reliable data - at the right time so they can make immediate decision and take action. In that light, great care must be given to ensure that only accurate and relevant data is brought together to create a Health Risk Index that Operations Managers can use to construct effective disaster response plans.

As in the case of Hurricane Maria, Emergency Operations Managers did not know the need for medical personnel until the response was already underway and it was too late to include medical personnel in the earliest stages of response. The Health SDI will highlight the medical and health needs of the impacted population so they can be addressed - and at the right stages of the response to have the greatest impact on saving lives.

Through field tests in later phases of this overall effort, we will ensure the data included in the Health Risk Index is comprehensive. Field tests will also ensure the Health Risk Index is coordinated with the First Responder communities' existing workflow and processes.

4.2. Semantic Mediation

Within the Healthcare space, there currently is limited semantic mediation overall. In other words, across the globe - and often also at local levels within individual health systems, the same medical conditions can be referred to differently. This does impact diagnosis and treatment to a certain extent. It also complicated medical research. There are efforts underway that indirectly aim to address or mediate such variation, one example being the current Gravity Project. A great value of a Health SDI is that it can be an effective and powerful tool for achieving Semantic Mediation within the space. The Health SDI can provide a platform for other industry efforts, including the Gravity Project, to achieve mediation.

4.3. Health Data

The Health Risk Index incorporates population-level health data that determines the population's risk of adverse health event specifically under the stresses of a natural disaster. This is related to, and a sub-case of general health risk. Included are data on the presence of health conditions and diseases that may be flair up in a disaster. Also included are data on the presence of those health conditions and diseases that are susceptible to health degradation after just one or two missed treatments or medication dosages. Disruption in treatment and medication dosage are common in disaster scenarios.

Also considered is data on those who are heavily reliant on infrastructure that may be unavailable in a disaster, such as transportation, power, community support, etc. The ambulatory status of the

underlying population is also considered. For instance, some individuals may simply need the evacuation route identified (and can drive themselves out of harm's way), others may need a vehicle for evacuation, others may need medical transport (e.g., ambulance), and still others may need assistance or stretchers from their home to the medical transport vehicle.

The health data gathered to produce the Health Risk Index has been merged into a single, new dataset called the HSR Medical Dataset that is published on the Health Geo Platform, or Health SDI.

4.4. Social Data

In order to determine a disaster-impacted population's health risks, data on social determinants of health (SDoH or social data) has been included in the Health Risk Index as social determinants are widely acknowledged as predictors of health outcomes. Care is given to include those SDoH factors that suggest how health posture may change in a disaster scenario - rather than the SDoH that inform health outcomes overall. In the disaster response scenario, it's important to know who the at risk patients are within the environment of that disaster event, and not just who may be at risk. One is a subset of the other, no doubt. In a disaster, where time and speed of response is of the essence, it is essential to address needs in the order of criticality.

The social data gathered to produce the Health Risk Index has been merged into a single, new dataset called the HSR Social Determinants Dataset that is published on the Health Geo Platform, or Health SDI.

4.5. Smart Cities

Smart Cities, and their large-scale application of distributed sensors, provide an exciting opportunity to continue and in fact drive further advancements in global health. Distributed sensors that are associated with smart cities can allow for new means of gathering data on the health risks present within communities at the population as well as at the individual level.

This constitutes both a larger and more real-time health data set that can help predict adverse health events, diagnose and treat patients, as well as monitor the success of prescribed treatments. And treatment plans that prove ineffective can be adjusted more quickly.

Examples include the use of sensors to:

- Monitor current bed occupancy and medical device utilization levels at hospitals, skilled nursing centers, and other medical facilities to enable seamless patient movement throughout the healthcare system.
- Monitor levels of medical supplies and other critical resources - to ensure treatment and care capacity is sufficient to meet demand and population health needs.

This information can address current challenges in assessing hospital and medical facility status during emergencies. Overall, the analytics that a smart city can provide will improve the ability to assess the overall medical care needs of the population.

4.6. Post-Disaster Recovery Needs

Assisting first responders address the needs of populations during a disaster is critical for saving lives.

It is also important to ensure post-disaster recovery leads to full restoration of the necessary healthcare service delivery capacity. The health risk index can be used to track overall recovery and adapting the index for such a purpose can certainly be an important and beneficial follow-on activity. For example, a storm that enables a source of pollutant to contaminate ground water can have an adverse impact on crop yields, area plant life and wildlife, as well as human health. Efforts to purify the water supply and rebuild safeguards can be tracked through the Health SDI to restore, or improve, pre-disaster population health risk levels.

Chapter 5. Scenarios and Tools

Demonstration

For the OGC Disaster Resilience Pilot, HSR’s philosophy of providing health-related insights at the point-of-care is being leveraged to design and deliver solutions to bring health data into the emergency or disaster response planning effort.

To do so, HSR is building a Health SDI to merge relevant health and social data related to a population’s risk of adverse health events due to a natural disaster. This is produced as a Health Risk Index at multiple geographic level scaling from the Global level (Figure 1), to the national or country level (Figure 2), and down to the Sub-National level, including the County and ZIP Code level (Figure 3) for the U.S.

