Pre-fire Plan Mapping for the Communities of Palo Colorado and Bryson Hesperia and Fire Danger Rating Area Rezoning of the CAL FIRE San Benito-Monterey Unit of CAL FIRE

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Executive Summary

The CAL FIRE mapping project had three general goals: to create maps that would be used for communicating strategic planning around fire suppression in and around the communities of Bryson-Hesperia and Palo Colorado in Monterey County, build a portable ArcGIS geodatabase that can be shared quickly and easily among agencies during an incident, and finally, to begin a preliminary study of how to rezone the CAL FIRE San Benito-Monterey Unit into new fire danger rating areas (FDRA). The maps will be used within the unit and be posted in firehouses in addition to being published online and will be reformatted into a flyer for citizen evacuation maps in a later project. In order to facilitate the most effective response during fire incidents that are large enough to require mutual aid from outside agencies, the geodatabase, because of its portability, will allow data to be shared quickly while using common map symbology. Rezoning fire response areas based on FDRA could improve the ability of CAL FIRE to staff more effectively and respond to fires using a geographic determination based on similar vegetation, topography and weather.
Project Objectives
The project had three primary objectives: to create pre-fire planning maps for two rural communities that are within CAL FIRE’s for fire protection jurisdiction, creation of a geodatabase for the CAL FIRE unit that is comprised of San Benito and Monterey counties, and a geo-statistical analysis of fire danger areas based on vegetation modeling done by CAL FIRE.

Pre-fire Plan Mapping
As development has moved beyond traditional urban or agricultural boundaries into the wildland-urban interface (WUI), vegetation fires have put increasing numbers of people and property at risk. This trend has been happening for decades and has resulted in more communities in California’s WUI falling under CAL FIRE’s jurisdiction. CAL FIRE can provide fire services at economies of scale that might not be possible by forming a local fire district (Personal communications, Jonathan Pangburn 8/2013). Part of CAL FIRE’s job when working with these communities is to plan ahead for an eventual fire and develop strategies to fight it. At the most basic level, this entails mapping the community and surrounding areas’ water assets and other infrastructure, the fire-lines that planners have determined will be the most effective and the evacuation routes that will be used by residents.

Study of Fire Danger Response Area Rezoning
Currently the San Benito-Monterey Unit (known by its CAL FIRE designation as BEU) has several fire response areas which are zoned in such a way that a firehouse is assigned a geographical area of responsibility based on professional expertise and historical happenstance, but not necessarily with regard to an assessment of a consistent level of potential danger across the response area. Sometimes these existing geographical areas of responsibility may be comprised of vegetation and terrain that have different fire danger ratings that require varying degrees of response. The BEU unit of CAL FIRE is investigating whether or not a repartitioning of geographical responsibility could be based on CAL FIRE’s fire behavior fuel model (FBFM40) fire model data (Scott & Burgan, 2005), along with precipitation and slope class, so that staffing and equipment allocations would better reflect the actual degree of danger during any given weather scenario. Realigning firehouse responsibility with FDRA’s may allow CAL FIRE to achieve more efficient and economically efficient resource allocations.

San Benito-Monterey Unit Geodatabase
The goal of the geodatabase component of the project is to create a portable dataset that can be shared easily and quickly using a USB drive among agencies during an incident in the San Benito-Monterey Unit or with other agencies in the area. The eventual goal of the geodatabase is to integrate all risk elements that could be used by area law enforcement, emergency medical response, and fire and rescue. All of the map components used in making pre-plan maps are contained, along with other detailed information or unit-wide feature or image inside of the geodatabase. So while the geodatabase contains the subset of data that make up Bryson-Hesperia and Palo Colorado pre-plan areas, it contains data that covers the whole CAL FIRE BEU unit.
Project Approach

