2009 BFRL Project Description

Project Title: Wildland Urban Interface Fire Behavior – Post Fire Analysis

9/9/08

Principal Investigator: Alexander Maranghides (x4886)

Co-Investigator(s): William Mell (x4797)

BFRL Program: Reduced Risk of Fire Spread in Wildland-Urban Interface (WUI) Communities

Objective: Determine fire behavior at the Wildland Urban Interface (WUI) using post fire analysis and collect data for the development and validation of the NIST WUI Fire Dynamics Simulator (WFDS), leading to a first generation methodology for assessing and mitigating risk in WUI communities.

Problem:

What is the problem? The Wildland-Urban Interface (WUI) is defined as a location where structures meet or intermingle with undeveloped wildland. Since 2000 in California alone an average of over one thousand structures per year have been lost to WUI fires. Despite this significant WUI fire problem, there is little information on fire behavior at the WUI. An improved understanding of WUI fire dynamics is critical to assessing and improving current methods of reducing structure ignitions. There are currently a number of approaches for reducing the risk of structure ignition. These include recommended actions for homeowners to take on both their structures and residential vegetation. To date, the effectiveness of these methods has not been thoroughly assessed via post fire study. Such a study requires comprehensive data collection methods which includes information on the design and materials of residential structures, characteristics of the residential and wildland vegetative fuels, knowledge of the type and times of human activity during the fire, and information on the wildland fire. The collection, management, and analysis of this information is a challenging task. Sources of the data include homeowners, emergency responders, satellite imagery, LiDAR data, and photographic data. New field measurement methods are also needed in order to obtain critical information in a timely manner immediately after the fire, as well weeks later.

Why is it hard to solve? The October 2007 California Witch Fire progressed at a peak spread of five miles per hour and had a maximum perimeter of approximately 100 miles. The Witch fire was responsible for taking two lives and forty fire fighter burn injuries. The fire destroyed nearly 200,000 acres and over 1,600 structures. Data collection and analysis on that scale is a very challenging undertaking. Understanding fire behavior at the interface is hard for several reasons.

The fire exposure from the wildlands needs to be understood; therefore fire behavior in the wildlands needs to also be understood for different wildland fuels in different weather and topographic conditions. This information is not available today. Since very little is known on fire behavior at the WUI, one of the big challenges is to determine what data are critical to understanding the evolution of the fire through a community. This is complicated by the fact that the data collected to date from various federal, state and local officials is not standardized or uniform making any analysis of previous WUI fire incidents unreliable. Additionally, in order to determine why certain structure survived and why others did not, manual interventions need to also be documented. Additionally, the half life of data is very short as community clean up and wildland habitat recovery are expedited. All of the above make the post fire analysis data collection problem very hard to solve.

How is it solved today, and by whom? The WUI post-fire analysis problem has not been solved to date. The WUI post-fire analysis problem spans many jurisdictions; land burned during the Witch fire belonged to 12 different federal, state, local and non-profit agencies and organizations in addition to the thousands of homeowners. The individual communities and cities lack the resources to develop tools and collect post-fire data. At the state level, the risk assessment tools used are unproven and their performance never assessed through post-fire analysis. This is not only driven by lack of resources, but also by difficulties in assessing fire behavior across different jurisdictions. At the federal level, there is not a single agency that collects post-fire data from the wildlands and the WUI. Finally, there is not an integrated effort to develop reliable tools to assess and mitigate risk at the WUI, therefore data collection has not been an issue to date, as no-one is addressing the WUI issue in its entirety.

Why NIST? The objectives of this project supports BFRL's mission and vision by providing measurement science and technology that will enable the development of new standards and risk assessment tools that reduce the destructive impact of wildfires on WUI communities. BFRL has an international reputation in developing unbiased scientific methodologies necessary for new building codes and standards. Developing data collection methods to understand fire behavior at the WUI is consistent with, and supports, BFRL's core competency of fire protection and fire spread within communities. The project directly supports BFRL's strategic priority of Measurement Science for Innovative Fire Protection.

Approach:

What is the new technical idea? The new technical ideas are the development of standardized data collection methodologies that once implemented will generate reliable post incident data, field data collection efforts in coordination with state and local agencies, the development of standardized data analysis methodology, and the use of the NIST WFDS and targeted lab and field experiments to improve our risk assessment and mitigation predictions.

Why can we succeed now? NIST is uniquely positioned to address hazard reduction at the WUI. Our collaborations with the federal, state and local agencies are giving us access to valuable post fire data. Additionally the State of California is fully supportive of the effort and is providing critical personnel resources for field data collection. The synergy provided by the NIST team is unique in the WUI research community. WFDS development is enhanced using real life inputs,

while in parallel the model is guiding our understanding of fire behavior. The use of WFDS on problems of this magnitude is made possible by improvements to the code to allow computational domains spanning several square miles. Additionally, the Coeur D'Alene NIST Grantee developed methodology is enabling us to use overflight Light Detection and Ranging (LIDAR) data to generate high resolution three dimensional input files for WFDS. Furthermore, laboratory and field scale experiments with the NIST Firebrand Generator (NIST Dragon) are permitting us to explore structure ignition pathways and therefore help in our understanding of fire behavior at the interface.

