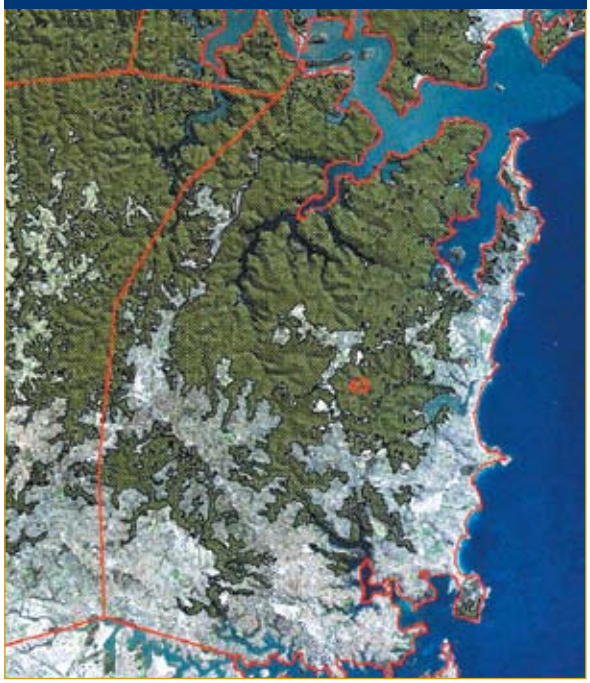
I-Zone planning: Supporting frontline firefighters

Byrne outlines the NSW Fire Brigade's I-Zone planning system designed to manage the effects of urban interface engagements.

> ***"I observed fire travel through urban bush corridors, igniting areas of grass and bush and then spread into vegetation located around the structures, leading to the ignition and destruction of numerous houses. These types of vegetation features acted as a funnel, drawing the fire deeper into the suburbs. I observed this funnelling first hand on numerous occasions."***
>
> Darryl Thornthwaite
> ACT Fire Brigade 18th Jan 2003

Image 1. Aerial view of Sydney's bushland urban interface showing the complexity of the urban vegetation mix. (Chen and McAneney, 2005 in Lowe, 2008).



Introduction

The focus of this paper is bushfires that impact on the built environment in the bushland urban interface or I-Zone. These fires are transitional by nature with the fuel source of the fire changing from vegetation to structural, as the fire travels from a bushfire prone area to an urban area. It is this transitional nature that causes the greatest challenges for a largely urban fire service such as the NSW Fire Brigades. A simple definition of an interface area is "Any area where structures (whether residential, industrial, recreational or agricultural) are located adjacent to or among combustible (bushland) fuels" (Cottrell, 2005:110). NSW Fire Brigades use I-Zone as an abbreviated term for any bushland urban interface.

During an 'I-Zone' type of emergency, fire commanders are required to make instant judgments regarding firefighter and civilian safety, appropriate firefighting strategies, resource placement, and values at risk, due mainly to the dynamic nature of these fires. Often these judgments are made with the acceptance of resulting property losses, due to the magnitude and speed of the fire and the often limited resources available. It is the dynamic nature of these fires and the time critical nature of decision-making that causes the greatest challenges for on ground commanders within the fire services. Therefore the greater the planning undertaken by the NSW Fire Brigades the greater the likelihood of mitigating the effects of these events.

As a result of internal investigation it was evident that NSW Fire Brigades could further improve its operational and risk management procedures in I-Zone emergencies. It was identified that the development of a robust method of supporting critical decision making by command officers, in the form of I-Zone Planning, was critical to successfully mitigating the effects of these emergencies. This decision support tool has the safety of firefighters, operating in these volatile high risk environments, as its key objective. I-Zone planning enhances the NSW Fire Brigades performance to mitigate the effects of I-Zone emergencies, and support the Rural Fire Service (RFS), the lead combat agency for bushfire in New South Wales.

I-Zone planning has three main goals:

1. firefighter safety;

2. improved emergency management; and

3. community education.

