

BUSHFIRE BUILDING DAMAGE SURVEY – A NSW PERSPECTIVE

Grahame Douglas, Stuart Midgley, Zhenxiang Tan and Lew Short
NSW Rural Fire Service

Abstract

Bushfires have damaged or destroyed hundreds of buildings in rural and urban interface areas within NSW for the last decade. For instances, more than 250 residential buildings were destroyed in the mid-December 1993 to January 1994 fires in NSW and a total 109 dwellings were destroyed in the 2001/2002 bushfires. These devastating bushfires have taught us many important lessons about bushfire causes and building damage mechanisms. One of these important lessons is that post fire building damage survey is an effective means for studying house damage mechanism and the survey findings can be used to develop better risk assessment models and consequently help us make informed decisions in bushfire risk mitigation planning and development assessment. In reorganizing the importance of bushfire building damage survey, NSW Rural Fire Service (NSW RFS) has established a bushfire building damage survey system for collecting, storing, retrieving and researching post bushfire damage survey data. The survey system comprises survey procedure, survey equipment and a survey database. The survey procedure documents when and how to initiate the bushfire damage survey. The survey equipment includes laptop computers with GIS functionality, GPS receivers, digital cameras, video cameras and other equipment required for measuring slope and distance. A database has been developed and installed in the laptop computers allowing the survey data to be entered, retrieved and studied in a more efficient and accurate way. The database captures three kinds of information, that is, general survey information about buildings and building owners, information required for bushfire attack assessment such as vegetation type, separation distance and slope, and building damage details like degree of damage, building materials of major building components, ignition source and residents behaviour prior to and after the fire front passes. The database is not only a survey data storage tool but also an analysing and reporting tool. This paper describes the components of the NSW RFS building damage survey system and the preliminary findings of the analysis of the survey data stored in the database.

Introduction

The objective of a post-fire building damage survey is to study building loss or damage mechanisms which will consequently help us make informed decisions in bushfire risk mitigation planning and development assessment. In recognizing the importance of bushfire building damage survey, NSW RFS has established a bushfire building damage survey system for collecting, storing, retrieving and researching post bushfire damage survey data. The survey system comprises a hand-held (Toughbook) computer installed with a survey database which is designed to a standardised AFAC/CSIRO protocol (developed during the 2001/02 Sydney bushfires) and other data collection equipment such as GPS reader, digital camera and video camera.

The main feature of the system is the use of GPS, GIS and database technologies for collecting, storing, retrieving and analysing building damage or loss data. So far, a total of more than 300 survey records have been collected and stored in the survey database. The majority of these records were obtained through the surveys conducted during the bushfire events of December 2001 to January 2002, October 2002 and December 2002.

An analysis of these bushfire damage survey records has been conducted and the preliminary results support the requirements of the *Planning for Bushfire Protection 2001* (PBP) and the buffer zone width prescribed for mapping bushfire prone areas in NSW in terms of the extent to which the developments in bushfire prone areas should be protected. In addition, the results have also confirmed some existing theoretical or established views in regard to bushfire attack.

Procedure

The procedure developed by the NSW RFS to be followed when conducting bushfire building survey is shown in Figure 1. As shown in Figure 1, the survey is initiated once the survey team within the Community Safety Directorate receives a building damage report from the relevant IC (Incident Controller) via reporting to RFS State Operations. After receiving the permission to enter the fire ground from the IC, the survey team will conduct the initial and detailed

survey. The initial survey is aimed to confirm and verify the initial building damage report received from the IC while the detailed survey is carried out in accordance with the AFAC/CSIRO building damage survey protocol.

