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Executive Summary

The primary purpose of this project is to perform crash analysis, i.e., to identify and analyze the patterns or trends in various types of crashes by visualizing those. Spatial analysis can help in devising and visualizing more accurate solutions to fatalities due to crashes. The necessary roads to be maintained and positioning the ambulances where there exists a lot of crashes through the dashboard. Various tools are being integrated in the application including Incident Analysis, Summary, Chart, Filter etc., Whenever one needs to find the rate of spread of fatality crashes in various places and to spot out a better location which is crash-free roads, this project comes to picture. It primarily concentrates in the crashes that took place in Florida state.

Web Application link

<https://fau.maps.arcgis.com/apps/webappviewer/index.html?id=0719d5fdd6e2476f93faae9910b2ebe4>

Objective

The objective of this project is to determine effect of road crashes across the counties of Florida that leads to fatalities. The Primary goal is to highlight the crashes that happened on roads, that included fatalities.

Software used

- **Citrix Server - Geoscience Desktop**
 - Citrix Server is a virtual application delivery tool that enables users to access the required applications from anywhere, without considering the fact of hardware that they use
 - Geoscience desktop is a remote desktop that can be connected through the citrix server, which helps in accessing all the windows application present in the system
- **ArcGIS**
 - It helps in working with geospatial information
 - It allows to create, view, edit and query the spatial data in both two dimension and three dimensions
 - It provides an infrastructure for GIS data management and manipulation of necessary tasks
 - Publish data as feature layers to use those in the applications

- REST Services to enable query options for the layer added to the web mapping application
- **ArcGIS Web App builder**
 - It allows to create web application using various templates
 - It helps in integrating multiple widgets and enables the user to customize it as needed

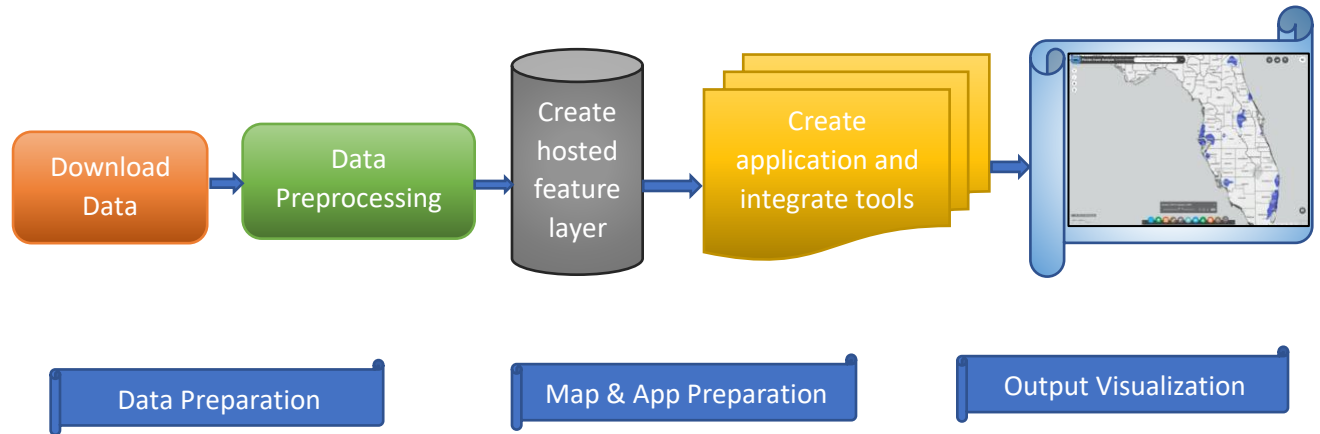
Data Source

Data for this project has been collected from various open-source resources. The necessary data for the Florida crash analysis and mapping project includes the Florida counties and Crashes happened across the state.

Counties data for the project has been collected from the **Florida Geographic Data Library (FGDL)**, whereas the crashes information has been downloaded from the **Florida Department of Transportation** website.

1. Florida Counties - <https://www.fgdl.org/metadataexplorer/explorer.jsp>
2. Crashes - <https://gis-fdot.opendata.arcgis.com/datasets/fdot::fatalities/about>

Workflow



Procedure

After downloading the required data, it needs to be published to the ArcGIS online as a hosted feature layer. Using this layer, a new web map has to be created, with which a web mapping application can be developed using ArcGIS WebAppBuilder. Since the data has the date and time for all the crashes happened, an arcade expression was designed such that a date field was populated. Using this, a time aware layer was created. All the necessary widgets were customized as required and integrated to the application.

Dataset Preparation

The necessary data needs to be acquired from the respective providers and the information has to be cleaned up. The collected data has been used to prepare the Crash analysis application.

Counties

County data stores polygon features of all existing counties in the State of Florida. The Collected County data from **FGDL** has been imported into the ArcGIS Online, which consists of all necessary information such as, **name**, etc.,

Display Name	Field Name	Type
FID	FID	ObjectID
OBJECTID	OBJECTID	Integer
NAME	NAME	String
FIPS	FIPS	String
Shape__Area	Shape__Area	Double
Shape__Length	Shape__Length	Double

Figure 1: Schema for counties data

Crashes Data

Crashes data contains point features of all crashes happened across all the existing counties in the State of Florida. The Collected crashes data from **FDOT** have been imported into the ArcGIS Online, which consists of all necessary information such as, **date, time, county, roadway, driver details, wrong way, aggressive driving, speeding, count of pedestrians, vehicles** etc.,

The downloaded Crashes data contains date, time, year etc. as string which can be converted to date format using ARCADE expression. Using this date field, a time-aware spatiotemporal layer was created.

The screenshot shows the 'Arcade Calculator: Crash Date' interface. It has a text input field labeled 'Expression' and a blue 'Test' button. The expression entered is: `DATE(Concatenate($feature["CRASH_DATE"], ' ', $feature["CRASH_TIME"]))`. The expression is displayed in a list with line numbers 1 and 2.

Figure 2: Arcade expression to compute date of crash

Display Name	Field Name	Type
FID	FID	ObjectID
XID	XID	String
Crash Date	CRASH_DATE	String
Crash Time	CRASH_TIME	String
Calendar Year	CALENDAR_Y	Double
Calendar Month	CALENDAR_M	String
Calendar Date	CALENDAR_D	Double
Day	WEEKDAY_TX	String
County Name	COUNTY_TXT	String
On Roadway Name	ON_ROADWAY	String
Int Roadway Name	INT_ROADWA	String

Figure 3: Schema for crashes data - I

Driver Action Vehicle 1	D1_FRST__1	String
Driver Action Vehicle 2	D2_FRST__1	String
Reporting Agency Type	AGENCY_TYP	String
Pedestrian Related	PEDESTRIAN	String
Bicyclist Related	BICYCLIST_	String
School Bus Related	SCHL_BUS_R	String
Count of Nonfatal Injuries	NUMBER_OF_	Double
Count of Pedestrians	NUMBER_O_3	Double
Count of Drivers	TOTAL_DRIV	Double
Count of Vehicles	NUMBER_O_4	Double
Count of Persons	NUMBER_O_5	Double
Wrong Way	WRONGWAY_I	String
Speeding	SPEEDING_I	String
Agressive Driving	AGGRESSIVE	String
GlobalID	GlobalID	GlobalID
CreationDate	CreationDate	Date
Creator	Creator	String
EditDate	EditDate	Date
Editor	Editor	String
Crash Date	New_Crash_Date	Date

Figure 4: Schema for crashes data - II

Data Publishing

After creating the data, it was published as a hosted feature layer, in order to use that in the web mapping applications. By clicking the “New Item” button at the top left corner of the ArcGIS Online.

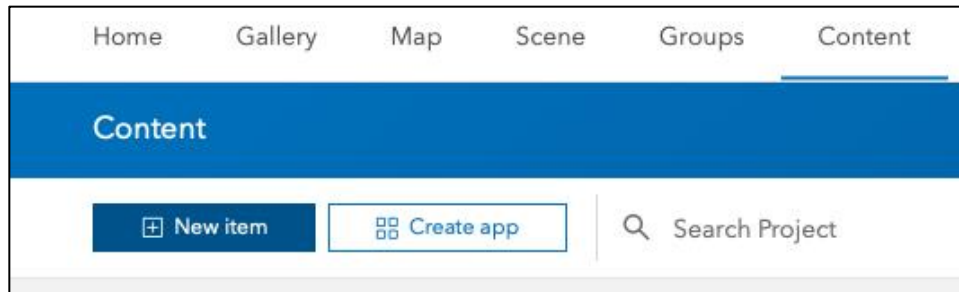


Figure 5: Adding new item to ArcGIS Online

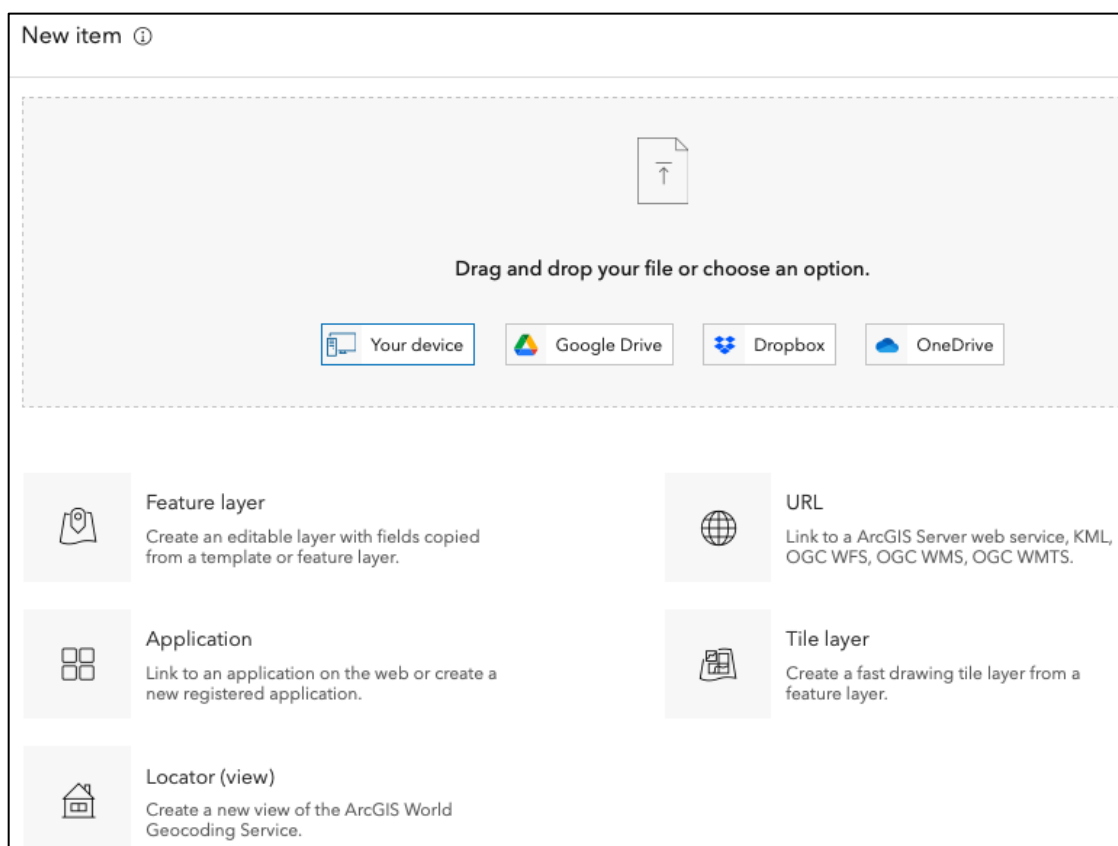


Figure 6: Publish as hosted feature layer

Both the crashes data and the counties data gets displayed in the online content once it is published.

 MonicaRajkumar_WebGIS_FL_Fatalities_Crashes	Feature Layer (hosted)
 MonicaRajkumar_WebGIS_FL_Fatalities_Crashes	Shapefile
 MonicaRajkumar_WebGIS_Florida_Counties	Feature Layer (hosted)
 MonicaRajkumar_WebGIS_Florida_Counties	Shapefile

Figure 7: Published contents in ArcGIS Online

The crashes layer needs to be time enabled based on the newly created crash date field through the Arcade expression.

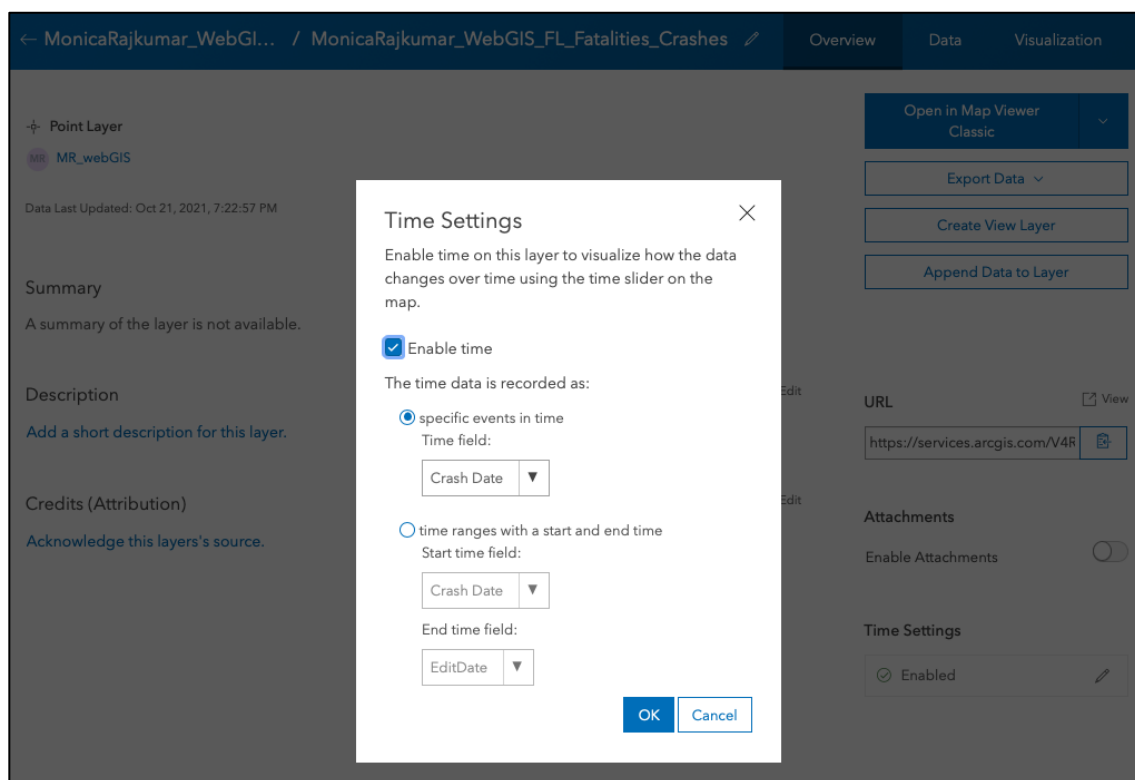


Figure 8: Enabling time settings for crash layer

Web Map Creation

The available county and crashes data have been added to the web map, since it needs to be visually interactive mode in Online WebGIS in order to share multiple users at the health and police department, particularly to the officials in the organizational level. Using ArcGIS Pro, one can be able to share the layers as web maps using the ArcGIS Online organization account. Web maps displays the geographic crash information.

