Measuring and monitoring resilience in Auckland

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Auckland Region CDEM Group

Measuring and Monitoring Resilience

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1. EXECUTIVE SUMMARY

Recognition that some people and groups adapt better than others to the loss and destruction associated with disaster has stimulated a need to develop this resilient capability. To do so, emergency planners must be able to identify the individual and community characteristics that predict resilience. The goal of this project was to identify from the large number and diversity of factors that could be implicated, a parsimonious and cost-effective resilience model.

A generic model that comprised personal, community and institutional indicators was proposed. A generic model was selected to accommodate the social and hazard diversity that underpins Auckland's complex natural hazard risk context.

A volcanic scenario was selected to ensure that the risk is evenly distributed amongst all Auckland residents. This is a prerequisite for the development of a model capable of providing Regional applicability.

The variables selected had all demonstrated a capacity to predict an ability to adapt. This project represents the first time that their collective role has been systematically examined. The assessment of their collective role is essential if the model is to be used to assess this complex social phenomenon. Data were collected using a telephone survey of 400 residents.

Analysis was complicated by the survey company's unauthorized use of a "don't know" option in questions where this was inappropriate. While this resulted in the loss of 103 cases, the 297 cases available for model development far exceeded the minimum of 150 recommended for structural equation analysis. This method of analysis was selected as it is the most appropriate for developing a model of complex social phenomena that requires the integration of several factors from diverse populations.

While it was originally intended to use measures of general hazard preparedness, hazard and mitigation knowledge, and levels of community hazard planning, the levels of these factors were so low as to preclude their use in the analysis. For this reason, a measure of intention (to develop resilience resources) was used. Where levels of adoption of specific actions are low, intentions has been found to represent a valid predictor of future actions. On this basis, it was adopted as the measure of resilience for this work.

The structural equation modelling analysis produced a model that that comprised three person-level (action coping, positive outcome expectancy, negative outcome expectancy), two community-level (community participation, ability to articulate community problems), and two institution-level factors (empowerment, trust). The statistical characteristics of the model indicated that it represented a very good fit for the data.

The development of a reliable model means that it can be used as a decision support tool for emergency planners to assess current levels of resilience and to plan its development. The mean levels of each factor were assessed and used to describe current levels of resilience. Prevailing levels of predictor factors were generally present at moderate levels, indicating considerable scope for their development. These data can serve as baseline data for resilience monitoring and program evaluation. The level of each factor and its contribution to the model are described. Comparison of data across ethnicity and area of residence failed to reveal any major differences. Consequently, planning can proceed at a Regional level.

In addition to using the data on each factor to provide baseline data, a composite measure of the responses to all eight factors was compiled. This can be used as a composite resilience indicator. Using this indicator, in which resilience is assessed on a 1 – 10 scale, Auckland currently scores 5.53.

The analysis produced an evidence-based model that represents a cost-effective device that can be used to guide the development of community resilience, facilitate planning decisions regarding the allocation of limited resources, and provide an empirically validated set of key performance indicators for the assessment, monitoring and evaluation of resilience. This format provides a comprehensive basis for modelling community resilience and for integrating this model with subsequent work on societal-level (e.g., economic, business continuity) resilience.

The implications of the model for planning, risk communication and public education, and community development are discussed. The nature of the variable identified in the model and the fact that the data reflect peoples' experience of life in Auckland (rather than specific hazard experiences) supports the integration of emergency planning and community development as a framework for intervention planning and delivery. This approach is consistent with the recommendation that resilience intervention be devolved to community members, representatives of wards/community groups, and to agencies with responsibility for facilitating community development outcomes.

The major limitation of this approach, and one common to all work in resilience, is that the utility of the model can only guaranteed following analysis of responses to an actual disaster.

2. BACKGROUND

This project was commissioned in 2005 by the Auckland Region Civil Defence Emergency Management Group (CDEM Group) as part of a programme of work aimed at defining, understanding and measuring community resilience.

The CDEM Group is responsible for regional emergency management in the Auckland Region. The vision of the CDEM Group, as outlined in the CDEM Group's Plan is "*A resilient Auckland region*." In order to ensure that the CDEM Group's work programme was aligned to this vision and that progress could be measured, the CDEM Group established a programme of work aimed at defining a model of community resilience and establishing a set of indicators for measuring community resilience.

This research report describes the results of the first stage of the project, including the development and testing of a model of community resilience. Further work is underway to verify the resilience model described in this report and a second survey is planned for 2006.

While the focus of this project is on community resilience, other aspects of resilience (e.g. organisational; economic; infrastructural etc) are also of interest. Expansion of the current programme of work into these areas is planned for 2008.

2.1 Acknowledgements

This project has been financially supported by the Auckland Region Civil Defence Emergency Management Group, the NZ Ministry of Civil Defence Emergency Management and GNS Science (the latter through the publicly funded *Resilient New Zealand* programme).

The project team comprised:

Dean Myburgh and Andy Thomson (Manukau City Council), Bruce Parkes (St John), Jocelyn Peach (Waitemata District Health Board), Greg Gallop and Sara Williams (Ministry of Civil Defence and Emergency Management), Jim Stephens (Auckland Region CDEM Group), Alison Reid (Auckland Regional Council), Douglas Paton (University of Tasmania) and Michele Daly (Kestrel Group Ltd).

The surveying was undertaken by Phoenix Research, Auckland, NZ.

3. INTRODUCTION TO RESILIENCE

3.1 Objectives of research

While loss and destruction are the outcomes most commonly associated with disaster, it is becoming increasingly clear that some people and groups appear to adapt to these circumstances better than others. These observations provided the foundation for the growing emphasis on resilience in emergency management. If this construct is to be utilized effectively by emergency planners, they need to be able to identify the individual and community characteristics that predict resilience. Given the potentially large number of factors that could be implicated in this context, the development of a cost effective approach to this task requires identifying those factors that provide the most parsimonious and cost-effective approach to modelling resilience. The overall goal of this project is to identify these factors and their inter-relationships to develop a cohesive model of community resilience.

The objective of this project is to produce a model that can:

- guide the development of community capacity (resilience) to adapt to and develop from exposure to natural hazard consequences in Auckland,
- assist the formulation of practical intervention strategies,
- facilitate the development of planning initiatives by supporting resource allocation strategies (e.g., to direct resources to areas/groups within the community according to need), and
- provide an empirically validated set of key performance indicators for the assessment, monitoring and evaluation of resilience at different levels of analysis (e.g., district, regional) and for different demographic groups.

This report describes the process of model development and testing. It commences with an introduction to the concept of natural hazard resilience. This introduction is used to provide a rationale for the development of a generic model of resilience that integrates at individual, community and institutional (societal) levels. It then describes the analyses used to construct the model. The report concludes with a discussion of the model, its characteristics, and its implications for emergency planning.

3.2 Resilience

A long history of development in locations which has increased societal susceptibility to experiencing adverse impacts from interaction with natural processes, such as volcanic, wildfire, storm, flooding, tsunami and seismic events, has stimulated interest in understanding how to manage the associated risk. This is no easy task. Objectively, societal risk from natural hazards is constantly increasing.

Even if the probability and intensity of hazard activity remain constant, continuing population growth and economic and infrastructure development results in a concomitant increase in the potential magnitude and significance of loss and disruption associated with hazard activity, and consequently, risk. This project discusses an approach to managing risk by influencing the consequences of hazard exposure through the proactive development of community members' capacity to cope with and adapt to the consequences of hazard activity.

Because, in cities such as Auckland, much economic, infrastructure and social development has already occurred in areas that are susceptible to disruption and loss from hazard activity, identifying the characteristics of sustainable, resilient communities becomes particularly important. In Auckland, as is true elsewhere, decisions regarding the location of societal development reflects the association between geological and other natural processes and the resources and amenities (e.g., fertile soils, natural harbours, coastal scenery) they create for human populations. To fully realize the potential community and societal benefits that can accrue from development in these locations, planning must address how to minimize the costs that arise when natural processes interact with human settlement in ways that create loss and disruption. That is, when these natural processes become hazards.

Hazards impact on people, they affect communities, and they disrupt the community and societal mechanisms that serve to organize and sustain community capacities and functions. When hazard activity results in significant loss or disruption to established social processes, functions, activities and interactions it can be defined as a disaster. Disasters expose populations and social systems to demands and consequences that fall outside the usual realm of human and societal experience.

Extensive loss of or disruption to the physical and social environment and to administrative systems means that, in the absence of activities implemented specifically to develop a capability for continued functioning, normal routines will no longer be supported or maintained within an affected area. Under these circumstances, resilience is a function of the capacity of community members and societal institutions to respond in ways that allow them to confront and adapt to the demands they encounter using their own resources and competencies.

3.3 Resilience and Adaptive Capacity

This report presents the findings of a project whose objective was to identify the factors that facilitate community members' capacity to adapt to hazard consequences and to model their interaction in a manner that could assist emergency planning. That is, to identify the factors that makes societies and their members resilient. First, it is pertinent to consider what is meant by "resilient"?

The term resilience is often used in a manner that implies an ability to "bounce back." This reflects its derivation from its Latin root, 'resiliere', meaning "to jump back". It implies a capability to return to a previous state. This usage, however, captures neither the reality of disaster experience nor its full implications. Even if people wanted to return to a previous state, changes to the physical, social and psychological reality of societal life that emanate from hazard consequences can make this untenable. That is, the post-disaster reality that people and social systems will have to contend with, irrespective of whether it reflects the direct consequences of disaster or the recovery and rebuilding activities[1] undertaken, will present community members

[1] This argument reiterates Quarantelli's (1985) concept of response generated demand. Inadequate recovery planning can pose challenges to a community that are equal or greater than those associated with the disaster itself.

with a new reality that may differ in several fundamental ways from that prevailing pre-disaster. It is the changed reality (whether from the disaster itself or the societal response to it) that people must adapt to.

In this report resilience is defined in terms of how well people and societies can adapt to a changed reality. The definition of resilience used here embodies the notion of adaptive capacity (Klein, Nicholls & Thomalla, 2003). Because it can involve confronting a new reality, the notion of personal, community and societal growth is implicit in this conceptualization of resilience.

Resilience refers to the capacity of a community, its members and the systems that facilitate its normal activities to adapt in ways that maintain functional relationships in the presence of significant disturbances. This can facilitate the development and maintenance of community resilience and contribute to a societal capability to draw upon its own individual, collective and institutional resources and competencies to cope with, adapt to, and develop from the demands, challenges and changes encountered during and after disaster.

Achieving these outcomes requires a conscious effort on the part of people, communities and societal institutions to develop and maintain the resources and processes required and to ensure that it can be maintained over time. In particular, it is important to ensure that civic agencies and institutions with a role in emergency planning and community development nourish this capacity in community members.

While the work presented here focuses on resilience at the person/community level, the development of capacity at these levels is an essential prerequisite for the development of societal (Regional) resilience. For example, an important element of societal resilience is economic sustainability in the event of disaster. For this, a return to normal business and commercial activity is required as soon as possible. The capacity of people and communities to adapt and cope will influence the speed with which they will be available to participate in these activities and, therefore, to contribute to societal adaptation. Viewing resilience in this way provides an insight into the cost-benefit aspects of work of this nature. For example, the impact of resilience on reducing economic losses per day can be estimated. If resilience reduces this down-time from 10 days to 9 days, the benefits can be expressed as the economic gain associated with a faster return to productivity.

The model is designed to facilitate its integration with subsequent work on other aspects of societal resilience (e.g., business, economic). It is also important to recognize the reciprocal nature of the relationships between these levels. Societal resilience relies on people and communities being available, and the latter rely on institutions providing them with resources and knowledge in ways that empower their capacity to adapt and cope.

In this context, resilience can be defined as comprising four general components (Paton, 2000; Paton & Bishop, 1996). Firstly, communities, their members, businesses and societal institutions must possess the resources (e.g., household emergency plans, business continuity plans) required to ensure, as far as possible, their safety and the continuity of core functions during the period of disruption associated with hazards consequences (e.g., ground shaking, volcanic ash fall, flood inundation). Secondly, they must possess the competencies (e.g., action coping, community competence, trained staff, disaster management procedures) required to mobilize, organize and use these resources to confront the problems encountered and adapt to the reality created by hazard activity. Thirdly, the planning and development strategies used to facilitate resilience must include mechanisms designed to integrate the resources available at each level

to ensure the existence of a coherent societal capacity, and one capable of realizing the potential to capitalize on opportunities for change, growth and the enhancement of quality of life. Finally, the model of resilience, and the strategies implemented as a result of its adoption, must ensure the sustained availability of these resources and the competencies required to use them over time and against a background of hazard quiescence and changing community membership, needs, goals and functions.

3.4 Resilience as a Multi-Level Phenomenon

Because hazard activity affects people and communities and disrupts the community and societal mechanism that serve to organize and sustain community capacities and functions, understanding how interdependencies between people, their communities, and societal institutions and organizations influence adaptation becomes important. That is, it is necessary to describe resilience, or adaptive capacity, at several, interdependent, levels.

People bring key resources to the community that influences the capacity to confront adverse events. However, the depth and breadth of the competencies that becomes available through cooperative action represents a resource whose capacity exceeds the sum of its parts. Models of social resilience must thus encompass individual and collective levels of analysis. To fully understand resilience, it is also important to include the wider social context.

Contemporary communities and their members rarely have all the resources (including physical, financial and informational) they require to achieve their goals. Consequently, their capacity to confront challenges often requires that they can represent their views to the wider society and secure the resources they need to achieve the outcomes they desire. In providing these resources, resilience will be sustained only if societal institutions act towards communities in ways that empower them rather than imposing solutions upon them. Comprehensive models of resilience must accommodate this aspect of the relationships between communities and institutions.

Breaking adaptive capacity down into its personal, collective (community), and institutional (societal) levels allows resilience to be mapped onto the different adaptive pressures that arise as people and communities negotiate the challenges and demands encountered as the disaster evolves through its impact, response and recovery phases (Paton, 2006). That is, while resilience always refers to a capacity to adapt, what this means in practice will change over time as people interact with the different demands posed by each phase of the human response to the disaster.

During the immediate impact phase, survival is influenced by the level of protective measures that have been adopted. For example, failure to have ensured the structural integrity of a house and secured internal furnishings and fittings increases householders' risk of injury and death. Such protective actions not only directly influence peoples' survival, it also affects their availability to participate in subsequent response (e.g., assisting search and rescue) and recovery (e.g., getting back to work to minimize economic losses) efforts (Paton, 2006).

Adaptation immediately following the period of impact (the first three or so days and possibly considerably longer) is also a function of levels of readiness. During this time, people are isolated from external assistance and have limited, if any, access to normal societal resources and functions. Under these circumstances, the effectiveness of adaptive and coping efforts will be a function of prevailing levels of individual/household preparedness (e.g., household

emergency plans, stored food and water, heating source) and their capacity for self-reliance. Given that disaster can strike with no or very little warning, the foundation upon which adaptive capacity rests involves ensuring that the requisite knowledge and resources are organized in advance and can be used to good effect when disaster strikes (Paton et al., 2005).
Preparedness research has focused, usually for pragmatic reasons, on households. Irrespective of levels of household preparedness, it must be acknowledged that some or all household members spend only limited periods of time at home. To accommodate this, community preparedness has been conceptualized in ways that include workplaces, schools, and places where people spend time (e.g., shopping malls) (Lasker, 2004). As Lasker points out, such activities can facilitate more general levels of preparedness. For example, work-based programs can help instil the importance of preparing into the community consciousness and increase the likelihood of preparation in a range of contexts (Paton, 2006). This point reiterates the need to ensure 'community' representation in models of resilience.

Workplaces and schools represent contexts for developing problem-solving competencies and beliefs and in which discussion of hazard issues can be facilitated. This could be done, for example, through school projects that include family members and the wider community and as part of the business continuity planning process in workplaces. This identifies an issue that could be pursued in future work: identifying linkages between personal/community resilience and societal-level resilience.

As the impact phase subsides, people will have more opportunities to work with neighbours and other community members to confront local demands. At this stage, adaptive capacity will reflect the capacity of community members to work with others to plan and execute tasks. Fully realizing the benefits of this collective capacity to deal with local issues will be influenced by the degree to which emergency response agencies have developed procedures that empower community members' response (e.g., developing mechanisms for mobilizing and coordinating community volunteers to assist recovery efforts).

As the event progressively moves through the response phase, adaptive capacity will increasingly involve interaction between communities and societal-level institutions (e.g., health, welfare and metal health providers, businesses, emergency response). The quality of reciprocal relationships between communities and societal institutions will influence the quality of the community experience of recovery. It will also determine whether physical and social rebuilding (which may extend over several months or years) enhances the subsequent quality of community life and lays the foundations for future resilience.

If a comprehensive capacity to adapt (resilience) to natural hazard consequences is to be developed, resources at the personal, community and institutional (societal) levels must be present. Recognition of this need provides the basis for the development of a conceptual generic model of societal resilience.

3.5 Generic multi-level model of community resilience

3.5.1 Strengths of a generic model

If supported by analysis, a generic model allows for the use of an evidence-based approach to guide planning and intervention and provides city and regional planners with a common assessment framework to assess resilience, facilitate resource allocation decisions, and monitor change over time.

The need for a generic approach is directly proportional to the complexity of the risk environment in which a resilience model has to be applied. In this report, risk is defined in terms of the interaction between the likelihood of hazard occurrence and the consequences of occurrence. Managing risk, in this context, involves changing the consequences that can result when hazards interact with social systems by increasing resilience or adaptive capacity.

Auckland has a highly complex risk environment. This complexity reflects both hazard and population diversity. Auckland has a complex hazard-scape, with the consequences of different hazards being differentially distributed throughout the region. For example, volcanic hazard consequences have an uncertain distribution (e.g., difficulties identifying eruption locations during quiescent periods, the distribution of consequences such as ashfall, as a result of dynamic meteorological conditions, during eruptive episodes). In contrast, flooding and tsunami hazards have more restricted distributions (e.g., because their impact is more directly constrained by geography and topography). Further complexity is evident when the distribution of secondary consequences (e.g., infrastructure loss, economic, employment) that can result from hazard activity is taken into consideration.

