AN INFORMATION INFRASTRUCTURE for DISASTER MANAGEMENT IN PACIFIC ISLAND COUNTRIES

Ken Granger
Australian Geological Survey Organisation

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Ken Granger

Brisbane
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EXECUTIVE SUMMARY

There is nothing more certain in the disaster management business than the fact that once a disaster starts to unfold, it is too late to start looking for the information needed to manage it.

This report is the outcome of a study into the information needs of disaster managers in Pacific Island Countries (PICs) and the nature of the information infrastructure needed to ensure the delivery of that information. It addresses two key aspects. First, it provides a guide to follow by those engaged in disaster management and research in building their own project, national or regional disaster information collections. It is specifically targeted at the National Disaster Management Officers (NDMO), regional agencies such as the South Pacific Applied Geoscience Commission (SOPAC) and aid donors. Second, it makes some observations on a range of technical and organisational issues, such as data formats, transfer standards and custodianship arrangements, that need to be considered in establishing and operating any modern information infrastructure.

The research undertaken clearly demonstrated that PIC disaster managers recognise and appreciate the need to have appropriate information available to them at all stages of the disaster management process. It was not possible, however, to investigate the reality of information use during an actual disaster situation. None-the-less, a culture of using information certainly exists.

It is also clear that disaster managers throughout the PICs possess a broad range of skills and experience in managing and applying information for decision making in disaster situations. Clear also is the fact that there is a nucleus of technical and professional staff throughout the PICs that have skills, training and experience in the use of geographic information systems (GIS) and the manipulation of spatial information – a major component of disaster management information. The level of collaboration and interaction between these two groups, however, is less certain.

As part of the research, PIC disaster managers were asked to complete a survey that asked them to rate a comprehensive range of topics according to their perceived need for information on those topics. Given the narrow focus of that survey, it is not surprising that the topics identified reflected a strong bias towards disaster response needs and closely parallel the needs identified in similar surveys of response-oriented emergency workers in Australia. It needs to be recognised, however, that 'disaster management' covers a much broader field than those whose primary responsibility is to manage the response phase. The scientists who develop an understanding of the hazard phenomena and operate monitoring and warning systems, for example, require a broad range of information, as do those responsible for designing and implementing mitigation activities and for planning and managing the recovery process. Disaster management, after all, is part of the total community governance process and its information needs fit within the broad needs of that process.

An impression was gained that disaster managers have an expectation that much of the information they need will be provided by other agencies should or when the disaster managers need it. Experience suggests that this is a very hazardous approach to disaster management unless those agencies who are expected to hold and manage that information see themselves as part of the disaster management process and are aware of the requirements of disaster managers for their information.

A key first step in establishing a information infrastructure, therefore, is the creation of a clearinghouse mechanism, including an information inventory through which disaster managers can find and arrange access to the information they need to make decisions. There is evidence, for example, that in some PICs, such as PNG, Vanuatu and Cook Islands, government agencies and/or universities of the former colonial administering nations such as Australia, New Zealand and the United Kingdom, have more complete and detailed inventories (and collections) of information than now exist in the country itself. This is clearly an area that needs much work, however, most PIC have access to the technology that can make such a mechanism accessible across the country and across the region.

The creation of an effective information clearinghouse to support disaster management throughout the PICs will inevitably mean the development of technical standards and institutional arrangements. Both of these factors lie well outside the realm of disaster managers. Disaster managers, however, will need to play a role in the development of both because it is simply not possible to reduce the impact of disasters without appropriate information. That may require using outside experts to influence the process, as suggested by one of the NDMOs, or using the experience of a significant disaster event to convince the 'powers that be' that the outcome would have been more favourable if the country (region, district, etc) had an appropriate information infrastructure in place. There is also a major role for agencies such as SOPAC and the regional universities to assist in the more technical areas of developing, negotiating and introducing standards – as they already do.

The experience of local governments and small regional groupings of spatial data users in Australia could serve as a useful guide for PICs, SOPAC and aid donors to look at if it is decided that a formally structured information infrastructure is to be developed. That experience may be more appropriate than the higher level experience at state and national level in Australia, New Zealand or the USA where issues such as metadata standards and clearinghouse directories tend to be rather formalised and heavily dependent on technology and a relatively large and skilled work force.

It is a relatively simple task to describe and define the components of an information infrastructure that would be suitable to support disaster management in PICs. Implementing such a process, however, will not be so simple. It will take time and it will take commitment on the part of all those involved because there are at least four sources of frustration that will need to be addressed before it can become a reality.

A recurring view was expressed by NDMOs that they had 'heard it all before' at various conferences and workshops, but nothing practical had ever eventuated. They are looking for a worked-through example that they can follow and the resources to do it. That can not be achieved in a workshop; it can only be achieved on the ground in a real-world situation.

The lack of communication reaching both down to, and up from, the village level was also seen as a major source of frustration, and consequently a major hurdle. For a process that is all about information and improving the effectiveness with which it may be disseminated and used, the sharing of information about the process is critical – and that depends on communication.

The third frustration revolves around a stated lack of coordination and cooperation between the people and agencies that should be working together to improve community safety. This was seen as part of the power and political processes that tend to build barriers, rather than bridges.

The fourth key frustration relates to the perceived lack of resources – human, financial and technical. This is probably a universal frustration for all disaster managers. Typically, they are allocated only limited resources because senior policy makers seem to hold the view that a disaster is unlikely to happen during their term in office, so why spend too much money on a disaster management system that does not bring significant votes with it. This may be a simplistic and cynical view, but it seems to correlate well with reality.

These are not technical issues, they are human issues - an information infrastructure is not a physical thing, it is more of an accepted way of doing things. An information infrastructure is a philosophy, not a technology.

Fortunately, frustrations can be overcome, even those as seemingly intractable as the four identified here. There are significant components of an information infrastructure already in place in most PICs and a number of real-world case studies are either under way or planned that can demonstrate and promote the value of the support an information infrastructure can provide to disaster management.

These include programs such as the SOPAC *Pacific Cities* and *Communities at Risk Projects* and SPDRP initiatives such as the Community Vulnerability Analysis process.

These established foundations are very sound indeed, and provide an excellent base on which to build an appropriate and sustainable information infrastructure that can address issues from the village level to the level of the national capital and beyond. There are undoubtedly frustrations and problems that will need to be addressed along the way, however, it is clear that NDMOs are committed to embarking on this journey. It is also clear that they will make a good job of it because they are committed to the task.

The way ahead

This report provides a 'road map' for NDMOs and others to follow in building and managing the information resources they need to manage disasters. Having a map, however, is of little value unless one is both prepared to start the journey and committed to completing it. The commitment appears to be there in PICs, so how best to help NDMOs and others to start the journey?

The following simple pointers might help:

- the best place to start is with the information that is already held by disaster managers. Develop an inventory of existing material as the first step so that it is easier to identify where the significant gaps are;
- sketch out an information management plan, as part of the disaster management plan;
- be prepared to take time - it is important to be practical in setting targets because if they are too ambitious at the outset and subsequently fail, the whole process of developing the information management process could be seriously set back;
- establish priorities using the 80/20 rule - that says that 80% of the answers can be provided by 20% of the information;
- develop partnerships with key data custodians and research agencies and involve as wide a cross section of stakeholders as possible in the process;
- whilst the ultimate objective may be to employ GIS and other computer decision support tools, it is not necessary to have such technology in place before starting to either use information or to build an information infrastructure. Hard copy maps, manuals, reports and so on, will always be needed and used, regardless of how many computers are available;
- it is much easier to 'sell' the message of information and information infrastructures if their benefits can be demonstrated in a real-world case study. Having a worked-through example to demonstrate is far more believable than a 'dummy' or artificial example. It is also human nature to want what the neighbour has, so by being able to demonstrate what one village or town has done and the advantages that they have gained, tends to stimulate other villages and towns to want the same advantages. Case studies are also very useful for disaster managers to share their experience and to exchange ideas that might be useful in other areas. The work completed by the *Pacific Cities Project* in establishing a broadly based information infrastructure for its case study cities provides an excellent starting point;
- insist that disaster management research and aid programs involving outside experts contain a strong information management component that can easily be incorporated into national and local systems; and,
- don't be afraid to ask for help – you are not alone.

CHAPTER 1: AN OVERVIEW

INTRODUCTION

This report is the outcome of a study into the information needs of disaster managers in Pacific Island Countries (PICs)[1] and the nature of the information infrastructure needed to ensure the delivery of that information. It addresses two key aspects. First, it provides a guide for National Disaster Management Officers (NDMO) and regional agencies such as the South Pacific Applied Geoscience Commission (SOPAC) which are engaged in disaster research, to follow in building their own national and regional disaster information collections. Second, it provides some observations on a range of technical and organisational issues, such as data formats, transfer standards and custodianship arrangements, that need to be considered in establishing and operating a modern information infrastructure.

This study was made possible by **Grant 19/98** from the Australian Coordinating Committee for the International Decade for Natural Disaster Reduction (IDNDR) and the support of the Australian Geological Survey Organisation (AGSO) under its National Geohazards Vulnerability of Urban Communities Project (more commonly known as the *Cities Project*). Support was also provided by the staff of the SOPAC, especially those in the Hazard Assessment Unit (HAU) and the Disaster Management Unit (DMU).

Key input was gained through two workshops. The first was held in Suva, Fiji, on 2 and 3 October 1998 in conjunction with the 7th IDNDR Pacific Regional Disaster Management Meeting and the 27th SOPAC Council Meeting. This workshop could be said to have reflected a national-level, urban centre focus. The second was held in Cairns, Australia, on 4 November 1998 and took advantage of the attendance of several PIC disaster managers at the *Disaster Management: Crisis and Opportunity* conference run by the Centre for Disaster Studies at James Cook University. This smaller workshop had a stronger focus on community or village-level needs. Appendix B lists the delegates at the two workshops. This study also builds on the experience I gained in co-facilitating a workshop held in Port Moresby, Papua New Guinea (PNG), in March 1998 aimed at initiating the development of a national spatial data infrastructure for PNG (Granger and others, 1998) and through the development of an information infrastructure to support the AGSO *Cities Project* study of Cairns (Granger, 1998).

BACKGROUND

At the 6th IDNDR Pacific Regional Disaster Management Meeting, held in Brisbane in 1997, it was resolved that the primary IDNDR theme on which the South Pacific Region would focus for the remainder of the Decade would be '**Shared Knowledge and Technology Transfer**'. Amongst the key activities recognised as being necessary to achieve this was the development of an effective information infrastructure and geographic information system (GIS) capability to underpin disaster management activities.

The South Pacific Disaster Reduction Program (SPDRP) Phase II project proposal, as revised at the Brisbane meeting, set as an immediate objective:

> *to enhance national capacity to reduce natural disaster risk through development and implementation of mitigation measures*

and went on to establish, as its first output:

> *requirements for disaster management information and communication systems at the regional and national levels identified.*

---

[1] A list of acronyms and abbreviations used in this report is provided in Appendix A.

These objectives were based to a significant degree on the report to the SPDRP by Professor Rob Stephenson on his analysis of the requirements for disaster management information systems in the PICs (Stephenson, 1995). Stephenson's study concentrated on the technology of information systems and communications components of an operational information infrastructure. This report concentrates on the non-technology components, especially the information that is needed to support disaster management in the PICs.

The development of a disaster management information infrastructure is already being pursued by SOPAC. This commenced with the establishment of the *Pacific Cities Project* which is developing comprehensive multi-hazard risk assessments of eight key PIC urban communities (Apia, Honiara, Lae, Luganville, Nadi-Lautoka, Nuku'alofa, Port Vila and Suva). Not only do these centres contain substantial populations themselves, they also provide the administrative, commercial, health, welfare, social and logistic services to much larger local, national and regional populations. The work done so far under the *Pacific Cities Project* has come largely from a scientific direction and has already adopted many of the more technical aspects of an information infrastructure. A proposal was accepted by the SOPAC Governing Council in 1998, to identify the rural population concentrations at risk from hazards such as tsunami, cyclones and volcanic eruptions following the major tsunami disaster experienced at Sissano in PNG. This project is titled *Communities at Risk*, and, whilst still evolving, it will build on the risk assessment approach already established under the *Pacific Cities Project.* That approach starts from an essentially external scientific perspective and integrates it with local community knowledge, experience and expectations. It takes an 'outside-looking-in' approach.

At the time of writing, a proposal is being developed in SOPAC to undertake a *Strengthening Community Resilience Through Applied Community Risk and Vulnerability Analysis* project. The concept established for this proposal is a fusion of the scientific (outside-looking-in) approach of *Pacific Cities/Communities at Risk* and the community self-assessment approach (or 'inside-looking-out' approach) known as Community Vulnerability Analysis (CVA). CVA was developed under the SPDRP and is outlined in UNDHA (1998). The development of a strong information infrastructure is also identified as a central feature of the *Community Resilience* concept.

Information, and its effective management, has been identified as the key to the success of these projects, as well as to operational disaster management. **Accurate, appropriate and timely information is clearly a key ingredient in effective disaster management – it can have life-or-death significance.** The key issues for information management for disaster management in the PICs was identified at the Brisbane meeting in the following terms:

> *Accessing and disseminating information is the core business of disaster managers. There is much information available within PICs both as raw data and as analysed data. This shows that apart from the technological requirements of information systems, the management process of information forms another crucial component. In order for the system to meet the needs of its users, namely Pacific disaster managers, the fundamental data/information needs must be understood. The following questions will help to create this understanding:*
>
> *a) What are the problems, the system should help to solve?*
> *b) What information does the system need to solve these problems?*
> *c) Where can this information be accessed?*
> *d) In which format should the information be disseminated?*
> *e) To whom should information be disseminated?.*
>
> *Some of these questions have been addressed already. **Ultimately all elements of the system have to be linked up in order to establish the information infrastructure**. The infrastructure will have various levels (local, national, regional and international) and must go hand in hand with administrative developments concerning hardware standards, data quality control etc. Inter-agency collaboration is not only crucial at the regional level but also at the national*

> *level. Information systems development will be considerably enhanced through inter-agency cooperation. National data centres corresponding to the regional data centre will be established, that will provide all in-country users direct access to data and information.*
>
> (SPDRP, 1998)

This project is aimed at addressing those questions and consequently providing PIC disaster managers at local, national and regional levels with the basic structure and guidance by which to build the essential information infrastructures. Given the overwhelming significance of spatial information in disaster decision making, and the increasing use of GIS as a disaster decision support tool in PICs and elsewhere, considerable emphasis is given to the development of an effective spatial information infrastructure (SII), as the key component in the wider information infrastructure.

DATA, INFORMATION & KNOWLEDGE

Before describing what is involved in an information infrastructure, it is useful to first consider the differences between data, information and knowledge, because these words are often used interchangeably, even though they are very different things. The relative availability of the material to support the decision-making process can be summarised as follows:

> *We have oceans of data, rivers of information, small puddles of knowledge and the odd drop of wisdom.*
>
> (Nix, 1989)

Collections of data are the raw material. They are of little value taken on their own, but begin to gain value when they are drawn together to create information. Decisions can begin to be made at the level of information. Information elements, in turn, gain greater value and potency when they are integrated with other relevant information elements (and experience) to generate knowledge – as Einstein once observed 'the only source of knowledge is experience'. Sound decisions are based on knowledge. Wisdom, for disaster managers, emerges from learning the lessons of success and failure gained through managing actual disasters and wisdom requires a store of knowledge. It is clear that a large store of knowledge of disasters already exists in villages and communities throughout the Pacific. For modern disaster managers it will need to be built through the formal analysis and assessment of actual events and the post-disaster debrief process.

Discussion of 'information' these days inevitably includes discussion of technology. Indeed, 'information' is commonly used interchangeably with 'information technology'. These are not the same things. Whilst the technology is important, it is the information that it helps to assemble, store and manipulate, that is paramount. It is as well to remind ourselves that human-kind had been using and storing information for tens of thousands of years before the invention of the printing press, let alone the computer. Without data and information, a computer is just an expensive desk ornament!

One of the first systematic reviews of the needs for information and the application of information technology in the disaster management field was undertaken by a subcommittee of the US Congress following the Mount Saint Helens volcano disaster of 1980. That group observed:

> *Improvement of the quality of information – narrative, statistical, graphic – which must be accessible to emergency managers is a* sin qua non. *'Profiles' of need and use must be established, and data categories of overlapping utilization have to be identified. Methods of keeping such files current, and dispatching updated 'essential elements of information' to outlying users, deserve review and refinement. In essence, there is a requirement to create a coordinated hierarchical information and communications capability that can fulfil known emergency management needs.*
>
> (US Congress, 1983)

The development of 'profiles of need' and the identification of the 'essential elements of information' are integral parts of the information management process that lies at the heart of any information infrastructure. Indeed, at the heart of any **use** of information, is the process of information management.

INFORMATION MANAGEMENT

Information management is a simple cyclical process (known in some areas as the 'intelligence cycle') that takes the form shown in Figure 1. It has four stages – direction, collection, processing (or collation) and dissemination.

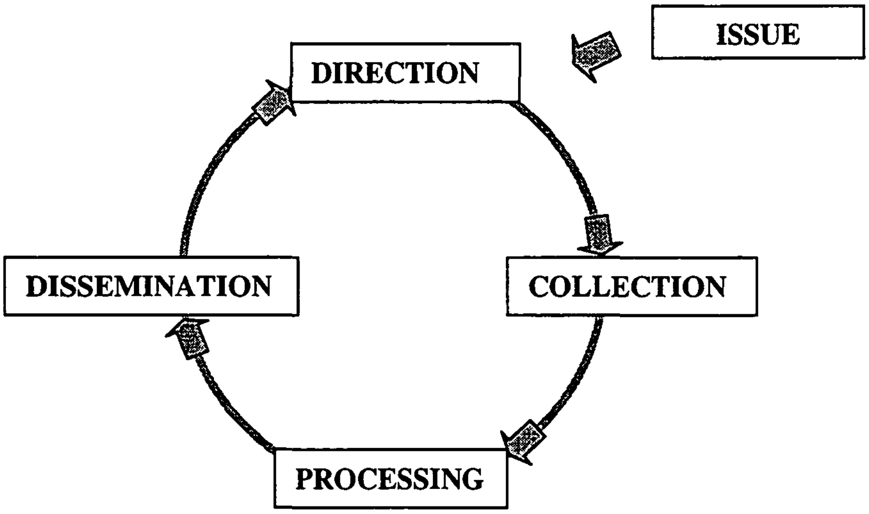


Figure 1: The information management ('intelligence') cycle.

Direction: The first steps in establishing any information management regime are to:

- monitor the external environment to identify problems as they evolve and to be responsive to issues that are identified from outside the 'system';
- define the problems to be addressed;
- identify the information requirements that flow from them; and,
- identify who is to benefit from the information.

This assumes that those involved accept that information is an essential ingredient in decision making – i.e. it assumes that an information culture exists.

It is through this problem identification and definition process that the elements of information and profiles of need discussed in the US Congress report are established. In that process, the very broad nature of the information requirement becomes clear. Identifying the beneficiaries (frequently the same people who identify that a problem exists) also helps to establish the level of detail that might be required, the area or extent needed to be covered, and so on.

Once the problem has been defined, it is possible to prepare an information collection plan to satisfy the profiles of need and to assign responsibility for gathering and maintaining the information. This will include the broad background information (sometimes called 'baseline', 'foundation' or 'fundamental' information) as well as the more immediate information relating to a specific situation.

In a disaster management context, delegation of responsibility for information collection and maintenance might parallel the responsibilities outlined in the disaster plan. For example, the agency with responsibility for the provision and management of emergency shelter would, as part of that responsibility, gather and maintain information on shelter resources and their status. Such an approach avoids the need to set up an information collection and management system completely separate from the disaster management system. This is commonly referred to as custodianship.

A central point of control for directing the information management process is, none-the-less, needed within the disaster management process. That point of control will also need to interface with the wider local, provincial or national information management control arrangements to ensure that the disaster management information requirements and needs are adequately represented in the wider process.

Collection: Implementation of the collection plan should be focused on the essential elements of information that have been identified (both baseline and situation-specific), with collection priorities flowing from the profiles of need. Working to the standards established by the directors of the information management system, information collectors need to employ all the data capture resources available to them. These include making use of <u>existing</u> information that may have been developed for other purposes, such as land management or social planning, but which is also relevant to disaster management.

