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The potential for combining indigenous and western knowledge in reducing vulnerability to environmental hazards in small island developing states

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Abstract

The benefits of indigenous knowledge within disaster risk reduction are gradually being acknowledged and identified. However, despite this acknowledgement there continues to be a gap in reaching the right people with the correct strategies for disaster risk reduction.

This paper identifies the need for a specific framework identifying how indigenous and western knowledge may be combined to mitigate against the intrinsic effects of environmental processes and therefore reduce the vulnerability of rural indigenous communities in small island developing states (SIDS) to environmental hazards. This involves a review of the impacts of environmental processes and their intrinsic effects upon rural indigenous communities in SIDS and how indigenous knowledge has contributed to their coping capacity. The paper concludes that the vulnerability of indigenous communities in SIDS to environmental hazards can only be addressed through the utilisation of both indigenous and Western knowledge in a culturally compatible and sustainable manner.

Keywords: Indigenous communities; Environmental hazards; Vulnerability; Small island developing states; Disaster risk reduction

1. Introduction

Small island developing states (SIDS) vary enormously according to distinct biophysical, socio-cultural and economic characteristics (FAO, 1999). Yet they share common challenges to their efforts to achieve sustainable development. Such challenges include small populations, limited resources, excessive dependence on international trade, vulnerability to global developments and a susceptibility to environmental hazards (naturally occurring physical phenomena caused either by rapid or slow onset events which have astronomical, biological, geological or hydrometeorological origins) (United Nations, 2003). It follows then that with such variation in characteristics and common challenges the best policy in managing SIDS would be to manage for diversity, hence ensuring sustainability. This is especially the case for environmental hazards which have increasingly become global affairs often linked to climate change (Van Aalst, 2006) and sea level rise (Rodolfo and Siringan, 2006) or where the interaction of global pressures with local dynamics has contributed to increased vulnerability to environmental hazards (Pelling and Uitto, 2001). Short-term thinking has resulted in a narrow outlook where much literature examining environmental disaster risk reduction including hazards like floods (Chowdhury, 2000; Zhang et al., 2002), landslides (Guinau et al., 2005) and volcanoes (Pareschi et al., 2000; Stevens et al., 2004) tends to focus upon the physical components of risk and their associated mitigation strategies rather than incorporating the human, societal

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and cultural factors which surround the 'risk'. Nonetheless, it would be remiss not to mention the significant positive benefits and contribution of such research to the field of environmental disaster risk reduction e.g., the use of scientific data in the forecasting and warning of floods (Chowdhury, 2000), use of GIS and comprehensive datasets to establish areas susceptible to landslides (Guinau et al., 2005) or use of complex scientific instruments to establish up-to-date topographic data enabling modelling of volcanic flow processes (Stevens et al., 2004). Yet by focusing on hazard and risk mitigation strategies alone we become isolated from the wider framework from within which environmental hazards occur. Such a narrow focus overlooks the interrelating factors which may contribute to a hazard becoming a disaster and ignores the depth of knowledge existing within communities that face such risk (Wisner et al., 2004). This has led to an abandonment of indigenous coping strategies and a loss of indigenous knowledge by the indigenous communities themselves as modernisation encroaches upon them and reliance upon Western philosophies and aid is increased. The catalogue of environmental hazards and their increasing severity in SIDS bears evidence to this (Lewis, 1999; Pelling and Uitto, 2001). For example, in the South Pacific the number of reported disasters and the effects of these have increased significantly since the 1950s (for more information see Bettencourt et al., 2006).

There is currently, evidence of a steady movement away from an era of 'vulnerability' i.e., a "proneness or susceptibility [of communities] to damage or injury" (Wisner et al., 2004, p. 11) where populations in the developing world were thought to be dependent, inferior and subordinate (Bankoff, 2001). Gradually it is becoming accepted that such populations are to some degree capable of undergoing change while still retaining the same controls on their function and structure, and have the capacity to learn and adapt (Wisner et al., 2004). Terms such as 'resilience' and 'coping capacity' are now being used as these new principles are incorporated into development strategies.