Auckland is also characterized by considerable community diversity with regard to, for example, the age, gender and ethnic characteristics of the population. Furthermore, the distribution of the members of these groups is not evenly distributed throughout the city. Taken together, interaction between hazard and social (community diversity) characteristics creates a complex resilience planning environment. If a model that can demonstrate its reliability for all hazards and groups can be developed, it would provide the most cost-effective approach to resilience planning under these circumstances.

A generic model offers several benefits to planning. Foremost amongst these is the development of a framework for evidence-based practice that can be used to make comparable assessments of resilience throughout the region. Cost effective planning activities are expedited by the availability of a model that is capable of assessing resilience and guiding intervention and whose operation is independent of geography, location, or demographics.

A generic model would allow comparable assessments to be made across demographic groups and at different level (e.g., ward, territorial authority, geographic area, region). With a common assessment and planning framework at their disposal, territorial, city and regional planners would be able to compare and contrast groups and regions and combine data from different groups or areas to construct a composite regional assessment of resilience.

Comparability of this nature is essential for the effective management of risk through facilitating resilience, for managing the effective distribution of limited resources using a common assessment method to assist intervention planning, and for response and recovery planning. This includes, for example, making resource allocation decisions to groups or areas according to need, planning resource deployment based on differences in resilience to ensure that planning facilitates the cost effective allocation of response and recovery resources.

3.5.2 Limitations of a Generic Model

As a consequence of its generic nature, a limitation of this approach is that it does not prescribe the intervention required to secure change in each of the individual components of the model. That is, while the model identifies areas for intervention (e.g., predictors of resilience such as outcome expectancy, trust), it does not specify the content of intervention required to change

levels of a specific predictor. However, given the fact that Auckland's natural hazard risk reflects complex interactions between hazard and demographic characteristics that change from area to area and over time, it would not be feasible to develop intervention strategies that could be applied across Auckland.

Although the planning process can identify those predictors that should be targeted for intervention, the task of developing strategies to secure change in predictors is devolved to local levels. This limitation should be viewed in the context of Auckland's demographic and hazard diversity. The alternative, the development of models for each interaction between demographic groups and hazard consequences, would add considerable cost and complexity to the planning process and, for reasons introduced above, would still not guarantee the development of a set of prescriptive intervention guidelines that would be universally applicable.

When using the generic model, responsibility for translating model variables into practical intervention strategies falls to community members, representatives of wards/community groups, and to agencies with responsibility for facilitating community development outcomes[2].

The transfer of responsibility for intervention planning and delivery to communities and community agencies is consistent with the tenets of resilience. As such, it could make an important contribution to the development of resilience, its sustained availability, and increase the likelihood that strategies will meet the needs and expectations of specific communities. Fundamentally, a need to devolve authority to local levels derives from the complex patterns of interaction between the demographic and hazard characteristics and the fact that the nature of these interactions will differ from place to place and from one group to another.

Even though the goal is the same (e.g., increase positive outcome expectancy or community participation) groups can differ with respect to how they get there (e.g., differences in baseline levels of hazard knowledge or opportunities for participation), and intervention strategies must accommodate these unique characteristics. Devolving this responsibility increases the likelihood that intervention will be consistent with the needs, goals, expectations and competencies of each group or area. Local representatives are best placed to make these choices.

The transfer of responsibility for making choices about change to those closest to the issue can also contribute to more cost-effective use of emergency planning resources. As will become evident when the characteristics of the model are discussed, several components of the model provide opportunities to integrate hazard resilience and community development planning. By tapping into resources specifically developed to facilitate change in community-level factors (e.g., community participation), emergency planning resource can be developed in ways that complement this work and that can be directed to those areas that relate specifically to hazard issues (e.g., positive and negative outcome expectancy). The integration of emergency and community development planning and intervention can contribute to the sustained availability of community resilience.

A major limitation of any model of resilience is that its utility can only really be evaluated after people have been exposed to an actual disaster. To do so, it is necessary to have pre-event

[2] While specific recommendations on intervention strategies are not available at this stage, it should be noted that, should a decision be made to pursue the development of this model further, future work would include the systematic, qualitative analysis of the reasoning processes that underpin recorded responses to the model variables. This would go some way to providing additional structure to the intervention planning process, particularly concerning social change issues.

data that can then be used to asses the utility of model variables as predictors of resilience. Given the unpredictability of disasters, identifying populations in advance and collecting appropriate data from them is problematic and, as yet, this not be done.

It is possible to increase confidence in the utility of the components of the model by using variables have demonstrated an ability to predict adaptation during recovery (e.g., Paton et al., 2001). While their true predictive validity is not guaranteed (this can only be done if their influence can be assessed during disaster impact or during actual recovery), they have all demonstrated a capacity to account for differences in rates of adaptation during the post-disaster period. All the variables used in this project fell into this category.

To establish a capability to test the predictive utility of the model, it would be necessary to identify a sample that could be followed over time. This would allow pre- and post-event analyses to be conducted and the ability of the selected variables to predict adaptation examined.

4. METHODOLOGY

4.1 Scenario selection

The assessment of resilience must take place in a context in which the demands that people have to adapt to is known or can be estimated. To develop a model, the potential demands associated with hazards must, at the time of data collection, be the same for all participants. For this project, a volcanic scenario was selected to provide this context.

The inherent uncertainty regarding the timing, location of future eruption episodes and distribution of volcanic hazard consequences, and the possibility for multiple events to occur at the same time in different locations makes a volcanic scenario an appropriate one in which to assess natural hazard resilience in Auckland. The widespread distribution of risk associated with volcanic hazards means that, during periods of hazard quiescence, risk is comparable for all residents irrespective of their specific location. This is an important caveat when developing models of resilience. Equality in risk requires comparable levels of adaptive capacity in all citizens of Auckland. This makes the differences between responses more meaningful and interpretable within a model. It is not possible to develop a generic model if participants can reason (e.g., on grounds of their geographic position) that they are not at risk from the action of a particular hazard. For example, the restricted distribution of flooding and tsunami hazards creates more finite distributions of risk. They are, therefore, less appropriate for model development. Furthermore, volcanic hazards present a more diverse set of consequences (e.g., direct and indirect effects of ash etc) and mitigation options (e.g., secure home from ash inundation, vehicle maintenance etc) that people need to know about. For these reasons, a volcanic scenario was selected. It represents the most suitable of Auckland's hazards for work on developing a model of natural hazard resilience that has regional applicability.

4.2 Variable selection

If the factors that influence adaptive capacity are understood, communities and emergency management planners will be in a better position to make informed choices regarding risk status. With this information, they are in a position to make choices about the characteristics of their communities, the relationships that exist between their members, and about the relationship between the community and the wider society. Furthermore, by being able to map

the distribution of risk between areas or groups, decisions regarding the distribution of resources to support readiness, response and recovery planning (e.g., allocating resources to those with low resilience) can be supported.

The criterion for selection was evidence that a measure had demonstrated a capacity to predict resilience to hazards. Where possible, variables that had been used with New Zealand populations (Paton, 2002; Paton et al., 2001; Paton et al., 2005) were selected. These selection criteria were adopted to increase the practical applicability of the model.

When dealing with complex social phenomena, it is not the variables per se that inform understanding, but how they relate to one another. The collective role of the variables selected for this study in predicting resilience has not been systematically examined before. A core objective of this project was to test their collective role and develop them into a model.

The principle objective of this project was to model the relationships between these variables to construct a coherent model of societal resilience to natural hazards. The model comprises individual and community characteristics and processes that are, potentially, amenable to change. As a result, the variables modelled can be incorporated within risk management and hazard planning process in ways that afford opportunities to make choices regarding their prevalence at individual, community and societal levels, and thus influence resilience.

It should be noted that some factors known to influence resilience were excluded from the model. For example, personality factors, hazard-related anxiety and family dynamics (conflict) are known to influence resilience (Paton, 2006; Paton & Burgelt, 2005; Paton et al., 2005). However, because these factors are not open to change through the emergency planning process and related intervention, they were excluded from the model development process.

4.3 Constructing the Generic Model

The conceptual version of the generic model is depicted in figure 1. This diagram illustrates the constituent factors and the nested relationships that exist between them. The model portrays adaptive capacity as the integration of personal (e.g., self-efficacy, sense of community, sense of place), community (e.g., reciprocal social support, community competence, participation), and institutional (e.g., trust, empowerment) levels. The corresponding factors examined at each level (the scales used in the questionnaire) are described in Table 1 and are summarized below (section 5). The variables described in Table 1 were used to compile a survey questionnaire.

4.3.1 Data collection

This questionnaire was administered to a random sample of 400 households by telephone in August 2005. A full list of the scales used in the survey can be found in Appendix 1.A telephone survey is the most appropriate medium with which to collect data, particularly with regard to the nature and level of peoples' preparedness and knowledge.

When using postal surveys, people are presented with options that can result in their artificially inflating their estimates of the level of their adoption of preparedness (Charleson, Cook & Bowering, 2003; Lopes, 1992). Telephone surveys represent a better medium for tapping into actual knowledge. The benefit of this approach is evident when comparing peoples' beliefs about their knowledge and their actual knowledge (Paton et al., 2000). The latter study, and the present project, revealed that people often overestimate their level of knowledge (e.g., beliefs

regarding knowledge of content of Yellow Pages). The most cost-effective way of detecting differences between beliefs about and actual knowledge involves telephone surveys. Accurate information on these issues is essential for model development and planning alike.

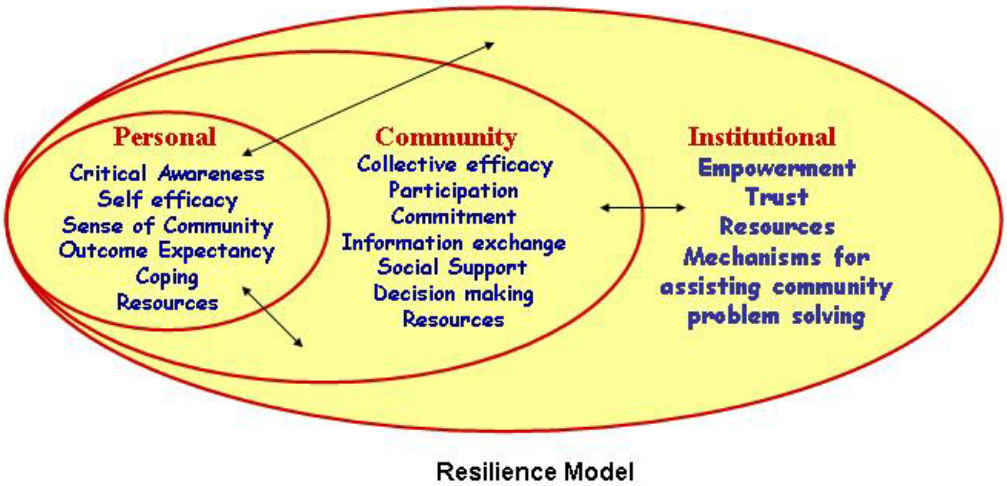


Figure 1 Conceptualisation of the generic multi-level model of societal resilience.

If people believe they are more prepared or knowledgeable than they actually are, they are less likely to perceive a need for further action on their part and are less likely to attend to risk communication messages (Paton et al., 2000).

It is important to use data collection methods that provide an accurate representation of levels of preparedness and knowledge. In this way, planning will be based on accurate information, as will subsequent evaluation of programs designed to facilitate hazard readiness.

5. COMPONENTS OF THE MODEL

5.1 Selection of Survey Questionnaire Items

In this section, information on the source of the variables that were included in the questionnaire is presented.

Critical awareness

The items used for this scale were developed for studies of hazard preparedness in New Zealand (Paton et al., 2005).

Self efficacy

This scale was adapted for work on environmental hazards in Australia (Bishop at al., 2000) and further developed for assessing response to volcanic hazards (Paton et al., 2001).

Action coping

This scale was developed by Carver et al. (1987) and developed for use in New Zealand samples (Paton et al., 2005).

Outcome expectancy
Adapted (Paton et al., 2005) from items developed by Bennett and Murphy (1999)
Cognitive empowerment/collective efficacy
Adapted from a scale developed by Speer and Peterson (2000)
Sense of community
Scale was adapted for work on environmental hazards in Australia (Bishop at al., 2000) and further developed for assessing response to volcanic hazards (Paton et al., 2001).
Participation
Adapted from a measure developed by Eng and Parker (1994).
Articulating problems
Adapted from a measure developed by Eng and Parker (1994).
Social support
Scale developed for work on participation in local affairs in Auckland (Paton, 2002).
Diversity
Scale developed for work on participation in local affairs in Auckland (Paton, 2002).
Empowerment
Scale items developed by Speer and Peterson (2000).
Trust
Scale developed for work on participation in local affairs in Auckland (Paton, 2002).

The variables selected for the initial stage of model development are described in Table 1.

Table 1 Variables included in the questionnaire survey.

Indicator	Measure
Personal indicators *Refers to the resources and competencies of individual people proposed to predict development of readiness at the person level.*	Attitudes and beliefs to change - frequency of thinking and talking about community issues (Critical Awareness) Beliefs regarding personal ability to deal with challenging situations (self efficacy) Belief in confronting problems in life (action coping) Beliefs regarding the benefits of (positive outcome expectancy and feasibility of personally dealing with hazard effects (negative outcome expectancy) Intentions – precursor of adoption of adaptive/ protective measures
Community indicators *Refers to those resources and competencies that exist collectively within neighbourhoods and relational communities (e.g., religious, sporting or recreational memberships).*	Capacity for representative decision making and beliefs regarding collective action within a community to deal with challenging situations (cognitive empowerment & collective efficacy) Commitment to community -Sense of belonging in relation to places and people (sense of community) Contribution to defining and achieving community goals (participation) Ability to describe community views, attitudes, needs and processes and how information is exchanged to derive common goals and meanings (Articulating problems/Leadership) Capacity for tangible or instrumental support in a context of diversity (Social support & Diversity)
Institutional level indicators *Refers to the resources and competencies possessed by institutions that have direct contact with communities and individuals/ and which community members believe can influence their capacity to deal with challenging situations*	Empowerment Trust Use of resources made available by wider societal institutions to deal with threats and opportunities and institutional mechanisms for assisting community problem solving (To be completed as part of the institutional resilience component of the process)
Collective (personal, community, institutional) model	Integrate data from above measures within a hierarchical model

Intentions

Intentions play an important mediating role in the development of protective behaviors. This scale was adapted (Paton et al., 2005) from original items developed by Bennett and Murphy (1999). The analysis focused on the assessment of intentions. Intention has proven to be a good indicator and actual behaviour (Paton et al., 2005) and thus represents an appropriate focus for this analysis.

Individual and Community Readiness

A series of questions (see Appendix 1) regarding household and community readiness for volcanic hazards was compiled. It was originally intended that scores on this scale would be adopted as the measure of resilience. Levels of adoption of recommended measures and hazard and mitigation knowledge were too low to be meaningfully interpreted in the model analysis. This issue is discussed in more detail below (section 6.3). As a consequence, the outcome measure of resilience used here was intentions (see above). Intention has proven to be a reliable predictor of peoples' future actions.

5.2 Issues during survey – impact on analysis

The interpretation of the data was compromised by the survey company's unauthorized inclusion of a "don't know" response category for several questions. With regard to the development of the model, this reduced the useable sample by 103 cases. Several analyses require full data profiles in order for a case to be included. The response "don't know" had to be treated as missing with a consequent loss of the case for regression, psychometric and structural analyses. Where cases had one or more "don't know" responses within a scale, no scale-score could be produced for the case. The cumulative effect of the deletion of cases on the basis of missing scale scores resulted in only 297 being available for the structural model that was tested. For other analyses, the maximum number of available cases was used.

The inclusion of the unauthorized "don't know" category also raised the possibility that people who used the "don't know" category differed systematically from those who did not in either their interpretation of the scales or in ways that related to other factors of interest. This possibility was examined. Follow-up tests that compared "don't know" cases with the other respondents revealed no important differences in relation to the recorded demographics. These analyses discount the possibility that "don't know" responses reflect membership of any specific demographic group, or that those who responded using this option possessed some unique characteristic. The pattern of "don't know" responses was idiosyncratic, the majority of cases having none, some cases having few and some many.

Taken together, the available evidence suggests that the use of "don't know" responses reflects a random pattern. This interpretation is reinforced by an analysis of the individual items within scales which indicates that the majority of missing data are for 1 or 2 items rather than for the entire scale or questionnaire.

5.3 Implications of Issue for Analysis and Model Development

The original setting of a sample of 400 built considerable redundancy into this aspect of the project. As a rule of thumb, it is recommended that structural equation modelling is run on samples of 150 or more (Bentler & Chou, 1987). Given that a sample size of 297 was still

available for this analysis, model development, testing and interpretation were not affected in any substantial way. In addition, the ratio of variables to cases (8/296) of 1:37 exceeds the recommended minimum requirement of 20-25 cases per variable.

The large number of missing cases means that the model presented represents a conservative estimate of its ability to predict resilience. That is, if the full number of cases were available, the amount of variance in intentions (R^2 in figure 2) that would have been predicted is likely to have been higher. The number of missing cases also meant that some variables were excluded on the grounds of failing to reach significance (e.g., self-efficacy). Had it been possible to have included them, which would have been the case if all the data had been available for analysis, the ability of the model to predict intentions would have been enhanced. The present analysis thus represents a conservative estimate of the utility of the model.

To reiterate the earlier point, the missing cases have no effect on the reliability of the model. The major issue concerns the fact that some variables (e.g., self-efficacy) were excluded. Since these were identified in the analysis, they can be included in future surveys and their contribution systematically assessed at that stage.

5.4 Type of analysis undertaken

The analysis had three goals. The first was to determine if the scales met acceptable psychometric standards. A Principal Components Analysis (PCA) of each scale's item set to determine the dimensionality and the relation of items to components. The components were rotated using the Promax method. Cronbach Alpha Reliabilities were calculated for each component.

