

## Introduction

Over the years there has been a growing trend in the occurrence, size, and severity of wildfires, particularly across the western United States. This has been due to prolonged drought, poor fire suppression policy, and land mismanagement. As urban development continues to push further into wild lands, and therefore widening the Wildland Urban Interface, lives, property, and natural resources face greater risk from wildfire. As a result, the general public has expressed a growing interest in wildfire. This project uses GIS and basic web development techniques to recommend an effective way to address public outreach in wildfire education and more specifically, wildfire behaviour.

The study area for this project is the Angeles National Forest located within Los Angeles County. It includes 11 wildfires that occurred between the years 2007 and 2014 that burned over 1,000 acres each.



Figure 1. Wildfires over 1,000 acres between 2007 and 2014 in Los Angeles County, Angeles National Forest

## Data and Data Sources

Data used to accomplish this project consisted of a collection of satellite images acquired from the USGS image repository, Earth Explorer. Fire perimeter shapefiles were collected from the California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP). Additional raster layers consisting of DEM's, slope, aspect and fuel models were acquired from LANDFIRE. This data was organized into shapefile and raster data layers.

Table 1. List of data and data sources used in the project

Dataset	Source
Satellite Imagery (30m)	<a href="http://earthexplorer.usgs.gov/">http://earthexplorer.usgs.gov/</a>
Fire Perimeter Shapefiles	<a href="http://frap.cdf.ca.gov/">http://frap.cdf.ca.gov/</a>
Digital Elevation Models (30m)	<a href="http://landfire.gov/">http://landfire.gov/</a>
Slope Raster (30m)	<a href="http://landfire.gov/">http://landfire.gov/</a>
Aspect Raster (30m)	<a href="http://landfire.gov/">http://landfire.gov/</a>
Fuel Behavior Fuel Mode (30m)	<a href="http://landfire.gov/">http://landfire.gov/</a>

## Methodology

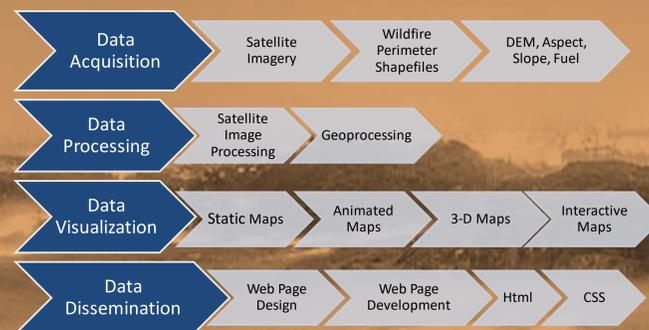


Figure 2. Project phases

Satellite imagery was converted into a useable format and imported into ERDAS Imagine software where it was prepared before running it through the unsupervised classification differenced Normalized Burn Ratio (dNBR) tool. This measurement identified wildfire burn areas by running each image through the process shown below.

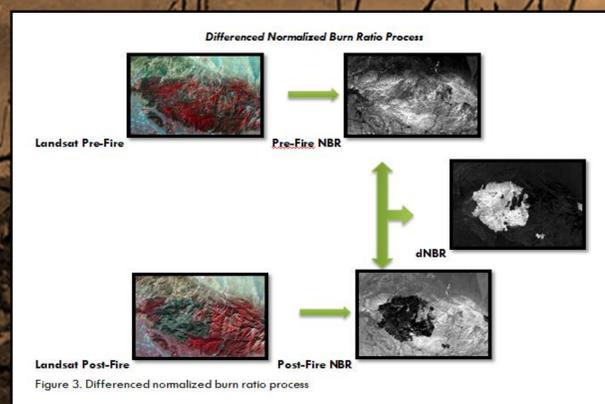


Figure 3. differenced Normalized Burn Ratio process, dNBR

Following calculation of the dNBR, images were imported into Esri ArcMap for further geoprocessing to simplify and smooth out before being clipped to each fire's respective perimeter shapefile.

## Timeline

Table 2. Project timeline

Timeline of Events	
Applied Research Project Paper	February 1 – August 06
Data Collection	March 21 – April 04
Map Design	April 04 – April 24
Map Development	April 11 – June 27
Python Scripting	April 11 – May 14
Map Products	April 25 – May 09
Web Page Development	May 16 – June 27

## Results

The result was a developed web page that housed individual pages for each wildfire, and consisted of Initial Burn Severity Assessments, Extended Burn Severity Assessments and interactive DEM maps. Users are able to freely explore the web page at their own pace where they will develop a basic understanding of how wildfire behaves according to the elements which affect it: fuel, topography, and weather (not included).

