Chapter 3

Introduction to fire intelligence—wildfires

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Overview

This chapter is designed to provide a brief introduction to aspects of how GIST is used in wildfire disaster management and the role of fire intelligence in the field of HSGI.

This chapter and the tutorial workflow provide a basic overview and insight into some of the considerations used in fire intelligence. At its conclusion, you will have actionable insights into the strategic aspect of fire intelligence, which will lay the foundation for thinking spatially and multidimensionally to address the threat of wildland fire.

Learning objectives

- Perform exploratory geospatial data visualization by examining fire hazard severity zone (FHSZ) data to identify areas with high wildfire risk.
- Identify specific wildland urban interface (WUI) areas that are most susceptible by proximity or overlap with high-risk FHSZ areas.
- Visually analyze which areas within the potential danger areas are at highest vulnerability risk due to a census tract population demographic of more than 25 percent of people 65-plus years of age.
- Analyze which of the identified high-risk WUI areas within the study region experience the longest response times by local fire support.
- Learn how to identify complexities within wildfire disaster management and response in conflagration scenarios.

Technical components

- Software: ArcGIS Online (at least Publisher-level access)
- Datasets:
  - FHSZ data for California
  - WUI for California
  - LA County city and county boundaries
  - LA County Fire Stations layer
  - US Census Bureau American Community Survey (ACS) demographic data for target demographic of population with 25% > 65 years of age
  - LA County roads
  - Select fire station layer for western LA County

Prerequisites

- Basic knowledge of GIS and ArcGIS Online, Map Viewer.
- Technical skill level: Introductory to intermediate GIS.
- Time to complete chapter: One to two hours without intelligence brief, two-plus hours with intelligence brief.

Background and situational context

Fire intelligence is the science and study of fighting one of nature's most formidable foes—fire. In fire intelligence, the opposing force is not human, as is often the case in other areas of GEOINT; instead, fire is the "enemy" and requires specialized forces to combat the threat it poses. These forces encompass a broad range of teams in which GIS professionals play a crucial role:

- Strategic
  - Modeling worst-case scenarios for community preparedness and after-disaster crisis events
  - Evaluating wildfire fuels and developing wildfire management plans (for example, controlled burns)
  - Planning for localized fire and conflagration events
  - Selecting sites for potential evacuation routing and evacuation shelter setup
  - Identifying potential risk areas to help community managers take proactive measures
  - Aiding emergency management with actionable information to determine fire station efficiency and needs, such as new station placement and equipment and staffing acquisition and allocation

- Operational—conflagration management
  - Often multiagency with mobilization of resources specialized in wildfire events, usually coming from other regions, including geographic information systems specialist (GISS) teams

- Tactical
  – Multiagency emergency management with resources on the ground, in the air, and in the field, including fire line intel, critical for fire support and updating nearby residents and communities
  – Determining and declaring evacuation "Ready, Set, Go" scenarios

This chapter is not an all-encompassing guide to assessing risk and resources in a WUI. The WUI issue is often interagency, with regional and national response efforts, the complexities of which will vary according to the severity of the incident and from one county or municipality and fire department to another.

Understanding wildfire risk is a complex process requiring analysis of multiple factors:

- Current weather conditions (for example, wind speed, direction, and relative humidity)
- Vegetation type and cover (fuels)
- Geographic aspect
- Elevation
- Geographic slope
- Fire weather contributing factors, such as areas that experience more wind due to specific geography, which can drive flame heights and embers
- Response times from fire support once a wildfire start has been reported
- Proximity to added human threat potential (beyond that of the WUI neighborhoods) posed by trailheads or other types of areas that are used or traversed by higher numbers of people (for example, parks, preserves, recreation areas, roadways, railways, and so on)

Advanced GIS users can develop fire risk maps and models using data from these components to develop current, real-time condition risk assessment or fire behavior modeling, which are beyond the scope of this chapter.

Instead, the purpose of this chapter is to briefly introduce some of the methods and techniques GIS users can employ in assessing the potential threat to neighborhoods and communities within the FHSZ and WUI zone. The WUI has become increasingly important because of the encroachment of urban areas on natural wildland open space. Living near open spaces holds considerable appeal because it provides ease of access for recreation, exercise, and general communion with nature.