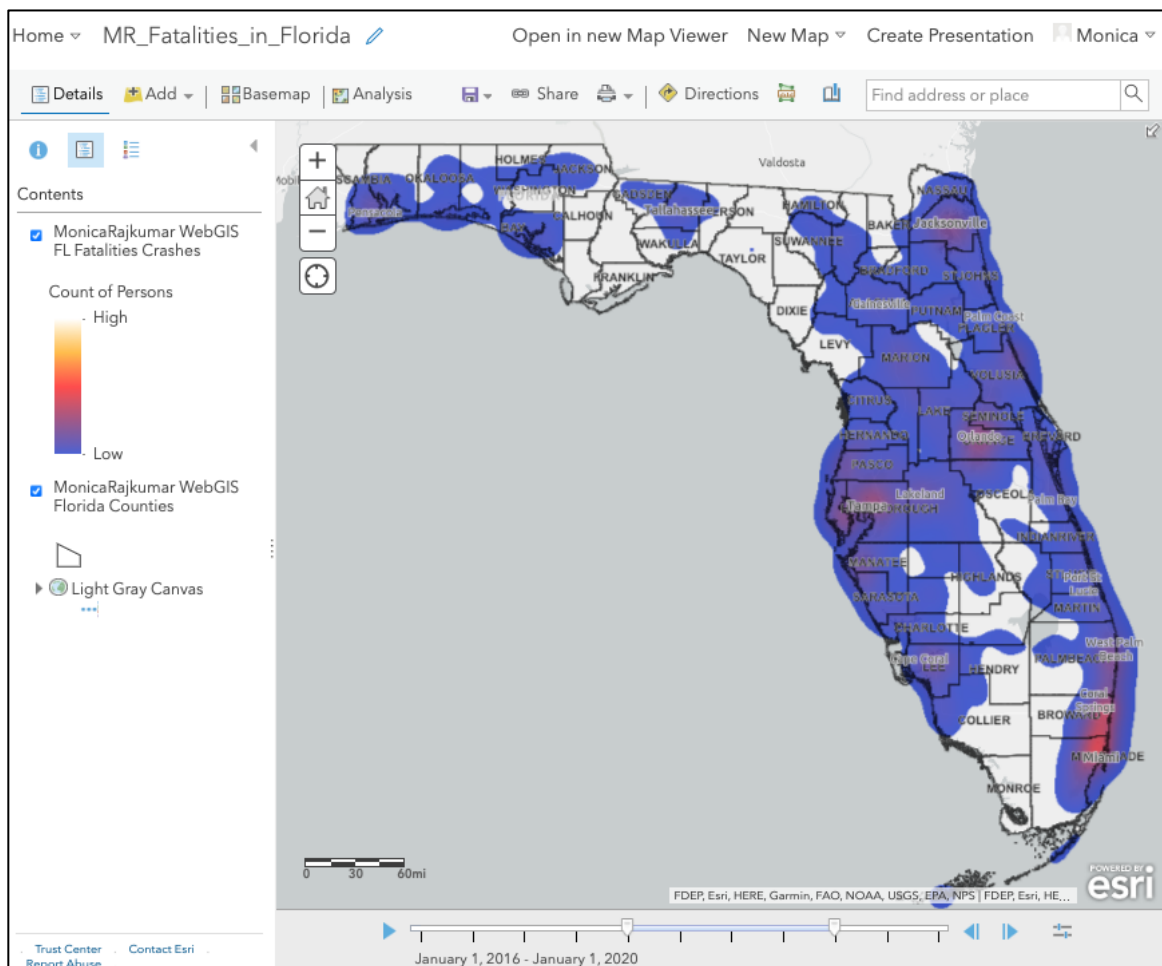
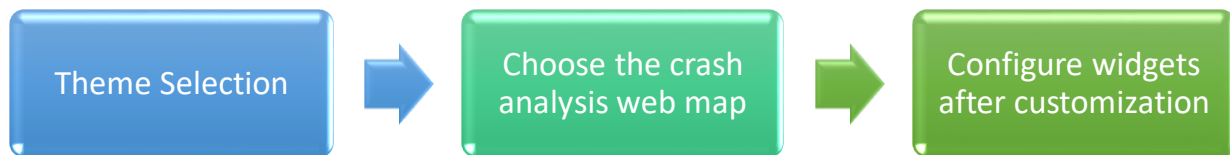


Figure 9: Webmap of Florida crash analysis

Web Application

The web map is available in the ArcGIS Online, which can be accessed through Contents tab, along with its respective layers. Using this shared web map, a web application for “**Florida Crash Analysis**” can be built. The following three major steps need to be followed in order to create such application.



The crash analysis application is helpful in finding the pattern of fatality crashes along the roadways of Florida.

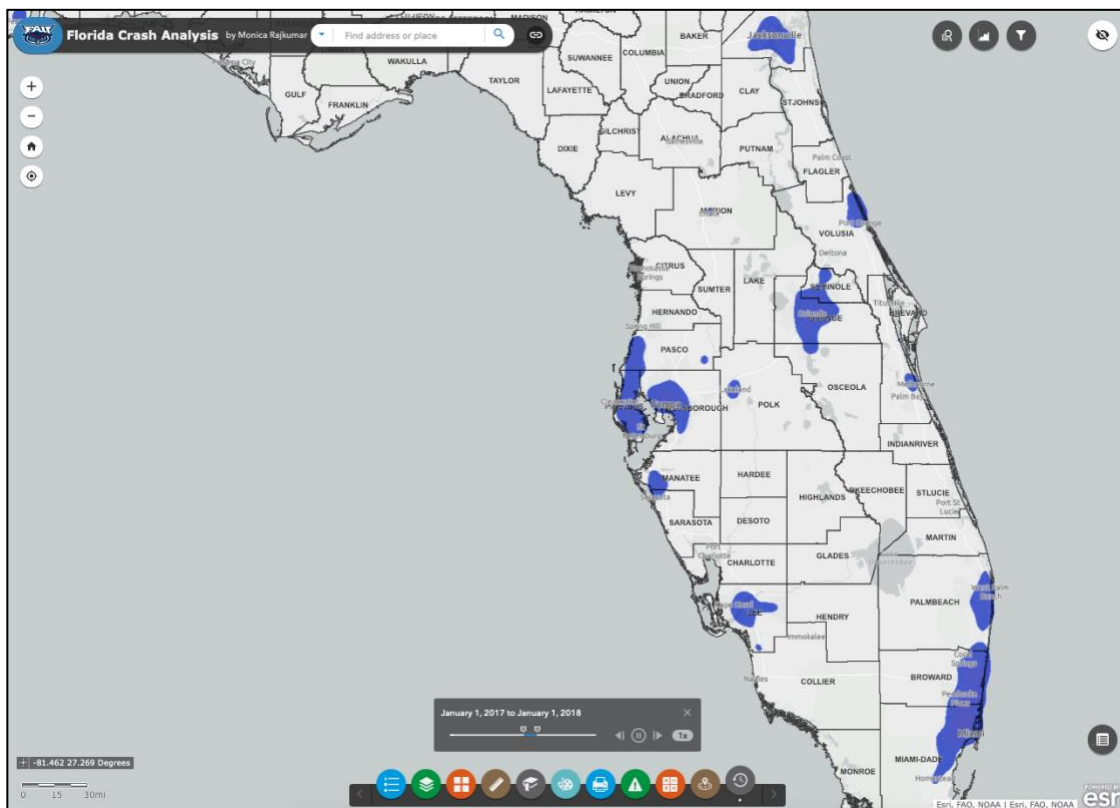


Figure 10: Florida Crash Analysis Application

Tool 1: Navigation Slider

Navigation buttons helps the web mapping application to zoom in and zoom out from all the layers on the map. Zoom level is controlled such that **zoom out is not possible after Florida extent.**



Figure 11: Navigation Slider

Tool 2: Home

Home widget helps in sending back the web map to its original position when the application first loaded.



Figure 12: Home button

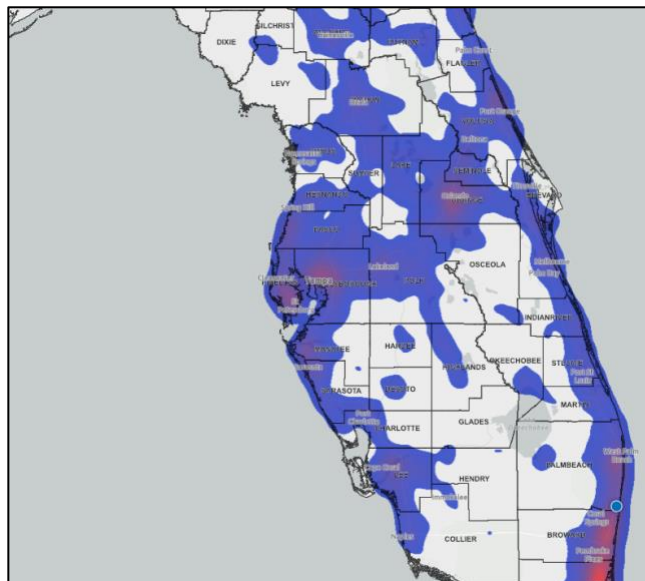


Figure 13: Map resumes to home position

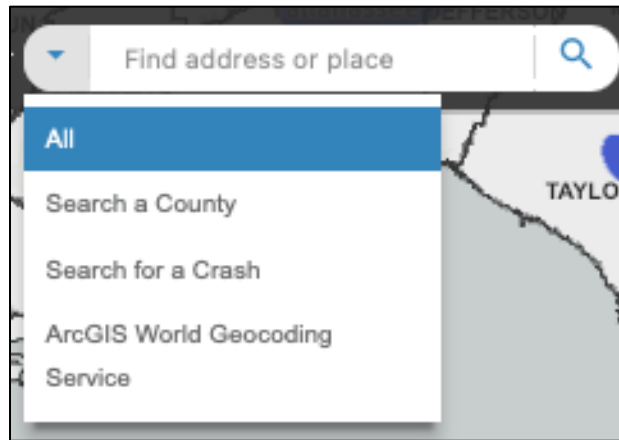


Figure 16: Search tool

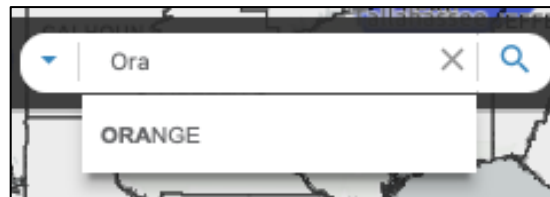


Figure 17: Searching a county

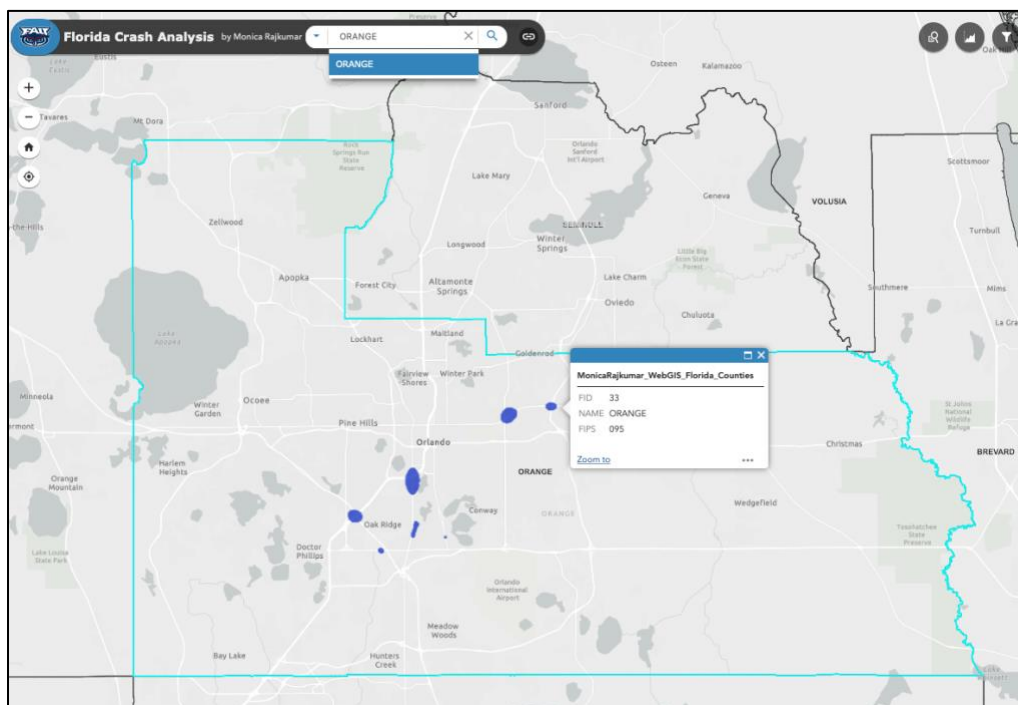


Figure 18: Search result

Tool 5: Link

Necessary links were integrated to the application, so that it can be easily navigated. In the developed Florida crash analysis application, three links corresponding to Florida Atlantic University (FAU), Florida Geographic Data Library (FGDL) and Florida Department of Transportation (FDOT) were all integrated.

