Community Risk, Vulnerability, and Resilience Data Module

Tari Martin
National Alliance for Public Safety GIS Foundation

June 2021

FEMA

Table of Contents

Tutorial: Resilience Analysis and Planning Tool (RAPT)

In this exercise, you will use FEMA's RAPT (https://www.arcgis.com/apps/webappviewer/index.html?id=90c0c996a5e242a79345cdbc5f758fc6) to develop data-driven capability targets to support your community's Threat and Hazard Identification and Risk Assessment (THIRA).

Audience: Preparedness planners and decision-makers who need to prioritize the allocation of resources and assistance.

Problem: A need to understand the potential impacts of a forecasted, modeled, or actual disaster on people and infrastructure within a specific region and the core capabilities required to respond.

Solution: Leverage data and analytical tools available in the RAPT.

What is the RAPT?

The Resilience Analysis and Planning Tool (RAPT) is a free GIS web mapping application that allows federal, state, local, tribal, and territorial emergency managers and other community leaders to examine the interplay of census data, infrastructure locations, and hazards, including real-time weather forecasts, historic disasters, and projected hazard risk.

By combining data layers, users can create community maps to inform preparedness, response, and recovery strategies. Additionally, the application provides analysis tools to identify the characteristics of a population that can inform planning requirements during an emergency.

View the RAPT StoryMap before getting started: https://www.arcgis.com/apps/Cascade/index.html?appid=1f788c5b5a044034b6ca7f3b2ff55597.

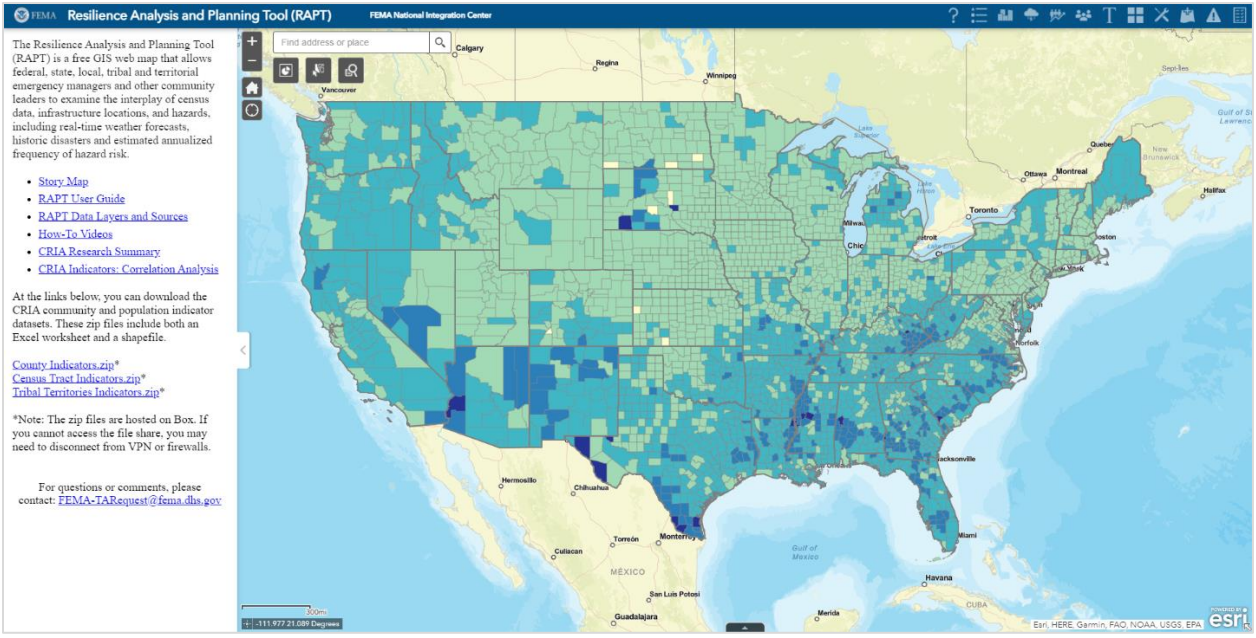

Figure 1. Access FEMA's RAPT (https://www.arcgis.com/apps/webappviewer/index.html?id=90c0c996a5e242a79345cdbc5f758fc6).

The Scenario

This tutorial will guide you through leveraging data and geospatial analytical tools to assess potential impacts and plan for needed capabilities for a high-risk hazard identified in a community's hazard mitigation plan.

SCENARIO

The Commonwealth of Virginia has well documented historical hazards in their All-Hazard Mitigation Plan. In the following hypothetical scenario, we will walk through using the RAPT and available data to support the development of a data-driven capability target for a THIRA/Stakeholder Preparedness Review (SPR).

One of the scenarios identified as potentially the most challenging threat and hazard is a repeat of a historic tornado through a densely populated region with a higher concentrated rate of poverty in the Commonwealth. A little to no-notice event such as a tornado, particularly in a densely populated area, would likely stress the community's ability to achieve public information and warning target Core Capability (https://www.fema.gov/emergency-managers/national-preparedness/mission-core-capabilities/development-sheets), identified in the National Preparedness Goal as the ability to:

> *Deliver coordinated, prompt, reliable, and actionable information to the whole community through the use of clear, consistent, accessible, and culturally and linguistically appropriate methods to effectively relay information regarding any threat or hazard, as well as the actions being taken and the assistance being made available, as appropriate.*

From the hazard mitigation plan, you know this community has been described as having a higher vulnerable population percentage. For the THIRA, you are looking for a data-driven approach to understanding more specifically:

- The characteristics of the community and their unique needs (elderly, language barriers, lack of transportation).
- What other infrastructure now exist in the community that could be impacted by a similar tornado.
- What geographic area, which if hit by a tornado, would stress the region's capabilities and resources greatest.

BACKGROUND

Hazard mitigation planning reduces the loss of life and property by minimizing the impact of disasters. It begins with state, tribal, and local governments identifying natural disaster risks and vulnerabilities that are common in their area. After identifying these risks, they develop long-term strategies for protecting people and property from future events. Mitigation plans are key to breaking the cycle of disaster damage, reconstruction, and repeated damage. View Hazard Mitigation

Planning Resources for State, Tribal, and Local Governments (https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning).

The THIRA is a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks by answering the following questions:

- What threats and hazards can affect our community?
- If they occurred, what impacts would those threats and hazards have on our community?
- Based on those impacts, what capabilities should our community have?

The outputs from this process lay the foundation for determining a community's capability gaps as part of the SPR. The SPR is a self-assessment of a jurisdiction's current capability levels against the targets identified in the THIRA. The THIRA/SPR is the first of six steps identified by the National Preparedness System (https://www.fema.gov/emergency-managers/national-preparedness/system) which outlines an organized process for achieving the National Preparedness Goal. The National Preparedness Goal (https://www.fema.gov/emergency-managers/national-preparedness/goal) describes five mission areas — prevention, protection, mitigation, response, and recovery — and 32 activities, called core capabilities, that address the greatest risks to the nation.

For this scenario, we will look at **Public Information and Warning** although the steps and tools could be applied across the Mission Areas to assess multiple Core Capabilities.

Planning

Public Information and Warning

Operational Coordination

Prevention	***Protection***	***Mitigation***	***Response***	***Recovery***
Intelligence and Information Sharing Interdiction and Disruption Screening, Search, and Detection Forensics and Attribution	Intelligence and Information Sharing Interdiction and Disruption Screening, Search, and Detection Access Control and Identify Verification	Community Resilience Long-term Vulnerability Reduction Risk and Disaster Resilience Assessment Threats and Hazards Identification	Infrastructure Systems Critical Transportation Environmental Response/Health and Safety Fatality Management and Suppression Logistics and Supply Chain Management	Infrastructure Systems Economic Recovery Health and Social Services Housing Natural and Cultural Resources

Prevention	*Protection*	*Mitigation*	*Response*	*Recovery*
	Cybersecurity Physical Protective Measures Risk Management for Protection Programs and Activities Supply Chain Integrity and Security		Mass Care Services Mass Search and Rescue Operations On-scene Security, Protection, and Law Enforcement Operational Communications Public Health, Healthcare, and Emergency Medical Services Situational Assessment	

Communities identify, through the THIRA/SPR process, what threats and hazards would **most challenge** their ability to deliver one or more of the core capabilities.

ADDITIONAL RESOURCES

FEMA provides Core Capability Development Sheets (https://www.fema.gov/emergency-managers/national-preparedness/mission-core-capabilities/development-sheets) to aid organizations in developing targets to build or sustain their capabilities and close identified gaps.

Communities seeking additional guidance to understand the differences between Hazard Mitigation Planning and THIRA/SPR or looking to streamline both efforts can consult FEMA's Job Aid: Increasing Resilience using THIRA/SPR and Mitigation Planning (https://www.fema.gov/sites/default/files/2020-09/fema_thira-hmp_jobaid.pdf).

BEST PRACTICE: CONVERT PLAN DOCUMENTS INTO GEO-ENABLED PLANS

What is geo-enabled? Emergency management plans, such as a community's Hazard Identification and Risk Assessment (HIRA) or Hazard Mitigation Plan, are full of critical information on where the risk for specific threats and hazards are the greatest, the potential impacts to the built and natural environments and the economy, and potential actions to mitigate and/or reduce those risks. These documents are often static and live in binders or on your organization's computer network.

Geo-enabling plans allow for the intended audience (decision-makers, operators, first responders, support staff) to view the geography, hazard exposure, critical infrastructure, resources, and population attributes, among others, in conjunction with their roles and responsibilities, under

various scenarios. Geo-enabled plans can display historic event data (hazard extent and impacts) to assist with preparedness activities as well as display live feeds to assist operators in shifting to the readiness and response phases.

Additionally, States and Locals are geo-enabling their Emergency Management Plans to inform the public of risks to their community and encourage preparedness activities.

Learn more about Geo-Enabled Plans in FEMA's Preparedness Toolkit: Geo-Enabled Plans - Hazard Explorer - Preparedness Toolkit (fema.gov) (https://preptoolkit.fema.gov/web/hazard-explorer/geo-enabled-plans).