These urban fringe zones have evolved because of urban expansion and sprawl and are often not quickly accessible by established emergency fire services. Although local fire departments train in WUI situations, most local county or municipal fire departments are equipped to handle structural and small- to medium-scale outside fires. These departments do not usually have the equipment employed by crews enlisted in wildland fire support units. These county or municipal fire departments are, however, most often the first responders on site in a WUI situation.

It is important that community and emergency management have a means of understanding and estimating potential scenarios in wildfire emergencies within these WUI zones. Understanding vulner-abilities allows emergency managers and regional leaders to assess the potential threat to WUI zone

neighborhoods and communities, as well as the efficiency of local municipality fire departments in responding to wildfire events in these high-risk areas.

Exercise workflow 3

Using the following datasets provided in the chapter data folder, you will follow a step-by-step guide to visually investigate spatial relationships between areas of potential threat due to high-risk wildland conditions, identify where these areas overlap with the WUI, filter ACS data to spatially identify specific census tracts with a population greater than 25 percent of 65-plus years of age, which presents a higher vulnerability factor and would require more resources in an evacuation scenario.

1 Add fire hazard layers to a map

1. In your browser, navigate to www.arcgis.com. Sign in to your ArcGIS Online account.

2. On the navigation bar, click the **Map** tab to open a new map in **Map Viewer**.

3. On the **Contents** toolbar (dark), click **Save and open** > **Save as**.

4. In the **Save map** window, apply the following settings:
   - **Title**: Wildfire Intelligence Ch. 3 <your initials>
   - **Folder**: SecurityFirst
   - **Tags**: Security First, Chapter 3
   - **Summary**: Wildfire intelligence case study in Los Angeles County.

   Note: If you need to create the folder, click the down arrow, choose **Create new folder**, and type the folder name.

5. Click **Save**.

6. On the **Contents** toolbar, click **Add** > **Add layer from file**.

7. From the **SecurityFirst_ExerciseData** folder, in **Chapter03**, add **FHSZ LRA Very High Risk.zip**.

8. For **File type**, select **Shapefile**. Save your layer to the **SecurityFirst** folder and leave all other settings with the default values.

9. Click **Create and add to map**.

10. Repeat the previous steps to add the following zip files as new map layers:

    *   **FHSZ SRA Very High Risk.zip**
    *   **FHSZ SRA High Risk.zip**
    *   **FHSZ SRA Moderate Risk.zip**

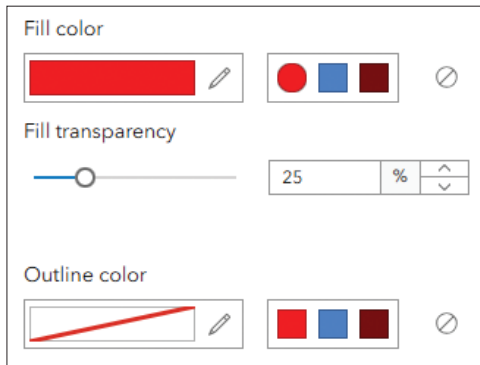| Layers	✕
⠿ FHSZ SRA Very High Risk	···
⠿ FHSZ SRA Moderate Risk	···
⠿ FHSZ SRA High Risk	···
⠿ FHSZ LRA Very High Risk	···
⬧ Add ⌄	
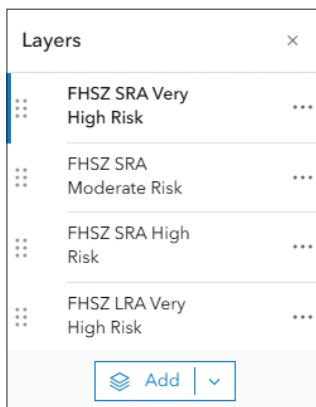
The FHSZ layer represents the California FHSZ. It uses various risk factors, such as slope, vegetation fuels, and weather patterns conducive to creating fire weather. It does not consider fuel modifications, such as prescribed burns or other wildfire fuel mitigation. The FHSZ layer reflects current conditions and estimates a burn probability with a 30-to-50-year window. The color codes are for local responsibility area (LRA) and state responsibility area (SRA). The zones determine the primary response and who is financially responsible for incidents in relevant boundaries.