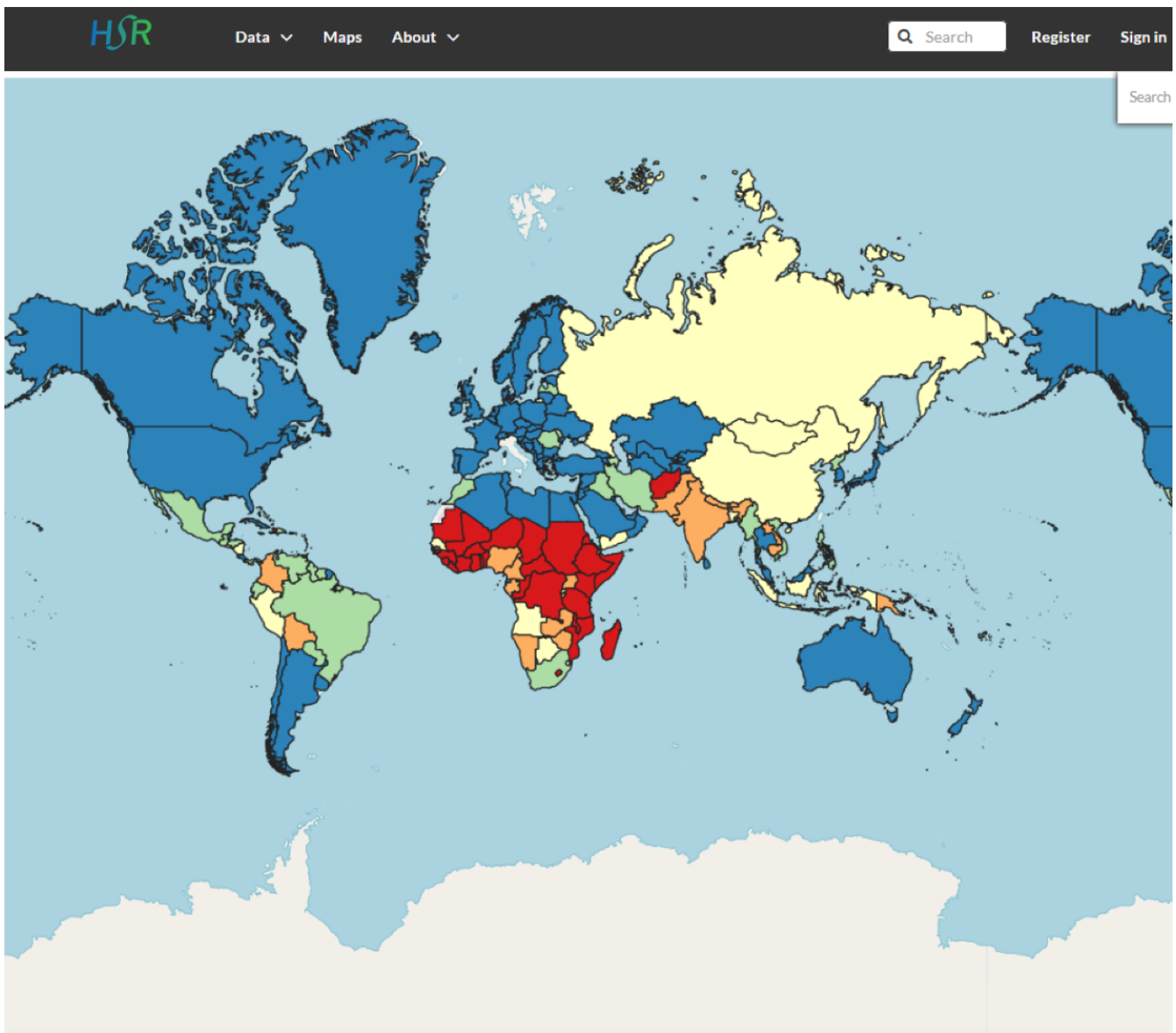


Figure 6. Health Risk Index Global Scale

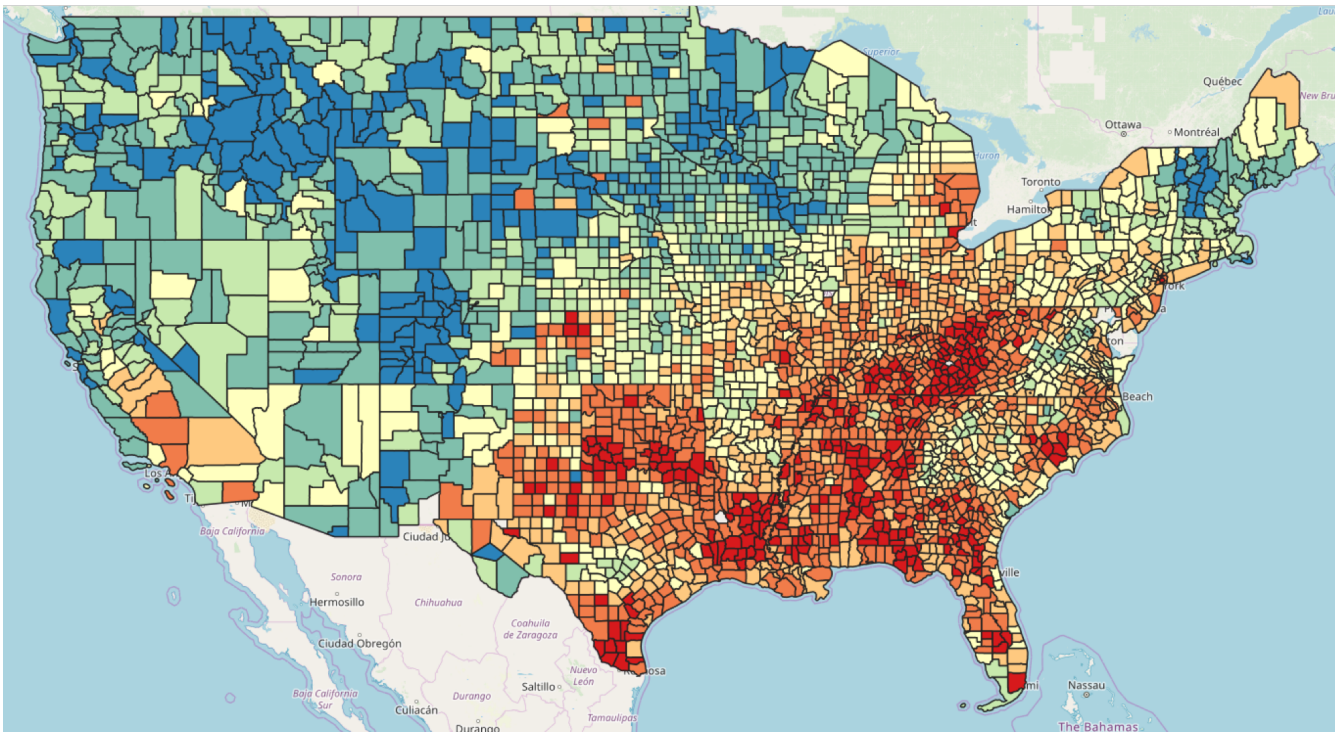


Figure 7. Health Risk Index National Scale

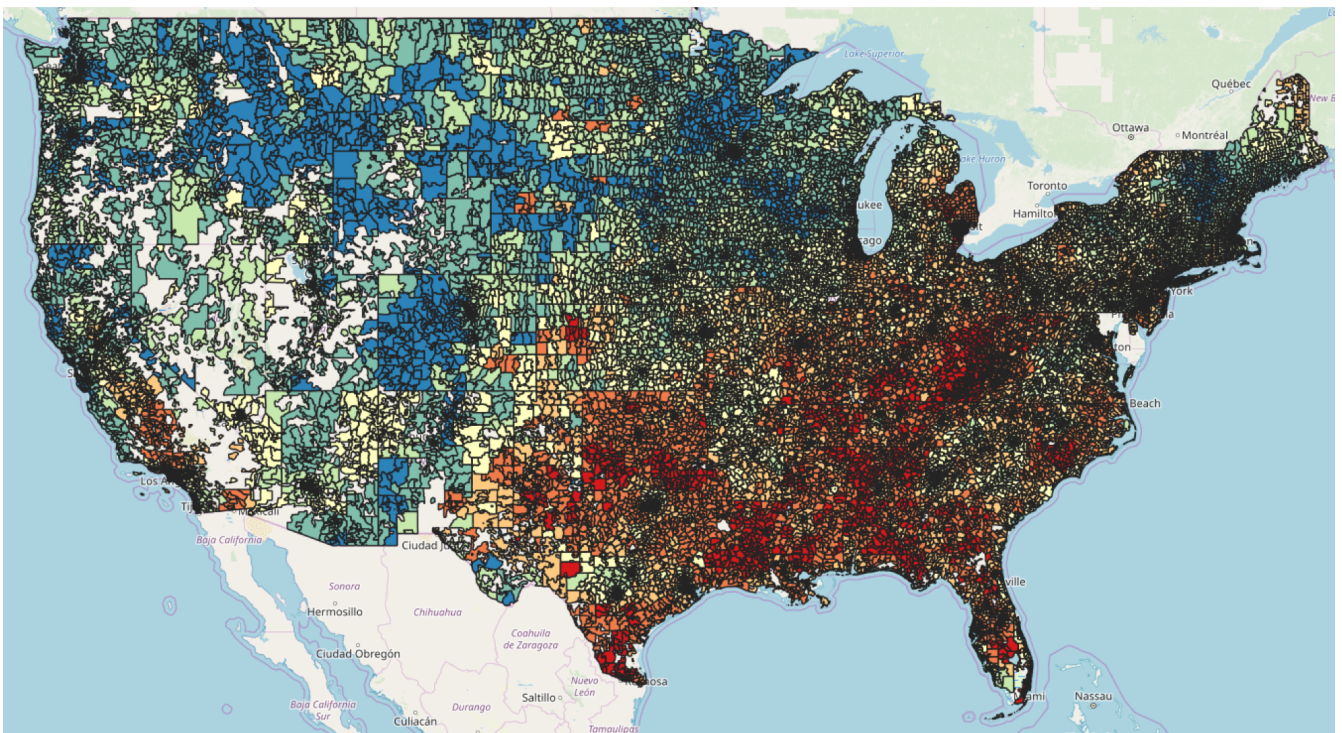


Figure 8. Health Risk Index ZIP Code Scale

5.1. Health Risk Index

Source	Field Name
CDC Social Vulnerability Index	Percent Persons below Poverty
CDC Social Vulnerability Index	Percent Civilian (age 16+) Unemployed
CDC Social Vulnerability Index	Percent Persons (age 25+) with no High School Diploma

CDC Social Vulnerability Index	Percent Persons aged 5 and younger
CDC Social Vulnerability Index	Percent Persons aged 65 and older
CDC Social Vulnerability Index	Percent Civilian Noninstitutionalized Population with a Disability
CDC Social Vulnerability Index	Percent Persons (age 5+) who Speak English "Less than well"
CDC Social Vulnerability Index	Percent Housing in Structures with 10 or more Units
CDC Social Vulnerability Index	Percent Mobile Homes
CDC Social Vulnerability Index	Percent More People than Rooms
CDC Social Vulnerability Index	Percent Households with no Vehicle Available
CDC Social Vulnerability Index	Percent Persons in Institutionalized Group Quarters
Dartmouth Atlas Data	Percent Elderly on High Risk Medications
Dartmouth Atlas Data	Percent Elderly Admitted for Ambulatory Care Sensitive Conditions
Dartmouth Atlas Data	Percent Elderly Readmitted within 30 Days
CMS Chronic Conditions	Percent Elderly with Arthritis
CMS Chronic Conditions	Percent Elderly with COPD
CMS Chronic Conditions	Percent Elderly with Asthma
CMS Chronic Conditions	Percent Elderly with Heart_Failure
CMS Chronic Conditions	Percent Elderly with Diabetes
CMS Chronic Conditions	Percent Elderly with Alzheimer's / Dementia
CMS Chronic Conditions	Percent Elderly with Autism Spectrum Disorder