It is the social science sector that is the leading forefront of this work, recognising that the approach to disaster risk reduction must encompass not only the 'hazard' but the risk which surrounds the hazard and why people are vulnerable in the first place. Recent key studies in this area include use of participatory methodology in volcanic hazard management (Cronin et al., 2004a, b), use of a participatory future search method to illustrate differences between top-down and local disaster risk reduction priorities (Mitchell, 2006) and exploration into the communication of risk during a volcanic crisis (Haynes, 2005). Méheux et al. (2006) in a recent review of the impact of natural hazards on SIDS has pointed to the need for more community involvement in the hazard impact assessment process. Yet despite this recognition, it seems western science remains firmly entrenched in its traditional methods. An entrenchment stemming from colonial times in the 17th and 18th centuries when our ignorance of the 'other' contributed to an increased divide between them (the developing world) and us (the Western world) (Bankoff, 2001).

To be fair, disaster risk reduction strategies have progressed enormously within the last 20 years among SIDS (Poncelet, 1997; South Pacific Applied Geo-Science Commission, 2004). Environmental hazards have been examined for characterising specific SIDS such as Antigua and Barbuda (Lewis, 1984) and the Solomon Islands (Blong and Radford, 1993); for developing general approaches applicable to all islands (e.g., Haynes et al., 2005; Kelman and Lewis, 2005); and for examining single events, such as a cyclone (e.g., Anderson-Berry et al., 2003; Mosley et al., 2004; Vettori and Stuart, 2004; Yates and Anderson-Berry, 2004; Kelman, 2005) or volcanic eruption series (e.g., Clay, 1999; Pattullo, 2000; Davison, 2003; Mitchell, 2006). However, the impact of this progression upon rural indigenous communities and their vulnerability to environmental hazards has been minimal (Wisner et al., 2004). Most likely as a result of a failure to recognise and incorporate the benefits of indigenous knowledge. As Mackinson and Nottestad (1998) note, most scientists would probably consider their greatest obstacle is finding and allocating resources to collect applicable information. However, what should be considered as the greater barrier is the unwillingness and inability to use 'non-scientists' or 'indigenous knowledge' as data. While disappointing that such a wealth of information is often overlooked or dismissed in its entirety, this disregard can be explained (Mackinson and Nottestad, 1998). This is due to the intrinsic assumption of most 'scientists' (i.e., those trained in physical scientific disciplines such as biology, physics and chemistry which have a strong emphasis on hypothesis testing supported by statistical methods) that only data collected in a scientific fashion can satisfy the rigours of statistical analysis (Mackinson and Nottestad, 1998). This assertion is supported by Schmuck-Widmann (2001) in her comparative study of indigenous and engineering knowledge along the Jamuna River in Bangladesh. She notes the limited interaction between the engineers working on the river and the Char people living on 'chars' or islands within the river and the readiness of the engineers to dismiss the applicability of the indigenous knowledge of the char people (Schmuck-Widmann, 2001).

'Non-scientists' knowledge, in this case the knowledge of rural indigenous islanders does not conform to the standard or format expected, making it hard for scientists to know how to deal with it (Mackinson and Nottestad, 1998; Schmuck-Widmann, 2001). As Weichselgartner and Obersteiner (2002, p.76) observe "disaster schemes and programs still treat people as 'clients' in disaster management processes where science and technology do things to them and for them, rather than together with them". This assertion is supported by Shah (2003) who in 2003 made an appeal for "The Last Mile", arguing that despite the availability of a wealth of material for making communities safer from disasters and the extensive research into this, a gap exists in reaching the right people with the right strategies for disaster, risk and vulnerability. He argues that well-known and well-understood techniques must be used to make a direct difference to those threatened by disaster. However, the "Last Mile" has been critiqued for placing last those who should be considered first. While retaining the need to overcome the gap to reach the right people with the right strategies, a further debate, or rather the other side of the coin, "The First Mile" emphasises that connecting with those who directly experience disaster should be the primary goal, not the last endeavour i.e., it is the indigenous people within SIDS who should be the first point of contact in discussing or developing any disaster risk reduction strategies.