Key stages of I-Zone planning include:

Macro risk assessment

- a risk assessment of the target area (NSWFB Station Area) by the Bushland Urban Interface (BUI) Section's I-Zone Officer using High Resolution Aerial Photography;
- additional assessment using FireAus[1] data in Arc View;
- inclusion of known fire history and fuel assessments through information provided by local Bushfire Management Committees Risk Plans; and
- I-Zone (macro) plan developed electronically.

Micro Risk Assessment

- identification of highest risk area within station boundaries. This includes analysis of Australian Incident Reporting System Data;
- ground truthing of I-Zone plan by firefighters at local station. This includes data collection by local crews in target location;
- development of hardcopy and electronic mapping including identification of sectors as per Incident Command System; and
- resulting data linked to the NSW Fire Brigades Computer Aided Dispatch System.

As described above, this information will be linked to the Computer Aided Dispatch system allowing the NSW Fire Brigades to dispatch the correct resources in key locations, as part of an increased weight of attack strategy, in a time critical environment. I-Zone planning is also available to all fire agencies through Section 52 (NSW Rural Fires Act 1997)[1] planning process through Local Bushfire Management Committees in New South Wales. This planning will assist all fire agencies in the event of major bushfires in urban areas.

Defining the issue - NSW Fire Brigades

Broadly speaking there are three major issues that have elevated I-Zone fires as a priority for the NSW Fire Brigades they are:

- climate change;
- population migration; and
- operational Command and Firefighter Safety.

1. Climate Change

Climate change projections indicate that Victoria and NSW are likely to become hotter and drier in future (Hennessy et al, 2005; Suppiah et al, 2005). Hennessy and Suppiah evidence that since 1950 Australia has warmed by 0.85 C. Rainfall has also decreased in the south-east and droughts have become hotter as the number of extremely hot days has risen. Southern Australia has the reputation of being one of the three most fire-prone areas in the world, along with southern California and southern France. The CSIRO and Bureau of Meteorology report, "an increase in fire weather risk at most sites in 2020 and 2050, including the average number of days when the FFDI rating are high or extreme. The combined frequencies of days with very high and extreme FFDI readings are likely to increase 4-25% by 2020 and 15-70% by 2050" (Hennessy et al, 2005). Interestingly, the study also concluded that the window available for prescribed burning may shift and narrow, thus adding a further constraint to the ability of agencies and land managers to mitigate the effects of bushfires. The recent Lucas & Hennessy et. al (2007) report prepared for the Climate Institute also confirms these trends.

The above scenario is already affecting the organisation with many bushfires impacting on, or originating in NSW Fire Brigades areas of operations. Statistics from the NSW Fire Brigades Annual Report, 2006/07, indicate that 25% of the 138,021 responses by NSW Fire Brigades units annually are bush or grass fire related, that translates to a total of 34,505 incidents, annually. These statistics illustrate the significance of grass and bushfires to the operational capacity of the NSW Fire Brigades.

2. Population migration

The majority of NSW's population resides in the Greater Sydney Area, defined as an area of land from Port Stephens in the north, west to the Blue Mountains, and south to Kiama. Within this area there has been a growing trend of people migrating to more rural locations. This has been driven by a number of issues including lack of available cost effective land in city locations, lifestyle considerations, decentralizing