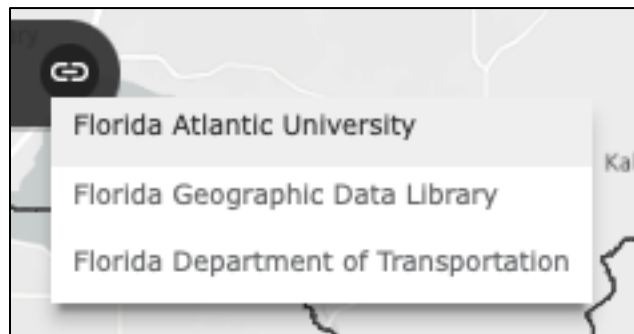


Figure 19: Link tool

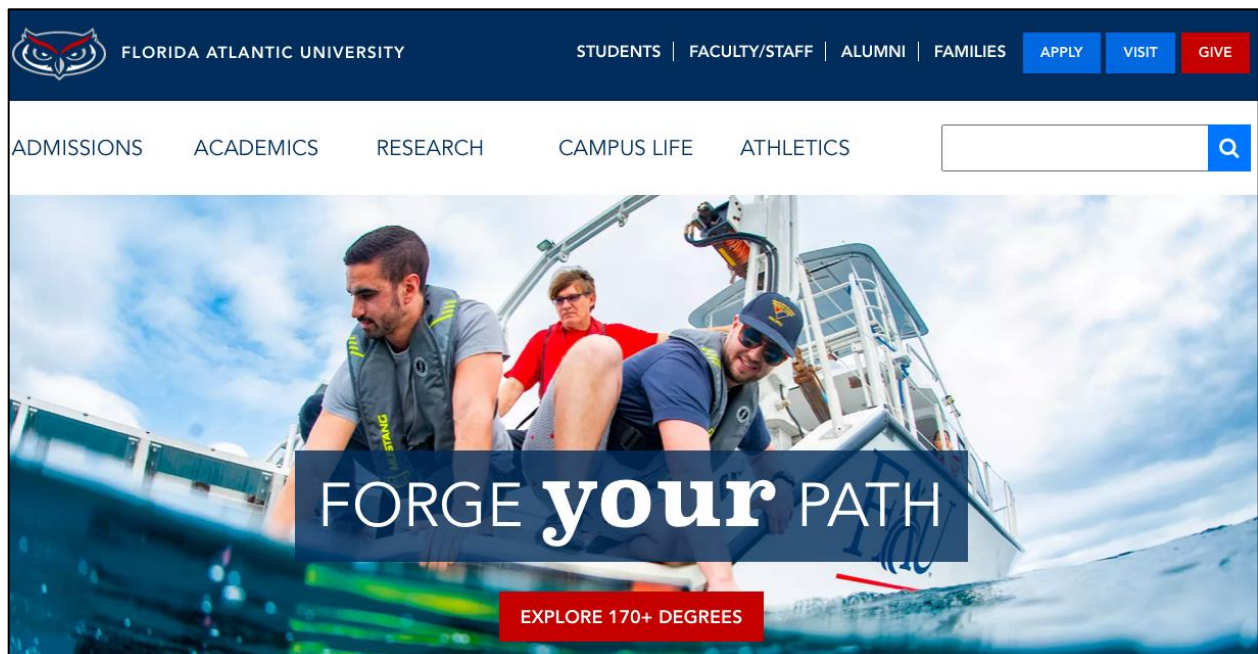


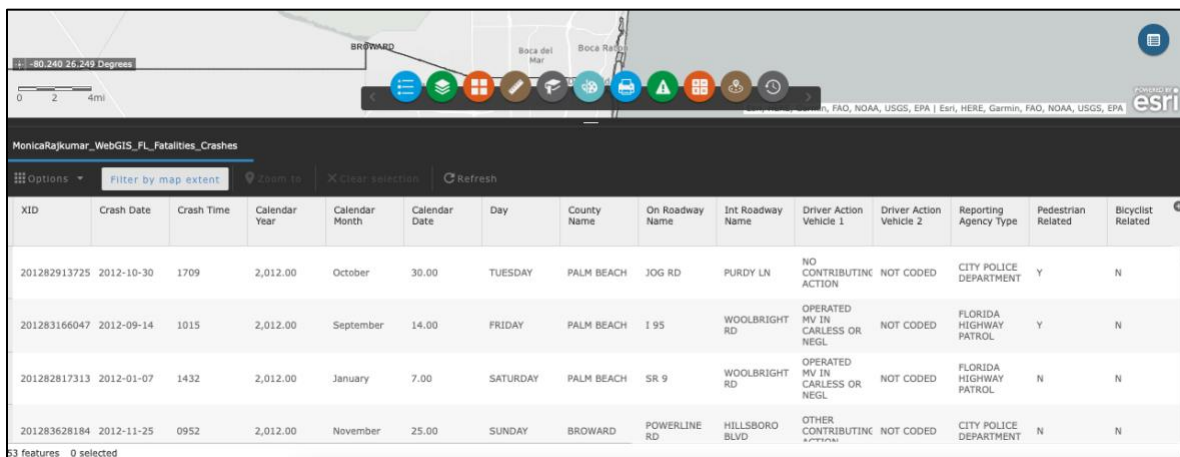
Figure 20: Link for FAU

Tool 6: Attribute table

Through this widget, all the attributes of the layers present in the map can be easily visualized. Certain options such as Filter, Zoom to, Show / Hide columns, Exporting attributes as csv are all available in this tool.

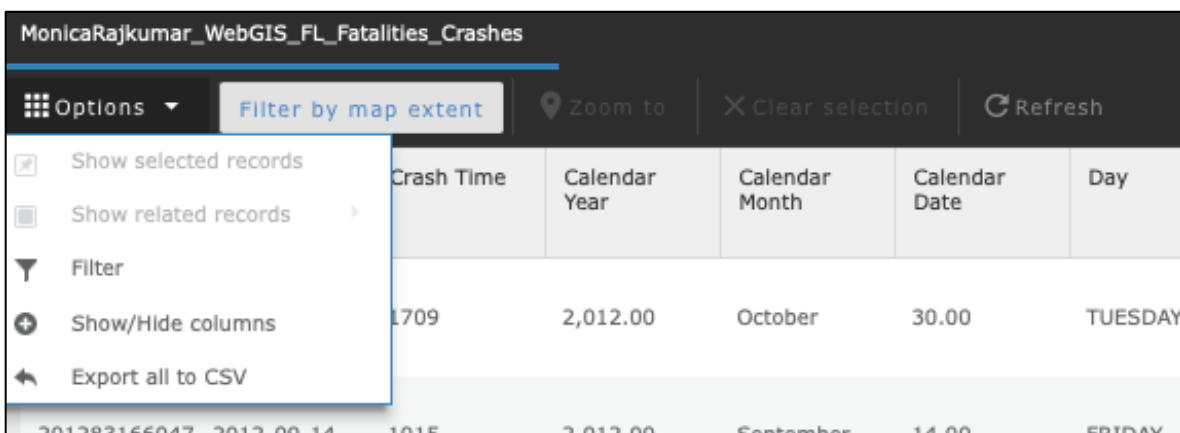


Figure 23: Attribute tool



XID	Crash Date	Crash Time	Calendar Year	Calendar Month	Calendar Date	Day	County Name	On Roadway Name	Int Roadway Name	Driver Action Vehicle 1	Driver Action Vehicle 2	Reporting Agency Type	Pedestrian Related	Bicyclist Related
201282913725	2012-10-30	1709	2,012.00	October	30.00	TUESDAY	PALM BEACH	JOG RD	PURDY LN	NO CONTRIBUTING ACTION	NOT CODED	CITY POLICE DEPARTMENT	Y	N
201283166047	2012-09-14	1015	2,012.00	September	14.00	FRIDAY	PALM BEACH	1 95	WOOLBRIGHT RD	OPERATED MV IN CARELESS OR NEGL	NOT CODED	FLORIDA HIGHWAY PATROL	Y	N
201282817313	2012-01-07	1432	2,012.00	January	7.00	SATURDAY	PALM BEACH	SR 9	WOOLBRIGHT RD	OPERATED MV IN CARELESS OR NEGL	NOT CODED	FLORIDA HIGHWAY PATROL	N	N
201283628184	2012-11-25	0952	2,012.00	November	25.00	SUNDAY	BROWARD	POWERLINE RD	HILLSBORO BLVD	OTHER CONTRIBUTING ACTION	NOT CODED	CITY POLICE DEPARTMENT	N	N

Figure 24: Attribute table for the crash layer



XID	Crash Date	Crash Time	Calendar Year	Calendar Month	Calendar Date	Day
201282913725	2012-10-30	1709	2,012.00	October	30.00	TUESDAY
201283166047	2012-09-14	1015	2,012.00	September	14.00	FRIDAY

Figure 25: Options for attribute table widget

Tool 7: Overview

Overview widget helps in visualizing the “**overview**” of the map present in the application.



Figure 26: Overview tool

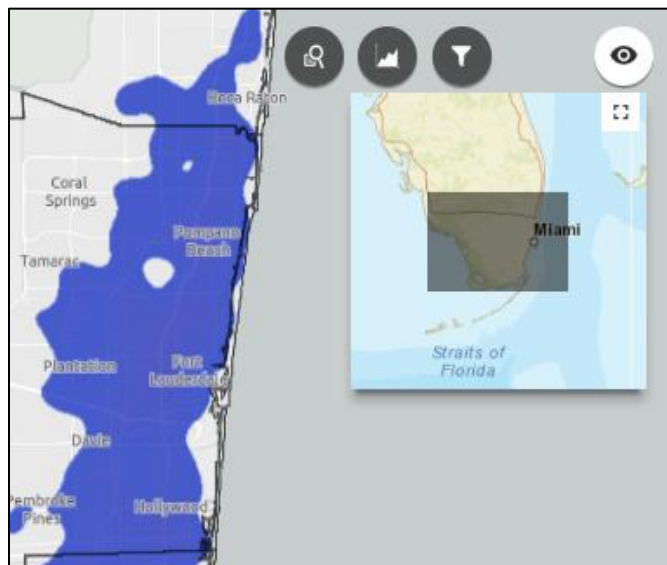


Figure 27: Map overview

Tool 8: Co-ordinate

Respective co-ordinates appear at the bottom left corner of the application, whenever mouse cursor is moved on the map.



Figure 28: Co-ordinate's widget

Tool 9: Scalebar

Scalebar for the map is shown at the bottom left of the application based on the scale and extent of the application.



Figure 29: Scalebar widget

Tool 10: Legend

Legend tool shows the symbology of all the layers that are present on the application. (E.g. Florida Counties and crashes data)

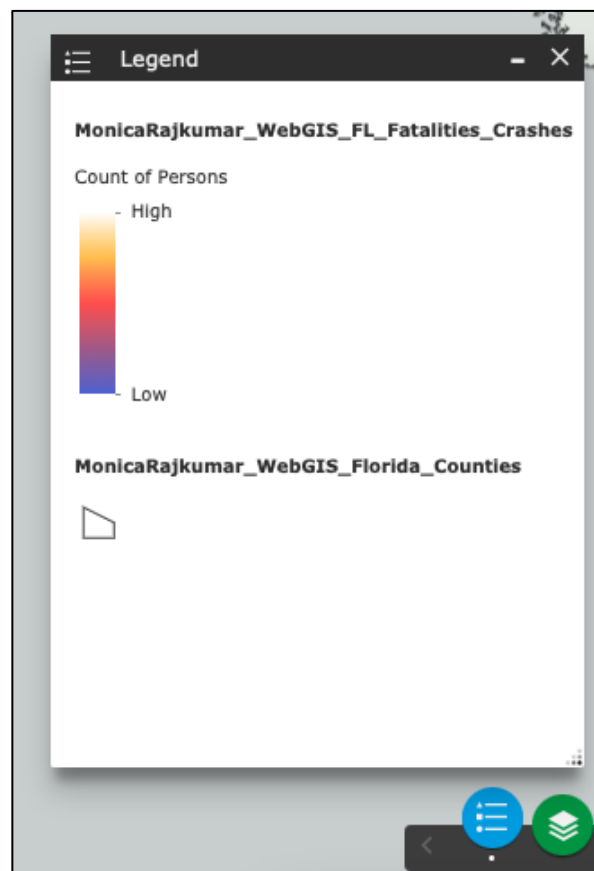


Figure 30: Legend tool

Tool 11: Layer list

The layers present on the application can be seen in this widget. Certain options such as zoom to layer, handling transparency and visibility of layer, popup-configuration, view in attribute table are all available in this tool.

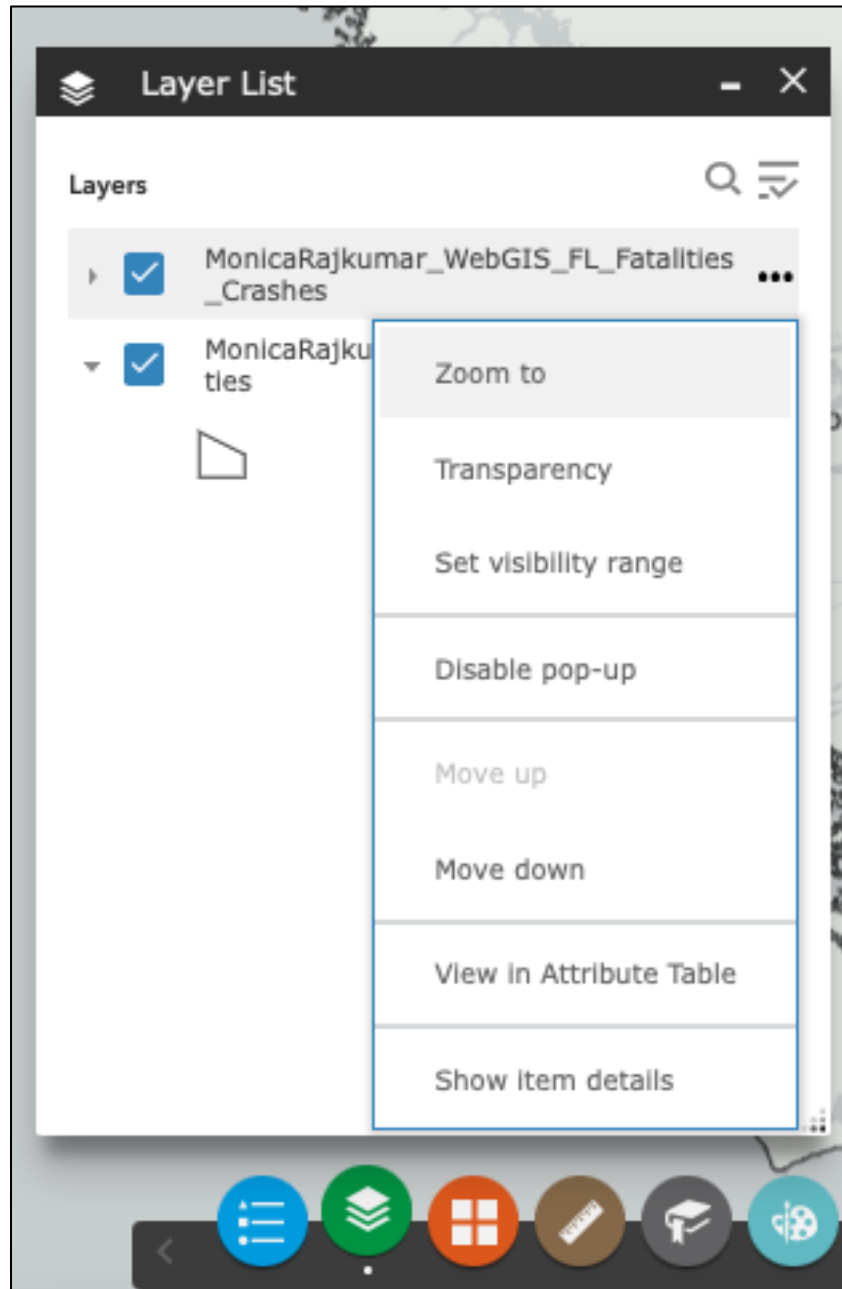


Figure 31: Layer list tool

Tool 12: Basemap Gallery

Necessary basemap as needed can be updated to the application using this widget.

