

Fighting California's Zaca Fire with Geospatial Technology Enterprise GIS Helped Agencies Battle Blaze and Develop an Emergency Response Plan to Protect Lives, Property

By Jesse Theodore, ESRI Writer

Santa Barbara—California has a long history of fires—from the destructive blazes that were sparked by the great 1906 San Francisco earthquake to more recent wildfires in heavily populated San Diego, San Bernardino, and Los Angeles counties. In 2007, the state endured one of its most damaging forest fires in history: the Zaca fire.

The Zaca fire began on July 4, 2007, northeast of Buellton, California, in Santa Barbara County. Consuming more than 240,000 acres, the fire had the potential to displace tens of thousands of people and destroy thousands of homes in Santa Barbara and Ventura counties before being declared controlled October 29.

Fire investigators say the Zaca fire was caused by sparks from grinding equipment being operated on private property about 50 miles north of Santa Barbara. Santa Barbara County officially declared a state of emergency August 3, as thousands of acres continued to burn and the enormous perimeter of the fire moved closer to residents and their homes.

Firefighters and public safety officials from many local, state, and federal agencies worked around the clock to successfully contain the fire, prevent injuries, and minimize property loss. Geographic information system (GIS) technology helped accomplish this mission, playing a vital role

as an information resource for everyone involved in responding to the fire. With Santa Barbara County setting up a GIS resource center inside its Emergency Operations Center (EOC) to provide a common operating picture and ongoing situational awareness, GIS applications were used both at the command center and at forward deployment camps. These applications included

- Continuous fire perimeter mapping
- Identification of critical facilities and infra-structure
- Allocation of resources and equipment
- Detailed evacuation planning
- Daily strategy meetings

GIS was also used as an emergency public information resource, with GIS maps and analysis used to inform the news media and the public about the fire's location, damage assessments, road closures, and potential evacuations. Law enforcement and local government staff used GIS to plan phased evacuations and generate optimized routes.

"This really was a turning point for the utilization of GIS in an Emergency Operations Center for our county," says Zacharias Hunt, geographic information officer, Santa Barbara County. "In the past, we relied on paper maps and paper-based methods. On August 3, I was called upon to help assist with the overwhelming need for spatial information. Right away, the emergency command center needed detailed maps and information. This was the catalyst for getting our enterprise GIS up and running. It spawned a whole new set of requests for a wide variety of maps."

An Advanced Common Operating Picture and True Situational Awareness

The county GIS team quickly began to assemble data from multiple sources and generate dozens of hard-copy maps on a daily basis. With more than a dozen agencies responding to the wildfire, GIS

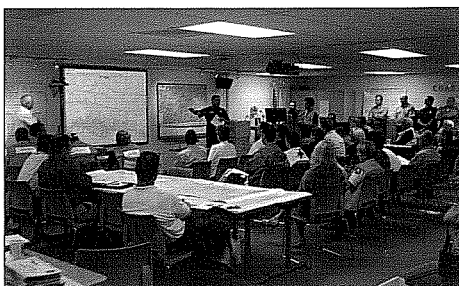
was used to help everyone operate using the same information palette.

One of the paramount uses of GIS was providing fire staff with a common operating picture. Detailed maps displayed information used for daily briefings and strategy sessions. Data mapped with ArcGIS software from ESRI included high-resolution imagery, aerial fire perimeter data, fire progression models, land parcel data, street networks, utility networks, historical landmarks, building structures, and population demographics.

Fire; law enforcement; local, state, and federal officials; the Red Cross; and others worked with a common spatial database and visualization tool for decision making and collaboration. Officials viewed and analyzed GIS data of vegetation type, landscape and slope characteristics, and wind and other weather data to predict where the fire was spreading and to determine whose homes and what property might be at risk. For instance, daily maps were generated showing the latest fire perimeter with a one-mile buffer overlaid around the perimeter. This helped staff identify structures and assets immediately threatened by the fire. Progression maps used color-coded polygons to show how the fire moved and evolved over time and place. Fire history maps showed polygons where previous fires occurred in relation to the Zaca fire. This gave officials insight into current vegetation conditions. Incident commanders could better understand what areas had light vegetation versus moderate to heavy vegetation. Moderate or heavy vegetation could provide greater fuel to the encroaching fire.

