Add the "Where" to the "What" with Location Analytics in SAS® Visual Analytics 8.3

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ABSTRACT

Seeing is believing—understand your data by seeing where it lives. Adding geographic context to your categorical and quantitative data through location analytics can present patterns to help you understand why things happen and what you can do to encourage that behavior or change outcomes. In this paper, you learn the geographic capabilities of SAS® Visual Analytics 8.3 Location Analytics, how to use them, and the value they deliver.

INTRODUCTION

Most of the data we generate and consume includes location information. Mailing address is clearly location. Sales Territories are regions which are also location, and of course GPS latitude/longitude is location. Including location in your visualizations adds a new **perspective of "where" to your busines**s analysis.

EveryTHING we interact with, monitor, or measure has a location: buildings, vehicles, people, roads, power and water lines, mountains, rivers, and so on.

Some of these things are stationary and others change position regularly, but they all have location. Visualizing how the location of these THINGS in your world interact and influence your business goals can offer tremendous insight.

In this paper you will learn about the Location Analytics capabilities in SAS Visual Analytics 8.3 and how to use them. By addressing multiple use cases using SAS Visual Analytics you will understand how to leverage the native location capabilities and deep integration with Esri **to add the "where" to the "what" in your data visualizations.**

SAS Visual Analytics Location Analytics capabilities include:

- Displaying your data on a map.

- Custom Regions **–** Define bounded areas such as states, counties, sales territories, and even stadium seats. Custom shapefiles can be added to SAS Visual Analytics as regions. These regions can be colored based on measures or categories in your data.

- Points of Interest **–** S**et a point on a map or "drop a pin" and explore that location** and the area around that location. Including geographic selection, demographics and geo-search.

- Routing **–** How to get from one point of interest to another in an optimal fashion.

- Viewing Dense Data on a Map (Clustering and Contours) - If you have dense data, proximity clustering and contour maps provide ways to visualize data and identify location clusters and patterns.

- Map Layers - Add map overlays to your maps to provide deeper context to the **"where" in your data on a map. For instance, if the data being displayed is store** locations, adding a highway layer and a railroads layer will help you understand the proximity of store locations to transportation corridors.

- Geocoding – Augment your data by adding latitude and longitude values for each record based on the location data you already have. That way, you can easily add your data to a map.

The use cases being addressed in this paper apply to a Business Analyst being asked to explore the following:

1. forest fire data to propose locations for Fire Shelters for future fire disasters,

2. forest fire impact at the county level to search for ways counties can be convinced to combine efforts earlier and proactively,

3. forest fire outbreaks to determine policy, outreach, and educational efforts that can be applied to reduce the number of future forest fires.

DISPLAYING YOUR DATA ON A MAP

To display your data in a Geo Map object in SAS Visual Analytics you start by creating a Geographic Item from the + New data item in the Data Pane, as shown in Figure 1.
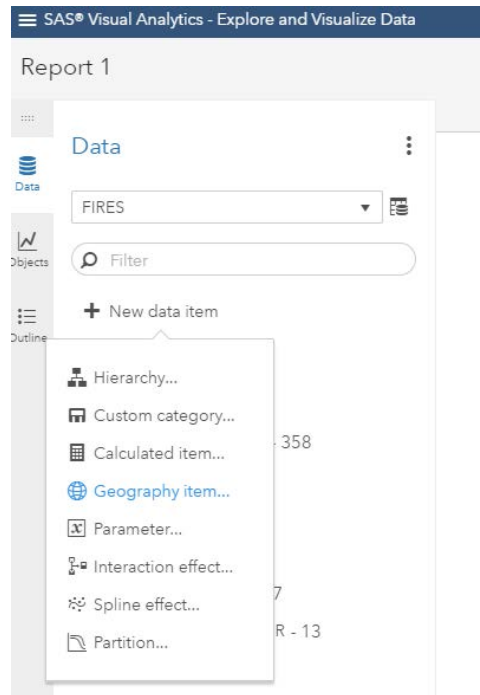

Figure 1. Add a Geography item to your data.

You can then specify the name of the Geographic Item, the category or measure to base the Geographic Item, and the Geography data type as shown in Figure 2.
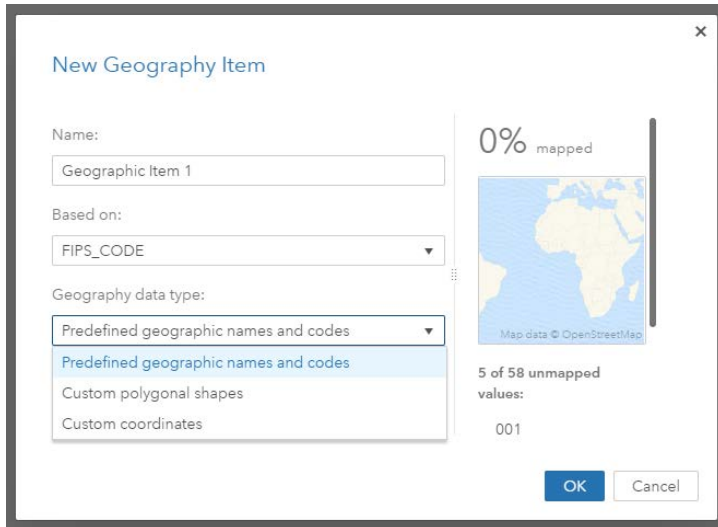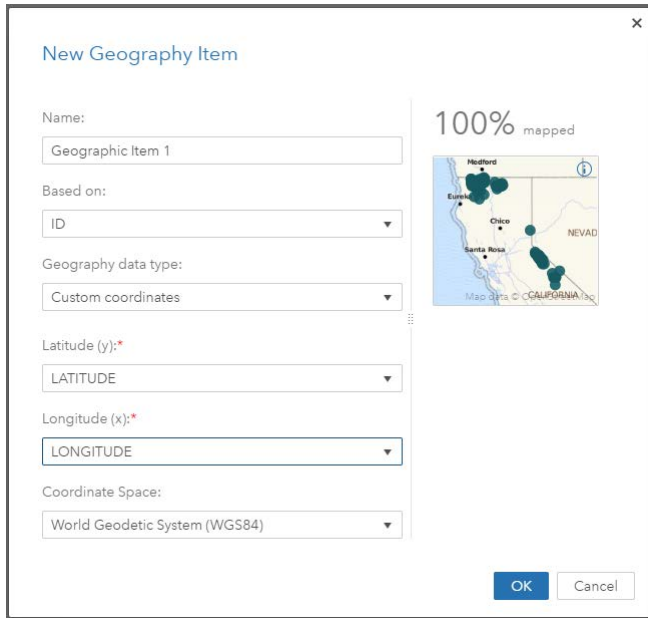
Figure 2. New Geography Item.

Based on the data being presented and the types of explorations being supported, you will determine whether to present the geographic data as coordinate data points, or as regions. Regardless, displaying data on a map requires location information to be present.

To display your data as coordinate data points you must have latitude and longitude information in your data. If latitude and longitude do not exist and you have other location data, you can Geocode your data to add latitude and longitude columns through the Manage Data action in SAS Visual Analytics, as shown in Figure 3. The geocoding operations calls the Esri geocode service to return latitude and longitude values. Note to access this capability, you must have an account with Esri and enter your Esri credentials in your SAS Visual Analytics settings.
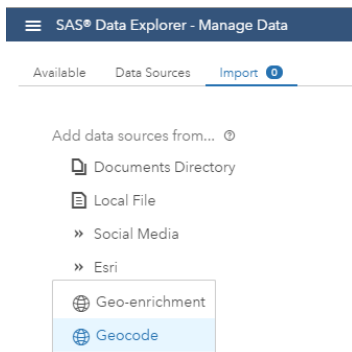

Figure 3. Geocode your data to add latitude and longitude columns.

Select the Geography data type: Custom coordinates and enter the latitude and longitude measures (columns), as shown in Figure 4.