We advocate that not only is it essential to work with those directly affected by disaster but that there needs to be an interdisciplinary, combined approach to disaster risk reduction in which the benefits of both Western science and indigenous knowledge are utilised to their maximum advantages in a culturally compatible manner. Although it has undoubtedly been identified as a worthy objective to gather indigenous knowledge (Sillitoe, 1998) and establish its use within disaster risk reduction (Brahmi and Poumphone, 2002; Jigyasu, 2002; Few, 2003; Howell, 2003), more importantly is how this knowledge is then utilised. Many have assessed how indigenous knowledge may benefit or complement western scientific knowledge or vice versa both in disaster risk reduction (e.g., Seitz, 1998; Schilderman, 2004; Ellemor, 2005; Rautela, 2005; Twinomugisha, 2005) and within general development literature (e.g., Gorjestani, 2000; Rahman, 2000; Dods, 2004; Wisner et al., 2004) but as yet there is no clear framework as to how this may be achieved in practice to reach an overall strategy to mitigate against environmental hazards. Cronin et al. (2004a) in their study on how traditional knowledge may be incorporated with scientific knowledge for volcanic hazard management on Ambae Island, Vanuatu moved some way towards this. This study used participatory approaches to produce readily understood hazard maps and community volcanic emergency plans for the community which entirely focused on the hazard itself rather than the underlying components of vulnerability. While this is useful in the immediate onset of a disaster and ensures plans are in place to deal with the effects of a hazard, it does not address the underlying vulnerabilities which contribute to the hazard becoming a disaster in the first place.

This paper aims to review the intrinsic effects of environmental processes upon rural indigenous communities in SIDS, examine how such communities coped with environmental hazards in the past and how, if at all, this information may be used in integration with western scientific knowledge to address their vulnerability to environmental hazards in the present and future.

2. SIDS, rural indigenous communities and vulnerability to environmental hazards

The interaction between 'vulnerability' and the occurrence of environmental hazards has been explored in some detail (e.g., Lewis, 1999; Wisner et al., 2004). However, disaster risk reduction still tends to concentrate on the hazard itself rather than on reducing the inherent vulnerabilities to that hazard within a community, a failure as some would see it to incorporate disaster risk reduction within development (Bankoff, 2001). We advocate that hazard scientists rather than just looking at new ways to explore old data or old methods should search for ways of accessing and incorporating new and/or different data i.e., indigenous knowledge with more standard data. The value of indigenous knowledge has been increasingly recognised in the international arena yet is frequently overlooked in practice. The International Decade for Natural Disaster Reduction (IDNDR) from 1990–2000 called for a concerted worldwide effort to utilise existing scientific, technical and indigenous knowledge to develop and implement a public policy for disaster prevention (Rouhban, 1999). Without such a policy, we are missing half the picture and in danger of repeating past mistakes. For example National Disaster Management Offices (NDMOs) have been set up throughout the island states of the South Pacific, but how relevant are they to their indigenous populations? Indigenous residents of Tikopia Island in the Solomon Islands struck by Cyclone Zoe in December 2002 survived using age old indigenous practices of traditional housing (some of which survived the cyclone) and taking shelter under over hanging rocks on higher ground as the cyclone struck (Anderson-Berry et al., 2003; Vettori and Stuart, 2004; Yates and Anderson-Berry, 2004; Kelman, 2005). They were supplied with aid through the NDMO and associated international agencies afterwards but ultimately they secured their own survival in the short-term.

Rural indigenous communities in SIDS and their vulnerability to environmental hazards are impacted upon by environmental processes both non-anthropogenic and anthropogenic at all spatial scales. Anthropogenic processes are defined as those human-induced processes, which through a chain reaction may result in a change that is detrimental to a given population. For example, increases in greenhouse gas emissions have most likely contributed to observed global warming (IPCC, 2001). Such increases in the earth's temperature could directly impact local communities through changes in agricultural growth or types of crop grown. Globalisation has led to an expansion of communication networks and cultural interaction at a scale not experienced before which ultimately could result in a loss of indigenous knowledge at the community level. Non-anthropogenic processes are defined as those naturally occurring changes within our environment at both a local and global level, such as desertification, erosion, climatic changes, sea-level rises, hurricanes, tsunamis etc.

Table 1
Examples of environmental processes and their intrinsic effects

Environmental processes	
Anthropogenic processes	**Intrinsic effects**
1. Global warming—human induced e.g., sea-level rises, seasonal changes, differentiated patterns of floods and drought	Change in cropping patterns Change in type of crops Salinisation of water sources Food shortages
2. Poverty	Poor education i.e., knowledge of early warning systems Limited access to services Low quality housing Lack of livelihood options Lack of suitable housing locations
3. Globalisation	Loss of indigenous knowledge Migration
Non-anthropogenic processes	**Intrinsic effects**
1. Global warming—naturally occurring e.g., sea-level rises, seasonal changes, differentiated patterns of floods and drought	Change in cropping patterns. Change in type of crops Salinisation of water sources
2. Erosion	Land loss
3. Cyclones	Crop devastation Destruction of houses

However, it is important to note that these may also have been impacted upon by human processes. Put simply, it is both changes in the natural and human environment that contribute to the vulnerability of a community to a potentially hazardous event (Wisner et al., 2004). Looking at vulnerability this way irrevocably links disaster risk reduction with development. To negate the effect of hazards means to develop and adapt to environmental processes.