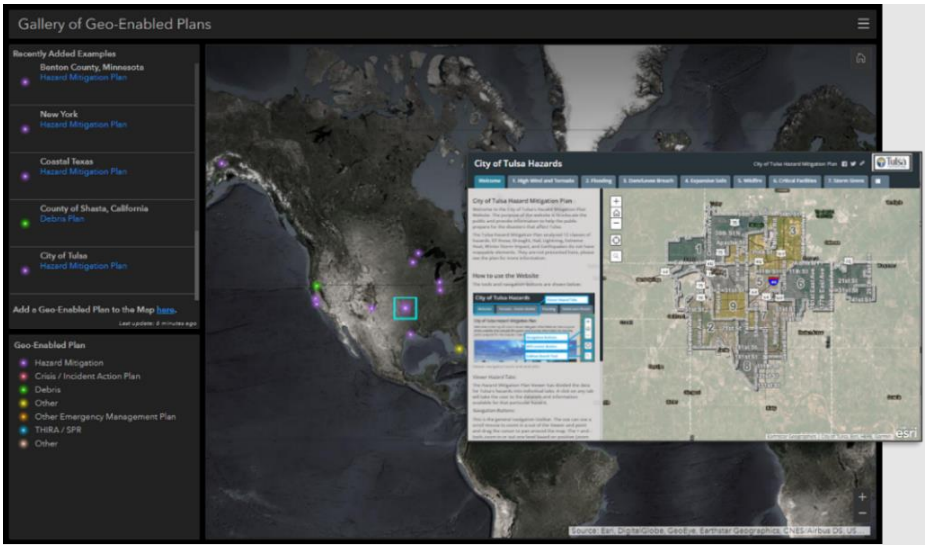

Figure 2. NAPSG Foundation Curated Gallery of Geo-Enabled Plans. https://arcg.is/1eqLz1

The Tutorial

1. Review a Community's Hazard Mitigation Plan

For our scenario, we will use the Commonwealth of Virginia's Hazard Mitigation Plan (https://drought.unl.edu/archive/plans/GeneralHazard/State/VA_2018.pdf) which is made publicly accessible by the Virginia Department of Emergency Management.

1. In your browser, go to the **Commonwealth's Hazard Mitigation Plan**.
2. Review Chapter 3: **Hazard Identification & Risk Assessment** to understand the risk of various natural hazards to Virginia and general population considerations that factor in the risk posed by natural hazards.
3. Review the **summary description of selected disasters**, which describe historic events that posed unique challenges. (Section 3.3, Page 4).

4. Review Section 3.5: **Hazard Assessment and Ranking Methodology**, which describes the criteria for the Hazard, Vulnerability, and Risk Assessment.

Note: States can develop their own methodology for completing a risk assessment. FEMA provides general guidance for jurisdictions; however, all plans should identify and describe hazards, identify assets, analyze risks, and summarize vulnerability.

METHODS FOR IDENTIFYING IMPACTS FROM HAZARDS INCLUDE

- **Historical Analysis Method**: May include data and a discussion of past insurance claims, reported property losses, or recorded injuries and fatalities from hazards. Reporting on the impacts of past events can indicate the impact of future events of a similar size. Common data sources for historical occurrences include flood insurance claims from FEMA's Community Information System; insured crop losses from the USDA Risk Management Agency; and the National Oceanic and Atmospheric Administration's (NOAA) Storm Events Database. States should work with their environmental and natural resource agencies to identify the availability of risk data related to historical events.

- **Exposure analysis**: Identifies assets located in identified hazard areas, usually by using geographic information system (GIS) overlays. Completing an exposure analysis in GIS is an efficient way to identify the state assets that are within the impact area of each hazard. This analysis will highlight which assets and communities may be affected by the hazard. It also results in a map of the vulnerable areas, and the assets within these areas, to visually demonstrate the areas of risk.

- **Scenario analyses**: Predicts the impact of hazard events and can be completed using modeling software, like Hazus-MH (https://www.fema.gov/flood-maps/products-tools/hazus). Modeling or scenario software determines a hazard's impact based on the defined extent and location of the occurrence and then uses the data to identify the assets and communities that would be impacted by this occurrence. Hazus-MH data are available for flood, earthquake, and hurricane wind events.

Source: View State Mitigation Planning Key Topic Bulletins: Risk Assessment (https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-risk-assessment-bulletin_06-03-2016.pdf) to see the Critical Steps and varying methodologies based on available data and modeling capabilities.

Explore other state and local Mitigation Plans in FEMA's Hazard Mitigation Plan Status Map (https://arcg.is/1nWH1P).

2. Explore Historical Hazardous Events

The **RAPT** is a free GIS web map that allows federal, state, local, tribal, and territorial emergency managers and other community leaders to examine the interplay of census data, infrastructure locations, and hazards, including real-time weather forecasts, historic disasters, and projected

hazard risk. Communities looking to review historic events to inform their various emergency plans can view historic tornado and hurricane tracks, or the estimated annualized frequency of 15 natural hazards on the map display and conduct further analysis, within the RAPT interface.

Tip: For additional help on navigating the RAPT application, consult the training resources (https://www.fema.gov/emergency-managers/practitioners/resilience-analysis-and-planning-tool) including How-To Tutorials and Instruction Guides.

2.1 VIEW HAZARD DATA AVAILABLE IN RAPT

In the next step, you will use the RAPT Application to explore historic disaster events in our region of interest.

1. In your browser, open the RAPT (https://www.arcgis.com/apps/webappviewer/index.html?id=90c0c996a5e242a79345cdbc5f758fc6).
2. In the search bar on the top left of the map window, enter **Richmond, VA** to zoom your map to roughly the central-eastern portion of the Commonwealth.
3. Collapse the **left panel** to maximize your map window.
4. Select the **Hazards** icon button (storm cloud) located on the Navigation Bar above the map window.
5. Expand each hazard to view the categories that will be displayed for that hazard by selecting the **grey arrow** to the left of the Hazard Layer Name.

Note: The differences in hazard data available: Regions of risk, historical tracks, and current severe weather events.

[See below for a screenshot of steps]

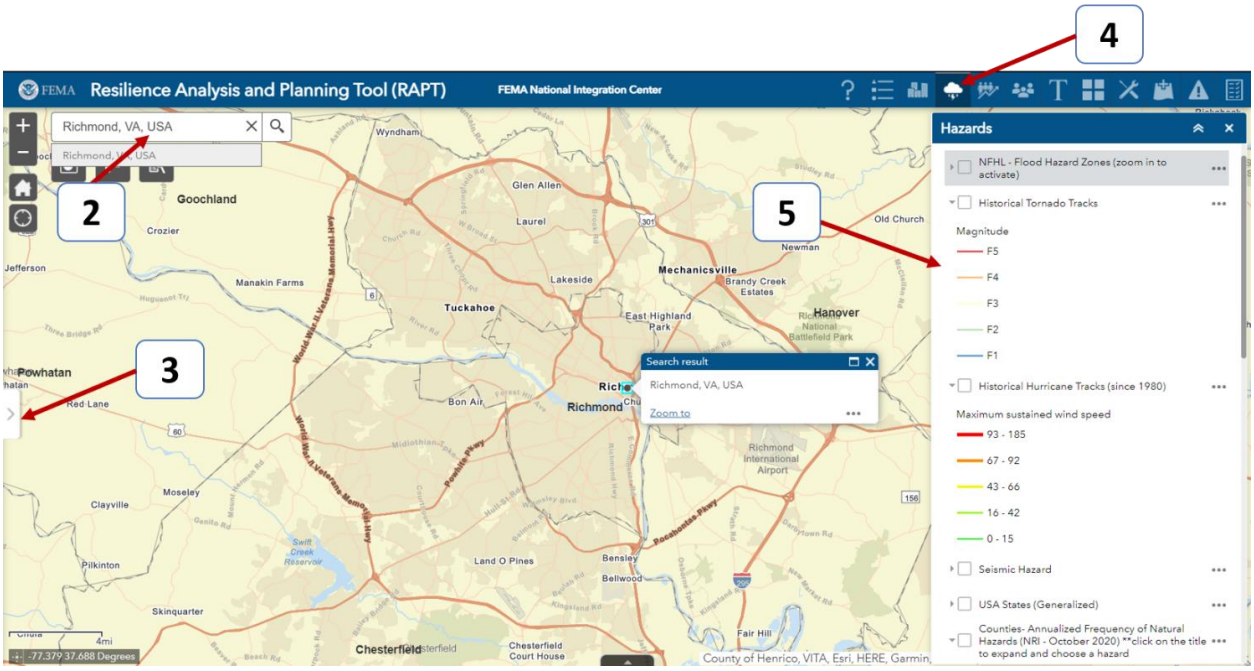

Figure 3.

2.2 VIEW HISTORIC TORNADO EVENTS

Next, we will review historic tornado events available in RAPT that were described in the Hazard Mitigation Plan and begin to give them context should they occur today.

1. Toggle the **Tornado Hazard** on in the **Hazards** window.
2. Select the ellipses (three dots) next to **Historical Tornado Tracks** and select **View in Attribute Table**.

A table with the data behind each Tornado hazard opens below the map window. Notice the number of tornadoes showing may be smaller than expected. The attribute table defaults to only showing the features (tornado paths) that are visible in the current map extent. Recall some of the more significant tornadic events, i.e., **Tornado in 1973** across Northern Virginia (near Fairfax) and the **Super Tornado Outbreak in 1974** that resulted in 8 tornadoes occurring across Virginia.

3. Sort the table by **Year**. **Zoom out** (if needed) to show the **1973 Tornado**. Select the tornado that matches the image by clicking on the square to the left of the row. Notice that the tornado path also highlights in the map window.
4. Click on the highlighted Tornado Path to view the pop-up window that displays the details of that event in plain language. Ex: Fujita Scale vs mag.