**Figure 4. New Geography Item - Custom coordinates.**

The location data is evaluated, and the correctness of your mapping is determined – 100%, not bad. This feedback lets you understand the quality of your geographic data, so you can consider resolving data quality issues and possibly receive better results. Now drag Geographic I tem 1 to the report palette, SAS Visual Analytics recognizes the Geographic I tem dragged to the report and renders the points on a GeoMap object as shown in Figure 5. Now edit the options, roles, actions, and other settings to set the data, presentation, and interactions to meet your exact requirements and expectations.
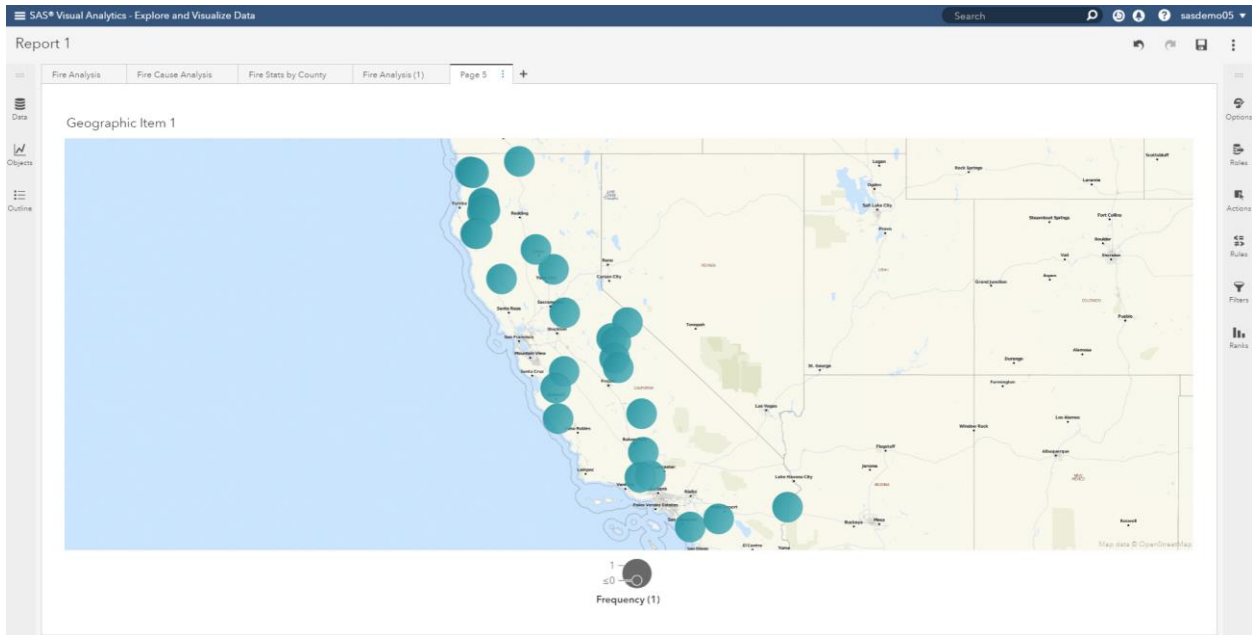
Figure 5. Data points on a GeoMap.

CUSTOM REGIONS

Regions shown on a map clearly display bounded areas such as countries, states, sales territories, and more as shown in the California Counties map in Figure 6. This report uses color saturation to represent the number of fire days for each county. Interactively filtering between the map and table of named fires shows the opportunities for cross-county collaboration.
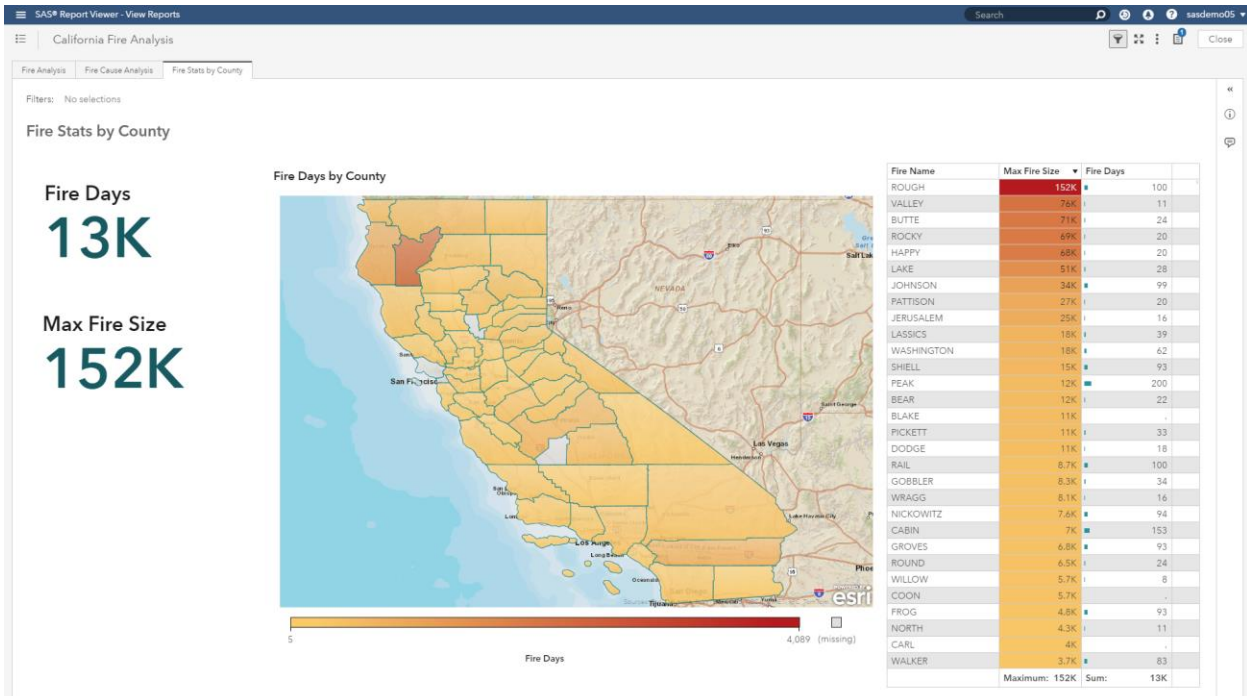

Figure 6. Fire Statistics for California counties.

With a little more effort and the use of a GIS tool, non-geographic maps can be created to display regions such as rooms in a conference hall or seats in a stadium. This paper does not cover this topic. Please refer to the paper from the SAS Global 2018 Conference, **"Leverage custom geographical polygons in SAS® Visual Analytics."**

Out of the box, SAS Visual Analytics provides built-in regions for countries and US states that you can use in your reports. To add custom regions to your reports you need to import a GIS Shapefile into SAS Visual Analytics and create a Custom Polygon Provider.

The SAS Macro, `%shpimprt`, is one way to import GIS Shapefiles into SAS Visual Analytics for use as the source for a custom polygon provider. See SAS Viya Documentation for information on how to do this. Figure 6 uses the California counties shapefile from the California Open Data Portal (data.ca.gov). The `%shpimport` SAS Macro was used to convert and load the shapefile data.