After seeing these variables in a map format, fire chiefs could determine proactive fire suppression tactics, such as where to send equipment and staff to construct firelines, conduct aerial water drops, and stage contingency resources.

Information about the locations of utility infrastructure—such as power lines, electricity towers, water lines, and gas valves—was also incorporated into the GIS database. Firefighters wanted to be



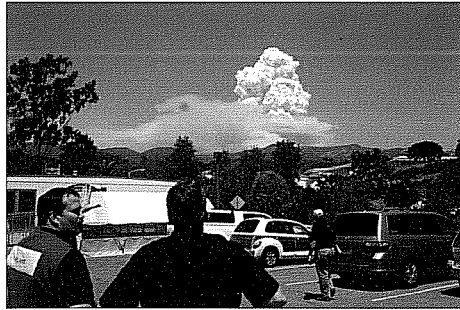
Daily briefings inside the Santa Barbara County Emergency Operations Center relied heavily on GIS data and GIS-based maps to show the march of the Zaca fire toward cities and the firefighters' efforts to put containment lines around it. Photo courtesy of the County of Santa Barbara.

ArcWatch

sure to protect these vital power supplies to avoid service disruption. Losing power or water would make protecting life and property more difficult, could cause panic among the public, and would hinder evacuations should they be needed. County data from water and gas departments was assimilated with local utility CAD data translated into a format compatible with GIS.

Building a Cohesive, Complete Evacuation Plan

One of the more complex undertakings involved generating a comprehensive evacuation plan for the cities of Santa Barbara, Goleta, and Carpinteria, as well as adjacent communities such as Montecito. Officials were concerned the wildfire would jump containment lines and race over the Santa Ynez Mountains into the coastal areas. The federal-state-county incident management team used GIS to create digital maps and contingency plans for a comprehensive GIS-based plan dubbed The Santa Barbara County Front Country Contingency Plan. The plan was developed for evacuating more than 100,000 residents in Santa Barbara County, if necessary.



A giant "Pyro Ice Cloud" rises above the distant mountains as the Zaca fire burns uncontrolled about 25 miles away from Santa Barbara County's Emergency Operations Center and media briefing tent (foreground). The spectacle of Pyro Ice Clouds was a common occurrence caused by huge amounts of water vapor being released into the atmosphere during intense burns of trees and other vegetation. Photo courtesy of the County of Santa Barbara.

GIS-generated maps were used to assess street networks, temporary street closures, and the creation of evacuation corridors via residential streets or state highways. California state fire officials and county staff collaborated to determine when to issue an evacuation warning or an evacuation

order. Looking at where the fire was, its rate of spread, and where it was in relation to the public, officials drew a perimeter for issuing warnings or mandatory evacuations. These two perimeters were plotted on the map using GIS. A reverse emergency 911 automated phone call application was in place so that if the fire reached the first evacuation warning perimeter, calls would be placed and other measures taken to warn residents and advise a voluntary evacuation. If the second perimeter was breached, a mandatory evacuation would be issued and a phased evacuation would be carried out.

The Front Country Contingency Plan also included the locations of vulnerable populations of senior citizens or disabled persons who would require special evacuation assistance. The plan contained detailed information as to where large animals were located that would need to be evacuated. It also contained the exact locations of critical infrastructure and historic buildings such as the County's 1920s-era courthouse, a national historic landmark. Firefighters, many of whom were from out of town and were unfamiliar with Santa Barbara County, could use the plan to quickly determine where to concentrate their limited resources during an all-out battle against racing flames.