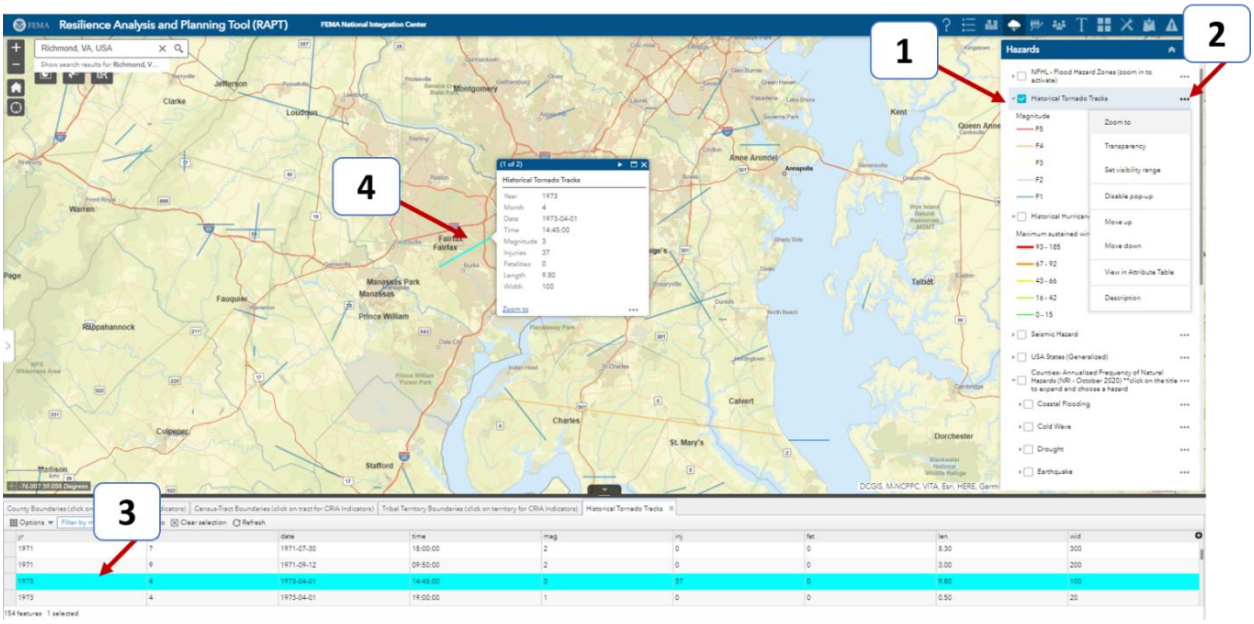

Figure 4.

2.3 REVIEW TORNADO HAZARD METADATA

Geospatial data is rich in information and includes location and attribute information for the specific feature mapped, as well as details on how the data was derived, the date, the precision, the accuracy, and may include intended uses. Analysts and decision-makers must understand the source, quality, and relevance (https://www.e-education.psu.edu/geog160/node/1922) before using for analysis and/or for the basis of operational decisions.

1. Sources of data layers available in RAPT can be consulted in the **RAPT: Data Layers and Sources** document. The link to the latest version (https://www.fema.gov/sites/default/files/documents/fema_rapt-user-guide-2022.pdf) can be accessed directly from the **left pane** in the RAPT interface.
2. Review the document and familiarize yourself with the various sources of data. Locate the **Hazard Data Sources** table and follow the link for the source to the Tornado Hazard.
3. The Severe Weather Data (SVRGIS) GIS Data page describes the source of the Tornado data (https://www.spc.noaa.gov/wcm/#data), the attributes (columns of information) available for each tornado (https://www.spc.noaa.gov/wcm/data/SPC_severe_database_description.pdf), and the update from the Fujita Scale to the Enhanced Fujita Scale.

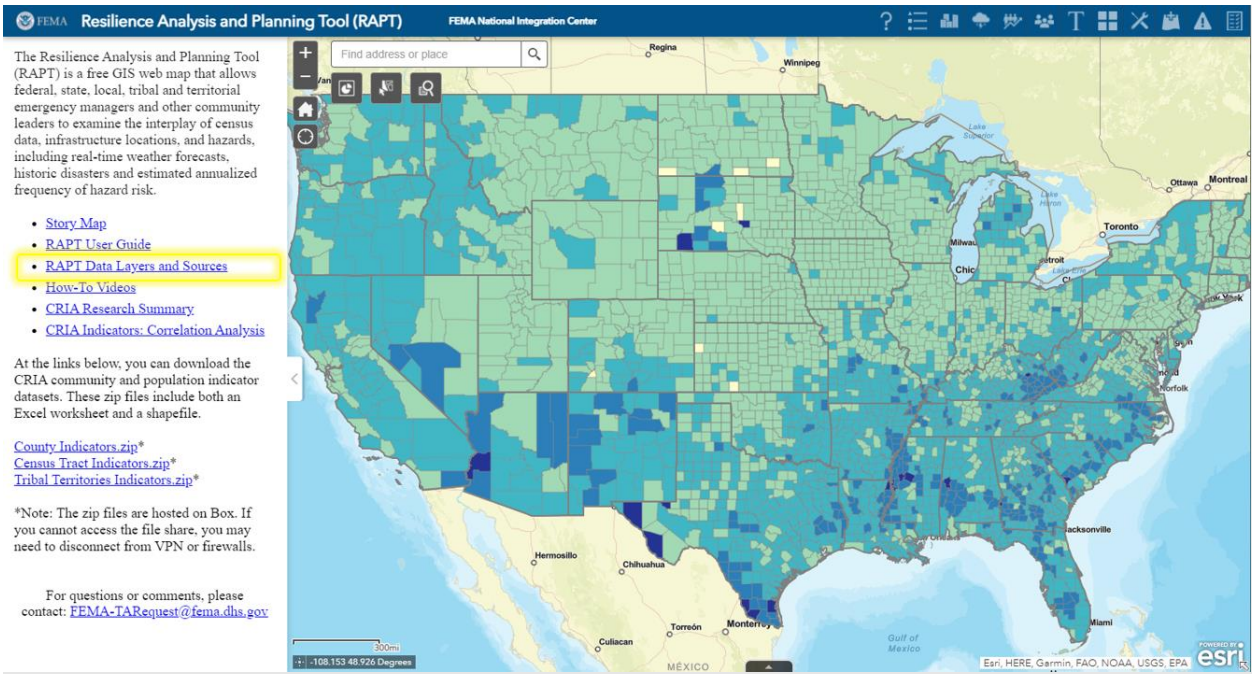

Figure 5.

2.4 EXPLORE IMPACTS USING A HISTORIC EVENT

Event Summary Excerpt:

> ***Tornado in 1973****: This F3 tornado is noteworthy because it touched down in heavily populated areas of Northern Virginia and caused $25 million in damages. The tornado touched down in Prince William County and traveled through the cities of Fairfax and Falls Church before dissipating. Fairfax was hit hardest by this tornado; within a 6-mile damage path, a high school, two shopping centers, an apartment complex, and 226 homes were damaged or destroyed. 37 people were injured.*

Next, we will run an analysis tool to determine what could be impacted today from a similar event that might require special planning considerations.

1. Select the 1973 **Tornado path** that traveled and then the **ellipses (Step 2)** at the bottom of the pop-up box to open available tools. Click on **Set as Incident (Step 3)**.

   Note: If another map feature gets selected, use the arrow at the top of the pop-up box to scroll through map features until the tornado path is selected.

4. Update the **Buffer** Distance to **1 Mile**.

5. Scroll through the different facility types listed in the blue **Incident Analysis** bar along the bottom to view infrastructure that falls within the 1-mile impact area and could be potentially impacted by similar tornado today.

[See below for a screenshot of steps]

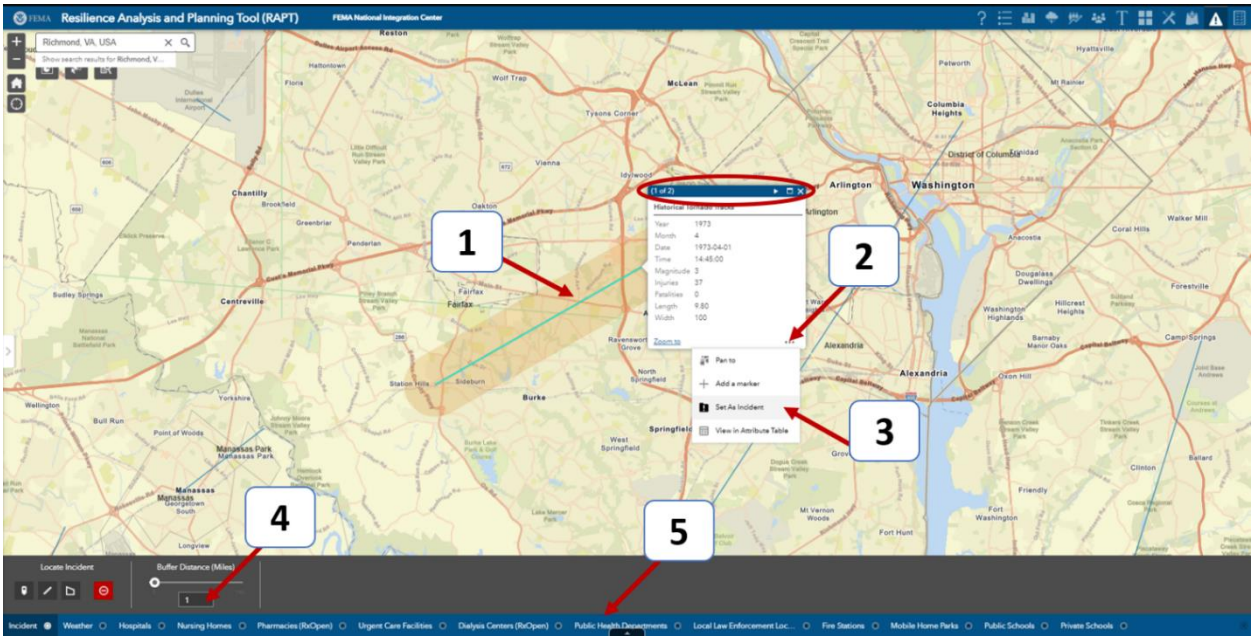

Figure 6.