U.S. Department of Transportation National Address Database	Address Data and Attributes

5.1.1. Audience

The primary audience for this effort includes:

- Emergency Operations Managers (Health Risk Index and Supplementary)

The Health Risk Index allows Emergency Operations Managers to quickly identify populations that most urgently need emergency services. This helps inform Emergency Operations Managers of the medical resources, personnel, and other needs they should anticipate in the disaster, at a County and ZIP Code levels.

- Emergency Medical Responders, or the On-the-Ground first responders (Specialized Supplementary Data)

More specific details are provided to Emergency Medical Responders on the local health posture that inform their delivery of medical service, such as Literacy levels, Mental Health, and Critical Conditions – again at the County and ZIP Code levels.

5.1.2. Publication of data

The Health Risk Index will be a published shapefile layer on the Health SDI at a County and ZIP Code level for the entire United States. The Health Needs Data will be contained within fields in the risk layer and will also be published as a document on the Health SDI. The Health and Social Determinants Datasets will also be published on the Health SDI as Documents.

5.1.2.1. In-situ Data

During field tests of the Health Risk Index, performed in Phase III of this pilot, effort will be made to build a feedback loop into the system to gain information from Emergency Medical Responders and other on-the-ground personnel and sensors that can feed into the overall planning and response effort. In addition, software and infrastructure, such as GeoSMS and Sensor API will also be explored to offer insights on the location of at-risk individuals.