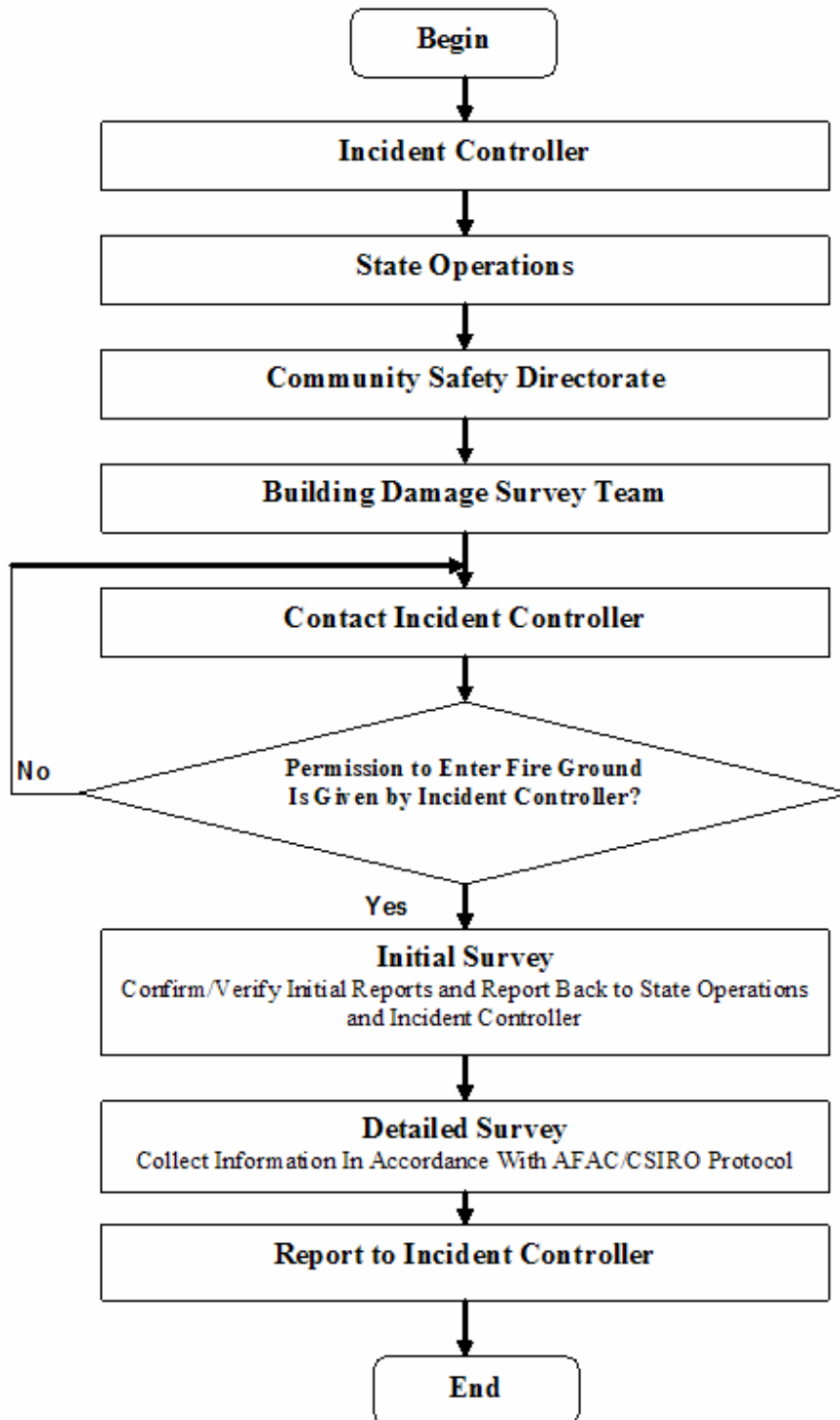


Figure 1. Bushfire building damage survey procedure

The detailed survey is carried out in accordance with the standardised AFAC/CSIRO protocol is designed to capture three sets of information (see below). For each set of information, a number of data items need to be collected through the survey (See Figure 2).

The major survey equipment includes a hand held computer, which is installed with a database designed to facilitate the on-site data collection and off-site reporting and analysis, a GPS reader, a digital camera and a video camera. The database is designed to accept the AFAC/CSIRO protocol data and is linked to a GIS application, MapInfo. The database is able to capture some of the survey information directly from existing GIS data files and therefore accelerates the survey process and improves the survey data quality. In addition, the survey data can be queried and reported in a number of different ways.