Modern technology can have a significant impact where data must be captured from scratch. Remote sensing technologies, whether carried by satellites or on aircraft, hold great potential for providing specific information of great value in a disaster situation, especially in remote areas, whilst the Global Positioning System (GPS) now makes accurate position finding very simple. The bulk of information collection, however, will need to rely on more basic and traditional methods such as getting out and asking questions or making measurements on the ground. Satellites can not tell us what people are thinking or feeling, nor can they educate us about the experience of villagers in coping with disasters over generations.

Getting the information that is gathered to those who have a need for it is part of the collection process. Here again, technology provides many advantages such as the instantaneous transfer of data and information from the field to a distant headquarters via satellite communications systems. Though traditional methods, such as writing a report or drawing a sketch map or plan on paper, and sending them by mail or by runner, continue to remain important in PICs.

It is important to involve the eventual users of the information in the design and development of the collection process, not only to ensure that their needs are fully taken into account, but also to maximise acceptance of the process by users. This is a central focus of the CVA methodology, for example.

Processing: It is in this stage that the answers to the various questions are developed by converting data into information. This calls for a system that facilitates the collation, analysis, evaluation and interpretation of the data. It is in this process that tools such as GIS and other information technologies (such as databases and spreadsheets) provide considerable help. It is important, however, to ensure that information processing for disaster management is neither totally dependant on technology nor on the skills and experience of a single person. The processing function should be quite robust, especially during disasters where they are under the most extreme pressure.

Some of the more complex forms of processing, such as terrain modelling or the analysis of multi-dimensional inter-relationships such as the effect of wind at different levels on the spread of ash during a volcanic eruption, are simply too slow, too difficult, or too daunting to undertake manually. They are also the types of processing that can (and should) be undertaken <u>before</u> the onset of disaster. It is also important to recognise that much of this processing does not need to be undertaken by disaster managers. This is the role of specialists such as vulcanologists, meteorologists, social scientists, engineers and so on. Disaster managers do, however, need to receive that processed information in a form that they can understand and use.

The processing phase is also the stage at which baseline information, such as population statistics, land tenure, terrain mapping and so on, is maintained and enhanced. It is also the stage in which data quality is checked and, if necessary, brought up to the desired standard.

Dissemination: The final process in the cycle is the timely distribution of the information to those who need it to make decisions. With modern systems, the ability to present the processed information in a variety of forms including text, tables and graphic products adds greatly to the capacity to both disseminate the information and for it to be understood. This reduces the chance of disaster managers and the general public falling into the old trap of 'information-free decision making'.

And then the process starts all over again as more disaster lessons are learned, problems posed and questions arise.

THE DISASTER MANAGEMENT AND RISK CONTEXT

In developing an information infrastructure for disaster management it is important that it be seen in the context the broader community-wide information infrastructure, and that the disaster management process be seen in the broader context of community governance and risk management. **Disaster management is not an end in itself, but one end point in the much larger process of community governance.** As such it involves a wide range of people and disciplines, not just those designated as 'disaster managers'.

The holistic nature of this broad view of disaster management can be illustrated by reference to the risk management process which is described in *AS/NZS 4360:1999* in the following terms:

> *Management of risk is an integral part of the management process. Risk management is a multifaceted process, appropriate aspects of which are often best carried out by a multi-disciplinary team. It is an iterative process of continual improvement.*
>
> (Standards Australia, 1999, p7)

The process is shown in overview in Figure 2.

I repeat the words of the Standard, that this is 'a multifaceted process' that should be carried out by 'a multi-disciplinary team'. That is to say that the prevention, preparedness, response and recovery (PPRR) components of disaster management requires a multi-disciplinary approach. The medical staff that are involved in treating victims; the agricultural people who monitor crop production; the businessmen that understand the supply and transport of food and other essentials; the Red Cross organiser involved in public awareness programs at the village level; for example, are all 'disaster managers' in their own right. Collectively they are involved in all stages of the PPRR process, even though they may not identify it as such until there is a need to respond to an actual disaster event.

The information that is required to support disaster management is, to a significant extent, the output from a wide range of other processes that are seemingly remote from disaster management. Professional disaster managers should, therefore, not attempt to carry out the whole process by themselves, but they should participate in the various stages so that the information that flows from each stage is understood and appropriate to the needs of disaster managers. If these linkages are established within the information infrastructure, then the process of communication and consultation is greatly enhanced and the disaster management effort is significantly more robust.

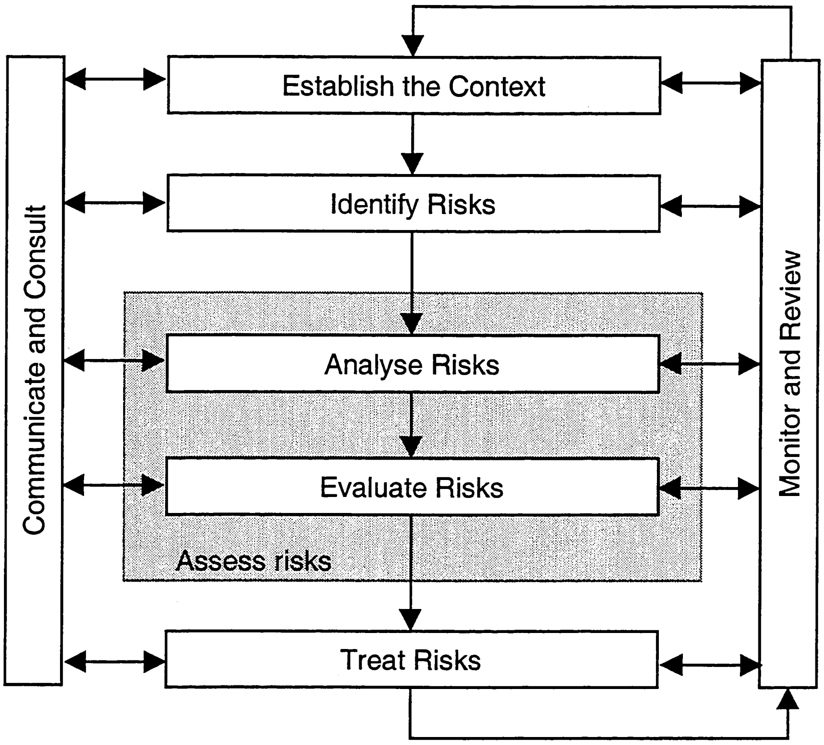


Figure 2: Risk management overview (Standards Australia, 1999, Fig 3.1, p 8)

SPATIAL INFORMATION AND *RISK-GIS*

I have already drawn attention to the fact that a very large proportion of the information needed by disaster managers to make effective decisions is to do with location – i.e. 'everything is somewhere'. This is spatial information. Spatial information typically includes the information that appears on maps but it can also include information that is linked to places or localities by name or by a variety of other referencing systems.

Over the past decade or so, GIS have been used increasingly as tools to provide information to address specific aspects of the disaster management problem, especially in hazard mapping and modelling for phenomena such as flood and storm tide inundation. Burrough (1987, p 6) provides a typical definition of GIS, the tool, as:

> *a powerful set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world for a particular set of purposes.*

This definition has a clear focus on the technology, and in this report I use the term 'GIS' to specifically refer to the technology component. There are clear advantages, however, in developing a fusion between the broad philosophy of risk and/or disaster management and the power of GIS as a decision support tool, hence *Risk-GIS* as it has been christened in the AGSO *Cities Project.* It has, as its philosophical roots, the comprehensive risk management approach outlined in the Australia and New Zealand risk management standard *AS/NZS4360:1999* (Standards Australia, 1999) and the view embodied in Dave Cowan's (1988) definition of GIS as:

> *a decision support system involving the integration of spatially referenced data in a problem solving environment.*

In this context, the 'problem solving environment' is risk or disaster management. I use the term '*Risk-GIS*' to refer to the broader application of the technology to disaster decision making.

The disaster management process imposes a significant demand for a wide range of information products. To cater for this demand, *Risk-GIS* must be structured to cope with all external inputs, internal operations and output to a wide range of external consumers. Figure 3 summarises the key structural elements of *Risk-GIS*.

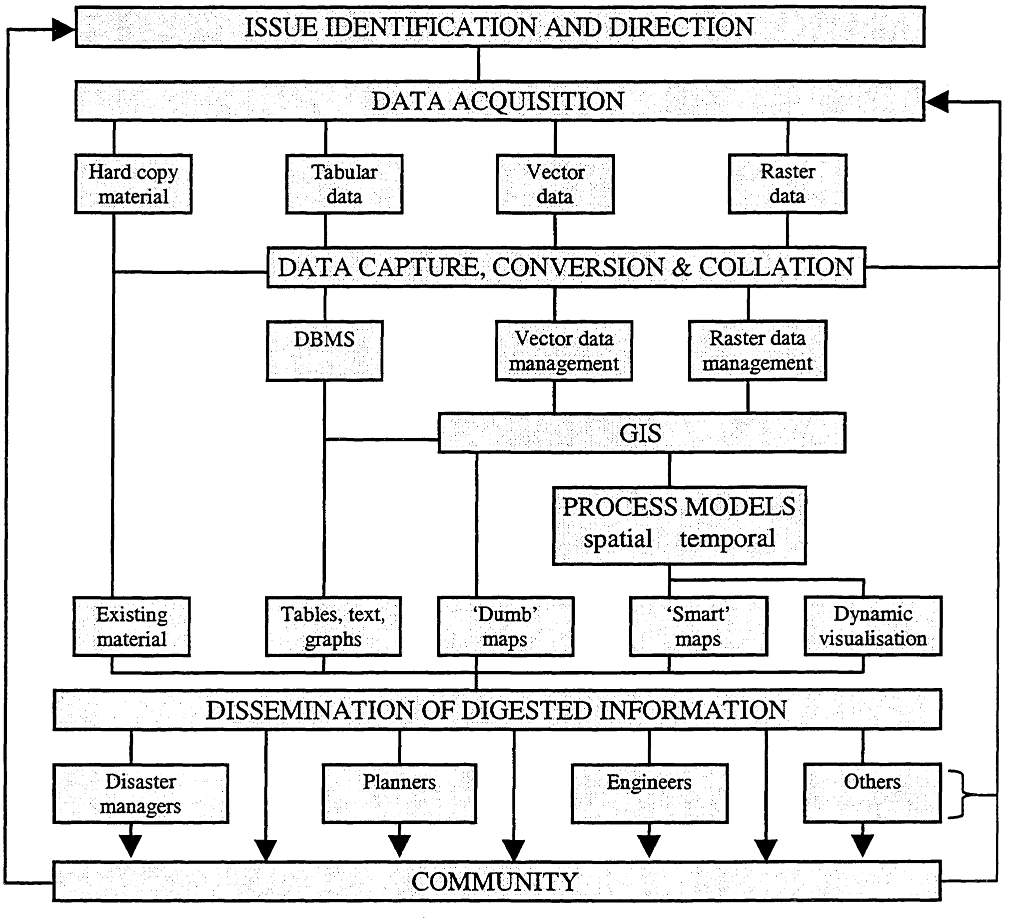


Figure 3: *Risk-GIS* structural elements

This model goes somewhat beyond the conventional view of GIS as being made up primarily of hardware, software and data. It also incorporates the people, administrative arrangements and infrastructure issues as well as recognising the significance of:

- the information management ('intelligence') cycle process. Implicit in this is the progressive enhancement of data to create information and the eventual formation of knowledge and wisdom;

- the range of information products that satisfy the diverse needs of risk managers and the communities they serve and the diverse source material that must be drawn on to create those products. These include conventional and well established 'hard copy' products such as printed maps, books, manuals and so on; simple (one-dimensional) tables, graphs or textual descriptions drawn from databases and spreadsheets; customised, but essentially 'dumb', two-dimensional maps and graphics; three-dimensional maps (i.e. those in which the attributes of map features contained in databases are interactively linked within a GIS); and dynamic visualisation including simulations, animations, 'virtual reality' and other 'multi-media' (i.e. four-dimensional) products;

- the information infrastructure that facilitates the flow of data and information throughout the model (shown as the linking lines);
- the recognition that the process and structures are aimed at meeting the needs of the community as the ultimate beneficiaries who in turn provide input to the system.

AN INFORMATION INFRASTRUCTURE

The process of information management and the structural requirements of *Risk-GIS* provide the foundations on which to build an information infrastructure, especially a SII. **It should be emphasised here that an information infrastructure is not a physical thing, it is more of an accepted way of doing things.**

There are six elements that go to make up this model of an information infrastructure. They are:

- an information culture;
- the right people;
- a coordination process;
- data and information products;
- guidelines and standards; and,
- an institutional framework.

This model is applicable at any level of jurisdiction - from the smallest local village or project; to the local council or business level; to the provincial and departmental level; to the national level; to the international level. It is also applicable to any 'industry' focus. In this report, however, I will generally relate to the disaster management 'industry' in its widest context.

These components have been placed in the above order to reflect their relative importance and the priority they might receive in the implementation process. This reflects a 'bottom-up', user-oriented emphasis that was consistently identified as being the requirement during both workshops, rather than the 'top-down' control-oriented approach that seems to be reflected in models such as the Australian Spatial Data Infrastructure (ASDI) outlined in Appendix C. Vertical integration, whether top-down or bottom-up, is very important in maximising the level of coordination, collaboration and integration that is the major objective of implementing an information infrastructure.

An Information Culture

I have already introduced the notion of an information culture and its role in stamping out the practice of 'information-free decision making'. This practice is not confined to disaster managers or the Pacific – it a very widespread phenomenon.

There are at least four powerful forces working against developing and sustaining an information culture. The first such force is what I have called 'spinformation' (i.e. the output from 'spin doctors') which distorts, misuses or censors knowledge for the purposes of exerting power and influence (Granger, 1997). This is epitomised in the 'First Law of Journalism', namely that *facts should not get in the way of a good story*. It is not the same thing as wrong or incorrect information; it is much the same thing as propaganda. It works against the development of an information culture because it devalues information and creates mistrust in it by decision makers.

The second limiting force is the general lack of spatial awareness exhibited by many decision makers, despite the fact that the overwhelming majority of decisions made in most fields contain a spatial element. How often have we seen decisions handed down by economists, politicians, engineers or planners that do not make sense environmentally or in terms of community safety, simply because spatial relationships have been ignored? Housing developments on flood plains or areas prone to coastal inundation, hazardous or noxious industries developed up-wind from residential areas, or waste disposal facilities sited in aquifer recharge areas, are just a few of the more obvious decisions that are spatially stupid, if not reprehensible.

The third force is the widespread fear of information and knowledge. There appears to be an unwritten law that the higher up the corporate or institutional ladder one climbs, the less knowledge one should seek because of the constraints it places on 'independent' decision making. In describing what he terms the 'brain-force economy', the American futurist Alvin Toffler observed in an interview published in *Wired* (November, 1993):

> *If you have the right knowledge, you can substitute it for all the other factors of production. You reduce the amount of labor, capital, energy, raw materials, and space you need in the warehouse. So knowledge is not only a factor of production, it is the factor of production. And none of the powers that be, in Washington and in the industrial centres of our country, seem yet to fully comprehend it. It scares them. It's threatening.*

The same observation could be made of any other country and, again, in any industry.

The fourth, and possibly most wide spread, force is an aversion to systematic record keeping and documentation – i.e. a general lack of good information management practices. The 'file and forget' and the 'why bother to file' approaches are said to be very much alive and well in PICs – and elsewhere.

These barriers have got to be overcome before an information infrastructure can become a reality. Disaster managers need to remind themselves regularly of the observation made by that other great futurist, Aldous Huxley, in his essay *Proper Studies*, that 'facts do not cease to exist because they are ignored.'

The Right People

GIS (the technology) is not a 'black box' solution that only requires the right buttons to be pushed to obtain 'the truth'. It requires people who not only understand the technology of GIS and its associated systems such as GPS and remote sensing, but who also understand the real world problems they are trying to solve with GIS (the disaster, natural resource, planning, engineering and human services managers, for example). The 'right' people provide the input that energises the whole infrastructure. The 'right' people are those who are competent, committed, cooperative and communicative. These human resources issues are discussed in more detail in Chapter 2.

Co-ordination Process

Given the widespread and diverse nature of the information required to support disaster management, a mechanism is needed through which knowledge of the nature and availability of spatial data products and data sets, both within the country and outside, can be made available and access facilitated. A central feature of this process is the operation of a directory, or network of directories. This directory serves as the index to the 'library' of data held across the country and beyond. It does **not** hold or control the data itself, it simply identifies where it is and who to contact to get it. These issues are also explored more fully in Chapter 2.

Data and Information Products

The identification and provision of the data sets and products that are required by the widest range of users is a central aspect of any information infrastructure. These data sets and products provide the foundation on which all GIS applications may be built. It is usual to establish minimum (or fundamental) requirements for both baseline data sets and those data sets required for direct disaster management, including scale, accuracy and the range of attributes to be included. Those requirements will evolve as experience in the application of spatial information increases in disaster management in PICs. It is a function of the coordination process to monitor and manage that evolution. These issues are covered in considerable detail in Chapter 3.

National Guidelines and Standards

To maximise the integration and exchange of spatial data it is necessary to establish a range of standards and guidelines as an integral part of the information infrastructure. Some of the more technical standards, such as the implementation of the national or regional spatial datum (such as WGS 84) may be mandated by legislation, whilst others may be established by default (e.g. through the widespread use of a specific GIS, such as MapInfo). The guidelines and standards developed will need to cover:

- transfer standards (detailed technical standards to enable data to be moved from one GIS environment to another without loss of information);
- geographic guidelines and standards include coordinate systems and projections, location keys (such as property address), attribute content and classification standards (e.g. standard soil or vegetation classifications);
- algorithm guidelines and standards to cover computational operations of GIS such as slope analysis or DEM generation; and
- interpretation guidelines and standards to cover aspects of accuracy, uncertainty statements, descriptions of ground truthing and so on.

These issues are addressed in Chapter 4.

Institutional Framework

The oversight of the policy and administrative arrangements for building, maintaining, funding, accessing and applying the national standards and guidelines and their application to the basic information products used across the nation requires an institutional framework. These matters typically lie outside the realm of disaster management, however, NDMOs will need to become involved so that their requirements and priorities are reflected in national and provincial spatial information programs. These matters are also covered in Chapter 4.

THE DESIRED OUTCOME

If the various components of the information infrastructure/SII come together, then disaster managers will be in a much stronger position to make better decisions at all stages of the PPRR process. This information will be more comprehensive, more current and more integrated than it presently is. I can illustrate this by way of an excellent quote and a few cartoons.

Psychologists Joseph Reser and Michael Smithson (1988) have observed that:

> *A hallmark of many ignorant people is their unflinching confidence that they possess total knowledge. Likewise, truly deep knowledge may bring with it a sober cautiousness about issues most people regard as settled, and a wider appreciation of how much remains unknown.*

The 'total knowledge' that we all seek requires information to be complete and properly organised. In the GIS literature this is typically shown by a diagram like Figure 4. The reality, that should give rise to 'sober cautiousness' is, however, more akin to the situation illustrated in Figure 5, or more frequently as shown in Figure 6.