Non-anthropogenic change as Pelling and Uitto (2001) note is nothing new for SIDS as they have been witness to a series of transformations reshaping, and shifting island societies and environments. However, historical global pressures differ greatly from contemporary global pressures which are serving to increase the vulnerability of rural indigenous communities within SIDS to environmental hazards (Harvey, 1990; Pelling and Uitto, 2001). Table 1 gives some examples of environmental processes impacting upon rural indigenous communities in SIDS and the possible intrinsic effects of these.

Environmental processes and the intrinsic effects of these as shown in Table 1 are contributing to an increased vulnerability of rural indigenous communities to environmental hazards. These intrinsic effects are a direct indicator of a community's vulnerability level and it is these factors which need to be addressed in increasing the capacity and reducing the vulnerability of a community to environmental hazards, both through Western and Indigenous knowledge. Incorporating this into the Pressure and Release Model developed by Wisner et al. (2004), enables the progression of vulnerability within rural indigenous populations in SIDS to be clearly identified (Fig. 1).

As Wisner et al. (2004) note, increasing pressure can come from either side of the model but to relieve the pressure, vulnerability (i.e., the left side of the model) needs to be reduced. While environmental processes need to be targeted at an international and national level, for indigenous communities in SIDS to reduce their vulnerability, the intrinsic effects and the unsafe conditions resulting from these will remain unless they are addressed.

3. Indigenous disaster risk reduction practices used in SIDS: changes experienced throughout the 19th and 20th centuries

Anthropogenic and non-anthropogenic processes are increasing the likelihood of adverse effects upon indigenous societies from environmental hazards (Hay, 2002; Wilbanks and Kates, 1999). A fundamental limitation of the Westernised approach to the management of environmental hazards has been to treat human and natural systems as independent entities, and to assume that responses of ecosystems to human use are linear and predictable, and can be controlled (Folke et al., 2002). As Hay (2002, p. 220) observes "[the] major challenge is to equip people, communities and societies to develop and modernise in less wasteful ways than is the current development