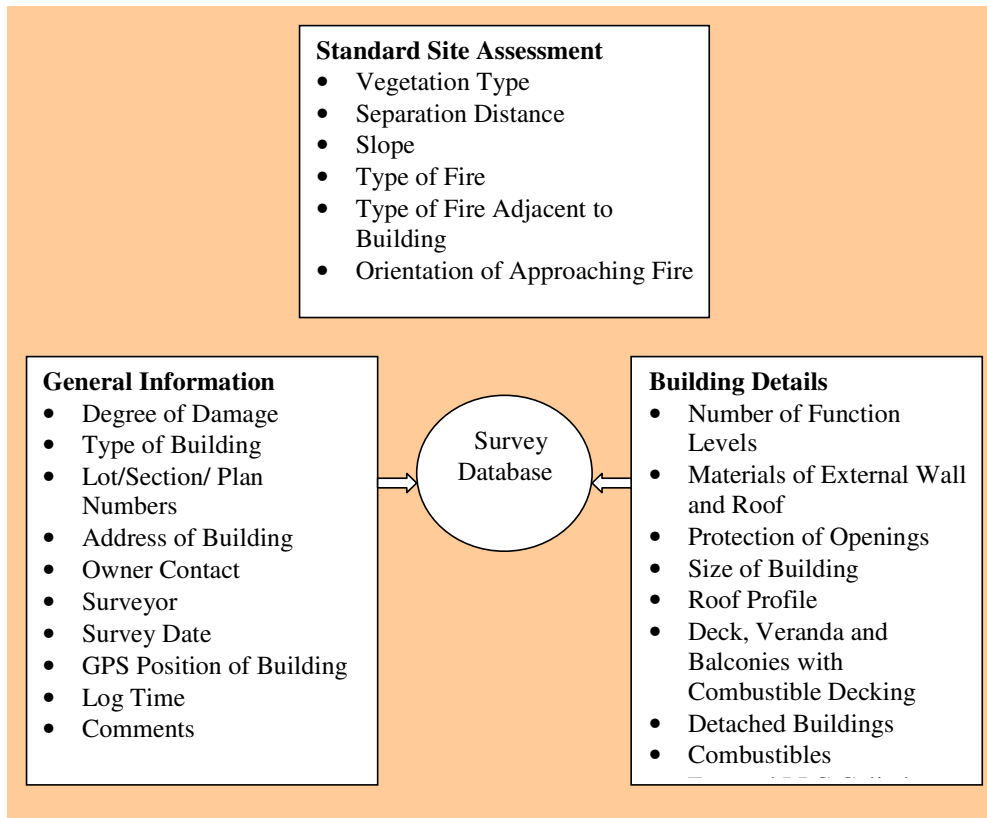


Figure 2. Information collected during the survey

Survey Database

A survey database has been developed by using Microsoft Access. The database is not only able to be used as a central database to store and process all the collected building survey data but also able to be used as a portable database when installed in the laptop computers which allows the survey data to be entered, retrieved and studied in a more efficient and accurate way. The database is designed to capture three kinds of information, that is, general survey information about building and building owner, information required for bushfire attack assessment such as vegetation type, separation distance and slope, and building damage details like degree of damage, building materials of major building components, ignition source and residents behaviour prior to and after fire front pass.

The startup screen of the database shown in Figure 3 provides a graphic user interface which enables surveyors to:

- Enter/edit the data contained in the interim cover sheet;
- Enter/edit the data contained in Section 1: Standard Site Assessment;
- Enter/edit the data contained in Section 2: Building details;
- Enter/edit the photos taken during the survey;
- Enter/edit the video clips taken during the survey;
- Query the database;
- Preview/print various survey report;
- Exit the application.

Figures 4 illustrates one of the three electronic data entry forms which are designed to capture and store the different types of data i.e. general survey information, site assessment information and building details.