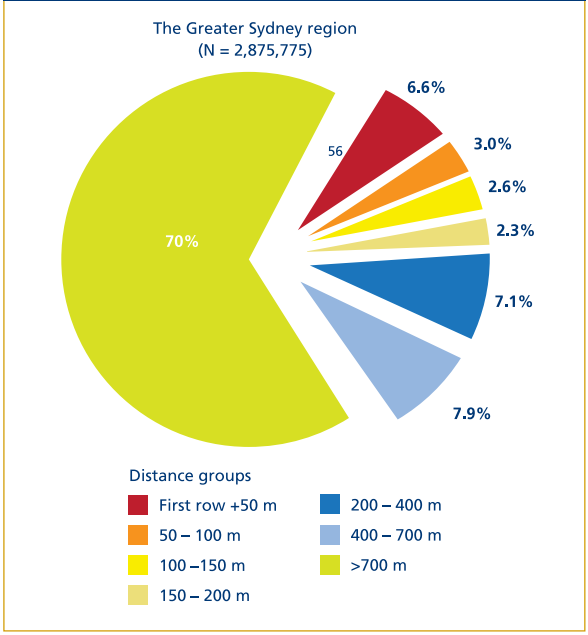
1. Section 52 of the NSW Rural Fires Act 1997 requires each bush fire management committee to develop a plan of operations and a bush fire risk management plan.

of workplaces, and greater availability of internet connections in rural locations. "The population in Sydney and the Central Coast is tipped to grow from the current level of 4.1 million to 5 million by 2022. The Illawarra and the Lower Hunter are home to another 750,000 people - and growing strongly too" (Sydney Metropolitan Strategy (2004), Minister's Message).

There are many similarities between the urban growth and subsequent fire regimes in California and New South Wales. In the United States a number of studies blame urban sprawl as the primary source of increasing ignition and a leading factor for increasing severity of urban interface fire in southern California (Goldstein, Candau, & Moritz, 2000; Keeley et al 1999).

The Californian Department of Forestry and Fire Protection suggest that for every 600 homes or 700 people, there will be one more ignition per year per 1,000 acres (California Department of Forestry and Fire Protection, 1995, p2). This is based on the linear regression data from 1921 to 1993 for California Sierra Nevada foothills and similar data from California's Riverside County suggesting with 95% confidence that the addition to former wildlands of 1 housing unit per square mile means an additional 0.001733 ignitions per year per 1,000 acres and an addition of an additional 1 person per square mile will lead to an additional 0.001438 ignitions per year per 1,000 acres. This suggests a strong correlation between expanding populations in I-Zone areas and increased fire activity.

Image 2. FireAus pie chart showing properties and distance from vegetative fuel edge in meters and subsequent risk category Red - Very High , Orange - High etc. Note 9.6% of structures are in the very high/high risk category. (Chen and McAnene, 2005 in Lowe, 2008).



3. Key issues in Command and fire safety

a. Command

The NSW Fire Brigades undertakes a number of emergency response roles:

- structure fires;
- hazardous Materials (Hazmat);
- bushfire;
- rescue;
- Urban Search and Rescue (USAR); and
- Chemical Biological Radiation (CBR).

As a largely urban-based fire service, bushfire response is just one component of the organisations role. Within this context, the challenge for the NSW Fire Brigades is how best to prepare its command level officers for I-Zone type events, given the overall training demands of a multi emergency response organisation.

Not all command officers will have sufficient experience of I-Zone fires to have developed the required mental schemata enabling them to make effective decisions in a time critical manner. What can the NSW Fire Brigades do to support these officers in this environment? The implementation of a decision support system through planning for I-Zone events is a solution offered in the I-Zone planning system.

I-Zone fires are problematic for fire services as they have a number of characteristics that are difficult to manage operationally:

1. they are fast moving, dynamic fires that pose serious safety risks for firefighters;
2. they impact on numerous structures simultaneously;
3. property losses can occur within a short time frame;
4. a large number of resources are frequently required to combat these events;
5. consistent inter-agency cooperation and understanding is required;
6. communications technology overload often occurs; and
7. large civilian populations are frequently affected.

b. Ember attack

Impact in the context of this paper is defined by Leonard and Blanchi as "the parameters that can describe the magnitude or persistence of the attack mechanism" (Leonard, J. Blanchi R., 2005). In the right conditions, embers will cause mass ignitions in the urban interface. These embers can travel large distances

from fuel beds and, borne by strong winds, impact on urban vegetation or buildings with devastating effect. It is the sheer volume of these embers that is the issue.