The second goal was to develop a model of resilience. For the model development and for improving the model fit, structural equation modelling (SEM) was used. LISREL (V8.54) was used to conduct the analysis. This method of analysis is well suited to the task of developing a generic model. SEM allows the assessment of each scale item, as well as incorporating how well the scale measures the concept (reliability), into the estimation of the relationships between dependent (i.e., intentions) and independent variables (e.g., positive outcome expectancy, trust etc). This makes it an appropriate analytical technique to use when dealing with developing a holistic model with data from different populations (e.g., different ethnic groups) (Hair et al., 1995). If the data fit the model, it allows the causal relationships that exist between variables to be reliably depicted. SEM seeks to explain the variability evident in the data. Note that this analysis is independent of the mean scores for any specific variable. SEM is concerned with identifying a) the factors that explain or predict why scores differ from person to person (i.e., that cause change in the target variable), and b) how good they are as predictors. It explains the causes of beliefs and behaviours. Only if a reliable model could be constructed would it be feasible to conduct an analysis of the variables in order to:

- identify the prevailing level of resilience and constituent components, and
- compare levels of each variable across area of residence and ethnicity to identify whether any significant inter-group differences were present.

For this a third type of analysis is required.

The final analysis conducted tested whether the means of the core model variables differed with regard to ethnicity and between area of residence. One-way Analysis of Variance (ANOVA) with

post hoc comparisons (Tukey's Honestly Significant Difference Test) were conducted. When comparing means of more than one group at the same time, post hoc analysis facilitates locating the source of any differences. This analysis was conducted to identify the similarities and differences between demographic and regional characteristics. This analysis is not only important from the perspective of making resource and intervention decisions (e.g., regarding areas or groups that should be targeted for intervention, it can also identify potential strategies (e.g., investigating reasons for differences between group scoring high and those scoring low) that can inform reasons for particular outcomes.

6. MODEL (RESULTS)

6.1 Response distributions

The data analysis section commences with a brief summary of the demographic characteristics of participants. Information on age and gender is presented in Table 2, primary ethnic affiliation in Table 3, area of residence in Table 4, and household income in Table 5.

Table 2 Age group by Gender

GENDER	AGE GROUP			Total
	18 to 29 years	30 to 49 years	50 years or over	
Male	45	84	63	192
Female	46	89	73	208
Total	91	173	136	400

Table 3 Primary Ethnic Affiliation (Thirty individuals claimed dual ethnic affiliation)

	Frequency	Percent	Cumulative Percent
New Zealand European	238	59.5	59.5
Maori	41	10.3	69.8
Samoan	14	3.5	73.3
Cook Island Maori	11	2.8	76.0
Tongan	10	2.5	78.5
Niuean	3	.8	79.3
Other Pacific	2	.5	79.8
Chinese	3	.8	80.5
Indian	23	5.8	86.3
Other (specify)	54	13.5	99.8
Refused	1	.3	100.0
Total	400	100.0	

Table 4 Area of Residence

	Frequency	Percent	Cumulative Percent
Rodney District	28	7.0	7.0
North Shore City	60	15.0	22.0
Waitakere City	45	11.3	33.3
Auckland City	89	22.3	55.5
Manukau City	123	30.8	86.3
Papakura District	26	6.5	92.8
Franklin District	29	7.3	100.0
Total	400	100.0	

Table 5 Total household income before tax

	Frequency	Percent	Cumulative Percent
Up to $30,000/year	56	14.0	14.0
$31,000 - $50,000/year	77	19.3	33.3
$51,000 - $70,000/year	79	19.8	53.0
$71,000 - $100,000/year	72	18.0	71.0
More than $100,000/year	78	19.5	90.5
Refused	38	9.5	100.0
Total	400	100.0	

6.2 Data analysis

The first stage in the analysis involves assessing whether the item sets for each proposed measure (the items in the scales used) met acceptable psychometric standards. The results of the principal components analyses support the contention that the scales are robust and that each can be meaningfully interpreted. In view of this conclusion component scores (regression estimates) were calculated for all cases with full data profiles (i.e., excluding those with "don't know" responses).

Correlation and multiple regression analyses were conducted to construct a picture of the relationships between variables. Multiple regression analyses were conducted to examine the proposed theoretical relationships between personal-level and community-level variables, and between community-level and institutional-level variables.

These analyses identified several variables that had low or non-significant influences on each level. This applied to several scales and to sub-scales within scales. This process was used to reduce the number of variables used in the SEM to test the model. These items were excluded from the model analysis. This process identified the items listed below (analysis of model components).

6.2.1 Key points to note about the model

Several of the variables have an R^2 value listed by them. This is a measure of the degree to which the factors that precede (predictor variables) it in the model explain the variability in scores (see also section 5.4) on the target variable(s). For example, positive outcome expectancy and negative outcome expectancy account for 8% of the observed scores in Community Participation.

The model contains only those pathways that depict significant causal relationships between variables. The numbers associated with the lines that link variables indicates the strength of the relationship between factors. This number indicates that a change in one standard deviation in the predictor variable (e.g., positive outcome expectancy) will result in an X% (e.g., 19%) change in the standard deviation of the target variable (e.g., community participation). This is consistent with the goal of the analysis to explain the variability in the observed scores.

The analysis used to construct the model explains the variability in scores between people, not the scores themselves. It identifies which factors need to be addressed to secure change in levels of resilience. Subsequent analysis of mean scores identifies which of these factors

actually require attention. For example, high mean scores identify a variable that would not require attention.

Because they identify causal relationships, these arrows also identify areas where intervention can be directed. For example, increasing positive outcome expectancy and decreasing negative outcome expectancy will bring about change in community participation. Though explaining only a small proportion of the scores in community participation, both positive and negative outcome expectancy are significant predictors.

This means that there are other factors that influence prevailing levels of community participation (section 6.4.5). By depicting the causal relationships between several variables, the model summarizes the interconnectedness between variables and their collective influence on the outcome in question (in this case, intention). It reduces the number of issues planners have to contend with and presents a more holistic view of the social context within which resilience planning and intervention will take place.

6.2.2 Model Development

The data provide a good fit for the model (figure2). The R^2 for Intention of 37% represents a good level of prediction for this model. The other statistics listed in figure also indicate a good fit between data and model (see Appendix 6). The non-significant $\chi 2$ (chi-square) value of (9.02, df = 11, p=0.62) indicates a good fit. The utility of the model as a planning device is further supported by the Goodness of Fit Index (GFI) of 0.99, the Root Mean Square Error of Approximation (RMSEA) value of 0.052, and the Normed Fit Index (NFI) of 0.98.

As outlined above, the number of missing cases means that this is a conservative estimate. If the full sample had been available an R^2 of 40-45% may have been possible. This is a measure of the degree to which the model explains the observed levels of intention. Before proceeding to discuss the analysis, an obvious question is, if the model provides a good fit for the data, why is this figure not 100%? As outlined above, there are many factors that will influence peoples' intentions.

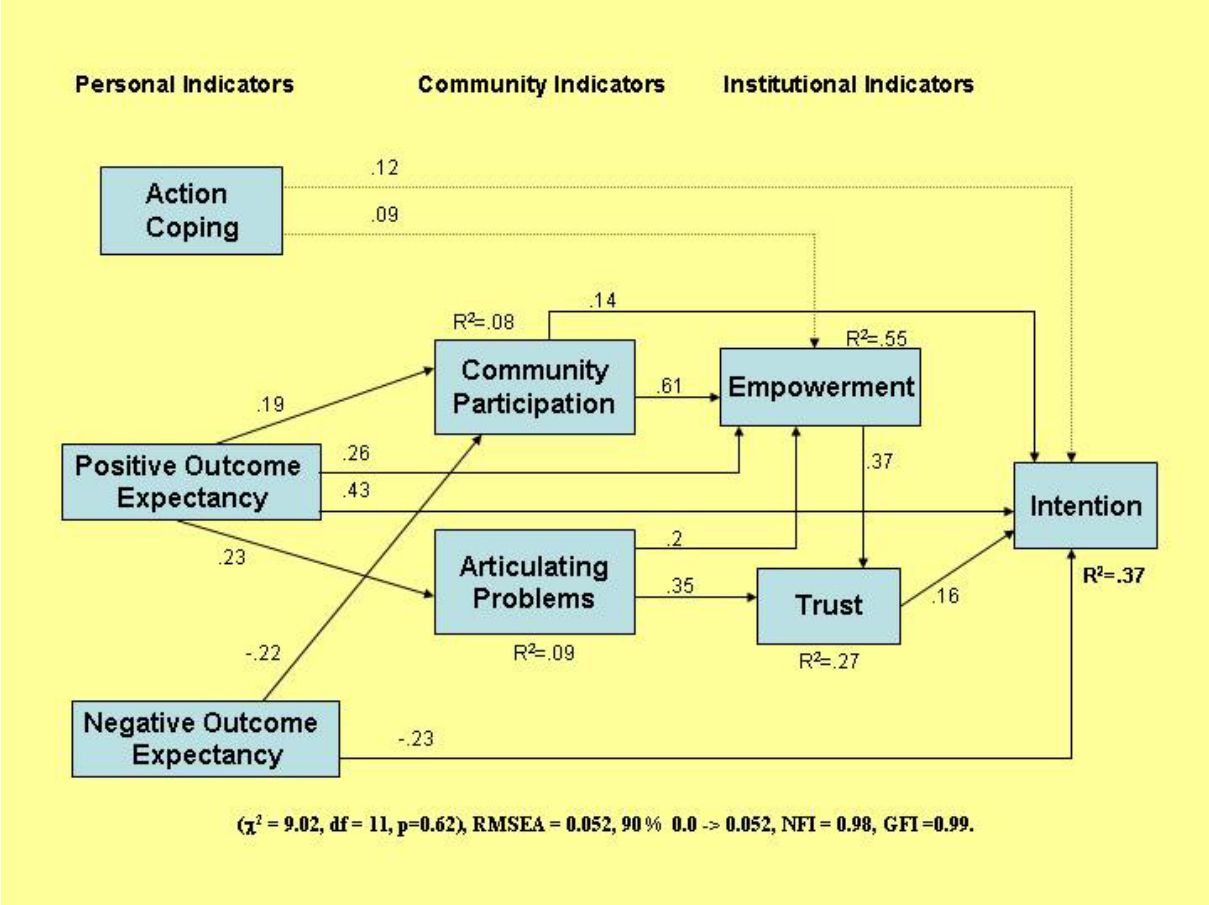
The factors that influence resilience decisions are not equally amenable to intervention. For example, personality factors, hazard-related anxiety and family dynamics (conflict) are known to be significant predictors of the adoption of the behaviours and attitudes that influence adaptive capacity (Paton, 2006; Paton & Burgelt, 2005; Paton et al., 2005). However, by their very nature, factors such as these are not open to change through the emergency planning process and related intervention. Analysis also excluded variables that made small contributions to explaining variance in intentions. These were excluded because a cost-benefit analysis would conclude that the cost of securing change in these factors would outweigh the benefits gained in increased resilience. This issue is discussed further in section 7.1.

The model development process is concerned with constructing a parsimonious model that represents a cost effective approach to resilience assessment and planning. An important aspect of this process is identifying those factors that a) make a substantive contribution to increasing resilience, b) are amenable to change, and c) are (potentially) under the control of the planning process. That is, the model focuses on identifying those factors that will provide the best return on investment.

6.2.3 The Components of the Model

Volcanic eruptions are rare and none have occurred during Auckland's history. With infrequent events, decisions to develop a capacity to adapt will commence with peoples' beliefs regarding their relationship with a hazard with which they have had no direct experience. If asked about their capacity to adapt to volcanic hazard consequences, it was hypothesized that people first ask themselves whether individual action to mitigate hazard consequences is possible and whether it could be effective. If they answer these questions in the affirmative, they develop positive outcome expectancy. If not, this decision is manifest in the development of negative outcome expectancy, with corresponding consequences for subsequent actions. This proved to be a valid and important starting point, and these hypotheses were supported.

Figure 2 The Resilience Model



The development of a negative outcome expectancy belief effectively curtails further development. Both its direct and indirect (via community participation) relationships with intentions indicate that negative outcome expectancy acts to constrain the development of resilience. That is, the more people believe that taking personal action to mitigate hazard consequences is futile, the less likely they are to engage in activities associated with the development of their adaptive capacity or to work with others to achieve this outcome. Model analysis (and a correlation of 0.06 between positive outcome expectancy and negative outcome expectancy) indicates that positive outcome expectancy and negative outcome expectancy are not related (i.e., decreasing negative outcome expectancy will not increase positive outcome expectancy and vice versa) and identifies a need to develop strategies to target each separately.

The model indicates that positive outcome expectancy represents an important starting point in the development of resilience to volcanic hazards. Positive outcome expectancy is a significant predictor, holding both direct and indirect relationships with intentions.

A role for action coping, a measure of peoples' beliefs in confronting problems, was also identified. Its relationship with empowerment indicates that as the predisposition to confront problems increases, the likelihood that people will feel empowered increases.

The importance of positive outcome expectancy is also evident in its indirect relationship with intentions. Positive outcome expectancy is a precursor of both community-level variables; community participation and articulating problems, accounting for a small, but significant, amount of variance (R^2 of 0.08 and 0.09 respectively) in both.

The magnitude of the R^2 means that other factors represent significant influences on peoples' decisions to participate in community activities and in the development of an ability to identify salient issues within their community. This is not surprising, natural hazard issues would be expected to play a relatively small role (compared with, for example, issues about crime in a neighbourhood) as a catalyst for community participation. Furthermore, hazard education programs rarely require the active participation of community groups on a regular basis. For example, only 6% of respondents had attended meetings to discuss hazard issues, and only 1% had worked with others to develop a plan.

The infrequent nature of hazard activity also reduces the likelihood of it acting as a catalyst for participative activities within a community. Other factors, such as having school-age children and consequent involvement in school-related community activities, membership of local clubs, societies and religious groups, and involvement in local action groups are more likely to be influence participation. Given this, the potential benefits for hazard reduction that could accrue from integrating emergency management and community development planning in order to increase levels of community participation should be explored.

With regard to articulating problems, if the full sample had been available, it is possible that action coping may have explained additional variance in this factor. Notwithstanding, as with community participation, peoples' beliefs about hazard mitigation would not be expected to make a substantial contribution to their competence in articulating problems. A relationship between articulating problems (e.g., with regard to salient community issues) and community participation might have been expected. While a small, though significant, correlation ($r = .16$, $p<0.001$) was evident, the strength of this relationship was insufficient for it to be included in the more rigorous causal analysis. This suggests that community participation is not generally linked to addressing problems. Intervention to increase resilience should be directed at securing change in both factors.

For both community-level variables, collaboration between emergency planning and community development agencies would represent a valuable resource for developing strategies to change levels of 'community participation' and 'articulating problems' variables.

Positive outcome expectancy had a direct influence on one institution-level variable, empowerment. The community-level variables, in turn, were strong predictors of the institutional-level factors; empowerment and trust. Causal relationship between the person-(positive outcome expectancy) and both community-level variables and the institution-level variables of empowerment (predicted 55% of variance) and trust (27% of variance) could be

discerned in the model.

The person- and community-level variables had both direct (positive outcome expectancy, community participation, articulating problems, and action coping) and indirect (positive outcome expectancy mediated by community participation and articulating problems) influences on empowerment. The development of the personal and community-level factors will influence the development and maintenance of empowerment. Its relationship with intentions was mediated by trust (which was also influenced by articulating problems).

The development of a reliable model means that it can be used as a decision support tool for emergency planners. Note that the model itself is independent of the mean scores of any particular factor. The model identifies which factors cause change in other factors. By identifying factors that represents a significant predictors, the model provide a framework within which mean scores can be interpreted to systematically examine their contribution to levels of resilience in Auckland.

It was originally intended to use levels of general preparedness, hazard knowledge and cooperation as the measure of resilience. The reason why it was not possible to do so is discussed next.

6.3 Household and Community Preparedness

This section includes a discussion of the data on household and community preparedness.Full details of the responses to the household and community preparedness questions can be found in Appendix 5.

The questions posed to respondents concerned levels of volcanic hazard preparedness, levels of hazard knowledge, and levels of community collaboration on plan development. Questions were presented in, first, and unprompted format. People were asked what they had done or knew. The same questions were then repeated after giving respondents specific prompts (see Appendix 1).

From the perspective of making an objective assessment of preparedness and knowledge, the unprompted questions will provide the more reliable insights into current levels of preparedness and knowledge.

6.3.1 Preparation

With regard to the observed levels of the adoption of general preparedness items, the unprompted question revealed their presence at very low levels. When reviewing these data, it is often valuable to differentiate items that may be present for reasons other than the specific preparation for natural hazards (Paton et al., 2005). For example, while it may be a valuable skill when dealing with hazard consequences, people are likely to know how to turn of water or gas mains because it represents a useful everyday (survival) skill. However, this means that its presence may not reflect an underlying attitude to specifically prepare for hazards. When developing resilience models, a more exacting test is secured when items that specifically result from decisions to confront natural hazard issues are used.

Actions such as securing water heaters and tall/heavy furniture are more indicative of people making choices to protect themselves from natural hazard consequences. Overall, levels of

adoption were low, with fewer than 1% of respondents being able to affirm that they had secured water heaters/furniture and only 7% stated that knowing how to turn off electric power at the mains as a preparatory measure (appendix 5). When prompted about specific measures, levels of adoption were higher, although actual levels of adoption remain low. When prompted, 13% identified fasten cabinet doors with latches, 12% identified each of fastening water heater and heavy objects, and 10% identified fastening water heaters as protective measures adopted. A comparison of prompted and unprompted responses is presented in Table 6.

Table 6 Comparison on prompted and unprompted responses to general preparedness questions

Item	UnPrompted %	Prompted %
Fasten cabinet doors	0.2	13
Fasten water heater	0.4	10
Fasten tall furniture	1	12
Fasten heavy objects	1	12

Another specific protective measure is having an emergency kit. Some 45% of respondents stated having one. However, assessment of the frequency with which items were included in the kit suggests relatively lower levels of preparedness. No items were recorded at 100%. That is, no respondent had a complete kit. Some 17% stated that their kit contained a first aid kit and a torch. Only 6% stated that their kit included stored water and a temporary toilet (appendix 5). Of those that stated having an emergency kit, only 9% checked the content and operation of their emergency kit regularly.