The next step is to create a Custom Polygon Provider. To do this, your data to be visualized as regions on a map must share a common value (shared index) with the custom polygon provider (shape file) to serve as the join variable for the two data sources. The California counties value COUNTYFP and the FIRES value FIPS_CODE are common and will be used to join the tables, as seen in Figure 7. This Custom polygon provider is created with ID Column: COUNTYFP and the is created with the Geography Item Region ID: FIPS_CODE, see Figure 7.
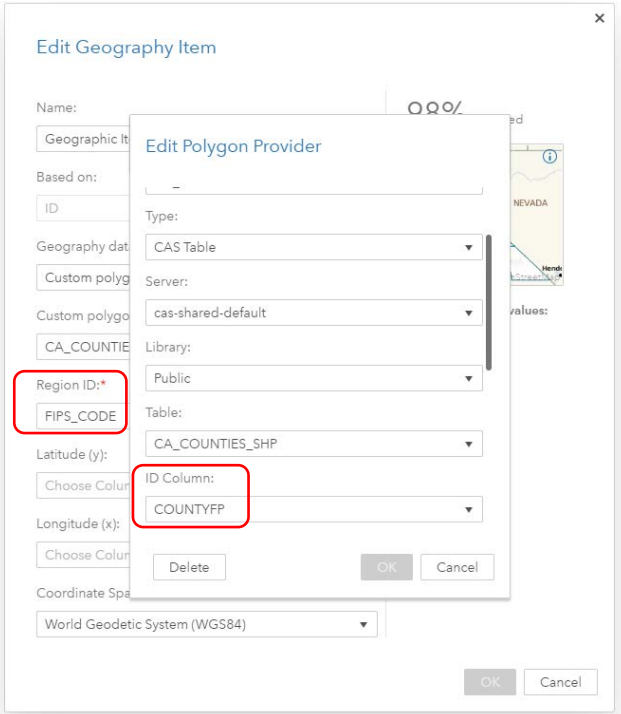
**Figure 7. Create Custom Polygon Provider and Geography Item that references it.**

POINTS OF INTEREST

"Drop a Pin" – it's what you often do when interacting with a map. You want to learn about a point of interest, so you drop a pin and investigate. SAS Visual Analytics supports Points of Interest allowing you to:

- Drop a Pin
- Geographic Selection
- Demographics
- Geo-search

DROP A PIN

Designate points of interest by dropping pins on a map as shown in Figure 8.
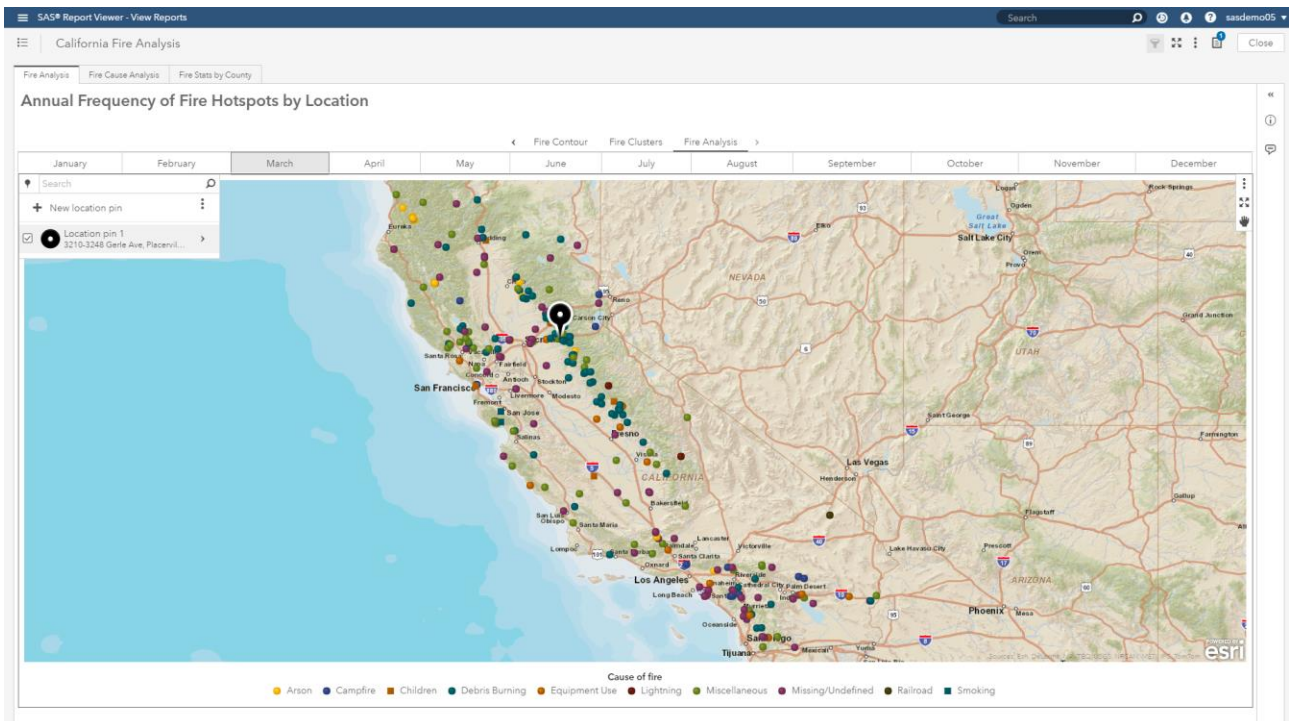
Figure 8. Drop a pin and learn more about a location.

For instance, if you were asked to identify areas to build fire shelters, you would look for areas of high fire activity in past years. After dropping a pin, your exploration begins.
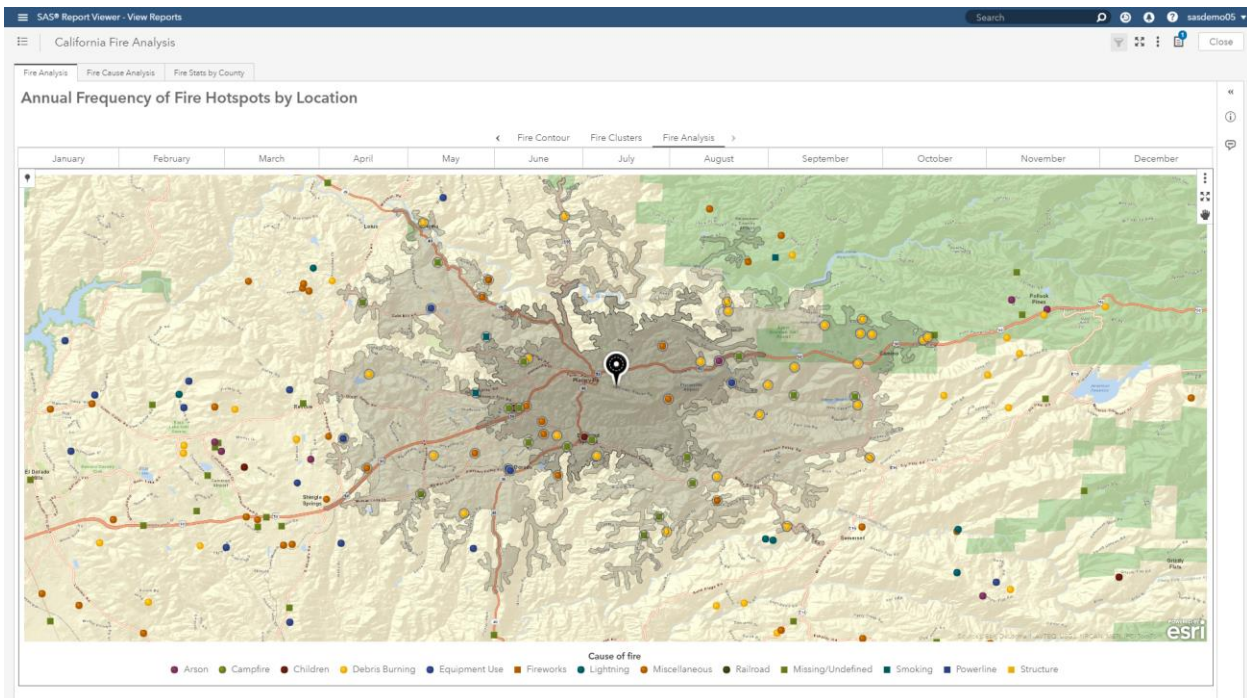
GEOGRAPHIC SELECTION