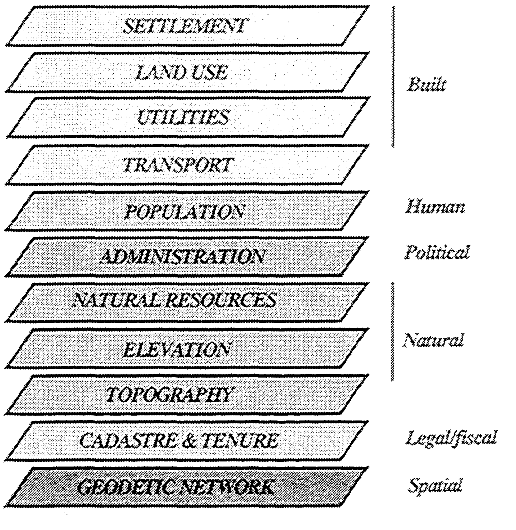


Figure 4: The idealised spatial information situation

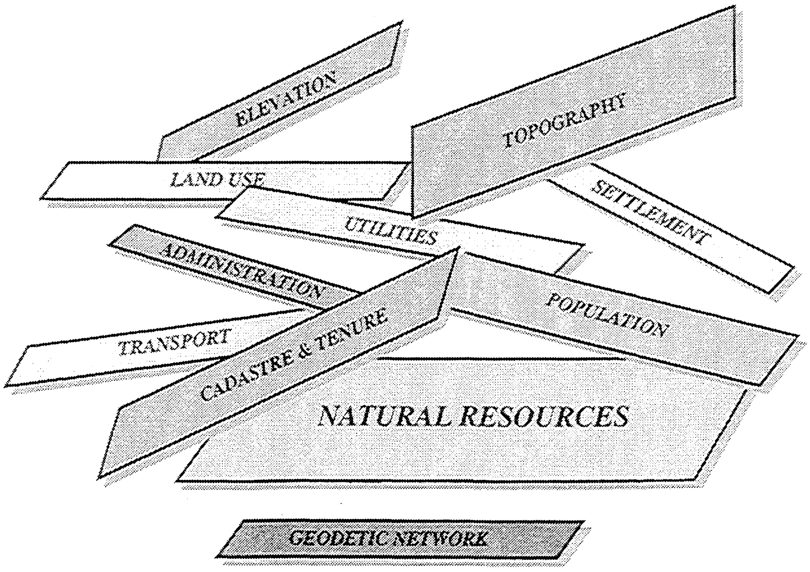


Figure 5: The complete spatial information 'reality'

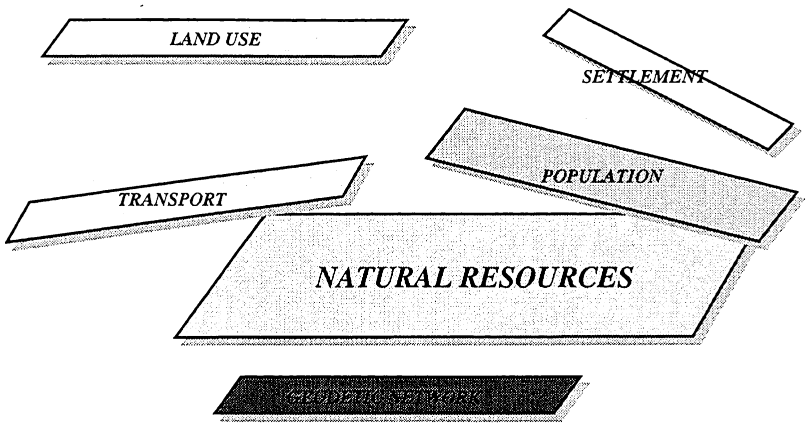


Figure 6: The incomplete spatial information 'reality'

The effect of the situation in Figure 5 would turn the Reser and Smithson quotation into a garbled mess like the following:

> *much remains unknown of many ignorant people is their unflinching confidence that they a hallmark possess total and a wider knowledge likewise truly regard as settled deep cautiousness about issues knowledge may bring with it a sober most people appreciation of how*

All of the words are there, but it would take time to unscramble them and, with luck, get the correct meaning of the statement. With the situation illustrated in Figure 6, it would be clearly impossible to get the complete message, with the result that a conclusion like the following could be the outcome!

> *truly* *sober*
> *people* *remain unknown.*

Unless it were known that this was not the complete story, remarkably different conclusions would be reached from those intended.

This is not unlike the situation faced by PIC disaster managers on a daily basis!

OBSERVATIONS

It was abundantly evident in both workshops, and in other contacts, that PIC disaster managers recognise and appreciate the need to have appropriate information available to them at all stages of the disaster management process. An information culture certainly exists, though it does perhaps need to be strengthened in some areas. It is also clear that disaster managers throughout the PICs possess a broad range of skills and experience in managing and applying information for decision making in disaster situations. Clear also is the fact that there is a nucleus of technical and professional staff throughout the PICs that have skills, training and experience in the use of GIS and the manipulation of spatial information.

It is equally clear that there is very little coordination either within countries or between countries as far as the maintaining of directories of information is concerned. In some PICs it would seem that government agencies and/or universities of the former colonial administering nations such as Australia, New Zealand and the United Kingdom have more complete and detailed inventories (and collections) of information than now exist in the country itself. This is clearly an area that needs much work.

Much of the time in both workshops was devoted to developing a better understanding of the information needs of PIC disaster managers and the information resources that existed in PICs. This work has enabled me to develop a generic profile of need that can be applied from the national/international level to the community/village level across the full risk management process.

Very few standards enjoy formal or widespread acceptance though it is evident that there are many actually in use that could be more widely promoted, if not formalised. This lack of formal adoption is perhaps a strong reflection of the lack of strong institutional arrangements within PICs.

The impression gained is that there is a very strong foundation in place on which to build an information infrastructure, with a solid SII base, for disaster management in PICs, however, much work remains to be done in building the structure on that foundation.

It goes without saying that in this report terms such as data and information are gender neutral and inclusive.

CHAPTER 2: PEOPLE AND COORDINATION

I have already observed that the 'right' people provide the input that energises the whole information infrastructure and the disaster management process that it underpins. The 'right' people are those who are competent, committed, communicative and cooperative. The importance of taking a cooperative and coordinated approach to information management, at the personal, corporate and jurisdictional levels, is recognised in the SII literature where it is usually referred to as the 'clearinghouse' component.

THE RIGHT PEOPLE

Competent People

Competent people are those who have and maintain the skills needed to do their job. This requires ongoing education and training, a fact well recognised in the disaster management field.

Identifying appropriate standards of competency in the administration of disaster management (how to manage disaster management) and many vocational aspects (mainly training in skills such as map reading and first aid or the operation of radio networks, flood boats or chainsaws) have already received attention in the PICs. I have not, however, been able to find in either the PICs or Australia, any guidance that identifies the particular fields, other than management, in which disaster managers should be competent.

Given the real world, holistic nature of disaster management, as discussed in Chapter 1, and its place in the wider risk management and community governance processes, it is clear that professional disaster managers would ideally have a broad span of knowledge, but should they be expected to have, for example, a competency in, or understanding of:

- the sciences associated with the various hazard phenomena (geology, meteorology, hydrology, vulcanology, etc);
- structural or civil engineering;
- the demographic, social, economic and cultural aspects of the people that make up their communities;
- the psychology, sociology and politics of disaster;
- the logistic, communications and transport resources that support the community; and/or
- all of these and more?

And if the answer to any or all of these is 'yes', then to what level should that competency or understanding extend? If the answer is 'yes, but', 'perhaps' or 'no', is it sufficient that their competency simply extend to having an understanding that information on these topics is important and to know who to contact (in the broader disaster management community) to get the necessary input and advice? I am sure that within the professional disaster management community there is a spectrum of competence in these topics ranging from strong academic background and experience to passing familiarity with the general concepts and terminology.

The Australian *National Emergency Management Competency Standards* (EMA, 1995) developed for professional and volunteer disaster managers, does not help to answer those questions definitively, but it does identify the need for emergency managers to be competent in the use of (unspecified) information. It contains two explicit competency units relating to information (Unit 10 - Manage Information and Unit 11 - Process Information). Both are 'core' (i.e. compulsory) competencies and are described in terms of the 'processes of collecting, recording, verification, interpretation, structuring, collation and dissemination of emergency management information' – i.e. they relate to the information (intelligence) cycle described in Chapter 1.

The Australian competency standard also contains reference to the use of GIS, as one of the activities under Unit 2 – Assess Vulnerability, a process described in the standard as examining 'the interaction of hazards, communities, agencies and the environment'.

There is another spectrum of competencies involving GIS. These range from the highly technical levels of professional GIS analysts who have strong skills in programming and spatial modelling; to those who use GIS to analyse spatial issues as part of their core work; to those who simply use GIS to display a map.

The Suva workshop clearly demonstrated that there is a good pool of competent people ranging across this spectrum of GIS use. At the professional and applications end, most of these are graduates from the University of South Pacific (USP) in Suva, the PNG University of Technology (Unitech) in Lae or from universities in Australia or New Zealand. USP offers a range of courses in disciplines including earth science, geography, land management, sociology, population studies, environmental science and tourism, some of these involve, or can include, training is the application of GIS. A good contact at USP is Mr James Britton, a senior lecturer in geography (britton_j@usp.ac.fj). A similar range of disciplines are available at the University of Papua New Guinea (UPNG) in Port Moresby. Unitech, however, is the acknowledged centre for education in spatial sciences such as surveying and the technical aspects of GIS and technologies such as GPS. Professor Rod Little, who heads the Department of Surveying and Land Studies (rlittle@survey.unitech.ac.pg) is the best contact at Unitech.

For those at the more casual applications and desk-top mapping end, specific vocational training and experience is available through short courses and on-the-job training provided by SOPAC and in some countries by both private and public sector agencies. Some non-government organisations (NGO) also provide training and experience in GIS use. SOPAC also provides technical support for GIS hardware and software installation and maintenance and a 'help desk' function that supports users throughout the PICs.

Whilst there may not be a large number of NDMOs or their staff who have yet gained access to, or experience in, the application of GIS and other spatial technologies, there are certainly competent people available in most PICs to provide that type of support to disaster managers.

Committed People

Skills alone do not guarantee a successful use of information or tools such as GIS (or indeed, disaster management). That requires a strong measure of commitment to the process involved. Again it is clear that there is a good resource of people in the PICs who understand the issues and challenges they are meeting in the GIS and disaster management processes and want to make a difference. They are dedicated to solving the problems that confront their communities.

Communicative People

Competence and commitment are of little value if the people with those attributes are not willing to pass on their knowledge of both GIS and the information they produce using those tools. In PICs the widely disbursed population and, at time, tenuous links calls for special efforts to be made to facilitate that communication. This requires the operation of both formal processes, such as workshops, conferences and newsletters such as those facilitated by SOPAC, and informal networks, such as the GIS User Groups that exist in some centres such as Suva. Promotion of the benefits gained by the community by the use of GIS and the operation of the SII will enhance this process.

It is useful to remember that the word 'communicate' is derived from the Latin *communicatus*, which means 'shared'. Communicative people, therefore, are people who share their information and experience.

Cooperative People

It is clear that no individual or organisation has all the answers, either in disaster management or in the use of GIS. To maximise the acknowledged benefits of both, it is essential that an environment of cooperation both within organisations and between organisations is strongly maintained. There is clearly a strong level of cooperation within and between the various NDMO organisations. That commitment is not, however, always experienced between organisations that develop, manage or look after spatial information and GIS resources.

This situation is not peculiar to the PICs. In the multi-hazard risk assessment undertaken by the AGSO *Cities Project* in Cairns, data was assembled from at least 35 different sources, most of whom, at the time, did not share information with any of the others. In some instances, some were not even aware that the others actually existed!

INFORMATION: COOPERATION AND COORDINATION

It is quite clear from both workshops that PIC disaster managers acknowledge that information is an essential ingredient to effective and sustainable decision making at personal, organisational and jurisdictional levels. A culture of information is well established in this community. The practice and experience of using it, however, is yet to develop to the same degree.

It was also clear that the information needed for decision making tends to be developed, used and managed in an insular fashion (also by individuals and organisations) without much reference to others who may have an interest or need for the same or very similar information. There are many instances of expensive information collection programs being undertaken by two or more different agencies, more or less simultaneously and in the same community, without the knowledge of, or reference to, agencies with similar needs.

It was acknowledged that this insularity is inefficient, uneconomical and (typically) socially inequitable. Whilst we can pour scorn on some of the more outrageous examples of duplication, such examples continue to flourish:

- in part because we want to 'control' our own material (*that other mob won't do it is well as we will, so we had better do it ourselves*);
- in part because we don't bother to find out (*there is no use asking that mob, they are useless*);
- in part because we are not willing to share our information with others (*we can't tell that mob because they might use our information against us*);
- in part because we are not prepared to reveal the detail of our information (*we can't make this public because it might scare people or cause a political row*); and,
- in part because it may be funded by an aid donor or under some other appropriation (*we have been given the money to do it, so it must be OK*).

Such a situation can only flourish where there is a lack of coordination and cooperation between information gatherers and users. It is typically made worse where there is a lack of commitment to work in open and active partnership with the community and where there is no mechanism by which information about information can be easily accessed.

There are solutions available to facilitate the linkage of the many 'islands' of information and thus break down this insularity. Whilst many of these solutions today are built around technology, the principles of coordination and cooperation, on which they are based, are non-technical. The development of these links is the objective of what is usually referred to in the literature on spatial data infrastructures as the 'clearinghouse' network or mechanism.

THE CLEARINGHOUSE

The US literature on their National Spatial Data Infrastructure (NSDI) describes the clearinghouse concept as 'a system of software and institutions to facilitate the discovery, evaluation, and downloading of digital geospatial data' (FGDC, 1997). This description identifies two distinct aspects, namely:

- from an *institutional* perspective, it is a referral service, or a 'library index' used to discover who has what information; and,

- from a *technical* perspective, it is a set of information stores that use hardware, software and telecommunications networks to provide access to information.

Institutional issues

The key objective of the clearinghouse is to identify what information is available, where it came from and who has it. In reality, a clearinghouse can be as simple as a box full of reference cards, or as complex as some of the directories, such as the Internet-based Australian Spatial Data Directory (ASDD) or the CD-ROM-based Queensland Spatial Information Directory (QSID), that are already in place. Details of these representative clearinghouse directories can be seen at:

- for ASDD see www.environment.gov.au/net/asdd/)
- for QSID see www.qsiis.qld.gov.au/spat_info_directory/qsid.html).

SOPAC's Internet-based 'virtual library' provides another, more general, example of a technology-driven directory (found at www.sopac.org.fj).

Like any 'library index', the clearinghouse directory does not contain the actual information, it only contains information that will help the researcher to make a judgement as to whether it is what they are looking for, and if so, where to find it. This information is typically referred to as metadata (data about data).

Metadata describes the content, quality, condition and other characteristics of the material of interest, be it data in a database, a satellite image or a coverage of aerial photography, a report or a map. The key headings for a metadata directory for spatial information (i.e the SII 'library index') should include:

Identification
- title of the database, map, report, etc;
- area, place, region, etc covered;
- themes and subjects addressed;
- currentness – when was the material produced or last updated or validated;
- can the material be released to anyone or are there access restrictions.

Data quality
- accuracy;
- completeness;
- logical consistency;
- lineage (where did the data originate and what has been done to it since).

Data organisation

- is it spatial or non-spatial, structured or free text, digital or analogue, etc;
- if it is spatial data
  - is it vector data with or without topology;
  - is it raster data;
  - what type of spatial elements are involved (point, line, polygon).

Spatial reference

- projection;
- grid system;
- datum;
- coordinate system.

Entity and attribute information

- features (topography, buildings, social value, cultural feature, etc);
- attributes;
- attribute values (quantitative, qualitative, names, scales, etc);
- time perspective (historical, real-time, forecast, etc).

Distribution

- distributor or custodian (who to contact);
- on line or postal access address;
- language or languages available;
- formats available (database, table, MapInfo table, map, book, etc);
- media available (audio tape, video tape, floppy disk, CD-ROM, paper, film, etc);
- price and payment details.

Metadata reference

- when was the metadata developed;
- who was responsible for the metadata.

This scheme can be applied to any form of information, be it the most sophisticated *Risk-GIS* information, or an oral history recorded in a remote village; a satellite image or a sketch in a field notebook, and so on – it is all information and it all needs to be properly indexed.

ANZLIC has established a standard for spatial metadata, the details of which can be found on their Internet site at www.anzlic.org.au/metaelem.htm. This is a highly technical standard, designed mainly for traditional spatial data products such as cadastral and topographic databases. It is, none the less, in increasingly wide use in Australia and it might be a useful model for SOPAC and PIC authorities to look at if it is decided to go down a more formal information infrastructure path.

Technical issues

Once the information needed has been identified and access has been arranged, the next issue is to transfer it from its source to the user. Traditional 'hard copy' material such as books, reports, maps, films and photos, is typically transferred physically i.e. it is sent by hand, post, courier, and so on. For material that is in digits, or can be converted to digits, the transfer options are somewhat greater, though in many cases the actual transfer will still rely on physically carrying or posting the transfer medium from the originator to the user.

Audio and video tape: A great wealth of information is captured on audio and video tape. Whilst these forms are not typically associated with spatial information they often contain information that is related to 'somewhere' – an interview with a village elder about traditional food preservation can be related to the village location, whilst a video of damage done during a cyclone relates to the localities affected. Transfer can be through physical transfer (post the tape) or by electronic means (broadcast the story or the imagery).

There is also an increasing range of software tools that enables audio and video material to be converted directly into word processor text (e.g. Dragon Natural Speech) or to introduce video (both analogue and digital) into a computer environment where it can then be transferred via the Internet.

Data tape and disk transfer: Until very recent times, most digital material was transferred by tape or disk. For data sets in which the constituent files are smaller than 1.4 megabytes this simply involves copying files onto a floppy disk and passing it on. Where individual files are larger than 1.4 megabytes, compression using software such as PKZIP can bring them down to a small enough size. If that is not practical, especially where numerous large files need to be transferred, tapes or disks of greater capacity are available. Amongst the more common of these are the 40 megabyte *Clik PC Card,* 100 and 250 megabyte *Zip* drives and 2 gigabyte *Jaz* multimedia drives produced by Iomega (www.iomega.com). All of these devices have to be physically transferred by conventional means for the data they contain to be accessed.

CD-ROM: Where the number of files to be transferred are large and/or where it is not practical to compress files to fit on a floppy disk, the files can be copied to a CD-ROM. This medium is clearly superior to floppy disks, and most modern personal computers now come with a CD-ROM reader as a standard feature. Most current models of PC can also be optioned to include a CD-ROM writer.. Fortunately the providers of the largest data sets today typically have that technology. CD-ROM also provide an excellent form of data archiving.

LapLink: Machine-to-machine copying via a connecting cable, employing software such as LapLink, is an extremely accurate and fast method of data exchange where practical. The very large hard disk capacity of modern laptop computers (typically greater than 2 gigabytes) makes it possible to transfer extremely large quantities of data by this means, however, it requires Mohammed to go to the mountain or *vice versa.*

Email: I have had some success with sending smaller data sets between Brisbane and Suva, in both compressed and uncompressed form, via Internet email, though the transfer of larger files (say more than one or two megabytes) has not always been reliable. Simple table data sets and text files tend to be easier to transfer than graphic files.

ftp: I have also had considerable success (within Australia) in transferring large uncompressed files of up to 50 megabytes using the Internet file transfer protocol (ftp) capability. This is clearly the way of the future for the rapid transfer of large data sets. It opens the prospect of transferring large and urgently needed files under disaster operational conditions to laptop computers in the field using the telephone/modem route. This technique, however, is completely dependent on telecommunications systems with good capacity and speed, a resource that is not always reliable across the Pacific.

Intranet: Access to data within organisations, such as SOPAC, is facilitated by their corporate local area or wide area networks (LAN or WAN). These arrangements certainly facilitate information management and issues such as version control i.e. making sure that the version of a database in use is the most recent. Evolution of this current technology towards an 'end-user' computing environment (the promise of the Intranet) will further enhance not only access to the data but also to applications and decision support tools such as *Risk-GIS.*

Most of these technologies are fairly intuitive to use under the Windows 95, 98 or NT operating systems, even by one who is not especially skilled in the use of that software or the Internet.

One of the hidden benefits of all of this transfer technology is that it adds significantly to preserving and protecting valuable data from loss, vandalism, technical failure and IO (idiot operator) problems. It certainly saved my bacon during the Cairns work under the AGSO *Cities Project* when I inadvertently corrupted the master copy of the primary database for the project. I was able to recover it from the copy I had sent to Cairns City Council.

OBSERVATIONS

There is certainly a good (and expanding) pool of the 'right' people to implement and operate an information infrastructure in most of the PICs and at a wider regional level.

There appears, however, to be a limited appreciation of the value of establishing an information infrastructure, or the SII component of it, in most PICs. It is evident that the greatest obstacle to be overcome in this regard is the lack of either a coordination mechanism, a tradition or spirit of cooperation between stakeholders, or both of these.

Given that disaster managers tend to have very limited influence in the agencies that would most likely be given responsibility for developing a national-level information infrastructure or SII, such as the Department of Lands or its equivalent, they may need to develop a range of strategies to bring pressure to bear to have such a mechanism developed. That may require using outside 'experts', as suggested by one of the NDMOs, or using the experience of a significant disaster event to convince the 'powers that be' that the outcome would have been more favourable if the country (region, district, etc) had an appropriate information infrastructure in place. They can not make effective decisions without the appropriate information – and in disaster management that could cost lives. The lack of appropriate information also retards development, a factor that will inevitably have long term consequences.

A key first step in establishing a information infrastructure is the creation of a clearinghouse mechanism, including a metadata directory, through which disaster managers can find and arrange access to the information they need to make those decisions. Most have access to the technology that can make such a mechanism accessible across the country and across the region.

The experience of local governments and small regional groupings of spatial data users in Australia could serve as a useful guide for PIC and regional agencies such as SOPAC to look at if it is decided that a formally structured information infrastructure is to be developed. This experience may be more appropriate that the higher level experience at state and national level in Australia where issues such as metadata standards and clearinghouse directories tend to be rather formalised and heavily dependent on technology and a relatively large and skilled work force.