What is the research plan?

Post incident data from the Witch fire will continue to be analyzed and the information will be used for the WFDS development. The methodology for post-fire field data collection will be developed and experiments will be planned to address current WFDS predictive limitations. Additionally, work will be done with the State of California and US Forest Service to evaluate the flammability of Southern California ornamental vegetation. The work will be done using the NIST/USFS developed methodology for Southeastern US vegetation. Field data collection will continue and high risk communities will be identified though interactions with California state and local governments. A select number of communities will be chosen as case studies for field data collection and risk assessment and risk mitigation evaluations.

Post Incident Data Collection

The post Witch fire data collection will continue with the support of CALFIRE and the City of San Diego. The State and City have provided access to NIST personnel during and after the fire. The analysis is divided into two components.

The first study will focus on *The Trails* subdivision at Rancho Bernardo. This community of approximately 270 homes was almost entirely within the fire perimeter. Over seventy homes were completely destroyed and five were damaged. The study will focus on the development of a timeline for the evolution of fire and structure ignitions throughout the community. An attempt will be made to understand why the fire took certain "paths" though the community and why certain structures burned while others survived. With input files generated from the Coeur D'Alene grantees WFDS will provide information on the track of fire brands through the community and the effects of topography on flow dynamics.

The NFPA Firewise methodology for WUI fire community protection will be applied to *The Trails* and the validity of the methodology will be assessed. This is possible through extensive data collection conducted during and after the fire. In order to map out the community, NIST, with CALFIRE support, has taken over 11,000 pictures of the destroyed and remaining homes.

The second study will look at the Witch fire. The objective of the second study will be to take the structure ignition and survival lessons learned from The Trails study and see to what extent they apply to the entire Witch Fire. The limiting factors in that study will be the amount of data available for other communities affected by the fire specifically wildland and residential vegetation and house construction. WFDS will be used again to map out flow dynamics through communities and explore fire dynamics and behavior.

Post Incident Methodology
A post-incident methodology is being developed to collect data after WUI conflagrations. The joint effort between NIST, CALFIRE and the City of San Diego is aimed at standardizing data collection to ensure that critical data is not lost (due to recovery efforts) and that data compatibility is assured. Different hardware, software and field methodologies are assessed, with the aim of creating a California State wide data collection infrastructure.

Recent Results:

- The one person level of effort for post-fire data collection has required extensive (over 40%) travel. A significant effort has gone into developing partnerships with the state and local officials and obtaining their critical support. Without State and local buy in and labor contributions the current post-fire analysis would not have been possible.
- Output: Completed an MOU between NIST and CALFIRE
- A. Maranghides, Post Incident Fire Analysis, Fire Research Division Seminar, February, 2008.
- Output: A Maranghides, The NIST Wildland-Urban Interface Program, Invited presentation to CALFIRE and City of San Diego Fire Department, February, 2008.
- Field data collection of destroyed structures at *The Trials* in Rancho Bernardo – October to December 2008
- Data collection of unburned structures at *The Trails* – April 2008
- Development of Witch Fire timeline at *The Trails* - March to September 2008
- Output: As a result of interactions with the USFS, an Interagency Agreement was established with funding to NIST for experiments in the Large Fire Laboratory.
- Output: Fifteen presentations in technical conferences and webcasts (five invited)
- Member of a number of influential national panels (OFCM Fire Weather Needs Assessment, FEMA Wildfire Panel, WUI National Blue Ribbon Panel)

Standards and Codes: At the National level, **n**ew findings will be included in NFPA Forest and Rural Fire Protection Committee. At the State level, work with CALFIRE will enable the developed data collection methodology to be used state wide. Once the methodology is tested in California, other western states will be targeted. At the city level, collaboration will continue with the City of San Diego Fire Department and building officials. Similarly to the State model, collaborations with other Cities will be explored in the out years. Input from the data analysis will be integrated through outreach programs such as the NFPA Firewise program.

Future Outcomes and Impacts

Outcomes:

- Generation of a comprehensive post WUI fire data set for the study of WUI fire behavior
- Southern California ornamental vegetation flammability guide available

- Risk assessment and mitigations tools will be available to decisions makers. The tools will enable risk reduction at the WUI.
- Dissemination of findings through influential national panels and technical committees.
- Post Incident data available for further WUI fire behavior analysis.

Impacts:

- Homeowners and planning officials can use Southern California ornamental vegetation flammability guide to reduce risk at the WUI for existing and new construction.