With regard to their having a household volcanic eruption emergency plan, only 23 people (6%) had such plan in place. Of these, only 16 people had a plan that identified where people should meet in the daytime, and only15 had a plan that identified where people could go if they had to evacuate.

Level of preparedness were also examined by a) asking people if they <u>believed that they could</u> name the five things to do in the event of a volcanic eruption contained in the Yellow Pages, and b) asking them to actually name them. Only 10% stated that they believed that they could name these 5 things.

Of the 39 people who believed that they could name all five items, 3 people were unable to name any, and 30 people could only correctly identify one item. Of this initial group of 39 people, only 1 person could actually name all five when asked to do so.

This illustrates the potential for people to over-estimate their knowledge and preparedness. In this case, 38 of 39 people over-estimated their existing level of knowledge. If people over-estimate their knowledge or level of preparedness, it can reduce their perceived need for additional action and reduce their perceived need to attend to risk communication messages (e.g., because they believe they are already well-prepared). Of those who could name some of these items, staying indoors was the most frequently recalled item (23%), followed by saving water (14%), using protective clothing (11%), keeping roofs and gutters clear (5%) and not going sightseeing (2%). Overall, levels of physical preparedness and knowledge of appropriate protective actions was poor. Next, questions were asked about hazard knowledge.

6.3.2 Hazard Knowledge

An important component of positive outcome expectancy is hazard knowledge (see section 6.4.4). Participants were asked what physical hazards they may have to deal with if there were

a volcanic eruption in Auckland. Questions were asked about both the nature of the volcanic hazards that could be encountered and their potential consequences (appendix 5). Over all, levels of knowledge were low.

Some 17% of respondents identified ashfall as a hazard, with 2% identifying inhaling it as a problem and 2% describing driving on ash –covered roads as problematic. Just under 1% of respondents identified ash accumulating on roofs as a potential hazard. Some 14% described lava as a volcanic hazard, with 7% linking it to potential fire hazards.

Some 8% identified gasses as a volcanic hazard, with 2% describing breathing problems as a consequence of this hazard. A very small number, two people (0.2%) identified corrosion as a consequences of gas hazards. Some 10% identified rock projectiles as a hazard, with 2% linking this hazard to physical damage. Some 7% identified earthquakes as a hazard, with 2% describing this as capable of creating household disruption (e.g., dislodging furniture). The unprompted data provides more accurate insights into the nature of peoples' understanding of hazards (see section 6.4.4). A comparison of prompted and unprompted responses to questions regarding volcanic hazards is presented in Table 7.

When prompted, the number of respondents identifying ashfall as a hazard remained unchanged (17% unprompted and 18% prompted). A similar picture emerged for lava (14% unprompted and 14% prompted). More substantive shifts in the number recognizing gasses as a volcanic hazard were recorded. Scores on this question increased from 8% to 22% between the two conditions. When prompted, the proportion identifying rock projectiles as a hazard rose from 10% to 20%, and those recognizing earthquakes as a hazard under this condition resulted in an increase from 7% to 24%.

Table 7 A comparison of prompted and unprompted responses to questions regarding volcanic hazards

Volcanic hazards identified	UnPrompted %	Prompted %
Ashfall	17	18
Gases	8	22
Bombs	10	20
Earthquakes	7	24
Lava	14	14

An important adaptive skill is knowing how to deal with hazard consequences. As would expected on the basis of the responses described above, level of knowledge of what actions they could take to limit volcano damage was low. For example, 150 respondents were unable to cite any actions. Some 5% identified having dusk masks as important and 4% identified using to tape to prevent ash entering as protective measures.

6.3.3 Community Preparedness

The interview included questions on peoples' involvement with others in discussing hazard issues and the extent to which they has worked with others in their community to develop response plans (see appendix 5). While the latter represents a measure of resilience, the former provides additional insights into its predictors. Discussion of hazard issues with other community members has been identified as a significant predictor of peoples' understanding of hazards and increases the likelihood of their adopting protective measures (Paton et al., 2005; McIvor & Paton, in press; Paton et al., in press). To examine this, the survey included questions about community preparedness.

Overall, levels of discussion and collaborative planning are low. With regard to the former, while 24 people (6%) stated having participated in meetings on volcanic preparedness, this did not always translate into action, with 12 of them (3%) having worked with others in the neighbourhood to consider how an eruption might affect community. Only 6 people (1.5%) progressed this to the point of discussing how they might prepare with their neighbours, with 5 people (1.3%) having worked with neighbours to develop a community volcanic response plan. These data are consistent with the view that hazard issues do not currently make a significant contribution to community participation.

6.4 Analysis of Model Variables

This section is sub-divided into two sections. The first describes the descriptive statistics for each model variable. The second compares the mean scores for each variable by ethnic group and by area of residence.

Table 9 Summary of Variables

	N	Min	Maxi	Mean	Std. Deviation	Ranking
Intention	400	5.00	15.00	7.63	2.79	L
Action Coping	400	4.00	20.00	15.63	3.06	H
Negative Outcome Expectancy	400	4.00	20.00	10.87	3.20	M
Positive Outcome Expectancy	400	3.00	15.00	9.35	2.61	M
Community Participation	400	5.00	20.00	11.97	3.49	M
Articulating Problems	400	4.00	20.00	14.70	2.36	H
Empowerment	400	4.00	20.00	11.51	3.33	M
Trust	400	5.00	25.00	16.72	3.83	M

Descriptive statistics for the variables included in the model are presented in Table 9. For illustrative purposes, variables have been ranked as low, medium or high. This was done by comparing the mean and median values. A ranking of low (L) reflects a mean score that was more than one standard deviation below the median; medium (M) reflects a high similarity between mean and median values; and high (H) reflects a mean score more than one standard deviation above the mean. This is for illustrative purposes only and is intended to facilitate the identification of areas where attention should be directed. According to this formulation, ‘action coping’ and ‘articulating problems’ are factors least in need of additional attention. In contrast, attention should be directed to reducing negative outcome expectancy and increasing positive outcome expectancy, community participation, empowerment and trust.

In the remainder of this section, each variable and its relationship with the model is discussed. Tables depicting mean levels of each item and the distribution of responses for each item are presented. This is used to identify whether the data highlight any specific issues where intervention would be particularly beneficial. Discussion commences with the dependent variable, intentions.

6.4.1 Intentions

In the absence of sufficient response to preparedness items, the measure of resilience used here was intention. The means (left column) for each scale item and the distribution of responses (%) are presented in Table 10.

Table 10 Means and distribution of responses for Intention items

	Mean	No	Possibly	Definitely
Check your level of preparedness for volcanic eruptions	1.48	63	27	10
Increase your level of preparedness for volcanic eruptions	1.55	58	31	11
Become involved with a local group to discuss how to reduce damage or loss from volcanic hazards	1.37	71	21	7
Seek information on volcanic risk	1.55	56	33	11
Seek information on things to do to prepare for volcanic eruptions	1.68	49	35	16

6.4.2 Action Coping

Action coping is a measure of peoples' general problem solving competence. It reflects peoples' experience in resolving problems in daily life and the development of a general predisposition to work out how to confront problems encountered. The means (left column) for each scale item and the distribution of responses (%) are presented in Table 11.
The mean scores and distributions reiterate the earlier point that this variable is in least need of additional attention. This means that, of the factors that trigger the process, more attention should be directed to positive and negative outcome expectancy.

Table 11 Means and distribution of responses for Action Coping items

	Mean	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I try to come up with a strategy about what to do	3.82	30	40	21	7	2
I make a plan of action	3.75	23	44	20	11	3
I think hard about what steps to take	3.94	30	44	19	7	1
I think about how I might best handle the problem	4.07	31	52	11	6	0

6.4.3 Negative Outcome Expectancy

Negative outcome expectancy measures peoples' beliefs that hazard consequences are too destructive or catastrophic for any personal actions to be effective. These beliefs decrease the likelihood of developing adaptive capacity. The means (left column) for each scale item and the distribution of responses (%) are presented in Table 12. In contrast to the other factors discussed in this analysis, for negative outcome expectancy, the lower the score the better.

Table 12 Means and distribution of responses for Negative Outcome Expectancy items

	Mean	Strongly agree	Agree	Neither Agree nor disagree	Disagre e	Strongly disagree
Volcanic eruptions are too destructive to bother preparing for	2.44	8	16	14	37	25
A serious volcanic eruption is unlikely to occur in my lifetime	2.79	10	25	17	31	15
Preparing for volcanic eruptions is Inconvenient	2.49	6	17	21	35	22
It is difficult to prepare for volcanic eruptions	3.16	14	34	21	35	22

Several factors have been implicated in the development of negative outcome expectancy. Negative outcome expectancy is linked to people believing that because volcanic eruptions are uncontrollable, their devastating effects are also uncontrollable. This process reflects their having an external locus of control, being predisposed to attribute the causes of events to chance or environmental factors rather than believing they can exercise control over events (Strickland, 1989). This reduces the likelihood of their being willing to take action to develop their capacity to confront hazards. This is reflected by the strong negative relationship evident between it and other variables in the model (figure 2). Because it acts to prevent development, these beliefs have to be countered before attempting to develop resilience. If not, these internal beliefs will result in people discounting or ignoring messages rather than taking them on board. From the data presented in Table 12, the major issue concerns beliefs that preparing is difficult (#4), with lack of perceived control being a common root of this difficulty.

Intervention to manage this issue should focus on encouraging people to see themselves as having control over events. However, this is not a straightforward task. These beliefs have firm cultural and psychological underpinnings. Fatalism and locus of control beliefs are not simply reversed by exposure to a factual message, but they can be modified when strategies are designed in ways that encourage people to focus on the fact that susceptibility to loss from hazard effects is not evenly distributed throughout the community (Paton et al, 2006).

Uneven distribution can be explained through, for example, identifying how some groups are more vulnerable than others and how damage is unevenly distributed through the built environment. For example, designing risk communication messages that first ask people if they thought anything could be done to help more vulnerable groups (e.g., people living in unsound buildings, the elderly) deal with hazard consequences can help people appreciate that personal and environmental characteristics influence susceptibility to loss. It is also important that if this approach is used that it includes elements to ensure that people can extrapolate from these examples to their situation. Negative outcome expectancy can also be reduced by switching citizens' attention from the awe-inspiring and catastrophic aspects of hazards to focus more on the fact that damage and loss are universals. An important issue in this context is the role of the media and the use of catastrophic images in risk communication.

Although hazard rarely create uniform destruction, media reports tend to focus on the catastrophic aspects of events and present it in ways that suggest that loss is total. That is, they do not provide representative coverage of how hazards interact with the social and built environment. When exposed to images that focus solely on loss, people become more fatalistic and more likely to believe that disasters are too catastrophic for personal action to be effective (Keinan, Sadeh & Rosen, 2003; Lopes, 1992), increasing negative outcome expectancy in the process. Given that actual experience of hazard events is rare, people have no basis to correct these misconceptions unless specifically presented to them through the risk communication process.

Negative outcome expectancy can be reduced if public education and the news media a) show that damage is not universal and b) demonstrate how the distribution of losses reflects factors about which people can make choices (e.g., building design, preparedness actions). More balanced and analytical articles (e.g., those that explain the relationship between hazard activity and how to cope) increase the likelihood of people adopting protective measures. The latter introduces the process of developing positive outcome expectancy.

The model demonstrated that positive outcome expectancy and negative outcome expectancy

are discrete factors. That is, reducing negative outcome expectancy will not increase positive outcome expectancy and vice verse. Changing positive outcome expectancy thus needs to targeted in its own right.

6.4.4 Positive Outcome Expectancy

Positive Outcome Expectancy measures peoples' beliefs that hazard readiness activities can enhance their capacity to deal with hazard consequences and contribute to the quality of everyday life. The means (left column) for each scale item and the distribution of responses (%) are presented in Table 13.

Table 13 Means and distribution of responses for Positive Outcome Expectancy items

	Mean	Strongly agree	Agree	Neither Agree nor disagree	Disagre e	Strongly disagree
Preparing for volcanic eruptions will significantly reduce damage to my home should an eruption occur	3.08	14	29	20	25	10
Preparing for a volcanic eruption will improve the value of my property	2.56	7	19	19	34	17
Preparing for volcanic eruptions will significantly improve my ability to deal with disruption to family/community life following an eruption	3.72	22	49	13	10	4

In contrast to its negative counterpart, positive outcome expectancy is linked with people believing that outcomes reflect their own actions (internal locus of control). They thus exert more control over their circumstances than those with an external orientation and are more likely to prepare for natural hazard events (Paton et al., 2006). In addition, positive outcome expectancy is influenced by the level of one's understanding of hazard issues (e.g., nature, causes, consequences etc) and their specific relationship with the actions required to mitigate their consequences (Hurnen & McClure, 1997; McClure et al., 1999). While expert models might include characteristics such as magnitude and proximity, building design, and so on, most people commonly have relatively simple hazard models that often reflect the macro characteristics of the hazard (e.g., a volcano). As the level of complexity in these hazard models increases, so does the perceived sense of control and this, in turn, increases the likelihood of their adopting protective measures.

The means and distribution of responses in Table 13 suggest that resilience is constrained by people failing to see preparation as adding value and not appreciating the link between preparation and reduced risk.

Low positive outcome expectancy has been linked with people perceiving the information they were given inadequate (i.e., providing inadequate explanation of complex hazard consequences and their relationship with mitigation measures). This made it more difficult for them to formulate their understanding of what happens when a hazard event occurs, reducing their ability to perceive the need for and relevance of protective measures. People believed that education that focused more on explaining how particular actions would mitigate specific consequences would motivate residents to prepare (Paton et al., 2006).

Peoples' understanding can be enhanced by presenting scenarios that increase the complexity of peoples' hazard models, demonstrating that hazard intensity and the damage they create are unevenly distributed and that damage and loss reflects the interaction between choices people can make (e.g., securing houses to their foundation, securing chimneys, water heaters and tall furniture) and hazard activity (e.g., shaking intensity). Demonstrating the reality of avoidable losses and how people can exercise control over these interactions increases positive outcome expectancy.

A significant issue in the context of the present model is the role that discussions about hazard issues with other community members have in developing people's understanding of the issues introduced above. Discussions with others about hazards legitimizes hazards as salient issues and represents a medium through which people share stories, build knowledge, and understand both why preparedness is important and what they can do (McIvor & Paton, in press; Paton & Burgelt, 2005). It also builds links with other community members. Engendering a belief in the effectiveness of mitigation measures is important but not sufficient to ensure the formation of intentions to adopt protective measures. The data collected for this study reveal that levels of discussion about hazard issues is uncommon (see section 6.3.3). In the model (figure 2), the personal factors were linked to community-level factors.

Level Two
Community

6.4.5 Community Participation

The means (left column) for each scale item and the distribution of responses (%) are presented in Table 14.

Table 14 Means and distribution of responses for Community Participation items

	Mean	Often	Sometimes	Rarely	Never
I have worked with others on something to improve my neighbourhood	2.38	16	30	35	9
I participate in local activities or events (e.g., festivals, fetes, fairs)	2.24	20	38	20	23
I have contributed money, food or clothing to local causes, charities, or others in my community	2.35	37	46	10	7
I have attended a public meeting on a community issue	2.52	12	20	20	49
I have been involved in volunteer activities intended to benefit my community (e.g., fundraising, clean-up days, local groups, Scouts/Brownies).	2.48	24	30	15	31

Participation describes the degree to which people take an active part in community life. Participation can include, for example, volunteering time, money or other resources to community/ neighbourhood activities, serving on local committees or groups, signing petitions, and serving in public office. Participation can also emerge through mutual assistance groups and through providing social support to other community members. Participation can occur by electoral participation (voting or working for a particular candidate or issue), grass roots efforts (where citizens start a group and define its goals and methods), or government mandated citizen participation in which citizens are appointed to watchdog committees or attend public hearings. Accordingly, participation includes both community service activities and those directly linked to promoting change.

Participation has been associated with several indicators of resilience (Bishop et al., 2000; Paton, 2006, Paton et al., 2001), particularly when discussion incorporates hazard issues. An important link in this context is community discourse, and this is facilitated by participative activities, particularly if they are directly concerned with hazard issues. While levels of discourse regarding hazard issues are low (section 6.3.3), participants demonstrated relatively good levels of involvement in public meetings on community issues (#4). This provides a good basis for utilizing existing participation as a vehicle for developing resilience. However, relatively lower levels of working with others (#1) suggest that active collaboration is an area that would benefit from additional attention.

Benefits of participation may include acquiring new information from discussions with people, learning new skills, being involved with important issues, making interpersonal contacts, personal recognition, and a sense of improving the community. It can also include taking pride in accomplishments, feeling that actions are in tune with values, feelings of well-being, discovering how much they have to contribute, working with those who share concerns and

hopes, knowing that efforts improve their own and others' quality of life, and enjoying better institutions (e.g., schools, housing, medical care) and resources (e.g., local amenities).

Knowledge of levels of participation has implications for readiness planning. Hazard education programs rarely include a component that involves active and sustained community participation. Given the infrequent nature of hazard activity this would be a difficult task. Given that discussion of hazard issues is important, developing this capacity through other routes would be beneficial. With regard to the model, it would provide a context in which peoples' outcome expectancy beliefs could be sustained and facilitate their conversion into actions. One approach is to encourage hazard discussion within existing participation fora. Likely candidates for this would be schools (e.g, school projects that could extend out into the wider community) and workplaces (e.g., as an extension of business continuity planning).

The more active the participation, and the more it is geared towards defining and resolving issues and problems, the more likely it is to facilitate the development of problem-solving skills at a collective level. With regard to hazard resilience, an important issue is the capacity to define the issues that will have to be dealt with and identify salient problems for a community. Given the complexity of hazard issues and the lack of experience on which to draw, this is a difficult task. Consequently, a resilient community is one that has a capacity to articulate salient problems or issues and to formulate these into questions that facilitate their receiving the information and resources they need to confront the issue themselves.

