# Conceptualising the Outcomes of Community Safety Programs for Natural Hazards in Australia

## Developing Program Theory Using Structured Concept Mapping

*Gerald Elsworth, Royal Melbourne Institute of Technology, Victoria, Australia, Bushfire CRC*
*Karl Anthony-Harvey-Beavis, Royal Melbourne Institute of Technology, Bushfire CRC*
*Alan Rhodes, Country Fire Authority, Royal Melbourne Institute of Technology, Bushfire CRC*

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## Introduction

In recent years major fires have taken a heavy toll on communities around Australia. Recent inquires into major fires and reviews of fire prevention have addressed a common set of themes relating to improved community safety (Auditor General Victoria 2003; Esplin, Gill et al. 2003; Mcleod 2003; Ellis, Kanowski et al. 2004). Fire agencies across Australia have generally acknowledged that when a major bushfire occurs they do not have the resources to defend every home that may be in danger. In the past decade there has been a shift amongst emergency management organisations to acknowledge that reducing the risk from natural hazards, such as fire, will be enhanced by the level of community preparedness and the ability of the community to respond effectively. Many emergency management organisations, including fire services have adopted a risk management approach with greater emphasis on prevention, mitigation and community preparedness (Smith, Nicholson et al. 1996).

A key element of this 'paradigm' shift has been a focus on involving communities in partnerships with emergency services organisations to deal more effectively with risks. In this new paradigm, a safe community has been defined as, "locally organised and resourced, well informed about local risks, proactive in prevention, risk averse, motivated and able to manage the majority of local issues through effective planning and action" (Hodges, 1999, p.2). The notion of community self-reliance is often used to encapsulate these ideas. More traditional approaches to dealing with bushfire risk such as regulations and restrictions on the use of fire, fire prevention planning, land use planning, building codes and standards, and prescribed burning are also used as part of a comprehensive and integrated suite of methods of dealing with the bushfire risk.

Increasingly, organisations are seeking ways to engage more effectively with communities to both promote greater understanding by providing information, but also to increase community involvement in the issues through consultation, and by enabling communities to share in decision making on these issues. Fire services and land management agencies now frequently advocate the importance of partnerships with other organisations, and with the community, in order to achieve common goals.

At present there is little understanding of how effective this 'community safety' approach and the associated programs are, and, if indeed they are effective, for which households and communities and in what particular settings they work best, and how. This paper describes the first step in a research program[1] designed to develop a comprehensive framework and methodology for evaluating the broad range of community safety programs from a theory and evidence-based perspective (Lipsey 1993; Kazi and Spurling 2000; Kazi and Rostila 2002; Pawson 2003; McGuire 2005). Concept mapping was used to identify the range of potential outcomes for community safety programs and provide a starting point for the development of a program logic model and a more elaborated program theory.

[1] The research program is funded by the Commonwealth of Australia together with Australian fire and emergency services agencies through the Bushfire Cooperative Research Centre (http://www.bushfirecrc.com)

## Concept Mapping

The term 'concept mapping' can be applied to any process that allows a diagrammatic representation of the way an individual or group thinks about the content and relationships associated with a specific object, idea or issue. The particular method of concept mapping used during the current research is based on the work of William M. K. Trochim and used his computer program, the *Concept System*. This methodology is particularly suited to work with groups of participants to develop a conceptual framework as a guide for program planning and/or evaluation (Trochim and Linton 1986; Trochim 1989; Trochim 1989).[2]

*Participants*

Fire agency personnel and community members took part in eleven concept mapping workshops. Table 1 shows the location and number of participants from each group.

