The Fire Information Engine:
A Web-Based Toolkit
for Wildfire-Related Needs

Faith R. Kearns
Noah C. Goldstein
Brent Pedersen
Max A. Moritz

ABSTRACT. The recently established Center for Fire Research and Outreach at the University of California, Berkeley has developed a web-based toolkit, the Fire Information Engine Toolkit (FIET), for wildfire-related needs. The FIET is intended to meet the needs of diverse user groups (homeowners, decision-makers, including fire operations, and researchers) at a variety of scales (local, community, and regional levels) before, during, and after wildfires. During the initial phase of the FIET, we have focused on developing pre-fire tools for homeowners and decision-makers at the local and community levels. For example, we have developed a science-based, parcel-level structure vulnerability assess-

Faith R. Kearns, Center for Fire Research and Outreach, University of California, Berkeley, CA 94720 (E-mail: fkearns@nature.berkeley.edu).

Noah C. Goldstein, Applied Statistics & Economics Group, Systems & Decision Sciences, Section, Lawrence Livermore National Laboratory, 7000 East Ave., L-644, Livermore, CA 94550-9234 (E-mail: goldstein8@llnl.gov).

Brent Pedersen, Center for Fire Research and Outreach, University of California, Berkeley, CA 94720 (E-mail: bpederse@nature.berkeley.edu).

Max A. Moritz, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720 (E-mail: mmoritz@nature.berkeley.edu).

ment and ranking approach that will help homeowners and communities to identify hazards and prioritize planning and mitigation activities. A version of this assessment can be completed anonymously by homeowners interested in decreasing their vulnerability to wildfire, and a similar version can be downloaded and used by decision-makers on a community-wide level. In addition, we have developed a number of innovative web-based Geographic Information System (webGIS) applications including an interface to display results of the structure vulnerability assessment at a community level, as well as search-by-address maps of California's wildland-urban interface (WUI), fire threat, fire recurrence, and upcoming changes to building codes. In collaboration with researchers at Lawrence Livermore National Laboratory, the next phases of the FIET development will concentrate on enhancing the available tools, including incorporating real-time weather into fire behavior modeling and tools for evacuation modeling of natural disasters. doi:10.1300/J230v04 n01_13 *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress. com> Website: <http://www.HaworthPress.com>*

INTRODUCTION

In an era of advances in technology, health, and appreciation of the global consequences of humans' effect on the environment, society is still dogged by one of the oldest and simplest natural hazards: wildfire. Each year, new development encroaches on fire-adapted landscapes, increasing the likelihood of subsequent loss of property and life. In California alone, over five million people are directly affected by the threat of wildfire along the growing wildland-urban interface (WUI) (Radeloff et al. 2005), and all are affected through taxes and insurance rates. In the last five years, the average cost to fight and manage wildfires has reached over a billion dollars (www.nifc.gov). This cost does not include property and productivity losses, nor does that dollar amount account for the psychological impact of wildfires.

Despite the recurring and integral nature of fire in many landscapes, we have not adjusted to the presence fire as well as we have to other natural hazards. Wildfires, like periodic floods or coastal storm waves, are phenomena that should affect where and how we build our communi-

ties. Rather than manage development in fire-prone areas, however, we continue to develop land in ways and locations that are inherently risky.

These issues may be further exacerbated by climate change, which increases the complexity of predicting future fire behavior (Stephens and Ruth 2005). The timing and patterns of fire are driven by factors including the probability of ignition, precipitation amount and timing, and drought cycles (Stephens et al. 2003). As a consequence, there is escalating concern over wildfire, particularly in the face of global climate change (Stephens and Ruth 2005).

Current fire management policies in the U.S. focus on fuels management and fire suppression, although little data exists to back the effectiveness of such approaches, particularly in shrubland ecosystems. Many are now realizing that homeowners have a key role to play in protecting themselves from wildfire. It has come to light that that some portion of the financial resources being spent on fuels treatment may be better directed toward homeowner outreach and toward political and regulatory changes that would mandate more fire safe structures and community planning.