The Initial Burn Assessment static maps (shown below in figure 4) are intended to illustrate to the user that wildfire does not burn evenly across the landscape it travels. These maps were created using ArcMap software.

The Extended Burn Assessments (shown below in figure 5) were created using multiple individual, Initial Burn Assessments in ArcMap, and were assembled in Windows Movie Maker to make an MP4 animated video. These maps demonstrated that just as wildfire burns unevenly, vegetation in burned areas also grows back with certain degrees of variability according to those fire influencing factors (fuel, weather, topography).

Interactive 3-D models (shown in figure 6 above) were created using QGIS and the qgis2threejs plugin which generated the HTML, CSS, and JavaScript files for an interactive web map. This demonstrated how wildfires burned according to topographical variability.

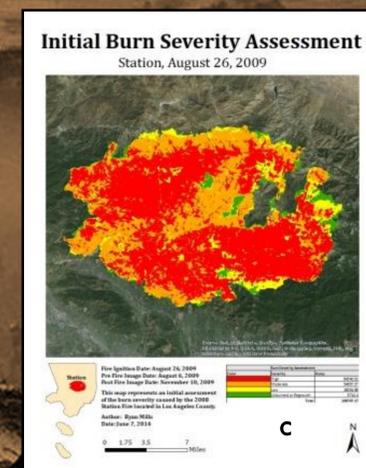


Figure 4. Initial Burn Severity Assessment (ex. 2009, Station Fire)

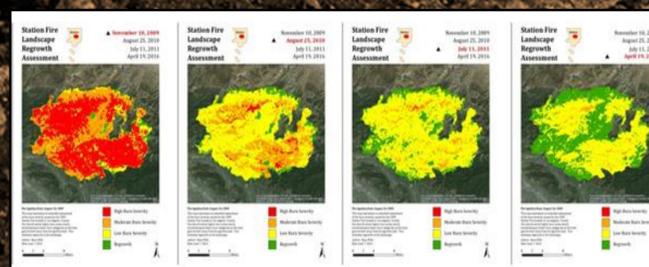


Figure 5. Extended Burn Severity Assessment (ex. 2009, Station Fire)



Figure 6. Interactive 3-D map using QGIS and the qgis2threejs plugin

## Discussion

The educational objective of this project was to reach out to public audiences by providing basic wildfire behaviour education tools through map presentations within a webpage. The data used in this project have been collected and used by government agencies and are publicly available.

In addition to providing a mechanism for developing a basic understanding of wildfire behaviour, users of this web page may become better informed in regards to wildfire and can voice their opinions to help redirect resources to relevant environmental restoration projects and based on his enhanced understanding, may make better informed voting decisions when casting their ballot in elections that may have an impact on wildfire suppression policy changes.

While this project still delivers the capability to provide basic wildfire education to users, it does not include all of the features that were originally intended to be developed. Technical difficulties were experienced while using QGIS and the qgis2web plugin. This plugin was intended to create 2-D interactive web maps that allowed users to navigate themselves through a wildfire, click on an area of interest, where additional information would pop-up, providing elevation, slope, aspect, and fuel data.

## Conclusion

This project was designed to provide an effective means to reach out to the general public using web page development and provide an educational tool through the use of GIS and map presentation. A basic web page was created using hyper text markup language (HTML) and cascading stylesheets (CSS). Maps as presented within the Results section were created using ArcMap and QGIS.

Future work on this project would involve the addition of data for those influencing fire behavior elements that were not included (fuel, weather, slope, aspect). Also, in order to make the web site more efficient, AJAX can be incorporated to prevent the need of having multiple individual web pages for each wildfire. To make the web page coding more robust, comments should be added to JavaScript files in order to provide better identification to the user regarding what each part of the script does. Lastly, while this project may not be ready to use as is by outside agencies, companies, or institutions, it can very well serve as an excellent prototype. Although wildfire is the topic of interest for this project, this can serve as an example for people looking to developing similar resources for other natural disaster events, such as, floods, tornadoes, and hurricanes.

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