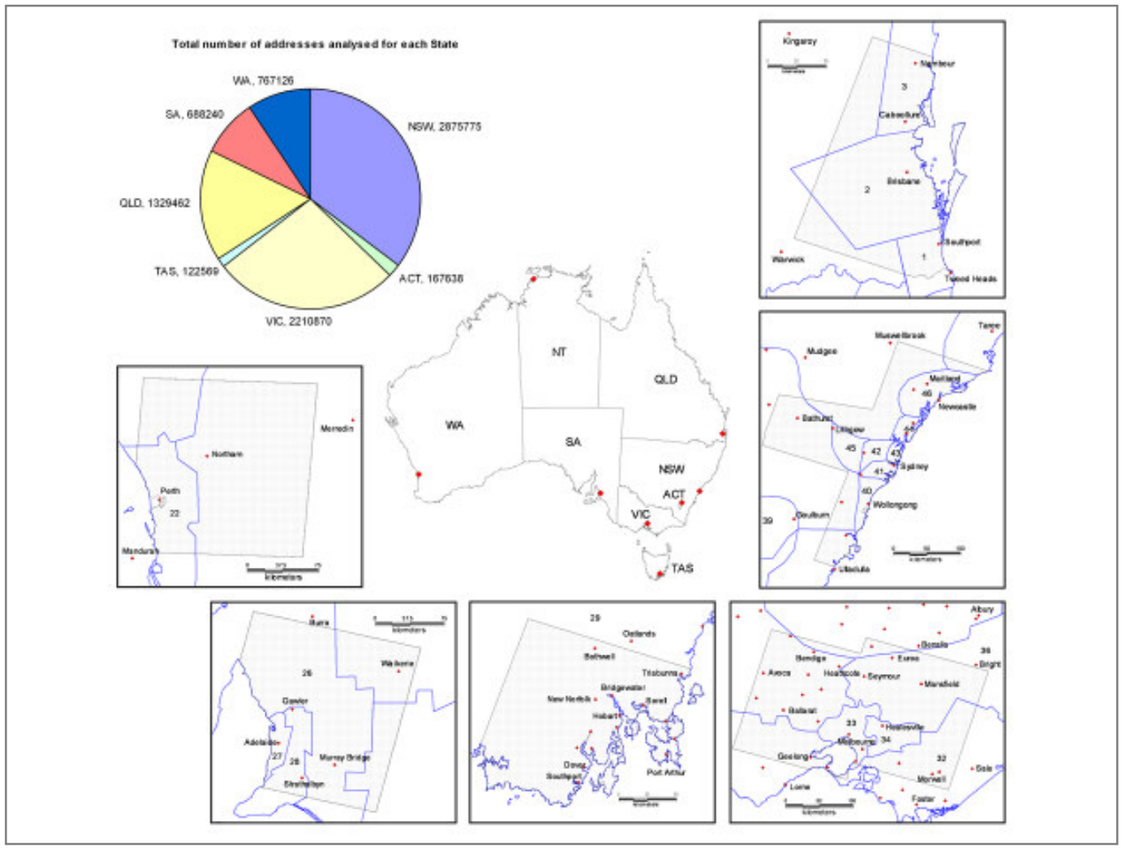

Figure 3: *Areal coverage (dotted) of FireAUS distance address database. The coverage for Canberra, ACT is shown in Figure 2. CRESTA/ICA zones are shown in blue, with zone numbers indicated.*

National coverage

Separation distances between addresses and adjacent bushland were calculated for all addresses in major capital cities in Australia, with the exception of Darwin. So far we have finished the calculation for a total of 8,161,680 addresses; their detailed coverage is shown in Figure 3.

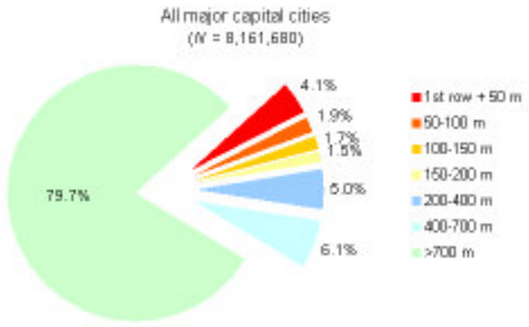

Figure 4: *The % of addresses falling within different distance ranges from bushland in Australia.*

For the total addresses analysed, about 4.1% of addresses are exposed to greater bushfire risk, being immediately adjacent and very close to extensive bushland (Group 1); about 500,000 addresses are located with distance Group 2 (first row plus 100 m); and about 80% of all addresses are located beyond 700 m. Further analysis is required to determine how these percentages vary from one state to another.