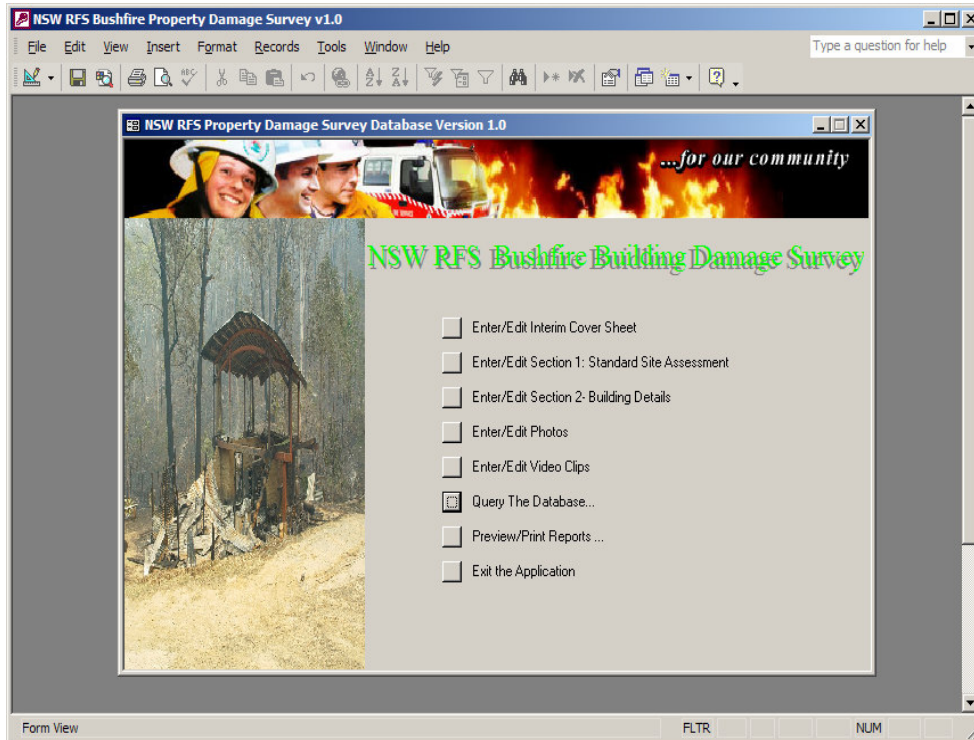


Figure 3. Start-up screen of the database

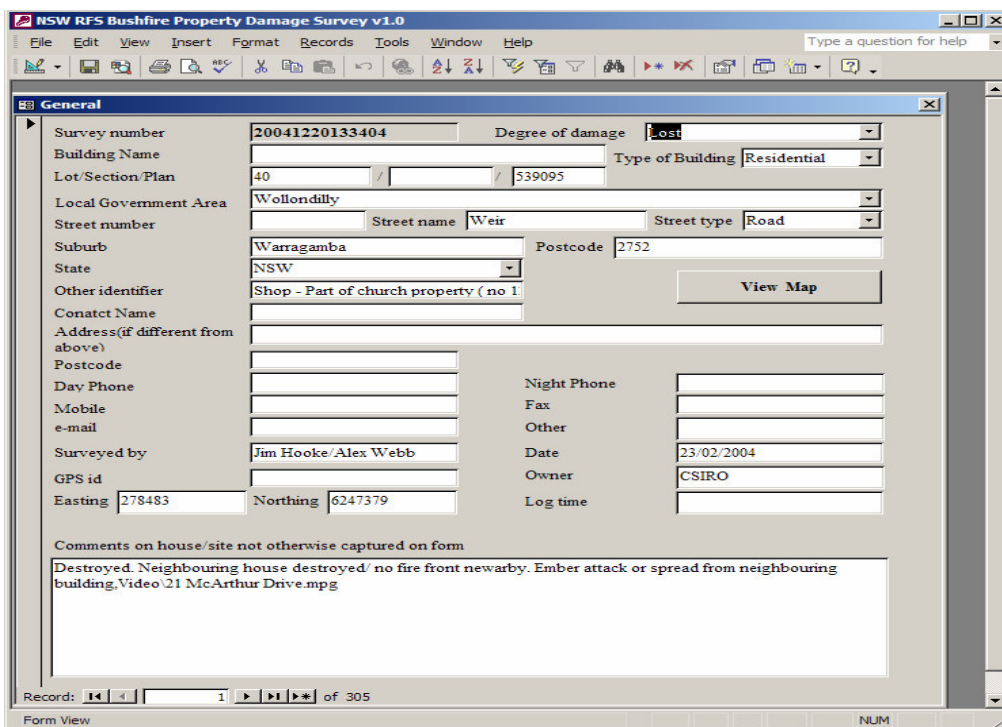


Figure 4. General survey data entry form

In order to facilitate users to query the information stored in the database, a user interface for querying has been built within the database. The database can be searched in many different ways via the query menu and the query results can be displayed in one of four formats i.e. datasheet, form, text or GIS map as shown in Figures 5 and 6.