Next, you'll color-code each layer.

11. In the **Layers** list, next to **FHSZ LRA Very High Risk**, click the **Options** button (three dots). Click **Show Properties**.

12. In the **Properties** pane, under **Symbology**, click **Edit layer style**.

13. Under **Pick a style**, for **Location (single symbol)**, click **Style options**.

14. In the **Styles** pane, under **Symbol style**, click the **Edit** button (pencil).

15. In the **Symbol style** window, edit the **Fill color**. In the prompt box next to **#**, type ff0000. Click **Done**.

16. For the **Outline color**, click the **No color** button.

This will be done for all layers.

17. Repeat the previous steps using the following colors for each layer:

- **FHSZ SRA Very High Risk**: #fac8e0
- **FHSZ SRA High Risk**: #ffb400
- **FHSZ SRA Moderate Risk**: #ff8519

18. Familiarize yourself with the layer's legend and contents. Make sure that the layers are arranged from top to bottom as follows:

a. FHSZ LRA Very High Risk
b. FHSZ SRA Very High Risk
c. FHSZ SRA High Risk
d. FHSZ SRA Moderate Risk

19. From **SecurityFirst_ExerciseData**, add the **WUI.zip** file to the map as a **Shapefile**. Set the **Title** of the layer to Wildlife Urban Interface. Save it to the **SecurityFirst** folder. Click **Create and add to map**.

20. In the **Layers** list, click **Wildland Urban Interface** to select it.

21. Open the **Styles** pane and edit the **Fill color** and **Outline color** using the following settings:

- **Fill color**: #ffae0
- **Outline color**: #fffb00

22. Click **Done** and click **Done** again.

23. On the map, zoom to the extent of Southern California, focusing on Los Angeles County.
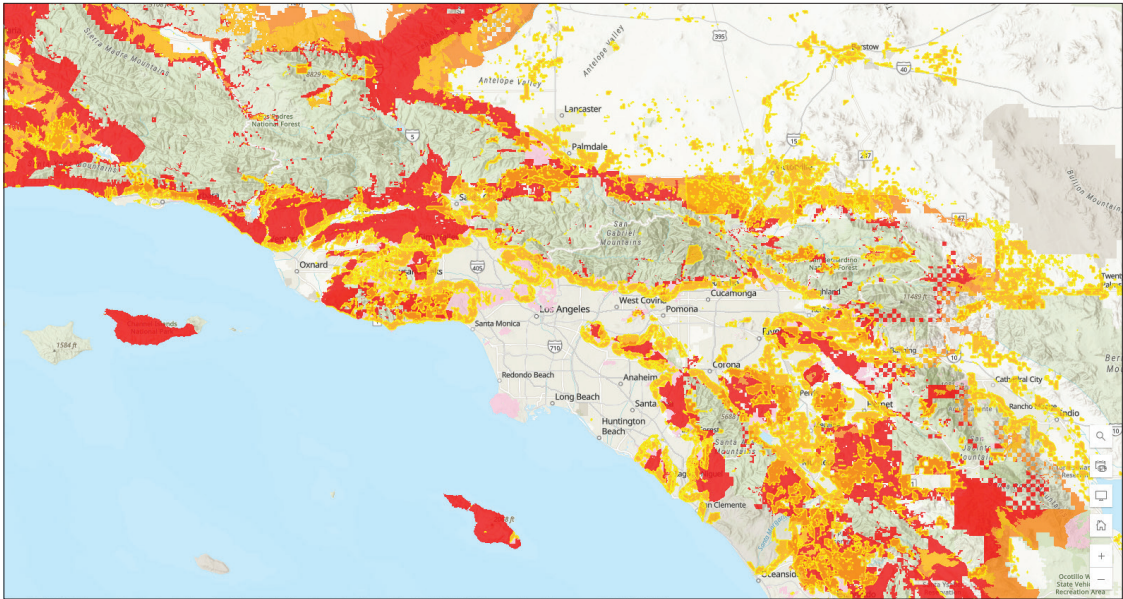
24. Add **LACounty_City_Boundaries.zip** to the map as a **Shapefile**. Set the **Title** of the layer to LA County and City Boundaries and save it to the **SecurityFirst** folder. Click **Create and add to map**.