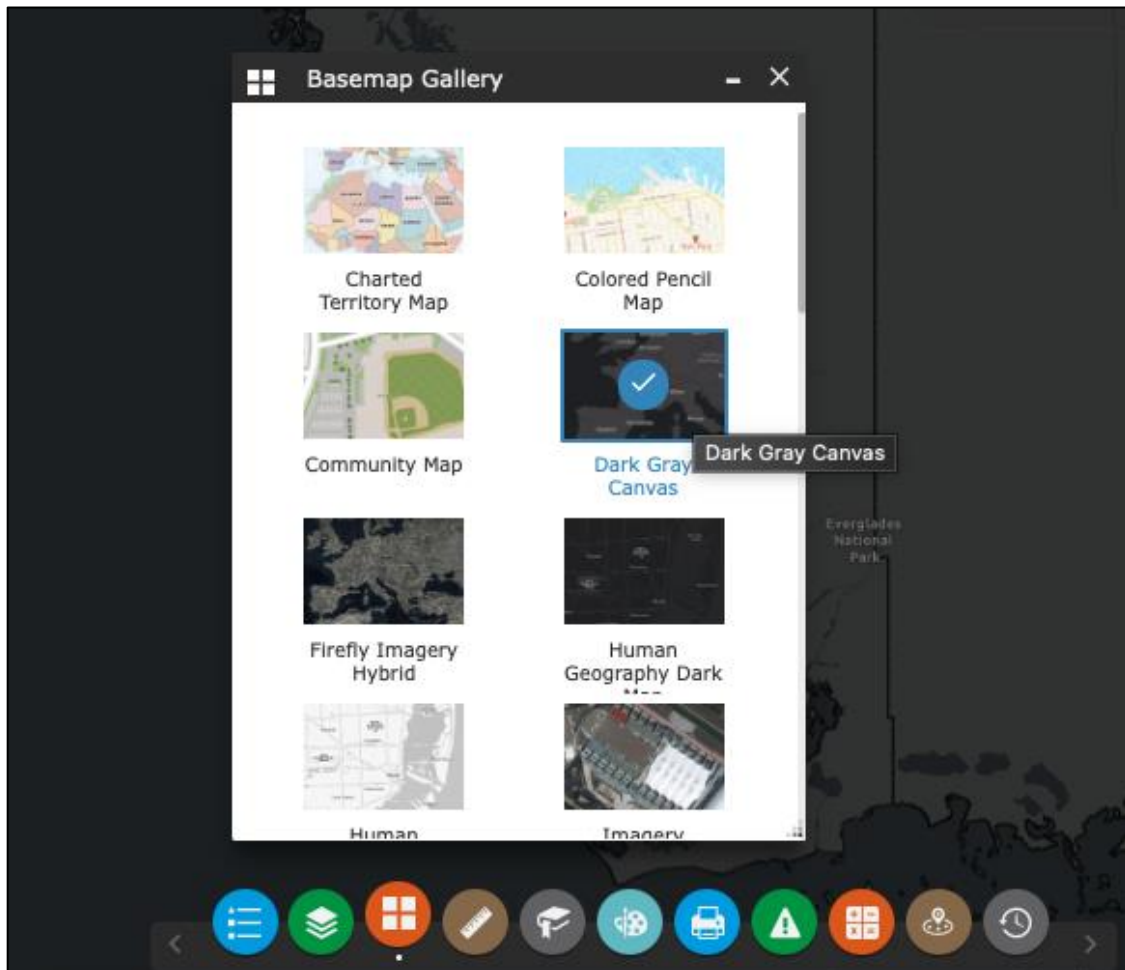


Figure 32: Basemap gallery widget

Tool 13: Measurement

Any measurements based on point, line and polygon can be made using the measurement widget.

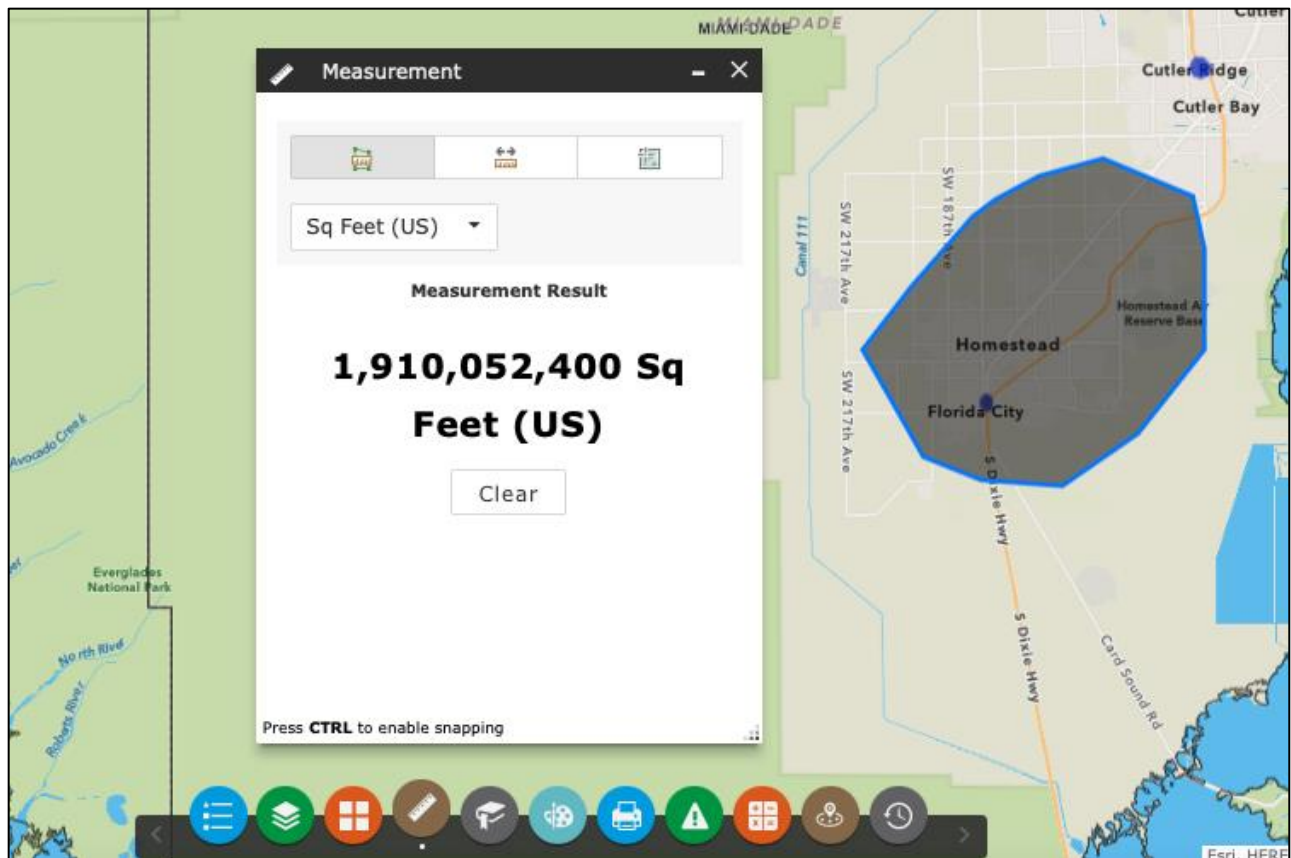


Figure 33: Measurement tool

Tool 14: Bookmarks

Bookmarks widget stores the pre-defined area, so that the user can easily navigate to the respective places without any struggle. Nearly 10 bookmarks are currently added to the web map, so that all those bookmarks gets loaded by default. In addition, the user can also add any number of bookmarks based on their convenience. These newly added bookmarks are stored in the application till that particular session, i.e., those bookmarks will not be present when the user reloads the web application at any point of time.

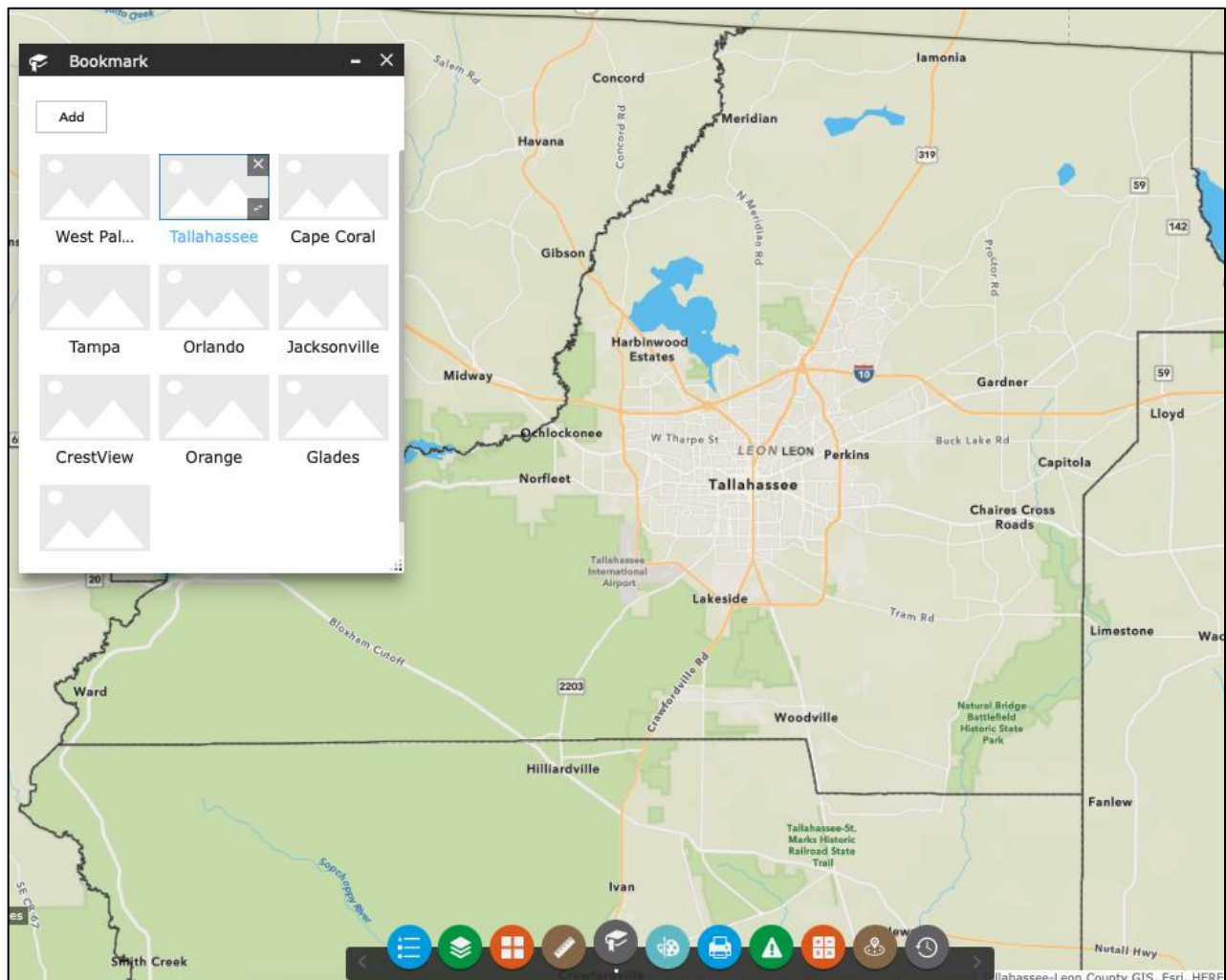


Figure 34: Bookmarks widget

Tool 15: Draw

Using draw tool, any kind of point, line, polygons can be drawn. Even freehand line and polygons are available. The user can be able to insert text as a graphic. All these features can be drawn at any required place using any customized symbology and fonts, which gets stored as a graphic layer on the map, that can be handled through the layer list widget.

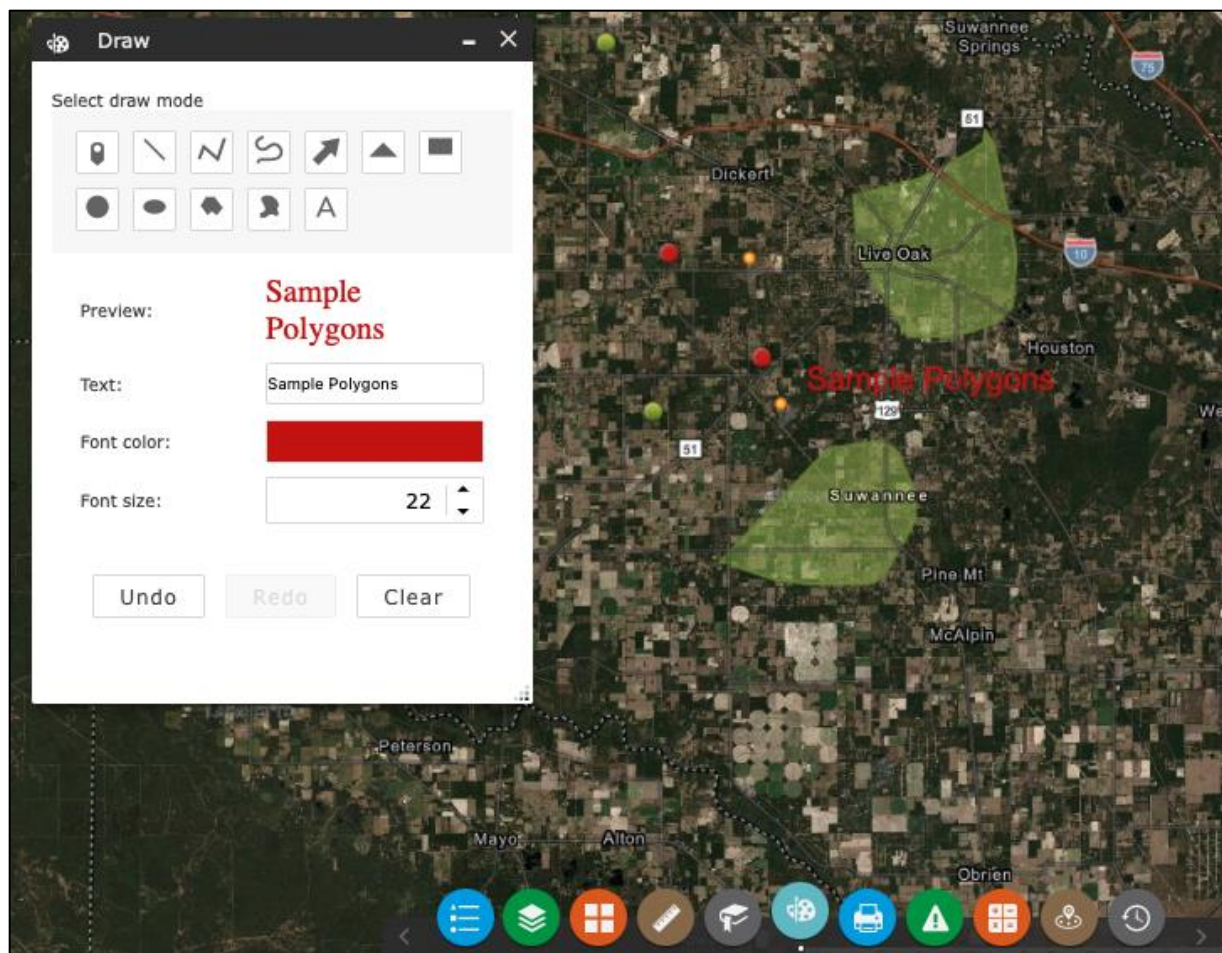


Figure 35: Draw tool output

Tool 16: Print

Maps can be printed at any defined layout and format with customized titles using Print widget. Certain advanced options are also available. Printing one sample map is shown in the figures below.