CHAPTER 3: DATA AND INFORMATION PRODUCTS

WHAT INFORMATION?

Disaster management is, by its very nature, an information-hungry activity. It must deal with real world issues in a holistic way and covers the full range of activities involved in preventing, preparing for, responding to and recovering from disaster impacts. It is also important to reiterate that the PPRR (prevention, preparedness, response and recovery) of disaster management is but one of the treatment strategies of comprehensive community risk management. It should, therefore, be supported by the process of risk assessment as outlined in Chapter 1. The information needed across this combined span of activity must, consequently, be capable of describing or defining the widest possible range of real world issues. This differs markedly from most other activities, such a land management or regional planning, for example, which tend to have a significantly narrower subject focus.

Not only must the subject coverage be broad, the temporal span may also need to be comprehensive. Throughout its various stages, disaster management can require information that is, at least by human timeframes, timeless (such as climate, terrain or geology); it needs information on past events; it needs immediate information about the current situation; and, it needs information about the future, in the form of forecasts or predictions. Disaster managers may need access to great detail down to the level of individual buildings or people, conversely, they may need general information across wide areas such as sea surface temperatures across the whole Pacific Basin.

This is no small challenge, a fact recognised by disaster managers at the Suva workshop. It clearly does not, however, mean that disaster managers need to know everything about everything. This is clearly impossible, even for such paragons as PIC NDMOs! The trick is to identify what information and information products are required at which stages of the risk assessment and disaster management processes so that the they can be prioritised. It is important, therefore, to follow a systematic process that maximises the efficiency of information management and minimises duplication of information collection and, more importantly, gaps in information – hence the need for an information infrastructure.

In the following discussion I will outline the general information needs and some of the more obvious sources for that information across PIC. A more detailed listing of subjects is provided in Annex D.

DIVIDING THE TASK

There are many ways of systematically dividing the task of information management. Many systems in use in Australia, for example, take a thematic approach based largely on the main users and/or the custodians of the information. The scheme described here is based on the experience we have gained under the AGSO *Cities Project.* To understand this approach, however, it is useful to outline some of the key principles followed. In our approach to risk assessment, for example, we have adopted the Office of the United Nations Disaster Relief Coordinator (UNDRO) definitions from 1979 and cited by Fournier d'Albe (1986) as follows:

- ***Natural hazard*** *means the probability of occurrence, within a specified period of time in a given area, of a potentially damaging natural phenomenon.*

- ***Vulnerability*** *means the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude...*

- ***Elements at risk*** *means the population, buildings and civil engineering works, economic activities, public services, utilities and infrastructure, etc., at risk in a given area.*

- ***Specific risk*** *means the expected degree of loss due to a particular natural phenomenon: it is a function of both natural hazard and vulnerability.*

- ***Risk*** (i.e. 'total risk') *means the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon, and consequently the product of specific risk and elements at risk.*

Total risk, the approach required by disaster managers, can be expressed simply in the following pseudo-mathematical form:

$$\textbf{Risk}_{\textbf{(Total)}} = \textbf{Hazard x Elements at Risk x Vulnerability}$$

This terminology may be a little different to that used in some disaster management agencies and because it is derived from work done twenty years ago it may be considered to be out of date. It remains, to my mind, the most comprehensive and inclusive set of definitions. I would encourage readers to consider what the words are being used here, rather than how they may use them in their current work. Certainly one of the most central terms here is 'vulnerability'. In this report I explicitly use the term to reflect the range of capacity from total susceptibility to the impact of a hazard event, to total resilience to the same event.

Regardless of the 'formula' or the definitions, 'risk' is the outcome of the impact of hazards on a community.

The organisation of information can, therefore be split between the two key factors:

- the hazards and environments in which they operate; and,
- the elements at risk and their characteristics that make them more or less vulnerable to disaster impact.

This approach, however, does not take account of the level of community awareness and acceptance of risk that is an important component in risk communication and in the prioritisation of risk treatment options, and hence disaster management. This factor also needs to be included.

These components come together in the *Cities Project's* understanding of the risk management process, and consequently our approach to information management. This is illustrated in Figure 7.

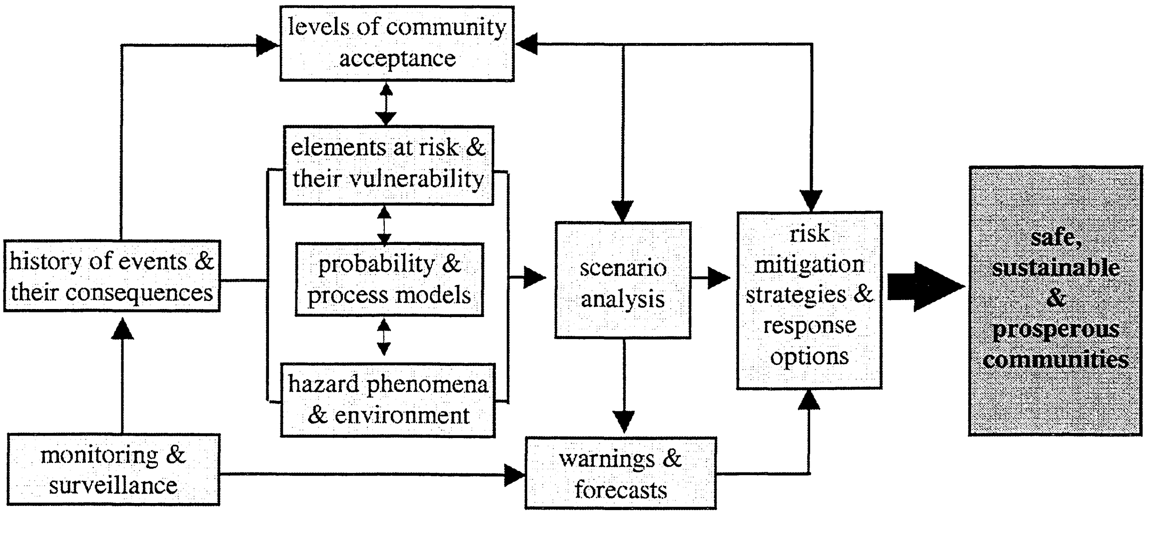


Figure 7: *Cities Project* understanding of the risk management process

HAZARDS

The hazard phenomena that are most relevant in PICs can be divided into four groups, on the basis of their origin, as shown in Table 1.

Table 1: Classification of hazards

ATMOSPHERIC	EARTH	BIOLOGICAL	HUMAN
tropical cyclones	landslides	human epidemics	industrial accidents
tornadoes	earthquakes	plant epidemics	transport accidents
storm surges	tsunamis	animal epidemics	crime
floods	volcanoes	plagues	political conflicts
frosts	lahar	bush fires	structure failures
droughts	erosion		structure fire
severe storms	ground failure		contamination

Obviously, not all of these hazards are experienced in all PICs. Frosts, for example, are probably only an issue in PNG, whilst tropical cyclones are a relatively rare problem in PNG and then only affecting a small part of that country; landslides are unlikely in countries such as Tuvalu and Kiribati; and so on. Overall, most countries can potentially be affected by most of these hazards as shown in Table 2 which was compiled by SOPAC from various sources.

The information required by disaster managers on the hazard phenomena are typically confined to:

- the history of hazard impacts and their consequences;
- warnings or forecasts of an impending hazard event; and,
- forecasts of the likely level of impact of events of different probability (i.e. hazard scenarios).

To provide that information on at least the last two of these, however, hazard scientists require a wide range of data on the respective phenomena and the environments that they function in. Whilst these data are of limited direct interest to disaster managers I have included them in this discussion and in the detailed listing in Annex D for completeness.

Hazard history

Information on the community's experience of hazard impacts is, in my experience, perhaps the single most important resource that should be available to disaster managers. It represents reality and helps to overcome the inherent problem that human memory tends to be significantly shorter than the return period of most hazard phenomena.

There are many sources for this information. The availability of well managed collections of such information, however, is highly variable and typically confined to the larger PIC and international agencies such as AGSO, the Australian Bureau of Meteorology (BoM), the Queensland Department of Natural Resources (QDNR), the New Zealand Institute for Geological and Nuclear Sciences (IGNS), the US Geological Survey (USGS) and the US National Oceanographic and Atmospheric Administration (NOAA). Many of these also provide current information on conditions such as global or regional El Nino and sea surface temperature conditions, as well as recent hazard events, via their respective Web sites.

Table 2: Estimated level of PIC vulnerability to specific natural hazards

Country	Population	Land Area (km^2)	Cyclone	Storm Surge	Coastal Flooding	River Flooding	Drought	Earthquake	Landslide	Tsunami	Volcanic Eruption
Cook Islands	19,500	240	H	H	M	M	H	L	L	M	-
FMS	114,800	701	M	M	H	-	H	L	L	M	-
Fiji	752,700	18,272	H	H	H	H	H	H	H	H	L
Kiribati	76,000	725	L	M	H	-	H	L	L	H	-
Marshall Is	50,000	181	H	H	H	-	H	L	L	H	-
Nauru			L	L	L	-	H	L	L	L	-
Niue	2,300	258	H	H	L	-	H	M	L	M	-
Palau	21,600	494	H	H	M	-	H	L	L	M	-
PNG	4,056,000	462,243	H	H	H	H	H	H	H	H	H
Samoa	163,000	2,935	H	H	H	H	L	M	H	H	M
Solomon Is	337,000	28,370	H	H	H	H	H	H	H	H	H
Tokelau	1,600	12	H	H	H	-	H	L	L	H	-
Tonga	97,400	720	H	H	H	M	H	H	L	H	H
Tuvalu	9,100	24	H	M	H	-	M	L	L	H	-
Vanuatu	156,500	12,200	H	H	H	H	H	H	H	H	H

(compiled by SOPAC DMU staff from various sources)

Note: The vulnerability of PNG to cyclone and storm surge is rather higher than I would have assessed it. Coast-crossing cyclones in PNG are very unusual and then confined largely to the smaller islands to the east of the mainland, though high seas and intense rainfall generated by more distant cyclones are a much more frequent hazard.

Some of these are:

AGSO	*www.agso.gov.au*
BoM	*www.bom.gov.au*
IGNS	*www.gns.cri.nz*
NOAA	*www.ceos.noaa.gov*
QDNR	*www.dnr.qld.gov.au/longpdk*
USGS	*gldss7.cr.usgs.gov/neis/bulletin/bulletin.htm*

Documentary records of disaster events can, in some areas, extend back to the mid-to-late 19th Century or (in rare cases) even as far back as the 16th Century. These records are found in the journals of explorers, missionaries and other travelers, official government reports and through contemporary press reports. These reports are valuable because they frequently contain much information on the consequences of the disaster and how the affected community coped with the experience, though they are largely presented from the perspective of those 'outside' observers.

Oral tradition, local myths and creation legends can also provide evidence of such events. These records also often contain information on how the affected community experienced the event and how they responded. Typically, they are associated with major events in specific named locations and can be of value as a guide to modern scientific investigation by geomorphologists and others.

More detailed scientific records, especially those in which instrument measurements are available, tend to date from the 1940's at best. The availability of satellite data on cyclones over much of the Pacific generally dates from the 1970's. The instrumental coverage of hazards such as earthquakes, volcanic eruptions, cyclones, severe storms and tsunamis is constantly improving, as is the number of researchers who take an interest in those phenomena in the Pacific.

The 'damage assessment workshops' held in three PICs under the SPDRP in 1997 and 1998 have established an excellent framework on which to collect post-event impact information. The generic 'initial damage report' forms developed for Cook Islands, Samoa and Tonga, and the 'drought assessment' forms used in Fiji and Solomon Islands during 1998, are very comprehensive. In the case of Tonga, their form has been translated into Tongan and has been distributed to outer island District Officers. They were used for the first time following Cyclone *Cora* in February 1999 (Angelika Planitz, SOPAC, personal communication).

It is, however, one thing to have the proforma in place, another to have it used, and yet another thing for the data collected to be subsequently collated, analysed and preserved to ensure that the maximum value can be gained from the effort of collecting it. At this stage completed forms tend to be accumulated at the National Emergency Operation Centre in the respective country.

It is worth observing that these proforma place the PICs well ahead of most Australian jurisdictions where there is a very poor record of detailed and coordinated post-event studies. The most comprehensive collection of post-event collection of information for Australia is that collated by the Newcastle Region Library on the experience of the 1989 earthquake in that city. This contains a wealth of documentary and visual material as well as interviews with survivors, rescue workers and so on. It is a very good model for such collections.

The Web site *www.newcastle.infohunt.nsw.gov.au/library/eqdb/earthq.htm* provides details.

Warnings and forecasts

There are only two hazard warning and forecasting services that cover all PICs. They are the Tropical Cyclone Warning Centre (TCWC) based in Nadi and the Pacific Tsunami Warning Centre (PTWC) based in Hawaii. The Pacific ENSO Applications Centre (PEAC) in Hawaii also provides forecasts of

El Nino events, though their primary clients are the US and former US Territories. These centres have well established procedures and communications networks to provide warning and tracking of their respective phenomena. Many of the active volcanic centres that are close to populated centres are also monitored for activity and warnings of impending eruption are provided. Perhaps the most comprehensive of these is that centered on the Rabaul Volcanological Observatory in PNG.

Apart from the flood warning system on Fiji's Rewa River, there appear to be no local warning systems available in PIC. The dissemination of the warnings from the Rewa system to the communities under threat relies on established telecommunications systems, especially broadcast radio.

Since the severe El Nino-created droughts in PNG, Solomon Islands, Fiji and elsewhere in 1997/98, there has been some research undertaken to explore the feasibility and practicality of developing an early warning system for drought across PICs, however, this is still to be developed.

Hazard scenarios

Perhaps the most familiar way of providing hazard information to disaster managers and others is through the use of maps which portray the extent of the area likely to be affected by scenario events such as the '1:100 year' flood or storm tide or the likely ash fall or blast areas for a given volcano. These are frequently referred to as 'risk maps' though they typically relate only to a modelled, or postulated, hazard scenario.

There are many hazard or site-specific studies that contain hazard scenario (or probability) information. These include Trevor Jones' earthquake hazard assessment of Fiji (Jones, 1997), Brian Gaull's MSc thesis on seismic risk in the principal towns of PNG (Gaull, 1979), various volcanic disaster plans in PNG, Solomon Islands and Vanuatu and the Suva earthquake risk management scenario pilot project (SERMP) developed under SPDRP (Rynn, 1997).

One of the key outputs from the SOPAC *Pacific Cities Project* will be specific hazard maps as part of their urban community risk assessments in eight PIC cities. The *Communities at Risk* project will provide similar hazard maps of areas of rural population concentration.

ELEMENTS AT RISK & THEIR VULNERABILITY

Information on the hazard phenomena alone does not provide an adequate base for disaster management, after all, if there are no people involved then there is really no disaster. The development of an understanding of the elements at risk in communities (also termed 'assets' or 'capacity' by some agencies), and their vulnerability (susceptibility to resilience) to a given hazard impact, involves input from a very wide range of disciplines such as geography, demography, psychology, economics and engineering. It also involves many sources from both public, private and academic sectors.

A significant effort may need to be made by disaster managers and others to develop the very detailed data on the principal elements at risk, if they aim to create a comprehensive risk assessment. This is reflected in the approach followed by the SOPAC *Pacific Cities/ Communities at Risk Projects* and the evolving *Community Resilience* concept.

There is undoubtedly a substantial amount of background or 'baseline' information available, such as maps, population figures from national censuses and other population counts and statistics from surveys of land use and so on. The biggest challenge is to find out that it exists, what form it is in and who has it – i.e. there is a need for a 'clearinghouse' directory. A systematic approach to listing the information needed – so as to more easily identify where gaps exist – is strongly recommended.

The experience we have gained under the *Cities Project* has led us to follow a system based five broad groups of elements at risk, we refer to as the 'five esses' – shelter, sustenance, security, society and setting. We have also developed an understanding of the attribute information needed to assess relative vulnerability of each element at risk.

Shelter

The buildings that provide shelter to the community at home, at work and at play, vary considerably in their vulnerability to different hazards. There is considerable diversity throughout the PICs as far as building structure and material is concerned. This ranges from engineered, high rise buildings in urban centres, to temporary, 'bush material' shelters in many rural areas, and virtually everything else in between. The nature of shelter also ranges from family or communal housing, be it in single detached houses, or in multi-occupant blocks of flats and barracks, in commercial accommodation such as tourist resorts, hostels and guest houses, to institutional accommodation such as hospitals, hostels and school dormitories.

For disaster managers there is also a need to have details of emergency shelter and buildings that can serve as safe haves from events such as cyclones and storm tides. There is also a need for information on the availability of material, such as tents, tarpaulins and rolls of plastic, to provide temporary shelter.

To assess the vulnerability of buildings, a range of information relating to their construction is required. These building characteristics contribute to the relative degree of vulnerability associated with exposure to a range of hazards. In Table 3, the number of stars reflects the significance of each attribute's contribution to building vulnerability.

Table 3: Relative contribution of building characteristics to vulnerability

CHARACTERISTIC	FLOOD[1]	WIND	FIRE	QUAKE	VOLC[2]
Building age	***	*****	*****	*****	****
Floor height or vertical regularity	*****	*	****	*****	***
Wall material	***	***	*****	****	**
Roof material		****	*****	****	****
Roof pitch		****	*		*****
Large unprotected windows	**	*****	*****	**	***
Unlined eaves		***	*****		
Number of stories	****	**	*	*****	*
Plan regularity	**	**	***	*****	***
Topography	*****	****	****	***	****

Notes 1: Includes all forms of inundation hazard including storm surge and tsunami.
2. Volcanic hazards including ash fall and blast.

A standard set of attribute information is now being collected in the urban centres covered by the SOPAC *Pacific Cities Project*. Details are provided in Annex E. It is very similar to the approach followed under the AGSO *Cities Project*. This system is probably appropriate for any urban centre or for non-village settlements in rural areas such as mines, logging camps and sawmills, missions, boarding schools and so on. They are, however, perhaps too detailed and complex for use in rural village communities. The UNDHA CVA method provides an alternative approach which classifies village buildings along the lines shown in Table 4.

Table 4: Example of a model building classification for village communities

TYPE OF BUILDING	USE	MATERIAL
Timber house class A	Family	Sawn timber, nails, fibro walls, corrugated iron roof
Timber house class B	Family	Bush timber, nails and bush rope, corrugated iron
Timber house class C	Family	Bush timber, bush rope, matting walls, thatch roof
Concrete block house	Family	Concrete block walls, corrugated iron roof
Kitchen shed	Cooking	Round poles, thatch roof
Toilet	Toilet	Round poles, matting walls, corrugated iron roof
Community hall	Meetings	Concrete frame and block walls, corrugated iron roof
School classroom	School	Sawn timber, fibro walls, corrugated iron roof
Church	Meetings	Concrete frame and block walls, corrugated iron roof

Note: The CVA methodology envisages such a classification be developed specifically for each community.

Based on UNDHA (1998) Table 5.9, p 39

A version of the AGSO *Cities Project* building database format, modified for use in PIC villages, has been used by Unitech in the Duke of York Islands near Rabaul, PNG. This modified AGSO model (in its MapInfo format) is also included in Appendix E.

Joe Barr suggested to the delegates at the Cairns workshop that to get a village mapping and building inventory working, it might be appropriate to run a contest with a good prize for the village that produced the best map. Those maps would be copied and laminated and returned to the villages to serve as the base for their community disaster plan, whilst copies could be accumulated into a district and national inventory. The village survey and mapping methods outlined in the CVA methodology, would provide a good model for this type of activity.

Obviously, the nature of building materials and the degree to which they are used will vary greatly from village to village and from country to country, however, the basic principle of measuring the potential vulnerability of shelter buildings remains. The availability of building materials and skilled workers to undertake repairs or to re-build after a disaster are resources that also need to be considered.

Access to shelter is also significant, so information on mobility within the community is needed. Within urban areas, details of the capacity and vulnerability of the road network, for example, are important, e.g. flood points, bridges, steep-sided cuttings, traffic 'black-spots' and so on.

The vehicles that use the road and the availability of those vehicles can also be important, especially for disaster managers who need to undertake an evacuation. For example, are there buses or trucks available to evacuate people who do not have their own transport or ambulances available to move people from hospitals, and so on? The availability of plant and material with which to repair or rebuild roads and bridges after disaster also needs to be known.