25. In the **Layers** list, next to **LA County and City Boundaries**, click the **Options** button and click **Zoom to layer**.

26. In the **Styles** pane, change the **Outline color** to #153e96 and the **Fill color** to **No color**.

27. Click **Done** and click **Done** again.

2 Add population data

1. On the **Contents** toolbar, click **Add** > **Add layer from URL**. Add the ACS Census Tracts for a population of 65-plus years of age by typing or pasting the following URL: https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/ACS_Highlights_Senior_Well_Being_Boundaries/FeatureServer.

2. Click **Add to map**.

3. In the **Layers** list, expand **ACS Highlights Senior Well Being Boundaries** and click **Tract**.

   You will filter the layer attributes to show only the census tracts that have your target population: 25 percent or more of 65-plus years of age.

4. On the **Settings** (light) toolbar, click **Filter**. Click **Add new**.

   Note: Clear any existing filters.

5. Click the **Field** box and select **Percent of Population that is 65 Years and Over**. Set the expression to **is at least** and set the percentage value to 25. Click **Save**.

6.   Click **Properties**, and under **Appearance**, change the **Transparency** to **50%**.

7.   In the **Layers** list, click the **Options** button for **the ACS Highlights Senior Well Being Boundaries** layer. Click **Rename** and type 25% of population over 65 years.

8.   On your map, zoom in until the **Tracts** layer is visible.

Your map now shows where the highest-risk FHSZ, WUI, and highest-percent population for a vulnerable demographic overlap within the greater LA County area.
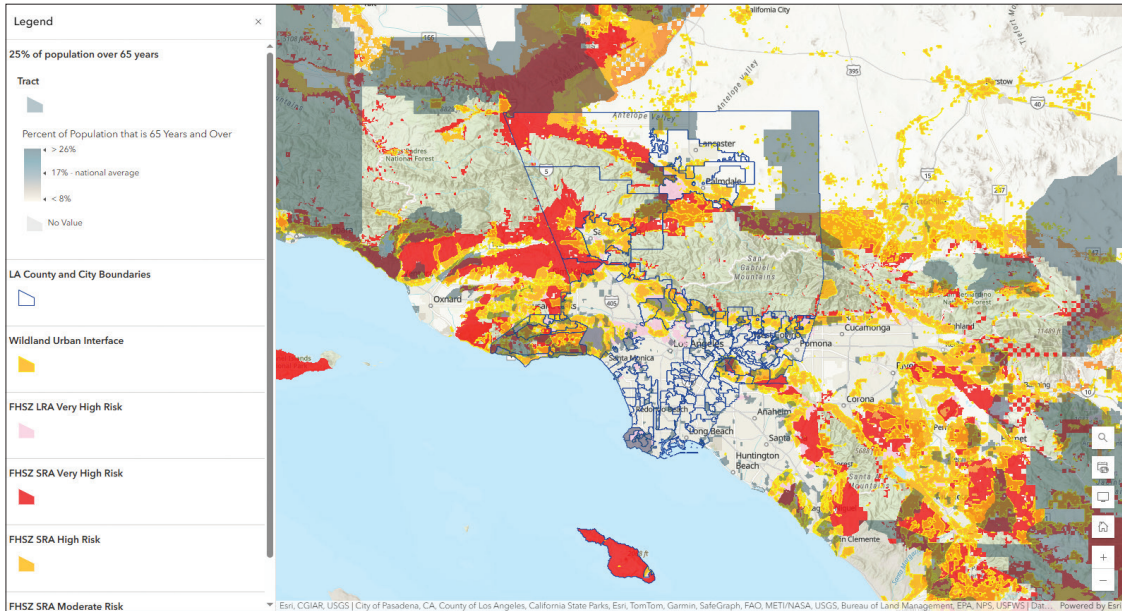

3 Add infrastructure data

1.   Add **LACounty_Roads.zip** to the map as a **Shapefile**. Name the layer LA County Roads and save it to the **SecurityFirst** folder. Click **Create and add to map**.

