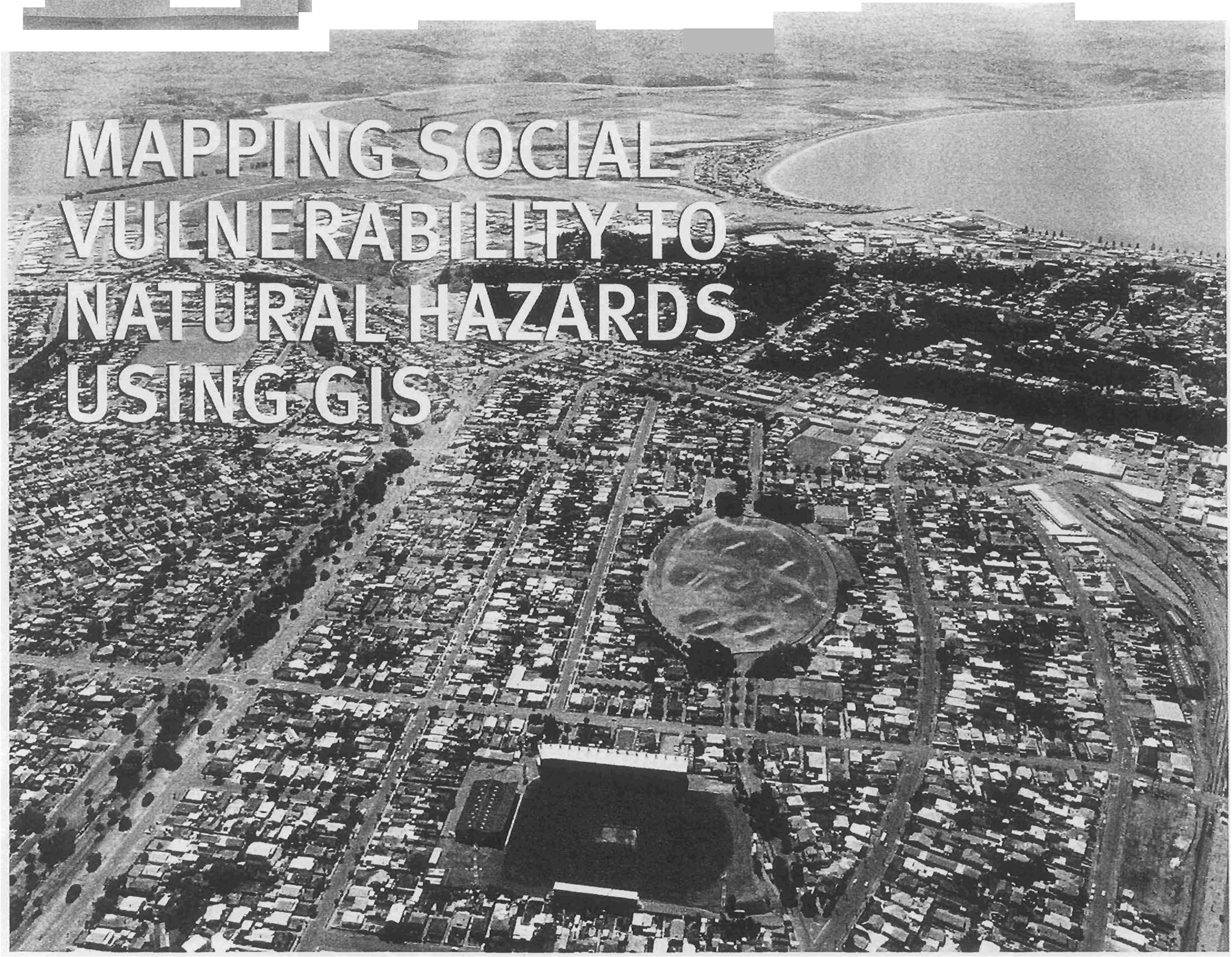
MAPPING SOCIAL VULNERABILITY TO NATURAL HAZARDS USING GIS



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The vulnerability of communities to natural hazards can be mapped before an event occurs, allowing planners, emergency managers and communities to plan for response, recovery, readiness (preparedness), and reduction measures. This in turn will increase a community's resilience to natural hazard events.

A primary aim of natural hazard mitigation planning is to manage risk, and to develop strategies that accommodate the differential susceptibility to loss throughout a community. This differential loss reflects the existence of factors such as age, disability, ethnic minority status, and socio-economic status that makes certain sectors of society more vulnerable and likely to experience loss following natural hazard events. Increased migration of people into hazard prone areas is increasing the vulnerability of populations. If they. are to develop these strategies, planners need more than just demographic data.

The planning task is complicated by, for example, the uneven distribution of vulnerable groups throughout a jurisdiction and by the uneven distribution of the hazard effects that each group may have to contend with. Both of these pieces of information must be accommodated within the planning process. Demographic information is required to identify the needs and issues to be addressed in risk communication. Hazard distribution data is required to integrate hazard preparedness and response issues with peoples' needs and expectations. The quality of risk communication is a function of how well these are integrated (Paton et al., 1999). Understanding how vulnerability and hazards interact is also vital to response planning (e.g., elderly/disabled residents will need to be prioritised for evacuation), and to the identification of recovery needs (e.g., elderly/disabled residents will need special resources and assistance with reintegration back into the community) (Paton et al., 1999).

Achieving this outcome is clearly a difficult task. A community's exposure to a range of hazards and its demographics creates a complex social vulnerability environment. To render this vulnerability more coherent, risk indices can be created using GIS to map the patterns of interaction between hazard characteristics (e.g. liquefaction, flooding levels and landslide susceptibility) and demographic characteristics known to influence social vulnerability (e.g. socio-economic status, age or ethnicity).