Survey Number	Degree of Damage	Property name	Lot	DP	Street Number	Street Name	Street type	Suburb	LGA
20050128160134	Lost		21	758005	15	Hamilton	Street	Abernathy	Cessnock
20050128160553	Damaged		23	758005	19	Hamilton	Street	Abernathy	Cessnock
20050128154902	Lost		7	758005	13	Stuart	Street	Abernathy	Cessnock
20050128140309	Damaged		275	755215	Lot 2-75	Howells	Road	Abernathy	Cessnock
20050128141040	Damaged		3	758005	32	Munroe	Street	Abernathy	Cessnock
20050128151245	Lost		230	813039	230	Murray	Street	Abernathy	Cessnock
20050128153920	Lost		8	758005	15	Stuart	Street	Abernathy	Cessnock
20050128155706	Lost		1	758005	XX	cnr of Murray	Street	Abernathy	Cessnock
20050128161219	Lost		20	758005	13	Hamilton	Street	Abernathy	Cessnock
20050128161641	Lost		7	758005	22	Munroe	Street	Abernathy	Cessnock
20050128095641	Lost		17	778684		Alymerton	Road	Alymerton	Wingecarr
20050128094355	Lost		Pt 1	384461		Alymerton	Road	Alymerton	Wingecarr
20050128084210	Lost		92	28521	35	Yallast	Street	Belimbria Park	Wollondilly
20050913200700	Lost		43		Lot 43	(Track off) Berowra Waters	Road	Berowra Heights	Hornsby
20050913200690	Damaged				12	Easton	Road	Berowra Heights	Hornsby
20050913200710	Lost				79	Bay	Road	Berrilee	Hornsby
20041221120235	Lost		4	773555	97	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20050917230146	Lost				109	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20050917232349	Damaged				79	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20041221105316	Lost		58	751658	816	Comleroy	Road	Blaxlands Ridge	Hawkesbury
20041221111355	Lost		192	710429	843	Comleroy	Road	Blaxlands Ridge	Hawkesbury
20041221112440	Lost		23	776370	113	Jacaranda	Road	Blaxlands Ridge	Hawkesbury
20041221115423	Lost		8	240411	41	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20041221121322	Lost		1	809800	135	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20041221130022	Lost		1	793903	183	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20050917131037	Damaged		A	397975	179	Cedra Ridge	Road	Blaxlands Ridge	Hawkesbury
20041221132209	Lost		1	793903	193	Cedar Ridge	Road	Blaxlands Ridge	Hawkesbury
20050120152438	Damaged		191	710429	851	Comleroy	Road	Blaxlands Ridge	Hawkesbury
20041221114318	Lost		22	785515	74	Blaxlands Ridge	Road	Blaxlands Ridge	Hawkesbury
20050917203607	Damaged				XX	Mellows Road	Road	Calderwood	Shellharbou
20050917191524	Lost				115	Range	Road	Corindi	Coffs Harbo
20050917193733	Lost				10	Bottle Brush	Road	Corindi	Coffs Harbo
20050913200670	Damaged				1295	Pacific Highway	Highway	Cowan	Hornsby
20050913200680	Damaged				1293	Paific	Highway	Cowan	Hornsby