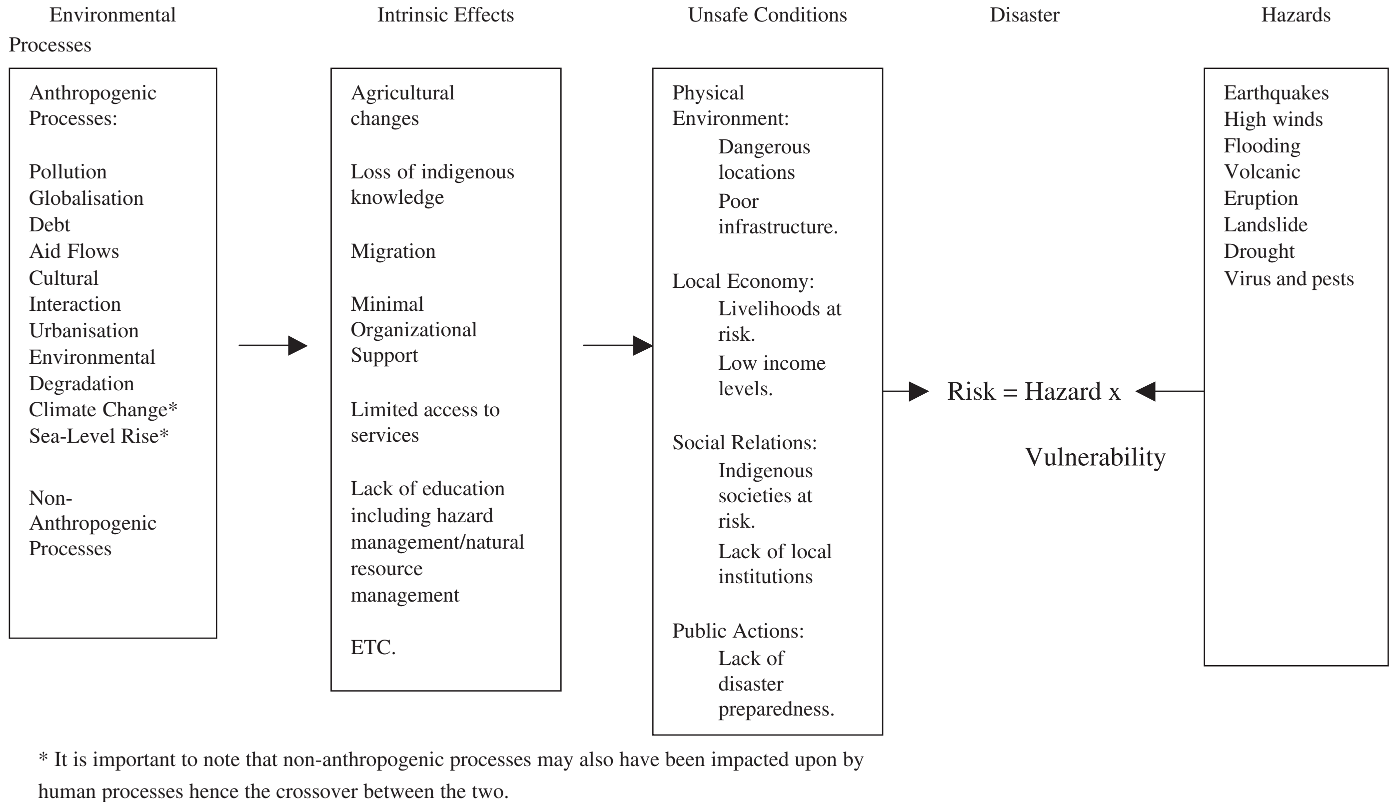

Fig. 1. Pressure and release (PAR) model for SIDS adapted from Wisner et al. (2004).

paradigm, but without losing the sound social and cultural values and practices that underpin their traditional way of life''. Approximately seven hundred years ago sea level falls and regional changes in the Pacific climate resulted in the abandonment of many coastal settlements and the disruption of islander travel patterns (Nunn, 2000; Nunn and Britton, 2001). Today if future sea level rises match the current projections of IPCC (2001) many island communities could be inundated or exposed to waves and storms along with the resulting difficulties in obtaining food and water (Lewis, 1989; 1990; Pernetta, 1992; Huang, 1997; Edwards, 1999; Roper, 2005; Parks and Roberts, 2006). Similarly climate change impacts relating to extreme events will be particularly felt on small islands (Lewis, 1990; 1999; Barnett, 2001; Pelling and Uitto, 2001; Ghina, 2003; Roper, 2005; Parks and Roberts, 2006). Therefore it is essential that rural indigenous communities in SIDS are equipped to deal with such an occurrence both through relevant indigenous and scientific knowledge.

The main disaster risk reduction strategies practiced within rural indigenous populations in SIDS can be grouped into a number of general categories including land use planning, building methods, food resilience, social resilience and environmental resilience (South Pacific Applied Geo-Science Commission, 2004). While previously successful strategies in preparing for, mitigating against and dealing with the effects of an environmental hazard, these strategies in many cases are falling into disrepair or are considered no longer viable in today's society, often by the communities themselves. The following section will explore the reasons why this is the case and highlight how indigenous knowledge has contributed to disaster risk reduction in the past.

3.1. Land use planning

Locations of villages and housing were often influenced by hazard vulnerability (South Pacific Applied Geo-Science Commission, 2004). Communities, where possible would site their settlements on high ground to avoid storm surges and floods, in areas not prone to landslides, and on volcanic islands in areas where lava flow was less likely and prevailing winds did not deposit ash or acid rain on crops (South Pacific Applied Geo-Science Commission, 2004). This practice has gradually changed throughout the 19th and 20th centuries as increased anthropogenic pressures including overexploitation of natural resources and increased populations have pushed people into more hazardous, marginalised areas. However, increased exposure to environmental hazards can also be a result of ignorance by land planners and the inability to foresee the value of indigenous knowledge. In the Marshall Islands of the South Pacific, islanders settlement patterns were traditionally governed by environmental considerations e.g., wind, wave action, storm protection, etc. (Spennemann, 1998). This began to change after World War II when settlements departed from this traditional wisdom with Japanese and US troops selecting areas on the basis of their base security, and favourable lagoon conditions for large ships and sea planes (Spennemann, 1998). This settlement has continued with an increased intensification of residential housing. Yet, these settlements, unlike the traditional settlement sites, are exposed on the windward side of the atolls and have consequently paid a heavy price in damage from typhoons and high tides (Spennemann, 1998).