Communities rely on critical government services and business functions to support day-to-day needs and those community assets enable society to function. Their disruption during a disaster can delay recovery and cause further harm. Recognizing the vital role community assets play in improving survivor outcomes, FEMA developed the Community Lifelines Construct (https://www.fema.gov/emergency-managers/practitioners/lifelines), which makes community lifelines a core focus of incident response. View The National Response Framework 4th Edition (https://www.fema.gov/sites/default/files/2020-04/NRF_FINALApproved_2011028.pdf), finalized in 2019.

The Lifelines construct in support of response planning and operations is most effective when applied across the entire preparedness cycle. Jurisdictions can, for example, build and deliver the response core capabilities needed to respond to a hazard; and develop plans to assist in resorting basic services, community functionality, and economic activity.

View the potential impacts of the 1973 Tornado in the present-day to the Health and Medical Community Lifeline. Recall that the critical components of the Health and Medical Lifeline include medical care, patient movement, public health, fatality management, and the medical supply chain.

1. Click through the different facilities listed at the bottom still showing from the **Incident Analysis**.
2. **Selecting** on the facilities in the map will open the **pop-up** to more information on the facility.

- What information can you glean to support planning? What type of facility is it? What critical services could be lost? Who might be impacted? How many might require transport, specialized medical transport, or sheltering?

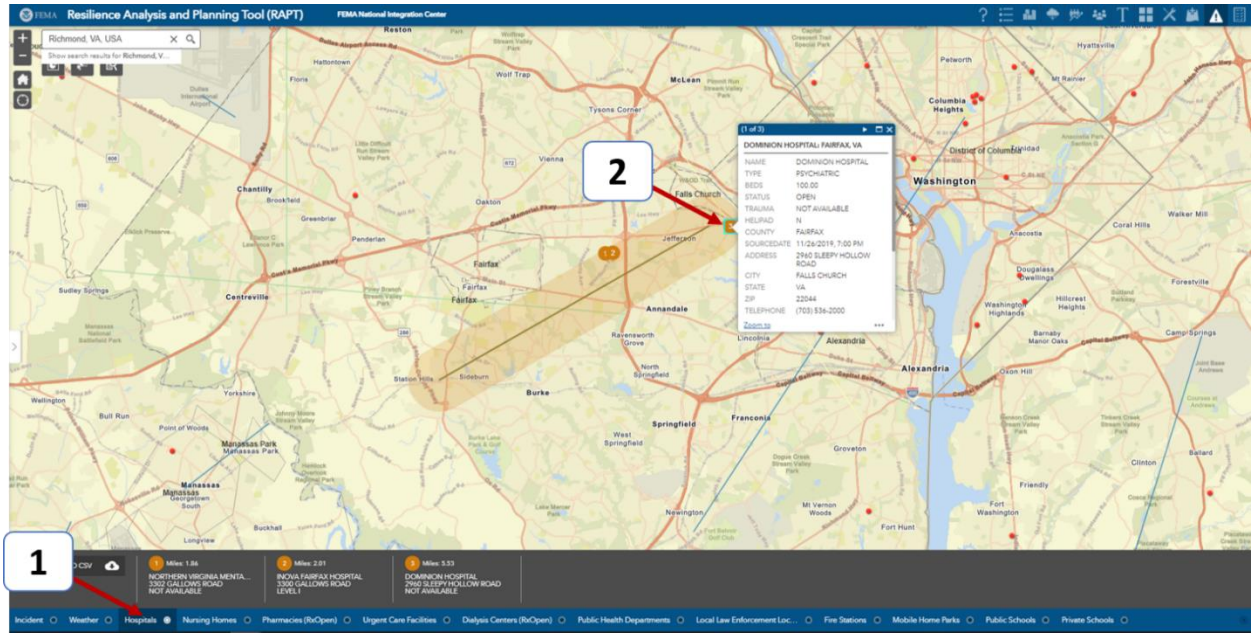

Figure 7.

3. Review Questions and Data Requirements for a THIRA

In the previous step, we reviewed a Hazard Mitigation Plan which included outputs from a HIRA. Sources such as a Community's HIRA can inform Step 1 of the THIRA, "Identify Threats and Hazards". Now that we have an understanding of the threats and hazards of concern and reviewed some of the available analysis, we want to give the threats and hazards context to determine potential impacts and begin to understand what scenario could **most challenge** a **core capability**.

Step 2 of the THIRA asks communities to assess the impacts a particular scenario would have on their community based on details such as location, magnitude, and time of an incident. Estimated impacts can be derived from real-world events, plans, exercises, subject matter experts, modeling, tools, etc.

Example questions that provide context and understanding of the challenges of a specific hazardous event:

Impact Categories
(#) jurisdictions affected
(#) people affected
(#) people with access and functional needs (affected)
(#) affected healthcare facilities and social service organizations
(#) people with limited English proficiency affected

For a complete list of standardized impact language, view the 2019 National THIRA: Overview and Methodology (https://www.fema.gov/sites/default/files/2020-06/fema_national-thira-overview-methodology_2019_0.pdf).

4. Explore Population Characteristics in the Community of Interest

The **Community Resilience Indicator Analysis or (CRIA)** is the underlying resilience indicator analysis within RAPT. CRIA aggregates 20 commonly used resilience indicators (both population and community-focused) to provide insight into how individuals and the community as a whole will cope with disasters. Communities can view the aggregated resilience indicator at the county level and explore each of the 20 variables that informed community's relative resilience at the county. 12 of the variables are available at the census tract level and 13 are available at the Tribal level.

Population-Focused	***Community-Focused***
Education Attainment	Hospital Capacity
Unemployment Rate	Medical Professionals
Disability	Affiliation with a Religion
English Proficiency	Presence of Mobile Homes
Home Ownership	Public School Capacity
Mobility	Population Change
Age	Hotel/Motel Capacity
Household Income	Rental Property Capacity
Income Inequality	Connection to Civic/Social Org
Health Insurance	
Single-parent Household	

The RAPT can help with understanding the underlying characteristics of a community that could require additional planning and support. To ascertain the planning considerations that might be needed to support communities that have relatively low resilience for any one of these variables, it is important to understand their connections to resilience.

1. Select the **CRIA Research Summary** link on the **left panel** to view a synopsis of each indicator and the research rationale behind the identified indicators as a measure of community resilience.
2. Review the connection to each of the indicators.

- What can be inferred by the higher presence of community-focused indicators in relation to resilience?

4.1 EXPLORE CRIA LAYERS

Next, we will investigate the characteristics of a community using CRIA in the Commonwealth of Virginia that could further assess how threats and hazards could challenge their ability to deliver core capabilities.

1. **Zoom** to the Commonwealth of Virginia.
2. Select the **County Indicators** button in the **Navigation Toolbar** at the top right.
3. Turn on the **Aggregate Resilience Indicator 2021** layer. Notice that each county has been sorted into one of five bins to create a choropleth map.

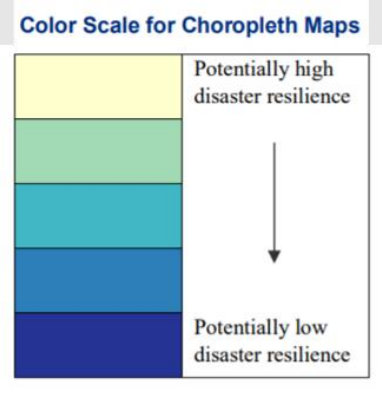

Figure 8.

4. Counties in the Commonwealth range from above to below average (2-4) out of the 5 Relative Resilience Bins. Zoom further in to turn on County names and select a few to explore further.
5. Next, we will explore neighboring jurisdictions, Henrico County, and the City of Richmond. With the County Aggregate Indicator Layer turned on, Richmond has a Relative Resilience of -0.48, and Henrico County has a relative Resilience of .18.

- What indicators appear to most influence their positive or negative relative resilience?
- Are these factors connected?

Tip: Review the Correlation Analysis findings in the [CRIA: County-Level Analysis of Commonly Used Indicators from Peer-Reviewed Research - 2020 Update](https://www.fema.gov/sites/default/files/documents/fema_2022-community-resilience-indicator-analysis.pdf) (https://www.fema.gov/sites/default/files/documents/fema_2022-community-resilience-indicator-analysis.pdf).

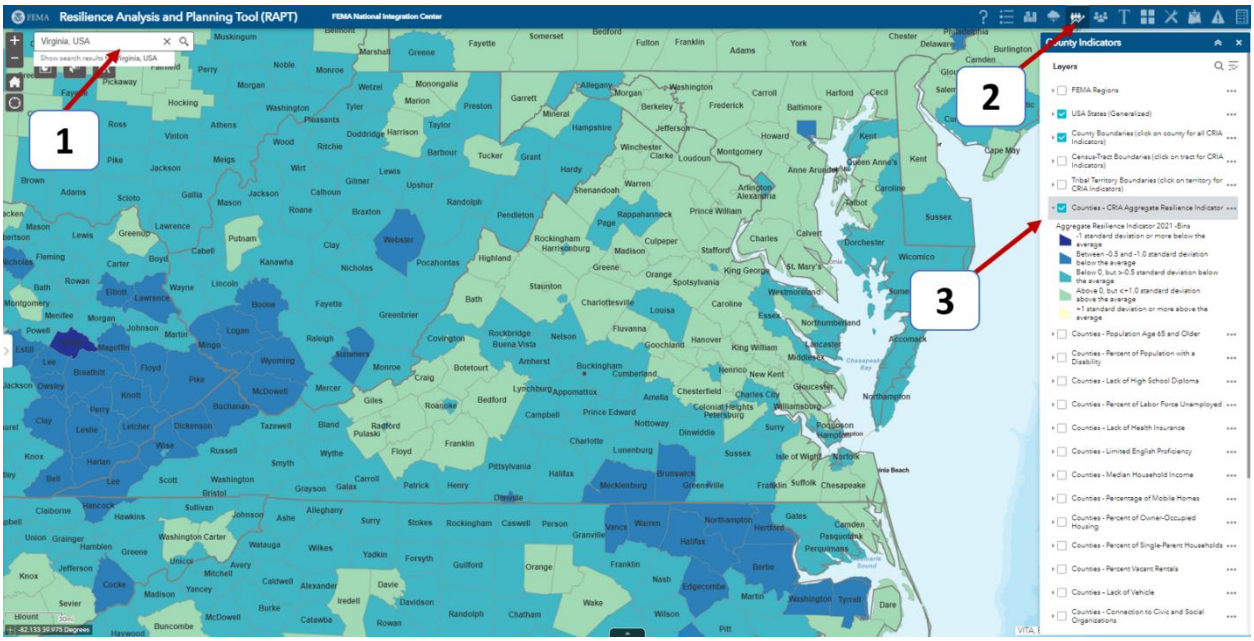

Figure 9.