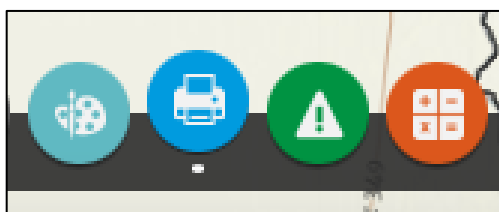


Figure 36: Print tool

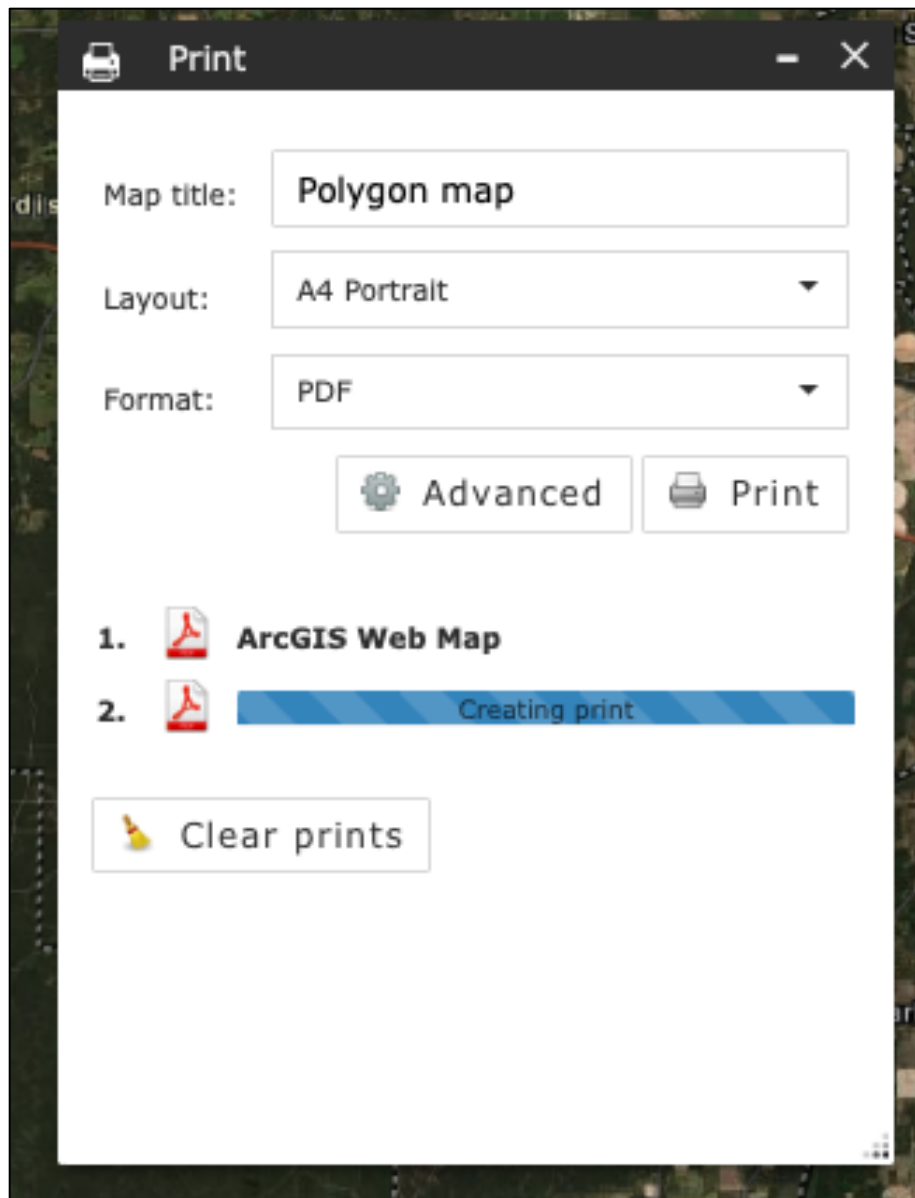


Figure 37: Printing maps using widget

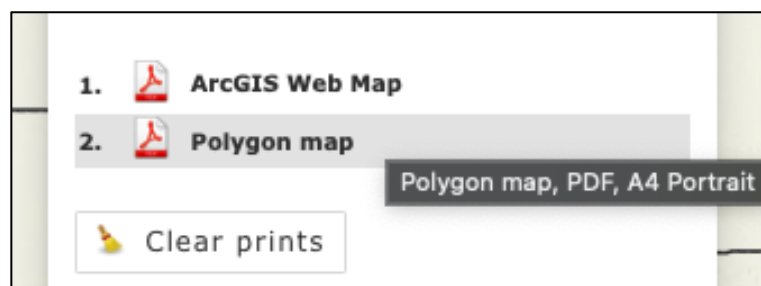


Figure 38: Printed maps

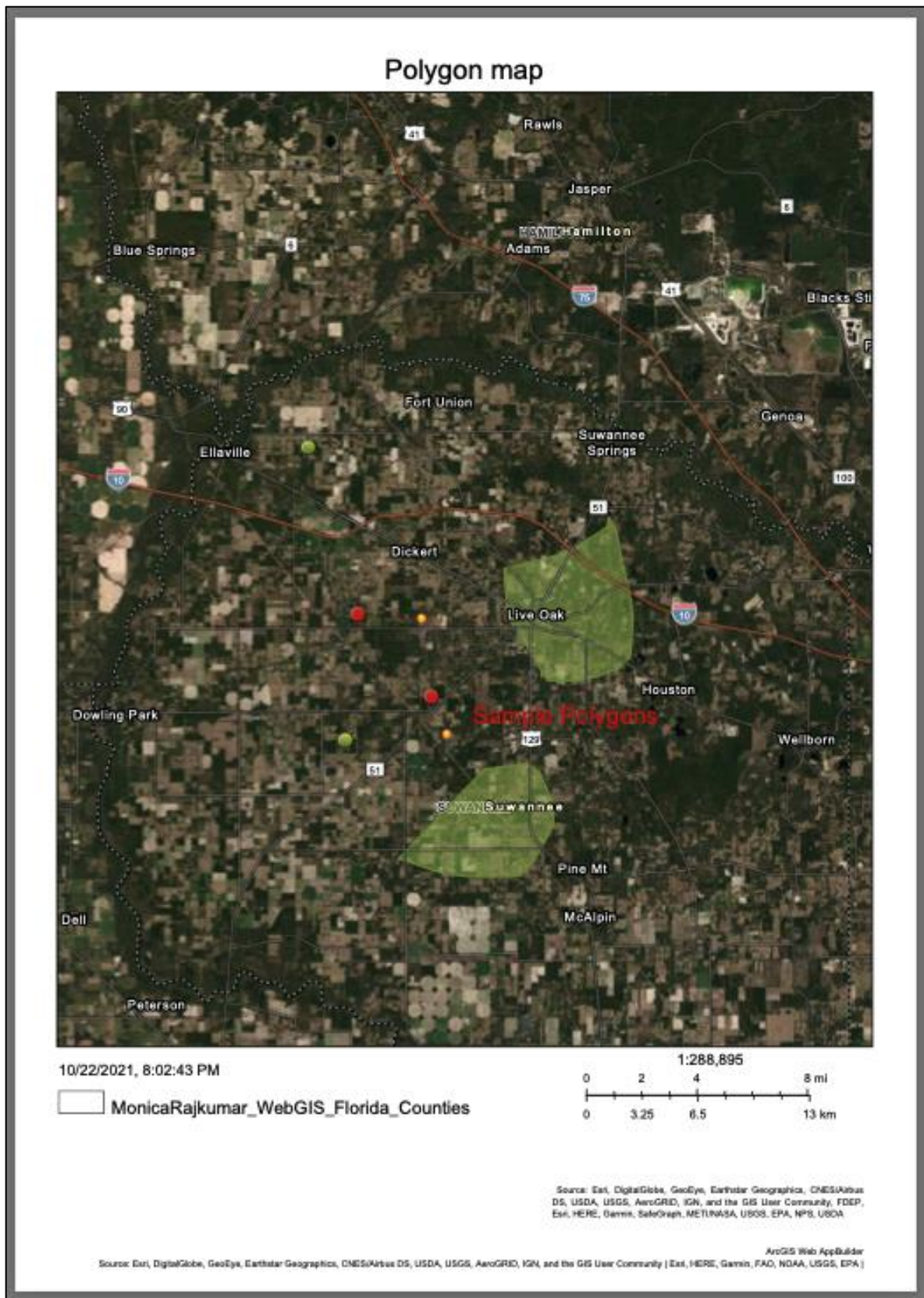


Figure 39: Printed map

Tool 17: Time Slider

Since a time-aware layer has been created using the “**Crash Date**” field, time slider can be integrated to the application. Crashes based on year can be filtered using the available time slider on map.

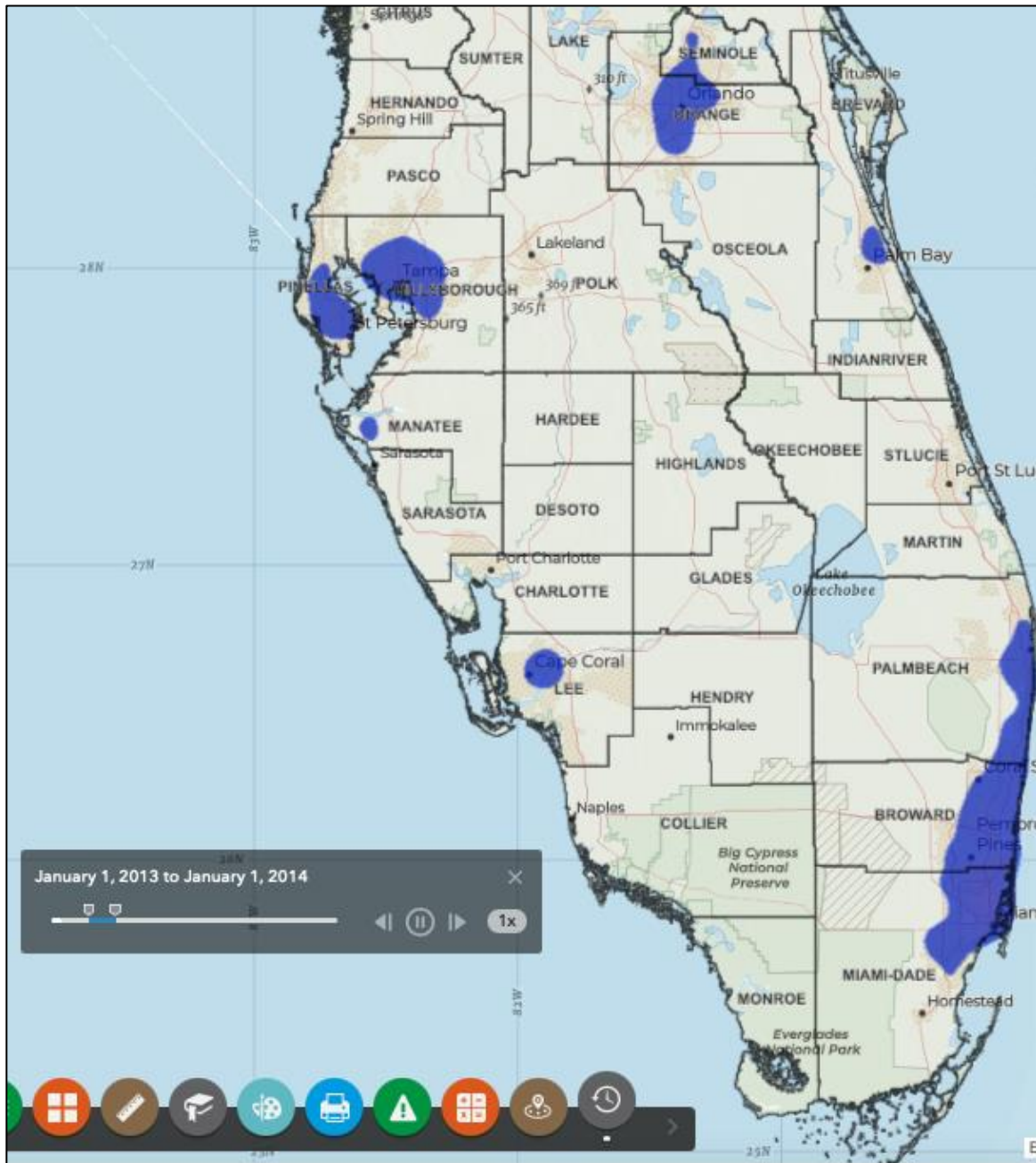


Figure 40: Time slider widget

Tool 18: Incident Analysis

Incident analysis based on the user defined location is shown through this widget. Weather data and the Closest crash will be listed after analysis based on a spatial extent given as an input by the user.