3.2. Building methods

Each island culture has its own traditional type of house appropriate to local environmental conditions. The Samoan fale, for instance, has a high thatched roof to protect against sun and rain, but no walls so that the breezes could keep it cool. On the other hand, the Kanak case in New Caledonia has thick walls and no windows, with a fireplace inside to keep it warm on cold nights and for smoke to keep out the mosquitoes (Dahl, 1989). However, the construction of traditional dwellings was mainly regulated by the occurrence and frequency of tropical cyclones. Indigenous communities in cyclone prone areas where caves were not available for shelter, developed wind-resistant housing (South Pacific Applied Geo-Science Commission, 2004). In Fiji, for example traditional housing or 'bure' are extremely resistant to strong winds with deeply buried strong hardwood posts, steeply angled, four-sided roofs and secure bindings to hold them down (Campbell, 1984). Modifications to 'bure' which have occurred throughout the 20th century with the addition of such things as nails and iron roofing have resulted in bure becoming more vulnerable (Campbell, 1984). This has subsequently contributed to the increased vulnerability of indigenous Fijians to cyclones. However, there are also those rural indigenous communities who have been able to secure the survival of their indigenous knowledge (Veitayaki, 2002). For example, indigenous communities residing on Tikopia Island in the Solomon Islands survived the onslaught of strong winds with the people themselves taking shelter under overhanging rocks on higher ground.

3.3. Food resilience

Rural indigenous societies in many SIDS developed hazard-resistant varieties of food crops, thereby ensuring their resilience in times of hardship or disaster. For example, the yam is very resistant to high winds, while it may suffer severe damage to its foliage and stems above ground, the root itself often remains unharmed or only partly damaged, enabling it to be salvaged and stored (Campbell, 1984; South Pacific Applied Geo-Science Commission, 2004). Communities also maintained a diverse range of crops thereby reducing the likelihood that all species in any one location would be heavily damaged (Campbell, 1984). The same principle has also applied at regional levels in the South Pacific with different indigenous groups growing different species dependent on the location and soil type. This meant that not only did different islands within a country vary in terms of their main staple but that they were also sufficiently dispersed. This ensured that it was extremely unlikely that all islands would suffer equally (Campbell, 1984; Campbell, 1990). Land use and crop planting were planned to ensure that food was available for as long as possible within each year while varieties that could be preserved were grown and processed for times of hardship or disaster (South Pacific Applied Geo-Science Commission, 2004).

Communities also identified alternative or 'famine' foods i.e., those supplementary crops that in many areas were rarely consumed during times of plenty and were only maintained as emergency resources (Campbell, 1984). Food items found in forests were also considered famine foods. In essence, the forest was a living store for many indigenous communities, a bank against shortfalls in crop production (Campbell, 1990).

Similarly many indigenous communities in SIDS are situated along the coast and dependent to a large extent upon marine resources for their livelihoods and food sources. The sea's produce was considered dependable but not unlimited, as Johannes (1978: p.352) notes "almost every basic fisheries conservation measure devised in the West was in use in the tropical Pacific centuries ago". Indigenous people were careful to conserve their resources and utilised a number of indigenous strategies to ensure they were not left short if for example they were unable to fish due to hazardous conditions e.g., the drying, smoking or salting of fish to preserve it or the storage of fish alive in man made or natural rock enclosures (Johannes, 1978).

Rural indigenous populations within SIDS have over the years developed a wide variety of techniques for storing and preserving food (Johannes, 1978; Campbell, 1990). In Fiji, for example, excess breadfruit and cassava were buried in specially prepared holes to ensure that some were saved for the off-season when the surplus became handy (Aalbersberg, 1988). Yams were stored for long periods in specially built houses, and fish and other proteins were smoked, dried or salted to allow for longer storage and preservation (Johannes, 1978; Veitayaki, 2002). It is important, however, to note that these strategies were not always successful and, in some cases, communities suffered severe hardship as a result of environmental hazards (Campbell, 1984).

In the late 20th century, these methods of ensuring food availability in times of hardship or disaster were being pushed aside as modernisation encroached upon indigenous communities. Cash cropping and commercial fishing has contributed to a loss of traditional methods and techniques. Increasingly, relief aid was supplied to these communities in times of hardship or disaster rather than promotion of the practice of self-sufficiency (Campbell, 1990). Those at the fore of disaster risk reduction programs bear a special responsibility to foster and support local attempts at self-sufficiency prior to and in the wake of a disaster whenever possible through such measures as food preservation techniques, rather than increase dependency on external assistance.