Information on internal access tends to be less significant at the village level where walking or bicycles tend to be the principal modes of transport. The information relating to mobility between settlements are covered under the 'setting' heading.

Sustenance

All communities are dependent on a safe and adequate supply of both water and food and to a slightly lesser extent on the fuel (or energy) for cooking and warmth. These are the minimum requirements for a sustainable community.

The larger and more complex the community, the greater the range of infrastructures and services that have been established to sustain it. Modern urban communities, for example, are highly dependent on their utility and service infrastructures such as water supply, sewerage, power supply and telecommunications. These so-called *lifelines* are, in turn, significantly dependent on each other and on other logistic resources such as fuel supply.

The interdependency aspect is shown in Figure 8. In this figure the loss of the lifeline in the left-hand column will have an impact on the lifelines across the row to a significant (**S**) or moderate (**M**) degree.

	POWER	FUEL	WATER	SEWER	COMMS	ROAD	RAIL	BRIDGE	AFLD	PORT
POWER		S	S	S	S	M	S		S	S
FUEL	S		M		M	S	S		S	S
WATER	M			S					M	M
SEWER			S						M	M
COMMS	S		S	S		M	S		S	S
ROAD	M	S	M	M	M		M	M	M	M
RAIL		M				M		M		M
BRIDGE	S	M	S	S	S	S	S			
AFLD		S								
PORT		S								

(based on Granger and others, 1999, Table 3.9)

Figure 8: Interdependency of lifeline assets

It is clear from this analysis that power supply and telecommunications ('comms') are overwhelmingly the most important of all lifeline assets in terms of what is dependant on them, followed closely by fuel supply, bridges, roads and water supply. Their significance to community sustainability, however, may be somewhat different - e.g. people can not survive for long without a safe water supply, but they can survive (albeit with some inconvenience) without the telephone, fuel, light and even power for some time. Ports, airports and fuel supply are the most exposed in terms of their dependence on the widest range of other lifelines.

In most PIC villages, supplies of lighting kerosene and fuel can, to some extent, replace the dependence on power, whilst water sources such as roof catchment, wells and streams substitute for a reticulated water supply.

The community is also dependent on the supply of food, clothing, medicine and other personal items. Information is needed on all of these, as well as on the enterprises that wholesale, distribute and service these sectors (especially facilities such as cold stores, warehouses and bulk storage depots).

In village communities the sources of food can be very diverse, ranging from garden crops and fishing to animals (such as pigs and cattle) and 'bush tucker' gathered from the surrounding countryside. The availability of these foods may be seasonal and in some communities there may be traditional methods of food storage to cover times of hardship or to cover the seasons when produce is in short supply. A good knowledge of these food sources and their susceptibility to hazards, such as drought, frost or pests, is every bit as important as a knowledge of the availability of rice and tinned fish in an urban warehouse.

Security

The security of the community can be measured in terms of its health and wealth and by the forms of protection that are provided.

To establish a better understanding of health factors, information is needed on issues including:

- hospitals, nursing homes, clinics, aid posts, doctors, nurses, dentists, x-ray services, etc;
- endemic diseases and efforts to control them, e.g. inoculation and screening campaigns;
- demographic characteristics such as the very young (under 5) and elderly (over 60 or 65);
- disabilities that reduce mobility or a capacity to cope with disaster and people who need to be accompanied by carers.

To better understand economic factors, information is needed on issues including:

- the primary industries such as commercial crops and grazing, mining, fisheries, etc;
- basic processing industries such as sawmills, abattoirs, copra mills, basic ore treatment, fish processing plants, etc;
- other secondary industries such as ship building, concrete batching plants and construction industries;
- principal tertiary industries including banks, insurance, clothing and footwear manufacture, crafts, tourist industry, repair services, etc
- the degree of dependence on subsistence agriculture and fishing – i.e. the significance of the informal economy;
- in the more formal economy, information on issues such as household income, unemployment and home ownership may be relevant.

To better understand protection factors, information is needed on issues including:

- ambulance stations, fire stations, police stations, defence force posts, etc;
- engineered works such as flood detention basins, levees, sea walls, etc;
- traditional defences such as mangrove belts to protect the coastline, etc;
- contact details for hazard specialists such as meteorologists, geologists, engineers, etc;
- contact details for key emergency services staff including disaster managers, police, fire service, military, etc;
- the resources available at the fire and police stations and military posts;
- local, district and national disaster plans.

It is particularly important to identifying those facilities and services, the loss of which would magnify the impact of the disaster on the affected community. These 'critical' facilities, such as hospitals and disaster management headquarters, may call for additional protection or planning because of their significance to the wider community.

Society

Here we find most of the more intangible, non-physical factors such as language, ethnicity, religion, nationality, community and welfare groups, education, disaster awareness, custom and cultural activities and so on. These are the aspects that define the social fabric of the community and the degree to which communities, families and individuals are likely to be susceptible or resilient to the impact of disaster.

Information required to better define and describe the social environment of the community can include consideration of:

- community and official languages and the levels of literacy in those languages;
- ethnic and racial groups and their inter-relationships, tensions, etc;
- religions represented in the community and their inter-relationships, tensions, etc;
- cultural, social or religious constraints such as dietary restrictions, funeral requirements, cultural tabus, etc;
- representation by NGOs such as Red Cross, Saint Vincents, etc;
- contact details for key community and welfare staff such as ministers/priests/pastors, NGOs, business leaders, teachers, parliamentarians, local councilors, etc;
- contact details for traditional leaders such as chiefs and other custom leaders and community elders;
- levels and availability of education and the contact details of teachers;

Some of this information may be available from the periodic censuses conducted nationally, however, the more detailed information will rely very heavily on site-specific studies such as those envisaged under the CVA methodology.

Some factors under the society theme may be measured in terms of the facilities that they use. These would include churches, meeting places, government buildings, libraries, museums and sporting clubs. These alone, however, do not provide an adequately meaningful measure of the social make up of the community.

Setting

To place communities in a broader spatial and disaster management context it is beneficial to develop information on factors including:

- the broad regional physical environment including climate, vegetation, geology, soils, land use, topography, elevation, etc (much of which may already be covered under the hazard component);
- population distribution and basic demographic information;
- external access, including links by road, rail, air, sea and telecommunications infrastructures;
- the services that provide that access, such as postal services, airline and shipping service schedules, charter services, radio broadcast programming, etc;
- external sources of power and water supply, such as remote hydro-electric and water supply dams;
- administrative arrangements, including local government, suburb, police district, electoral and other administrative boundaries;
- legal arrangements such as cadastre and land tenure.

The broad administrative arrangements under which disaster management services are provided (whilst well known to insiders such as NDMOs) also needs to be well documented, especially for outsiders.

For a more detailed listing of potential topics in each of the above themes, readers are referred to Appendix D.

COMMUNITY AWARENESS & RISK ACCEPTANCE

PIC communities are said to have a good level of awareness of the hazards that could have an impact on them. Certainly where such events are fairly common (such as cyclones) or more obvious (such as an active volcano), a strong level of awareness is clearly the case. Where events are less frequent, such as tsunami and major earthquake, the level of awareness is less well developed. For communities to take active steps to reduce risks, they must obviously be aware that the risk exists and is real. This is central to determining issues such as risk tolerance or risk acceptance. To a large degree this is a key output of the risk assessment process.

In the approach to risk assessment set out in the Australian risk management standard (Standards Australia, 1999), it is the practice to compare the level of risk found during the assessment process with previously established risk criteria, so that it can be judged whether the risk is 'acceptable' or not. At first glance this may seem to be something of a chicken-and-egg process - if you do not know what the level of risk posed by earthquake is in a given locality, for example, how can disaster managers and other government authorities realistically determine what level of risk is acceptable?

Levels of acceptability are, however, built in to such things (where they exist) as urban planning constraints and building codes. In many formal urban planning schemes, for example, the '1:100 year flood level' is often set as a constraint for residential development, whilst building code criteria are based on 'design levels' of hazard impact. For example, under the Australian earthquake loading code the 'design level of earthquake shaking' is one in which there is an estimated 10% probability of the ground motions being exceeded in a 50 year period, i.e. the acceptability criterion is set at a 10% chance of exceedence over the nominal lifetime of a typical building. A similar approach is followed in the wind loading and earthquake loading codes adopted in some PICs.

Not all acceptability criteria can be expressed as categorically as this because they deal with human nature and the political *outrage* dimension of disaster management. They also vary considerably over time. The threshold of acceptance is typically much lower immediately <u>after</u> a hazard impact than it was immediately before the impact. This reinforces the need for a strong feedback mechanism between establishing acceptability and the formulation of risk mitigation and disaster response strategies.

The acceptability factor is central to the process of risk prioritisation, and hence the development of appropriate treatment strategies, including disaster plans. This is the first step in the allocation of resources to risk mitigation, especially if considered in a multi-hazard context. Under the AGSO *Cities Project*, and with our SOPAC *Pacific Cities Project* colleagues, we are beginning to address the complex issue of comparing the risks posed by hazards with greatly different impact potential. In many coastal areas, for example, there is often a strong spatial correlation between the areas that are most at risk from major inundation hazards (river flooding, storm tide and tsunami) and those in which deep soft sediments are most likely to maximise earthquake impact. Conversely these are the areas that are at least risk from landslide impact and, to some degree, from severe wind impact. These issues are, to a degree, able to be addressed scientifically by computing probabilities and modelling *Risk-GIS* scenario impacts and so on.

This scientific approach, however, does not really tell us what the community understands about the risks of disaster impact and how they believe those risks might be treated. It is here that the community consultation process embedded in the CVA approach really comes into its own. It will enable the community and the disaster management consultants working with them to develop the information needed to make decisions about their own vulnerability and capacity to cope, and to develop prioritised 'action plans'. According to Angelika Planitz of SOPAC (personal communication) the process of prioritisation the community's treatment options under the CVA methodology implicitly measures the level of acceptance. It is not clear, however, how the CVA process deals with risks of which the community is not aware but which the hazard scientists consider likely.

There are very few examples in the international literature to serve as a guide to what type of questions need to be answered in this process. One of the few I have encountered is the work undertaken in Cairns by Linda Berry of James Cook University. Her report (Berry, 1996?) includes a copy of the questionnaire used to survey some 600 Cairns households regarding their understanding of the risk of storm surge and their preparedness to cope. Whilst that questionnaire would need to be modified for use in PICs it provides an excellent starting point.

OBSERVATIONS

During the Suva workshop PIC disaster managers were asked to complete a survey that asked them to rate a comprehensive range of topics according to their perceived need for information on those topics. The results are summarised in Appendix F. The themes identified as being needed by more than 75% of respondents were:

- hazard history – details of previous earthquake, landslide, flood, etc
- hazard history – previous cyclones, severe storms, drought, etc
- population – census and estimates of numbers, age, sex, etc
- settlement type – city, town, village, hamlet, etc names and locality
- settlement structures – houses shops, schools, resorts, etc
- health services – hospitals, doctors, clinics, dentists, ambulance, etc
- welfare services – Red Cross, St Vincents, NGOs, etc
- agriculture – subsistence & other crops, livestock, storage, etc
- roads & streets – surface, capacity, bridges, etc
- telecommunications – phone, radio, TV, Web, mobile phone, etc
- water supply – source, storage, treatment, reticulation, etc
- technical experts – GIS & computer staff, plant operators, builders, etc.

This result is remarkably similar to the results of a similar survey I conducted within the police and emergency service agencies in Queensland in 1991. In that study the Queensland State Emergency Service respondents (the equivalent of the NDMOs) identified the following themes as 'must have' information.

> Rank 1: emergency service facilities, telecommunications, population, emergency shelter arrangements, urban hazards (fire, flood, etc), health services, natural hazards (cyclones, earthquake, etc), plant & animal hazards;
> Rank 2: power supply; transport hazards, settlement structures (buildings, etc), secondary hazards (fire, explosion, pollution, etc);
> Rank 3: settlement patterns, fuel storage, airfields, roads, water supply, local government services, community and welfare services, terrain;
> Rank 4: the rest.

Both reflect a strong bias towards a response culture, rather than embracing a broader risk management culture. They also convey to me that there is an expectation that other information will be provided by other agencies should or when the disaster managers need it. I would suggest that this is a very hazardous approach to disaster management, let alone risk management, unless those agencies who are expected to hold and manage that 'extra' information see themselves as part of the disaster management process and are aware of the requirements of disaster managers for their information.

There is nothing more certain in the disaster management business than the fact that once a disaster starts to unfold, it is too late to start looking for the information needed to manage it. The risk management process tends to overcome this potential problem because much of the information needed to manage disasters has already been developed in the risk assessment process and is in a form best suited to the needs of disaster managers.

CHAPTER 4: STANDARDS AND OTHER INSTITUTIONAL ISSUES

BACKGROUND

It is an unfortunate fact that interesting and exciting activities like disaster management and information management must conform to a whole range of technical rules and bureaucratic oversight. But that is the way of the world.

The international models for SII give prominence to standards and an institutional framework in which the infrastructure is administered. Typically, as shown with the Australian Spatial Data Infrastructure's components outlined in Appendix C, these aspects are the first mentioned. This reflects the 'top-down' view of the ASDI which is in contrast to the 'bottom-up' approach described in this study. Whilst many disaster managers may view these issues as being outside their realm of interest, they are relevant and important if a sustainable information infrastructure is to be established. They may, however, decide to skip the following discussion on standards as they are largely technical.

STANDARDS

The American geographer and GIS guru Joseph Berry once wrote in an article on standards:

> *In the past, maps were accepted principally on face value. A neatly drafted map indicated the cartographer's concern for accuracy. If it looked good, it probably was good. But GIS modeling has changed the playing field, as well as the rules. Without effective standards that address this environment, GIS will have difficulty going beyond mapping.*
>
> (Berry, 1993)

He went on to describe four areas in which standards were needed if GIS were to go beyond being simply electronic drafting machines.

Transfer Standards

A policy decision taken by SOPAC some time back has ensured that MapInfo is the standard GIS software for use in their projects throughout the Pacific. This decision has greatly simplified the process of transferring GIS data from one country or user and another because it is all in the same format. But MapInfo is not the only GIS software in use, either in the PICs or elsewhere, and it is inevitable that data from AGSO, for example, that has been developed in Arc/INFO, will need to be transferred to SOPAC. The two softwares do not share the same native format so the data must pass through translation software before it can be used. Even then, it may not carry over the same symbols, for example. The translators, however, will carry over the attribute and graphic data without problems. The more recent versions of MapInfo and Arc/INFO both contain such two-way translation software so that, for all intents and purposes, the translation is a minor inconvenience.

Not all data, however, is as easy to exchange. Computer aided drafting (CAD) packages (e.g. AutoCAD or Microstation), for example, do not always store their graphic data and attribute data in the same tables. Interchange of data from those systems to a GIS typically utilises the data exchange format, or DXF as it is known. This format is (or at least has been) limited by its ability to transfer only 'dumb' graphic data, rather than 'intelligent' attributed data. It is, none-the-less, widely used as a *de facto* intermediate format for the transfer of graphic data.

The GIS industry is now moving to adopt an 'open' structure that will effectively eliminate these transfer problems, either by adopting common formats or by establishing a universal intermediary format that all systems can pass to and from. Whilst Open GIS technical issues are still evolving, there are already very few problems in shifting data between the systems typically encountered in PICs.

Geographic Standards

The same happy situation does not extend to geographic standards, especially standards for coordinate systems, non-coordinate location systems and for attribute classification. Without appropriate standards in these areas it is difficult, if not impossible, and potentially dangerous to integrate data developed by two different agencies or researchers, an issue already identified in the discussion of metadata in Chapter 2.

Coordinates and datum: I have been told that, in one particular PIC, there are six different sets of coordinates in use for the national survey control point! This spatial datum chaos makes it virtually impossible for surveys conducted and maps drawn using different coordinate values for the same real object to be directly related. And if there is no metadata to identify which datum version is used, it is impossible to know how to regard that data.

A similar situation also exists with elevation datum. The 'normal' height datum is (more or less) mean sea level, however, some agencies (such as water supply and sewerage engineers, harbour masters, etc) can use their own datum which may have little, if any, obvious relationship to mean sea level. Again the absence of metadata can create many potentially dangerous and expensive error problems.

The wide use of GPS has caused many countries to adopt what is known as an 'earth-centred' or 'geocentric' geodetic datum because that is the way in which GPS functions for latitude and longitude (as well as elevation).

In March 1999, SOPAC accepted the responsibility to coordinate, on behalf of its 16 member PICs, the implementation of a regional geodetic control system (including a geocentric datum) as part of the wider Asia-Pacific component of the global geodetic framework WGS 84. This work is being coordinated by the Permanent Committee on GIS Infrastructure for Asia & the Pacific (PCGIAP), a group established under United Nations auspices. This committee has a strong focus on technical mapping and cartographic issues rather than the much broader information needs and infrastructure considered in this study.

The SOPAC point of contact is Franck Martin who can be contacted by email at Franck@sopac.org.fj. Information on PCGIAP can be found on the Web at www.permcom.apgis.gov.au.

Non-coordinate location: In urban centres in countries like Australia, the location of buildings is typically communicated by the combination of a street address (house number and street name) and locality or suburb name. As a spatial reference, street address is by far the most frequently used methods in such countries. Similar addressing schemes are also being implemented in many rural areas as well, based on the model rural addressing scheme published by ANZLIC (1995). Such addressing schemes do not appear to exist, or are not well developed, in the PICs, a fact that has probably made the collection of data in the SOPAC *Pacific Cities Project* more complex than for its Australian counterpart. I suspect that, as cities such as Suva grow and the demand for postal and other home delivery services and the more rapid and accurate dispatch of services such as ambulance and police, increases, so will the need for street addressing increase.

For this to be effective, there will be a need to establish standards, guidelines or conventions, for such things as street names (to avoid duplication and/or confusion), numbering and the display of numbers on properties.

Locality names can also be used as a spatial reference, especially if they are listed in a gazetteer which links the name of the feature to a coordinate reference. The development of national gazetteers with the standard spelling of the names of settlements and physical features would greatly assist disaster managers in communication and to avoid confusion. Historic and informal local names, as well as 'official' names should also be included in such a gazetteer.

Attribute classification: Anyone who has tried to relate the classification schemes for themes such as soils, geology or vegetation used by two different authors over the same area will appreciate the need for some form of standard when it comes to those classifications. Without such standards it is likely that the uninitiated will end up trying to compare apples with oranges!

With a well designed classification scheme it is possible to communicate a wide range of important attribute information that can fall into the category of 'essential elements of information'. For example, standard classifications should enable information about attributes such as canopy height, canopy closure and species composition to be directly associated with a given category of forest. Similarly, for a given category of soil, attributes such as horizon depth, clay content and geotechnical properties; and, for a given class of road, the width of pavement or trafficability, should be confidently interpreted from the classification used.

The larger PICs, such as PNG, Solomon Islands and Vanuatu, are fortunate in that such standard classification schemes have been in place for some years, thanks to the work done by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and their collaborators during the 1980s and 90s in the PNG Resource Information System (PNGRIS) and the Vanuatu Resource Information System (VANRIS). There is obviously scope for SOPAC to play a role in promoting and extending such standards throughout the PICs.

Similar classification and attribute standards are also needed for elements in the built environment such as buildings and utility lifelines.

Algorithms Standards

Most GIS contain mathematical routines (algorithms) that are used to interpret or manipulate data to produce new information. For example, most GIS can interpret slope and aspect from digital elevation data. There are many versions of these algorithms in use and there is a need for standards to be established to ensure that the output from different systems are comparable. Joseph Berry described this issues in the following terms:

> *At the computational level, various algorithms need to be benchmarked, and users need to be given guidelines for their appropriate use. For example, the differences among maximum, average and fitted slope algorithms should be established and users should be advised which is most appropriate for particular applications. Spatial interpolation, distance measurement, visual analysis and fragmentation indicies are other examples of algorithms awaiting review.*

He goes on to predict that market forces will largely take care of this issue given that GIS vendors tend to incorporate the 'good ideas' of others in their own products quite rapidly.

Interpretation Standards

The output from the application of spatial modelling techniques and the mapping of themes from remotely sensed data has tended to be accepted without question - but how good are the models employed and how accurate are the analytical algorithms provided? This raises the question of uncertainty and the need for 'ground truth'. Again Berry describes the requirements succinctly:

> *To date, emphasis has been on producing products, not verifying the results or logic behind a final map. As more and more "modeled" maps surface, there is an increasing opportunity to scrutinize modeling results. If an area is classified as excellent elk habitat, or ancient forest, but those on the ground know different, the product eventually will be deemed to be sub-standard.*

Two procedures might accelerate this process. First, empirical verification results could be included with a final map, like geographic descriptors of scale and projection. If "ground truth" shows that ancient forest was incorrectly identified one third of the time, the user of the product should be advised. If empirical verification isn't possible, error propagation modeling can be used to estimate the reliability of the final map. Keep in mind that modeling is an abstraction of reality (an "educated" guess).