**Table 1: Distribution of participants across the 11 Concept Mapping workshops**

| | Community Group | Bushfire Agency |
|---|---|---|
| New South Wales | 2 workshops – 6, 7 participants | 2 workshops – 5, 6 participants |
| South Australia | 1 workshop – 10 participants | 1 workshop – 12 participants |
| Tasmania | 1 workshop – 8 participants | 1 workshop – 7 participants |
| Victoria | 1 workshop – 10 participants | 1 workshop – 9 participants |
| Western Australia | - | 1 workshop – 6 participants |

*Method*

As an initial step, participants were asked to brainstorm ideas in response to the statement:

> *'Thinking as broadly as possible, generate statements that describe specific changes or improvements you think need to be achieved to make households and neighbourhoods safer from bushfires'.*

The brainstormed statements were printed onto individual paper slips and returned to participants. Each person was then asked to sort the statements into piles that '*made sense to them'*. Participants were free to sort the statements in any way they chose, with the following restrictions: (a) More than one pile should be used; (b) the number of piles should be less than the number of statements; (c) there should not be a 'miscellaneous' pile; and (d) statements that cannot be sorted into a pile should be placed singly, in their own pile. Participants were also asked to rate each statement on two five-point scales according to the *importance* of achieving the change or improvement and the perceived *difficulty* in implementing it.

During a break in the proceedings, a two-stage, computer assisted analysis was done using the sorted statements. The first step involved the use of multi-dimensional scaling (MDS) to array the statements in two-dimensional space according to the degree of similarity between each statement. This procedure resulted in a two-dimensional 'point-map' on which each statement was represented as a single point on the map and where the closeness (proximity) of two points was a measure of the similarity (common meaning) of the statements as perceived by the group as a whole.

Following the creation of the point-map, a further procedure known as Hierarchical Cluster Analysis (Ward's method) was carried out. The Hierarchical Cluster Analysis involved the grouping of the two

[2] The concept mapping workshops were facilitated by Roy Batterham, Plexus Consulting, Melbourne. Version 1 of the *Concept System* program was used for the workshops.

closest, individual points into a single cluster; this was repeated until the number of clusters equalled approximately one-fifth the number of statements (the default for the particular program that was being used). The clustering results can be portrayed by a structured listing of the brainstormed statements or as a two-dimensional map (the Cluster Map) where the point-map can be overlayed by lines that mark the cluster borders.

During the final stage of each concept mapping workshop the participants were presented with copies of the Point Map, the Cluster Map and a list showing which statements made up each cluster. They were then asked to name each cluster and suggest any alterations they felt would be appropriate. Finally, participants were encouraged to add their interpretations to the map and to note anything that they felt was missing from the final concept map.

*Post Workshop Analysis*

The lists and maps generated during the workshops were very useful in providing feedback to participants and for eliciting their interpretation of the structure in the statements generated. However, the statistical analysis available in the *Concept System* program is quite limited (in particular, the MDS solution is restricted to two dimensions where, frequently, a three-dimensional solution may be necessary to represent adequately the complexities in structure in the data). In order to achieve a more precise statistical representation of the results, data from the workshops were re-analysed using the specialised cluster analysis and MDS program *Clustan Graphics* (Wishart, 2004).

Comparisons of the results obtained in the concept mapping workshops with a three-dimensional MDS solution using *Clustan Graphics* showed the three-dimensional solution typically yielded a more detailed and precise representation although there was always considerable congruence between the two solutions. For this reason all workshop results were re-analysed using *Clustan Graphics*. Firstly a three-dimensional MDS solution was calculated. Then the statements, arrayed along these three dimensions, were analysed by hierarchical cluster analysis (Ward's method) and the optimal ('best-cut') number of clusters suggested by the program was selected as the starting-point for interpretation. This cluster number was sometimes modified in order to locate the solution that provided the most interpretable separation of clusters and coincided best with the workshop solution agreed by participants.

The primary result of this analysis was a series of three two-dimensional scatter-plots on which the cluster solution (identified by differently coloured points) was arrayed across Dimensions 1 and 2, Dimensions 1 and 3 and Dimensions 2 and 3. These three plots are analogous to the single Cluster Map provided by the Concept System program. Each member of the research team independently examined each of the new cluster maps, naming both the axes and the clusters.[3] A final consensus on the best representation of the results of each workshop was reached in a series of group meetings following this individual work.