2.   Change the **Color** of the layer to #0BDEB2.

3.   In the **Layers** list, hover over **LA County Roads** and click the **Visibility** button (eye) to turn the layer off.

4.   From the **LACounty_FireStations** folder, add the **GEOJSON** file to your map. Click **Upload the file as an item and add it to the map**. Rename the layer LA County Fire Station Locations and save it to the **SecurityFirst** folder. Click **Create and add to map**.

5.   On the map, examine the extent of the **LA County Fire Station Locations** points. Zoom to mainland Los Angeles.

6.   Add the **Western_LACounty_Stations.zip** file to the map as a **Shapefile**. Rename the layer Western LA County Fire Stations and save it to the **SecurityFirst** folder. Click **Create and add to map**.

7. In the **Layers** list, confirm that this layer is at the top of the list.

8. In the layer's **Style** pane, under **Pick a style**, confirm that **Location (single symbol)** is checked. Click **Style options**.

9. Edit the **Symbol style**. Under **Current symbol**, click **Basic point**. Change the **Category** to **Public Safety**, scroll down, and select the fire truck icon. Click **Done**.

> **Tip:** You can switch to the List view and search for symbols by typing their name. To find the fire truck icon, search for Fire-Truck.

10. Change the **Size** to 20 px and confirm that the box for **Adjust size automatically** is unchecked.
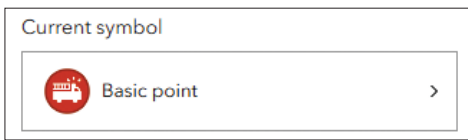
This will change the **Western LA County Fire Stations** points to red fire trucks.

11. Turn off the **Visibility** for this layer.

When you finish, the order of your layers list should be as follows:

    a. Western LA County Fire Stations
    b. LA County Fire Station Locations
    c. LA County Roads
    d. 25% of population over 65 years
    e. LA County and City Boundaries
    f. Wildland Urban Interface
    g. FHSZ LRA Very High Risk
    h. FHSZ SRA Very High Risk
    i. FHSZ SRA High Risk
    j. FHSZ SRA Moderate Risk

4 Analyze the data

1. Turn off the **Visibility** for the **LA County Fire Station Locations** layer. Zoom to the **Western LA County Fire Stations** layer.

2. Click a point or census tract to view its pop-up and examine the correlating information.
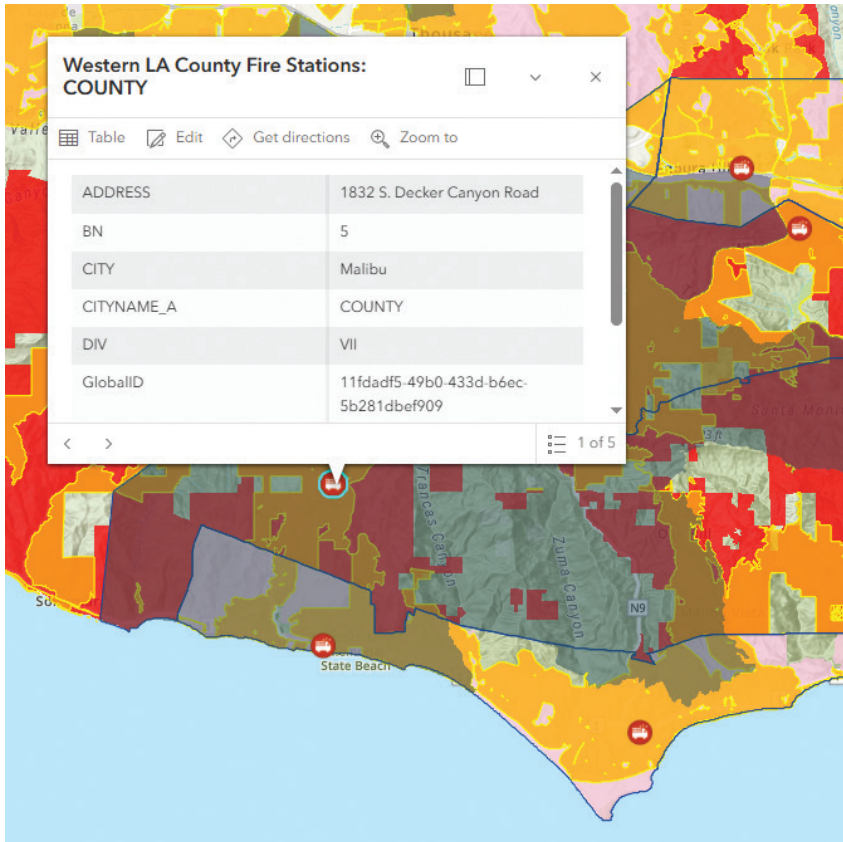
You will be analyzing the area of greater Malibu, where more than 30 percent of the population is over 65 years of age, creating potential challenges for timely, lifesaving evacuations in a "Ready, Set, Go" scenario. You will determine how far the current stations can reach in 610 seconds (10 minutes and 10 seconds).