3.4. Social resilience

Rarely were communities under stress from tropical cyclones or other natural hazards, as they were often not totally dependent upon their own resources (Campbell, 1990). For example, in pre-European Vanuatu inter-village and inter-island trade flourished, continuing in some areas well into the 20th century and to some extent in some forms still today (Campbell, 1984, 1990). Patterns of behaviour within rural communities in SIDS evolved throughout the 19th century to reduce the risk of social disruption and support each other in times of need. Islanders were in many cases bound together in complex political, social and economic systems that ensured risks to communities and their resources were reduced. However, in the late 20th century these systems have been challenged as rural communities were increasingly incorporated into the global economy. Increased population, poverty levels, out-migration and new forms of trade all contributed to a disruption in existing social and support structures. For example, the increase in cash cropping and a dependency on relief aid in times of hardship has reduced the necessity for islanders to continue with the practice of inter-village and inter-island trade, thereby cutting off a previously essential support link for communities in times of hardship (Ali, 1992; Campbell, 1990).

3.5. Environmental resilience

Indigenous communities dependent upon the environment for their livelihoods have developed a vast body of knowledge enabling them to identify signs of impending trouble. For example villagers on the volcanic island of Ambae, Vanuatu use such signs as pervasive gas smells, the death of trees, unusual active bubbling within the lake surrounding the volcano, rumbling and booming from the crater and the rapid rotting of taro roots in the ground as a sign that something may be about to happen within the volcano (Cronin et al., 2004a). This ability to anticipate the onslaught of an environmental hazard has in many cases been instrumental to the survival of indigenous populations, often allowing for adequate preparation time for indigenous communities to prepare for the hazard event (UNESCO, 2005). The possible utilisation of such knowledge is, however, often ignored by hazard scientists who prefer the more acceptable scientific analysis to determine whether a hazard is going to occur. An extreme example of such an occurrence is the 2004 Indian Ocean Tsunami where scientists were unable to provide adequate warning for the event but yet a number of indigenous groups survived. A survival determined by their in-depth knowledge of the environment. Only seven people were killed on Simeulue Island in Indonesia's Aceh province during the tsunamis of 26 December 2004 and 28 March 2005, a survival rate unprecedented considering no warning was given and the Northern end of the island was only 40 km south of the December earthquake's epicentre (McAdoo et al., 2006). The high survival rate was attributed to local oral histories which account for a similar event happening in 1907 and advise running to the hills after prolonged shaking of the ground (McAdoo et al., 2006). Simeulue's oral history provided an extremely powerful mitigation tool, which saved countless numbers of lives. Similar incidents of survival attributed to oral histories have been documented in the Andaman and Nicobar Islands (Bishop et al., 2005; Dybas, 2005). Yet still scientific analysis of the event continues to look at improvements within scientific early warning systems (Harinarayana and Hirata, 2005). While such improvements are essential science would benefit from the study of indigenous environmental knowledge and how this may be incorporated within disaster risk reduction.

4. Learning from the past and moving forward

Christopher Columbus's (1493) letter announcing the success of his voyage to the Caribbean described an area rich in natural resources, a paradise full of safe and wide harbours, high mountains and a large variety of trees. European settlers that followed soon realised that this idyllic description was misleading, as environmental hazards such as drought, floods, cyclones, earthquakes and volcanic eruptions occurred. Yet indigenous people were successfully living in spite of these environmental hazards. This is not to paint a picture of an idyllic existence for indigenous populations as this was far from the case, but they have however, withstood changes in their environment and adapted over a period of time (in many cases with sufficient loss to their population and livelihoods). Nunn (2000) and Nunn and Britton (2001) detail the impact of environmental change upon populations in the Pacific Islands around AD 1300 and the hardship which resulted. However, such communities were able to adapt to some degree, which raises the question of why it is that the Western world usually ignores the indigenous knowledge of such populations, preferring instead to focus attention largely on technocratic, Western style solutions and deny the wider historical and social dimensions of environmental hazards (Bankoff, 2001). Solutions, which for the best part have not led either to a reduction in the occurrence of environmental hazard events or a reduction in the vulnerability of populations to their effects (White et al., 2001).