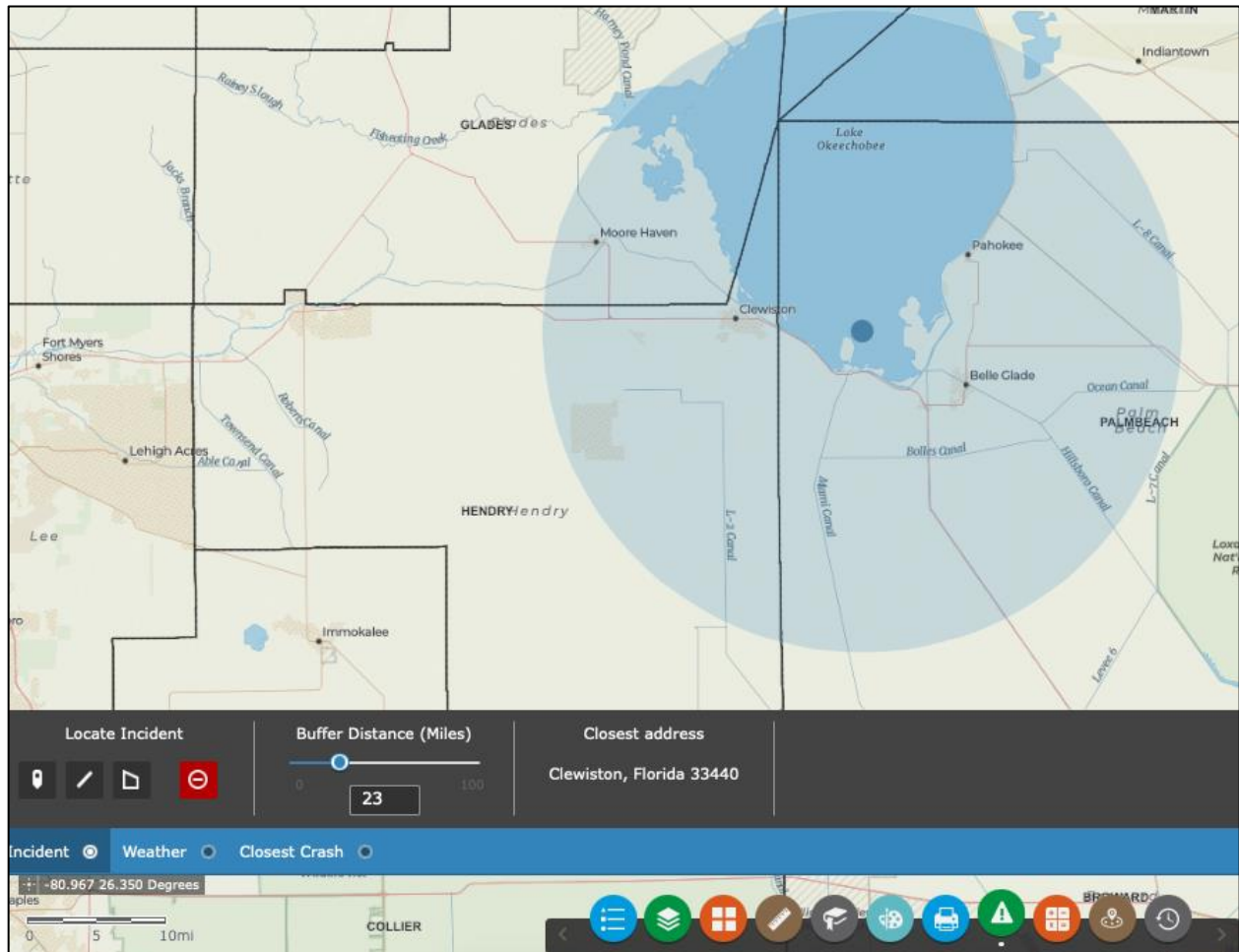


Figure 41: Incident Analysis tool

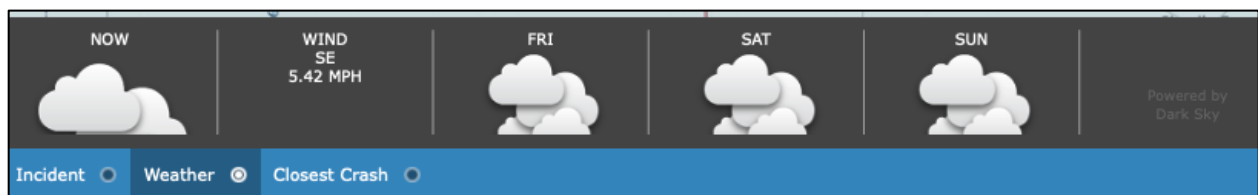


Figure 42: Weather option of incidents

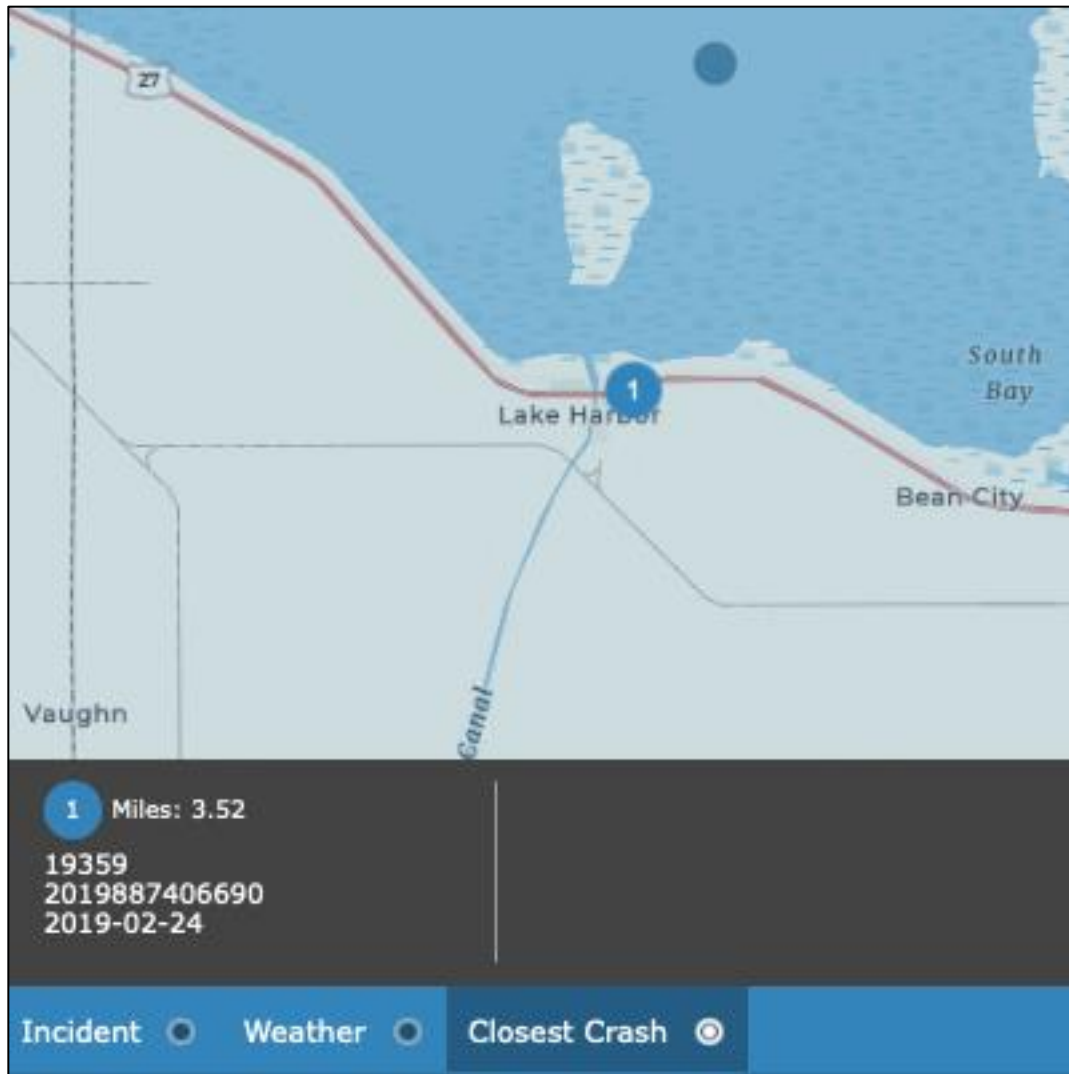


Figure 43: Closest crash using incident tool

Tool 19: Summary

Summary widget shows the overall summary of all the crashes present on the map based on its extent. Total number of crashes, count of pedestrians, vehicles, drivers, persons, nonfatal are all displayed based on the user defined extent on the application. It triggers whenever the extent gets changed by the web application user.

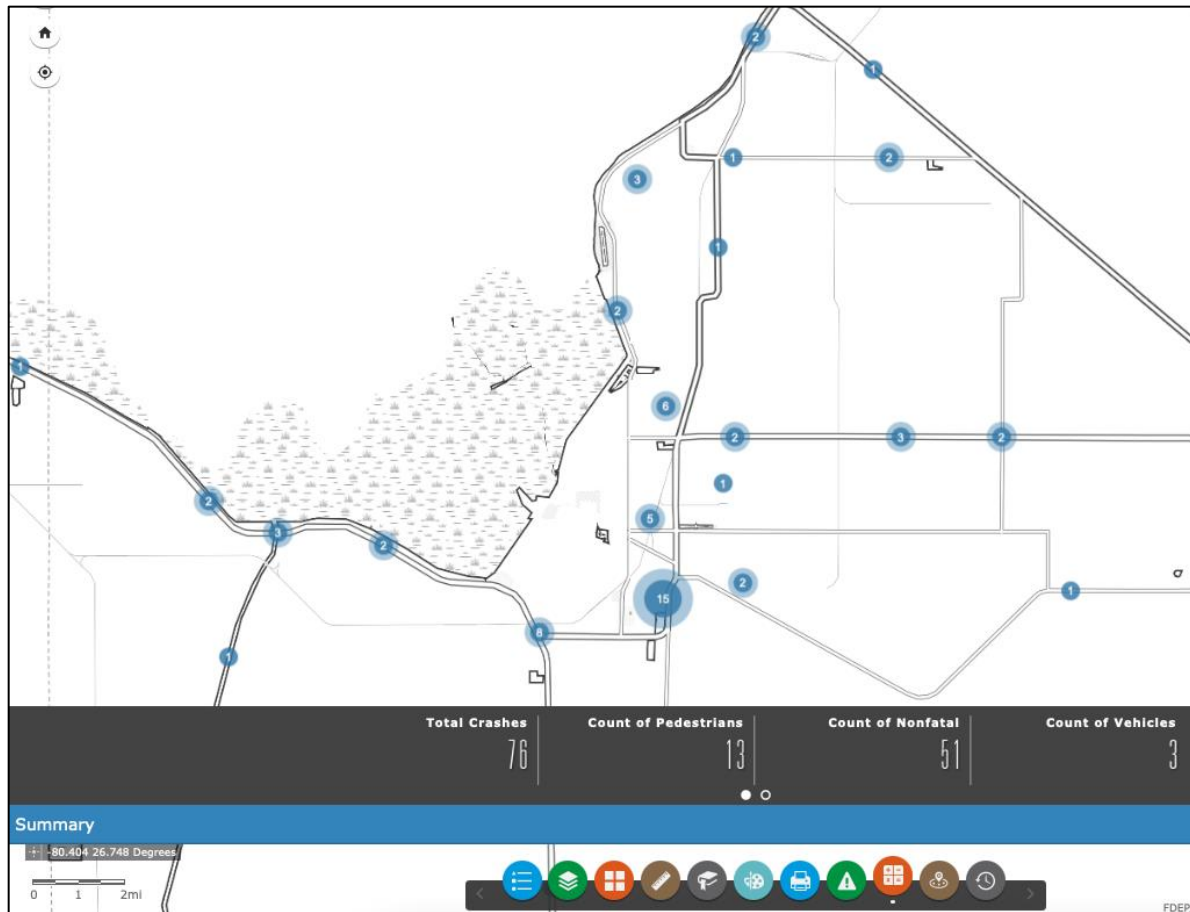


Figure 44: Summary tool - I

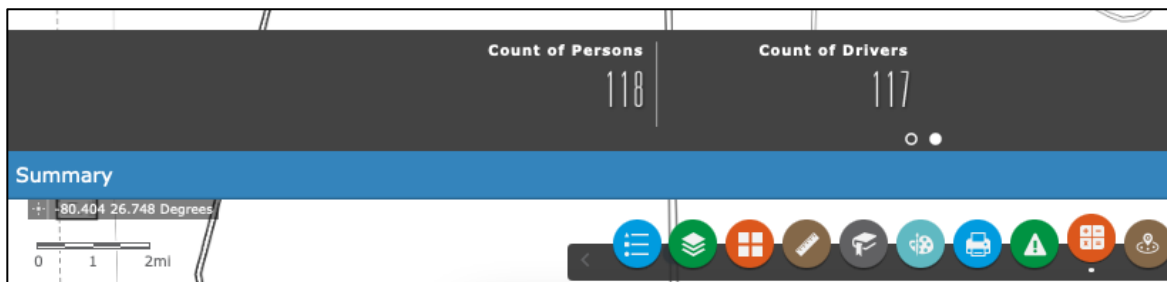


Figure 45: Summary tool - II

Tool 20: Near me

Through near me tool, user can visualize the nearby crashes based on the user defined location on map.

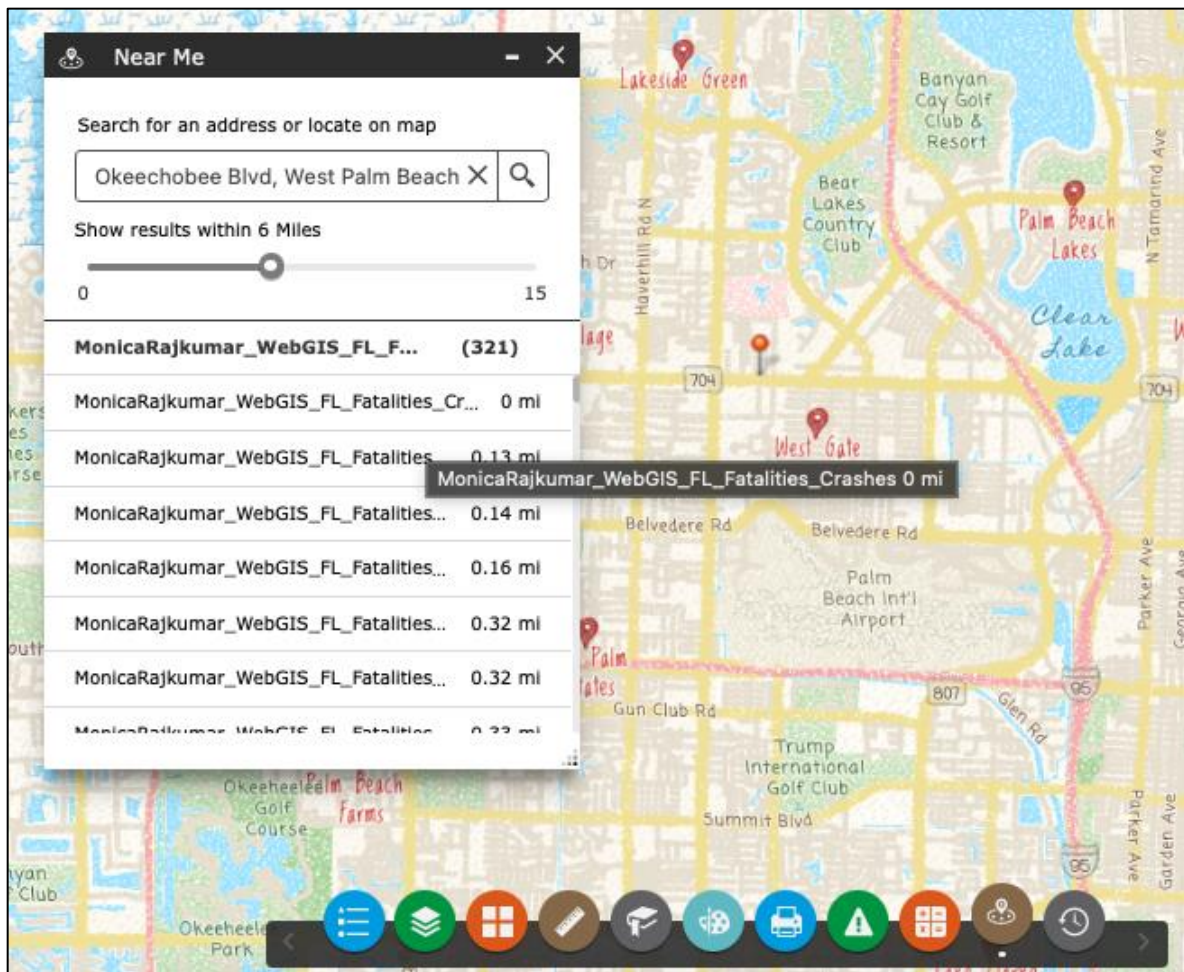


Figure 46: Near me widget

Approximate Distance: 0.74 mi	
MonicaRajkumar_WebGIS_FL_Fatalities_Cras	
XID	2013813651110
Crash Date	2013-10-12
Crash Time	0507
Calendar Year	2,013.00
Calendar Month	October
Calendar Date	12.00
Day	SATURDAY

Figure 47: One of the crashes using near me tool

Tool 21: Query

Two queries namely crashes based on year and whether the crash is related to school bus are integrated to the Query tool. One sample query is been shown in the figures below.