Understanding proximity of a proposed shelter to past fires can aid your decision. To visualize this, make geographic selections based on distance, travel-distance, or travel-time. Using the Travel-distance Geographic Selection selects all fires within the travel distances specified. For example, 5- and 10-mile drive distances selections as shown in Figure 9Figure 10.
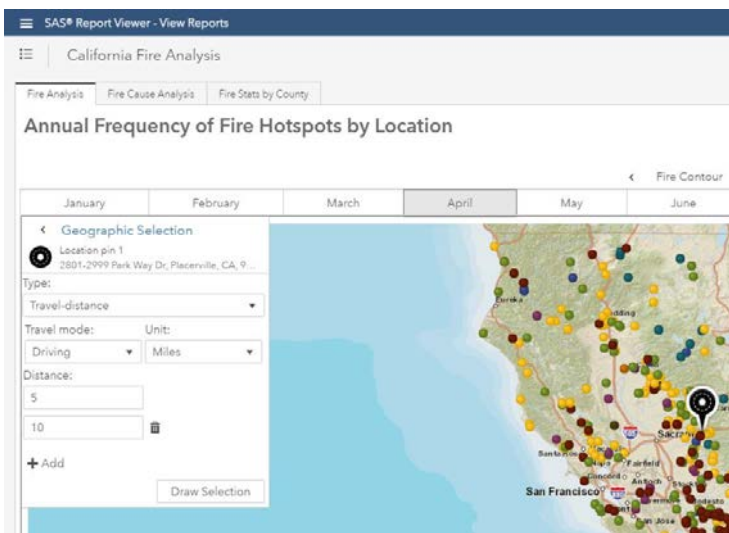
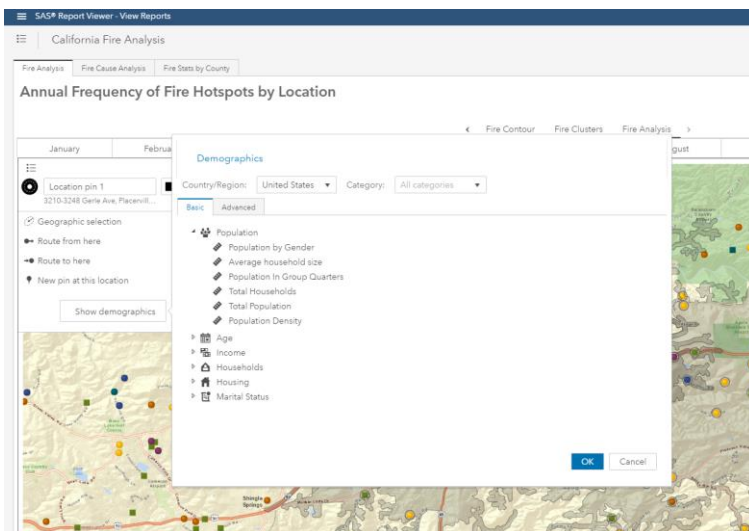**Figure 9. Make a geographic selection.**

Based on the large number of fires captured in the geographic selection area in Figure 10 it makes sense to continue evaluating this location as a possible fire shelter site. Distance geographic selection is included out of the box with SAS Visual Analytics. Geographic selections for Travel distance and Travel time require access to your Esri account.

**Figure 10. 5- and 10-mile Geographic Selections from the specified pin.**

DEMOGRAPHICS

Fire shelters are intended to serve the community in times of need, so it is important to understand the population being served. Leveraging the SAS Visual Analytics integration with Esri, demographic information can be chosen and shown directly on the map during exploration as shown in Figure 11 and Figure 12. Demographics information requires access to your Esri account.

Figure 11. Select Demographics information for the Geographic Selection area.
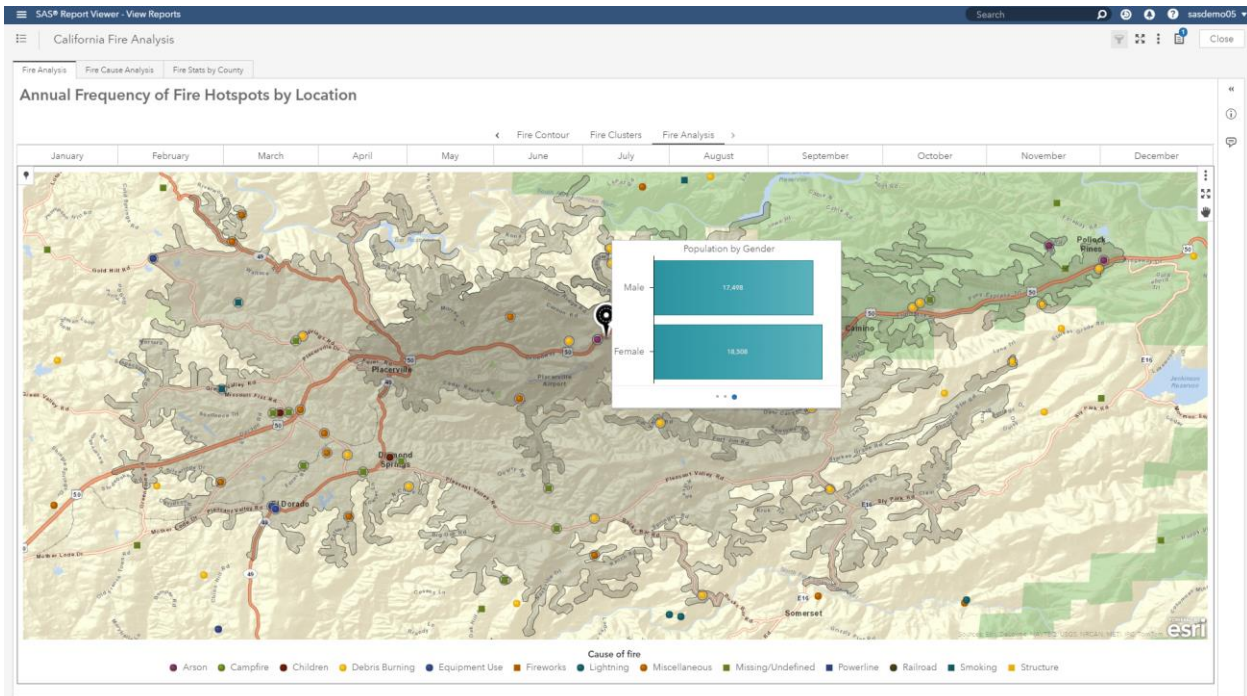
Figure 12. Population by Gender for the Geographic Selection.

From the demographics information we can tell that the male and female population for the area is very similar. This information will aid in stocking supplies for this shelter.

GEO-SEARCH

It is also important for fire shelters to be located near locations such as hospitals for fire shelter visitors in need of medical, and grocery stores to restock supplies. Figure 13 shows a geo-search of nearby grocery stores.
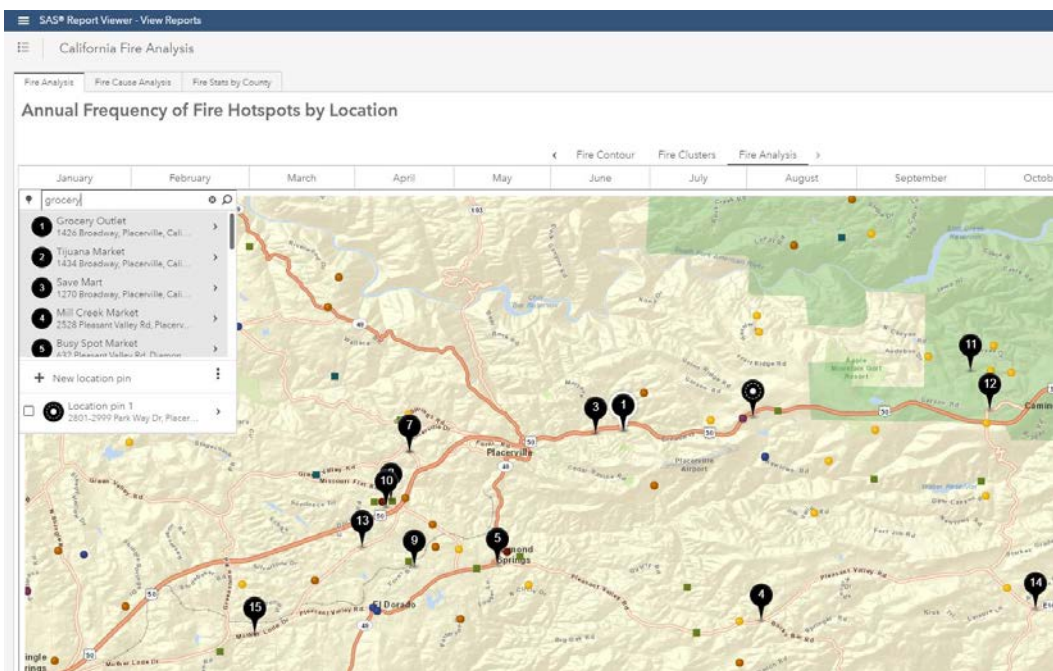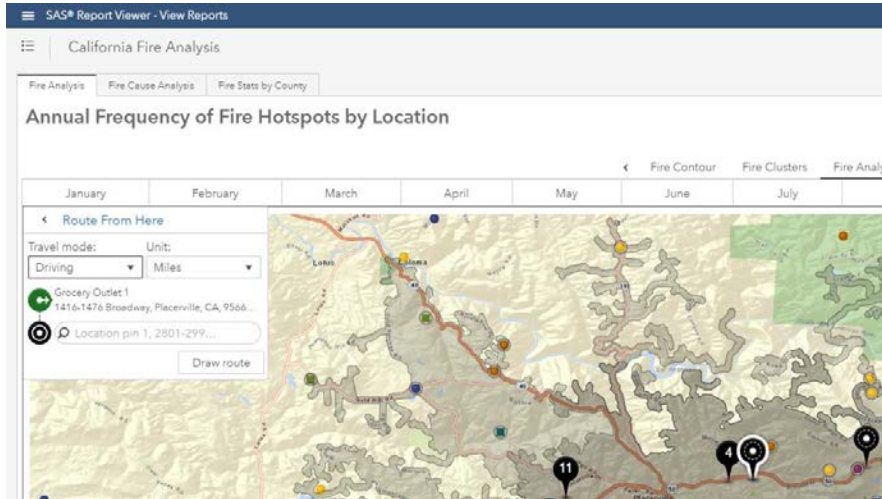