*Synthesis of Results across the 11 Workshops*

Following the re-analysis of the data using *Clustan Graphics* a further meeting of the research team was conducted to achieve a synthesis of the concepts developed in the community and agency concept mapping workshops. The synthesis was achieved using a process that could be described as a qualitative version of Ward's method. For the meeting, cluster names were written on A4 sheets of paper and displayed on the meeting room walls. The group started off by pairing the cluster names that were most similar in meaning, justifying each pairing as it was suggested, and referring back to the detailed content of the clusters where necessary. After a small number of pairs was established, the group worked in an hierarchical fashion, adding cluster names to already established pairs. When all

[3] The team involved in this step comprised Karl Anthony-Harvey-Beavis, Gerald Elsworth, John Gilbert, Helen Goodman, Sandra Nolte and Alan Rhodes

individual cluster names had been included in a synthesized group, each was named and a final revision was undertaken. This procedure yielded 14 general concepts that are outlined below.

**Results**

As an example of some of the results generated in each individual workshop, Table 2 shows a typical list of concepts developed by one of the community group workshops and Figure 1 shows a cluster map from the same workshop generated by the *Concept System* program. Seven clusters of statements were identified and named by the workshop participants. During the final discussion, the group also identified two broad regions of their concept map (*Education, Information and Advice*; *Preparation of Your Household and Neighbouring Households*), suggested that Clusters 5, 7 and 6 were causally related to Clusters 2, 3 and 4, and noted that the workshop process had not suggested any specific implementation strategies that might be used to achieve the outcomes identified in the map.

**Table 2: A Typical List of Statements Generated by a Workshop Group**

| | |
|---|---|
| 1. | Effective communication at times of a fire or a high fire risk (eg radio) |
| 2. | Local groups that can check individual household preparation and encourage proper preparation (eg at a street level) |
| 3. | Local resource people who can provide advice to others on practical things they can do to be better prepared |
| 4. | Community are educated to understand the BENEFITS of being fire safe |
| 5. | People understand the impact that not being fire-safe can have on them and the community |
| 6. | People at local (eg street) level receive advice and support from fire services about how to make their properties as safe as possible |
| 7. | People need to be clear about whether they will stay or go based on a realistic understanding of their own circumstances and capacity |
| 8. | People are provided with clear information about things they need to consider in deciding to stay or go |
| 9. | Households have appropriate fire and evacuation plans |
| 10. | Households that have decided to stay need a readily available list of things they need to do in case of a fire |
| 11. | People need to know safe places to go to in case they need to evacuate |
| 12. | People need to see how quickly things they do wrong can lead to devastating results (eg through graphic TV ads) |
| 13. | People need to understand the circumstances under which they can be directed to leave their property and by whom |
| 14. | People have an independent water supply and means of pumping water if there is a power failure |
| 15. | People clear rubbish, leaves etc from their property |
| 16. | Where guidelines are issued to household they need to be appropriately specific about exactly what they need to do (eg pumps) |
| 17. | People should be able to get an assessment of their property and situation, and get recommendations specific to them |
| 18. | Councils provide information about importance of cleaning up when they inform residents of their collection services |
| 19. | Local brigades and planning bodies can help residents access the tradespeople and services they need in order to be properly prepared ('a one-stop-shop') |
| 20. | Needs to be a register of people who have special needs in case of a fire (eg elderly, disabled) |
| 21. | Residents know about people with special needs in their street/locality (eg elderly, disabled) |
| 22. | Adequate fuel reduction in ALL properties in a street |
| 23. | People know about the rural fire service website and are able to use it (and the website is kept active and up to date) |
| 24. | Communication during a crisis needs to be less haphazard and more locally precise (eg using local radio) |
| 25. | Need to have efficient ways for communities to provide information about fire behaviour to the fire services |
| 26. | Better two-way communication during a fire |
| 27. | In the case of a fire residents need to feel that lines of communication within the fire services are effective (and not blocked by internal squabbles) |
| 28. | Need means of contacting owners of holiday properties to notify them of needs regarding clean-up and preparation |
| 29. | People are provided with education in their own setting (eg street meetings) |
| 30. | Better understanding of what neighbours have for fighting fires |
| 31. | People maintain all the equipment that they need for fire protection |
| 32. | People maintain all the equipment that they need for fire protection |
| 33. | Agencies provide positive education (benefits of being fire safe) rather than negative education (don't do this) |
| 34. | 1. Information/education needs to focus on practical issues that people may not know |

*Figure 1 about here*

Reanalysis of the card-sort results using a three-dimensional MDS solution in *Clustan Graphics* also yielded seven-clusters that were, however, somewhat differently characterised by the research team. The reanalysis revealed a slightly different grouping, with a new cluster concerned with householders with special needs emerging, as well as two clusters relating to educational activities essentially merging into one named *Community Education to Improve Individuals Understanding and Knowledge*. This process of reanalysis and comparison with the original cluster solution was followed for all eleven workshops.