Ember attack takes place over a long period of time, before the fire front hits, during the fire front, and for considerable hours after the fire has passed. The risk from these embers is a complex issue and many factors are involved. The atmospheric conditions, type and mass of vegetation, building construction, and building surrounds.

Dowling argues that ember attack is responsible for 90% of all houses destroyed by bushfires and that radiation and direct flame play a relatively minor role in fire propagation (Dowling, 2008). Human activity plays a significant part in mitigating these ember attacks, prevention and suppression activities, before during and after ember attack are critical (Ramsay 1996). Consequently, any capability to reduce the effect of these ember storms is invaluable. The introduction of Community Fire Units Program by the NSW Fire Brigades in these urban areas is critical. "The CFU approach is intended to empower community members to be proactive in the defence of their own properties" (Lowe, Haynes, Byrne, 2007)".

c. House to house fire spread

A key factor in the spread of fire in the urban interface is house to house fire spread. Studies conducted by Leonard, CSIRO, conclude that a significant percentage of fire damage was caused by structure to structure fire spread. This is caused principally by direct flame attack. In many urban and suburban areas houses are built in close proximity to each other, often with common structural elements such as garaging, pergolas, and fencing, facilitating the spread of fire from one structure to another. This is further exacerbated by the trend to build larger houses on relatively small blocks of land in many of these areas. When structures are less than 15 metres apart, they are considered by the NSW Fire Brigades as a mutual exposure. That is, a fire commencing in one of these structures has the ability to spread to all other structures if there is no human intervention, either from fire services or local residents.