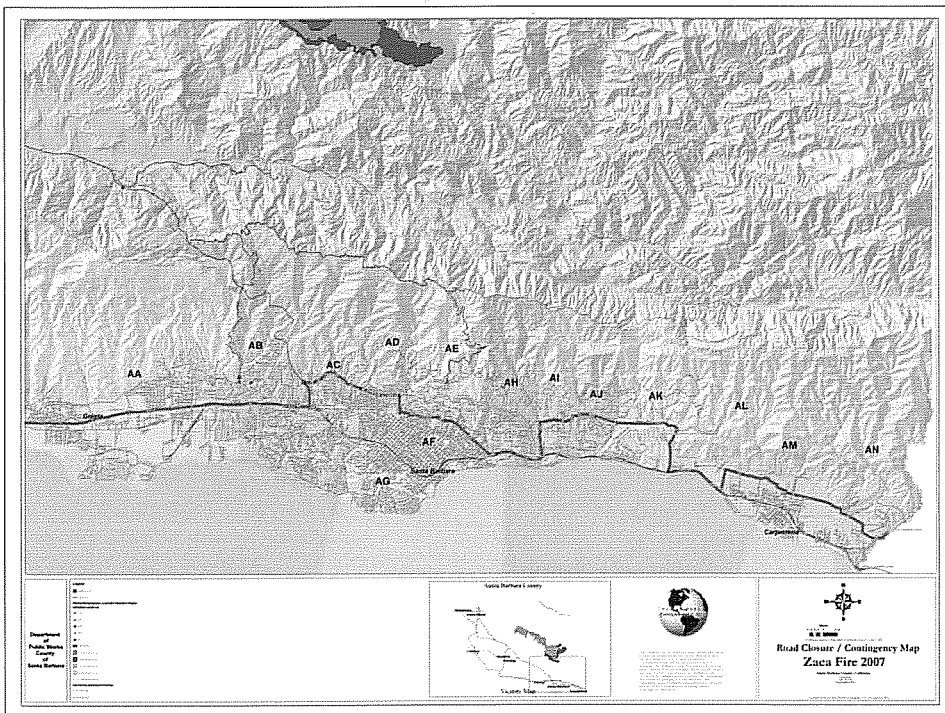
Hunt's use of GIS data allowed the incident commanders to divide the "Front Country" into battlefield grids that included lists of equipment, staging areas, water resources, and other data that battalion commanders would need to direct firefighters.

"They kind of collectively made that decision as far as where those decision points were going to be placed and then what the response was going to be for each of those decision points," says Hunt. "We looked at possible road closures and where we might have to control the signal for intersections. There was a big public works traffic transportation data effort to get all that spatially mapped."

Addresses of the elderly, disabled, and hospitalized people were taken from county social services databases, uploaded into ArcView, and geocoded so commanders could spatially view where staff would need to go into the community and help assist in relocation if a required evacuation took place.

The known locations for horses and other livestock were also collected and mapped to help assess where temporary animal shelters could be placed.

"It was a three-pronged spatial data approach," says Hunt. "We looked at road closures and routing, vulnerable populations, and critical infrastructure.



Santa Barbara County's Emergency Operations Center advance planners worked closely with the state's CAL FIRE team to develop the "Front Country" plan, which focused on how to respond if the Zaca fire spread to populated coastal areas. The plan produced this map, part of a highly detailed, multilayered GIS database, that shows key road closure information for the South Coast area of Santa Barbara County. Photo courtesy of the County of Santa Barbara.

We then looked at where we could place medical staging areas, ambulance staging areas, and temporary shelters. We took into account where critical infrastructure like water, electricity, and roadways were located to pick the best places for those areas.”

The GIS technicians assisted incident commanders with twice-a-day briefings, which brought together government staff, the media, and political leaders. The GIS analysis presented during the briefings was based on emergency responder requests and the specific, daily needs at the incident command post.