*A second useful tool in establishing interpretation standards is the map "pedigree". This is a new addition to the map's legend brought on by GIS modeling. In its simplest form, the pedigree is merely a listing of the macros (commands) used to create the final map. More elegant renderings also contain a flowchart of processing. These succinct descriptions of model logic provide an entry point for evaluating the model and suggesting changes. As GIS modeling matures, a map without its pedigree will be as unacceptable as a dog show contestant without (*American Kennel Club*) papers.*

In applications such as risk analysis, which might combine data from the modelling of an extremely complex environmental phenomenon (e.g. storm tide) with data describing the built environment of an urban community to produce an estimate (model) of the economic impact of an event, the question of uncertainty is extremely important. This is especially significant where observational data on rare events, such as severe earthquakes, is very limited, thus making the estimation of event return periods, or specific probabilities, sensitive to significant degrees of uncertainty. The communication of uncertainty takes us well beyond the capacity of the 'reliability diagrams' traditionally provided with topographic mapping, for example.

As I said at the start of this chapter, technical standards may not directly concern disaster managers, however, without them, there will remain risks of misinterpretation, inaccurate information and confusion reducing the effectiveness of the decisions that have been based on the information. Disaster managers should at least be aware of the potential problems that exist without good standards. They are a necessary (and typically very boring) evil.

INSTITUTIONAL ISSUES

The Australian management consultant Alistair Mant (1997) has observed that:

If politics is driven by competing interest groups squabbling in the marketplace, what is the place for long-term vision or for intelligent leadership?

It is patently obvious that, for an information infrastructure to flourish, the institutional framework in which it operates will need to be as free as possible from 'competing interest groups squabbling in the marketplace'. Given that disaster managers carry relatively little 'power' when it comes to spatial information, they need to develop strategies to give themselves a greater degree of standing in what has been termed the 'information power environment'.

In these 'environments', information is **controlled** (owned, collected and maintained directly), **influencable** (the collection and maintenance of data can be influenced by long-term relationships, mutual interest, or money) or **appreciated** (users can only appreciate that the data exists and must anticipate the way in which it will evolve).

In a 'normal' organisational situation (Figure 9a) much of the information, such as that on budgets, accounts, inventory, assets, and so on, and the personnel resources that collect and maintain that data, belong to the organisation and hence, the information is 'controlled'. In the 'typical' GIS environment (Figure 9b), by contrast, there is significantly less control or influence, hence a greater reliance is placed on externally sourced (appreciated) information such as digital cadastral and topographic data. Knowledge of the existence and relevance of 'appreciated' information is, typically, also limited.

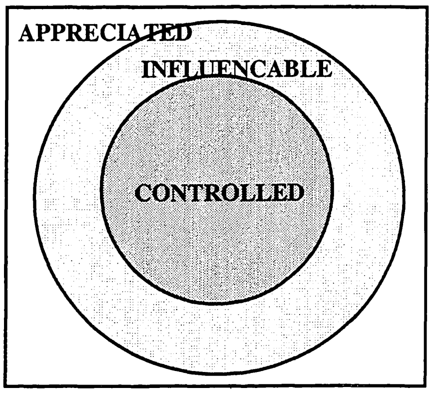


Figure 9a: 'Normal' power environment

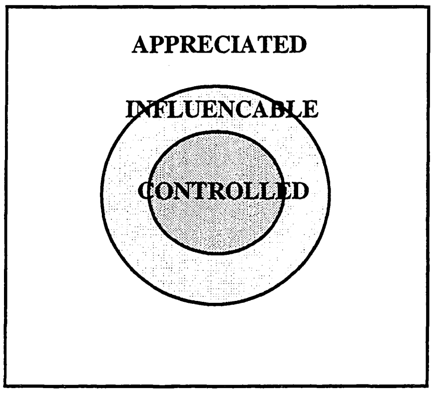


Figure 9b: 'Typical' GIS power environment (after Lyons, 1992)

In the AGSO *Cities Project* study of Cairns, for example a relatively crude measure of the 'information power environment' can be gauged from the total data volumes (in megabytes) of databases in each class (controlled, influencable and appreciated). This is shown in Figure 10 (from Granger, 1998, Fig 16, p 44). It is clear that we controlled, or influenced very little of the data we used so we had to establish a wide range of relationships with the owners or custodians of all of that 'appreciated' data.

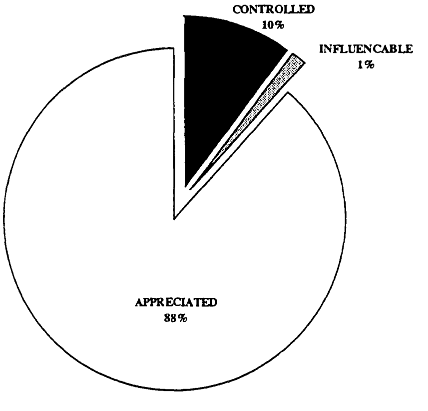


Figure 10: Cairns Pilot Study total data 'power environment' (by volume)

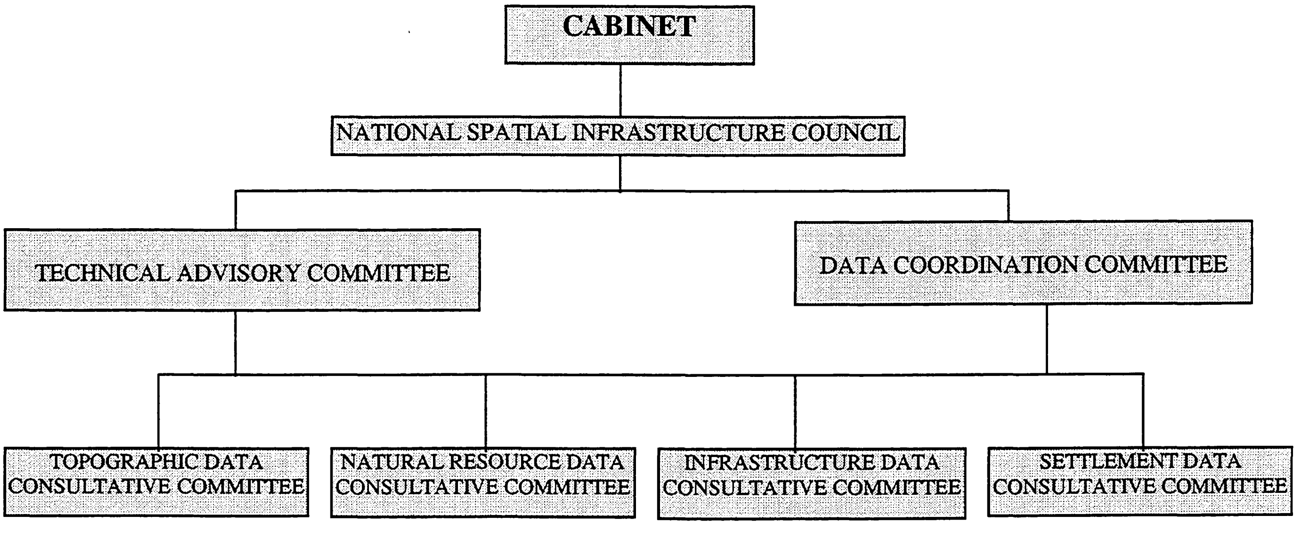
An institutional framework is required to facilitate the non-technology links (legal, fiscal, administrative, bureaucratic, etc) between the various stakeholders in the information infrastructure, from the smallest user-focused project, such as a village CVA, to the highest national or international-level policy environment and laterally within the widest circumference of the disaster management and spatial information communities. The institutional framework is the indispensable infrastructure within the overall information infrastructure.

It has been my experience that the institutional framework will tend to take on a nested hierarchical form. At the lowest level (the project level) the framework should be simple and can be largely informal. In the AGSO *Cities Project* Cairns case study, for example, it tended to reside in my head, my computer and in a few key documents. It only had to serve a couple of people within the project. At the next level up, our project information infrastructure is but one of many that go to make up the city information infrastructure; the city information infrastructure forms part of a regional information infrastructure, which in turn is part of a state information infrastructure and so on.

The following extract describes the national-level framework suggested for PNG following a major workshop involving a wide cross section of spatial information users and managers in 1998. It may provide a suitable model for other PICs at the national level. Figure 11, taken from the same study, illustrates the concept.

> *At the most senior level, policy and administrative guidance and support would be provided by a PNG Spatial Infrastructure Council with members drawn from the Permanent Heads of the relevant departments, together with senior representatives from the private spatial data industry, the education sector and provincial government. The Council would be chaired by the head of a central department, such as Prime Minister and Cabinet or Finance. The Council would report to Cabinet on a regular basis.*
>
> *Two advisory committees would support the work of the Council, one focused on technical issues and logically chaired by the National Mapping Bureau; the other focused on coordination issues and chaired by the Office of National Planning and Implementation.*
>
> *Those two committees would receive input from users through a series of theme-based consultative committees. Senior officers from relevant line departments would chair those committees, eg. a Natural Resources Data Consultative Committee might be chaired by an officer from the Department of Primary Industry and Livestock or the Department of Environment, whilst an Infrastructure Consultative Data Committee might be chaired by an officer from the Department of Works and Transport, and so on. Their main role would be to provide a channel for two way communications for users.*
>
> ***It must be emphasised that for this institutional framework to succeed it must have strong support and commitment at the most senior levels.***

(Granger and others, 1998, pp 16-17, emphasis added)



(Granger and others, 1998, fig.3, p 16)

Figure 11: An institutional framework structure suggested for PNG

It would clearly be advantageous for one of the theme-based consultative committees to be a disaster management theme, chaired by the NDMO. A key role of these consultative committees would be to oversight the custodianship and coordination arrangements for information.

CUSTODIANSHIP

The concept of data custodianship is a key aspect of the institutional arrangements and hence, central to the creation of an information infrastructure. This concept is strongly developed in Australia and elsewhere and is based on seven principles as follows:

- ***Principle 1 - Trusteeship:*** *Custodians do not 'own' data but hold it on behalf of the community.*
- ***Principle 2 - Standard setting:*** *Custodians, in consultation with the national sponsor and users are responsible for defining appropriate standards and proposing them for national ratification.*
- ***Principle 3 - Maintenance of Information:*** *Custodian agencies must maintain plans for information collection, conversion and maintenance in consultation with the national sponsor and users.*
- ***Principle 4 - Authoritative Source:*** *The custodian becomes the authoritative source for the fundamental dataset in its care.*
- ***Principle 5 - Accountability:*** *The custodian is accountable for the integrity of the data in its care.*
- ***Principle 6 - Information Collection:*** *Collection or conversion of information can only be justified in terms of a custodian's business needs.*
- ***Principle 7 - Maintain Access:*** *A custodian must maintain access to the fundamental datasets in its care at the highest level for all users.*

(condensed from ANZLIC, 1998)

If an effective custodianship network can be established, the burden on individuals and organisations to collect and maintain their own information is greatly reduced. The most appropriate individual or organisation commits to maintaining their part or parts of the community's (region's or nation's) information resource. It may, however, take time for information users to develop confidence in a system based on custodianship given the long history in most placed of people doing their own thing as far as information is concerned.

OBSERVATIONS

The creation of an effective information infrastructure to support disaster management throughout the PICs will necessitate the development of technical standards and institutional frameworks. Both of these factors lie well outside the realm of disaster managers. Disaster managers, however, will need to play a role in the development of both because it is simply not possible to reduce the impact of disasters without appropriate information.

There is clearly a role for agencies such as SOPAC to assist in the more technical areas of developing, negotiating and introducing standards – as they already do.

CHAPTER 5: WHERE TO FROM HERE?

FRUSTRATIONS

It has been a relatively simple task for me to describe and define the components of an information infrastructure that would be suitable to support disaster management in PICs. Implementing such a process will not be so simple. It will take time and it will take commitment on the part of all those involved because there are at least four sources of frustration that will need to be addressed before it can become a reality.

A recurring view was expressed by delegates at both workshops that they had 'heard it all before' at various conferences and workshops, but nothing practical had ever eventuated. Yes, NDMOs knew that they needed information and, yes, they have a good idea about what information they need, but they are frequently frustrated when it comes to getting the information packaged in a form they can use. They are looking for a worked-through example that they can follow and the resources to do it. That can not be achieved in a workshop; it can only be achieved on the ground in a real-world situation.

The lack of communication reaching both down to, and up from, the village level was also seen as a major source of frustration, and consequently a major hurdle. For a process that is all about information and improving the effectiveness with which it may be disseminated and used, the sharing of information about the process is critical – and that depends on communication.

The third frustration revolves around a stated lack of coordination and cooperation between the people and agencies that should be working together to improve community safety. This was seen as part of the power and political processes that tend to build barriers, rather than bridges.

The fourth key frustration relates to the perceived lack of resources – human, financial and technical. This is probably a universal frustration for all disaster managers. Typically, they are allocated only limited resources because senior policy makers seem to hold the view that a disaster is unlikely to happen during their term in office, so why spend too much money on a disaster management system that does not bring significant votes with it. This may be a simplistic and cynical view, but it seems to correlate well with reality.

These are not technical issues, they are human issues. To repeat the point emphasised in Chapter 1, an information infrastructure is not a physical thing, it is more of an accepted way of doing things. An information infrastructure is a philosophy, not a technology.

Fortunately, frustrations can be overcome, even those as seemingly intractable as the four identified here. There are significant components of an information infrastructure already in place in most PICs and a number of real-world case studies are either under way or planned that can demonstrate and promote the value of the support an information infrastructure can provide to disaster management.

Our experience with the Cairns case study under the AGSO *Cities Project* has demonstrated the potency and benefits of an information infrastructure in a disaster management role by:

- winning significant support from previously skeptical disaster managers;
- greatly improving bottom up and top down communication;
- creating an environment of cooperation and coordination between a wide range of stakeholders; and,
- stimulating the significant investment of resources in further risk management work by the State and local government stakeholders.

What is needed is a number of similar case studies in PICs.

EXISTING FOUNDATIONS

I have already identified in this report three disaster management-oriented programs that are being undertaken by SOPAC that provide a foundation for the development of an information infrastructure for PIC disaster managers. These are the *Pacific Cities Project,* the *Communities at Risk Project* and the *Community Resilience* concept which incorporates the science approach (from the outside-looking-in) of *Pacific Cities/Communities at Risk* and the self-assessment approach of CVA (from the inside-looking-out). Each of these have a significant information collection and management component. There is clearly an opportunity (and need) for these programs to be more closely coordinated, especially to develop and demonstrate aspects of an information infrastructure at the local level in PICs (and within SOPAC itself).

There is an opportunity, in choosing areas to develop under both the *Communities at Risk* project and *Community Resilience* concept, to address most, if not all of the four frustrations. Given the cultural differences across PICs it would be appropriate for case studies to be established in Melanesian, Polynesian and Micronesian communities to test the appropriateness of the information infrastructure approach and to refine it where necessary to cope with those cultural differences.

Apart from these SOPAC-based projects there are other disaster management projects under way or proposed in PICs that have a potentially strong information infrastructure component. The most advanced of these is the MapInfo-based Volcanic-hazard Mapping and Information System (VMIS) developed by AGSO as part of the post-Rabaul eruption Volcanological Service Support (VSS) Project. VMIS has been developed as a decision support tool for both the staff of the Rabaul Volcanological Observatory and disaster managers in communities in PNG identified as having an exposure to the risks posed by volcanic eruption. It is now operational and could serve as a good model for similar disaster decision support systems elsewhere in the PICs. Similar work has been developed by Mike Petterson and colleagues for the Savo volcano in Solomon Islands and Shane Cronin and Vince Neall, through their work on the volcanic risk on Fiji's Taveuni Island.

On an international scale, the Decade Volcano project, sponsored by the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), aims to develop risk mitigation strategies using 16 volcanos around the world as case studies. In the Pacific, Mount Ulawun in PNG's West New Britain Province has been selected for detailed study. An international workshop was held near Mount Ulawun in 1998 to look at:

- the hazard presented by this volcano;
- the risks they pose directly to local communities and economies, and to more distant communities because of the potential for major (potentially Pacific-wide) tsunamis being generated by the collapse of the Ulawun cone during an eruption; and,
- the disaster management options that flow from that risk assessment.

The report on the Uluwan workshop (IAVCEI, 1999a) contains several recommendations that have an information infrastructure content.

The United Nations-sponsored RADIUS Project (Risk Assessment Tools for Diagnosis of Urban Areas Against Seismic Disaster) is developing a similar international approach to earthquake risks and how to address them. Nine case study cities have been selected around the world and some 30 other cities (including *Cities Project* work on Cairns and Newcastle) are also providing input from their own experience. This international experience will flow through to PICs as one of the outcomes of IDNDR.

Outside the disaster management realm there are several other systems in place that can provide a foundation for disaster management information infrastructure. The Fiji Land Information System (FLIS), for example, is a national-level SII that provides a solid foundation of the more conventional cadastral and topographic information in Fiji. FLIS contains many features derived from ANZLIC standards. PNGRIS and VANRIS, by contrast are information systems developed with a focus on nation-wide natural resource and land use management in PNG and Vanuatu respectively. They both contain significant information and structural components that could provide models for a disaster management information infrastructure. To some extent, however, both PNGRIS and VANRIS also provide examples of the lack of cooperation and coordination that can exist, given that both appear to be closely held by their respective custodian departments. It was reported at both workshops that disaster managers have had significant difficulty gaining access to these valuable information resources.

It is clear that the foundations exist on which to build very strong information infrastructure for disaster management. Whilst the material in Chapter 4 may intimidate some disaster managers about taking the next step, there are many steps that can be taken before getting too heavily technical and bureaucratic.

SOME IMPLEMENTATION STRATEGIES

The development of a disaster management information infrastructure need not be a difficult or expensive process, nor need it be dominated by the technical and bureaucratic considerations that appear to be so significant in other schemes such as NSDI and ASDI. The following thoughts may help PIC disaster managers to ease into the task and build very robust information infrastructure to support their work.

Start with your existing material: The best place to start is with the information that is already held by disaster managers. Develop a metadata inventory ('library index') of existing material as the first step so that it is easier to identify where the significant gaps are.

Develop a plan: Sketch out an information management plan, as part of the disaster management plan, that clearly identifies the desired outcomes, benefits and likely costs.

Take your time: Given that an effective information infrastructure requires the development of strong networks of collaborators and the development, or strengthening, of an information culture, its evolution will take time. It is preferable to plan for the process to take five or even ten years, if necessary. It should be seen as an evolutionary process of constant improvement and enhancement – it may never actually provide all of the information needed, but it should provide the most important. It is important to be practical in setting targets because if they are too ambitious at the outset and subsequently fail, the whole process of developing the information management process could be seriously set back.

Establish priorities: The so-called '80/20 rule' needs to be kept in mind. That says that 80% of the answers can be provided by 20% of the information. There are, consequently, themes of information that are much more significant and urgent than others. The summary of themes identified by NDMOs as representing their greatest need, provided on page 29 and in Appendix F, could be used as a guide for the prioritisation of information collection.

History is important: In my experience, the best returns can be gained from investment in collecting detailed disaster histories, including community response. That material represents reality and can be used to generate both community and political support for disaster management and community awareness programs. It also contains lessons on past disaster management that can be built into present practice.

Document disaster experience: It is clearly much easier to document history as it happens than to search for information well after the event. The damage assessment forms already developed in PICs are a good start, however, it is most important to have in place the capacity to analyse and digest the results. The information management performance of the disaster management system should be reviewed as part of the post-disaster performance process.

International assistance: In the case of major disasters it is usual for PICs to receive assistance from the international community. This can take various forms, ranging from relief and humanitarian assistance to scientific input to the study of the disaster event. This input needs to be documented as part of the disaster experience. Most of these operations will need (and seek) access to local information and they will generate significant information from their own involvement. It is most important that the arrangements for the flow of information in both directions be as smooth as possible. This may require the negotiation of standing bilateral or multi-lateral agreements with likely sources of assistance that addresses the information flow in both directions.