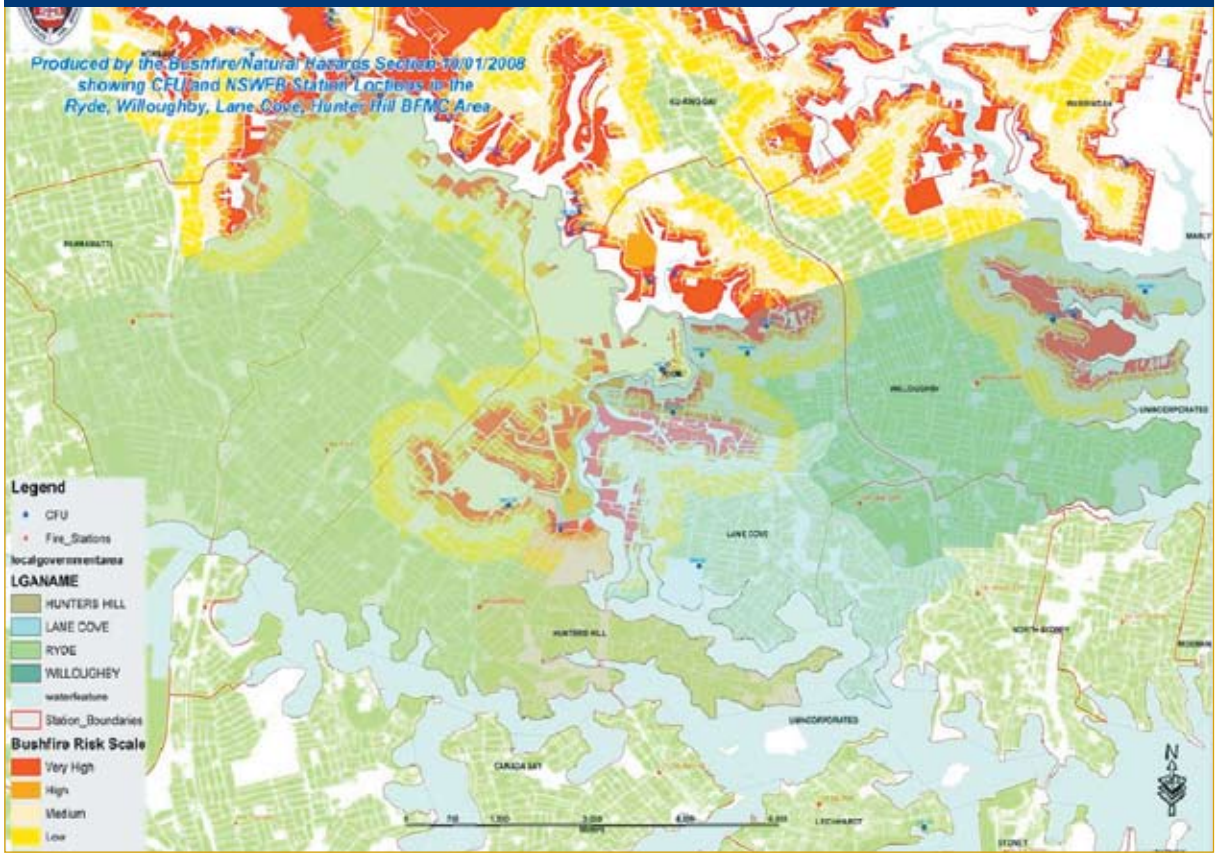
d. Defendable space

The defendable space is defined as "a home's characteristics, its exterior material and design, in relation to the immediate area around a home within 30 metres, principally determine the home ignition

Image 3. FireAus Risk Rating Thurlgano Rd. Engadine, southern Sydney.
NSWFB Bushland Urban Interface Section.

Image 4. Thurlgano Rd Engadine - actual structures lost in Bushland Urban Interface fire in October 2002. Note the properties lost are identified as Very High risk as in previous, Figure 3.
NSWFB Bushland Urban Interface Section.

Image 5. NSW Fire Brigades Macro Planning Tool using Fire Aus layer in ArcView, Lane Cove valley Sydney 2008. Areas denoted in red represent locations of very high to high risk.
NSWFB Bushland Urban Interface Section.



potential" (Jack Cohen, USDA Forest Service Missoula MT, 2003). Cohen further argues that a home's location does not necessarily determine its vulnerability to bushfire; the condition of the home ignition zone determines its vulnerability to fire. This introduces the concept of defendable space around a home that is threatened by bushfire. Therefore if there is sufficient defendable space around such a structure, despite its location and the severity of the fire, it may be deemed defendable by either occupants or fire services.

Identifying such defendable spaces is intrinsic to developing an effective structure triage capability. This becomes critical for fire commanders as it enables them to effectively and efficiently allocate resources at the fire front.

e. Structure triage

No discussion of the bushland urban interface would be complete without discussing structure triage. The overarching operational doctrine in combating these fires is maximizing the often limited available resources for maximum effect. Therefore a system for deciding on which assets to concentrate on saving is essential. If for example, a fire commander arrives at a location where a major fire is running and multiple houses are alight, how would he or she decide which properties to concentrate the efforts of their resources on Structure triage identifies, through a series of criteria, the defendability of individual structures. In broad terms there are three types of structures:

1. structures that are quite safe and therefore require little or no resources;
2. structures that will require resources to save; and
3. structures that, despite allocating resources, cannot be saved.

This logic demands of Incident Controllers a decision not to save particular structures. The principle here is to use the available resources for the greatest good. By applying the above classification an incident controller can make rapid decisions on which structures to which they will allocate resources. This helps greatly in clarifying and justifying fireground decision-making. The same logic can be applied in the risk assessment phase of the I-Zone project, and in terms of planning it is an invaluable tool for local fire crews.

Implications for I-Zone planning

The primary responsibility for any fireground commander is the safety of personnel. I-Zone fires provide significant challenges to urban fire services. Therefore the primary aim of I-Zone planning is to provide critical information to firefighters in relation to the risk in these bushland urban interface communities.