County GIS staff developed a grid system consisting of a one-mile-by-one-mile cell captured on an 11-by-17 hard-copy printout that could be handed out to crews that were going out into the field and dealing with potential evacuations and the fire threat. The grid system was created for the entire South Coast County area. The support grid utilized spatial layers developed by the county; it was also tied in to the California Fire geographic requirements for the branch and the divisions.

In addition, digital and paper fire maps that showed the fire perimeter, fire progression, fire breaks, and property data helped inform com-

munities about what was occurring. This data was provided in digital map format available from the county Web site. A high-resolution map could be printed out in PDF format. A lower-resolution map was also available for people interested in seeing fire data who had limited broadband or computing capability.

These data and maps were also provided to the county’s Public Information Office, and to the news media for their reporting. In addition, paper maps showing daily fire perimeters were displayed throughout the county at public buildings, shopping centers, and other locations.

“The maps were critical to helping the public and the news media understand where the fire was, where it had been, and where it was likely to go,” says William Boyer, the county’s communications director and chief public information officer during the Zaca fire. “Not only were the maps critical to our emergency public information efforts, but they also were stunning works of art that many people wanted for historic purposes. People were offering to buy the maps from my staff as they went out to the information boards with daily updates.”

“We have fantastic people in our operations that have been with the county for years and have a lot of

institutional knowledge,” says Hunt. “By bringing the spatial element of this knowledge to a map and having that map be part of daily internal briefings to figure out how they’re going to deal with things was extremely valuable. It also helped in collaboration with other agencies that were brought in that weren’t very familiar with some of the dynamics of our terrain and our coastal community. I think it was a good mix of having institutional knowledge as well as these maps and analysis that helped with outside people and agencies helping in the response. It got everyone on the same page as far as what the plan’s going to be.”

For more information, contact Zacharias W. Hunt, geographic information officer, County of Santa Barbara, at zhunt@co.santa-barbara.ca.us.

GIS Teams Map the Zaca Fire

By Jesse Theodore, ESRI Writer

Santa Barbara—The day California governor Arnold Schwarzenegger declared a state of emergency in Santa Barbara County because of the Zaca fire, Zacharias Hunt swung into action. As the county’s geographic information officer, Hunt had to quickly assemble a GIS team to provide the spatial information about the fire that county officials, firefighters, and other emergency responders needed.

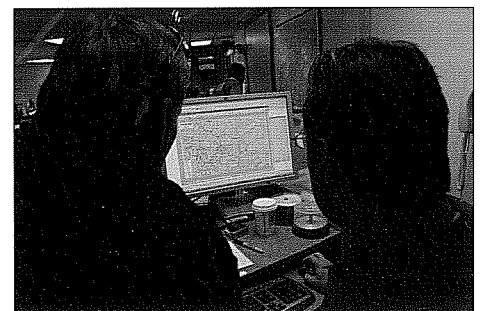
Three separate GIS teams operated during the Zaca fire. The Santa Barbara County GIS team, headed by Hunt, quickly set up shop inside the Santa Barbara County Emergency Operations Center (EOC)—three modular temporary buildings normally used for classroom training. The EOC would become the county’s management nerve center overseeing the Zaca fire emergency. Team members included Kevin Donnelly from the county’s Public

Works Department and Cory Gallipeau from the county’s Planning and Development Department.

Quickly Assembling Multiple GIS Teams

Dozens of staff worked at a frantic pace inside a large windowless room that was covered wall to wall with maps and marker-filled white boards. Sections of the room were portioned off for operations, planning, logistics, the Red Cross, and other groups. Each worked at independent tables covered with computers, books, and paper documents.