Fire is a unique hazard, intensified by the convergence of several related challenges (Figure 1). In the coming decades, the importance of reaching a sustainable coexistence with fire will only become more critical. Therefore, a major leadership opportunity also emerges from the need for fire-related research and outreach activities.

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A recent recommendation to the Governor's Blue Ribbon Commission on California Wildfires (Dargan and Hoover 2004) highlighted the need for a new center at a major university that would serve as a clearinghouse and focal point for research, education, data, literature, and activities related to wildfire. The College of Natural Resources at the University of California, Berkeley, with an outstanding legacy in applied ecology and fire science created by Harold Biswell, met this need by establishing the Center for Fire Research and Outreach (CFRO) (firecenter.berkeley.edu).

The challenge of reaching a sustainable coexistence with wildfire is exemplified in California, with high development pressure in at-risk wildfire prone regions, particularly with the potential for an altered cli-

FIGURE 1. Intersecting Factors Related to Fire. Fire May be the Single Most Important Natural Hazard in the Struggle for Sustainable Interactions Between Human and Natural Systems.

mate in the coming decades (Moritz and Stephens 2005). The primary goals of CFRO are:

- Become a focal point for science-based solutions to fire-related challenges in California.
- Encourage and facilitate collaboration on fire-related research questions among academics, practitioners, decision makers, and government agencies.
- Provide the general public, decision-makers, fire operations, and researchers with a centralized clearinghouse for information and tools that meet their needs at appropriate spatial scales before, during, and after wildfires.

CFRO researchers include experts in Fire Science, Forestry, Ecology, Planning, and Geography. Collaborators are primarily affiliated with UC Berkeley, and outside collaborators include The Nature Conservancy, the Australian Bushfire Cooperative Research Center, and the California Department of Forestry and Fire Protection. Additionally, CFRO has established collaboration with the Lawrence Livermore National Laboratory to focus particularly on the development of fire weather and evacuation modeling tools.

To date, CFRO efforts have included a number of seminars; workshops with international, federal, state and local researchers and government agencies; development of a Web-based data clearinghouse for the Global Fire Partnership (a partnership between The Nature Conservancy, the Worldwide Fund for Nature, and the World Conservation Union); and the development of a Web-based toolkit, the Fire Information Engine Toolkit (FIET), for wildfire-related needs.

The FIET (Figure 2) is intended to meet the needs of diverse user groups (homeowners, decision-makers, fire operations, and researchers) at a variety of scales (local, community, and regional levels) before, during, and after wildfires. The primary focus of FIET development during the initial phase has been the development a science-based, parcel-level structure vulnerability assessment and ranking approach that will help homeowners and communities to identify hazards and prioritize planning and mitigation activities. In addition, we have developed a number of innovative Web-based Geographic Information System (webGIS) applications including an interface to display results

FIGURE 2. The Fire Information Engine Toolkit Web Interface.
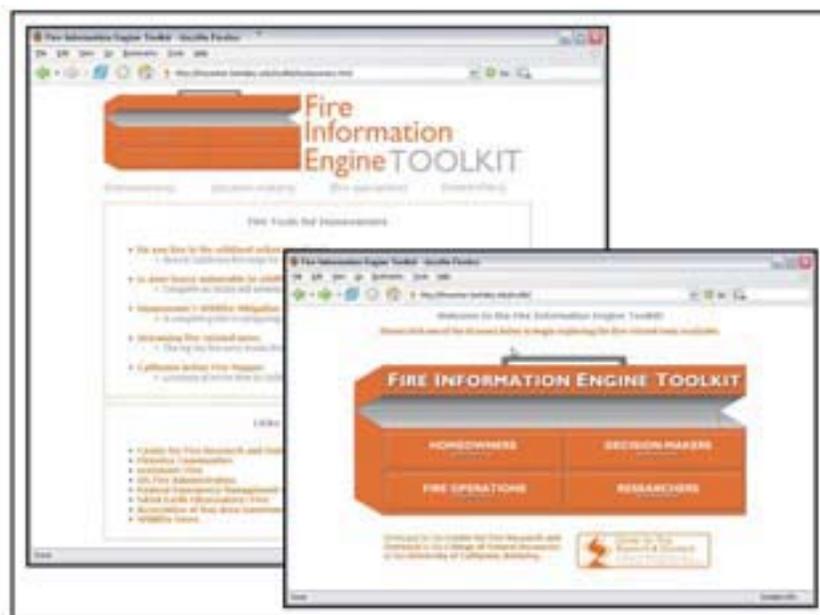
of the structure vulnerability assessment at a community level, as well as search-by-address maps of California's WUI, fire threat, fire recurrence, and upcoming changes to building codes. Each of these is discussed further below.