The generic information contained in each I-Zone Plan includes the following:

1. aerial view of target area;
2. roads (primary and secondary);
3. fuel sources;
4. hydrants;
5. static Water Supplies; and
6. property boundaries

Additional information that is sourced by the NSW Fire Brigades Bushland Urban Interface Officers in cooperation with local fire crews include:

1. divisional and Sector boundaries;
2. safe refuge areas;
3. helicopter landing points;
4. assembly/Staging areas; and
5. areas of High Medium and Low Risk.

Point 5 above refers to the identification of areas of high risk etc. The author has modified the Californian Risk Assessment Matrix (RAM), developed by Battalion Chiefs Mike Rohde (Orange County Fire Authority) and Bill Clayton (CDFF San Diego) for use in I-Zone planning. This RAM was developed by the military for use by military personnel when deployed into unfamiliar territory. The RAM provides a quick visual display of the risk to firefighter safety at a specific geographical location. This type of system is invaluable when fast briefings are required for field operations.

The below sample I-Zone Plan illustrates the volume of information available on these documents and the value of this information to fire ground commanders. The plans are available in hardcopy to Station Commanders for their local area. Higher command ranks within the organisation will also have both micro and macro plans available as incidents develop exponentially.

Conclusion

The NSW Fire Brigades I-Zone planning system represents a sophisticated, integrated approach to managing or mitigating the effects of bushland urban interface emergencies on communities within a specific geographical location i.e. the Bushland Urban Interface. The I-Zone Planning system is a winner of the Emergency Management Australia Safer Communities Award for Pre-Disaster Planning, 2007. The system continues to be developed and improved for the benefit of at risk communities and fire services alike. Importantly, I-Zone planning is a very useful tool to educate communities in these high risk bushland urban interface communities. The NSW Fire Brigades is making this planning tool available to the volunteers in their Community Fire Unit Program.

Image 6. NSW Fire Brigades I-Zone Plan – Macro. The map shows the South Katoomba area west of Sydney. Note the areas denoted as high risk in red are largely found on the urban fuel edge.
NSWFB Bushland Urban Interface Section.