**Figure 13. Geo-search for grocery stores in the area.**

ROUTING

How is the best way to get from here to there? We now know that there are grocery stores nearby, but what is the best route to get there?

Taking the geo-search results, we select search pin #1 "Grocery Outlet" and route from that point back to the proposed shelter location as seen in Figure 14.
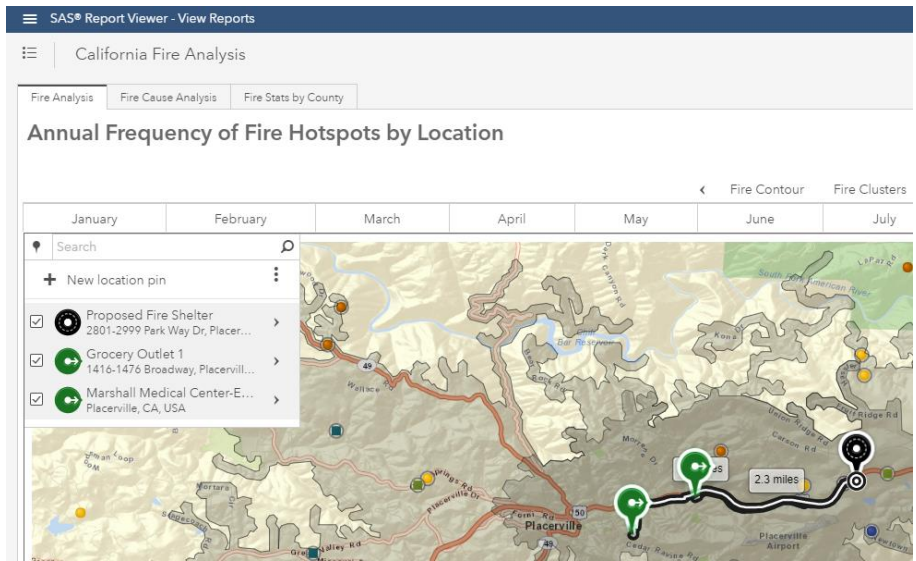

Figure 14. Drawing routes between pins.

Various travel modes: Direct, Driving, Trucking, Walking can be used to draw routes as shown in Figure 15 and Figure 16. Routing uses the Esri routing service called through your Esri account.
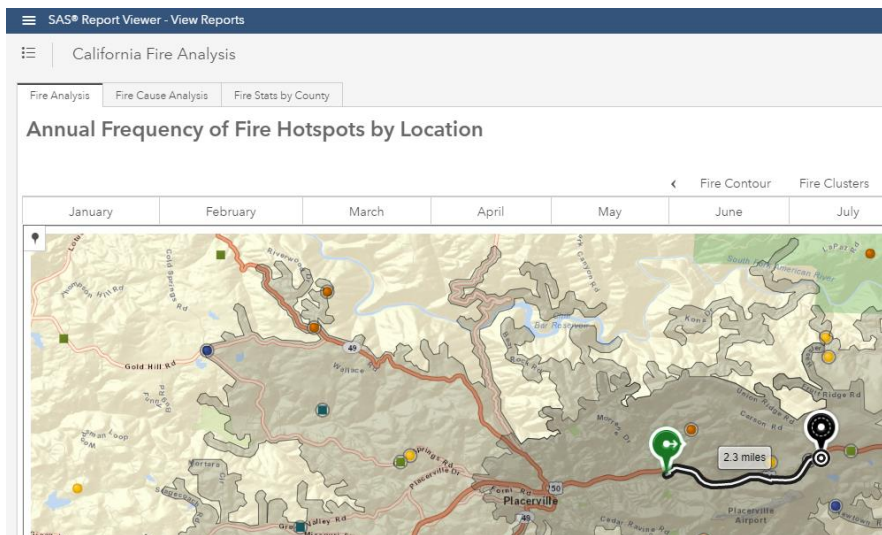
**Figure 15. Driving route between points.**

Figure 16. Routes from grocery store and hospital to the proposed fire shelter.

VIEWING DENSE DATA ON A MAP

Relying on a single view of your data may lead to an incorrect assessment. To get the complete picture, it is important to view various perspectives before acting. An example of this involves displaying dense data points on geographic maps. In situations where there is high saturation of data there is risk of coincident data points which overlap and hide other data points. SAS Visual Analytics provides options for gaining insight into dense data.