6.4.6 Articulating Problems

Natural hazard events are rare. In the absence of experience to guide action, people and groups are required to define the kinds of issues they may have to contend with. Consequently, a capacity to identify and define salient issues plays an important role in developing a capacity to adapt. Given that they will need to seek information to clarify circumstances from formal sources, a link with trust would be expected. That is, as the capacity to formulate problems or questions increases, the more likely people are to be able to direct their information search. Consequently, information received is more likely to be consistent with expectations and contribute to understanding and goal attainment, increasing trust in the source of information.

The opposite is also true; a failure to receive information consistent with needs and expectations reduces trust in the source (Paton et al., 2006). In the absence of a capacity to formulate questions and thus information needs, the less likely people are to be able to seek and then evaluate information in ways that act to clarify the issues they face. Hence low scores on articulating problems will be linked to low trust. That is, limited ability to identify issues (and formulate questions) makes it difficult to seek and then evaluate information to clarify the issue. Because people tend to attribute failure to external sources (fundamental attribution error), they blame the source of information, with their level of trust in that source being diminished as a consequence. A similar relationship between Articulating Problems and Empowerment can be proposed. The better people are at defining issues, more likely to utilize resources for action (see below).

'Articulating problems' is a social process. While related to participation as a consequence, the model analysis identified it is a discrete process. That is, encouraging community participation will not automatically lead to the development of a capacity to articulate problems. This must goal must be targeted specifically. It is more likely to develop when participatory activities involve problem definition and resolution activities.

Articulating problems reflects the quality of debate and discussion that takes place with other community members. It thus represents that component of the model that provides the context in which thinking about hazard issues manifests itself into discussion with others. As outlined in the earlier discussion of positive outcome expectancy, this activity plays an important role in the development of adaptive capacity, and helps explain the link between these two elements of the model.

The means (left column) for each scale item and the distribution of responses (%) are presented in Table 15.

Table 15 Means and distribution of responses for Articulating Problems items

	Mean	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
What a community talks about depends on what residents are interested in	3.87	19	62	11	6	3
Struggles always occur to determine what issues this community should focus on	3.31	7	45	28	14	1
Community perceptions depend on the quality of the individuals in that Community	3.71	13	61	15	9	1
How people think about community problems controls what is done about those problems	3.81	13	66	13	20	2

The distribution of responses and mean scores reiterate the earlier point that this factor is present at high levels.

While articulating problems will play an important role during the early stages (inferred from low actual preparedness) of developing adaptive capacity, as adaptive capacity increases, the model may have to be revised to include other aspects of problem solving. In this regard, Eng and Parker (1994) described a competent and resilient community as one in which it's various parts are able to (1) collaborate collectively in identifying the problems and needs of a community, (2) achieve a working consensus on goals and priorities, (3) agree on shared means to implement the agreed-upon goal, and (4) collaborate effectively in the required actions.

Effective interaction is characterized by: (1) the match between the problem-solving preferences of an individual and the resources provided by a system, (2) informational feedback between two parties which allows for adjustment on either side, and (3) the availability of advocacy or participatory process. The last point emphasises the importance of the relationship between collective problem-solving competence and empowerment. The community-level variables were significant predictors of the institutional-level variables.

Level Three
Institutional Level Indicators

6.4.7 Empowerment

The means (left column) for each scale item and the distribution of responses (%) are presented in Table 16.

Table 16 Means and distribution of responses for Empowerment items

	Mean	Always	A great deal	Sometimes	Not very much	Not at all
I feel that I can influence what happens in my community	2.88	6	19	43	23	9
I feel that I see positive results from participating in community activities	3.29	16	26	38	12	7
I feel that I have an active part in keeping this community going	2.79	10	15	36	25	14
I think that elected representatives seriously consider my opinions	2.56	5	10	42	24	19

Empowerment describes citizens' capacity to gain mastery over their affairs and to deal with issues and opportunities using intrinsic resources (and if necessary being supported in this regard by external sources rather than being led by them). Given that a capacity to confront issues using intrinsic resources is a fundamental tenet of resilience, empowerment has an important role to play in a model of resilience.

Empowerment strategies are driven by the goal of promoting the equitable distribution of resources (material, social, knowledge, peer helping, belongingness) to facilitate such ends as justice, equity, equality, respect for diversity, sense of community, and the development of a collective capacity to confront local issues, whether of a hazardous nature or not.

Empowerment occurs through cooperative linkages with other individuals and between the community and the wider society. Community empower may be independent of traditional social institutions (e.g., a local environment group or mutual assistance group) or related to them (e.g., a church group). Empowerment reflects both reciprocal relationships between community members and between community members and societal institutions. The quality of these relationships will define the degree to which responsibility for action is devolved to local levels (see earlier discussion on the relationships between resilience and the phases of disaster) and will, consequently, influence the level of trust that exists between community members and societal institutions.

The data in Table 16 suggests that the perceived relationship with elected representatives is an area where attention should be directed. A similar argument can be made for items #1 and #3.

6.4.8 Trust

The means (left column) for each scale item and the distribution of responses (%) are presented in Table 17.

Table 17 Means and distribution of responses for Trust items

	Mean	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I trust my Council to respond to meet the needs of its residents	3.36	13	41	33	19	5
I trust the community leaders in my Community	3.27	7	41	29	18	4
I trust the media (newspapers, TV, radio) to report fairly	3.01	7	32	25	28	9
I trust my Council to do what is right for the people they represent	3.48	14	46	20	15	5
I have confidence in the law to protect and maintain order in my community	3.60	15	51	18	14	3

Trust is a prominent determinant of the effectiveness of interpersonal relationships, group process and societal relationships. Trust is influenced by (a) an individual's previous experiences (e.g, prior hazard experience, dealings with societal institutions, council etc), (b) structural and situational factors (e.g., informational social support, levels of participation in community, existence of problem solving mechanisms), and (c) dispositional psychological factors (e.g., personality, coping style). These factors interact to influence how people and community groups perceive the motives and actions of those upon whom they rely for such things as information and resources (e.g., societal institutions).

Trust also influences their perceptions of the competence of these agencies and this, in turn, influences the credibility attributed to their actions (e.g. as providers of information). Individual experience of these institutions over time becomes manifest as some corresponding degree of subjective trust or suspicion. The importance of trust in a model of resilience is directly proportional to the degree of uncertainty in the issues that brings people and groups into contact with societal institutions. In this case, it is concerned with the hazard mitigation. Uncertainty and risk thus become significant components of these interactions, conferring upon trust a pivotal role in the model.

With regard to hazard situations, trust relations exist between citizens and emergency planners, and each of them with the societal/institutional systems in which they are embedded. In this model, we are concerned with the former. It should, however, be noted that the beliefs that prevail in the emergency management sector will influence this relationship. This is an issues that could be addressed in the development of the societal model of resilience.

It is thus important to understand the act of trusting in the context of hazard preparedness, why trust may not occur, and why trust may develop into a generalized attitude towards an institution over time which influences <u>all</u> trusting acts. When dealing with hazard situations, specific experience tends to be absent, hence people rely on their generalized beliefs regarding trust ion the social institution they rely on to provide for their needs. This generalized trust interacts with

the demands of the specific context. That is, the level of trust will depend on prior experiences (which may or may not have had anything to with hazard issues), peoples' ability to formulate their needs (see above discussion on articulating problems) and the perceived attractiveness of the outcomes, and the perceived likelihood of the outcome occurring (Paton, in prep).

It follows from this that the low level of importance or salience attributed to natural hazard issues will influence levels of trust. This is evident in the collective influence of positive outcome expectancy and articulating problems on trust. The relationships between empowerment and trust can also be supported by the literature. When emergency management agencies engage community members about hazards, the commitment of community members to take responsibility for their own safety increased. Thus, levels of trust, satisfaction with communication, risk acceptance, and collective commitment to confront hazard consequences (resilience) are increased by community engagement (Paton et al., 2006). This issue reiterates the relationship between levels of hazard knowledge and resilience, and provides another illustration of how positive outcome expectancy and articulating problems can influence trust.

The data in Table 17 indicate moderate to good levels of trust in their local council. The area most in need of attention concerns the media (#3). Though this question is tapping into general beliefs, the significance of this observation is heightened by the role the media can play in promoting positive outcome expectancy.

The preceding discussion emphasizes the inter-relationships that exist between the factors that comprise the model. The process commences with peoples' beliefs regarding whether hazards are amenable to personal and collective mitigation or not. If the believe that they are, the development of their resilience or adaptive capacity is a function of the collective action of the remaining factors described in the model. Consequently, risk management strategies designed to develop resilience must treat the model holistically and intervene to enhance each factor.

There are, however, some circumstances that would support action being directed to only some factors. The first of these relates to the prevailing levels of variables. If already high, further intervention is less necessary. For example, the relatively high levels of 'action coping' and 'articulating problems' recorded here suggests that attention could be focused on those recorded at moderate levels. The other circumstance which could justify more restricted action occurs when intervention resources are limited. This issue should be followed as a last resort. Its implications are discussed in a later section of this report (section 5.4.2). Before discussing this, the remaining question to be addressed here concerns how levels of each factor are distributed through the region. This issue is examined in the next section.

6.5 Comparison of Mean Scores

The final analyses involved comparing levels of each variable across area of residence and ethnicity to identify whether any significant inter-group differences were present. These analyses provide baseline data for intervention planning (e.g., prioritizing based on levels of resilience), monitoring and the evaluation of resilience strategies.

One-way Analyses of Variance (ANOVA) with post hoc comparisons (Tukey's Honestly Significant Difference Test) were conducted. When comparing more than one group, post hoc analysis facilitates locating the source of any differences. Because of the relatively large sample size, the recommended procedure of setting a significance level of $p<0.001$ was used for this analysis.

The full results of the analysis for each variable can be found in appendix 3 (ethnicity and appendix 4 (area of residence). The findings are summarised here. For ethnicity, no significant differences were found expect for intentions. Comparison of the means for intention scores revealed a significant difference between New Zealand European and Cook Island Maori and between New Zealand European and Tongan. New Zealand European recorded the lowest mean intention score (6.93) and Cook Island Maori (10.9) and Tongan (11) the highest. No other significant differences were found for this factor.

For area of residence, no significant differences were found for any variables. If the rigorous assessment criterion were relaxed, a difference for intentions could be identified between Rodney District and Manukau City for this variable. Rodney District recorded the lowest mean intention score (6.39) and Manukau City the highest (8.39). This difference is statistically marginal. No other significant differences were found for this factor.

Overall, these analyses suggest considerable comparability in mean scores across ethnic groups and areas of residence. The differences that were found were minor and afford very limited opportunity for the more detailed analyses of differences. These data suggest that intervention can be planned for the region as a whole. It should, however, be noted that the several ethnic groups had small sample sizes. The distribution of respondents across areas of residence provided a more representative distribution of response for this comparison.

7. CONCLUSION ABOUT MODEL

7.1 Implications of excluded variables

An important question concerns the degree to which the model accounts for resilience relative to those factors excluded on the grounds of their not being amenable to change through the planning process. The model currently accounts for 37% of the variance in intentions. If the full 400 cases had been available, the model could have accounted for 40-45% of the variance in intentions (and this would have allowed other factors such as self-efficacy to be included). On the basis of accounting for 37%, the model represents a good predictor, and this represents a conservative estimate.

The next question concerns the contribution of factors excluded from the analysis. For other studies, the independent contribution of these factors can be estimated as personality (20%), generalised anxiety (5%), specific hazard anxiety (5%), and social norms/attitudes (8%). Personality (as measured by the five factor model) cannot be changed. The other factors can, although with difficulty. Taken together, it can be estimated that they might account for another 20-30%. Other factors that fall into this category are interpretive biases.

Peoples' judgments regarding their need to confront hazard issues is influenced by their decisions being made from comparisons with 'other people' rather than on a more objective assessment of environmental threat. When asked to rate their preparedness relative to others within their community, individuals often believe themselves to be better prepared relative to the average for their community. This pattern was found in the present study. People rated themselves as better prepared than other members of their community. This statistical anomaly, known as unrealistic optimism bias, means that while people may accept the need to prepare, they perceive this need as applying to others but not to themselves (Paton et al., 2006). That is, they transfer risk to others within their community. If everybody is making similarly biased assumptions about the distribution of risk within a community, the need for action will be attributed to others, with personal motivation to act being diminished accordingly.

A discrepancy between expert and citizen estimates of risk can reflect citizens' tendency to overestimate the capacity of hazard mitigation strategies to eliminate a threat. This overestimation reflects the operation of an interpretive bias known as risk compensation (Adams, 1995). This construct describes how people maintain a balance between the perceived level of safety proffered by their environment and the level of risk that they can take in their actions and attitudes. Thus, a perceived increase in extrinsic safety (e.g., the fact that hazard monitoring and structural mitigation are being undertaken by ARC) will decrease perceived risk, reducing their motivation to act. For example, the dissemination of information on volcanic hazard preparedness to the public in Auckland reduced levels of both perceived risk and the need for preparedness in households, and resulted in Auckland residents transferring responsibility for their safety to ARC (Ballantyne et al., 2000).

As is true of all the actions and decisions that people make, there are likely to be many things that contribute to explaining the differences in the outcomes observed between people. The above list outlines those that are commonly occurring. There are other factors that may be more idiosyncratic. This is true for all behaviour and not just for resilience. We can include other factors, but they may only account for another 1-2%, and the costs of changing them may not be supported by the low benefit obtained from doing so. The object is to identify how well we can make predictions and whether the level represents a good return on investment. This model allows us promote a 40% change by acting on only 8 factors.

The low levels of adaptive capacity recorded (general preparedness, knowledge, community) also has a bearing on this interpretation. The prevailing low levels of adaptive factors suggest that the developmental process could defined as being in its early stages. The fact that the model can provide this level of explanation at this point in the process adds to its utility. With regard to what this means in practice, if the application of the model resulted in a conservative increase of 10% in adaptive capacity that could translate into a reduction in economic recovery from, for example, 10 days to 9 days. Savings that would ensue are substantial. They are even greater if the reduction in insurance costs, impact on mental health services and, in more immediate terms, the increase in social capital, is taken into account.

7.2 Using Intentions versus Preparedness/knowledge

Resilience is fundamentally about people and communities having the resources, competencies and relationships with others and with societal institutions in place to facilitate their capacity to cope with, adapt to, and develop from disaster experience. For this reason, it was originally intended to use measures of actual preparedness, knowledge and collaboration as the measure of resilience. However, analysis revealed that levels of these were very low.

When most people are scoring at low levels, the level of variability in the data is low. Techniques like structural equation modelling rely on variability. It explains why this variability occurs and identifies those factors that account for the variability in peoples' actions. If, however, their is no variability, it is not possible to conduct an analysis as their is nothing to explain (nobody does anything). For this reason, the focus was switched to intentions.

When people have not done things, intentions represent a good predictor of future actions (Bennet & Murphy, 1999; Paton et al, 2005). While a measure of intentions would always have been included in the model, it would have been as a mediating variable rather than the dependent variable. As work is undertaken to develop resilience, it will be important to reapply the model to examine the relationships between it and actual levels of adaptive capacity (preparedness, knowledge, community collaboration, relationships with societal institutions).

7.3 Implications for future surveys

An important outcome of the project was a reduction in the number of variables required. This not only provides a more parsimonious model for planning, it also reduces the costs of conducting future surveys and the costs of future resilience assessment and program evaluation work.

8. IMPLICATIONS OF THE MODEL FOR CDEM GROUP WORK PROGRAMS

8.1 A cost-effective planning tool

An important outcome of the current work was reducing the number of variables required to model resilience. This provides emergency management planners with a parsimonious, cost-effective device to assist planning and making choices regarding the nature and distribution of interventions.

8.2 Benefits of Model: Planning implications

A generic model possesses the flexibility to assess resilience within an all-hazards environment in ways that accommodate demographic and regional differences. Having a measure of certainty regarding what causes change in salient factors is an important tool for planning. It identifies those issues that can profitably be attended to and those that can be relegated. Given the complexity of social change phenomena, this process simplifies the highly complex social change management process.

By demonstrating its reliability for all hazards and groups the model provides a cost-effective approach to resilience planning and offers several benefits. It provides an evidence-based framework capable that facilitates making comparable assessments of resilience throughout the region.

With a common assessment and planning framework at their disposal, territorial, city and regional planners can compare and contrast groups and regions and combine data from different groups or areas to construct a composite regional assessment. Comparability of this nature is essential for the effective management of risk through facilitating resilience, managing the effective distribution of limited resources to assist intervention planning, and planning resource deployment based on differences in resilience assessment to assist response and recovery.

8.3 Implications of the Model for Risk Communication and Readiness Programs

The factors that comprise the model have significant implications for risk communication and hazard readiness strategy design (including public hazard education based on the dissemination of information to people). In particular, it calls into question the value of strategies based on the passive dissemination of information to the public. The model identifies several issues with implications for risk communication.

An important issue here relates to the discrete nature of positive and negative outcome expectancy. This means that one strategy is required to undermine negative outcome expectancy. Only after this has been done are strategies intended to increase positive outcome

expectancy likely to be effective. Strategies designed to change positive outcome expectancy will not influence negative outcome expectancy and vice versa. Currently, most public hazard education programs are designed to influence positive outcome expectancy. However, for those with negative outcome expectancy beliefs, this information is more likely to be ignored, reducing the effectiveness of this approach.

Strategies based on the passive dissemination of information are ill-suited to helping people a) make the diverse range of decisions associated with developing adaptive capacity, and b) through the developmental process of learning (knowledge and skills). The first point reflects the diversity of the variables in the model. The second relates to the fact that resilience does not just come into being. It has to be learnt over time and any process designed to facilitate this must accommodate this learning process.

An important issue here is that, at any point in time (as evident on examination of the standard deviations in Table 9), people are likely to be at different stages in this developmental process. If the public education program is to be effective it must be able to match its content with the stage in the developmental process that people are at. That is, people must be able to access information at a level commensurate with their needs and expectations. This is a difficult issue for any public education program to deal with. As is evident from the data discussed here, people differ with regard to their prevailing levels of knowledge and their capacity to develop their understanding of hazards. Given this variability, the information presented need not be relevant for everybody; for some it may be right, but others may find it superficial (Paton et al., 1999). This issue will become more pertinent over time as levels of adaptive increase. At present, low levels of preparation and knowledge justify the use of information dissemination techniques. Because this tends to be passive, however, it is less appropriate as a device capable of contributing to the sustained development of resilience.