Figure 5. Sample query results in the format of datasheet

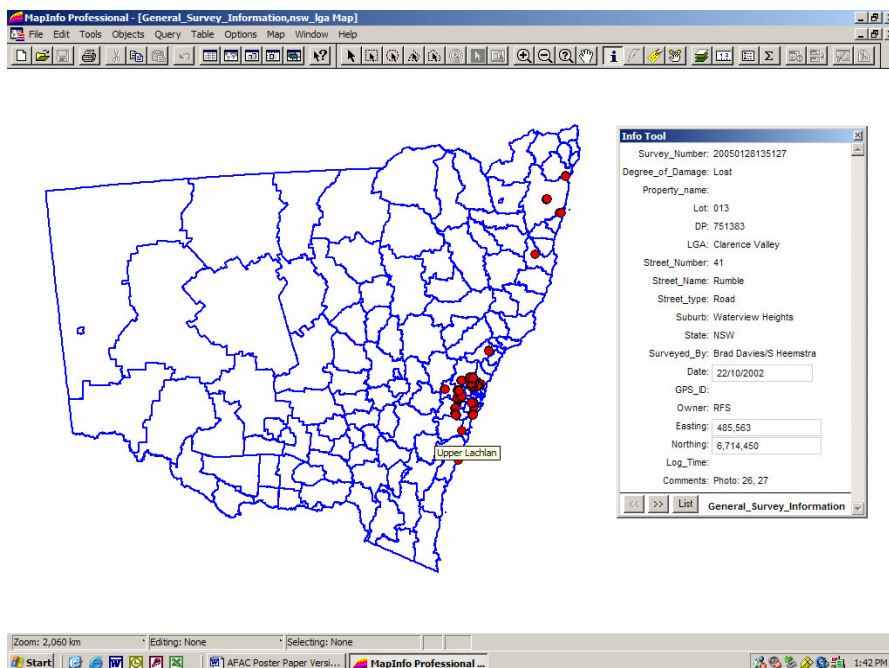


Figure 6. Sample query results in the format of GIS Map

In addition to the querying capacity, a report menu is built within the database to facilitate the off-site data reporting and analysis process. With the report menu, one can generate a number of different reports. These reports can be previewed or printed in different formats such as text, chart or GIS map (Figures 7 and 8).