Synthesis of the *Clustan Graphics* results from the 11 workshops yielded 14 general concepts. Twelve were derived from the results of both community and agency workshops while two were derived from community workshops only and one from agency workshops only. Thirteen of the 14 general concepts were derived from the results of more than one workshop. The 14 concepts together with a summary of their content are listed in Table 3.

## From the Concept Mapping Results to a Generic Program Theory

A common criticism of program logic models is that they are merely *ad hoc* representations of linkages between program activities and presumed outcomes. Thus, for example, Chen (1990) described a program logic as "…simply a series of ad hoc logical premises about how the program elements fit together". Additionally, a frequent criticism is that many program logics are merely extended 'black-box' models, linking 'inputs' to presumed 'outputs' and 'outcomes' in a linear chain with little or no information about the processes that might be thought to bring about the apparent linkages (it should be noted, however, that Funnell's (1997; Funnell 2000) program logic matrix is a notable exception). That is to say, many logic models simply obfuscate the very problem the idea of a program logic model or theory was meant to address.

Leeuw (2003) suggested that one general way to reconstruct program theories was to use one of a variety of approaches to generating 'mental models' or 'cognitive maps' of program processes and outcomes. A small number of recent studies discuss the possible use of structured concept mapping as the source of these 'mental models' in the development of program logic models or program theories (Yampolskaya, Nesman et al. 2004; Rosas 2005; Anderson, Gwaltney et al. 2006). Yampolskayo et al. provide the most extensive account of the method used in generating a program logic model from a concept map in their study of a (US) state-wide community-based agency providing mental health services for children with multiple needs. They describe an iterative three-step process in which: (a) The evaluation team filled out a pro forma logic model diagram using concept mapping results; (b) this model diagram was reviewed in a discussion with program staff (who had previously generated the concept map) and some minor modifications were made; and (c) a final review by the evaluation team was undertaken and the result checked with program staff. A central element of the resulting logic model is a set of four 'categories of service' and lists of associated activities that are directly based on the results of the brain-storming and clustering components of the concept mapping workshop. The service activities are subsequently subsumed under two general 'strategy' dimensions ('assessing conditions' – 'changing conditions'; 'individual activities' – 'team activities') derived from an examination and naming of the apparent axes of the two-dimensional point map.

One evident strength of the 'mental models' approach to program logic development, seen clearly in the Yampolskavo et al. study, is that the implicit theories held by practitioners provide a potentially rich source of ideas and hypotheses about program processes and mechanisms and the ways these might usefully be classified and linked. As the present study yielded multiple concept maps that were subsequently consolidated into a single list of constructs by the project team, an approach to program logic development was evolved that did not necessitate (at this stage) further work with the community and agency groups who provided the initial concept mapping data. Additionally, an attempt was made

to represent the nature of the causal processes implicit in the arrows linking the concepts in the logic model by seeking to identify the most appropriate linking word (or phrase) for selected pairs of concepts. In this way at attempt was made to move beyond a simple 'boxes-and-arrows' logic model towards a more elaborated program theory. Linking words are a critical feature of freehand concept maps (Novak and Gowin 1984; Novak Undated) but aside from the inventive application to a hospice program by McClintock (McClintock 1990; Greene and McClintock 1991) they appear to have been rarely (if ever) used in program logic models in the evaluation literature.