4.2 VIEW RESILIENCE INDICATORS AT THE CENSUS TRACT

Communities are rarely homogenous. To better understand specific communities and geographies that might require the most support and potentially strain resources during a disaster, we will view CRIA at the Census Tract level. Census tracts are small, relatively permanent statistical subdivisions of a county or equivalent entity that range in population between 1,200 and 8,000 people, with an optimum size of 4,000 people (U.S. Census: https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13). This relatively consistent boundary and small scale allow for more granular examination and statistical analysis over time.

1. If needed, zoom back into the City of Richmond/Henrico County region.

Recall some of the differing factors between the City of Richmond and Henrico that led to the different relative Aggregate Resilience Indicator Values for each of the communities.

- What factors were less present in the City of Richmond but were more prevalent in Henrico?
- What factors that may be related to each other, are present at significantly higher rates in the City of Richmond?
- Can you start to narrow in on communities that trend in the lower bins more frequently?

CRIA Indicators	*Henrico, Virginia*	*Richmond, Virginia*
County Population	327,535	226,622
Percent Age over 65	14.99%	12.83%
Percent with a Disability	11.14%	15.21%
Percent without HS Diploma	8.26%	14.60%
Percent Unemployment	4.40%	6.50%
Percent Lacking Health Insurance	7.60%	12.00%
Percent HH with Limited English Proficiency	2.87%	2.40%
Median HH Income	$70,307	$47,250
Percent of Mobile Homes	0.51%	0.50%
Percent of Owner-Occupied Housing	58.69%	38.32%
Percent of Single Parent HH	22.50%	38.73%
Vacant Rental Rate	4.70%	4.60%
Percent of HH without a Vehicle	5.47%	16.49%
Income Inequality (GINI Index)	0.46	0.54
Percent of Religious Adherents	50.90%	52.70%
Health Diagnosing and Treating Practitioners per 1,000	22.60	22.25
Public School per 5,000	1.27	1.32
Hotels/Motels per 5,000	1.11	0.91
Social and Civic Organizations per 10,000	0.65	1.18
Hospitals per 10,000	0.06	0.23
Population Change as a Standard Deviation	0.21	0.67
Aggregate Resilience Indicator	0.18	-0.48

*Demographic Data as of 2021.

5. View Infrastructure in the Region of Interest

The presence or lack of certain types of infrastructure may impact the resilience of a community. For example, both the presence of hospitals and their capacity to serve the community can positively impact a community's resilience, both because it represents the capacity of the healthcare system to support residents' overall health and to provide critical emergency medical care. Conversely, the lack of this critical capacity can negatively affect a community's ability to respond to and recover from disasters.[1] The presence of higher numbers of mobile homes are related to lower levels of resilience because of the lower-quality construction of these homes and the lack of basements, which makes them particularly susceptible to damage from hazards.

Within RAPT, infrastructure layers can be viewed overlaid on both county and census tract resilience indicators to further explore the interplay of specific types of infrastructure and resilience. Infrastructure data available in RAPT comes from the Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data portal (https://hifld-geoplatform.opendata.arcgis.com). HIFLD Open is publicly available national foundation-level geospatial data. Communities may have access to local, more up-to-date geospatial data that can be consulted or added to RAPT directly for a higher level of analysis.

1. Select the **Infrastructure** button on the Navigation menu.
2. Toggle on and off the different Infrastructure data layers pre-loaded in RAPT, paying attention to their location in relation to the census tracts and different Resilience Indicators.

- View Infrastructure related to the **Health and Medical Community Lifeline**. Is there a pattern of availability of this essential community infrastructure?
- Are there regions lacking accessible health and medical facilities that also have a significant population without medical insurance?

3. Toggle on the **Mobile Homes** Infrastructure Layer.

- How does the presence of mobile homes correlate to areas of higher disability, unemployment rate, lack of health insurance, or percent without a high school diploma?
- Is there a correlation between household income and medical professional capacity?
- What added challenges would a hazardous event in this or a similar region need to plan for?

[1] ANDRI: Phil Morley, Melissa Parsons, and Sarb Johal, 2017, "The Australian Natural Disaster Resilience Index: A System for Assessing the Resilience of Australian Communities to Natural Hazards," Bushfire & Natural Hazards CRC. https://www.bnhcrc.com.au/research/hazard-resilience/251, accessed March 27, 2018.

Hint: You can change the transparency of any of the data layers by selecting the ellipses next to the layer name.

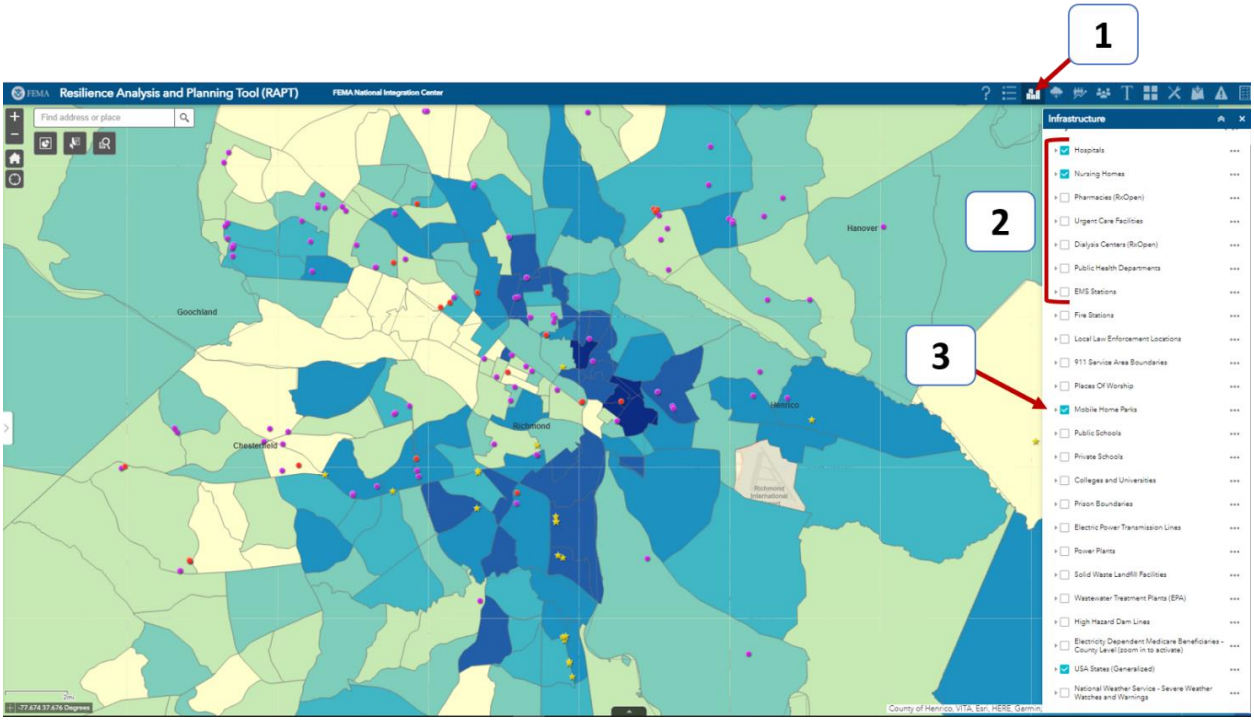

Figure 10.

Optional Step: Add the City of Richmond boundary to get a clearer view of what census tracts fall within the City.

1. Select the **Add Data** button in the Navigation menu.
2. **Search** ArcGIS Online for "Richmond boundary."
3. To determine which of the results is for the correct Richmond and is also from an authoritative source, select **Details** from the results.
4. One of the top results returned is from the City of Richmond's Assessor's Office. Select this authoritative data layer for your map by clicking on **ADD**.
5. **Note**: A detailed boundary has been added to your map. To improve the drawing speed of RAPT which contains many national-level datasets, some data layers are drawn using a generalized (simplified) polygon.
6. **Close** the Add Data window by selecting the **X** in the top right.

Important: Adding data is temporary. If you close or refresh the webpage, data added will not persist and will need to be added again.