RIGHT:: Figure 1. The distribution of socio-economic status and earthquake amplification hazards for the Napier City area. The first map shows those areas at risk from earthquake and associated effects; the second map shows the risk a DI = vulnerability and the third incorporates population density, showing the distribution of those populations with low socio-economic status.

LEFT:: Napier City looking towards the north

Amplification

In this study, a range of hazards in Napier City were exclored to assist planners and emergency managers understand the vulnerability of residents. Hazaros layers were developed for liquefaction, amplification, and landslide. The socio-economic status was assessed using Deprivation Index (DI) scores (Salmond & Crampton 2002). Based on the 2001 census meshblock information, the DI provides a composite measure of socio-economic status by combining several relevant indices of vulnerability, as shown in Table 1. Community members possessing high DI scores are less likely to possess the resources required to engage in appropriate preparatory and risk reduction strategies. They are also more likely to perceive threat/hazard information as having a lower priority than other daily needs and concerns, and less likely to possess the resources required to sustain them during recovery (particularly if the latter is prolonged).

Given that hazards such as earthquakes strike with no warning, it is important to target members of this group. If the riskcommunication strategy applied to this task is to be effective, it must address the relationship between peoples'needs and the hazards they will have to contend with. GIS represents a resource that can assist in this planning.

Socio-economic status can interact with physical hazard characteristics directly. For example, with regard to ground amplification hazards (earthquakes), the members of lower socio-economic groups may be more vulnerable because their housing may be of relatively poorer construction and/or less well maintained, making it more prone to damage and/or loss. For members of this group, periods of re-location could be prolonged and even permanent (e.g., as a consequence of total destruction or lack of insurance).

It is also important to acknowledge that people with low socio-economic status may be particularly sensitive to disruptions to societal and economic activities, even if not affected by hazard impact directly (e.g., those in part-time, casual or seasonal employment are more at risk of employment loss). As mentioned above, disruption to welfare/social service provision should be considered in this regard. Consequently, hazard effects can further erode their economic, material, and psychological resources, increasing immediate and longer-term vulnerability.

Socio-economic factors can influence peoples' attitudes and reactions to hazard effects and other stressful situations. Socio-economic status influences awareness of risks, knowledge of household and/or personal preparedness, and the availability of resources to implement them. It also influences patterns of help seeking. For example, persons in lower socio-economic groups are generally more inclined to seek medical rather than psychological assistance for mental health and adjustment problems, and are more likely to seek assistance from within their community than approach formal authorities. GIS mapping can identify localities where risk is greatest, and allow local resources to be developed to provide the information and advice required to tailor risk management needs to those in a community. This last issue reiterates the value of integrating hazard reduction and community development processes. From reduction and response management perspectives, liaison mechanisms should be established with community, health and counselling resources, with mitigation and risk communication strategies being channelled through them.

An uneven distribution of high DI scores indicates a complex social risk environment in regard to city-wide public education and hazard

TABLE 1: VARIABLES INCLUDED IN THE DEPRIVATION INDEX 2001

Variable in order of decreasing weight in the *index*
Peopled aged 18-59 receiving a means tested benefit
Peopled aged 18-59 unemployed
People living in equivalised households with income below threshold
People with no access to a telephone
People with no access to a car
People aged <60 living in a single parent family
People aged 18-59 without any qualifications
People not living in own home
People living in equivalised households below a bedroom occupancy threshold

(Salmond & Crampton, 2002)

reduction programs. High DI scores indicate households where limited financial resources, high demands on time, more pressing social needs and other factors, limit a household's ability to implement reduction and preparedness measures.

By imposing structure on a complex risk context, the mapping of risk in this manner can be used to assist the planning process, and to provide a foundation for several risk management activities, particularly risk communication and the development of readiness strategies tailored to the specific needs of different groups. By facilitating the planners' ability to target strategies rather than adopting a blanket, city-wide approach, a more cost effective use of limited resources can be made. Identification of high risk areas allows resources to be targeted to areas of greatest need. As resources become available, intervention can broaden to include medium and low risk areas. This provides a mechanism planners can use to target and tailor their strategies and consultation, resulting in a more cost effective use of resources.

Figure 1 provides an example of the DI index being used to show earthquake risk and associated DI distribution.

The DI scores indicate that low socio-economic groups are distributed throughout Napier, with clusters of high deprivation scores being located at the southern end of Bay View, Ahuriri, Nelson Park, Marewa, Maraenui, Onekawa South, Tamatea North, Tamatea South, and Taradale South. Their uneven distribution means that the blanket distribution of a common message on public education initiatives and hazard reduction programs throughout Napier is an ineffective strategy. When population density is included, high risk areas (hazards x high population density) were Maraenui, Marewa and Onekawa South. This identifies where readiness resources should be focused, and how their content should be developed to meet local needs. Furthermore, by identifying differences in the distribution of the amplification-DI and landslide-DI interactions, risk communication could be targeted in a more specific and cost-effective manner. By allowing efforts to be focused in this way, GIS not only affords a more cost effective use of resources, it also enhances the quality of risk communication.

For planners, this information can provide a tool for prioritising and targeting specific future education/public awareness initiatives, consultation, and risk reduction strategies. Not only will this result in an increased resilience of communities to natural hazards, but will allow targeting of specific "at risk" populations for other consultative requirements.

Acknowledgements

This work has been supported by the Napier City Council, Hawke's Bay Regional Council, and the Foundation for Research, Science and Technology.

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