Conclusions

This research answers some big questions about the spatial distribution of exposures in relation to neighbouring bushland.

While the current study has concentrated on major capital cities and surrounding areas and covers the majority of bushfire-prone addresses, further investment is needed to include addresses in regional cities in the south-east and south-west parts of the continent. As we stressed previously, the separation distance between address and nearby bushland is not the only factor that determines bushfire risk, but is the most important and easily quantifiable variable. Future enhancements will also include integration of attributes such as slope and aspect into the risk ratings.

For more information on *FireAUS* and database sales please contact:

Keping Chen and John McAneney
Telephone: +61-2-9850 9683
Facsimile: +61-2-9850 9394
Email: riskfrontiers@els.mq.edu.au

September 2004 Volume 4 Issue1
quarterly newsletter
Risk Frontiers

This Issue

Sponsors

Aon Re
Benfield Australia
Swiss Re
Guy Carpenter
IAG Insurance
QBE
Suncorp-Metway
GE Insurance Solutions
CGU Insurance
Promina
RACQ Insurance

MACQUARIE UNIVERSITY ~ SYDNEY

How many bushfire prone addresses are there in Australia?

In the last Quarterly Newsletter (June 2004), we reported on the *FireAUS* project and progress towards developing bushfire risk ratings for individual addresses in Australia. In some ways, modeling bushfire risk is similar to terrorism where even with the resources of the CIA and FBI, quantifying the probability of an attack is extremely difficult. Nonetheless, modeling a company's relative exposure given an attack can still prove useful.

With bushfire ratings, we are interested in assessing the relative vulnerability of properties once fire management systems have broken down and fire impacts upon urban properties. This is the big risk for insurers: extreme fires destroying large numbers of buildings as witnessed so graphically not long ago in Canberra and California.

Let's briefly recap our results to date. Firstly spatial analysis of property damage from several major historical fires revealed the critical importance of distance from the bushland edge in determining the likelihood of home destruction. In itself, this is hardly surprising but the distance statistics and relationships that emerged were both intriguing and useful. We then combined distance to adjacent bushland with other site-specific attributes: vegetation density around the home, local aspect, and slope and weighted all these in a multi-criteria decision framework to derive relative risk ratings. These ratings allow insurers to identify the most at-risk zones based upon spatial attributes of addresses.

How useful is this? Well one obvious application is that an insurer can now compare its exposure to bushfire relative to the market portfolio. Is it insuring a higher proportion of at-risk properties than its competitors? How might it engineer its portfolio to change this exposure? How would it risk-adjust premiums to better reflect bushfire risk? These are all questions that *FireAUS* seeks to answer.

We have now taken the problem several steps further. In particular we were interested in testing both the accuracy and efficiency of the tools that facilitate the extraction of the risk ratings. We were also interested in a pretty basic but important question: what proportion of properties in Australia is at risk? And how does this proportion vary nationally? Answering these questions is a first step in moving from Relative Risk Ratings to pricing this risk.

In what follows we focus on one key attribute only: separation distances between addresses and adjacent bushland. Not only is this distance demonstrably the most important factor in discriminating between zones of urban bushfire risk, it can also be estimated relatively easily. A single address database on distance would also prove useful for bushfire risk management.

Methodology

As a first critical test, we applied the methodology to a bushfire-prone area in the Sydney region, Lane Cove National Park and Hornsby. The most detailed geospatial data sets available - geocoded street addresses, satellite imagery and digital terrain models – were used. Because of the high-proportion of at-risk properties, this study area provides an important check on the accuracy of the extraction algorithms and an opportunity to see how accuracy degrades as resolution of the satellite imagery is relaxed. Resolution has a big bearing on the cost of providing this information to insurers.

Prerequisites for analysis are accurate location of property addresses and a map of the bushland distribution. For the former, Risk Frontiers employed the latest G-NAF (Geocoded National Address File http://www.g-naf.com.au) street address database. Location here refers to the centroid of each land parcel in cadastre. G-NAF is regarded as Australia's most authoritative geo-located address database.