**Table 3: Synthesised Concept Names and Descriptions**

| Concept # | Concept Name | Concept Description |
|---|---|---|
| 1 | Agency/Community Interaction | The flow of information between agencies and the public, before an incident occurs, with the aim of increasing resident awareness of the risks posed by bushfire as well as encouraging preparation to mitigate those risks. |
| 2 | Household/Neighbourhood Planning & Preparation | The formulation of a plan that outlines an appropriate response to a bushfire and preparation that enables the chosen plan to be implemented. |
| 3 | Deciding & Planning for 'Stay or Go' | Understanding of the issues surrounding the 'Stay or Go' message as well as making decisions about what individuals or households will do when threatened by bushfire, based on accurate information. |
| 4 | Use of Incentives to Achieve Preparedness | The use of incentives to encourage preparedness or, conversely, the use of penalties to discourage inappropriate or risky behaviour. |
| 5 | Understanding/Application of Regulations for Bushfire Safety | The need for appropriate legislation to be put in place and enforced as well as ensuring community members and local governments understand why those laws are necessary. |
| 6 | Policy Framework for Agency & Organisational Roles | Ensuring the fire agencies implement appropriate policies and procedures to support community safety initiatives. |
| 7 | Principles Underpinning Program Development & Adult Learning | The importance of creating an environment conducive to effective learning by adults/ |
| 8 | Individuals/Community have a Realistic Understanding of Risk | The focus of the statements in this cluster is on the importance of community members understanding the range of factors that influence risk. |
| 9 | Appropriate Information/Education Activities | The provision of education, to a range of groups and using a number of different methods. |
| 10 | Greater Community Ownership & Responsibility for Bushfire Safety | The statements in this cluster are about community members taking increased responsibility for their own safety, planning for themselves and the communities they belong to. |
| 11 | Agency/Inter-Agency Responsibilities & Co-ordination | Within cluster 11 the researchers have identified two related, yet distinct concepts. The first relates to agency responsibilities for the community. The second relates to the intra-agency relationship between the operational branches of an agency and those concerned with community safety initiatives. |
| 12 | Effective Communication of Information during Bushfire | The majority of statements in this cluster are concerned with the way in which fire agencies deliver information to community members during a bushfire. Another element expressed in cluster 12 is that to improve community safety from bushfire, systems need to be implemented that enable community members to communicate information to fire agencies, making use of local knowledge. |
| 13 | Neighbourhood & Community Networks & Partnerships | The majority of people are, in some way part of community networks. These networks will influence the capacity of communities to self-organise, and to work effectively with fire agencies, and other authorities. The networks will also influence community resilience and sustainability of community safety efforts. |
| 14 | Community & Agency Responsibilities to Address Specific Needs | Statements in this cluster are related to very specific, local issues, offering practical solutions to identified problems. |

A feature of the 14 generic 'community safety' concept clusters that became clearly evident during their development from the results of the individual concept mapping workshops by the project team was that the concepts extended across at least three 'levels' of desired change: (a) Individual and household; (b) community and local bushfire agency; (c) central agency and policy institution. These three structural 'levels', together with the elements of a typical context/input/process/outcomes model, were initially used to form a two-dimensional matrix and the 14 generic concepts were sorted into the matrix cells. Next, using the elements of an extended outcomes hierarchy (context, strategies, outputs, outcomes) together with any 'causal arrows' in the workshop maps to suggest the possible causal direction, pairs of concepts that potentially represented strong proximal (and more distal) links were selected by one member of the project team. Linking words or phrases that appeared best to represent the nature of the causal relationship were then identified by searching the content of the statements that were encompassed by the two generic concepts for which the link was required. These suggestions were subsequently reviewed by other members of the research team and a consensus was sought. The precise meaning of the link was then checked against the definitions and synonyms provided by the on-line lexical reference system WordNet (Fellbaum 1998). The most appropriate synonym provided by this system was then chosen to represent the link. Finally, the resulting logic model (Figure 2) was reviewed by all members of the project team.