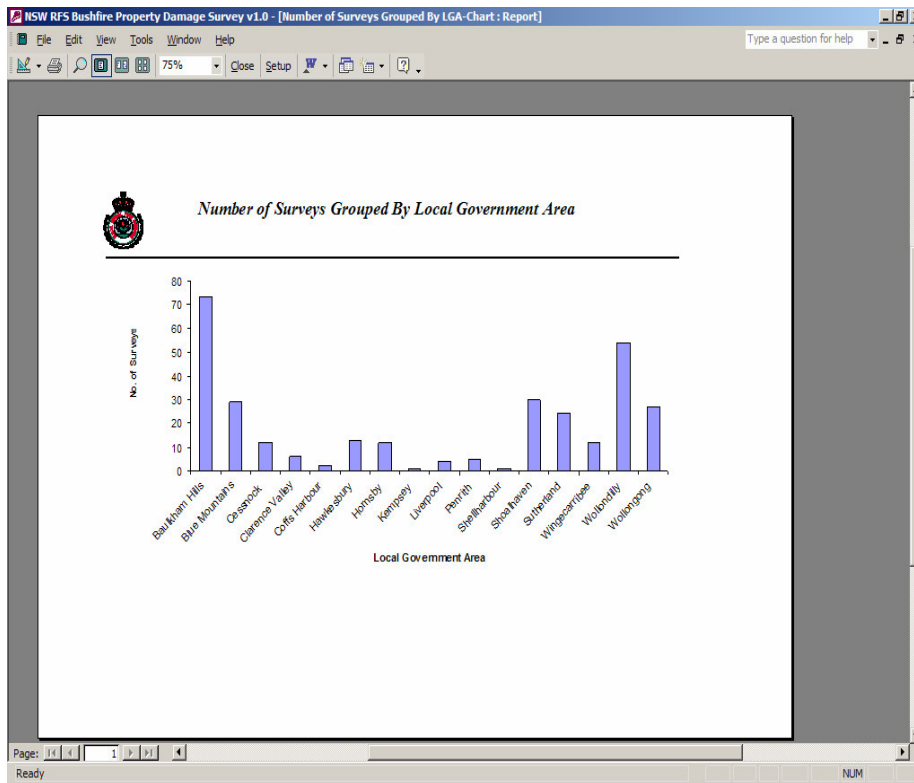


Figure 7. Sample report in chart format

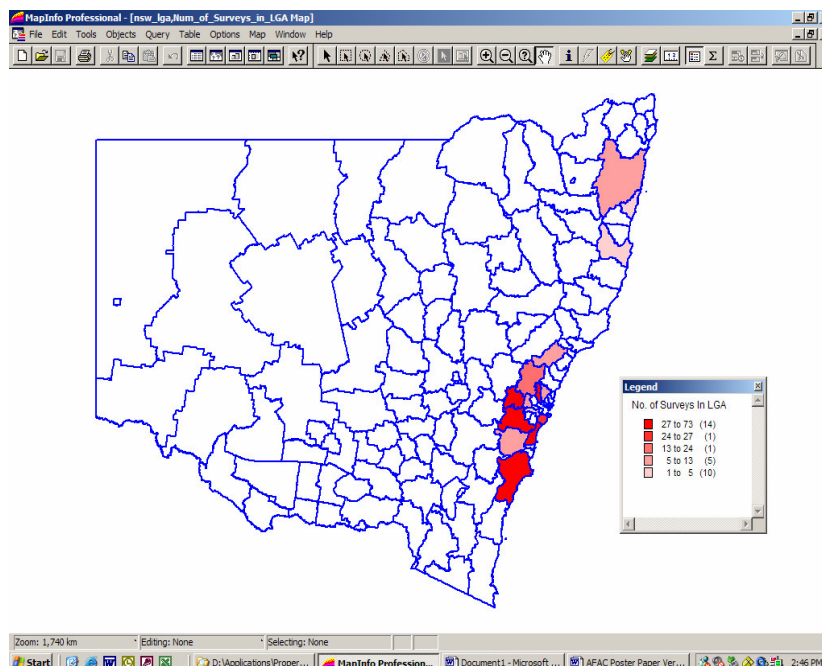


Figure 8. Sample report in GIS Map format

Preliminary Results

A preliminary analysis of the data stored in the database has been conducted and the results are:

- The accumulated rate of building ignition (damaged or destroyed) varies from the separation distance of building to vegetation (See Figure 9). The accumulated ignition rates within 20m, 40m, 60m, 80m and 100m are 58%, 76%, 83%, 86%, and 92% respectively. This supports the PBP 2001 and previous findings of Ahern and Chladil, 1999 in regard to the adoption of 100m as the threshold distance beyond which no construction requirements are required and also justifies the 100m buffer zone width for mapping bushfire prone areas for forests and woodlands in NSW.
- The percentages of the ignited buildings which are attacked by the fires approaching from South West and North West are 52.0% and 40.7% respectively being more than 92% together (See Figure 10). This indicates that aspect may have an effect on the building ignition in the event of bushfire. The extent of this effect may be significant but requires further investigation and statistical analysis to confirm this.
- The percentages of the ignited buildings which take the positions of *Ridge/plateau* and *Top of 1/3 Slope* are 48.3% and 27.0% respectively being more than 75% together (See Figure 11). This finding further confirms the established view that the buildings sited at such positions are subject to high level of bushfire attack.