5.1.2.2. Model Data

The Index includes health and social data that stratifies populations at the County and ZIP Code level to the risk of an adverse health event due to a natural disaster. There are several conditions that may flair up during a disaster and there are also several conditions that require regular and constant treatment (e.g., Dialysis) or medication-based management (e.g., diabetes) for which even a gap of one or two days or treatments can lead to a significant health impact, up to and including the loss of life.

Future phases of this effort will expand the Health Risk Index to the Census tract level.

5.1.2.3. Remote Sensing Data

The Health Risk Index leverages Remote Sensing Data for the base map.

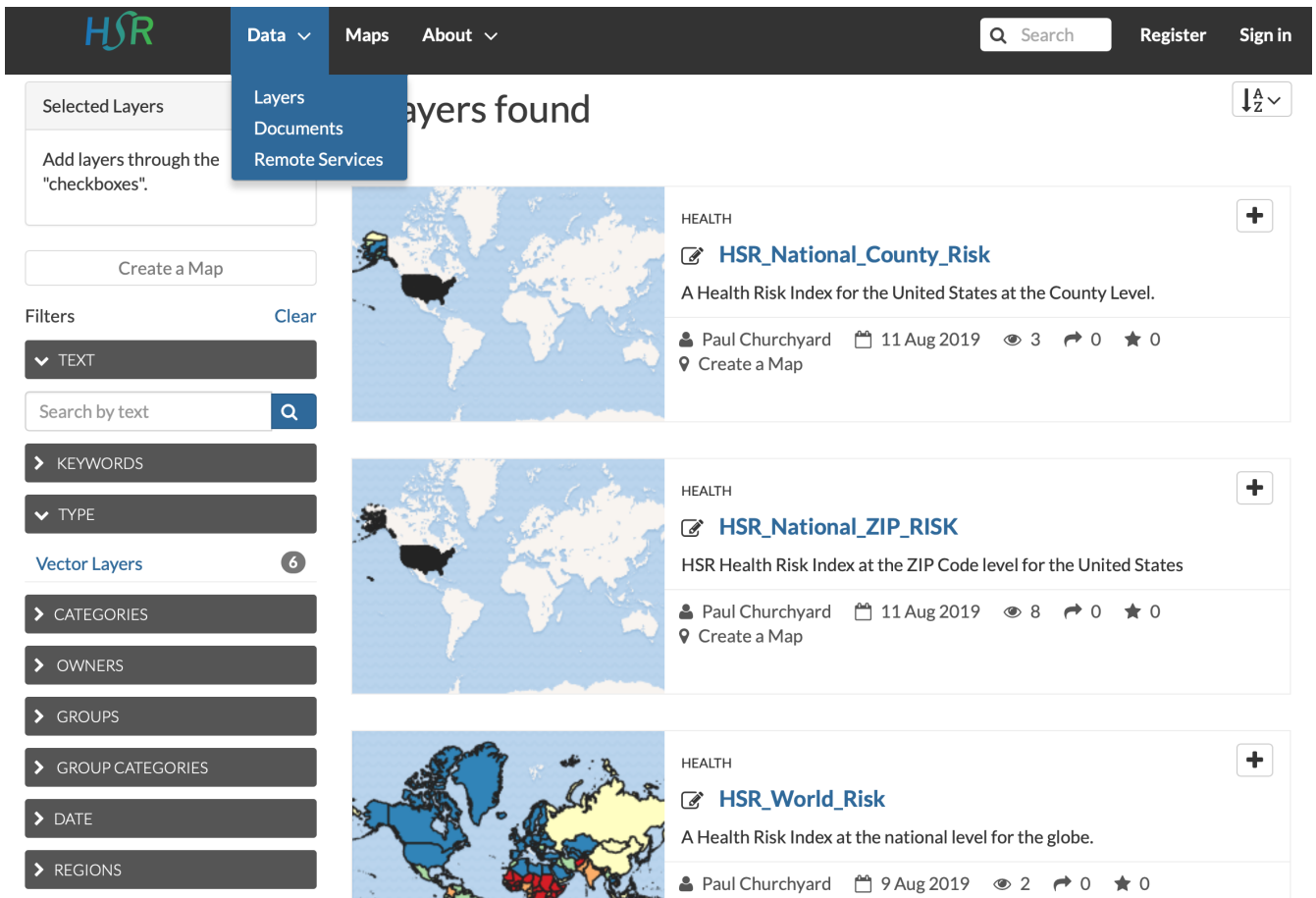
A number of remote sensing data is considered for future phases of this effort, partially including use of the Sensor API, the inclusion of Land Use and Land Cover Data to determine staging areas, accessibility issues, live situational awareness, status of transportation systems; Real-time situational awareness such as through drones; as well as leveraging the distributed Internet-of-Things (IoT) and Internet-of-Medical-Things (IoMT) sensors of Smart Cities to expand situational awareness, resource availability, and service capacity within healthcare, to advance emergency response efforts.

5.1.3. Registration of data

At this time, the Health Risk Index uses the most currently available data for the identified datasets that are in the public domain. Later phases of this effort will include discussion of licensing these data sets from providers to have access to either (or both) more regularly updated data and more current data (if available). These discussions will involve addressing and documenting policy and procedure issues, security and privacy issues, as well as the republication of data.

5.1.4. Discovering of data

The Health Risk Index and health needs data documents can be discovered through the Health SDI. The Health Risk Index at each geographic level can be accessed through the Layers data tab.



HSR

Data Maps About

Search Register Sign in

Selected Layers

Add layers through the "checkboxes".

Create a Map

Filters Clear

TEXT

Search by text

KEYWORDS

TYPE

Vector Layers 6

CATEGORIES

OWNERS

GROUPS

GROUP CATEGORIES

DATE

REGIONS

Layers found

HEALTH

HSR_National_County_Risk

A Health Risk Index for the United States at the County Level.