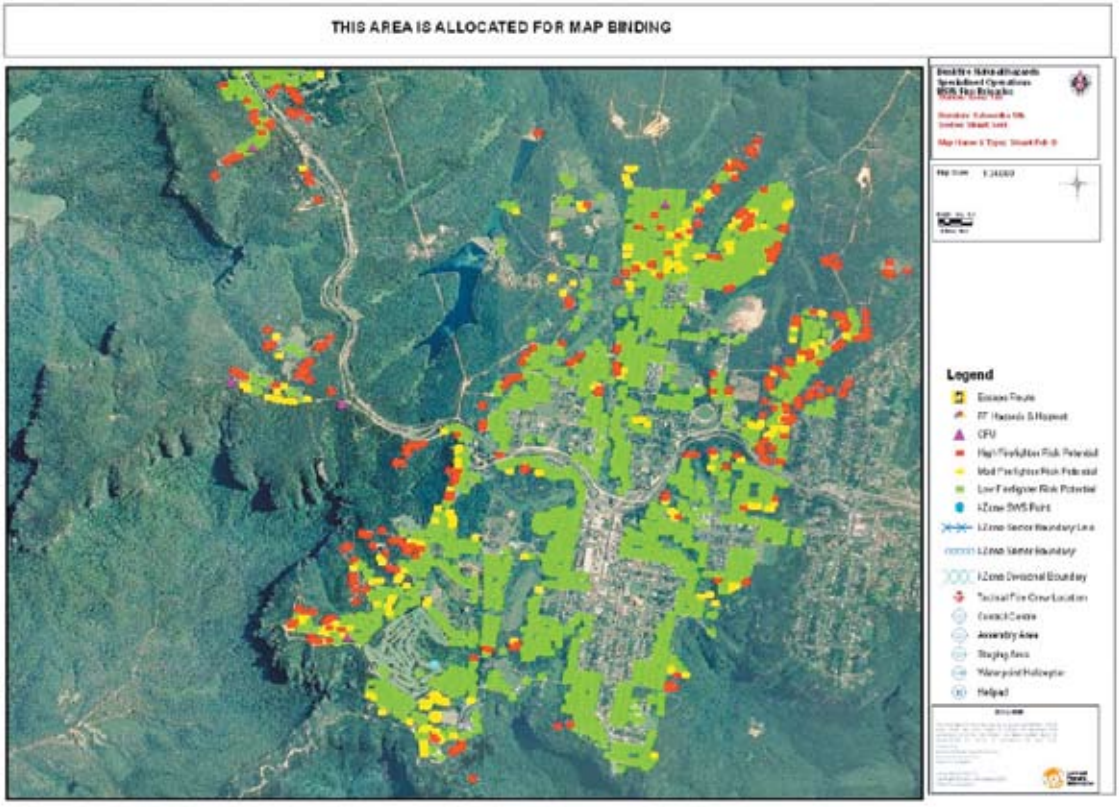
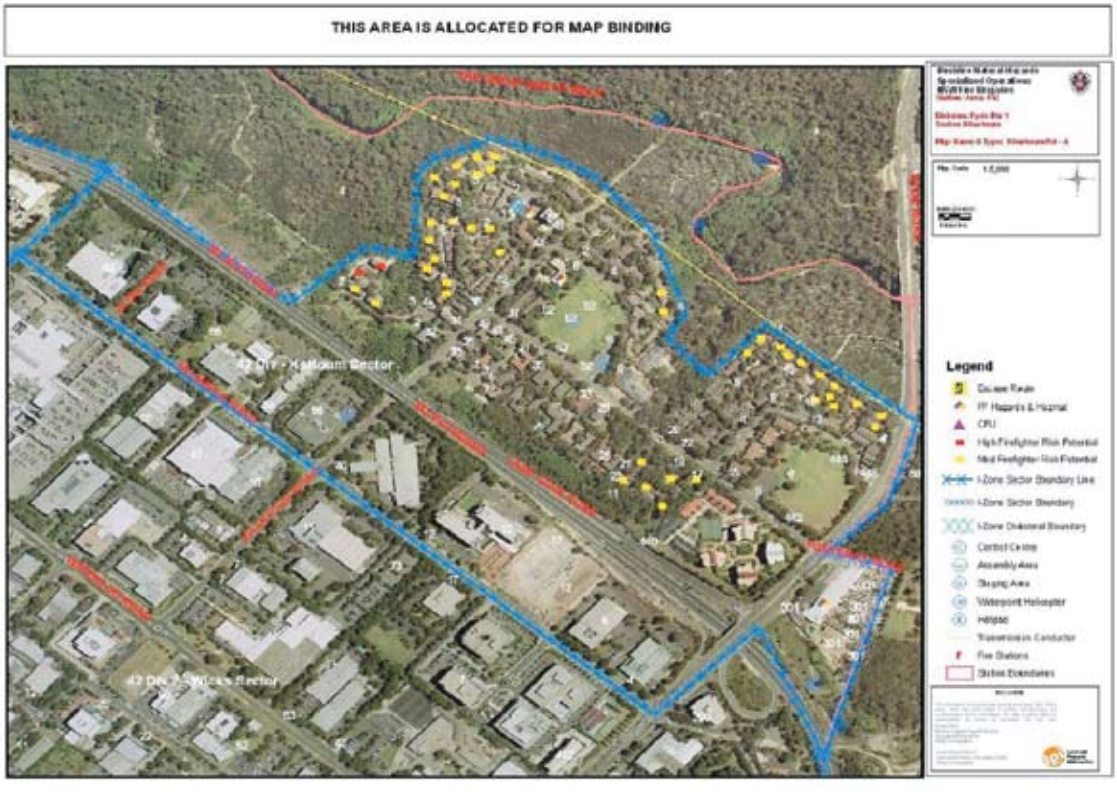


Image 7. I-Zone Plan – A Decision support tool. The legend on the right hand side provides key information for operational decision making.
NSWFB Bushland Urban Interface Section.