The illusion caused by dense data can mask the intensity in highly saturated areas as shown in Figure 17.
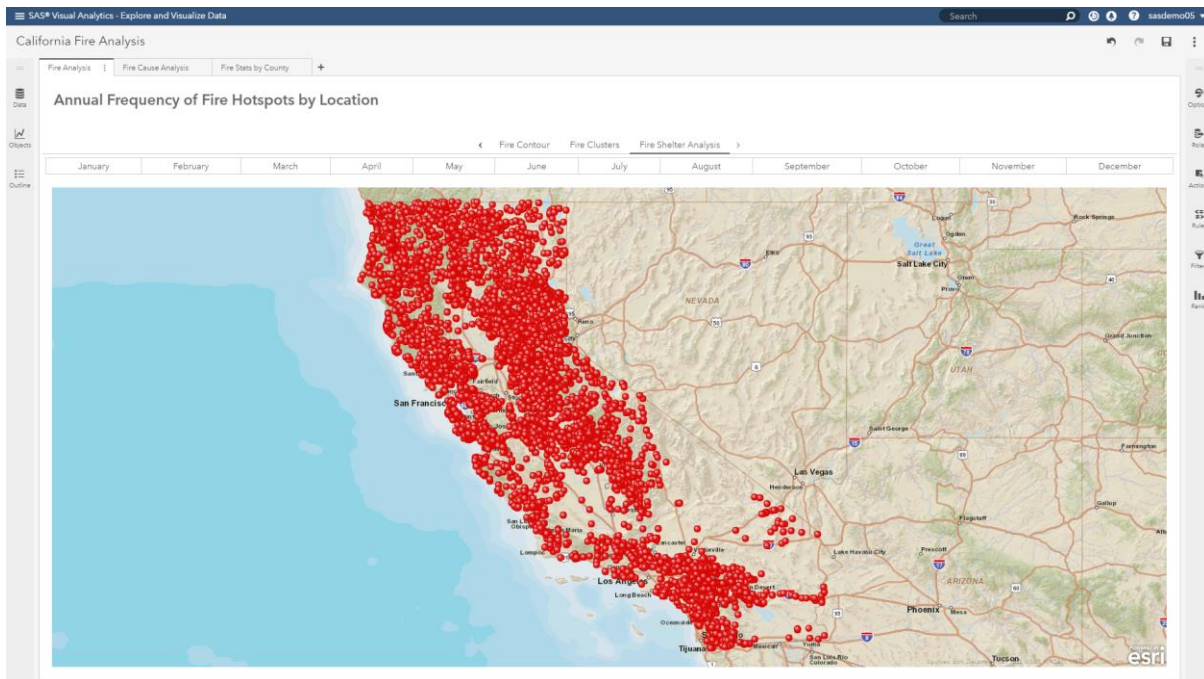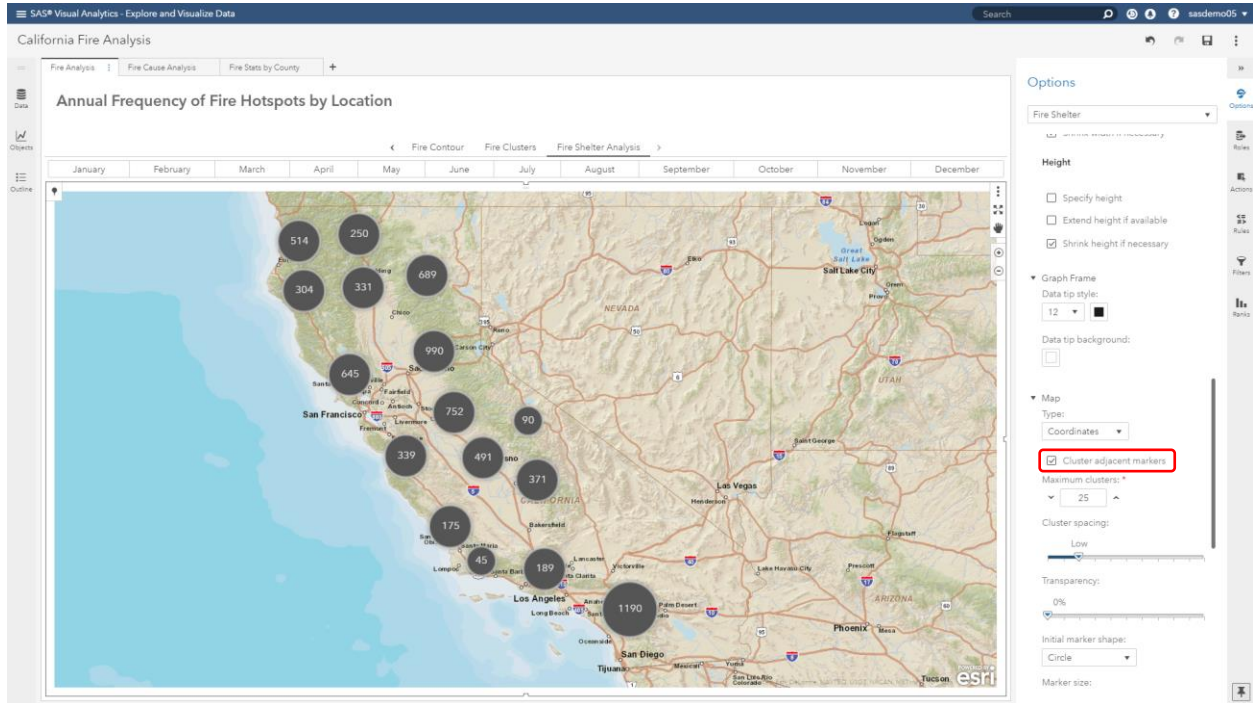

Figure 17. Dense data displayed on a map.

In this map you can see that there were many fire hotspots in California. You can see where the fires occurred and where fires did not but speculating beyond that is risky.

PROXIMITY CLUSTERING

One way to provide clarity in this situation is Proximity Clustering as shown in Figure 18.
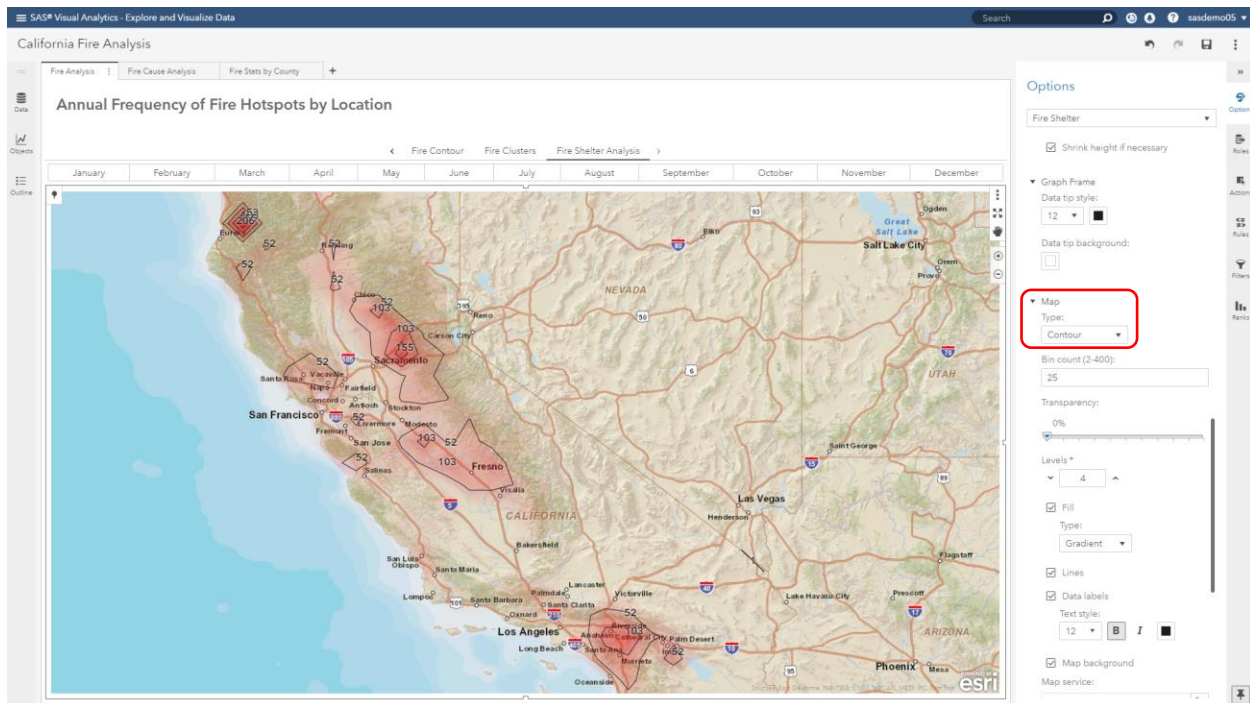

Figure 18. Gain insight from dense data with Proximity Clustering.

If you are displaying Coordinate points on a map (points displayed based on latitude, longitude), then the Cluster adjacent markers option is available. Simply select that option and your data is clustered, allowing you to see the areas of high saturation and how areas relate to one another based on the frequency number displayed as part of each cluster bubble. In this mode, as you zoom in and zoom out the clusters are recalculated. Zooming in eventually results in singleton data points being displayed as there is enough sparsity for the clusters to no longer be useful.

CONTOUR MAPS

Another way to provide clarity when dealing with dense data on a map is by using Contour Map which is shown in Figure 19.

**Figure 19. Gain insight from dense data with Contour Maps.**

Simply change the Map Type to Contour and the map is displayed with color saturation based on the Color Data Role. You can specify the precision of your contour map by setting options including:

1. Bin count: specifies the number of grids to use when clustering. The higher the number of bins, the closer together the contour lines will be and the smaller and more precise the contours are drawn.