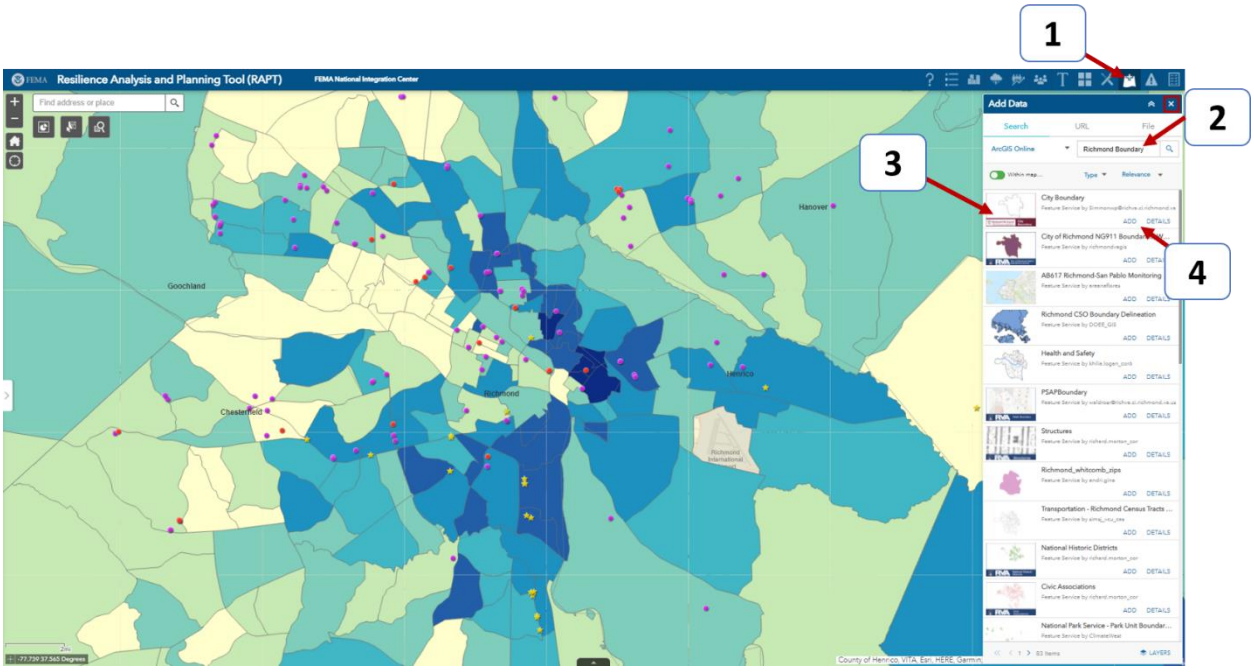

Figure 11.

6. Estimate the Potential Impacts of a Tornado Event

Next, we will review a couple of different hazard scenarios to get a sense of the potential impacts, i.e., the population that could be impacted that would require (notification/transportation/sheltering/mass care), and the infrastructure that could be damaged.

Turning on and off each of the individual indicators, we can start to see which census blocks fall into the lower bins more often, indicating they may require additional and special support post-disaster. Selecting a hypothetical path through the community allows us to quantify the potential, total population impacted, and the characteristics of the population that may require specialized outreach during preparedness activities (see tutorial #2).

Within RAPT are multiple analysis tools available to identify, summarize, and count people and infrastructure.

- **Selection Tools** (located below the Search Bar): Multiple actions are available for infrastructure and census or counties selected in the tool.
- **Summarize Selected Indicators**: Get a quick summary of a specific indicator, i.e., the percentage of the population with a disability within an area.

For our purposes, we will focus on a region near the eastern side of the City. Planners could go through the following steps focusing on different indicators and regions to get a better sense of their capabilities that could be stressed. To start, we will need to turn on the layers needed for our analysis.

1. If necessary, **zoom** back into the City of Richmond and open the **Census Tract** Layer Window.
2. **Toggle** through each of the **Indicator layers** to narrow in on an area that falls into the lower bins for multiple resilience indicators, **select** an **indicator** to summarize, e.g., disability, home ownership, etc.
3. Open the **Infrastructure** window and turn on infrastructure that might require special planning for vulnerable populations, e.g., nursing homes, hospitals, mobile homes, etc.

6.1 ESTIMATE IMPACTS TO INFRASTRUCTURE

Next, we will use the tools within RAPT to select an area and identify facilities that could be impacted by our Tornado scenario as required in developing impact estimates for a THIRA. In Step 2, communities complete the Standardized Impact Categories for each scenario.

Example impacts include:

- (#) jurisdictions affected.
- (#) people affected.
- (#) people with access and functional needs (affected).
- (#) affected healthcare facilities and social service organizations.
- (#) people with limited English proficiency affected.

There are multiple ways to identify infrastructure within an area in RAPT. In Section 3.3, we used the Incident Analysis Tool to view facilities that intersected a historic tornado path. In the next steps, we will use the Selection Tools to select facilities and summarize population characteristics.

1. If necessary, ensure the Infrastructure that you are interested in are turned on using the **Infrastructure** button in the Navigation menu.
2. Click on the **Selection** button located under the Search bar in the map.
3. Scroll down and ensure the boxes next to the infrastructure layers you selected are checked and the “County Boundaries (Click on county for all CRIA Indicators)” and “City Boundary” is not checked (this will allow us to only summarize census tract data).
4. Click on the dropdown arrow in the green Select box and choose **Select by polygon** to select the census tracts you identified earlier, ensuring you include the infrastructure in your shape.

   Hint: The Census Tracts Layer for your selected CRIA Indicator must be turned on in the map to view the ones your polygon selects.
5. Follow the instructions on the **grey box** that appears when you hover over the map. Select the Clear if needed to redraw and get the tracts and infrastructure as desired.

Extra Credit: Select any of the Layer Names that show an Infrastructure count greater than zero to view a list of selected features. Alternatively, return to the main Select window and select the ellipses to view them in a table and export to a *.csv.

- What infrastructure, if impacted in this scenario could stress the community?
- We previously identified Public Information and Warning as a Core Capability that might be most challenging in a little to no-notice event in a densely populated area. Review the 32 Core Capabilities. What other capabilities could be stressed in this scenario?

[See below for a screenshot of steps]

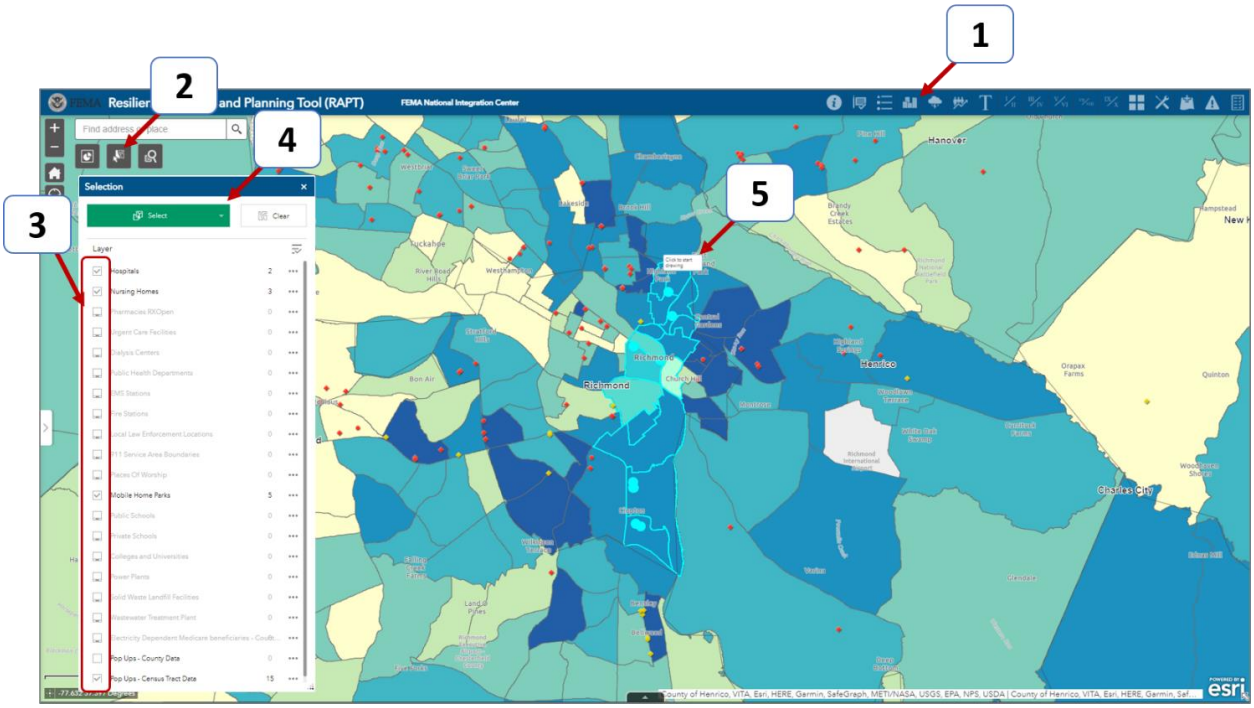

Figure 12.

6.2 ESTIMATE IMPACTS TO PEOPLE

1. Open the **Summarize Selected Indicators** button on the Navigation menu.
2. Use the **polygon** option to select a line simulating a tornado path. Follow the tool directions to **draw a shape on the map** to select the Census Blocks that would be impacted by our hypothetical tornado.
3. Choose the **Indicator** you selected to leave displayed in the previous Step 2 "Toggle through each of the Indicators…" to summarize the population within the selected census tracts by that Indicator. Click **Run**.
4. The population summary for that indicator will display in the **bottom window**.

- Are you able to start to answer some of the impact language required using this tool?
- Are the population statistics for the area within the tornado path?

Tip: For organizations with advanced geospatial capabilities, you can export your Tornado path and share it with your GIS Analysts to potentially run a more granular analysis. This might include estimating the number of households impacted to refine your population estimates; parcels impacted to estimate economic impacts; etc.