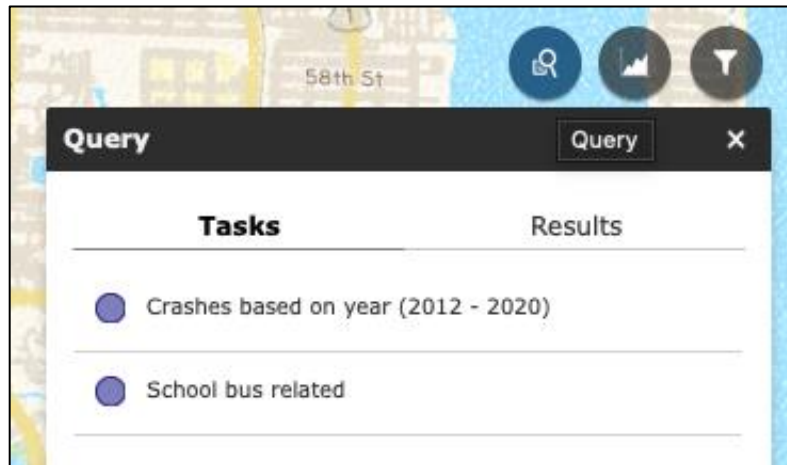


Figure 48: Query tool with 2 spatial queries

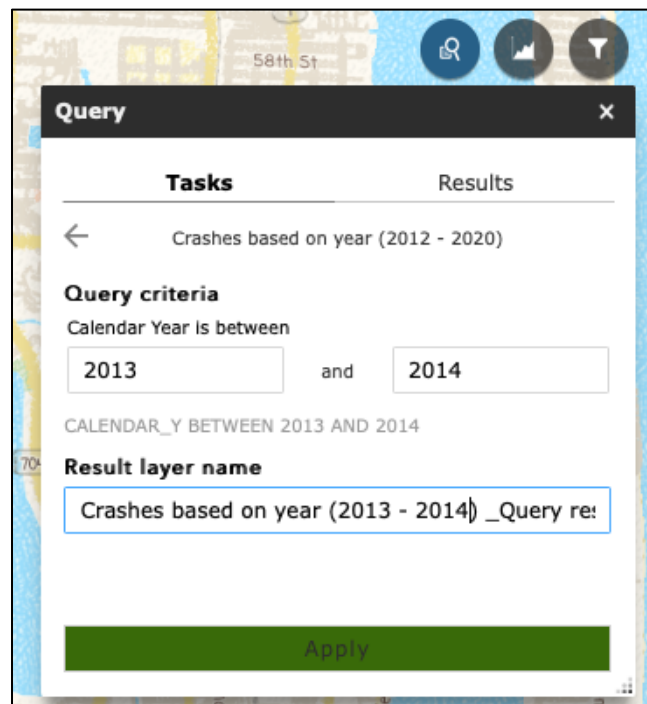


Figure 49: Crashes based on a year range

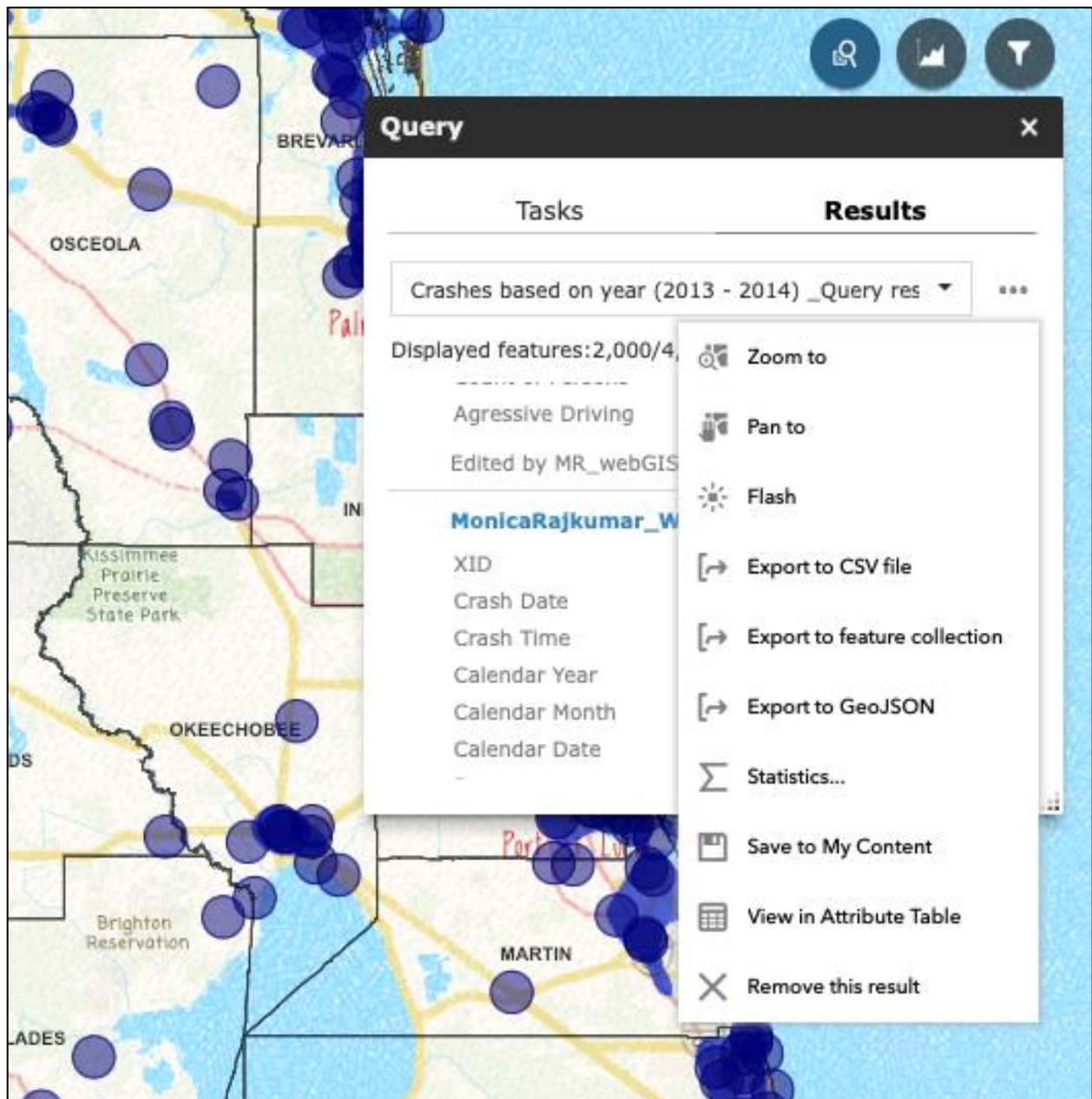


Figure 50: Output of crashes query

Tool 22: Chart

Seven different types of charts based on the crashes have been integrated to the chart widget. One sample chart for crashes based on the road is shown in the figures below.

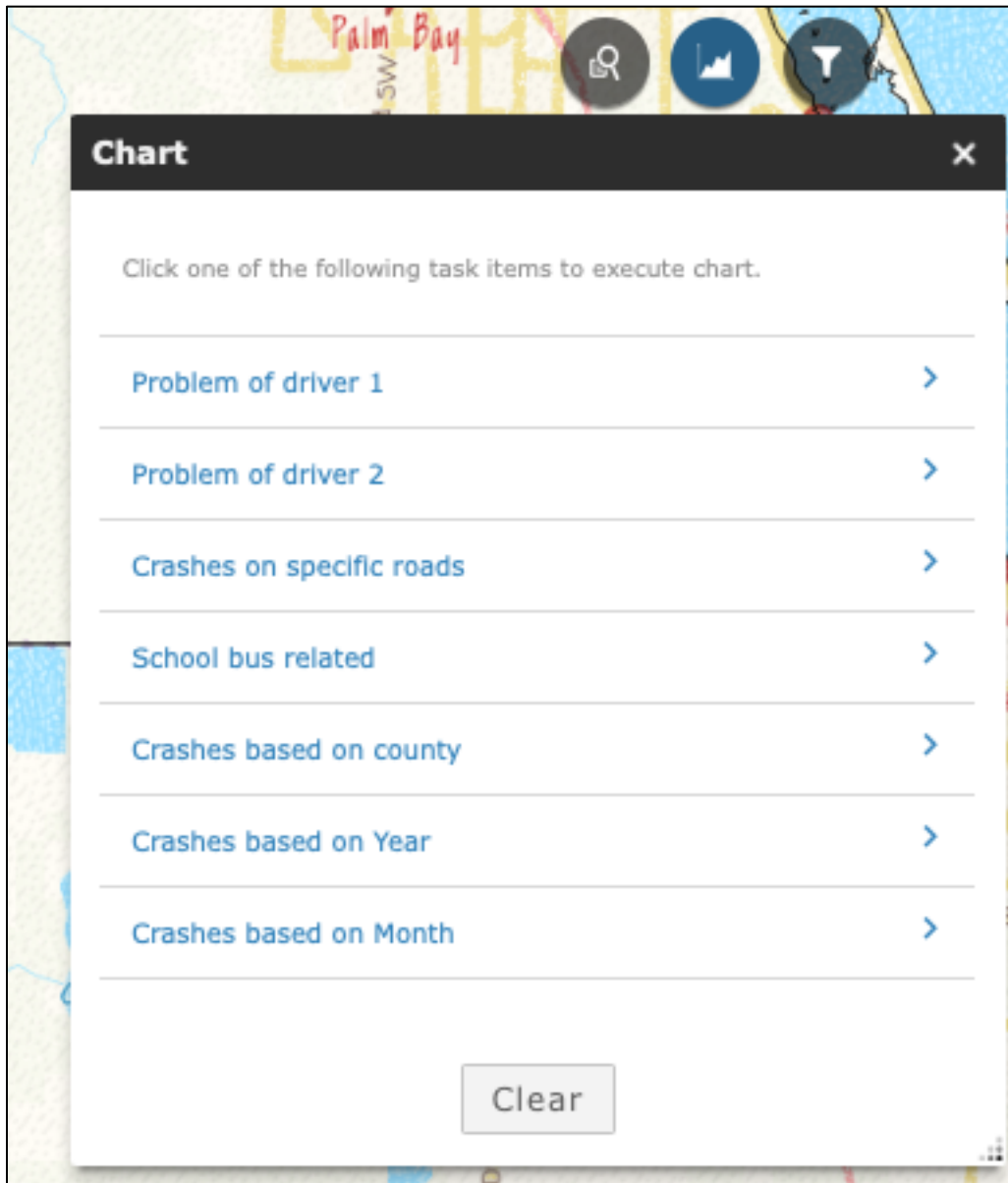


Figure 51: Chart tool with various dynamic charts

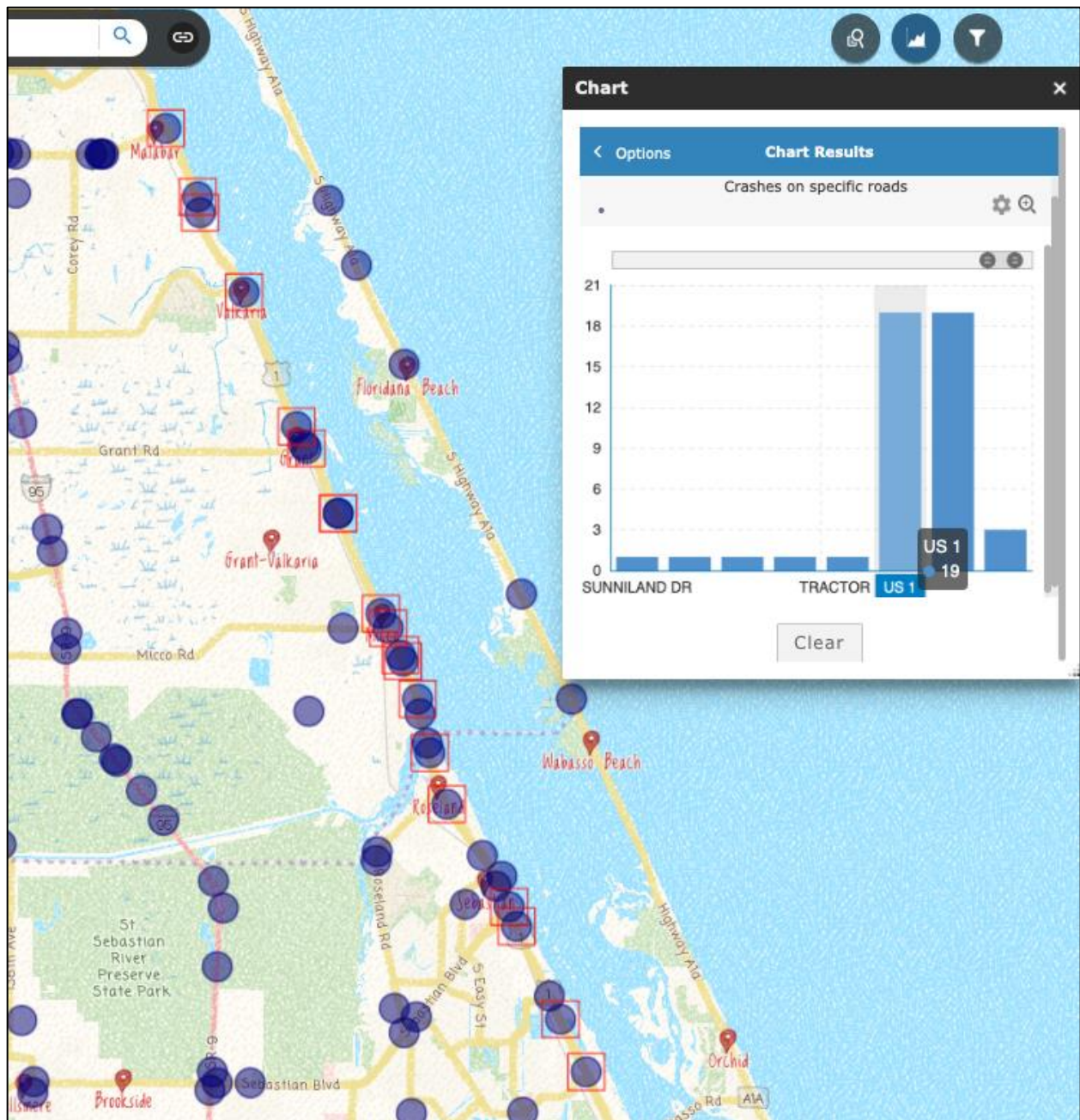


Figure 52: Chart based on specific road types

Tool 23: Filter

Six filter based on the Florida fatality crashes is added to the filter widget. Among those, some of the filters is been explained in the below shown figures.