There have been frequent complaints by PICs (and other developing countries around the world) that international scientists rarely provide back to the host country the information that was gathered during their disaster assistance mission. This 'scientific imperialism' can not be tolerated and protocols need to be established to manage the process. An IAVCEI subcommittee has developed an excellent set of protocols which governs the conduct of scientists during volcanic crisis (IAVCEI, 1999b), including their obligation to share their information. These protocols could easily be applied to any science and any disaster phenomenon.

Establish networks: The disaster management process can become rather isolated and inward looking, especially if it is not activated regularly. It can be difficult to maintain the level of 'profile' that guarantees attention or attracts support. That inevitably has an impact on the degree to which information management and disaster research programs can attract support. The development of partnerships with key data custodians and research agencies is, therefore, very important. Similarly, it is important to involve as wide a cross section of stakeholders as possible in the process. By involving agencies or businesses that control critical facilities such as hospitals, power supply or fuel supply, for example, in the total process, the chances of gaining access to their information and political support is greatly enhanced. NDMOs should aim to place themselves at the centre of their own web of networks, rather than being on the edge of everyone else's network.

Apply appropriate technology: Whilst the ultimate objective may be to employ *Risk-GIS* and other computer decision support tools, it is not necessary to have such technology in place before starting to either use information or to build an information infrastructure. Hard copy maps, manuals, reports and so on, will always be needed and used, regardless of how many computers are available. This is particularly the case with field operations under disaster conditions because computers may not be available or reliable under those circumstances. It is important, however, that the hard copy material provided is the most accurate and current available – hopefully produced from GIS and so on.

Information packaging: Not everyone needs access to all of the available information. It is, therefore, helpful to design specific information products or packages of products tailored for particular users. The agencies that have specified roles under the disaster management plan, be it transport and logistics, health, welfare and so on, should identify their requirements for information products as part of the overall disaster management information infrastructure development process. Those separate products, however, must be produced from the common set of core information to ensure that all participants are 'singing from the same sheet of music'.

By following the scenario modelling approach to risk assessment it is also possible to develop specific packages of information relating to various disaster scenarios (e.g. different flood heights) and to have them prepared <u>before</u> the disaster strikes.

Use case studies: It is much easier to 'sell' the message of information and information infrastructures if their benefits can be demonstrated in a real-world case study. Having a worked-through example to demonstrate is far more believable than a 'dummy' or artificial example. It is also human nature to want what the neighbour has, so by being able to demonstrate what one village or town has done and the advantages that they have gained, tends to stimulate other villages and towns to want the same advantages. Case studies are also very useful for disaster managers to share their experience and to exchange ideas that might be useful in other areas. The work completed by the *Pacific Cities Project* in establishing a broadly based information infrastructure for its case study cities provides an excellent starting point.

Cost/benefit: It is not always easy to demonstrate the costs and benefits of information. In disaster management terms, one useful approach is to demonstrate the potential savings that would flow from having the right information, or conversely, what the loss would be without the information. This can be illustrated by the following observation from a study undertaken by the Institution of Engineers, Australia (IEAust).

> *The costs of data collection are usually readily identifiable. The dollar benefits are generally less so. However a simple method is now available which enables ready estimate of the benefits achieved through utilisation of data. This method is based on the concept that the value of data is the value of the reduced uncertainty which results from the incremental use of data to improve knowledge. Hence the dollar value of data can be directly determined as being the dollar value of the improved knowledge. The improved knowledge being quantifiable in terms of reduction in risk of failure or minimisation of over-investment of funds.*
>
> (IEAust, 1993)

Invest wisely: I have seen many GIS implementations that have turned out to be financial and management disasters, more often than not because they invested most of their resources in the technology rather than spreading it across the information and the people as well. A good rule of thumb is to allocate 5 to 10% of the budget to the technology, 10 to 20% to people and the remaining 70 to 85% for data.

There may be better long term returns from investing in the training of a couple of key NGO volunteers in the processes and benefits of information collection and management, for example, than in upgrading computers in the disaster management headquarters to the latest software. Providing a single computer for an NDMO office where no computer currently exists will probably return greater benefits than upgrading computers in an office which already has several machines. Most aid projects tend to focus on large-scale and big budget programs. It is often more difficult to find funding for a few hundreds of dollars to cover the small, but strategically important, investments that provide the biggest proportional return. There is perhaps a role for SOPAC to manage a fund designed to make such small-scale strategic injections of funds.

Think risk management: The focus on disaster response is a natural and important aspect of the disaster manager's role. It will, however, be greatly enhanced by taking a broader view of their role to embrace the risk assessment and broader risk mitigation process as well. By taking a holistic view, disaster managers will be in a better position to influence the direction of scientific research into both the hazard phenomena and community vulnerability. It is important to acknowledge that it is a complex world that we live in and no single person, organisation or science has the complete solution.

CONCLUSIONS

The development of an information infrastructure to support disaster management in PICs has been identified as an important objective. This study confirms and reinforces the importance of:

- information, especially spatial information, as a critical decision making resource for disaster managers;
- the information management process as a core disaster management activity;
- the value of information management being supported by an information infrastructure, especially a SII;
- building the disaster management information infrastructure from the ground up, but within the guidelines and structures established at a national level; and
- collaborating and cooperating with a wide range or partners and stakeholders in the disaster management and wider risk management process.

Much has already been achieved in establishing disaster management information infrastructure in PICs, though a lot of that effort has been undertaken by agencies such as SOPAC and foreign researchers than by NDMOs and other national bodies. The foundations that have been established are sound and provide an excellent base on which to build an appropriate and sustainable information infrastructure that can address issues from the village level to the level of the national capital and beyond. There are undoubtedly frustrations and problems that will need to be addressed along the way, however, it is clear that NDMOs are committed to embarking on this journey. It is also clear that they will make a good job of it because they are committed to the task.

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APPENDIX A: ACRONYMS AND ABBREVIATIONS

AGSO	Australian Geological Survey Organisation
ANZLIC	Australia New Zealand Land Information Council
ASDI	Australian Spatial Data Infrastructure
BoM	(Australian) Bureau of Meteorology
CAD	computer aided drafting
CSIRO	(Australian) Commonwealth Scientific and Industrial Research Organisation
CVA	Community Vulnerability Analysis
DMU	(SOPAC) Disaster Management Unit
DXF	data exchange format
EMA	Emergency Management Australia
FGDC	(US) Federal Geographic Data Committee
FLIS	Fiji Land Information System
ftp	file transfer protocol
GIS	geographic information system
GPS	Global Positioning System
HAU	(SOPAC) Hazard Assessment Unit
IAVCEI	International Association of Volcanology and Chemistry of the Earth's Interior
IDNDR	International Decade for Natural Disaster Reduction
IEAust	Institution of Engineers, Australia
IGNS	(NZ) Institute for Geological and Nuclear Sciences
LAN	local area network
NDMO	National Disaster Management Officers
NGO	non-government organisation
NOAA	(US) National Oceanographic and Atmospheric Administration
NSDI	(US) National Spatial Data Infrastructure
PCGIAP	Permanent Committee on GIS Infrastructure for Asia & the Pacific
PEAC	Pacific ENSO Applications Centre
PIC	Pacific Island Country
PNG	Papua New Guinea
PNGRIS	PNG Resource Information System
PPRR	prevention, preparedness, response and recovery (the disaster management process)
PTWC	Pacific Tsunami Warning Centre
QDNR	Queensland Department of Natural Resources
RADIUS	Risk Assessment Tools for Diagnosis of Urban Areas Against Seismic Disaster
SDI	spatial data infrastructure
SERMP	Suva Earthquake Risk Management Scenario Pilot Project
SII	spatial information infrastructure
SOPAC	South Pacific Applied Geoscience Commission
SPDRP	South Pacific Disaster Reduction Program
TCWC	Tropical Cyclone Warning Centre
UNDHA	United Nations Department of Humanitarian Affairs
UNDRO	Office of the United Nations Disaster Relief Coordinator
Unitech	University of Technology (PNG)
UPNG	University of Papua New Guinea
USGS	United States Geological Survey
USP	University of the South Pacific
VANRIS	Vanuatu Resource Information System
VMIS	Volcanic-hazard Mapping and Information System
VSS	Volcanological Service Support
WAN	wide area network
WGS 84	World Geodetic System 1984

APPENDIX B: WORKSHOP PARTICIPANTS

NAME	POSITION	COUNTRY	WORKSHOP
Pilimi 'Aho	Deputy NDMO	Tonga	1 & 2
Joe Barr	Consultant	Australia	2
Linda Berry	CDS Administrator	Australia	2
Randall Biliki	NDMO	Solomon Islands	1
Douglas Billy	SOPAC Counterpart	Solomon Islands	1
Litea Biukoto	SOPAC Project Assistant	SOPAC	1
Jone Bolaitamana	Principal Assistant Sec.	Fiji	1
James Britton	Lecturer USP	Fiji	1
Tony Brown	NDMO	Samoa	1
Clinton Chapman		Niue	1
Joe Chung	Chief Technical Adviser	UNDHA	1
Job Essau	NDMO	Vanuatu	1 & 2
Wolf Forstreuter	Scientist	SOPAC	1
Williams Ganileo		Vanuatu	1
Ken Granger	Facilitator AGSO	Australia	1 & 2
Judy Granger	Recorder	Australia	1 & 2
Christopher Ioan	Hydrogeologist	Vanuatu	1
Nilesh Kumar	Scientific Tech. Assistant	Fiji	1
Atu Kaloumaira	Technical Adviser	UNDHA	1
Ludwig Kembu	NDMO	PNG	1
Gabriel Kuna	Principal Hydrogeologist	PNG	1
Kelepi Mafi	Geologist	Tonga	1
Franck Martin	Scientist SOPAC	SOPAC	1
Vaipo Mataora	Survey Department	Cook Islands	1
Herman Patia	Volcanologist	PNG	2
Angelika Planitz	Consultant	UNDHA	1 & 2
Leo'o Polutea	Survey Department	Samoa	1
Gajendra Prasad	GIS Officer	Fiji	1
Telefoni Pulu	Engineering Officer	Tonga	1
Juno Laban	NGO Volunteer	Samoa	2
Rashmi Rita	GIS Officer	Fiji	1
Susanna Schmall	Consultant	SOPAC	1
Harald Schoelzel	Scientist	SOPAC	1
Graham Shorten	Scientist	SOPAC	1
Alf Simpson	Director	SOPAC	1
Arvin Singh	Scientific Officer	Fiji	1
'Dingle' Smith	Consultant	Australia	2
Monika Swamy	Project Assistant	SOPAC	1
Abere Tababaki	GIS Officer	Solomon Islands	1
Sakaria Taituave	NDMO	Samoa	1 & 2
Lameko Talia	Senior Geologist	Samoa	1
Akapusi 'Tui' Tuifagalele	Disaster manager	Fiji	1
Lasarusa Vuetibau	Senior Technical Assistant	SOPAC	1
Andre Zerger	Student ANU	Australia	2

APPENDIX C: THE AUSTRAIAN SPATIAL DATA INFRASTRUCTURE

The concept of a national spatial data infrastructure (NSDI) is generally seen as being first articulated by US President Bill Clinton, in Executive Order 12906 on 11 April 1994. That Order defined the US NSDI concept as:

> *the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data*

and 'geospatial data' as:

> *information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. This information may be derived from, among other things, remote sensing, mapping, and surveying technologies. Statistical data may be included in this definition at the discretion of the collecting agency.*
>
> (US, 1994)

A Federal Geographic Data Committee (FGDC) was established under the Executive Order and charged with coordinating the development of the NSDI through three major activities, namely:

- *Establishment of a National Geospatial Data Clearinghouse, which is a distributed electronic network of data producers and users connected through the Internet.*
- *Development of standards for data documentation, collection, and exchange so that data can be shared across State and local boundaries on many different hardware platforms and with many different software programs.*
- *Development of procedures and partnerships to create a national digital geospatial data framework that would include important basic categories of data significant to a broad variety of users.*

(FGDC, 1994)

This US lead has been taken up by many jurisdictions since 1994 including Australia. In Australia the lead has been given by the Australia New Zealand Land Information Council (ANZLIC) which has been actively promoting Australian Spatial Data Infrastructure (ASDI).

The ANZLIC vision of the ASDI is one that 'comprises a distributed network of databases, linked by common policies, standards and protocols to ensure compatibility. In this model, each database would be managed by custodians with the expertise and incentive to maintain the database to the standards required by the community and committed to the principles of custodianship.' The core components of this model are linked as follows:

INSTITUTIONAL FRAMEWORK
defines the policy and administrative arrangements for building, maintaining, accessing and applying the standards and datasets

TECHNICAL STANDARDS
define the technical characteristics of the fundamental datasets

FUNDAMENTAL DATASETS
are produced within the institutional framework and fully comply with the standards

CLEARING HOUSE NETWORK
is the means by which the fundamental datasets are made accessible to the community, in accordance with policy determined within the institutional framework, and to the technical standards agreed.

(ANZLIC, 1997)

A more detailed description of these components of the ASDI concept can be found on the ANZLIC web site, whilst the Australian Government's position paper can be found on the Australia Survey and Land Information Group (AUSLIG) web site. ASDI has also been caste in the context of an even wider Oceania region infrastructure promoted by the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). The Oceania GIS Infrastructure has the same structure as ASDI.

The ASDI concept achieved remarkably broad acceptance at the policy level throughout Australia in less than twelve months, due largely to the effective promotion given it by ANZLIC. The concept has quickly found its way into all Australian jurisdictions and its principles and terminology have already being taken up in entities such as the Queensland Spatial Information Infrastructure Strategy (QSIIS) – formerly known as the Queensland Land Information System (QLIS). In the wider information technology (IT) industry, ASDI has already been accepted as an integral part of the wider national information infrastructure.

Key Web sites worth looking at include:

FGDC	http://fgdc.er.usgs.gov
ANZLIC	http://www.anzlic.org.au/anzdiscu.htm
AUSLIG	http://www.auslig.gov.au/pipc/csdc/sdi4.htm
PCGIAP	http://www.permcom.apgis.gov.au

APPENDIX D: INFORMATION NEEDS

GROUP A: SURFACE OF THE EARTH

TOPIC	THEME
GEOLOGY - rock type, strata, age, faults, seismic network, etc	Hazards, Setting
GEOTECHNICAL – engineering properties, etc	Hazards, Shelter
SOILS – type, properties, depth, etc	Hazards, Setting
DRAINAGE FEATURES – lakes, salt pans, rivers, feature names, etc	Hazards, Setting
HYDROLOGY – ground water, bores, water quality, river flows, etc	Hazards, Sustenance
TERRAIN – elevation, slope, aspect, feature names, etc	Hazards, Setting
COASTLINE – beaches, tidal flats, rocks, reefs, tides, feature names, etc	Hazards, Setting
OCEAN – depth, currents, sea state, etc	Hazards, Setting
HAZARD HISTORY – details of previous earthquake, landslide, flood, etc	Hazards
HAZARD POTENTIAL – earthquake, landslides, tsunami, flood, etc 'threat'	Hazards

GROUP B: CLIMATE

TOPIC	THEME
WINDS – direction, strength, gusts, etc	Hazards, Setting
TEMPERATURE – maximum, minimum, means, extremes	Hazards, Setting
RAINFALL – amount, seasonal variation, extreme amounts, intensities, etc	Hazards, Setting
OTHER ATMOSPHERIC CONDITIONS – sunshine, lightning, fog, etc	Hazards, Setting
WEATHER – current, forecast, satellite images, weather station sites, etc	Hazards, Setting
HAZARD HISTORY – previous cyclones, severe storms, drought, etc	Hazards
HAZARD POTENTIAL – cyclones, severe storms, drought, etc threats	Hazards

GROUP C: PLANTS AND ANIMALS

TOPIC	THEME
VEGETATION – type, structure, species, traditional foods, etc	Hazards, Setting
ANIMALS – mammals, birds, fish, reptiles, insects, traditional foods, etc	Hazards, Setting
HAZARD HISTORY – bushfire, snake bite, shark attack, etc history	Hazards
HAZARD POTENTIAL – bushfire, poisons, venoms, munchies, etc threat	Hazards

GROUP D: POPULATION & SETTLEMENT

TOPIC	THEME
POPULATION – census and estimates of numbers, age, sex, migration, etc	Setting, Security
SETTLEMENT TYPE – city, town, village, hamlet, etc names & locations	Setting
SETTLEMENT REGULATION – land use zoning, building codes, etc	Shelter
STRUCTURE TYPES – houses, shops, schools, resorts, etc	Shelter
BUILDING CONSTRUCTION & MATERIALS	Shelter
EMERGENCY SHELTER – shelters/safe havens, assembly points, etc	Shelter
HAZARD HISTORY – building fires, inundation or earthquake damage, etc	Hazards
HAZARD POTENTIAL – fire spread, rubble, etc	Hazards

GROUP E: CULTURAL

TOPIC	THEME
LANGUAGE – what languages are spoken, translators, etc	Society
RELIGION – types, adherence, churches, temples, etc	Society
CUSTOM – cults, taboos, sacred sites, etc	Society
CULTURE – theatres, libraries, museums, heritage sites, meeting houses, etc	Society
HAZARD HISTORY – civil conflicts, pay back, racism, land disputes, etc	Hazards
HAZARD POTENTIAL – civil conflict, pay back, land disputes, etc	Hazards

GROUP F: POLITICS

TOPIC	THEME
INTERNATIONAL LEVEL – borders, EEZ, embassies, consulates, etc	Setting
NATIONAL LEVEL – parliament, electorates, etc	Setting
LOWER LEVEL – councils, wards, electorates, etc	Setting
HAZARD HISTORY – war, diplomatic conflict, civil war, coups, etc	Hazards
HAZARD POTENTIAL – international conflict, civil war, political strife, etc	Hazards

GROUP G: PUBLIC ADMINISTRATION

TOPIC	THEME
INTERNATIONAL – Forum offices, UN offices, etc	Setting
NATIONAL – department offices, facilities, etc	Setting
LOCAL – council chambers, offices, depots, etc	Setting
TRADITIONAL – chiefs or other meeting places, etc	Setting, Society
JUSTICE – courts, prisons, etc	Setting
JURISDICTIONAL BOUNDARIES – regions, districts, suburbs, etc	Setting
LAND TENURE – cadastre, formal tenure, customary tenure, etc	Setting
UNIONS & ASSOCIATIONS – professional, trade, industry, etc	Setting
HAZARD HISTORY – land disputes, strikes, crime, etc	Hazards
HAZARD POTENTIAL – land disputes, strikes, crime, etc	Hazards

GROUP H: PUBLIC SAFETY

TOPIC	THEME
DEFENCE FORCES – HQ, barracks, facilities, resources, etc	Security
PROFESSIONAL SERVICES – fire station, police station, control centre, etc	Security
VOLUNTEER FORCES – bases, control centres, etc	Security
DISASTER PLANS – prevention, preparedness, response, recovery	Security

GROUP I: SOCIAL

TOPIC	THEME
HEALTH SERVICES – hospitals, doctors, clinics, dentists, ambulance, etc	Security
DISABILITIES – blind, deaf, handicapped, etc	Security
DEATH SERVICES - morgues, undertakers, cemeteries, crematoriums, etc	Security
EDUCATION - schools, colleges, universities, etc	Society
COMMUNITY SERVICES - shelters, refuges, social workers, etc	Society
WELFARE SERVICES - Red Cross, St Vincents, NGOs, etc	Society
HAZARD HISTORY - epidemics, plagues, etc	Hazards
HAZARD POTENTIAL - epidemics, plagues, prevention programs, etc	Hazards

GROUP J: PRIMARY INDUSTRIES

TOPIC	THEME
AGRICULTURE - subsistence & other crops, livestock, storage, etc	Sustenance, Security
FISHERY - aquaculture, shore facilities, traditional fish traps, etc	Sustenance, Security
FORESTRY - logging, plantations, nurseries, etc	Security
MINING - mines, basic processing, etc	Security
HAZARD HISTORY - pests and diseases, fire, accidents, etc	Hazards
HAZARD POTENTIAL - pests and diseases, fire, accidents, etc	Hazards

GROUP K: SECONDARY INDUSTRIES

TOPIC	THEME
BASIC PROCESSING - abattoirs, mills, sawmills, refineries, brick kilns, etc	Security
FABRICATION - ship building, concrete batching plants, chemicals, etc	Security
CONSTRUCTION INDUSTRIES - design, plant & equipment, workshops, etc	Shelter, Security
HAZARD HISTORY - fires, explosions, accidents, pollution, etc	Hazards
HAZARD POTENTIAL - waste disposal, accidents, etc	Hazards