WILDLAND-URBAN INTERFACE (WUI) FIRE HAZARD ASSESSMENT AND RANKING APPROACH

Wildfire risk and hazard assessment systems can be important support tools for planning and decision making before, during, and after wildfire events. Wildfire assessment systems generally focus on one of three spatial scales: (1) regional assessments, (2) community assessments, and (3) parcel-specific assessments (Caballero 2001). As part of the initial phase FIET development, we have developed a parcel-specific assessment designed to identify structure vulnerability (here defined as a weakness in the structure or a component of the structure that could allow wildfire to cause measurable damage to the structure) of homes in the WUI (the full method is described in Frontiera et al. 2006).

Two versions of this assessment are currently available via the FIET website (http://firecenter.berkeley.edu/toolkit): (1) an anonymous, interactive self-assessment for homeowners, and (2) a group of downloadable assessment and ranking forms for use at a community level. For the homeowner self-assessment, using a guided online form, homeowners are asked a series of questions about vulnerabilities in their building structure and site characteristics (including nearby vegetation). Vulnerabilities in the building structure include elements like a wood roof or combustible decking. A key element of the assessment approach is that it focuses on spatial interactions between vulnerable structural components and nearby vegetation. For example, homeowners are asked whether they have combustible siding, which would be rated as hazardous, and would be rated as even more hazardous if there were combustible vegetation nearby. Based on their answers, homeowners then receive a customized "report card" based on their answers (Figure 3). The report card gives a brief overview of any structure related vulnerabilities, as well as suggestions for improvement, and links to more extensive information.

Alternatively, if communities are interested in completing this survey on a neighborhood or community-wide level to get a more regional sense of hazard levels or communicate those hazards with the public, the assessment form and rating key are available for download and free

FIGURE 3. Completing an Online Homeowner Assessment Returns a Customized "Report Card."

of charge. Communities can then use these forms to have staff complete field-level surveys. The community-assessment form is also available as an XML document that can be loaded onto any handheld device running the ESRI ArcPad software. In addition, if data is collected using this XML form, it can then be uploaded via a Web interface that will automatically generate a Web page containing an imbedded Google Map, a rating, and a report card for each parcel that community leaders can use to work with homeowners. Communities could also choose to use the data in any number of ways. For example, they could create their own Web mapping interface or send a mailing to homeowners giving them suggestions for improvements.

The Web based tools we have developed promote involvement through accessibility and applicability. Indeed, the overall goal of this work is to provide a tool that encourages homeowner and community involvement and education while retaining a sound scientific basis. This combination of rigor and simplicity allows us to use the same hazard rating system in both a simple Web form geared toward homeowners and for field as-

sessments completed by our research group. In addition, the simplicity makes the hazard assessment itself a tool for education and outreach: homeowners learn about wildfire hazards as the form is filled out.

This type of active encouragement of community involvement is not a new concept; however, the collection of multimedia/Web-based tools that actually enable individual and community involvement in mitigation and education of fire hazard risks is novel. Rating at the parcel-based level promotes individual responsibility, while the display and aggregation of the assessment results promote a community based response to hazards.