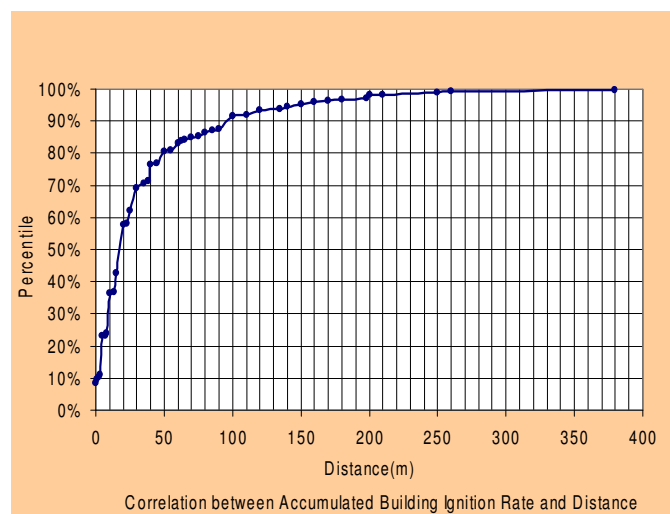


Figure 9. Correlation between percentage of ignition and distance

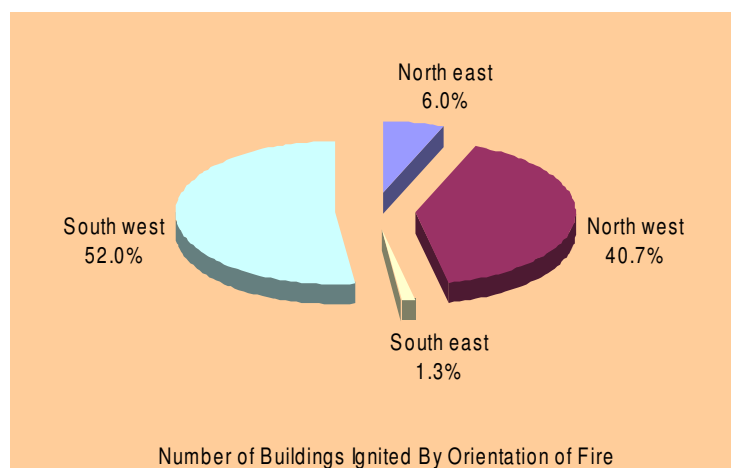


Figure 10. Number of buildings by orientation of fire

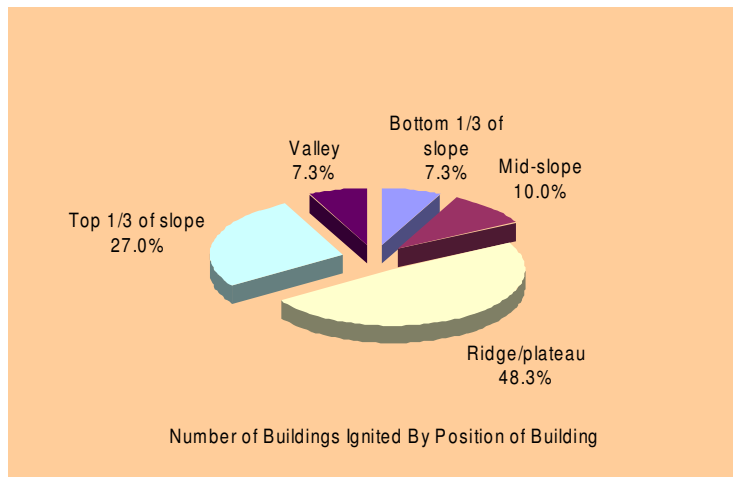


Figure 11. Number of buildings ignited by position of building

Conclusions

The development of a computer-based bushfire building survey system has been applied in NSW with the aim of improving data collection and analysis. The system is able to take the advantages of modern technological tools such as GPS, GIS and database technologies for collecting, storing, reporting and analysing the bushfire building damage information. This allows the survey to be conducted more accurately and more efficiently.

A preliminary analysis of the survey data currently stored in the NSW RFS survey database supports the principles adopted by Ahern and Chladil (1999) in regard to the adoption of 100m as the threshold distance beyond which no construction requirements are required and also justify the 100m buffer zone width in PBP 2001 for mapping bushfire prone areas for forests and woodlands in NSW.

The preliminary results also suggest that the position of a building may have a significant effect on its survival in the events of bushfires. The extent of aspect requires further investigation with more data to determine the significance of this factor.

Future Work

The NSW RFS is examining the upgrade of the database to further enhance the usability and the off-site reporting and analysis capacity aspects of the database.

The NSW RFS is further refining its suite of Standard Operation Procedures to administer the whole survey process and intends to conduct further in-depth analysis of the existing survey data to establish or verify the mechanisms of bushfire attack and the effects of aspect.

References

Ahern, A and Chladil, M (1999) *How far do bushfires penetrate into urban areas?* Pp 9-18 In: Lord B. (ed) *Bushfire 99. Proceedings of the Australian Bushfire Conference*, Albury, Australia, July 1999. Charles Sturt University, Albury.

Leonard, J.E., and McArthur, N.A. (1999) *A history of research into building performance in Australian Bushfires*. In Lord B. (ed) *Bushfire 99. Proceedings of the Australian Bushfire Conference*, Albury, Australia, July 1999. Charles Sturt University, Albury.

NSW Rural Fire Service (2001) *Planning for Bushfire Protection 2001*. Sydney.

Ramsay G.C., McArthur, N.A., and Dowling, V.P. (1996) *Building in a fire-prone environment: research on building survival in two major bushfires*. *Proceedings of the Linnean Society of New South Wales* 116:133-140.