GROUP L: SERVICE INDUSTRIES

TOPIC	THEME
RESEARCH & DEVELOPMENT - laboratories, test facilities, etc	Security
FINANCE INDUSTRIES - banks, insurance, etc	Security
MANUFACTURING - clothing, footwear, crafts, etc	Security
ACCOMMODATION - resorts, hotels, motels, hostels, etc	Shelter, Security
COMMERCE - markets, shops, stores, bakeries, cafes, etc	Security
HAZARD HISTORY - fires, accidents, etc	Hazards
HAZARD POTENTIAL - fires, accidents, etc	Hazards

GROUP M: TRANSPORT & STORAGE

TOPIC	THEME
ROADS & STREETS - surface, capacity, bridges, etc	Shelter
ROAD TRANSPORT - cars, buses, trucks, recovery vehicles, etc	Shelter
OFF-ROAD MOVEMENT - cross country mobility, etc	Shelter
RAIL & TRAMWAYS - permanent ways, bridges, etc	Security, Setting
RAILWAYS - rolling stock, engines, repair facilities,, etc	Security, Setting
PIPELINES - material carried, pumping stations, pipe material, age, etc	Sustenance, Setting
PORTS - wharves, cargo facilities, anchorages, etc	Security, Setting
SHIPPING SERVICES - ship types, services, repair facilities, etc	Security, Setting
AIRFIELDS - capacity, surface, facilities, etc	Security, Setting
AIR SERVICES - aircraft register, services, repair facilities, etc	Security, Setting
SPECIAL STORAGE - cold stores, ice plants, explosives, chemicals, etc	Sustenance, Security
HAZARD HISTORY - accidents, pollution, etc	Hazards
HAZARD POTENTIAL - accident black spots, warning signs, etc	Hazards

GROUP N: COMMUNICATIONS

TOPIC	THEME
TELECOMMUNICATIONS - phone, radio, TV, Internet, mobile phone, etc	Sustenance
OTHER FORMS - postal, print media, couriers, etc	Sustenance, Society
HAZARD POTENTIAL - communications disruption, etc	Hazards

GROUP O: LIFELINE SERVICES

TOPIC	THEME
FUEL SUPPLY - bulk fuel & gas storage, service stations, etc	Sustenance
POWER SUPPLY - generation, distribution, reticulation, etc	Sustenance
WATER SUPPLY - source, storage, treatment, reticulation, tanks, etc	Sustenance
WASTE TREATMENT - sewage, garbage, hazardous waste storage, etc	Sustenance
FOOD SERVICES - freezers, bulk stores, bakeries, supermarkets, cafes, etc	Sustenance
GENERAL SERVICES - clothing, hardware, repair services, etc	Sustenance, Security
HAZARD HISTORY - fire, explosion, pollution, contamination, etc	Hazards
HAZARD POTENTIAL - safety regulations and standards, fire, etc	Hazards

GROUP P: SPACE

TOPIC	THEME
ASTRONOMY - sun rise & sun set times, moon phases, etc	Setting
SATELLITES - type, access, footprint, etc	Sustenance, Setting
HAZARD POTENTIAL - space junk re-entry, solar flares, etc	Hazards

GROUP Q: AUTHORITIES (sources of 'expert' advice)

TOPIC	THEME
PROFESSIONAL - meteorologists, geologists, engineers, etc	Hazards, Security
TECHNICAL - GIS and computer staff, plant operators, builders, etc	Shelter, Security
EXTERNAL ASSISTANCE -aid agencies, etc	Security
EMERGENCY MANAGERS - key police, fire, rescue and military staff	Security
CIVIL - business, political, church and community leaders	Security, Society
TRADITIONAL - custom leaders, community elders, etc	Security, Society

Comments

The thematic groupings used in this appendix was used to survey NDMOs and national GIS officers involved in the Suva workshop. The results of that survey are summarised in Appendix F.

This listing has evolved over the past decade as a result of my experience in undertaking or being involved in information user needs studies in the public safety sector including the Australian Defence Force and the police and emergency service agencies in Queensland.

APPENDIX E: REPRESENTATIVE BUILDING INVENTORY FORMATS

A. SOPAC Pacific Cities Project Building Data Attributes

Main use

house
flats
shed
commercial
industry
public services
health services
public safety
church, temple etc.
education
accommodation
community facilities
depot/garage
communication
other

Second important use

none
house
flats
shed
commercial
industry
public services
other

Plan regularity, main structure

regular
irregular

Wall material

concrete
timber
metal
fibre-cement sheets
brick
traditional material
other

Windows or glass doors

normal <75% of wall
large >75 % of wall
open wall space
none

Roof material

metal
tiles
concrete
fibre-cement sheets
traditional material
wooden shakes
other

Roof shape

flat = gable
gable ended
hip ended

Roof pitch

flat
low (<1:4 slope)
high (> 1:4 slope)

Number of storeys

Numeric value, e.g. 0, 1, 20, of occupiable levels

Base floor area per storey

< 50 sqm
50 - 100 sqm
100 - 200 sqm
200 - 400 sqm
> 400 sqm

Minimum floor height

Numeric value in cm, e.g. 0, 30, 180

Maximum floor height

Numeric value in cm, e.g. 0, 30, 180

UD material

slab
wooden poles
concrete columns
steel columns
steel + concrete columns
load bearing walls
wooden poles + walls
concrete columns + walls
steel columns + walls

UD structure

slab
soft
stiffened

Concrete cantilever

Numeric length of cantilever in cm e.g., 0, 100, 800

Burglar bars

yes
no

For open space areas the following attributes are collected

Open space

vegetated
grassed
sealed
gravelled
equipment yard
storage yard
other

Level

flat
steep

Source: Dr Graham Shorten, SOPAC HAU

B. Suggested *Building* Database Format & Coding for Duke of York Survey

The objective of this trial was to locate and gather information on each community in the Duke of York group so that its level of risk from the impact of any major hazard, such as tsunami, volcanic ash fall, etc could be calculated.

PRIORITY 1: BUILDINGS. The following information on each building in each community should be recorded:

1. Building name (if it has one e.g. St Josephs Church)
2. Address*
3. Locality*
4. Building use or function*
5. Height of the floor above the ground*
6. Number of stories*
7. Material of the walls*
8. Material of the roof*
9. Pitch of the roof*
10. Location (GPS latitude and longitude)
11. Elevation (GPS elevation above height datum)
12. Comments (any additional information that may be relevant)

* see accompanying notes for suggested categories, coding and database structure.

PRIORITY 2: INFRASTRUCTURE. In addition to buildings, careful note should be made of supporting infrastructure, especially :

- water supply (wells, pumps, tanks, etc)
- power supply (generators, power lines, etc)
- fuel supply (bulk storage of drum stores for fuels and bottled gas)
- transport infrastructure (roads, wharves, airstrips, etc)
- communications facilities (radio transmitter/receiver towers or antenna, etc)

Careful note should be made of their GPS location and elevation and descriptions recorded and/or photos taken.

PRIORITY 3: GENERAL. General descriptions, photos and sketch maps of anything else that may be of interest such as gardens, dense stands of forest, coconut plantations, etc would be useful.

Suggested Format (MapInfo table)

UFI	Integer	
Feature	Character	35
Address	Character	35
Locality	Character	25
Type	Character	1
Fl_ht	Decimal	3,1
Gd_ht	Decimal	4,1
Sto	Decimal	2,0
Wa	Character	1
Ro	Character	1

Ro_pi	Character	1
Comments	Character	35
Longitude	Decimal	9,4
Latitude	Decimal	9,4

UFI Unique Feature Identifier - unique number for each record. Computer generated.

Feature Name of the feature as indicated by signs on or at the feature or local knowledge.

Address If street names are used in the community include number and street name.

Locality Village or settlement name.

Type Major activity conducted at feature as identified from field. The following broad activity groups have been used and features are displayed with the MapInfo symbols indicated in the following table:

CODE	CLASSIFICATION	SYMBOL	COMMENTS
P	**P**ublic safety - police, fire, ambulance, SES, defence, etc	12pt solid cross, black	*Sensitive facilities* related to the provision of emergency response
L	**L**ogistics - bulk supplies of fuel, gas & food; bulk storage and transport services	12pt solid dot, yellow	*Sensitive facilities* that contribute significantly to community sustainability
D	**D**octors and other health services - hospitals, nursing homes, clinics, dentists, etc	12pt solid cross, green	*Sensitive facilities* that provide all forms of health service
U	power **U**tilities - generation, distribution and service facilities	12pt solid star, black	*Sensitive facilities* that provide power supplies
W	**W**ater supply and sewerage utilities - above ground storage, treatment, pumping, etc	12pt solid dot, light blue	*Sensitive facilities* that store, treat or reticulate water and sewerage services
T	**T**elecommunications - radio, telephone, TV, etc	12pt asterisk, black	*Sensitive facility* providing communications services
A	**A**ccommodation - commercial (non private) accommodation such as hotels, motels & resorts	10pt solid square, red	*Special risks* associated with commercial accommodation where concentrations of people are found - typically short term accommodation
B	**B**usiness - commercial and professional facilities such as shops, offices, etc	10pt solid square, yellow	*Special risks* associated with shopping centres and other places of business
E	**E**ducation - schools, TAFE, convents, child care centres, etc	12pt 'flagged building', red	*Special risks* associated with concentrations of children

R	**R**ecreation facility - sporting clubs, grandstands, etc	10pt solid square, green	*Special risks* associated with periodic concentrations of people
I	**I**ndustry - manufacturing and processing industries such as sawmills, sugar mills, cement plants, ship building, etc	12pt solid triangle, yellow	*Special risks* associated with either processes and materials used and/or concentrations of people
H	**H**ouses - private, detached houses only	9pt solid diamond, black	Detached houses only
F	**F**lats - includes all multi-occupant private dwellings including units, town houses and apartments	9pt diamond, red	All forms of private accommodation other than detached houses - includes self contained holiday units or apartments typically used for longer stays than motels, resorts, etc
C	**C**ommunity facilities - churches, halls, public toilets, libraries, scout huts, monuments, etc	12pt solid dot, purple	Mainly non-government facilities providing direct service to the community
G	**G**overnment facilities - offices, depots, etc of all levels of government	12pt solid dot, dark blue	Facilities from which government services are provided or administered
S	**S**heds - informal buildings used mainly for storage	9pt open diamond, black	

Fl_ht Height of the floor above ground level. Estimated to the nearest 10cm from field observation. A value of 0.3 indicates a slab-on-ground construction.

Gd_ht GPS height of the ground at the lowest corner of the building (ie where the floor is highest above the ground.

Sto The number of stories.

Wa Material from which the features walls are constructed with the following codes:

- B brick, masonry or stone
- C concrete block
- P precast concrete slab
- R reinforced concrete
- T timber
- F fibro
- M metal
- N 'native' (bush) material

Ro	Material from which the roof is constructed with the following codes:		
		T	tiles
		F	fibro
		M	metal
		C	concrete
		N	thatch
Ro_pi	Roof pitch with the following codes:		
		H	high (>1:4 slope)
		L	low (< 1:4 slope)
		F	Flat
Comments	Note field for added information on the feature derived from field notes.		
Longitude	Decimal GPS longitude.		
Latitude	Decimal GPS latitude.		

APPENDIX F: SUMMARY OF NDMO INFORMATION NEEDS SURVEY

GROUP A: SURFACE OF THE EARTH

TOPIC	NEED
GEOLOGY - rock type, strata, age, faults, seismic network, etc	1
SOILS - type, properties, depth, etc	2
DRAINAGE FEATURES - lakes, salt pans, rivers, feature names, etc	3
HYDROLOGY - ground water, bores, water quality, river flows, etc	6
TERRAIN - elevation, slope, aspect, feature names, etc	3
COASTLINE - beaches, tidal flats, rocks, reefs, tides, feature names, etc	4
OCEAN - depth, currents, sea state, etc	0
HAZARD HISTORY - details of previous earthquake, landslide, flood, etc	**8**
HAZARD POTENTIAL - earthquake, landslides, tsunami, flood, etc 'threat'	5

GROUP B: CLIMATE

TOPIC	NEED
WINDS - direction, strength, gusts, etc	3
TEMPERATURE - maximum, minimum, means, extremes	3
RAINFALL - amount, seasonal variation, extreme amounts, intensities, etc	5
OTHER ATMOSPHERIC CONDITIONS - sunshine, lightning, fog, etc	1
WEATHER - current, forecast, satellite images, weather station sites, etc	2
HAZARD HISTORY - previous cyclones, severe storms, drought, etc	**9**
HAZARD POTENTIAL - cyclones, severe storms, drought, etc threats	5

GROUP C: PLANTS AND ANIMALS

TOPIC	NEED
VEGETATION - type, structure, species, traditional foods, etc	2
ANIMALS - mammals, birds, fish, reptiles, insects, traditional foods, etc	1
HAZARD HISTORY - bushfire, snake bite, shark attack, etc history	2
HAZARD POTENTIAL - bushfire, poisons, venoms, munchies, etc threat	1

GROUP D: POPULATION & SETTLEMENT

TOPIC	NEED
POPULATION - census and estimates of numbers, age, sex, etc	**9**
SETTLEMENT TYPE - city, town, village hamlet, etc names & locations	**9**
SETTLEMENT STRUCTURES - houses, shops, schools, resorts, etc	**8**
SETTLEMENT REGULATION - land use zoning, building codes, etc	4
EMERGENCY SHELTER - shelters/safe havens, assembly points, etc	4
HAZARD HISTORY - building fires, inundation or earthquake damage, etc	4
HAZARD POTENTIAL - fire spread, rubble, etc	4

GROUP E: CULTURAL

TOPIC	NEED
LANGUAGE - what languages are spoken, translators, etc	3
RELIGION - types, adherence, churches, temples, etc	6
CUSTOM - cults, taboos, sacred sites, etc	5
CULTURE - theatres, libraries, museums, heritage sites, meeting houses, etc	1
HAZARD HISTORY - civil conflicts, pay back, racism, land disputes, etc	2
HAZARD POTENTIAL - civil conflict, pay back, land disputes, etc	2

GROUP F: POLITICS

TOPIC	NEED
INTERNATIONAL LEVEL - borders, EEZ, embassies, consulates, etc	2
NATIONAL LEVEL - parliament, electorates, etc	3
LOWER LEVEL - councils, wards, electorates, etc	3
HAZARD HISTORY - war, diplomatic conflict, civil war, coups, etc	2
HAZARD POTENTIAL - international conflict, civil war, political strife, etc	2

GROUP G: PUBLIC ADMINISTRATION

TOPIC	NEED
INTERNATIONAL - Forum offices, UN offices, etc	2
NATIONAL - department offices, facilities, etc	3
LOCAL - council chambers, offices, depots, etc	6
TRADITIONAL - chiefs or other meeting places, etc	3
JUSTICE - courts, prisons, etc	1
JURISDICTIONAL BOUNDARIES - regions, districts, postcodes, suburbs, etc	5
LAND TENURE - cadastre, formal tenure, customary tenure, etc	2
UNIONS & ASSOCIATIONS - professional, trade, industry, etc	0
HAZARD HISTORY - land disputes, strikes, crime, etc	2
HAZARD POTENTIAL - land disputes, strikes, crime, etc	2

GROUP H: PUBLIC SAFETY

TOPIC	NEED
DEFENCE FORCES - HQ, barracks, facilities, resources, etc	3
PROFESSIONAL SERVICES - fire station, police station, control centre, etc	4
VOLUNTEER FORCES - bases, control centres, etc	3
DISASTER PLANS - prevention, preparedness, response, recovery	5

GROUP I: SOCIAL

TOPIC	NEED
HEALTH SERVICES - hospitals, doctors, clinics, dentists, ambulance, etc	**9**
DEATH SERVICES - morgues, undertakers, cemeteries, crematoriums, etc	0
EDUCATION - schools, colleges, universities, etc	7
COMMUNITY SERVICES - shelters, refuges, social workers, etc	4
WELFARE SERVICES - Red Cross, St Vincents, NGOs, etc	**8**
HAZARD HISTORY - epidemics, plagues, etc	3
HAZARD POTENTIAL - epidemics, plagues, prevention programs, etc	3

GROUP J: PRIMARY INDUSTRIES

TOPIC	NEED
AGRICULTURE - subsistence & other crops, livestock, storage, etc	**9**
FISHERY - aquaculture, shore facilities, traditional fish traps, etc	6
FORESTRY - logging, plantations, nurseries, etc	2
MINING - mines, basic processing, etc	2
HAZARD HISTORY - pests and diseases, fire, accidents, etc	2
HAZARD POTENTIAL - pests and diseases, fire, accidents, etc	2

GROUP K: SECONDARY INDUSTRIES

TOPIC	NEED
BASIC PROCESSING - abattoirs, mills, sawmills, refineries, brick kilns, etc	1
FABRICATION - ship building, concrete batching plants, chemicals, etc	1
CONSTRUCTION INDUSTRIES - design, plant & equipment, workshops, etc	3
HAZARD HISTORY - fires, explosions, accidents, pollution, etc	2
HAZARD POTENTIAL - waste disposal, accidents, etc	3

GROUP L: SERVICE INDUSTRIES

TOPIC	NEED
RESEARCH & DEVELOPMENT - laboratories, test facilities, etc	1
FINANCE INDUSTRIES - banks, insurance, etc	3
MANUFACTURING - clothing, footwear, crafts, etc	1
ACCOMMODATION - resorts, hotels, motels, hostels, etc	4
COMMERCE - markets, shops, stores, bakeries, cafes, etc	3
HAZARD HISTORY - fires, accidents, etc	2
HAZARD POTENTIAL - fires, accidents, etc	2

GROUP M: TRANSPORT & STORAGE

TOPIC	NEED
ROADS & STREETS - surface, capacity, bridges, etc	**8**
ROAD TRANSPORT - cars, buses, trucks, recovery vehicles, etc	7
OFF-ROAD MOVEMENT - cross country mobility, etc	2
RAIL & TRAMWAYS - permanent ways, bridges, etc	1
RAILWAYS - rolling stock, engines, repair facilities,, etc	1
PIPELINES - material carried, pumping stations, pipe material, age, etc	1
PORTS - wharves, cargo facilities, anchorages, etc	4
SHIPPING SERVICES - ship types, services, repair facilities, etc	7
AIRFIELDS - capacity, surface, facilities, etc	4
AIR SERVICES - aircraft register, services, repair facilities, etc	3
SPECIAL STORAGE - cold stores, ice plants, explosives, chemicals, etc	1
HAZARD HISTORY - accidents, pollution, etc	2
HAZARD POTENTIAL - accident black spots, warning signs, etc	1

GROUP N: COMMUNICATIONS

TOPIC	NEED
TELECOMMUNICATIONS - phone, radio, TV, Web, mobile phone, etc	**9**
OTHER FORMS - postal, print media, couriers, etc	3
HAZARD POTENTIAL - communications disruption, etc	4

GROUP O: LIFELINE SERVICES

TOPIC	NEED
FUEL SUPPLY - bulk fuel & gas storage, service stations, etc	3
POWER SUPPLY - generation, distribution, reticulation, etc	7
WATER SUPPLY - source, storage, treatment, reticulation, tanks, etc	**8**
WASTE TREATMENT - sewage, garbage, hazardous waste storage, etc	3
FOOD SERVICES - freezers, bulk stores, bakeries, supermarkets, cafes, etc	1
GENERAL SERVICES - clothing, hardware, repair services, etc	2
HAZARD HISTORY - fire, explosion, pollution, contamination, etc	2
HAZARD POTENTIAL - safety regulations and standards, fire, etc	4

GROUP P: SPACE

TOPIC	NEED
ASTRONOMY - sun rise & sun set times, moon phases, etc	0
SATELLITES - type, access, footprint, etc	0
HAZARD POTENTIAL - space junk re-entry, solar flares, etc	0

GROUP Q: AUTHORITIES (sources of 'expert' advice)

TOPIC	NEED
PROFESSIONAL - meteorologists, geologists, engineers, etc	5
TECHNICAL - GIS and computer staff, plant operators, builders, etc	**8**
EXTERNAL ASSISTANCE -aid agencies, etc	4
EMERGENCY MANAGERS - key police, fire rescue and military staff	4
CIVIL - business, political, church and community leaders	4
TRADITIONAL - custom leaders, community elders, etc	4

Notes:

1. The totals include the responses by NDMOs who completed the survey and the inclusion of these topics in the damage assessment and drought assessment report proforma in use in PIC and explicitly identified in the Community Vulnerability Analysis methodology.
2. The maximum score possible is 10. Those with scores of 8 and above are highlighted in bold.

AGSO

AUSTRALIAN
GEOLOGICAL SURVEY
ORGANISATION