2. Levels: the maximum number of contour levels to display.

3. Lines: displays an outline around each contour level on the map.

WEB MAPS AND MAP LAYERS

"An ArcGIS web map is an interactive display of geographic information that you can use to tell stories and answer questions.", "Esri ArcGIS Online – Web maps", doc.arcgis.com/en/arcgis-online/reference/what-is-web-map.htm. You can create custom web maps in Esri ArcGIS Online to provide geographical information using publicly available geographic data or private data that only you can access. Figure 20 is a web map displaying map layers for railroads, hydrocarbon pipelines, and parks. This web map was created with publicly available geographic data and will be used to help answer questions about wildfire data.
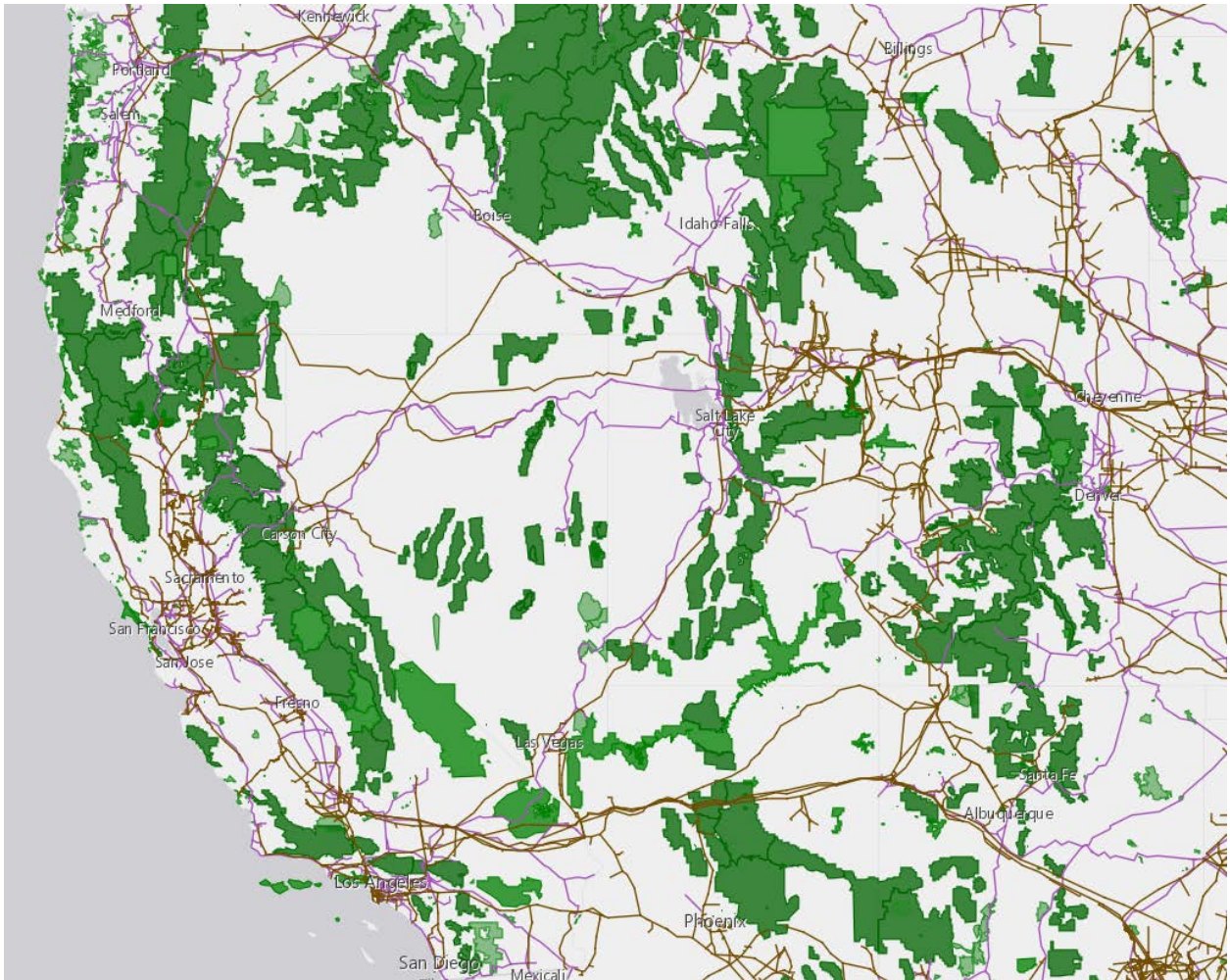
Figure 20. ArcGIS web map showing map layers for railroads, hydrocarbon pipelines, and parks.

To include web maps in SAS Visual Analytics, you just add a Data-Driven Content object to your report. See SAS Documentation for information about working with the Data-Driven Content object.

You will need to build and host the sas-visual-analytics-geowebmap project from the SAS GitHub site, and include the URL for the web app as the *URL property* in your Data-Driven Content object. Modify your URL using the Query string arguments shown in Figure 21.

Query string arguments

| Argument	Description
visualizationType	Optional. Possible values include "scatter", "bubble", or "choropleth". If unspecified, the value will be inferred from other arguments or left as "scatter".
x	The label of the column containing longitude expressed in the same terms as the base map. Defaults to "Longitude". Required for scatter and bubble visualizations.
y	The label of the column containing latitude expressed in the same terms as the base map. Defaults to "Latitude". Required for scatter and bubble visualizations.
size	The label of the column containing the size measurement. Required for bubble visualizations.
color	The label of the column containing the color measurement. Optional for bubble and choropleth visualizations.
animation	The label of the column containing the date used when animating through the data. Optional. Animations are not currently supported in choropleths or 3D views, and they should be considered experimental. It has been observed that performance degrades rapidly when the data's row count enters the tens of thousands. Acceptable date formats are those correctly interpreted by Moment, which include RFC2822 and ISO formats.
colorMin	A hex, rgba, or named color for the minimum value of the range. Defaults to "#bfe4e7" (also expressed, for example, as "rgba(191,228,231,1)", which is somewhat close to "LightCyan").
colorMax	A hex, rgba, or named color for the minimum value of the range. Defaults to "#00929f". Also controls dot color for the scatter plot as well as default color for the choropleth (when no color column is assigned).
outline	A hex, rgba, or named color for an outline on drawn shapes. Defaults to "#007E88". Also controls highlight color for 3D views.
geoId	The label of the column containing the geographic identifiers for the areas to be drawn. Required for choropleth.
featureServiceUrl	The url to the Esri feature service containing the shapes of the geographies identified by the geoId. Required for choropleth.
featureServiceGeoId	The name of the attribute in the Esri feature service that will match values found in the geoId column of the VA data. Required for choropleth.
featureServiceWhere	A where clause to be provided to the Esri feature service that filters results. Optional.
featureServiceMaxAllowableOffset	The optional maxAllowableOffset provided to the feature service. Can be used to restrict the amount of detail (and thus transmission size) of the geographic shapes it returns.
portalItemId	The ID for a web map served at arcgis.com. Optional. Defaults to basemap "osm" (OpenStreetMap).
baseMap	The ID for a basemap from arcgis.com (e.g., "streets", "satellite", "hybrid"). Optional. Defaults to basemap "osm" (OpenStreetMap). Ignored if portalItemId is set.
use3D	Set to "true" to display the map in a 3D SceneView. Defaults to false.
title	The title of the layer that includes VA data. Optional. Defaults to the geoId, if available, or to "SAS VA Layer", if not.
zIndex	The index of the layer that includes VA data. Optional. Use "0" to insert the layer below all others. Defaults to the top-most level.
featuresMax	The maximum number of features allowed in the SAS layer. Optional. If set, the user will receive a warning when the data's row count exceeds this number, and the SAS layer will be cleared.
period	Defines the interval used to subdivide the animation date. Valid values are units of time accepted by Moment (e.g., "millisecond", "day", "month", "year"). Defaults to "year".
useSmartLegends	Set to "true" to use Esri's "smart mapping" legends for color and size (where appropriate). Defaults to false. This feature is experimental.
useSampleData	Set to "true" to load data from SampleData.json instead of VA. Useful for testing. Optional.