Stationed at the EOC, Hunt’s first job on August 3, 2007, was to assess potential software, hardware, data, and staffing needs and put in place an enterprise GIS technology environment. “I was rushing that whole weekend to get all the resources into the EOC,” says Hunt. “For example, we had



Santa Barbara County Geographic Information Officer Zacharias Hunt goes over map details with fire personnel before a daily briefing at Santa Barbara County’s Emergency Operations Center. GIS-based maps were produced daily and played a key role in keeping emergency personnel, elected officials, the news media, and the public informed about the Zaca fire’s progress. Photo courtesy of the County of Santa Barbara.

to get a couple of high-end computer workstations and plotters operational to make maps. I also had to quickly assemble a GIS staff. I was fortunate to be able to work with two technicians from other county departments [Donnelly and Gallipeau]. We began generating data and making it available via an internal server.”

The Santa Barbara County GIS team, already an ESRI software user, approached ESRI for additional assistance. The latest ArcGIS 9.2 software, including ArcInfo; ArcGIS extensions 3D Analyst, Spatial Analyst, Tracking Analyst, and Network Analyst; and ArcPad, were quickly shipped by ESRI and deployed by the team. For cartographic output of GIS-generated maps, the County GIS staff used 3 plotters: a 44-inch Epson plotter and two 36-inch Hewlett-Packard plotters. The team produced up to several dozen maps every day showing the fire’s progress, containment lines, and how close the fire was to populated areas.

A second team consisted of GIS professionals from federal and state agencies, deployed any time a major fire occurs. They worked out of trailers at two incident command posts on opposite sides of the fire in the Santa Barbara County area adjacent to the Los Padres National Forest.

The command posts, known as the Live Oak and Richardson base camps, provided a staging area for frontline firefighters, pilot crews, and personnel working to create firelines—large areas of cleared vegetation that can act as a barrier to prevent the fire from spreading.

Inside the trailers, people worked in shifts side-by-side at computer terminals stretched out over long, rectangular foldout tables.

Each staff member worked to generate maps showing constantly updated perimeter data that was captured from daily helicopter flights. Pilots and GIS technicians would fly around the fire and use high-tech infrared cameras that captured x,y coordinates through the fire’s dense smoke. The data, fed to a laptop computer with desktop GIS software, was automatically georeferenced to points on the ground.

This point data, saved on CDs, would be handed off to the GIS team and uploaded to ArcGIS software back at the trailer. Staff would move the data to an FTP site that was password protected and accessible by Hunt’s team.

“They’re geared toward supporting the firefighters in the field, so their primary responsibility was making operation maps and public information maps,” says Hunt. “They were the ones receiving the daily information with infrared data, mapping the new perimeters, and pushing that out.”

A third GIS crew, consisting of California Department of Forestry and Fire Protection (CAL FIRE) GIS professionals, provided assistance as well. They helped county emergency personnel with longer-term strategic planning to generate a staged evacuation plan for the entire South Coast area of Santa Barbara County. “The state team was responsible for developing a geographic breakdown of assignments and resources if the fire came over

the mountains and into our coastal cities,” says Hunt. “They outlined the area into five branches and then the branches were actually split up into divisions.”

Approximately 30 to 40 different layers of spatial information provided from city, county, and state sources, as well as data captured from the field, were maintained and used at various times by the GIS groups. Teamwork and coordination were at the heart of the operation, along with ArcGIS software, which was used 24/7 as an information resource by all the GIS professionals supporting the firefighters and other emergency responders who worked long and hard to snuff out the Zaca fire.

This article was reprinted from the February 2008 edition of *ArcWatch*, an e-magazine for GIS news, views, and insights published monthly by ESRI. Visit www.esri.com/arcwatch.



ESRI
380 New York Street
Redlands, California
92373-8100 USA

Phone: 909-793-2853
Fax: 909-793-5953
E-mail: info@esri.com

For More Information

1-800-GIS-XPRT (1-800-447-9778)

www.esri.com

Locate an ESRI value-added reseller near you at

www.esri.com/resellers

Outside the United States, contact your local ESRI distributor. For the number of your distributor, call ESRI at 909-793-2853, ext. 1-1235, or visit our Web site at www.esri.com/distributors

ESRI Regional Offices