The second issue concerns the fact that the development of resilience is a learning process that involves acquiring progressively more complex and/or new information (e.g., building understanding of hazards and their link to mitigation options), competencies (e.g., applying preparedness measures, working with others to identify salient issues) and relationships (e.g., community participation). Even if the information made available triggers the process, it would be necessary to provide progressively more advanced information to match peoples' learning progress. This is a difficult task. Because people learn at different rates, it is not easy to provide information through a public education medium to support this learning.

One approach to dealing with this issue would involve making use of interactive web sites as a vehicle for hazard readiness and education strategies. This medium is better suited to the progressive dissemination of information through different levels of complexity. The system can be set up to allow progress to the next level only after satisfactory performance at a previous level. This approach would accommodate different levels of existing knowledge and rates of learning. Additional work would be required to identify the content of each level and the relationships between them. This approach should not, however, be seen as negating the need to include a community development aspect to readiness planning.

While some factors (e.g., the outcome expectancy variables) are amenable to change through public education routes <u>to some extent</u> (e.g., making more comprehensive information on the nature of hazards available), wholesale change in outcome expectancy will not be achieved by the use of this media alone. For example, the development of sustained levels of positive outcome expectancy (which is important given the infrequent nature of hazard events) is linked to discussion with others. Change strategies thus require a social component.

The other factors identified in the model are less amenable to change using public communication strategies. For example, public information can advise of the importance of discussion with others but it cannot develop problem solving skills. The latter can only achieved through active involvement in problem solving activities with others. That is, change requires some measure of community engagement and working with community members to encourage their participation in community activities. The model also suggests that resilience is enhanced when civic agencies empower community members rather than imposing their views upon community members. At this level change may be required at both community and institutional levels.

Building capacity through engaging community members about hazards with potentially devastating consequences significantly influences their commitment to take responsibility for their own safety and to trust sources of information. By involving community members in decision making about risk management, citizens are less inclined to 'scapegoat' those responsible for emergency management planning (Paton & Bishop, 1996). This appears to be due to greater community knowledge of the trade-offs involved in creating safer environments.

The finding that people may over-estimate their hazard preparedness (see section 6.3.1) has additional implications for risk communication. If people over-estimate their preparedness they are less likely to attend to risk messages, particularly if presented in a passive format.

8.4 Emergency Management and Community Development

The model comprises factors that reflect a) personal disposition (action coping) b) peoples' perceived relationships with hazards (positive and negative outcome expectancy), and c) their perception of their relationship community activities and the wider society (community participation, articulating problems, empowerment). Trust falls in between. It will reflect the attitudes and expectations that citizens have developed as a result of their interaction with societal institutions and it will be influenced by their specific experiences with emergency management agencies. The infrequent nature of hazard events, the lack of direct experience, and the consequent need to rely on information from formal (e.g., emergency management agencies) and informal (e.g. other community members, social clubs, church group) sources, means that their perception of the adequacy of the information and advice received from formal sources means that trust remains a significant component in a model of resilience.

Intervention to increase resilience will thus require strategies designed to accommodate both hazard and community factors. That is, they will require the integration of emergency planning and community development resources. From an intervention perspective, this means that strategies designed specifically by emergency management agencies will be required to secure change in positive and negative outcome expectancy. Securing change in community participation, articulating problems, empowerment and trust will require collaborative efforts between community development and emergency management agencies.

8.4.1 Resilience, Community Engagement and Community Development

Several studies (Bishop et al., 2000; Lasker, 2004; Paton & Bishop, 1996; Paton et al., 2001; Pearce, 2003; Rich et al., 1995) have identified prior involvement in community activities and functions (e.g., membership of clubs or social action groups) as a significant predictor of adaptation to hazard consequences. Adaptive capacity can be forged and sustained through community engagement in activities concerned with identifying and dealing with local issues

even if they have little or nothing to do with hazard readiness per se. This is reflected in the fact that the levels of the community- and institution-level factors in the model reflect peoples' general experience of life in Auckland. This is important. It provides a strong, pre-existing base from which to build a more resilient Auckland. Emergency management planners do not need to start from scratch.

Participation in identifying shared problems and collaborating with others to develop and implement solutions to resolve them engenders the development of several resilience competencies (e.g., self-efficacy, action coping, community competence). The effectiveness of these activities can be increased when motivated and sustained by active community leadership (Dalton et al., 2001). Lasker (2004) revealed community members' preference for community-based hazard planning to be based around competent and credible individuals selected from within their community who are trained (e.g., to provide advice, assist them to make decisions that reconcile protective actions and their needs) specifically to assist their fellow community members. According to this approach, an important aspect of community engagement involves identifying and training people within the community to fulfil these roles.

While a role for community leadership was not evident in the present sample (the leadership items were not significant predictors), it is possible that this reflects currently low levels of community participation regarding hazard issues. Furthermore, given the rarity of volcanic events, it will be difficult for people to identify someone to whom they could turn for guidance. It may become more important as hazard issues become progressively more important as subjects for community action. It may also become more prevalent when examining hazards with greater immediacy (e.g., a pandemic scenario).

The feasibility of adopting this approach was demonstrated by a community engagement project undertaken by Auckland City Council in 2000-2001. This process involved using community board representatives in this leadership role, providing them with training in hazard mitigation issues, and developing their capacity to provide feedback regarding salient hazard issues within their respective jurisdictions. This project demonstrated not only the feasibility of this approach, it also demonstrated its potential as a cost-effective means of both disseminating information (that could be tailored to the specific needs of its recipients) and obtaining information on community needs. With respect to the latter, is clear that emergency management planning may profit from being actively integrated with community development planning (Paton, 2000).

To facilitate this integration, representatives of community groups (e.g., community boards or action groups, neighbourhood watch, religious and ethnic groups) could be invited to review hazard scenarios with regard to the potential challenges, opportunities and threats they could pose for each group (Lasker, 2004; Paton, 2000). The outcome of this process would provide the information and resource requirements necessary for community-led mitigation strategies that are more consistent with the diverse beliefs, values, needs, expectation, goals and systems that characterize contemporary communities. This point reiterates the need for emergency management planning to facilitate community empowerment. That is, to ensure that intervention focuses on mobilizing community resources to facilitate adaptive capacity rather than imposing institutional decisions on a community. The identification of links between emergency management and community development agencies in the model also identifies potentially cost-effective approaches to intervention by utilizing programs designed to enhance quality of community life.

One approach to achieving this would involve emergency planners assimilating and

coordinating the needs and perspectives derived from community consultation, and providing the information and resources necessary to empower community groups and sustain self-reliance and resilience. Emergency management agencies would thus act as consultants to communities (e.g., facilitators, resource providers, change agents, coordinators) rather than directing the change process in a top down manner (Paton, 2000). This approach can help embed the processes by which adaptive capacity is developed into the fabric of community life.

8.4.2 Implications for planning: Resource limitations

Optimizing change in resilience requires intervention across all variables in the model. However, if resources are scarce, the model can be used to plan the most cost-effective use of resources by selecting those factors with the greatest individual impact on resilience. For example, if resources were scarce, attention could be directed to securing change in those factors with a direct relationship with intentions; reducing negative outcome expectancy and increasing positive outcome expectancy, action coping and community participation. Change in these factors would have some knock-on effect with regard to changing levels of articulating problems, empowerment and trust.

In this way the model affords opportunities for making decisions regarding resource use. If resources are limited, attention can be directed to a smaller number of variables. This approach should be seen as a last resort. Intervention at all levels is recommended. A focus on only a restricted range of factors would result in a corresponding reduction in the overall level of change in resilience that can be achieved.

It is important to view the model in an holistic way. It is their collective action that is important. While what you suggest is valid, if the resilience development program had limited resources. However, positive outcome expectancy only has this value when it is included with the other model variables. On its own, its beta value (strength of prediction) drops from .43 to .18 and it would account for only about 8% of the variance in intentions. So, if this action were followed, the impact would be considerably muted relative to its influence in conjunction with other model variables. The same is true for all other model variables; their values and influence is a function of their collective action.

9. DISCUSSION/ FUTURE WORK/ RECOMMENDATIONS

9.1 Future work suggestions

9.1.1 Intervention Strategies

Work with practitioners to develop risk communication strategies and work through issues involved in converting ideas into practical intervention strategies.

9.1.2 Testing Model Against other Scenarios

Auckland has a complex hazard-scape and is susceptible to the action of several hazards. Consistent with the all-hazards philosophy implicit within contemporary emergency management, it is important to test the utility of the model against other hazards. The question arises regarding the selection of an appropriate scenario to conduct a confirmatory test.

A key requirement for any scenario is that it creates relatively uniform levels of risk for all residents in Auckland. It is also important that it requires people to engage in preparatory actions, the choice of which are under their control (i.e., they decide whether to have them or not) and that can be secured through relationships with others and the wider society (note, this includes information, clarification etc).

This first condition, regarding uniform risk, is necessary to limit confounding effects for those whose geographical location would reduce their need to confront hazard consequences. This would rule out, for example, using flooding or tsunami hazards. The distribution of their consequences is geographically constrained. If future work were conducted in specific areas, the model could be re-run for these hazards. To do so would, however, limit the generalizability of the model. It is the relatively equal distribution of risk throughout Auckland associated with volcanic hazards that makes it an appropriate hazard for model development.

An alternative for future work would be a health issue, with bird flu or a flu pandemic representing an appropriate choice. It creates a uniform level of risk for all. This provides a basis for examining variations in levels of preparedness and satisfies the criteria for a scenario capable of testing a generic model.

9.1.3 Testing with Full Sample

Subsequent tests of the model would also include variables (e.g., self-efficacy) that were excluded here as a result of the need to exclude cases as a consequence of the inclusion of a “don’t know’ category. The inclusion of these variables would still represent a significant saving on future surveys (fewer variables) and provides a concise instrument that can be used by ARC for future resilience assessment and program evaluation.

9.1.4 Including Controllable and Non-controllable Factors

The model could be developed to include non-controllable factors (e.g., personality, anxiety, social (community) norms, and attitudes to hazard and their mitigation) to construct a more comprehensive model.

9.1.5 Model Testing and the Evaluation Process

As resilience develops, additional factors can be included in the model. Factors that fall into this category would include problem solving and leadership (see section 8.4). An important point here is recognition that the development of these factors, and those in the existing model, can provide a return on investment in terms of enhancing quality of community life. This would not be required until a substantial increase in levels of preparedness had occurred.

9.1.6 Demographic Issues

It should be noted that numbers in some demographic groups (e.g, Chinese) were low. Previous work in Auckland City (Paton, 2002) had tested a simpler version of this model (which included a sample of 100 Chinese residents and 67 Pacific Island residents) which supports the utility of the underlying theory. However, the low numbers preclude identifying whether this group should be prioritized for intervention or whether level of variables are comparable with those of other groups. Future work could specifically target this issue to ensure that the distribution of groups is comparable to that described in the census.

9.2 Personal and Community Resilience: Integration with comprehensive model of societal resilience

The work presented here models personal/community resilience. It represents one component of a comprehensive resilience model. The ability of a community to adapt to adverse or challenging circumstances and recover using its own resources requires that attention be directed to safeguarding the physical integrity of the built environment and lifelines (e.g., land use planning, design standards, building codes, retrofitting buildings). Given that work on the latter has been conducted by the Auckland Lifelines Engineering group will allow the outcomes of the present project to complement these activities and provide a more comprehensive basis for future risk assessment regarding Auckland's capability to adapt to and develop from hazard events. Future work can examine links between personal/community factors and sustained business continuity and economic sustainability in the process of developing a model that focuses on societal-level resilience. The present model provides several points of contact and integration. For example, levels of action coping and articulating problems could be sustained by work, providing a link with business continuity planning.

10. A RESILIENCE INDICATOR

A basic resilience indicator is used here. It was calculated by converting all scales to a common 1-10 scale and calculating the mean score from these re-calibrated values. Using this indictor, the resilience score is a composite expressed as a value from 1 – 10.
Auckland's current resilience indicator score is 5.53.

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12. APPENDICES

APPENDIX 1 — INITIAL COMMUNITY RESILIENCE QUESTIONNAIRE

For the purpose of this study, the localities mentioned throughout the survey are defined as follows:
Neighbourhood: The surrounding residential locality where you live.
Community: The larger surrounding district composed of a number of neighbourhoods or adjacent suburbs.

Demographic Information (please circle a response as appropriate)

Age:	20 or under	1	Ethnicity	Maori	1
	21 - 40	2		Pakeha/European	2
	41-64	3		Pacific Islander	3
	65 or over	4		Asian	4
				Other	5

Average Household Income:

$25,000 or less	1
$26,000 – 44,000	2
$45,000 – 65,000	3
$66,000 and over	4

Level One
Individual Community Member

1. Critical Awareness

In regard to what happens in your *community*, please describe the extent to which you agree or disagree with each of the following statements:

	Once a week or more	A few times a month	Once a month	A few times a year	Rarely	Never
I think about issues and problems in my community	6	5	4	3	2	1
I talk about problems and issues in my community	6	5	4	3	2	1

2. Action Coping
In regard to how you normally deal with any problem in your *life*, please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I try to come up with a strategy about what to do	5	4	3	2	1
I make a plan of action	5	4	3	2	1
I think hard about what steps to take	5	4	3	2	1
I think about how I might best handle the problem	5	4	3	2	1

NEGATIVE OUTCOME EXPECTANCY

3. Please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
Volcanic eruptions are too destructive to bother preparing for	5	4	3	2	1
A serious volcanic eruption is unlikely to occur in my lifetime	5	4	3	2	1
Preparing for volcanic eruptions is inconvenient	5	4	3	2	1
It is difficult to prepare for volcanic eruptions	5	4	3	2	1

POSITIVE OUTCOME EXPECTANCY

4. Please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
Preparing for volcanic eruptions will significantly reduce damage to my home should an eruption occur	5	4	3	2	1
Preparing for a volcanic eruption will improve the value of my house/property	5	4	3	2	1
Preparing for volcanic eruptions will significantly improve my ability to deal with disruption to family/community life following an eruption	5	4	3	2	1

5. Self-Efficacy

In regard to the issues and problems you deal with in your *everyday life*, please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I feel I have control over the things that happen in my life	5	4	3	2	1
There is no way I can solve some of the problems I have by myself	5	4	3	2	1
I can't do much to change what happens in my life	5	4	3	2	1
Somehow problems in my life usually solve themselves	5	4	3	2	1

6 Intentions

In the next month or so, do you intend to (please circle as appropriate):

	No	Possibly	Definitely
Check your level of preparedness for volcanic eruptions	1	2	3
Increase your level of preparedness for volcanic eruptions	1	2	3
Become involved with a local group to discuss how to reduce damage or loss from volcanic hazards	1	2	3
Seek information on volcanic risk	1	2	3
Seek information on things to do to prepare for volcanic eruptions	1	2	3

Level Two
Community

1. Sense of Community

In regard to living in this *community* generally, please describe the extent to which each statement applies to you

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I think my neighbourhood is a good place for me to live	5	4	3	2	1
People in this neighbourhood do not share the same values	5	4	3	2	1
My neighbours and I want the same things from the neighbourhood	5	4	3	2	1
I can recognize most of the people who live in my neighbourhood	5	4	3	2	1
I feel at home in this neighbourhood	5	4	3	2	1
Very few of my neighbours know me	5	4	3	2	1
I care about what my neighbours think of me	5	4	3	2	1
I have almost no influence over what this neighbourhood is like	5	4	3	2	1
If there is a problem in this neighbourhood people who live here can solve it	5	4	3	2	1
It is very important to me to live in this particular neighbourhood	5	4	3	2	1
People in this neighbourhood generally do not get along with each other	5	4	3	2	1
I expect to live in this neighbourhood for a long time	5	4	3	2	1

2. Community Participation

In regard to participating in life in this *community*, please describe how often you undertake each of the following.

	Often	Sometimes	Rarely	Never
I have worked with others on something to improve my neighbourhood	4	3	2	1
I participate in local activities or events (e.g., festivals, fetes, fairs)	4	3	2	1
I have contributed money, food or clothing to local causes, charities, or others in my community	4	3	2	1
I have attended a public meeting on a community issue	4	3	2	1
I have been involved in volunteer activities intended to benefit my community (e.g., fundraising, clean-up days, local groups, Scouts/Brownies).	4	3	2	1

3. Cognitive empowerment/Collective efficacy

In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I can have power in my community only by working in an organized way with other people	5	4	3	2	1
Power is collective, not individual	5	4	3	2	1
Power lies in the relationship between people	5	4	3	2	1
A person becomes powerful through other people	5	4	3	2	1
The only way I can have power is by connecting to others	5	4	3	2	1

4. Social Support

In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
If need be, I would trust my neighbours to watch my home when I am away	5	4	3	2	1
The friendships and associations I have with other people in my neighbourhood mean a lot to me	5	4	3	2	1
People in my neighbourhood lend things or exchange favours with one another	5	4	3	2	1
People in my neighbourhood are happy to help one another	5	4	3	2	1
My neighbours are willing to provide advice to me if I ask for it.	5	4	3	2	1

5. Diversity

In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
A mixture of cultures makes life in my community better	5	4	3	2	1
I enjoy living among people of different life styles	5	4	3	2	1
Cultural and language barriers make it difficult to communicate with my neighbours	5	4	3	2	1

6. Articulating Problems/Leadership

In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
People around here will express an opinion even though they know it will be unpopular	5	4	3	2	1
When it comes to saying something in front of a group, most people around here will do it	5	4	3	2	1
When people are needed to stand before a group of outsiders to tell them what this community needs, most people here could do it	5	4	3	2	1
In community meetings, I am often a leader	5	4	3	2	1
In community meetings I prefer to be a leader rather than a follower	5	4	3	2	1
In community meetings, I prefer others to take over the leadership role	5	4	3	2	1
What a community talks about depends on what residents are interested in	5	4	3	2	1
Struggles always occur to determine what issues this community should focus on	5	4	3	2	1
Community perceptions depend on the quality of the individuals in that community	5	4	3	2	1
How people think about community problems controls what is done about those problems	5	4	3	2	1

Level Three
Institutional Level Indicators

1. Empowerment

In regard to what happens in your *community*, in general, to what extent do you think that:

	Always	A great deal	Sometimes	Not very much	Not at all
Voting in local elections influences what happens in my community	5	4	3	2	1
Voting in local elections helps solve local problems	5	4	3	2	1
Community groups can get something done about local problems	5	4	3	2	1
I feel that I can influence what happens in my community	5	4	3	2	1
I feel that I see positive results from participating in community activities	5	4	3	2	1
I feel that I have an active part in keeping this community going	5	4	3	2	1
I care about how my community looks	5	4	3	2	1
I feel that what happens in this community can affect my life	5	4	3	2	1
I have strong opinions about the way things are done by elected representatives	5	4	3	2	1
I think that elected representatives seriously consider my opinions	5	4	3	2	1
I think that elected representatives try to influence what goes on in my community	5	4	3	2	1

2. Trust

In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I trust my Local Government to respond to meet the needs of its residents	5	4	3	2	1
I trust the community leaders in my community	5	4	3	2	1
I trust the media (newspapers, TV, radio) to report fairly	5	4	3	2	1
I trust my Local Government to do what is right for the people they represent	5	4	3	2	1
I have confidence in the law to protect and maintain order in my community	5	4	3	2	1

Outcome Measure?