For bushland maps, we first sourced government agencies and publicly available land cover databases. These have major limitations: coarse spatial resolution and many have not been updated recently.

High-resolution imagery is better but comes at a cost. The most recent generation of satellite images, including DigitalGlobe's QuickBird imagery (Black/White band with a spatial resolution of 0.6 m, and multispectral bands with a spatial resolution of 2.4 m) were considered before being rejected because of high cost and relatively small swaths.

More affordable is medium-resolution satellite imagery, and after examining several alternatives, we finally settled on Landsat 7 ETM+ images (B/W band 15.0 m, multispectral bands 30.0 m) to classify bushfire-prone vegetation - forests and pine plantations. Small, scattered, and discontinuous areas of vegetation were first eliminated using a spatial filter. By focusing upon large areas of continuous bushland, i.e. areas that might allow large fires to develop and, on occasions, get out of control, the overall classification accuracy is very high – approaching 100%.

Given the locations of all addresses and classified bushland, the calculation of shortest distance between them is straightforward using our *FireAUS* tool sets. Seven distance ranges were categorised. Group 1 comprises the first row of addresses immediately adjacent to bushland and those up to 50 m beyond the first row. The other six groups are in 50 m intervals out to 700 m. While the maximum distance from the bushland/urban interface at which property damage occurs varies between fires, 700 m is the maximum extent of fire penetration of which we are aware. Group 1 lies within about 80 m of the bushland edge and so comprises the most at-risk properties.

Validation

Is medium-resolution satellite imagery up to the job? To examine this question, we compared the results from Landsat ETM+ with the high-resolution QuickBird imagery. Figure 1 shows the cumulative percentages of addresses within each distance group or zone for the Lane Cove National Park – Hornsby area, a study area containing a total of 33,700 addresses. Surprisingly perhaps, both curves display very similar results: there is very little dependence on image resolution. About 40% of addresses are located within the first row and 150 m beyond. For larger study areas containing millions of addresses, it is reasonable to expect that the difference between the two cumulative percentages to be even smaller. So this looks promising.

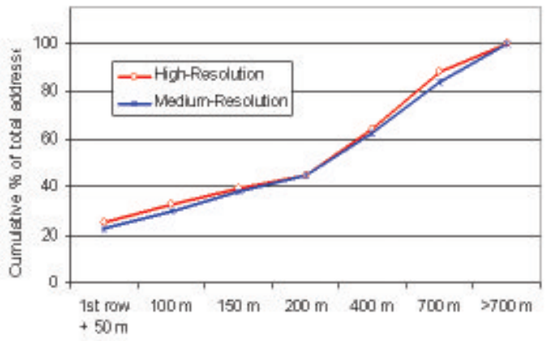

***Figure 1**: Cumulative % of addresses at different distance ranges from bushland using both high- and medium-resolution imagery.*

Next in a manner analogous to testing for false positives or negatives in a medical procedure, we checked to see whether individual addresses were ascribed to the same distance group given either the high- or medium –resolution imagery. For the most vulnerable category, a large portion of addresses showed discrepancies with only 68.2% of the 33,700 addresses grouped identically. However, consistency rates increase to 76.4% and 88.9% respectively as we combine the first two distance groups (Group 1 plus Group 2 - first row plus 100 m), and the first four together (first row plus 200 m). In other words, if a zonation of some 200 m was considered adequate, then accuracy approaches 90%. This is sufficient for identifying high-risk zones.

Emergency Management Applications

In a further test, distance maps were developed for all of the most severely damaged suburbs from major historical fires in Australia. Not surprisingly, all were located in close vicinity to areas of extensive bushland. Suburbs tested include Duffy-Chapman (18 January 2003 Canberra bushfires), Como-Jannali (7-8 January 1994 Sydney bushfires), Mt Macedon (16 February 1983 "Ash Wednesday" bushfires), and Cascades, Old Farm and South Hobart (7 February 1967 Hobart bushfires).

