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.

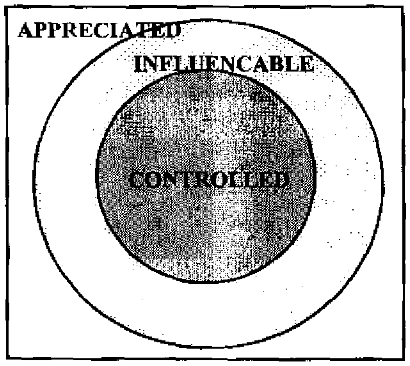


Figure 9a: 'Normal' power environment

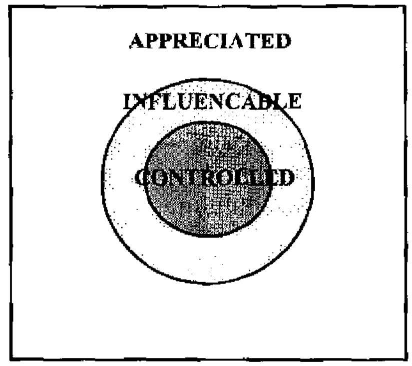


Figure 9b: 'Typical' GIS power environment (after Lyons, 1992)

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.

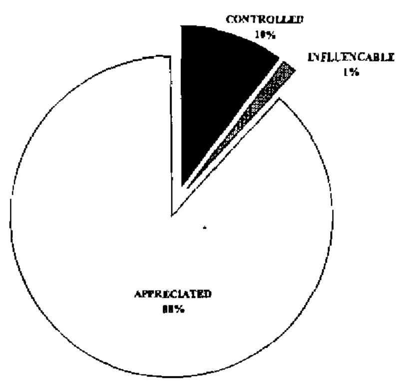


Figure 10: Cairns Pilot Study total data 'power environment' (by volume)

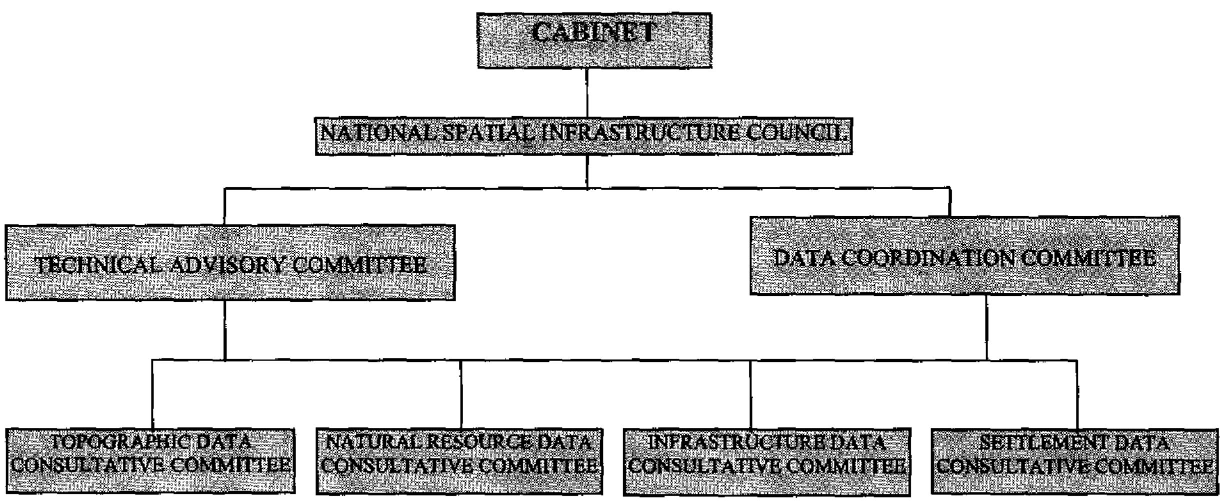
An institutional framework is required to facilitate the non-technology links (legal, fiscal, administrative, bureaucratic, etc) between the various stakeholders in the information infrastructure, from the smallest user-focused project, such as a village CVA, to the highest national or international-level 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 before 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.

REFERENCES

ANZLIC (1995) *Rural Addressing: a Model for the Systematic Addressing of Rural Properties*, Australia New Zealand Land Information Council Rural Addressing Working Party, Canberra.

ANZLIC (1997) *ANZLIC's Vision for the Australian Spatial Data Infrastructure* Background Paper, Australia New Zealand Land Information Council, Canberra.

ANZLIC (1998) *Guidelines for Custodianship*, Australia New Zealand Land Information Council, Canberra (www.anzlic.org.au/custodn).

Berry J.E. (1993) 'Effective standards required to go beyond mapping', *GIS World*, March, pp 22-23, GIS World Inc., Fort Collins.

Berry L. (1996?) *Community Vulnerability to Tropical Cyclones and Associated Storm Surges: Case Study of the Cairns Northern Beaches Townships*, Centre for Disaster Studies, James Cook University, Cairns.

Burrough P.A. (1987) *Principles of Geographical Information Systems for Land resources Assessment*, Oxford University Press, Oxford.