Paul Churchyard 11 Aug 2019 3 0 0

Create a Map

HEALTH

HSR_National_ZIP_RISK

HSR Health Risk Index at the ZIP Code level for the United States

Paul Churchyard 11 Aug 2019 8 0 0

Create a Map

HEALTH

HSR_World_Risk

A Health Risk Index at the national level for the globe.

Paul Churchyard 9 Aug 2019 2 0 0

Figure 9. Health SDI Layers Page

The health needs documents can be accessed through the Documents data tab.

The screenshot shows the Health SDI Documents Page. At the top, there is a navigation bar with 'Data', 'Maps', and 'About' menus, a search bar, and 'Register' and 'Sign in' links. Below the navigation, a 'Selected Documents' section shows 'Documents found' with a search icon. A sidebar on the left contains 'Filters' with categories like 'TEXT', 'KEYWORDS', 'DOCUMENT TYPE', 'CATEGORIES', 'OWNERS', 'GROUPS', 'GROUP CATEGORIES', 'DATE', 'REGIONS', and 'EXTENT'. The main content area displays a list of documents. Two documents are highlighted:

- HSR Social Determinants Dataset.xlsx**: Data on Social Determinants of Health for all ZIP Codes in the United States. FIELDS: ZIP, Num_Disabled, Total_Population, Age_U5, Age_65P, Non-Fluent. Author: Paul Churchyard, 11 Aug 2019, 2 views, 0 shares, 0 stars.
- HSR Medical Dataset.xlsx**: Linked HRR, ZIP, County geographies including, Chronic Conditions Data from CMS and CDC. FIELDS: hsanum, hscity, hsastate, hrrnum, hrrcity, hrrstate, HRR_name, Percent_of_beneficiaries_filling_prescriptions_for_high-risk_medications, Percent_of_diabetic_beneficiaries_age_65-75_receiving_recommende... Author: Paul Churchyard, 11 Aug 2019, 2 views, 0 shares, 0 stars.

A third document, 'NAPSIG Symbology', is partially visible below with the note 'No abstract provided'.

Figure 10. Health SDI Documents Page

5.1.5. Downloading of data

The Health Risk Index can be downloaded directly as a shapefile from the Health SDI or can be accessed through an OGC standard WMS layer. The health needs data can be directly downloaded as an Excel file from the Health SDI.

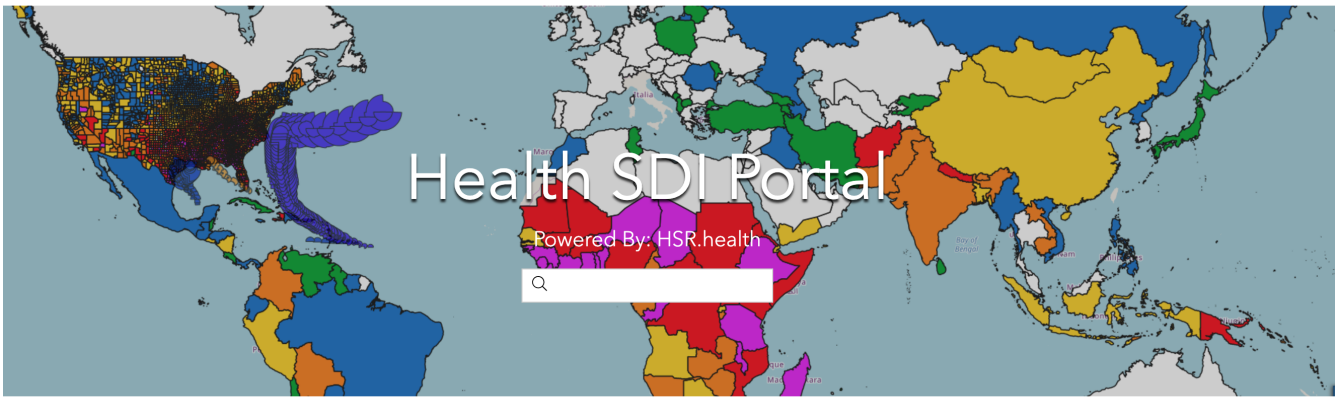
5.1.6. Data Integration

The Health Risk Index can be accessed through an OGC standard WMS layer allowing for partners like Esri and CompuSult to utilize the data in their platforms. This in turn allows for wide use of the information by Emergency Operations Managers and the First Responder community.

Predicted storm paths from NOAA or other sources of disaster impact areas can be overlaid with the Health Risk Index to retrieve the Index at all geographic levels. This provides targeted situational awareness to Emergency Operations Managers allowing for quick decision making in the impacted region.

5.1.7. Republication of data

The Health Risk Index can be republished following OGC standards through the Health SDI, such as through partners like Esri and CompuSult. The Health Risk Index is also available on the Health Community through GeoPlatform.Gov.



Volcano



Health



Category Link



Category Link

Figure 11. Health Community on GeoPlatform.Gov

5.1.8. Displaying of the data with proper symbology

The symbology used in the Health Risk Index is based on the symbology guidelines produced by the National Alliance for Public Safety GIS Foundation. This includes the symbols for hospitals, roads, the thematic coloring, as well as the legend.

The legend is a 7-point scale ranging from very low risk, or a white color on the map, to a extremely high risk, or purple. The greater the risk, the more urgent the need to provide appropriate medical care and intervention, up to and including potential evacuation to a specific medical facility, to the population within the geographic region.

Description/Examples for Use	Color	RGB	HEX
No severity or risk; Normal Operations/Status	White	255,255,255	#FFFFFF
Low severity or risk; No Damage; Open Status	Green	0,172,58	#00AC3A
Low to medium severity or risk; Alert/Action Notice	Blue	35,122,207	#237ACF
Medium severity or risk; Moderate damage	Yellow	255,215,24	#FFD718
Medium to High severity or risk; Watch Notice;	Orange	255,137,24	#FF8918
High severity or risk; Warning Notice; Severe Damage; Closed Status	Red	255,24,30	#FF181E
Extreme severity or risk; Highest category possible.	Purple	237,26,252	#ED1AFC

Figure 12. NAPSG Symbology Guidelines

Chapter 6. Conclusion and Way Forward

Phase I of the OGC's Disaster Resilience Pilot is a rousing success that demands further and continued action! This Chapter will summarize the successes, identifies lessons learned, and discusses specific considerations for the further development of a national Health SDI and this specific Health Risk Index.