3. Click the **Western LA County Fire Station** layer. On the **Settings** toolbar, click the **Analysis** tab.

4. Click **Tools** and expand the **Use Proximity** group. Open the **Generate Travel Areas** tool.

5. For **Input layer**, select **Western LA County Fire Station**.

6. Under **Analysis settings**, for **Cutoffs**, type 610 and click **Add**. For **Cutoff units**, select **Seconds**.

> **Tip:** Disregard the warning that appears below the Cutoffs value.

This is the National Fire Protection Association (NFPA) Standard 1710 for Initial Full Alarm High Hazard/High Rise response.

7. For **Departure time**, select **Now**.

8. Check the box for **Generate detailed polygons**.

Analysis settings

Travel mode •

🚗 Driving Time

Cutoffs •

Enter a value and click Add   + Add

610 ✕

Cutoff units •

Seconds

Travel direction •

↘ Away from input locations

Departure time •

Now

Overlap policy •

⊙ Overlap

☑ Generate detailed polygons

9. Under **Result layers**, set the **Output name** to 610 Second Response. Check the box for **Include reachable streets**. Save the results to the **SecurityFirst** layer.

10. Click **Run**.

You can now see the spatial coverage of a 610-second response for each of the western LA County fire stations.

11. In the **Layers** list, reposition your layers so that the **Western LA County Fire Station** layer is on top and the newly created **610 Second Response** layer is below it.

12. Expand the **610 Second Response** layer and turn off the **Visibility** for the **Travelareas** layer to get a clear idea of the response coverage by accessible roads.

The map now shows the 610-second response reachable streets and response areas, with the FHSZ layer, WUI, and high-vulnerability demographic. This is a high-risk area for all the elements under examination.

13. Turn on the **Visibility** of the **LA County Roads** layer that you added earlier.

You can now see where the local fire support cannot reach within 610 seconds.
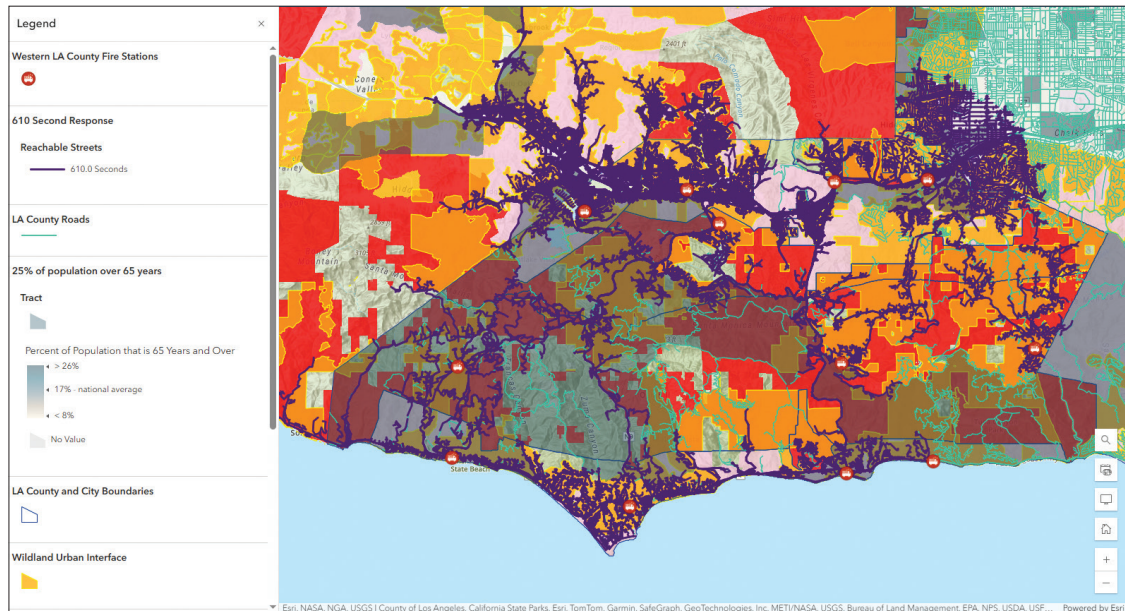
Interpretation of analysis