Pre-fire Plan Mapping
Maps were created for the rural communities of Palo Colorado near Big Sur and of Bryson-Hesperia in south Monterey County, working with CAL FIRE Battalion Chiefs and Fire Captains who gave input to map extent, symbology and content. Both community pre-plan DRAFT maps were reviewed at various times during the course of the project and changes were made as needed based on feedback. The communities are distributed over a fairly wide area (Figure 1 and Figure 4) and are far from major services and urban amenities. The maps were created using publicly available data from multiple sources as well as data collected by BEU personnel. CAL FIRE provided the data set they use in their map products. Additionally, road data were obtained from Tiger online, NAIP imagery was obtained from the USDA geospatial portal, and digital elevation models (DEMs) were obtained from the USGS earth explorer. Addresses were extracted from a parcel database by querying only those records that had them and then displaying them by converting labels to an annotation feature class in order to be able to move them around later in order to improve the display of information. Evacuation routes were symbolized in red for easy reference. Houses in the structure layer mostly came from an existing unit waypoint database, but using NAIP imagery, additional houses were manually added after noting that some houses had not been marked in the original database. Finally, using the DEM, contour lines were created and labeled to give firefighters a way of quantifying the topography.

Fire Danger Response Area Rezoning
The preliminary FDRA map (Figure 9) was created through an iterative process. Using ArcMAP 10.1 (ESRI, 2012) the original FBFM40 raster layer was resampled to do an initial smoothing of land cover classifications. Then, the Focal Statistics tool was used to apply a majority rule algorithm on pixels with a radius that was increased in order to obtain a fairly high level of generalization. This means that the resulting map, while showing a huge swath as only grassland, is actually comprised of many other types of land cover types, but in general the area would contain mainly grass which also would be the primary carrier of fire. Additional raster algebra using would possibly been needed to ascertain an aggregate level of danger using additional inputs including annual average precipitation and slope class.

San Benito-Monterey Unit ArcGIS Geodatabase
The geodatabase was compiled from most of the layers that were created, modified or imported from the CAL FIRE dataset. These data were all re-projected in Teale Albers projection for consistency and much of it was used in the pre-plan maps. Feature classes were clipped to the BEU unit boundaries with a 10 mile buffer in most cases in order to show the map for the unit while allowing for the ability to view across unit boundaries. Feature datasets were created in order to aggregate similar types of data, but this is a process that will take additional refinements. Features were named so that they would sort in a way that made data easier to find. Also included in the geodatabase were fire history data and fuel reduction projects.

Project Outcomes
Project outcomes are for the following map products: pre-fire planning maps, a preliminary study map of possible new fire danger rating areas and a portable CAL FIRE unit geodatabase.
Pre-fire Planning
The final pre-plan maps were completed on 3/31/2014 and delivered to CAL FIRE via Google Drive. Changes were being requested until the last minute.

Fire Response Area Rezoning Preliminary Study
FDRA preliminary analysis indicates that Focal Statistics in ArcMap will probably be a good tool, but more work needs to be done in determining how to aggregate and weight fire danger weights from other data layers that need to be included in the eventual analysis.

San Benito-Monterey Unit ArcGIS Geodatabase
The final iteration of the BEU geodatabase was completed and delivered to CAL FIRE via Google Drive on 3/31/2014. The geodatabase is a work in progress according to CAL FIRE, but this is a start and includes the most pertinent data for general mapping of BEU and all of the data needed for the maps that were created for preplanning. Since it is a CAL FIRE unit geodatabase, the kinds of details in the two pre-plan areas will need to be obtained from any other areas that require preplanning, so currently this will be a partially constrained in its utility, at least when trying to use the geodatabase for incidents in areas outside of Palo Colorado and Bryson-Hesperia. However, general data is included in the whole of the BEU unit so data that is used to supply layers for electrical transmission, roads, bridges, pipelines, and parcel data (like addresses) will be usable for the entire geodatabase area coverage. Additionally, some reorganization of the geodatabase hierarchy may be needed and renaming may be desirable to match more closely CAL FIRE operational needs.
Figure 1. Final pre-plan map for the community of Palo Colorado. Reduced resolution for purposes of this report. Data from USDA, USGS, CAL FIRE, NOAA, Monterey County Assessor’s Office, and Tiger.
Figure 2. Detail of pre-plan map for the community of Palo Colorado. Houses including addresses are shown along with water sources, gates and evacuation routes. Data from USDA, USGS, CAL FIRE, NOAA, Monterey County Assessor’s Office, and Tiger.