6.1. Phase I of the Disaster Resilience Pilot

The OGC's Disaster Resilience Pilot is a response to a recognized gap in overall disaster response planning and execution - that is the lack of health information of disaster-impacted population. The response to Hurricane Maria demonstrated the consequences of that gap: If geospatial health and medical needs are not known in advance, efforts to address those needs may not be executed in the most timely fashion to have the greatest impact. This can lead to increased economic costs in addition to costs in human lives and suffering.

HSR is able to establish a Health SDI hosting a Health Risk Index to fill that gap by leveraging publicly available health and social data from numerous governments, research organizations, education institutions, and other sources. OGC standards can then be leveraged to provide that data to Emergency Operations Managers and Emergency Medical Responders directly, as well as through partner organizations. Further efforts (discussed below) will address licensing issues, field tests to refine the Health Risk Index, as well as ensuring the information is actionable by First Responder community by integrating with their current workflow and process flow. The end result will be more timely delivery of essential medical care and intervention resulting in fewer lives lost to natural disasters.

6.1.1. Lessons Learned:

- Prescription Drug Monitoring Programs and Health Information Exchange data sources.

The initial thought was that Prescription Drug Monitoring Programs (PDMP) and Health Information Exchanges (HIE) could be valuable data sources for the creation of the Health Risk Index. However, closer examination of these data repositories identified that these repositories are not entirely necessary. PDMP systems contain prescription data only related to Schedule I controlled substances and therefore is an incomplete set of prescription data. Further, controlled substances can be but may not be and often are not high-risk medications (prescribed medications for which the patient may suffer a potentially life-threatening complication with gap of even one or two dosages). In other words, a gap in the kinds of medications PDMP systems monitor may not result in a life-threatening situation for the patient. And therefore, this dataset may not be entirely relevant from an emergency response perspective. An additional source of data for High Risk Medication has been discovered through the CDC.

HIE systems are designed to support clinician look up of an individual patient's medical history, and not as ideal a source of population level health data. Various datasets from the CDC serve this purpose, along with data maintained at the State and County levels.

- Dialysis Patient Information

Dialysis is a critical medical condition as dialysis treatments must be administered on a regularly scheduled basis and often multiple times a week - and with the potential for life threatening complications with even one or two missed treatments. During the course of this effort, it became clear that an organization (DaVita, a provider of dialysis treatment) currently collects and coordinates information on dialysis patients around the country to facilitate continued treatments during disaster scenarios. DaVita currently interfaces with FEMA to a certain level and is interested in further improving their coordination and data sharing with FEMA and other emergency response organizations. This effort can help facilitate this improved data sharing.

- CDC's Social Vulnerability Index

The Agency for Toxic Substance and Disease Registry (ATSDR) within the CDC maintains a Social Vulnerability Index (SVI) that assesses the "resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks" (<https://svi.cdc.gov>). The Health Risk Index leverages the SVI in part. The purpose of the SVI is more broad than supporting disaster response efforts - which is a more narrow situational use case. However, the work done by the ATSDR and the CDC certainly advances the cause of identifying the health risk of disaster-impacted populations.

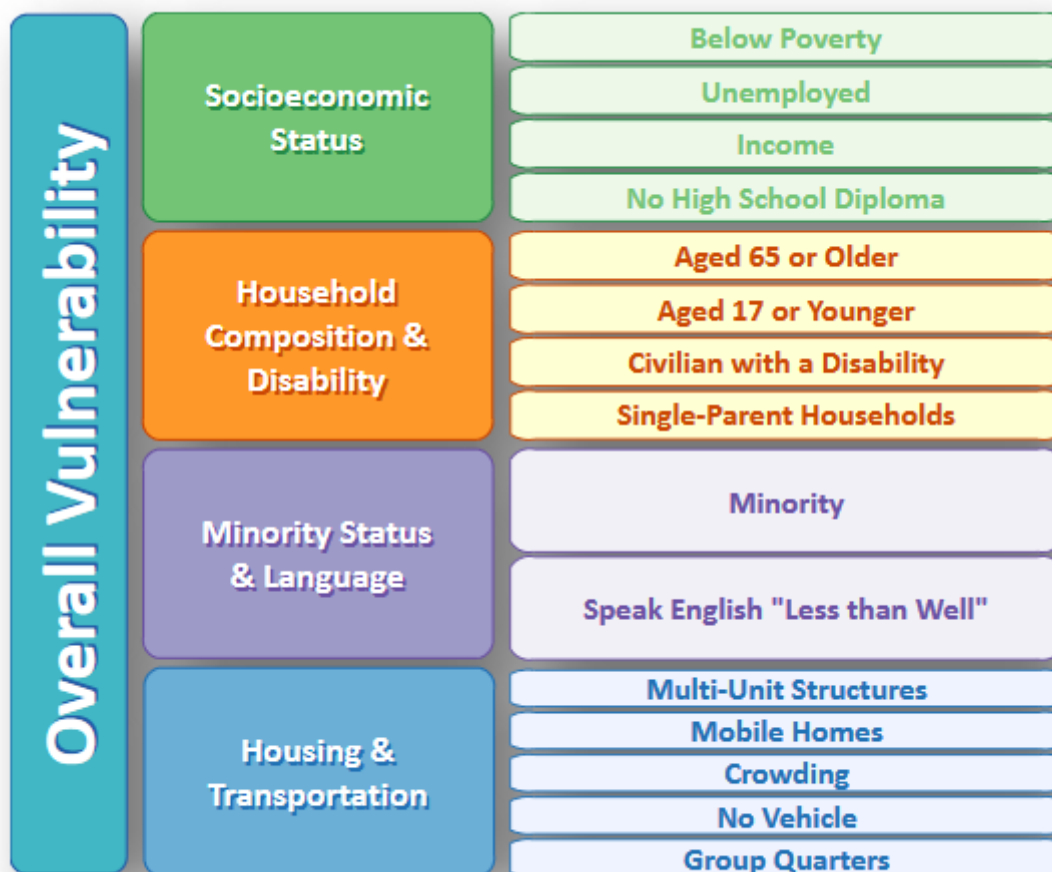


Figure 13. CDC's Social Vulnerability Index Data

- Hospital Status During Emergencies

Emergency Operations Managers learn of individual hospital and medical facility status during declared emergencies, such as inpatient bed availability and Emergency Department occupancy

rate, through a manual process. It has been reported that an individual within the Operations Command Center is tasked with calling hospitals to get their status. In Maryland, an electronic application serves as a digital interface for this manual process. Hospital staff report their status into an electronic system, and that status is then available to the State's Emergency Operations Managers. However, there is both a lack of timeliness in this reporting as well as a great deal of subjectivity leading to inconsistencies among hospital reports. An automated and standards-based system is required to inform Emergency Operations Managers of hospital status throughout disaster scenarios to optimize the coordination of medical care delivery during disasters.