Figure 21. Geowebmap project Query String Arguments, from the SAS GitHub site.

The SAS Visual Analytics report in Figure 22 shows the web map combined with SAS Visual Analytics data points. From this visualization, you can see that many of the wildfires occurring in March tend to follow the western border of park land. This insight may indicate the need to better educate landowners whose land backs up to park land on appropriate strategies to reduce forest fires.
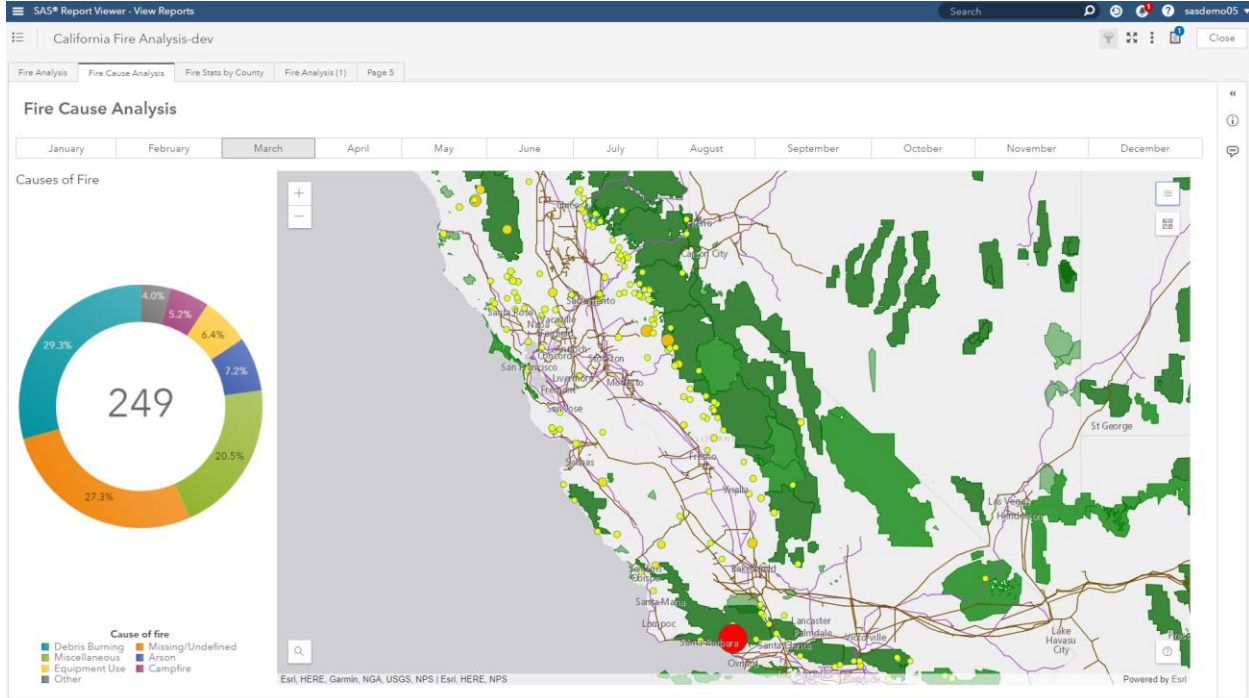
Figure 22. SAS Visual Analytics data combined with a web map, in a data-driven content object.

The standard SAS Visual Analytics data interactions, such as filtering and brushing, are supported between the web map visualization and the other objects in the report. The web map layers can also be toggled on and off through the drop-down menu on the map, as seen in Figure 23.
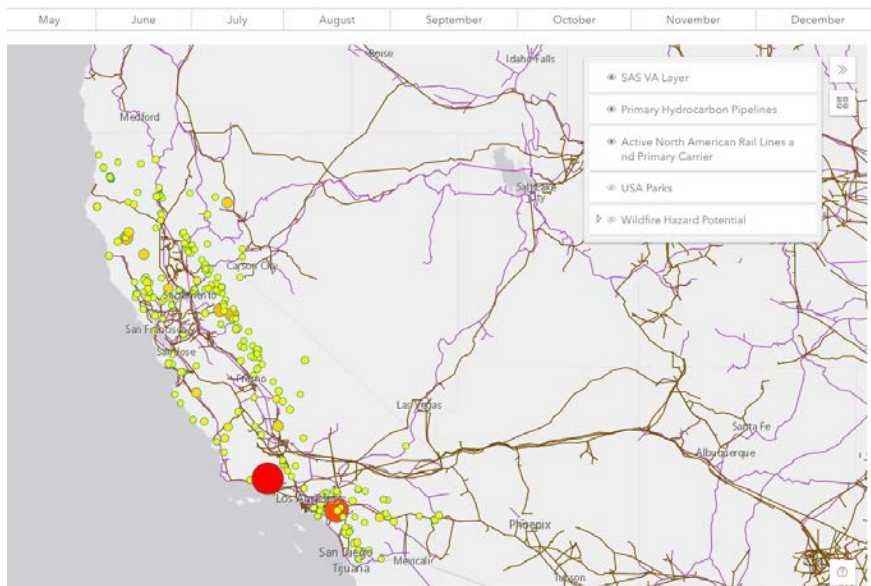
Figure 23. Toggle on and off map layers in the web map.

Using the SAS Visual Analytics Location Analytics capabilities presented in this paper, the Business Analyst is now able to present a case for:

1. Proposed fire shelter locations for next fire season, based on previous years data, proximity and routes to necessary points of interest (hospital, grocery), and demographics information about the local population.

2. Describe opportunities for counties to work together to proactively address wildfires.

3. Policy, outreach, and educational efforts to reduce the number of future forest fires by reaching out to property owners who own land adjacent to park land.

CONCLUSION

Most of the data we generate and consume includes location. SAS Visual Analytics provides a wide range of location analytics through native capabilities and integration with Esri ArcGIS Online. Adding location analytics to your reports and explorations magnifies your insight to address your use cases and support your decisions.

REFERENCES

We acknowledge the use of data and imagery from LANCE FIRMS operated by the NASA/GSFC/Earth Science Data and Information System (ESDIS) with funding provided by NASA/HQ. MODIS Collection 6 NRT Hotspot / Active Fire Detections MCD14DL. Available on-line [https://earthdata.nasa.gov/firms] DOI: 10.5067/FIRMS/MODIS/MCD14DL.NRT.006

Schulz, Falko, "Leverage custom geographical polygons in SAS® Visual Analytics," *Proceedings of the SAS Global 2018 Conference.* Cary, NC, SAS Institute Inc. Available at: https://www.sas.com/content/dam/SAS/support/en/sas-global-forum-proceedings/2018/1732-2018.pdf

SAS Institute Inc. 2019. "SAS® Viya® Administration: Data – Loading Geographic Polygon Data as a CAS Table," https://go.documentation.sas.com/?docsetId=caldatamgmtcas&docsetTarget=p1dwawsidsczlpn121j0glleicxp.htm&docsetVersion=3.4&locale=en

RECOMMENDED READING

Report Images: "*SAS Visual Analytics Gallery.*" Available at:
https://communities.sas.com/t5/SAS-Visual-Analytics-Gallery/tkb-p/vagallery

- **YouTube Video:** "*Location Analytics – Where things happen.*" Available at:
  https://www.youtube.com/watch?v=5P_oiFf-xh4

- SAS Global Forum 2019 Conference Papers:
  - Phillips, Jeff, Hicks, Scott, and Graham, Tony "Introduction to Esri Integration in Visual Analytics**," Cary, NC, SA**S Institute Inc.
  - Phillips, Jeff, Hicks, Scott, and Graham, Tony**,** "There's a Map for That! What's new and coming soon in SAS Mapping Technologies**," Cary, NC, SAS Institute Inc.**

Nori, Murali and Patel, Himesh, "New Location Analysis and Demographic Data Integration with SAS® Visual Analyti**cs and Esri,"** *Proceedings of the SAS Global 2018 Conference.* Cary, NC, SAS Institute Inc. Available at:
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