One particular use of this kind of generic program logic model is, we believe, worth highlighting. At present, the project team is working on the application of a theory-based approach to evaluating community safety for bushfire in relation to three broad kinds of initiative: (a) Community education programs; (b) community development programs that might utilise, or alternatively seek to develop, existing community infrastructure and strengths; and (c) regulatory initiatives, frequently requiring inter-agency partnerships. A generic logic model can be used as a starting point for conjecturing about the more detailed theory that might underpin each of these three types of initiative, and about a theory for specific examples within each type. Figure 3 shows a portion of the generic model that might usefully form a starting point for development of a logic model for community education programs for bushfire. Using the language developed by Tilley (2004) to distinguish the intended (STD - "Supposed to Do") from the unintended (OAD – "Otherwise/Also Does") outcomes of a program, the STD causal pathway for a community education program is contrasted against one possible OAD pathway where the desired distal outcome of *Enhanced Community Safety From Bushfire* is potentially achieved by an increased householder understanding of regulatory interventions (e.g. prescribed burning, fire-ban days) associated with bushfire safety in addition to (or instead of) the modelled community education intervention. In addition, identification of short-term outcomes along with words that link them, on the one hand, with enabling strategies and, on the other, with more distal outcomes creates a model of a causal sequence that has many of the characteristics of a 'Context-Mechanism-Outcome' configuration (Pawson and Tilley 1997) where the short-term outcome is identifiable as the 'Mechanism'. Thus, for example, the model suggests that *Principals Underpinning Program Development and Adult Learning (Context)* "Inform the development of" *Appropriate Information/Education Activities (Strategy)* that, in turn "Help individuals achieve" *A Realistic Understanding of Risk (Mechanism)* that, again in turn, "Activates" *Deciding and Planning for Stay or Go (Outcome).*

*Figures 2 and 3 about here*

## Conclusion

Fourteen generic clusters of community safety outcomes were generated by the synthesis of multiple concept maps. Mapping the clusters across three structural 'levels' and arranging them into a tentative causal sequence with linking words and phrases suggests a basic causal structure that encourages interpretation from a realist theoretical perspective (Pawson and Tilley 1997, Tilley 2004). It provides a basis from which to identify community safety outcomes, the logic of the relationships between outcomes in the community safety approach, the ways in which possible mechanisms may operate to bring about these outcomes, and some of the conditions necessary to achieve such outcomes.