- Data at the Address Level

In order to develop the Health Risk Index and the Health Needs data, publicly available health and social data at the National, State, County, and ZIP Code levels are sufficient. The Health SDI greatly benefits from the high quality data produced by the various and numerous data providers that have been leveraged in this effort.

However, in practice, First Responders will be further aided with data down to the most granular level possible - including at the Census tract and even at the address level. If an Emergency Medical Responder is tasked with evacuating a Dialysis patient to a medical treatment center, they will need an address for that individual.

As a demonstration, a percentage of addresses from a coastal ZIP Code in North Carolina that is within the Hurricane Dorian anticipated storm track have been pulled from the U.S. Department of Transportation's National Address Database (NAD) and shown in Figure 2 below. This percentage is the percentage of individuals with critical health conditions in that ZIP Code.

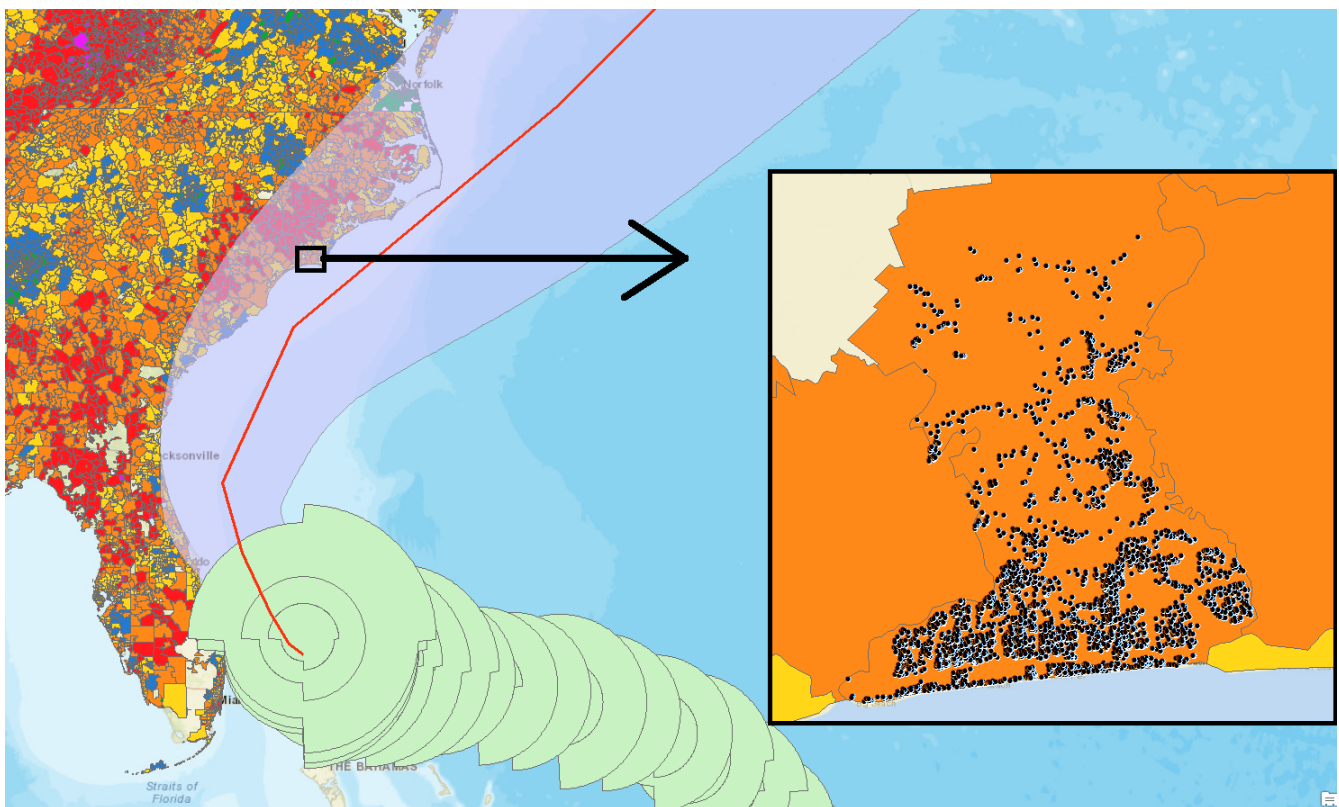


Figure 14. Demo of Address Data Sourced from National Addressed Database

This address data can be presented to Emergency Medical Responders as a part of the Health Needs information at either the County or the ZIP Code layer, as shown in Figure 3 below.