Figure 2 shows all Canberra addresses and their distance ranges from adjacent bushland. Only 0.18% of all 167,638 addresses are located within Group 1 (1st row plus 50m); 89.6% were beyond 700 m from the first row. Startling revealed as two of the most bushfire-prone suburbs before the January 2003 Canberra bushfires are the suburbs of Duffy and Chapman. In this fire some 500 homes were destroyed in these suburbs. Clearly, this approach has potential to aid emergency planning and changing the perception of the public about bushfire threats.

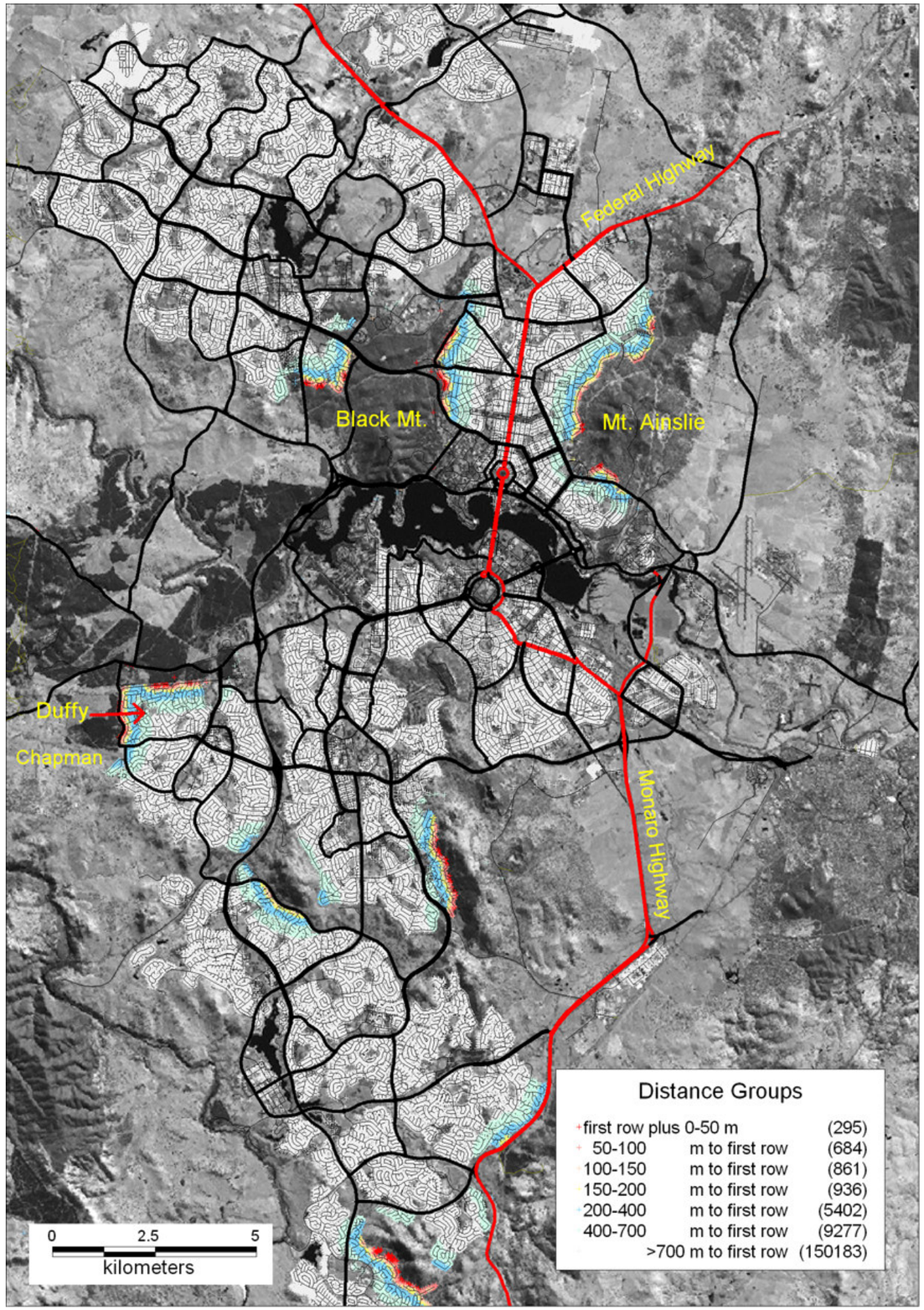

***Figure 2:** Addresses adjacent to extensive bushland in Canberra, ACT.*