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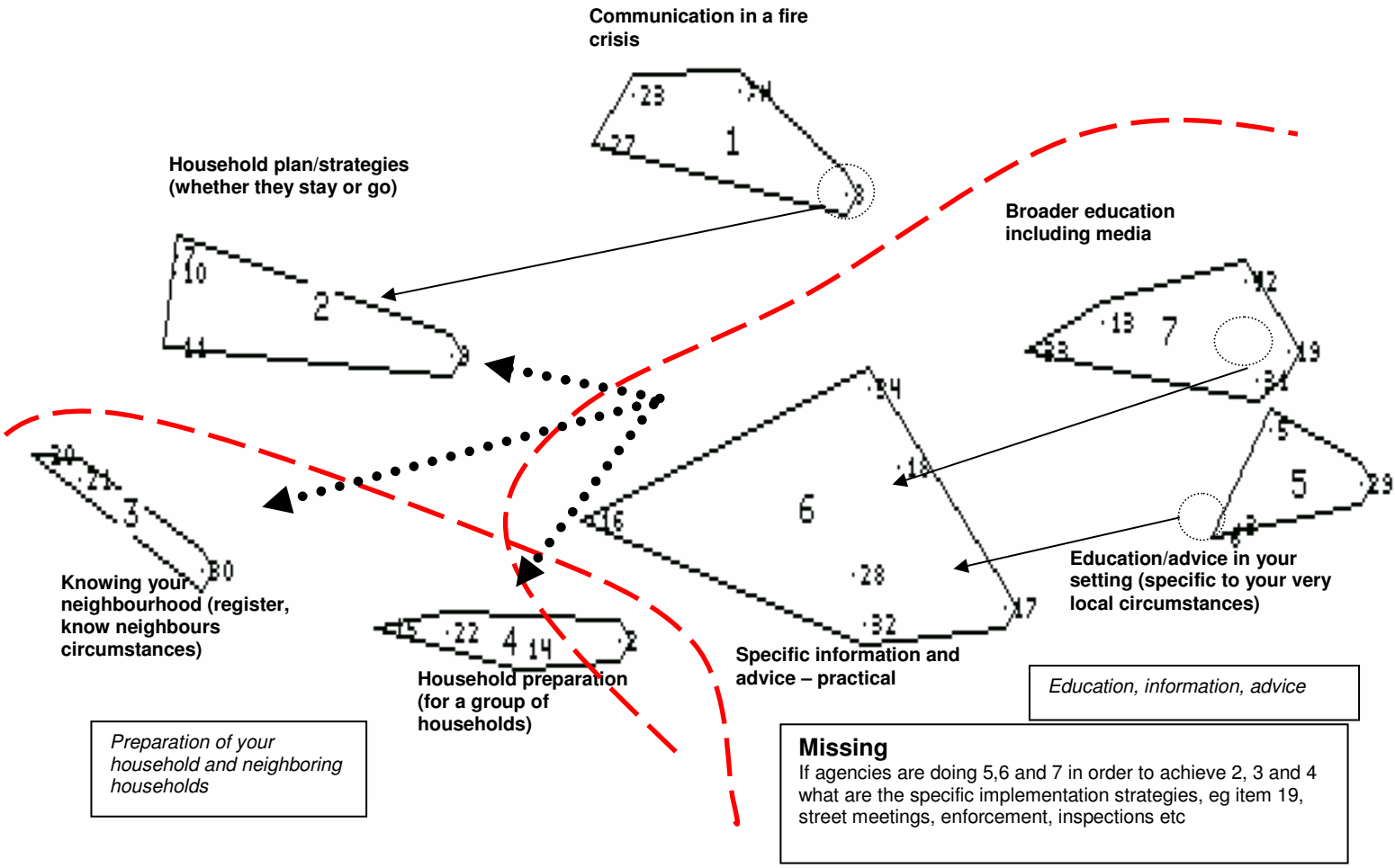
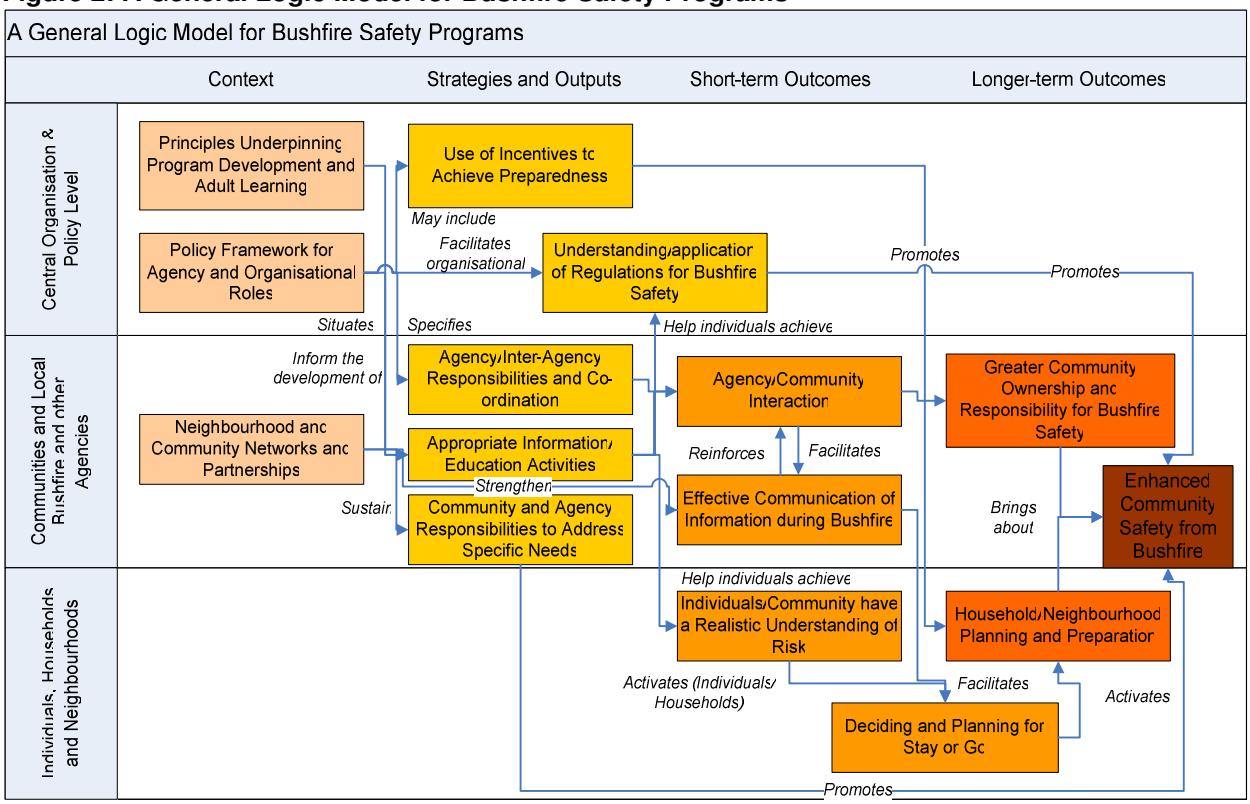
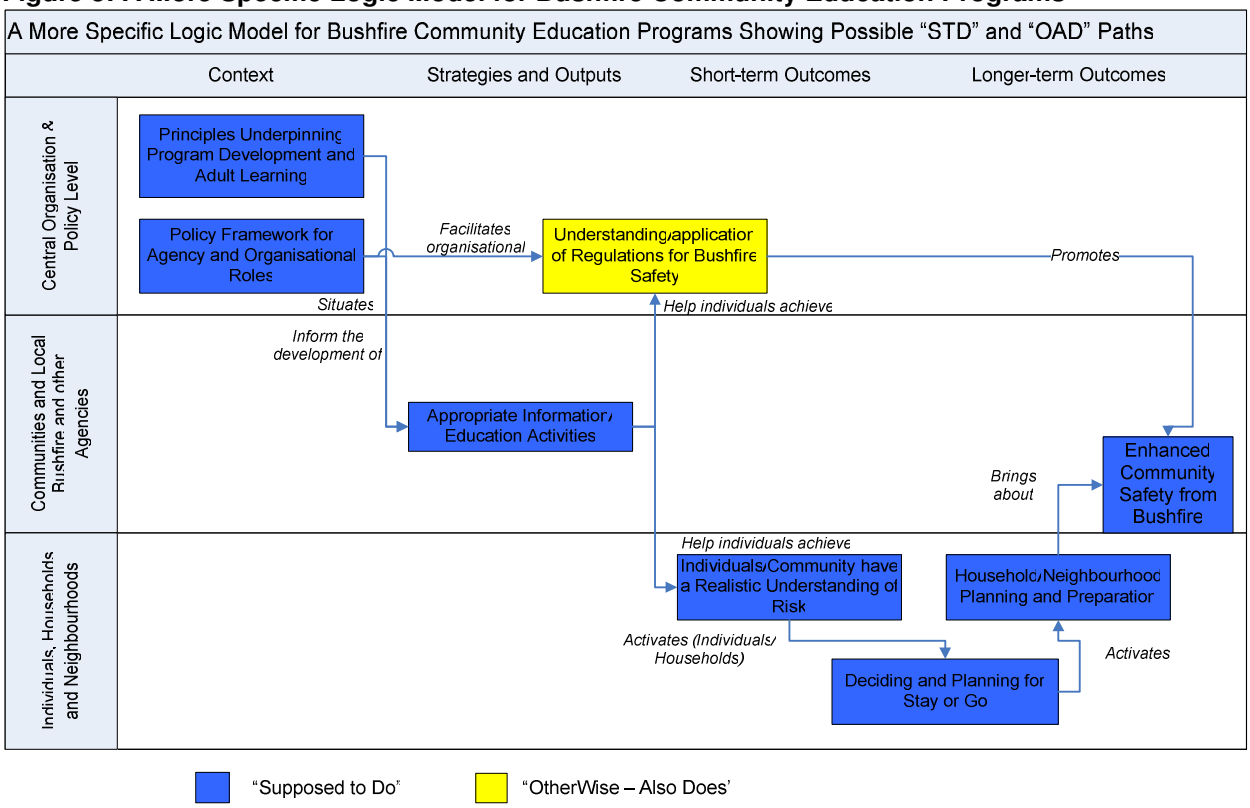
**Figure1: Cluster Map Generated During a Concept Mapping Workshop with a Community Group**



## Figure 2: A General Logic Model for Bushfire Safety Programs




## Figure 3: A More Specific Logic Model for Bushfire Community Education Programs