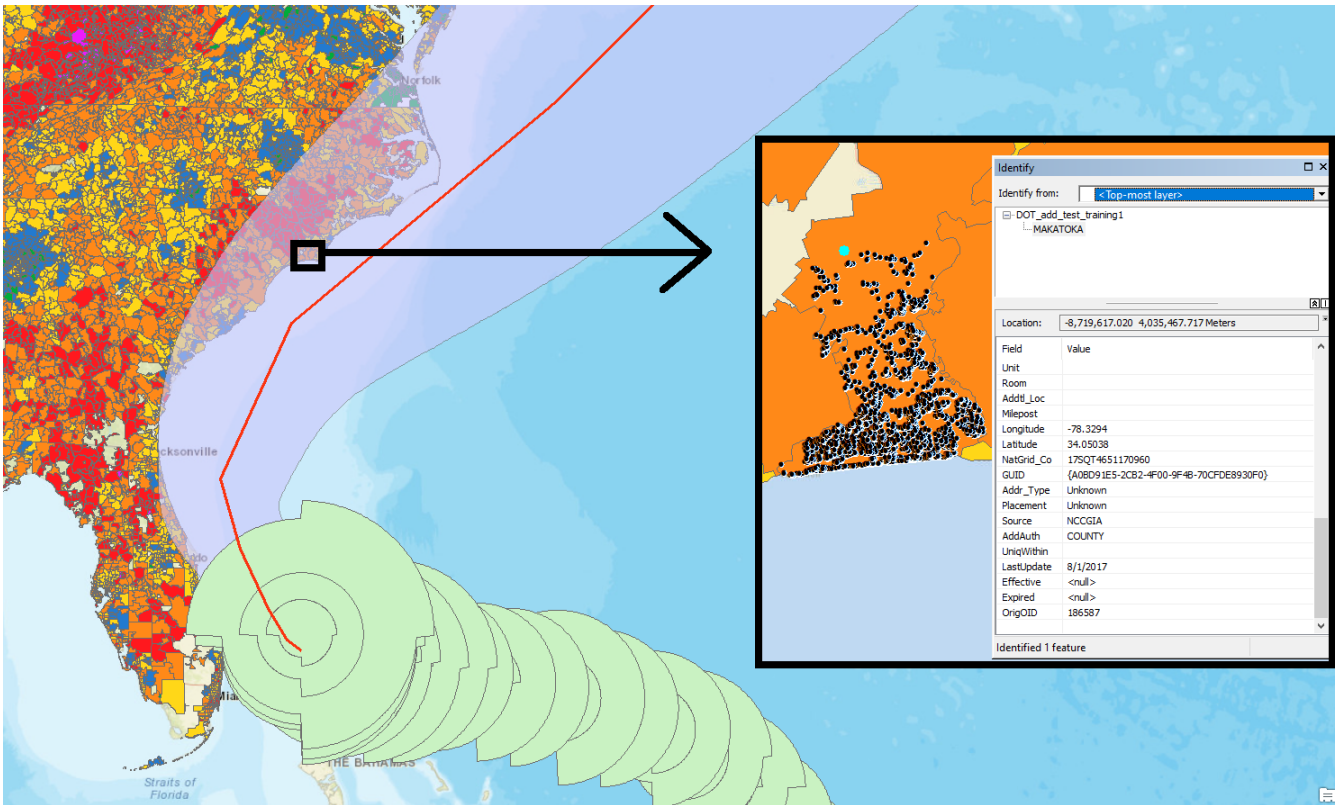


Figure 15. Address Data and Attributes Shown at the ZIP Code Level

The value of the NAD is that it contains longitude and latitude data as well as (at times) landmark data that can help actually find an address, especially in a disaster scenario when roads, etc., may be flooded, and debris may complicate finding a particular home or residence.

HSR commits to working with the data providers on licensing, policy and procedure, as well as security and privacy issues to access and provide the Health Risk Index and Health Needs data at the Census tract and address level.

6.2. Way Forward

In Phase II of this effort, HSR will work to formalize the data sharing Policy and Procedure agreements with all data providers. Currently, publicly available data sources are sufficient for assessing the initial health risk of an impacted population to a specific disaster event - however, closer to real-time data will be more helpful for both response planning as well as on-the-ground delivery of emergency medical care. This Phase II effort will discuss with data owners the licensing, policy, and procedures issues involved in accessing the most currently available data (hopefully closer to real-time), as well as data at the Census tract and address level. Data at the Census tract and address level will involve security and privacy considerations.

In addition, HSR will continue to search and determine optimal data sets and sources for inclusion in the Health Risk Index. This will include exploring data at the Census tract and the address levels.

In Phase III of this effort, the Health Risk Index will be refined through formal field tests with FEMA, their peers, and all current and potential new partners within and/or serving the First Responder community. This will also ensure the Index conforms to the First Responder community's planning and execution workflows.

In addition, HSR will also work with the provider community on mechanisms to identify, track, and aid post-disaster recovery efforts. In other words, depending on the size and scope of the disaster, the underlying health posture of a community may change - demanding specific and targeted efforts to reverse that impact. For example, a storm that enables a source of pollutant to contaminate ground water can have an adverse impact on crop yields, area plant life and wildlife, as well as human health. Efforts to purify the water supply and rebuild safeguards can be tracked through the Health SDI to restore, or improve, pre-disaster population health risk levels.

6.2.1. Smart Cities

Smart Cities, and their large-scale application of distributed sensors, provide an exciting opportunity to continue and in fact drive further advancements in global health. Distributed sensors that are associated with smart cities can allow for new means of gathering data on the health risks present within communities at the population as well as at the individual level.

This constitutes both a larger and more real-time health data set that can help predict adverse health events, diagnose and treat patients, as well as monitor the success of prescribed treatments. And treatment plans that prove ineffective can be adjusted more quickly.

Examples include the use of sensors to:

- Monitor current bed occupancy and medical device utilization levels at hospitals, skilled nursing centers, and other medical facilities to enable seamless patient movement throughout the healthcare system.
- Monitor levels of medical supplies and other critical resources - to ensure treatment and care capacity is sufficient to meet demand and population health needs.

This information can address current challenges in assessing hospital and medical facility status during emergencies. Overall, the analytics that a smart city can provide will improve the ability to assess the overall medical care needs of the population.

6.2.2. Post-Disaster Recovery Needs

Assisting first responders address the needs of populations during a disaster is critical for saving lives.

It is also important to ensure post-disaster recovery leads to full restoration of the pre-disaster health posture of the population. Disasters may cause harm to the environment, key infrastructure, as well as the healthcare service delivery capacity all of which can change the health posture of a community. The health risk index can be used to track overall recovery and adapting the index for such a purpose can certainly be an important and beneficial follow-on activity.

Specifically, the Health Risk Index can identify the possible post-disaster health risks to the disaster-impacted region as well as the wider, surrounding area and population. This can include disaster-related complications such as, for example, contaminated water and soil, destroyed roads, transportation and other infrastructure, destroyed hospitals and other medical service buildings and infrastructure, damaged crops and food supply. This information will be of interest to the CDC for disease containment, state/local government, economic development representatives, as well as community groups.