To be read out by interviewer:

A volcanic eruption can damage property (e.g., your home, car) and result in the loss of the services we normally rely on (e.g., power, water). Emergency Management has identified several things that people can do within a household to minimise damage and disruption should a volcanic eruption occurs. Could you please describe/list what you have done to protect yourself/family?

If respondents have difficulty responding or are unsure, please prompt with:

Have you secured items that could be knocked over and injure someone;
have you accumulated items that would allow you to get by if your house lost its power/water has your family thought about what it might do?

Do you know the location of the Know how to operate it

Main water valve
Gas valve
Electric power switch

Do you have spanners to operate shut off valves an d switches
Are cabinet doors fastened with latches
Is the water heater fastened to the wall
Is tall furniture (bookcases) fastened to the wall
Are heavy objects (e.g. mirrors, paintings) fastened to the walls
Does your house have a volcanic eruption emergency plan
If a volcanic eruption occurred during the day, does your plan cover where the family should meet
If a volcanic eruption necessitated that you evacuate your house, does your plan cover where the family will go

Relatives
Friends
Marae

Have you listened/watched radio or television for volcanic eruption preparedness methods
Do you have an emergency kit containing

Flashlight/torch
Batteries for flashlight/torch
Portable radio
Batteries for radio
First aid kit
2 litres of water (in plastic containers) per person for 3 days
3 days supply of dehydrated or canned food
A portable stove or barbecue for cooking heating

Do you check the contents/operation of your emergency kit every month
Do you have a fire extinguisher
Do you know how to operate a fire extinguisher

Do you know the five things listed in the Yellow Pages of what to do in the event of a volcanic eruption

Name them

1
2
3
4
5

To be read by interviewer:
If a volcanic eruption were to occur in Auckland Region, what volcanic hazards (i.e., the physical consequences capable of causing harm/disruption) might you have to deal with
If respondents have difficulty responding or are unsure, please prompt with:
People usually think of lava when they think of volcanoes. Could it cause earthquakes or through material into the air?

Ashfall
Hazard from inhaling it
Hazard from it accumulating on roofs/spouting/downpipes
Hazard when driving on roads
Gases
Breating problems, particularly for asthmatics etc
Problems from corrosion of metals
Bombs
Physical damage
Earthquakes
Dislodge furniture/disrupt pipes etc
Fire from falling volcanic rocks or lava
Tape to prevent fine ash entering windows and doors
Removal of ash from roof
Metal buckets and water hoses
Storing ash until it is removed by the authorities
Ensuring ash is not washed into the storm water system
Knowing how to remove ash from car/windscreen
Having spare air filter for car
Having dust masks to prevent inhaling ash/dust
Know to turn off/cover air conditioners and computers to prevent ash destroying internal moving parts
Not using vacuum cleaners to clean up ash inside the house

The following activities help prepare a *community* if a volcanic eruption occurs. Please record whether they currently apply to your community (circle those that apply).

Yes No

Have you worked with others in your neighbourhood or community to consider how a volcanic eruption might affect your community
If yes, please briefly describe what this involved/what was decided?
_____
Have you worked with others in your neighbourhood or community to develop a volcanic response plan
If yes, please briefly describe what this involved/what was decided?
_____
Does your neighbourhood have a fire protection plan
Have you or any family members been involved in meetings on volcanic eruption preparedness

At school
In the local community

If yes, please briefly describe what this involved/what was decided?
_____
Have you discussed the need for volcanic eruption preparedness with:

Your neighbours
Your council

If yes, please briefly describe what this involved/what was decided?
_____

Please rate (from 1 = not at all prepared to 5 = very prepared) the extent to which you perceive each of the following is prepared to deal with an volcanic eruption

	Not at all prepared			Very prepared	
Yourself	1	2	3	4	5
Your community	1	2	3	4	5
Your local council (incl Civil Defence/Emergency Management)	1	2	3	4	5
Central government	1	2	3	4	5

APPENDIX 2 — FINAL COMMUNITY RESILIENCE QUESTIONNAIRE

For the purpose of this study, the localities mentioned throughout the survey are defined as follows:
Neighbourhood: The surrounding residential locality where you live.
Community: The larger surrounding district composed of a number of neighbourhoods or adjacent suburbs.

Demographic Information (please circle a response as appropriate)

Age:	20 or under	1	Ethnicity	Maori	1
	21 - 40	2		Pakeha/European	2
	41-64	3		Pacific Islander	3
	65 or over	4		Asian	4
				Other	5

Average Household Income:

$25,000 or less	1
$26,000 – 44,000	2
$45,000 – 65,000	3
$66,000 and over	4

Level One
Individual Community Member
1. Action Coping
In regard to how you normally deal with any problem in your *life*, please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I try to come up with a strategy about what to do	5	4	3	2	1
I make a plan of action	5	4	3	2	1
I think hard about what steps to take	5	4	3	2	1
I think about how I might best handle the problem	5	4	3	2	1

NEGATIVE OUTCOME EXPECTANCY
2. Please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
Volcanic eruptions are too destructive to bother preparing for	5	4	3	2	1
A serious volcanic eruption is unlikely to occur in my lifetime	5	4	3	2	1
Preparing for volcanic eruptions is inconvenient	5	4	3	2	1
It is difficult to prepare for volcanic eruptions	5	4	3	2	1

POSITIVE OUTCOME EXPECTANCY

3. Please describe the extent to which you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
Preparing for volcanic eruptions will significantly reduce damage to my home should an eruption occur	5	4	3	2	1
Preparing for a volcanic eruption will improve the value of my house/property	5	4	3	2	1
Preparing for volcanic eruptions will significantly improve my ability to deal with disruption to family/community life following an eruption	5	4	3	2	1
	5	4	3	2	1

Level Two
Community

1. Community Participation

In regard to participating in life in this *community*, please describe how often you undertake each of the following.

	Often	Sometimes	Rarely	Never
I have worked with others on something to improve my neighbourhood	4	3	2	1
I participate in local activities or events (e.g., festivals, fetes, fairs)	4	3	2	1
I have contributed money, food or clothing to local causes, charities, or others in my community	4	3	2	1
I have attended a public meeting on a community issue	4	3	2	1
I have been involved in volunteer activities intended to benefit my community (e.g., fundraising, clean-up days, local groups, Scouts/Brownies).	4	3	2	1

6. Articulating Problems

In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
What a community talks about depends on what residents are interested in	5	4	3	2	1
Struggles always occur to determine what issues this community should focus on	5	4	3	2	1
Community perceptions depend on the quality of the individuals in that community	5	4	3	2	1
How people think about community problems controls what is done about those problems	5	4	3	2	1

Level Three
Institutional Level Indicators

1. Empowerment
In regard to what happens in your *community*, in general, to what extent do you think that:

	Always	A great deal	Sometimes	Not very much	Not at all
I feel that I can influence what happens in my community	5	4	3	2	1
I feel that I see positive results from participating in community activities	5	4	3	2	1
I feel that I have an active part in keeping this community going	5	4	3	2	1
I think that elected representatives seriously consider my opinions	5	4	3	2	1

2. Trust
In regard to your general feelings about living in this *community*, please describe the extent to which you agree or disagree with each statement.

	Strongly agree	Agree	Neither Agree nor disagree	Disagree	Strongly disagree
I trust my Council to respond to meet the needs of its residents	5	4	3	2	1
I trust the community leaders in my community	5	4	3	2	1
I trust the media (newspapers, TV, radio) to report fairly	5	4	3	2	1
I trust my Council to do what is right for the people they represent	5	4	3	2	1
I have confidence in the law to protect and maintain order in my community	5	4	3	2	1

3 Intentions
In the next month or so, do you intend to (please circle as appropriate):

	No	Possibly	Definitely
Check your level of preparedness for volcanic eruptions	1	2	3
Increase your level of preparedness for volcanic eruptions	1	2	3
Become involved with a local group to discuss how to reduce damage or loss from volcanic hazards	1	2	3
Seek information on volcanic risk	1	2	3
Seek information on things to do to prepare for volcanic eruptions	1	2	3

APPENDIX 3 — ETHNICITY AND MODEL VARIABLES

The descriptive statistics for each model factors by ethnic group are presented here. The second table summarizes the results of the Tukey's HSD test to ascertain whether differences between means were statistically significant. In this table similar mean scores are listed in the same column. Significant differences are identified by the number of columns.

Positive Outcome Expectancy (belief that hazard preparedness adds value to their everyday life)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	8.8661	2.42164	3.00	15.00
Maori	41	9.4634	2.91631	3.00	15.00
Samoan	14	10.5000	2.76656	5.00	14.00
Cook Island Maori	11	10.7273	2.32770	7.00	14.00
Tongan	10	10.8000	2.69979	5.00	14.00
Niuean	3	13.0000	2.00000	11.00	15.00
Other Pacific	2	10.5000	3.53553	8.00	13.00
Chinese	3	9.6667	4.04145	5.00	12.00
Indian	23	9.8696	2.47358	5.00	14.00
Other (specify)	54	10.0741	2.69067	3.00	15.00
Total	400	9.3500	2.61143	3.00	15.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	New Zealand European	239	8.8661
	Maori	41	9.4634
	Chinese	3	9.6667
	Indian	23	9.8696
	Other (specify)	54	10.0741
	Samoan	14	10.5000
	Other Pacific	2	10.5000
	Cook Island Maori	11	10.7273
	Tongan	10	10.8000
	Niuean	3	13.0000
	Sig.		.097

Means for groups in homogeneous subsets are displayed.

Negative Outcome Expectancy (belief that it is impossible to mitigate hazard consequences through personal action)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	10.9665	3.12602	4.00	19.00
Maori	41	9.5122	2.28169	4.00	15.00
Samoan	14	10.5000	3.52464	5.00	19.00
Cook Island Maori	11	11.0909	3.50584	7.00	18.00
Tongan	10	12.7000	4.83161	5.00	19.00
Niuean	3	14.0000	4.58258	10.00	19.00
Other Pacific	2	11.0000	.00000	11.00	11.00
Chinese	3	13.3333	2.08167	11.00	15.00
Indian	23	11.8696	3.74535	5.00	18.00
Other (specify)	54	10.4259	3.08742	4.00	16.00
Total	400	10.8675	3.20087	4.00	19.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	Maori	41	9.5122
	Other (specify)	54	10.4259
	Samoan	14	10.5000
	New Zealand European	239	10.9665
	Other Pacific	2	11.0000
	Cook Island Maori	11	11.0909
	Indian	23	11.8696
	Tongan	10	12.7000
	Chinese	3	13.3333
	Niuean	3	14.0000
	Sig.		.232

Means for groups in homogeneous subsets are displayed.

Action Coping (General problem solving ability)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	15.6025	3.07145	8.00	20.00
Maori	41	16.4634	2.87313	7.00	20.00
Samoan	14	16.3571	2.16997	13.00	20.00
Cook Island Maori	11	14.0909	3.17662	8.00	20.00
Tongan	10	14.8000	4.54117	4.00	20.00
Niuean	3	12.6667	4.16333	8.00	16.00
Other Pacific	2	15.5000	2.12132	14.00	17.00
Chinese	3	14.6667	2.30940	12.00	16.00
Indian	23	15.3913	2.21029	11.00	20.00
Other (specify)	54	15.7222	3.24716	7.00	20.00
Total	400	15.6300	3.06130	4.00	20.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	Niuean	3	12.6667
	Cook Island Maori	11	14.0909
	Chinese	3	14.6667
	Tongan	10	14.8000
	Indian	23	15.3913
	Other Pacific	2	15.5000
	New Zealand European	239	15.6025
	Other (specify)	54	15.7222
	Samoan	14	16.3571
	Maori	41	16.4634
	Sig.		.421

Means for groups in homogeneous subsets are displayed.

Community Participation (in local, community activities)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	11.5816	3.51835	5.00	20.00
Maori	41	13.5610	3.50035	6.00	20.00
Samoan	14	13.1429	4.05457	7.00	20.00
Cook Island Maori	11	11.9091	3.50584	7.00	17.00
Tongan	10	12.7000	3.71334	8.00	20.00
Niuean	3	7.0000	1.00000	6.00	8.00
Other Pacific	2	11.5000	.70711	11.00	12.00
Chinese	3	12.0000	1.73205	11.00	14.00
Indian	23	11.3043	3.13970	5.00	16.00
Other (specify)	54	12.6111	2.99948	7.00	20.00
Total	400	11.9675	3.49385	5.00	20.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	Niuean	3	7.0000
	Indian	23	11.3043
	Other Pacific	2	11.5000
	New Zealand European	239	11.5816
	Cook Island Maori	11	11.9091
	Chinese	3	12.0000
	Other (specify)	54	12.6111
	Tongan	10	12.7000
	Samoan	14	13.1429
	Maori	41	13.5610
	Sig.		.021

Means for groups in homogeneous subsets are displayed.

Articulating Problems (ability of members to define important issues for their community)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	14.4895	2.47655	4.00	20.00
Maori	41	15.2195	1.69576	12.00	19.00
Samoan	14	15.2857	2.84006	10.00	19.00
Cook Island Maori	11	13.8182	3.09251	8.00	17.00
Tongan	10	15.4000	1.83787	12.00	18.00
Niuean	3	16.0000	2.64575	13.00	18.00
Other Pacific	2	16.0000	.00000	16.00	16.00
Chinese	3	16.0000	.00000	16.00	16.00
Indian	23	14.9130	2.55686	9.00	19.00
Other (specify)	54	14.8704	1.94302	10.00	20.00
Total	400	14.7025	2.35858	4.00	20.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	Cook Island Maori	11	13.8182
	New Zealand European	239	14.4895
	Other (specify)	54	14.8704
	Indian	23	14.9130
	Maori	41	15.2195
	Samoan	14	15.2857
	Tongan	10	15.4000
	Niuean	3	16.0000
	Other Pacific	2	16.0000
	Chinese	3	16.0000
	Sig.		.806

Means for groups in homogeneous subsets are displayed.

Empowerment (degree to which community members feel the wider society facilities their ability to deal with their issues)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	10.7573	3.20184	4.00	19.00
Maori	41	12.6829	3.27444	5.00	18.00
Samoan	14	14.3571	2.53004	8.00	19.00
Cook Island Maori	11	12.4545	4.18004	4.00	18.00
Tongan	10	13.5000	3.80789	7.00	20.00
Niuean	3	15.3333	2.51661	13.00	18.00
Other Pacific	2	12.5000	.70711	12.00	13.00
Chinese	3	12.0000	6.55744	5.00	18.00
Indian	23	12.1304	2.36075	6.00	15.00
Other (specify)	54	12.1111	3.15431	7.00	20.00
Total	400	11.5100	3.33432	4.00	20.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	New Zealand European	239	10.7573
	Chinese	3	12.0000
	Other (specify)	54	12.1111
	Indian	23	12.1304
	Cook Island Maori	11	12.4545
	Other Pacific	2	12.5000
	Maori	41	12.6829
	Tongan	10	13.5000
	Samoan	14	14.3571
	Niuean	3	15.3333
	Sig.		.226

Means for groups in homogeneous subsets are displayed.

Trust (in social institutions and their members)

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	16.2845	3.69911	5.00	25.00
Maori	41	17.0732	3.45970	7.00	25.00
Samoan	14	18.0714	4.35827	11.00	25.00
Cook Island Maori	11	16.0000	4.53872	8.00	23.00
Tongan	10	20.7000	2.66875	15.00	25.00
Niuean	3	19.0000	5.56776	14.00	25.00
Other Pacific	2	20.0000	1.41421	19.00	21.00
Chinese	3	17.6667	.57735	17.00	18.00
Indian	23	18.4783	3.07290	12.00	23.00
Other (specify)	54	16.3519	4.30952	6.00	25.00
Total	400	16.7150	3.83478	5.00	25.00

	ETHNICITY	N	Subset for alpha = .001
			1
Tukey HSD	Cook Island Maori	11	16.0000
	New Zealand European	239	16.2845
	Other (specify)	54	16.3519
	Maori	41	17.0732
	Chinese	3	17.6667
	Samoan	14	18.0714
	Indian	23	18.4783
	Niuean	3	19.0000
	Other Pacific	2	20.0000
	Tongan	10	20.7000
	Sig.		.412

Means for groups in homogeneous subsets are displayed.