Cowan D.J (1988) 'GIS versus CAD versus DBMS: what are the differences?' *Photogrammetric Engineering and Remote Sensing* 53 (10), pp 1367-1370, American Society of Photogrammetric Engineering and Remote Sensing, Falls Church, Virginia.

EMA (1995) *National Emergency Management Competency Standards*, Emergency Management Australia, Canberra.

FGDC (1994) *The National Spatial Data Infrastructure*, pamphlet produced by the (US) Federal Geographic Data Committee, Reston, Virginia.

FGDC (1997) 'Clearinghouse background' *FGDC Home Page* (http://fgdc.er.usgs.gov/fgdc.html), US Federal Geographic Data Committee, Reston.

Fournier d'Albe E.M. (1986) 'Introduction: Reducing vulnerability to nature's violent forces: cooperation between scientist and citizen' in Maybury, R.H. (ed.) *Violent Forces of Nature*, pp. 1-6, Lomond Publications, Maryland.

Gaull B.A (1979) *Seismic Risk at the 20 Principal Towns of Papua New Guinea*, unpublished MSc thesis, University of Papua New Guinea, Port Moresby.

Granger K. (1997) 'Spinformation', *GIS Asia Pacific*, December 1997/January 1998, p12, Pearsons professional, Singapore.

Granger K. (1998) *ASDI* (Australian Spatial Data Infrastructure) *From the Ground Up: a Public Safety Perspective*, Australia New Zealand Land Information Council and AGSO, Canberra.

Granger K., Little R., Lyons K. & McAlpine J. (1998) *PNG National GIS, Spatial Data & Systems*, report of proceedings and results of a workshop sponsored by the PNG National Mapping Bureau and the Office of National Planning and Implementation, Port Moresby.

Granger K., Jones T., Leiba M. and Scott G. (1999) *Community Risk in Cairns: a Multi-Hazard Risk Assessment*, AGSO, Canberra.

IAVCEI (1999a) *Volcanic Cone Collapses and Tsunamis: Issues for Emergency management in the South Pacific Region*, IAVCEI in conjunction with the Geological Survey of PNG and AGSO, Canberra.

IAVCEI (1999b) 'Professional conduct of scientists during volcanic crises', *Bulletin of Volcanology*, No 60, pp 323-334, Springer-Verlag.

IEAust (1993) *At What Price Data?* National Committee on Coastal and Ocean Engineering, Institution of Engineers, Australia, Canberra.

Jones T. *Probabilistic Earthquake Hazard Assessment for Fiji*, AGSO Record 1997/46, AGSO, Canberra.

Lyons K. (1992) *Data Sets Required and issues Arising for the Use of Geographic Information Systems by the Portfolio of Police and Emergency Services for the ESMAP Project*, unpublished report to the Queensland Department of Emergency Services, Spatial Information Services, Montville.

Mant A. (1997) *Intelligent Leadership*, Allen & Unwin, St. Leonards.

Nix H. (1989) 'Keynote address' in C. Parvey & K. Granger (eds) *A National Geographic Information System: and Achievable Objective?*, AURISA Monograph 4, Australasian Urban and Regional Information Systems Association, Canberra.

Reser J.P. and Smithson M.J (1988) 'When ignorance is adaptive: not knowing about the nuclear threat', *Knowledge in Society: The International Journal of Knowledge Transfer*, Vol.1, No. 4, pp 7-27.

Rynn J. (1997) *Earthquake Risk Assessment: Suva Earthquake Risk Management Scenario Pilot Project*, reprot to the 6th IDNDR Pacific Regional Disaster Management Meeting (Brisbane), Centre for Earthquake Research in Australia, Brisbane.

SPDRP (1998) unpublished report of a panel discussion by Permanent/First Secretaries and selected NDMOs on information systems and information management presented to the 6th IDNDR Pacific Regional Disaster Management Meeting (Brisbane) as part of the South Pacific Disaster Reduction Program.

Standards Australia (1999) *Australia/New Zealand Standard AS/NZS 4360:1999 Risk management*, Standards Australia and Standards New Zealand, Homebush and Wellington.

Stephenson R.S. (1995) *Review and Analysis of requirements for Disaster Management Information Systems in the South Pacific Region*, United Nations Department of Humanitarian Affairs, South Pacific Program Office, Suva.

UNDHA (1998) *Guidelines for Community Vulnerability Analysis: an Approach for pacific Island Countries*, South Pacific Program Office of the United Nations Department of Humanitarian Affairs and the United Nations Department for Economic and Social Affairs, Suva.

US (1994) *Coordinating Geographic Data Acquisition and Access: the National Spatial Data Infrastructure* Executive Order 12906, Federal Register, Vol 59, No. 71, pp 17671-4, Washington (http://www.fgdc.gov/execord.html).

US Congress (1983) *Information Technology in Emergency Management*, report on a hearing and workshop conducted by US Congressional Subcommittee on Investigations and Oversight of the House Committee on Science and Technology, Washington.