Mojave Desert Ecosystem Program

Aviation Crash HEATMAP

A geospatial representation of the NTSB Aviation Accident Databse

crash.mojavedata.gov/heatmap

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Project Overview

The Mojave Desert Ecosystem Program (MDEP) is driven by an ambition to support geospatial needs through effective, user friendly solutions. Over the past year, we have been migrating some of our current solutions in the open source direction, this gives the user a lighter solution that can be used on nearly any device with a web browser, it is also low cost and highly customizable. We commonly utilize; Geo Server, Q GIS, Leaflet JS and PostgreSQL.

MDEP has contributed projects to the University of Redlands Masters of Science GIS program. Through this masters program two iterations of a plane crash modeling tool have been developed. Plane crashes have a clear impact on the ecosystem, disturbing or destroying terrain and habitat, hazardous liquid and materials are strewn many times across large areas, through the modeling tools and plane crash heatmap, MDEP offers resources to support the initial response, possibly saving lives as well as providing data and a platform for further analysis to assist in recovering the land to its natural state.

While supporting the development of the Recovery of Crash Site (RoCS) application, MDEP searched through many National Transportation Safety Board (NTSB) records finding plane crashes to check the model against. While checking these records we found the NTSB Aviation Accident Database and Synopses but could not find a map product associated with this information.

The Data

NTSB is a government agency responsible with investigating all civil aviation accidents in the U.S. in order to find the probable cause and provide recommendations that serve to prevent future accidents. The aviation accident database consists of aviation crashes that the NTSB has investigated, 77,752 incidents to date. This database contains a number of details including; date, latitude and longitude and includes many flying craft from gliders to rockets. If you are like us you immediately wonder, what would that look like on a map?

Sadly before the 21st century many of the data do not contain coordinates. Sorting through the data we can see that it wasn't until 2002 that the majority of incidents had coordinates recorded. See table 1.

Year	Total Records	Records with XY	Difference
2015	1469	1281	188
2014	1522	1348	174
2013	1545	1395	150
2012	1861	1615	246
2011	1884	1690	194
2010	1821	1593	228
2009	1806	1640	166
2008	1931	1771	160
2007	2016	1876	140
2006	1850	1709	141
2005	2031	1884	147
2004	1952	1799	153
2003	2085	1975	110
2002	2020	1682	338
2001	2063	864	1199
2000	2220	147	2073
1999	2208	9	2199

Table 1

With this data and initial assessment we wanted to created the web map to show multiple representations of the data including coordinates in a point layer, a static heatmap, to view hot spots from the entire record and lastly, a heatmap on a timeline so that you can view month by month where hotspots have occurred.

The Map

There are almost as many ways to create a webmap as there are plane crashes, we used the Leaflet JS library and multiple java script plug-ins, (listed at the end of this paper) to build the aviation crash heatmap.

To show each of the layers, we used a variety of solutions. The point data is downloaded as delimited text, we did a little pre-processing before adding point data to our map using QGIS. Rendering delimited text is very simple in QGIS since they have an add CSV layer button on their layers panel, the layers panel is very easy to use and can only be compared to the add layers button in ArcMap. Once data is in QGIS you can simply right click and "save as" nearly any geospatial format. We chose shapefile only because we have loaded many shapefiles into GeoServer and knew exactly how it would work . Once loaded and published through Geo Server, the data was added to the map by utilizing the TileLayer.WMS variable in our java script. As for the Major Airports data, It was downloaded as a shapefile from naturalearthdata.com. From this data we selected major airports from the type column, then loaded and published that subset on GeoServer also adding it to the map using the TileLayer.WMS variable.

The heatmaps were created using a time dimension plug-in developed for leaflet by a group at the Balearic Islands Coastal Observing and Forecasting System. This plug-in creates a SODA layer that pulls in JSON data and renders it as a heatmap using the leaflet-heatmap.js plug-in. In order to get the csv data into the correct JSON format, we loaded it to opendata.socrata.com and then copied the JSON data to our own server.

From the start, we had an expectation that most incidents would occur within close proximity to airports. Now seeing the static heatmap along with major airports, you can get the impression that this may be true. Additional geospatial analysis and deeper research would be beneficial in coming to a conclusion, that there is a strong correlation between crashes occurring more frequently within close proximity to major airports.

There is a statistical rule known in aviation, "plus 3/ minus8" wherein it is stated that the most dangerous parts of a flight are the first three minutes and the last eight minutes, take-off and landing. This idea that more crashes occur within close proximity to major airports is likely proven in some research and analysis, so keep in mind all we are doing is displaying the data geospatially and loosely observing that correlation. Through our initial sorting of the NTSB data, we found that 44% percent of crashes did occur in the take-off and landing phases of flight. See table 2.

Broad Phase of Flight	# of Incidents	% of total
Approach	2199	9
Climb	523	2
Cruise	2090	9
Decent	611	3
Go-Around	476	2
Landing	6387	26
Maneuvering	2855	12
Other	37	0
Standing	413	2
Take-Off	4453	18
Taxi	670	3
Unknown	130	1
Blank	3445	14
Total Incidents	**24289**	

Table 2

Turning on the Aviation Crash Points layer in the map, you get an idea of how many aviation crashes the NTSB has investigated; the points alone are so dense that they show you the shape of the United States. To view the Animated Heatmap, simply turn the layer on in the layer switcher and pull the time slider to a particular month in time between December 1999 and December 2015, the user can push the play button and watch for recurring hot spots.

Conclusion

From this geospatial representation of the NTSB Aviation Accident Database, a user can observe hotspots for aviation incidents. A user can view point data for individual incidents and can observe their geospatial relationship to major airports. By viewing the heatmap layers a user can see where hotspots are for aviation incidents over the entire NTSB record (when coordinates were recorded), using the animated heatmap a user can observer month by month where hotspots have occurred and re-occurred, or by sliding to months of particular season observe what time of year incidents might be more likely.

In the future we would like to continue with analysis to see how far the average plane can get from the airport in three minutes or how far it can be within eight minutes of landing, then using that information, buffer the major airports for takeoff and landing and see how many incidents occur within those buffers.

Keep an eye on the MojaveData twitter feed for any updates, or do your own analysis with this data and let us know what you come up with.

Code sources and other programs used:

Leaflet JS - http://leafletjs.com/

Leaflet Sidebar - https://github.com/turbo87/leaflet-sidebar/

Time Dimension Plug-in - http://apps.socib.es/Leaflet.TimeDimension/examples/example12.html

Leaflet Styled Layer Control - https://github.com/davicustodio/Leaflet.StyledLayerControl

Leaflet Easy Button - https://github.com/CliffCloud/Leaflet.EasyButton

Font Awesome - https://fortawesome.github.io/Font-Awesome/

Geo Server - http://boundlessgeo.com/products/opengeo-suite/geoserver/

QGIS - http://boundlessgeo.com/products/qgis/