Intention to develop protective actions

	N	Mean	Std. Deviation	Minimum	Maximum
New Zealand European	239	6.9289	2.37440	5.00	15.00
Maori	41	8.5610	3.17056	5.00	15.00
Samoan	14	8.7857	2.69411	5.00	13.00
Cook Island Maori	11	10.9091	3.59039	5.00	15.00
Tongan	10	11.0000	2.82843	5.00	15.00
Niuean	3	12.3333	3.05505	9.00	15.00
Other Pacific	2	8.5000	2.12132	7.00	10.00
Chinese	3	6.3333	2.30940	5.00	9.00
Indian	23	8.7826	2.25543	5.00	13.00
Other (specify)	54	7.5741	2.52984	5.00	14.00
Total	400	7.6100	2.75625	5.00	15.00

	ETHNICITY	N	Subset for alpha = .001	
			1	2
Tukey HSD	Chinese	3	6.3333	
	New Zealand European	239	6.9289	6.9289
	Other (specify)	54	7.5741	7.5741
	Other Pacific	2	8.5000	8.5000
	Maori	41	8.5610	8.5610
	Indian	23	8.7826	8.7826
	Samoan	14	8.7857	8.7857
	Cook Island Maori	11	10.9091	10.9091
	Tongan	10	11.0000	11.0000
	Niuean	3		12.3333
	Sig.		.032	.005

Means for groups in homogeneous subsets are displayed.

APPENDIX 4 — AREA OF RESIDENCE AND MODEL VARIABLES

The descriptive statistics for each model factors by area of residence are presented here. The second table summarizes the results of the Tukey's HSD test to ascertain whether differences between means were statistically significant. In this table similar mean scores are listed in the same column. Significant differences are identified by the number of columns.

Positive Outcome Expectancy (belief that hazard preparedness adds value to their everyday life)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	8.5357	2.54562	4.00	14.00
North Shore City	60	9.1167	2.73143	3.00	14.00
Waitakere City	45	10.0222	2.43543	4.00	15.00
Auckland City	89	9.1798	2.44746	3.00	15.00
Manukau City	123	9.7642	2.75824	3.00	15.00
Papakura District	26	9.0000	2.33238	5.00	15.00
Franklin District	29	8.6552	2.46802	3.00	13.00
Total	400	9.3500	2.61143	3.00	15.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD(a,b)	Rodney District	28	8.5357
	Franklin District	29	8.6552
	Papakura District	26	9.0000
	North Shore City	60	9.1167
	Auckland City	89	9.1798
	Manukau City	123	9.7642
	Waitakere City	45	10.0222
	Sig.		.121

Means for groups in homogeneous subsets are displayed.

Negative Outcome Expectancy (belief - impossible to mitigate hazard consequences through personal action)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	11.8214	3.50717	5.00	18.00
North Shore City	60	11.2333	2.88988	4.00	19.00
Waitakere City	45	10.1556	3.16196	4.00	18.00
Auckland City	89	11.2921	3.22702	4.00	18.00
Manukau City	123	10.6829	3.25505	4.00	19.00
Papakura District	26	10.3077	3.94735	4.00	19.00
Franklin District	29	10.2759	2.15301	6.00	15.00
Total	400	10.8675	3.20087	4.00	19.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Waitakere City	45	10.1556
	Franklin District	29	10.2759
	Papakura District	26	10.3077
	Manukau City	123	10.6829
	North Shore City	60	11.2333
	Auckland City	89	11.2921
	Rodney District	28	11.8214
	Sig.		.204

Means for groups in homogeneous subsets are displayed.

Action Coping (General problem solving ability)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	14.8571	3.08778	8.00	20.00
North Shore City	60	15.6500	3.11815	8.00	20.00
Waitakere City	45	15.6000	2.79122	9.00	20.00
Auckland City	89	15.7528	3.33808	7.00	20.00
Manukau City	123	15.6016	2.96631	4.00	20.00
Papakura District	26	15.4615	3.42030	9.00	20.00
Franklin District	29	16.2759	2.58977	11.00	20.00
Total	400	15.6300	3.06130	4.00	20.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Rodney District	28	14.8571
	Papakura District	26	15.4615
	Waitakere City	45	15.6000
	Manukau City	123	15.6016
	North Shore City	60	15.6500
	Auckland City	89	15.7528
	Franklin District	29	16.2759
	Sig.		.346

Means for groups in homogeneous subsets are displayed.

Community Participation (in local, community activities)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	12.0000	3.11508	8.00	20.00
North Shore City	60	11.9333	3.19357	5.00	20.00
Waitakere City	45	11.9111	3.92441	5.00	20.00
Auckland City	89	12.2360	3.58666	5.00	20.00
Manukau City	123	11.9837	3.34856	5.00	20.00
Papakura District	26	11.3077	3.72848	5.00	18.00
Franklin District	29	11.7931	4.06535	6.00	20.00
Total	400	11.9675	3.49385	5.00	20.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Papakura District	26	11.3077
	Franklin District	29	11.7931
	Waitakere City	45	11.9111
	North Shore City	60	11.9333
	Manukau City	123	11.9837
	Rodney District	28	12.0000
	Auckland City	89	12.2360
	Sig.		.890

Means for groups in homogeneous subsets are displayed.

Articulating Problems (ability of members to define important issues for their community)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	14.8214	2.24522	6.00	19.00
North Shore City	60	15.0000	1.98298	8.00	18.00
Waitakere City	45	14.8889	2.60439	8.00	20.00
Auckland City	89	14.7528	2.32223	4.00	20.00
Manukau City	123	14.5772	2.34349	8.00	20.00
Papakura District	26	15.0000	2.88444	4.00	19.00
Franklin District	29	13.7931	2.42574	8.00	19.00
Total	400	14.7025	2.35858	4.00	20.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Franklin District	29	13.7931
	Manukau City	123	14.5772
	Auckland City	89	14.7528
	Rodney District	28	14.8214
	Waitakere City	45	14.8889
	North Shore City	60	15.0000
	Papakura District	26	15.0000
	Sig.		.226

Means for groups in homogeneous subsets are displayed.

Empowerment (degree to which community members feel the wider society facilities their ability to deal with their issues)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	11.2857	3.55754	6.00	19.00
North Shore City	60	10.8000	3.49236	4.00	18.00
Waitakere City	45	11.4889	3.20952	5.00	20.00
Auckland City	89	11.6180	2.93298	4.00	16.00
Manukau City	123	11.8455	3.51352	4.00	20.00
Papakura District	26	10.1538	3.42569	4.00	17.00
Franklin District	29	12.6897	2.86735	7.00	18.00
Total	400	11.5100	3.33432	4.00	20.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Papakura District	26	10.1538
	North Shore City	60	10.8000
	Rodney District	28	11.2857
	Waitakere City	45	11.4889
	Auckland City	89	11.6180
	Manukau City	123	11.8455
	Franklin District	29	12.6897
	Sig.		.009

Means for groups in homogeneous subsets are displayed.

Trust (in social institutions and their members)

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	16.2857	3.50510	9.00	22.00
North Shore City	60	17.0500	3.46618	10.00	25.00
Waitakere City	45	16.8222	3.79167	7.00	25.00
Auckland City	89	15.8876	3.92960	5.00	23.00
Manukau City	123	17.1138	4.25846	7.00	25.00
Papakura District	26	16.1154	3.01101	9.00	22.00
Franklin District	29	17.6552	3.09696	9.00	24.00
Total	400	16.7150	3.83478	5.00	25.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Auckland City	89	15.8876
	Papakura District	26	16.1154
	Rodney District	28	16.2857
	Waitakere City	45	16.8222
	North Shore City	60	17.0500
	Manukau City	123	17.1138
	Franklin District	29	17.6552
	Sig.		.344

Means for groups in homogeneous subsets are displayed.

Intention to develop protective actions

	N	Mean	Std. Deviation	Minimum	Maximum
Rodney District	28	6.3929	2.16606	5.00	11.00
North Shore City	60	7.3667	2.52423	5.00	13.00
Waitakere City	45	8.1111	2.51561	5.00	15.00
Auckland City	89	7.1124	2.56035	5.00	15.00
Manukau City	123	8.3902	3.11168	5.00	15.00
Papakura District	26	7.4231	2.28338	5.00	14.00
Franklin District	29	6.8966	2.62331	5.00	15.00
Total	400	7.6100	2.75625	5.00	15.00

	COUNCIL AREA LIVE IN	N	Subset for alpha = .001
			1
Tukey HSD	Rodney District	28	6.3929
	Franklin District	29	6.8966
	Auckland City	89	7.1124
	North Shore City	60	7.3667
	Papakura District	26	7.4231
	Waitakere City	45	8.1111
	Manukau City	123	8.3902
	Sig.		.014

Means for groups in homogeneous subsets are displayed.

APPENDIX 5 — PREPARATION, HAZARD KNOWLEDGE AND COMMUNITY ENGAGEMENT

5.1 General Preparation

Unprompted responses

Category label	Count	Responses
Turn off water mains	15	3.3
Turn off gas mains	6	1.3
Turn off electric power mains	31	6.8
Fasten cabinet doors with latches	1	2
Fasten water heater to the wall	2	4
Fasten tall furniture (bookcases) to the wall	5	1.1
Fasten heavy objects (such as mirrors etc	4	9
Other (specify)	313	68.9
Nothing	13	2.9
Don't know	64	14.1
Total responses	454	100

0 missing cases; 400 valid cases

Prompted responses

Category label	Count	Responses
Turn off water mains	236	15.6
Turn off gas mains	208	13.6
Turn off electric power mains	311	20.6
Fasten cabinet doors with latches	201	13.3
Fasten water heater to the wall	153	10.1
Fasten tall furniture (bookcases) to the wall	182	12.1
Fasten heavy objects (such as mirrors etc	177	11.7
None of these	40	2.7
Total responses	1508	100.0

0 missing cases; 400 valid cases

5.2 Emergency Kit

5.2.1 Do you have an emergency kit?

	Frequency	Percent	Cumulative Percent
Yes	178	44.5	44.5
No	221	55.3	99.8
Don t know	1	.3	100.0
Total	400	100.0	

5.2.2 Multiple response tables for specified contents of emergency kit

Category label	Count	Responses
Flashlight/torch	165	16.0
Batteries for flashlight/torch	146	14.1
Portable radio	105	10.2
Batteries for radio	97	9.4
First aid kit and essential medicines	174	16.8
3 litres of water (in containers) per person	62	6.0
3 days supply of dry (flour, pasta)	109	10.5
A portable stove or barbecue for cooking	107	10.3
A temporary toilet facility with toilet	69	6.7
Total responses	1034	100.0

222 missing cases; 178 valid cases

5.2.3 Check contents or operation of emergency kit every month?

		Frequency	Percent	Cumulative Percent
Valid	Yes	36	9.0	20.2
	No	142	35.5	100.0
	Total	178	44.5	
Missing	System	222	55.5	
Total		400	100.0	

5.2.4 Do you have a fire extinguisher?

	Frequency	Percent	Cumulative Percent
Yes	211	52.8	52.8
No	187	46.8	99.5
Don t know	2	.5	100.0
Total	400	100.0	

5.2.4.1 Do you know how to operate a fire extinguisher?

	Frequency	Percent	Cumulative Percent
Yes	347	86.8	86.8
No	52	13.0	99.8
Don t know	1	.3	100.0
Total	400	100.0	

5.3 Household Emergency Plans

5.3.1 Does household have volcanic eruption emergency plan?

	Frequency	Percent	Cumulative Percent
Yes	23	5.8	5.8
No	368	92.0	97.8
Don t know	9	2.3	100.0
Total	400	100.0	

5.3.2 Of those who said "Yes" - Have plan where household should meet in daytime?

	Frequency	Percent	Cumulative Percent
Yes	16	4.0	69.6
No	6	1.5	95.7
Don t know	1	.3	100.0
Total	23	5.8	

5.3.3 Of those who said "Yes" to first question– Do you have a plan where you should go if evacuated?

	Frequency	Percent	Cumulative Percent
Yes	15	3.8	65.2
No	8	2.0	100.0
Total	23	5.8	

5.3.4 Multiple response table of those who said "Yes" – Where would you go?

Category label	Count	Responses
Relatives	4	23.5
Other (specify)	13	76.5
Total responses	17	100.0

385 missing cases; 15 valid cases

5.4 Preparedness Knowledge

5.4.1 Do you know any of five things in yellow pages for volcanic eruptions?

	Frequency	Percent	Cumulative Percent
Yes	39	9.8	9.8
No	356	89.0	98.8
Don t know	5	1.3	100.0
Total	400	100.0	

5.4.2 Multiple response table for those who answered "Yes".

Category label	Count	Responses
Stay indoors with your pets as much as possible	13	22.8
Save water at an early stage as supplies	8	14.0
Keep gutters and the roof clear of ash	3	5.3
Do not go sightseeing	1	1.8
If you must go outside, use protective clothes	6	10.5
Other (specify) – Not in Yellow Pages	26	45.6
Total responses	57	100.0

364 missing cases; 36 valid cases
(Three respondents who said "Yes" could not name anything)

5.4.3. Number of correct responses to Yellow Pages list

Number Correct	Frequency	Percent	Cumulative Percent
.00	364	91	91
1.00	30	7.5	98.5
2.00	3	.8	99.3
3.00	1	.3	99.5
4.00	1	.3	99.8
5.00	1	.3	100.0
Total	400	100.0	

Only one person could correctly name all five!

5.5 Hazard Knowledge

5.5.1 Volcanic Hazards Identified (Unprompted)

Participants were asked what physical hazards they may have to deal with if there were a volcanic eruption in the vicinity of Auckland. The multiple response table below summarises their answers.

Category label	Count	Responses
Ashfall	183	17.1
Hazard from inhaling it	19	1.8
Hazard from it accumulating on roofs	7	7
Hazard when driving on roads	23	2.1
Gases	82	7.7
Breathing problems, particularly for asthma	23	2.1
Problems from corrosion of metals	2	2
Bombs (Rocks Projectiles)	102	9.5
Physical damage	23	2.1
Earthquakes	72	6.7
Dislodge furniture/disrupt pipes etc	26	2.4
Lava	153	14.3
Fire caused by falling volcanic rocks	77	7.2
Other (specify)	204	19.1
Don t know	74	6.9
Total responses	1070	100.0

0 missing cases; 400 valid cases

5.5.2 Volcanic Hazards Identified (Prompted)

When prompted the following multiple responses were added to the list of what people said they knew.

Category label	Count	Responses
Ashfall	203	18.0
Gases	251	22.3
Bombs (rock projectiles)	222	19.7
Earthquakes	275	24.4
Lava	157	13.9
Don t know	3	3
None of these	16	1.4
Total responses	1127	100.0

5 missing cases; 395 valid cases

5.6 Specific Action to Protect from Volcanic Hazards

Respondents were asked what actions they could take to limit volcano damage. Their replies are shown in the multiple response table below.

What actions could you take to limit volcano damage?

Category label	Count	Responses
Tape to prevent fine ash entering window	17	3.9
Removal of ash from roof	2	0.5
Ensuring ash is not washed into the storm water drains	1	0.2
Having dust masks to prevent inhaling ash	20	4.6
Know to turn off/cover air conditioners	1	0.2
Other (specify)	240	55.7
Total responses	431	100.0

4 missing cases; 396 valid cases

5.7 Community Preparedness

5.7.1 Have you worked with others in neighbourhood to consider how eruption might affect community?

	Frequency	Percent	Cumulative Percent
Yes	12	3.0	3.0
No	388	97.0	100.0
Total	400	100.0	

5.7.2 Have you discussed the need for volcanic eruption preparedness with - ?

	Frequency	Percent	Cumulative Percent
Your neighbours	6	1.5	1.5
Your council	3	.8	2.3
Neither of these	391	97.8	100.0
Total	400	100.0	

5.7.3 Have you been involved in meeting on volcanic eruption preparedness?

	Frequency	Percent	Cumulative Percent
Yes	24	6.0	6.0
No	370	92.5	98.5
Don t know	6	1.5	100.0
Total	400	100.0	

5.7.4 Those who answered "Yes": Where were meetings held?

	Frequency	Percent	Cumulative Percent
Missing	374	93.5	93.5
At school	6	1.5	95.0
Community Centre/Hall	2	.5	95.5
My house	1	.3	95.8
Other (specify)	10	2.5	98.3
Don t know	7	1.8	100.0
Total	400	100.0	

5.7.5 Have you worked with others in neighbourhood to develop volcanic response plan?

	Frequency	Percent	Cumulative Percent
Yes	5	1.3	1.3
No	395	98.8	100.0
Total	400	100.0	

APPENDIX 6 — STRUCTURAL EQUATION MODELLING

Structural equation modeling is a multivariate analysis technique that combines factor analysis and path analysis. It allows the analysis of dependence or causal relationships between several variables simultaneously and to test the goodness-of-fit of a whole model rather than just specific relationships. Importantly, SEM improves statistical estimation by accounting for measurement error in the process of estimating relationships. As with any form of measurement, whether physical or social, concepts can rarely be measured perfectly, either because of inaccurate responses by respondents or problems with describing the construct. As a result, measured variables usually contain at least moderate amounts of error. This error can bias the analysis, usually with unknown degree and direction. SEM has the ability to account for measurement errors associated with the measured variables, and thus improves the estimation process. It thus provides the most accurate means for describing the model. By incorporating measurement errors into the statistical estimation, the structural paths between variables are relatively free of the unreliability. In the measurement model, it allows the assessment of each scale item as well as incorporating how well the scale measures the concept (reliability) into the estimation of the relationships between dependent and independent variables. This makes it an appropriate analytical technique to use when dealing with developing a holistic model with data from different populations (Hair et al., 1995).

The most fundamental measure of overall fit is the $\chi 2$ (chi-square) statistic. In contrast to other analyses, when used in SEM the researcher is looking for non-significant differences between actual and predicted models. Accordingly, the smaller the chi-square value, the better the fit of the model. The Goodness of Fit Index (GFI) measures how much better the model fits compared with no model at all. Its value ranges from 0 (poor fit) to 1 (perfect fit). Higher values indicate better fit between data and model (i.e., the quality of the model as a predictor). The Root Mean Square Error of Approximation (RMSEA) value is representative of the goodness-of-fit. Values ranging from 0.05 to 0.08 are deemed acceptable. The Normed Fit Index (NFI) also measures fit, with the higher the value the better the fit.

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