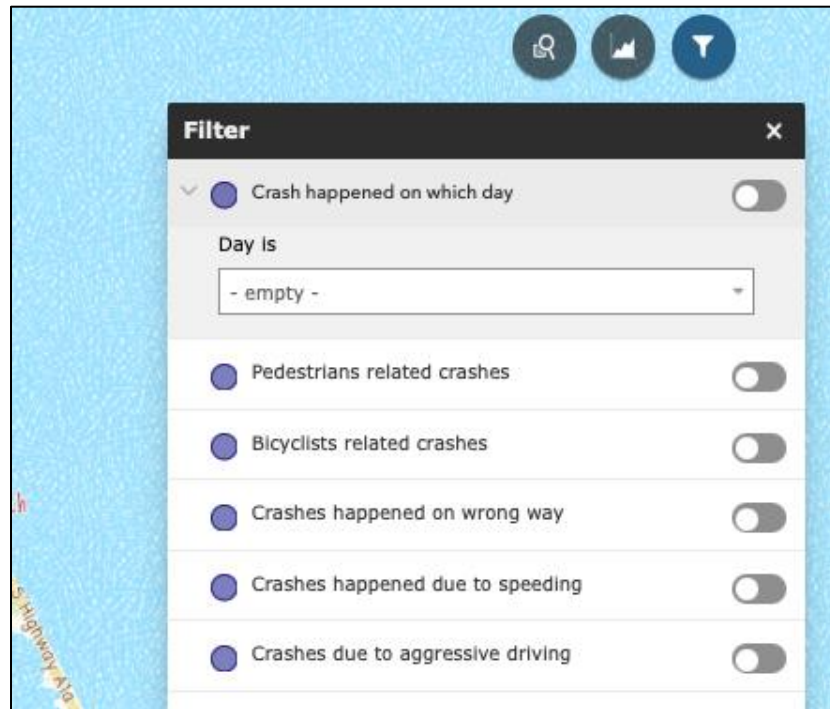


Figure 53: Filter tool with various queries

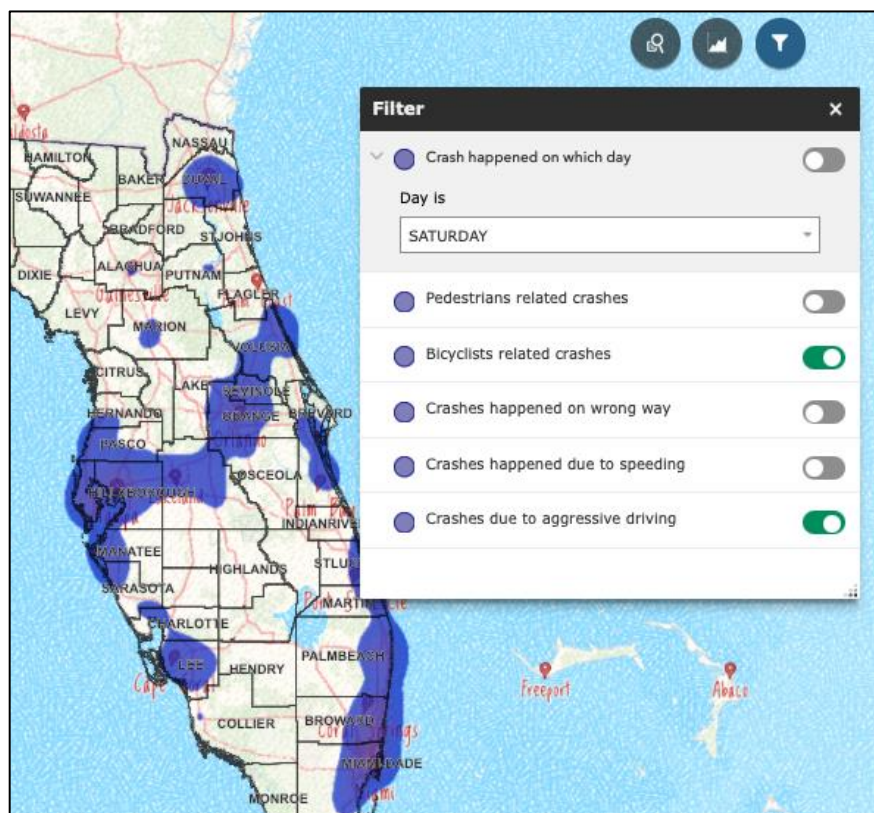


Figure 54: Output of certain filters

Project Outcome

The respective links for the whole Florida Crash Analysis project is listed below.

Florida Counties Data

https://services.arcgis.com/V4Rx2DXlIHdEvTZA/arcgis/rest/services/MonicaRajkumar_WebGIS_Florida_Counties/FeatureServer

Crashes Data

https://services.arcgis.com/V4Rx2DXlIHdEvTZA/arcgis/rest/services/MonicaRajkumar_WebGIS_FL_Fatalities_Crashes/FeatureServer

Web Map link

<https://fau.maps.arcgis.com/home/item.html?id=309ad4a44f5d425082265afd5906ed2c>

Front Page of Application

<https://fau.maps.arcgis.com/home/item.html?id=0719d5fdd6e2476f93faae9910b2ebe4>

Web Application link

<https://fau.maps.arcgis.com/apps/webappviewer/index.html?id=0719d5fdd6e2476f93faae9910b2ebe4>

Summary and Conclusion

To conclude, I have performed spatial analysis of various types of crashes that includes fatalities along the roadways of Florida, and mapped it accordingly visualize it in a better way. The web developed application appears to be desirable, and I believe it would be very helpful for health, transport, and police departments. The data used in this project involves records from 2012 till 2021, which have more viable information with major fatality crashes that speaks about pedestrians, school bus related, aggressive driving etc., Some of the most common widgets like basemap gallery, draw, print, measurement, layer list, legend, navigation, attribute table etc., have been integrated in the developed Crash analysis application. Various other tools such as bookmark, charts, query, filter, incident analysis, summary, near me etc., have been customized and set up in the application.

Future Scope

This project can be further extended to various other states of the United States of America. In addition to that, variety of analysis can be done using the crashes data on the fly by developing any kind of geoprocessing tool and publishing it online, so that it can be used in the widget. The work can also be enlarged by setting more charts, queries, and filter after expanding the dataset years that is currently available. In addition to these, a mobile based application can be created such that any other crashes happening around the road can be tracked and given as input by the public themselves. Moreover, a story map telling about all the crashes happened along with the developed web application and an additional dashboard can be integrated, so that it makes a more appealing website and will be more helpful for the public as well as the government.

References

<https://ftp.fdot.gov/file/d/FTP/FDOT/>

<https://www.fgdl.org/>

Class Presentations - 1 to 12

<https://www.esri.com/en-us/arcgis/>

Appendix A

Crash Data of Florida

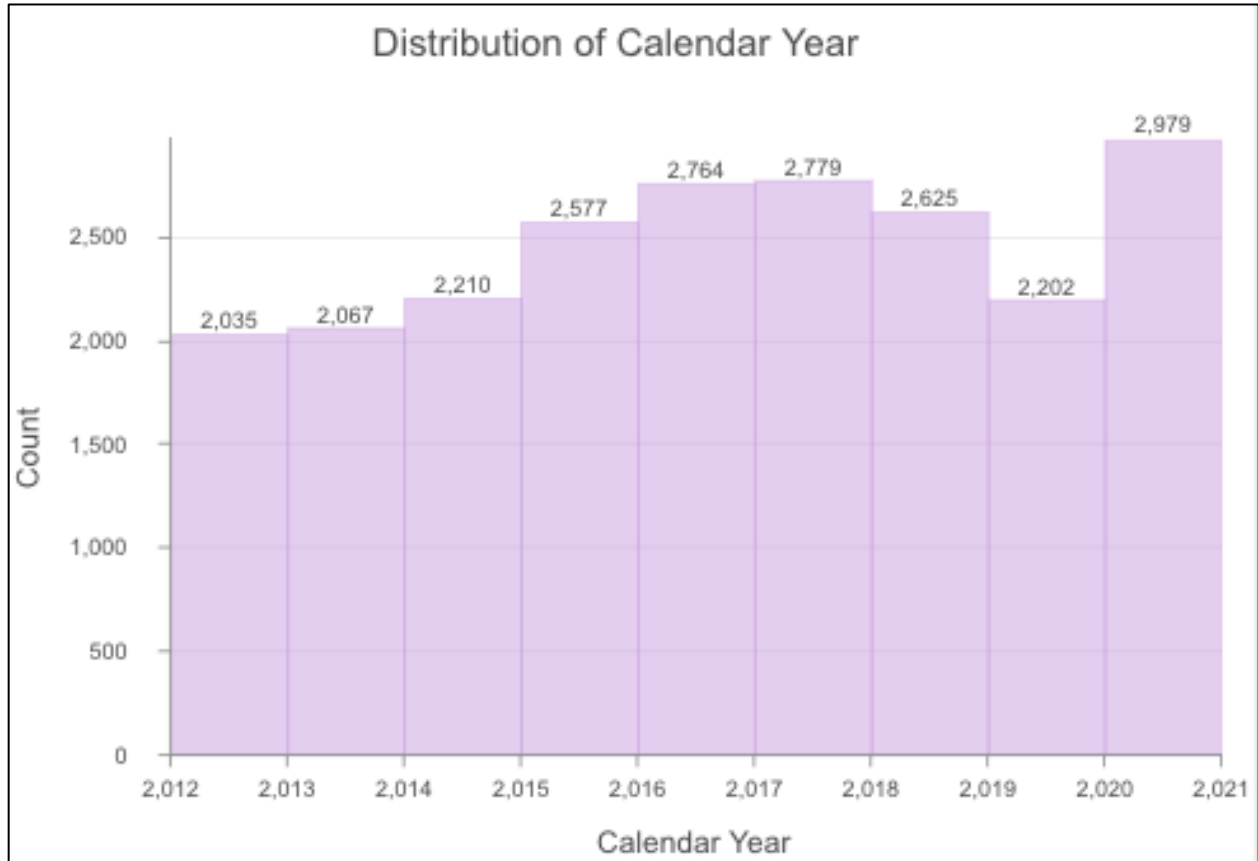


Figure 55: Calendar year distribution

Appendix B

Crash Data of Florida

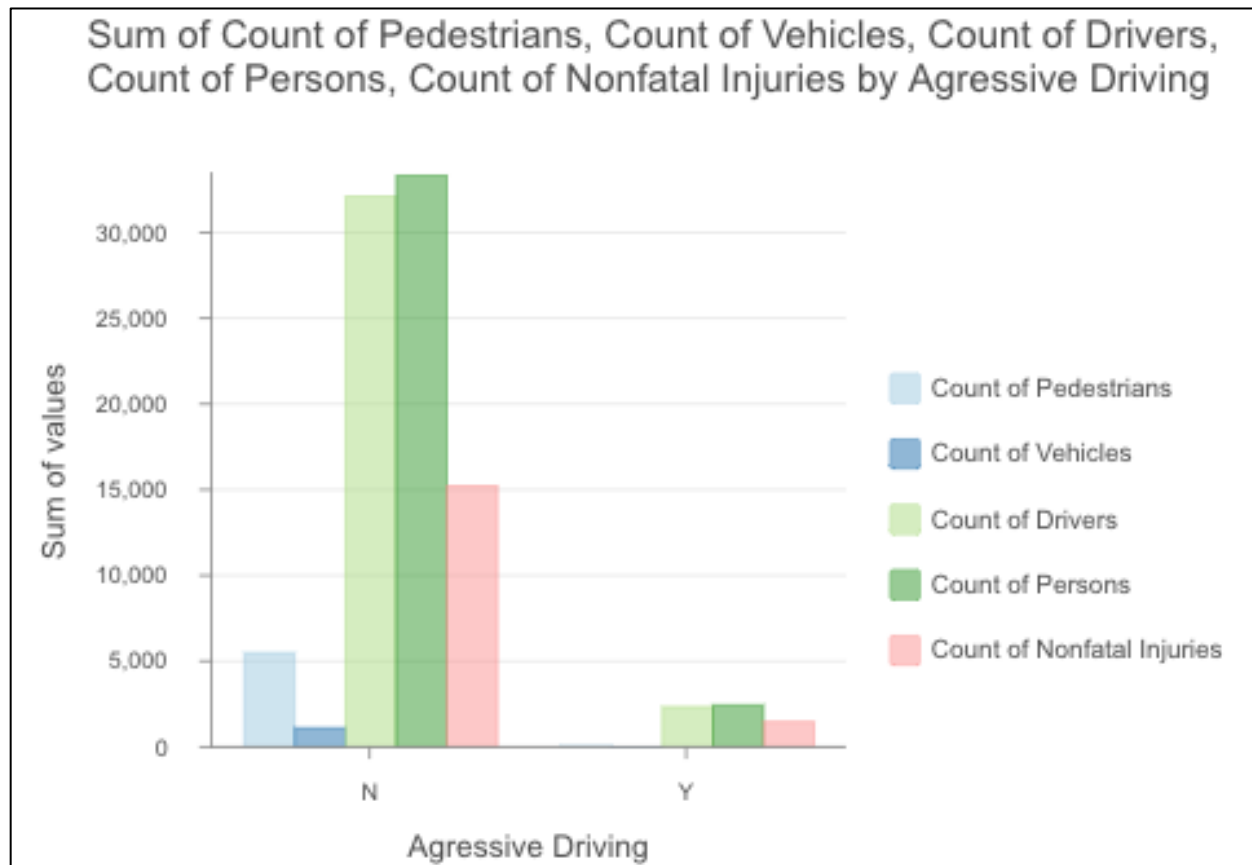


Figure 56: Aggressive driving vs Counts