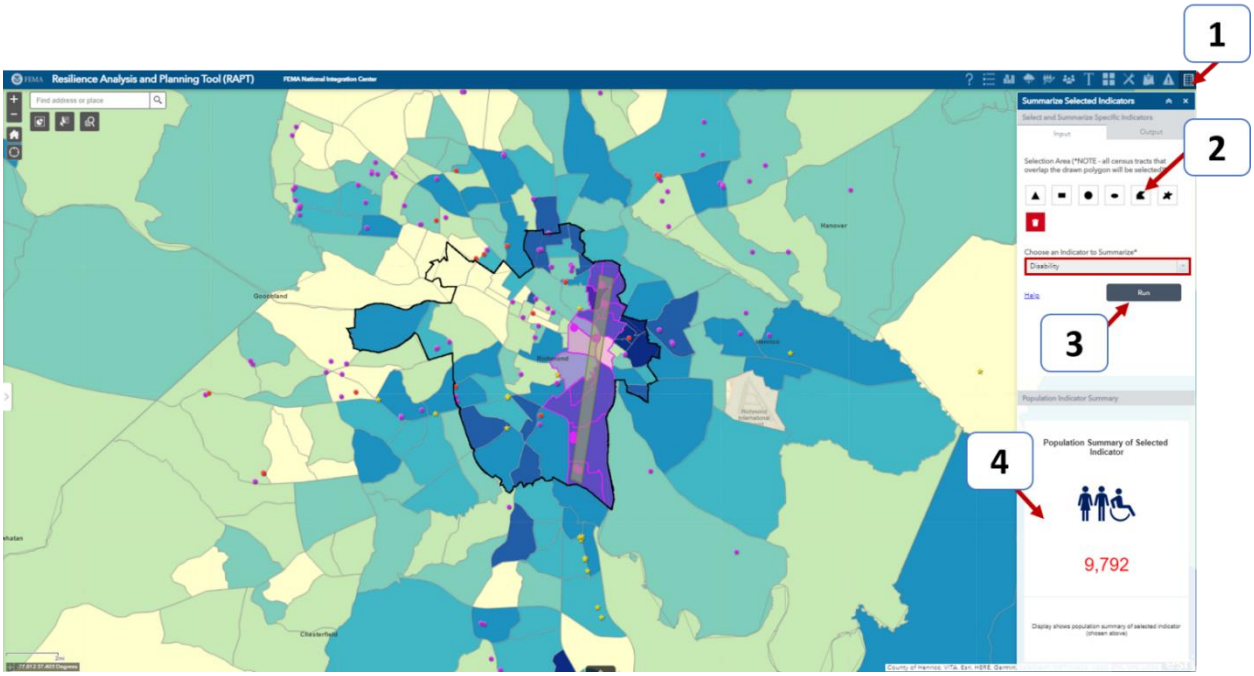

Figure 13.

View Details for the selected census tracts and export.

1. Select the **Output** tab in the **Summarize Selected Indicators** window.
2. Click on the ellipses to the right of "**The result is drawn on the map.**"
3. Select **View** in Attribute Table. The table lists the census tracts selected which can be exported to a *.csv for inclusion in reports or further analysis.

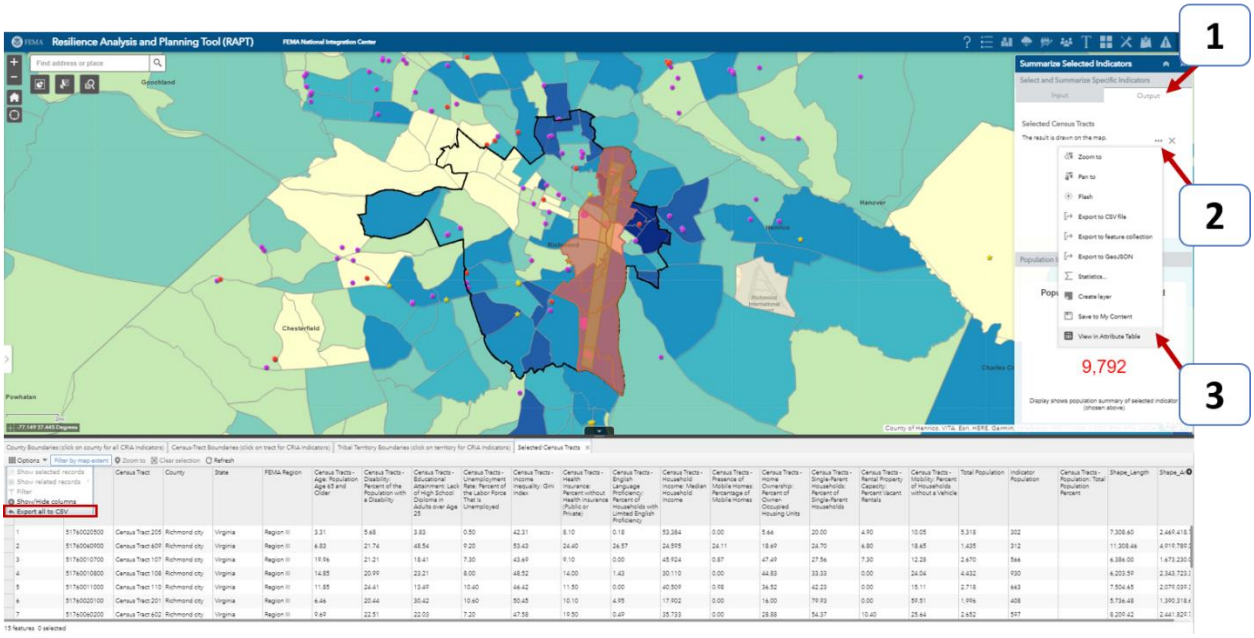

Figure 14.

Tip: Select the **red triangle** to **erase** and draw again. To unselect the census tracts, click on Output tab and then the **X** next to "**The result is drawn on the map.**"

Extra Credit: Review guidance for developing a Standardized Target Statement in CPG 201: THIRA/SPR Guide – 3rd Edition (https://www.fema.gov/sites/default/files/2020-04/CPG201Final20180525.pdf). Complete the below or identify another Core Capability that could be challenged by our scenario.

Draft Capability Target: Public Information and Warning

Within _____ notice of an imminent incident, deliver coordinated, prompt, reliable, and actionable information to # or % people, including # or % people with _____ and # or % with _____.

WRAP-UP

In the above steps, we demonstrated how tools like RAPT can enable community leaders and planners to better understand their community's relative resilience using a data-driven approach. Communities can take the outputs to inform a number of preparedness activities to drive priorities. Data and geospatial analysis, in conjunction with SME's and community-wide input, are critical in the development of plans such as a community's THIRA/SPR. By understanding potential impacts from threats and hazards, and assessing the capabilities required to quickly respond and recover, communities are better positioned to increase their overall resilience to adverse events.

Next: Explore **Tutorial #2** included with this module which guides users through developing targeted community outreach geared toward increasing flood preparedness and resilience.

Tools and Terminology

Add Data (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-add-data.htm) – Add data to the map by uploading a local file, entering a URL, or through searching ArcGIS Online.

Attribute Table (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-attribute-table.htm) – Displays a tabular view of operational layers' attributes. It displays at the bottom of your web application and can be opened, resized, or closed.

Basemap (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-basemap.htm) – Change the basemap to imagery or other thematic maps.

Coordinate (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-coordinates.htm) – Displays x and y coordinate values on the map. With the default coordinate system of the web map, the coordinate values change dynamically when the mouse pointer moves to different locations on the map. Configure to work with U.S. National Grid.

Home (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-home-button.htm) – Zooms the map to the initial map extent.

Incident Analysis (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-incident-analysis.htm) – Locate features within a specified area of the map.

Layer List (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-layer-list.htm) – Turn layers on/off and find out more about the layer.

Legend (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-legend.htm) – Displays labels and symbols for layers in the map.

My Location (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-my-location.htm) – Allows the network to detect your physical location and zoom the map to it. The location can be highlighted if necessary. **NOTE**: Some browsers require https to be enabled.

Scalebar (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-scalebar.htm) – Displays a scalebar on the map. The widget respects various coordinate systems and displays units in English or metric values.

Search Widget (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-search.htm) – Search for an address, coordinate, or place name on the map.

Summarize Selected Indicators (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-infographic.htm) – Visualize statistics for a given feature.

Toolbox – Draw or write (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-draw.htm), measure on the map (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-

measurement.htm), and export or print map (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-print.htm).

Zoom Slider (https://doc.arcgis.com/en/web-appbuilder/create-apps/widget-zoom-slider.htm) – Provides interactive zoom controls in the map display. **Tip**: SHIFT + drag the mouse to zoom in, SHIFT + CTRL + drag the mouse to zoom out.

References

Federal Emergency Management Agency, F. E. (2015, May 15). *Resilience analysis and planning tool (RAPT)*. https://www.fema.gov/emergency-managers/practitioners/resilience-analysis-and-planning-tool.

Federal Emergency Management Agency. (2016, June). *State mitigation planning key topic bulletins: Risk assessment*. https://www.fema.gov/sites/default/files/2020-06/fema-state-mitigation-plan-risk-assessment-bulletin_06-03-2016.pdf.

Federal Emergency Management Agency. (2018, May). *Threat and hazard identification and risk assessment (THIRA) and stakeholder preparedness review (SPR) guide*. https://www.fema.gov/sites/default/files/2020-04/CPG201Final20180525.pdf.

Federal Emergency Management Agency. (2019, October 28). *The national response framework 4th edition*. https://www.fema.gov/sites/default/files/2020-04/NRF_FINALApproved_2011028.pdf.

Federal Emergency Management Agency. (2019, July 25). *2019 national THIRA: Overview and methodology*. https://www.fema.gov/sites/default/files/2020-06/fema_national-thira-overview-methodology_2019_0.pdf.

Federal Emergency Management Agency. (2020, July 27). *Community lifelines*. https://www.fema.gov/emergency-managers/practitioners/lifelines.

Federal Emergency Management Agency. (2020). *Community resilience indicator analysis: County-level analysis of commonly used indicators from peer-reviewed research.* https://www.fema.gov/sites/default/files/documents/fema_2022-community-resilience-indicator-analysis.pdf

Federal Emergency Management Agency. (2021, May 25). *Resilience analysis and planning tool (RAPT)*. https://www.fema.gov/emergency-managers/practitioners/resilience-analysis-and-planning-tool.

Federal Emergency Management Agency. (2021, May 13). *National preparedness*. https://www.fema.gov/emergency-managers/national-preparedness.

Federal Emergency Management Agency. (n.d.). *Geo-enabled plans*. Preparedness Toolkit. https://preptoolkit.fema.gov/web/hazard-explorer/geo-enabled-plans.

Federal Emergency Management Agency. (2021, February 16). *Hazus*. https://www.fema.gov/flood-maps/products-tools/hazus.

FEMA. (2018, May). *CPG 201: THIRA/SPR guide – 3rd edition*. https://www.fema.gov/sites/default/files/2020-04/CPG201Final20180525.pdf.