Figure 3. Palo Colorado pre-plan map zoomed to community center. Fire station depicted near lower right intersection and the solid blue circle shows a helispot along with its latitude and longitude. Data from USDA, USGS, CAL FIRE, NOAA, Monterey County Assessor’s Office, and Tiger.
Figure 4. Final map of Bryson-Hesperia pre-plan. Data from USDA, USGS, CAL FIRE, Monterey County Assessor’s Office, and Tiger.
Figure 5. Detail area of Bryson-Hesperia pre-plan map. Green hued area indicates land managed by a water agency, orange hash is Department of Defense lands and red road depicts the evacuation route. Data from USDA, USGS, CAL FIRE, and Tiger.

Figure 6. Bryson-Hesperian preplan detail. Symbolization for safe refuge and incident command center. Line with alternating blue and white pattern shows the proposed lines of control in the event of a large conflagration. Data from USDA, USGS, CAL FIRE, and Tiger.
Figure 7. FBFM40 fuel map. The map represents 40 different fuel classifications based on the ground cover’s ability to carry fire. Data from LANDFIRE.

Figure 8. Initial map distilling fire danger rating areas from the FBFM40 raster. Data from LANDFIRE.
Figure 9. Preliminary study map for geo-statistical rezoning of fire danger rating areas. The map further distills the vegetation types and uses the ArcMap Focal Statistics tool to smooth the raster and apply a majority-rule algorithm so that the areas appear as one class of fire danger rating area. Data from LANDFIRE.
Data Products: Geodatabase of San Benito- Monterey Unit

Figure 10. Screenshot of geodatabase for the BEU unit. On the left a partial view of the data hierarchy and on the right a sample shape file of parcels within the CAL FIRE unit that have addresses (not all parcels have addresses). Data from USDA, USGS, NOAA, CALFIRE, Monterey County Assessor’s Office, and Tiger.
Conclusions

The pre-plan maps for Palo Colorado and Bryson-Hesperia were created for CAL FIRE to address planning issues and will be used by CAL FIRE firefighters. By pre-planning the response, CAL FIRE can maximize resources during a crisis and minimize loss of life and damage to property and infrastructure, and mitigate damage to the environment. The maps will be posted on the relevant fire station walls, as well as published on the internet for more general use. Having these maps allows CAL FIRE to communicate advance planning to incident responders and form the basis for citizen evacuation maps that will eventually be distributed to residents and published on the internet. The data that were used to create these maps were compiled and organized within the geodatabase product that now can be shared easily amongst responding agencies during a crisis. The database includes not only topographical information and roads that would be relevant to a firefighting crew, but street addresses, gate locations, water tank locations and capacities, and locations of hydrants and ponds. All of these different data elements can be added to a map on the fly depending on what is needed, and, because of the geodatabase’s portable nature, it can be loaded onto a USB disk drive and distributed quickly. Finally, the initial study on FDRA rezoning using geo-statistical analysis of CAL FIRE’s FBFM40 fuel map shows that similar land cover types can be aggregated and then statistically smoothed to form relatively contiguous areas. Assigning danger values to these contiguous areas while simultaneously reallocating command geography to the areas could allow CAL FIRE to allocate better human and other firefighting resources to respond to incidents more effectively at a lower cost. Further analysis is still required that involves adding additional components to the FDRA analysis map in order to have it more accurately reflect fire danger including slope and annual average precipitation data.

Citations