FIRE INFORMATION ENGINE webGIS DECISION SUPPORT TOOLS

A primary aim of the FIET is communication of geographically relevant fire hazard information to the public via a webGIS interface. While some communities may prefer an anonymous self-assessment, others may opt to do a community-wide survey as mentioned in the section above. To allow communities maximum flexibility in using the fire hazard assessment approach, they can choose to create a webGIS interface via our server (Figure 4), or to create their own on their server. Using the pre-made webGIS interface means that GIS expertise is not needed, nor is any proprietary software, which may be preferable for some communities. Others may have the resources to create and maintain comprehensive databases and Websites with other local information.

We are currently optimizing this set of tools by:

1. Implementing fire hazard rating model(s) in a "transparent" and understandable way;
2. Enhancing the storage, management, and processing of parcel level data as inputs to the model(s);
3. Allowing scalability to support data for and users from all WUI communities;
4. Flexibly supporting changes in and extensions to the models;
5. Allowing visualization and/or recalculation of ratings based on suggested mitigation activities;
6. Allowing incorporation of feedback/evaluation tools; and
7. Maintaining privacy of home-owner identities when requested.

FIGURE 4. The Fire Information Engine Community Fire Hazard Assessment webGIS Interface. Users Can Query Parcels to Get Back a Customized Hazard Ranking Report.

In addition, we have created a webGIS interface that allows homeowners, decision makers, fire operations, and researchers to search a variety of maps containing regional fire information by address (Figure 5). For example, homeowners can enter their address and determine whether their home is located in the WUI. Municipal managers can navigate through the map to look at what portions of a city fall into different fire threat zones; and planners can search to see if areas of new development will be affected by new fire building codes soon going into effect in California.

FUTURE DIRECTIONS

CFRO is currently exploring multiple avenues of research. Some of these avenues are more theoretical, like creating simulation tools for fire

FIGURE 5. The Fire Information Engine Toolkit webGIS Interface. Users Can Search Maps of the California Wildland-Urban Interface, Fire Threat, Fire Recurrence, and Upcoming Building Code Changes by Address.

regime analysis, while others are more applied, like exploring linkages with evacuation models, and including more areas in the community level fire threat rating use our rating system, and creating an on-line resource for community stakeholders after a wildfire has occurred. Given the importance of valid models and information to first responders, incorporating real-time weather into a fire spread and risk assessment model is invaluable. At Lawrence Livermore National Laboratory (LLNL), the National Atmospheric Release Advisor Center (NARAC, narac.llnl.gov), can provide real-time and near-term weather models for plume forecasts. Current discussions are underway to integrate wildfire behavior model into this capability. LLNL and the National Labs have a legacy of sophisticated fire modeling simulation research, in both urban and wildland settings (Wagoner et al. 2003). At LLNL, the FIRETEC full-physics model has been developed and implemented for 3D fire behavior modeling. There are currently discussions underway to marry the real-time atmospheric modeling capabilities of NARAC to incorpo-

rate wildfire behavior and smoke dispersal. Additionally, a LLNL-CFRO project is being proposed to evaluate the value and form of evacuation models of natural disasters. The LLNL-CFRO collaboration can help advance the legacy of wildfire expertise to incorporate contemporary issues of wildfires, including connections to National Security and Infrastructure Vulnerability.

CONCLUSIONS

The UC Berkeley Center for Fire Research and Outreach has rapidly established itself as a place of innovative research and tools for stakeholders of many types. Through the creation and deployment of the Fire Information Engine Toolkit, CFRO can provide homeowners and communities with tools that help them to understand wildfire risk at a parcel level. Additionally, the FIET has made transparent the often conflicting assessments of wildfire risk to structures and neighborhoods. By continuing to collaborate with colleagues in the fire community, particularly those at LLNL and the National Labs, CFRO will continue to provide unique solutions and novel approaches to understanding the consequences and management of wildfire as an important natural process.

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