Morley, P., Parsons, M., & Johal, S. (2017). *The Australian natural disaster resilience index: A system for assessing the resilience of Australian communities to natural hazards*. Bushfire & Natural Hazards CRC. https://www.bnhcrc.com.au/research/hazard-resilience/251.

NOAA/NWS Storm Prediction Center. (2016, March 9). *Storm prediction center WCM page*. https://www.spc.noaa.gov/wcm/#data.

Penn State College of Earth and Mineral Sciences. (n.d.). *5.1 Geospatial data quality: Validity, accuracy, and precision*. https://www.e-education.psu.edu/geog160/node/1922.

U.S. Department of Homeland Security. (2018, August 14). *Presidential policy directive 8: National preparedness*. https://www.dhs.gov/presidential-policy-directive-8-national-preparedness.

U.S. Department of Homeland Security. (n.d.). Homeland Infrastructure Foundation-Level Data (HIFLD). https://hifld-geoplatform.opendata.arcgis.com.

The United States Census Bureau. (2019, September 16). *Glossary*. https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13.

Virginia Department of Emergency Management. (2018, March). *Commonwealth of Virginia hazard mitigation plan*. National Drought Mitigation Center. https://drought.unl.edu/archive/plans/GeneralHazard/State/VA_2018.pdf.

Catalog of Resources

What is Risk, Resilience, and Vulnerability?

Risk

Definition: *Risk Steering Committee, DHS Risk Lexicon: 2010 Edition, (Sept. 2010)*. https://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf.

Additional Resources:

- Increasing Resilience Using *THIRA/SPR* and Mitigation Planning, 3/21/20. https://www.fema.gov/sites/default/files/2020-09/fema_thira-hmp_jobaid.pdf.
- Methodology: *FEMA Preparedness Grants Manual 2020*. https://www.fema.gov/sites/default/files/2020-06/fema_preparedness-grants-manual.pdf.
- Risk Management Fundamentals: Homeland Security Risk Management Doctrine April 2011. https://www.dhs.gov/sites/default/files/publications/rma-risk-management-fundamentals.pdf.
- The *National Risk Index* – Online tool to help illustrate the nation's communities most at risk of natural hazards. https://www.fema.gov/flood-maps/products-tools/national-risk-index.
- The *Risk Capability Assessment* is a suite of assessment products that measures risk and capability across the nation in a standardized and coordinated process. https://www.fema.gov/emergency-managers/risk-management/risk-capability-assessment.

Resilience

Definition: Patel, S. S., Rogers, M. B., Amlôt, R., & Rubin, G. J. (2017). What Do We Mean by 'Community Resilience'? A Systematic Literature Review of How It Is Defined in the Literature. PLoS currents, 9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5693357.

Additional Resources:

- *Baseline Resilience Indicators for Communities (BRIC)* developed by the University of South Carolina – Hazards Vulnerability Research Institute describes the differences in community resilience among counties within the state and within the nation. http://artsandsciences.sc.edu/geog/hvri/bric.
- *Community Resilience Indicator Analysis (CRIA)* aggregate indicator provides a relative assessment of potential resilience and is the underlying data for the FEMA Resilience Analysis and Planning Tool (RAPT). https://www.fema.gov/sites/default/files/documents/fema_2022-community-resilience-indicator-analysis.pdf.
- *Community Resilience Planning Guide for Building and Infrastructure Systems*: A Playbook. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190GB-16.pdf.
- *FEMA Community Lifelines*: https://www.fema.gov/emergency-managers/practitioners/lifelines.
- *HIFLD Data*: https://hifld-geoplatform.opendata.arcgis.com.

Vulnerability

Definition: Full Source: Fothergill, A., Peek, L.A. Poverty and Disasters in the United States: A Review of Recent Sociological Findings. *Natural Hazards* **32**, 89–110 (2004). https://doi.org/10.1023/B:NHAZ.0000026792.76181.d9.

Additional Resources:

- *CDC Social Vulnerability Index* (SVI) uses 15 U.S. census variables to help local officials identify communities that may need support before, during, or after disasters. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html.
- Godschalk, David R. (1991). "Disaster Mitigation and Hazard Management." In *Emergency Management: Principles and Practice for Local Government*, ed. Thomas E. Drabek and Gerard J. Hoetmer, 131-60. Washington, DC: International City Management Association.
- *Social Vulnerability of the United States* (SoVI). SoVI allows users to visualize (compare) the differences in social vulnerability among counties within their state and within the nation. http://artsandsciences.sc.edu/geog/hvri/sovi%C2%AE-0.

- The *National Response Framework* details the roles and responsibilities of community members during day-to-day preparedness activities, through response and recovery, including the conduct of Vulnerability Assessments. https://www.fema.gov/sites/default/files/2020-04/NRF_FINALApproved_2011028.pdf.

How are Indices Created?

Definitions:

- *Index*: https://www.qualityresearchinternational.com/socialresearch/indicator.htm#index.
- *Indicator*: von Schirnding, Yasmin. "Health in Sustainable Development Planning: The Role of Indicators." World Health Organization, *World Health Organization*, 6 Dec. 2010, https://apps.who.int/iris/bitstream/handle/10665/67391/WHO_HDE_HID_02.11.pdf.

Additional Resources:

- Bastian, Hilda. "5 Key Things to Know about Meta-Analysis." *Scientific American Blog Network*, Scientific American, 20 Jan. 2014. https://blogs.scientificamerican.com/absolutely-maybe/5-key-things-to-know-about-meta-analysis.
- Community Resilience Indicator Analysis: *County-Level Analysis of Commonly Used Indicators from Peer-Reviewed Research*. https://www.fema.gov/sites/default/files/documents/fema_2022-community-resilience-indicator-analysis.pdf.
- Gini Index: https://www.census.gov/topics/income-poverty/income-inequality/about/metrics/gini-index.html.
- Iain K Crombie PhD FFPHM Professor of Public Health, University of Dundee; Huw TO Davies PhD Professor of Health Care Policy and Management, University of St Andrews. "*Meta-Analysis in Healthcare Research*" https://www.linkedin.com/pulse/meta-analysis-healthcare-research-ajay-bidyarthy and "*Meta-analysis is to analysis…*" https://feinmantheother.com/2015/08/12/meta-analysis-is-to-analysis.
- "Seminar on the Role of National Statistical Offices in the Production of Leading, Composite and Sentiment Indicators." *UNECE*, United Nations Economic Commission for Europe, 2017, https://unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.42/2017/Seminar/Report_of_Seminar_on_LCS_indicators_July_2017.pdf.
- Thompson, Karl. "What Are the Most Useful Indicators of Development?" *ReviseSociology*, 19 July 2017. https://revisesociology.com/2017/07/23/most-useful-indicators-development.

Overview of GIS and Mapping Technology

Definition:

- USGS. "What Is a Geographic Information System (GIS)?" USGS, U.S. Department of the Interior. https://www.usgs.gov/faqs/what-a-geographic-information-system-gis?qt-news_science_products=0#qt-news_science_products.

Additional Resources:

- FEMA Lifeline Dashboards: https://www.arcgis.com/apps/MinimalGallery/index.html?appid=f5d016d2cf6a4ea9941740ab28e8ac04.
- FEMA Wildfire Dashboards: https://gis-fema.hub.arcgis.com/pages/wildfires.
- NAPSG Disasters Crowdsourced Photos: https://2020-crowdsourced-disaster-photos-napsg.hub.arcgis.com.
- "What Is GIS? | Geographic Information System Mapping Technology." Esri, Esri. www.esri.com/en-us/what-is-gis/overview.

Review of Available Indices and Tools

- *Baseline Resilience Indicators for Communities (BRIC)*: http://artsandsciences.sc.edu/geog/hvri/bric.
- *CDC Social Vulnerability Index (SVI)*: https://www.atsdr.cdc.gov/placeandhealth/svi/index.html.
- *FEMA's Community Resilience Indicator Analysis (CRIA)*: https://www.fema.gov/emergency-managers/practitioners/resilience-analysis-and-planning-tool.
- *National Risk Index (NRI)*: https://www.fema.gov/flood-maps/products-tools/national-risk-index.
- *Social Vulnerability Index for the United States (SoVI)*: http://artsandsciences.sc.edu/geog/hvri/sovi%C2%AE-0.

Additional Indices and Resources:

- Argonne National Laboratory, Resilience Measurement Index: Indicator of Critical Infrastructure Resilience (RMI): https://publications.anl.gov/anlpubs/2013/07/76797.pdf.
- Australian National Disaster Resilience Index (ANDRI): https://www.bnhcrc.com.au/research/hazard-resilience/251.
- Community Disaster Resilience Index (CDRI): https://www.researchgate.net/profile/Walter-Peacock/publication/254862206_Final_Report_Advancing_the_Resilience_of_Coastal_Localitie

s_10-02R/links/00b7d51feb3e3d0d4a000000/Final-Report-Advancing-the-Resilience-of-Coastal-Localities-10-02R.pdf.

- Disaster Resilience of Place (DROP): https://www.degruyter.com/document/doi/10.2202/1547-7355.1732/html.
- NAPSG Guidance on Risk Resilience, and Vulnerability Indices: https://experience.arcgis.com/experience/376770c1113943b6b5f6b58ff1c2fb5c.
- PEOPLES Resilience Framework (PEOPLES): http://peoplesresilience.org/wp-content/uploads/2013/07/2010_Renschler_PEOPLES_Resilience.pdf.
- Resilient Capacity Index (RCI): https://www.macfound.org/networks/research-network-on-building-resilient-regions.
- The Composite Resilience Index (TCRI): https://theresilienceindex.weebly.com/our-solution.html.

Explore FEMA's RAPT

- *RAPT Application*: https://fema.maps.arcgis.com/apps/webappviewer/index.html?id=90c0c996a5e242a79345cdbc5f758fc6.
- *RAPT Overview, Training Resources, How-To Tutorials, and Supporting Documents*: https://www.fema.gov/emergency-managers/practitioners/resilience-analysis-and-planning-tool.