After completing this exercise, answer the following questions in detail. The answers to these questions, as well as the analysis results from the exercise workflow, will inform the intelligence brief.

1. What is the most important takeaway from the analysis workflow in this chapter?
2. What actionable information could local and regional emergency management use to protect residents existing in the WUI if a wildfire starts in proximity to the high-risk areas identified?
3. What communities in the county would benefit the most by implementing proactive measures, including control burns, or defensive space measures and community outreach and education on the importance of proactive measures and fire preparedness in a "Ready, Set, Go" scenario?

Sample response

The results of the preceding workflow reveal that [X number of] areas of LA County are at an elevated risk for wildfire and a possible conflagration event. This presents a human security challenge for those communities, as well as a national health and potential security threat because smoke exposure from conflagration events can significantly affect populations well beyond the extent of the local region. Smoke can potentially affect even military installations, and poor air quality can also affect military trainings. These effects would be akin to how the 2024 Canadian wildfires seriously affected air quality and population health on the US East Coast.

Intelligence brief

Based on the analysis from the exercise workflow, produce a three- to five-page intelligence brief by responding to the following question prompts. Incorporate your geospatial outputs from the exercise to enrich and illustrate your conclusions.

- **BLUF:** List three to five primary observations from your analysis in bulleted-list format that summarize findings of this work.
- **Top-level analysis:** Report the primary data points supporting your BLUF.
- **Secondary analysis:** Provide the data sources and deeper analytic products from this analysis.
- **Impact:** Describe the impacts of your findings on the department or organization.
- **Confidence:** Report the level of confidence of your assessment based on available data, accuracy, and so on.
- **Bias:** Explain any background or information you have that could have affected your analysis.
- **Conclusions:** Determine what type of analytic conclusions there may be and how the data requirements, analysis, and brief writing may change based on what analytic framework you are following (descriptive, predictive, prescriptive).

Applying and extending your skills

Wildfire data is often available in near real time from multiple sources.

- The Esri Wildfire Aware app is an excellent source for exploring active wildfires with information about the area in the vicinity of an active fire. The interface provides fire perimeter, area population, aspects of current fire weather, fuels, and the resources currently on incident. For more information, go to livingatlas.arcgis.com/wildfireaware.
- Another great source is Geographic Area Coordination Centers (GACC), which provides information about current and recent fires throughout the US. Visit gacc.nifc.gov.
- Visit the CAL FIRE Data Hub at hub-calfire-forestry.hub.arcgis.com.

Additional resources

Consider the following resources to learn more about fire intelligence.

- FEMA. Wildfire and WUI blog. www.usfa.fema.gov/wui/data.
- Nevada Fire and Aviation. https://nvfireintel-nifc.hub.arcgis.com.
- The Center for Climate & Security. "Wildfires in the US and Their Effects on Security" (Sept. 15, 2020). https://climateandsecurity.org/2020/09/wildfires-in-the-u-s-and-their-effects-on-security.
- USDA Forest Service. "Wildfire Risk in the Wildland Urban Interface." https://research.fs.usda.gov/treesearch/36420.
- Just Security. "Burning Threats: How Wildfires Undermine US National Security." www.justsecurity.org/87265/burning-threats-how-wildfires-undermine-u-s-national-security.