Bibliography

California Department of Forestry and Fire Protection, 1995, p2.

Chen, K. and McAneney, J. (2005). The bushfire threat in urban areas. Australasian Science, 26(1): 14-16.

Clayton, B. & Rohde, M., 2005, Wildland Urban Interface Risk Assessment Matrix, Applying Military Combat Preplanning to the Fire Service, viewed 20 January 2007, <http://www.wilfirelessons.net/documents/wui.ram.

Cohen, J., 2003, Wildland-urban fire a different approach, In: Proceedings of the Firefigther Safety Summit, Nov. 6-8, 2001, Missoula, MT. Fairfax, VA.

Cottrell, A. (2005) Communities and bushfire hazard in Australia: more questions than answers. Environmental Hazards (6): 109-114.

Dowling.V., P., How do we prevent houses being destroyed in bushfires? CSIRO Sydney 2008.

Goldstein, N,. Candau, J. T., & Moritz, M. A. (2000) Historical Santa Barbara up in flames: A study of fire history and urban growth modeling. Paper presented at the 4th International Conference on Integrating GIS and Environmental modeling (GIS/EM4) Problems, Prospects and Research Needs, Banff, Alberta, Canada.

Hennessy, K., Lucas, C., N., Nicholls, Bathols, J., Suppiah, R. and Ricketts, J. (2005) Climate change impacts on fire-weather in south-east Australia. CSIRO Marine and Atmospheric Research, Bushfire CRC and Australian Bureau of Meteorology. CSIRO Publishing.

Keeley et. al (1999), Reexamining Fire Supression Impacts on Brushland Fire Regimes, Science, Vol 284, No. 5421 pp 1829-1832.

Lambert, K., 2005, Canberra Bushfire Report (Unpublished) NSW Fire Brigades.

Leonard, J. Blanchi, S. Investigation of Bushfire Attack Mechanisms resulting in house loss in the ACT bushfires. Bushfire CRC Report, 2005.

Lowe, T., Haynes, K., Byrne, G., 2008, Resilience at the Urban Interface, the Community Fire Unit Approach, CSIRO, Melbourne.

Lucas, C., K. Hennessy, G. Mills and J. Bathols, (September 2007) Bushfire weather in Southeast Australia: Recent trends and projected climate change impacts, Consultancy report prepared for The Climate Institute of Australia.

NSW Fire Brigades 2007 Annual Report Government Printing Office Sydney.

New South Wales Government (2006) New South Wales Government Metropolitan Strategy - website, viewed May, 2006 http://www.metrostrategy.nsw.gov.au/dev/ViewPage.action?siteNodeId=50&contentd=141&languageId=1.

Ramsay G. C, McCarthur N. A. 1995. Building in the urban interface: lessons learned from the January 1994 Sydney Bushfires '95 Conference Hobart.

Rhode, M. S. (2002) Command decisions during catastrophic urban interface wildfire: a case study of the 1993 Orange County, California, Laguna fire.

Unpublished Masters Thesis. Department of Occupational Studies California State University, Long Beach, U.S.A.

Rural Fires Act 1997, Government Printing Office Sydney.

Suppich et. al (2005) Australian Climate Change Projections derived from simulations performed for the IPCC 4th Assessment Report, CSIRO Marine and Atmospheric Research Australia.

Thorntwaite, D., 2003 ACT Fire Brigade, Canberra.

About the author

Chief Superintendent Gerry Byrne is the former Manager Bushland Urban Interface with the NSW Fire Brigades. Gerry has 25 years experience with the New South Wales Fire Brigades in both structural and bushland urban interface firefighting. He holds a Masters of Emergency Management (Charles Sturt University) with a major focus on I-Zone firefighting. He also holds a Graduate Certificate in Social Science, Emergency Management (Critical Thinking). He is a member of the New South Wales Joint Fire Services Standing Committee.

He can be contacted on gerry.byrne@fire.nsw.gov.au.