Watt (1972) in his article on 'Man's efficient rush towards deadly dullness', followed by other scholars such as Campbell (1984; 1990), Ali (1992) and Gegeo and Watson-Gegeo (2002) have recognised the need to be aware of other resource use practices and concepts, and that "over the short term, the ideas of civilisation 'A' might appear vastly superior to those of civilisation 'B'. But over the long term it could turn out that the apparently 'primitive' practices of civilisation 'B' were based on millennia of trial and error and incorporated deep wisdom that was unintelligible to civilisation 'A'". Despite this, it is only in the late 20th and early 21st centuries that the potential of indigenous knowledge within development has been recognised (Gray and Morant, 2003; Pfeifer, 1996; Sapre, 2000; Singhal, 2000) and only recently has its potential within emergency management, and disaster risk reduction been considered (Cronin et al., 2004a; Ellemor, 2005; Wisner, 2004).

It is essential that the knowledge of rural indigenous communities is considered a primary source of information despite possible biased perceptions of their natural resource wealth and their own impact upon this (Mackinson and Nottestad, 1998). Rural communities know a lot about the environmental hazards they face and their occurrence since their livelihoods often revolve around land use and therefore any environmental hazard may be detrimental to their survival. There are a number of documented cases of indigenous communities identifying, reacting and as a consequence surviving the threat of an environmental hazard including communities of Tikopia Island, Solomon Islands who survived the threat of a tropical cyclone (Anderson-Berry et al., 2003; Yates and Anderson-Berry, 2004) and the survival of the Sea Gypsies in Yan Chiak, Myanmar from the 2004 Indian Ocean Tsunami who escaped because they heeded tales of monster waves created by the spirit of the sea (Dybas, 2005; UNESCO, 2005). It is believed the spirit gave the gypsies a warning, first the earth shook, and then the sea quickly receded which was the Gypsies cue to run for high ground (Dybas, 2005). Howell (2003) discusses the potential application of indigenous early warning indicators of cyclones in coastal Bangladesh. The knowledge of indigenous communities comes compiled, often deeply ingrained within the daily life of the community concerned. The knowledge of how to cope with and recover from environmental hazards is often based not only on their own present day experience but also on generations of knowledge which has been built up within the community from those who have experienced and dealt with environmental hazards in the past.

There are many notable references on the importance of local, traditional or indigenous knowledge. Typically anthropologists have been at the forefront of these investigations but an increasing number of environmentalists and ecologists are becoming involved. In natural resource management for example the value of indigenous knowledge is increasingly being recognised. Donovan and Puri (2004) provide a detailed account of the traditional knowledge used to process non-timber forest products of the Penan Benalui of Indonesian Borneo and how this could fill gaps within scientific knowledge. Other examples are noted within fisheries (Johannes, 1978; Mackinson and Nottestad, 1998; Mackinson, 2001), land use planning (Gobin et al., 2000; Moller et al., 2004; Xu et al., 2005) and soils (Gray and Morant, 2003; Payton et al., 2003; Sandor and Furbee, 1996). There are also examples of indigenous communities who are successfully managing diversity and change. Berkes and Jolly (2001) provide a detailed account of the Inuvialuit people of a small indigenous community in Canada's Western Arctic who have successfully developed coping mechanisms and adapted livelihood strategies which have evolved from past knowledge and expertise of the environment within which the community is situated, to deal with the impacts of global climate change. While not a SIDS, this is an isolated community with relevant and applicable lessons, which could be applied to communities in SIDS. Increasingly knowledge of these examples has led disaster risk reduction practitioners to evaluate the benefits and use of indigenous knowledge within disaster risk reduction. Ellemor (2005) provides a detailed review reconsidering emergency management and indigenous communities in Australia while others have looked at the potential role of traditional knowledge (Jigyasu, 2002; Cronin et al., 2004a) and the effectiveness of traditional coping strategies (Howell, 2003).

Essentially there are two types of knowledge applicable to disaster risk reduction within SIDS: scientific knowledge (i.e., hard data either western or developed within SIDS) and indigenous knowledge (i.e., data developed or adapted by the indigenous communities themselves). Both may be advantageous to a rural indigenous community in reducing their vulnerability to environmental hazards. Therefore, it is paramount that the gap between these two data sources is closed and they are integrated in a culturally compatible and sustainable way which benefits both hazard scientists and the indigenous communities. Unfortunately, the appropriate state agencies responsible for disaster risk reduction are often distanced from the needs of indigenous populations, especially in the case of SIDS where the population is often spread over an area difficult to access and divided into a number of islands. As Lewis (1982, p. 245) states, "a multidisciplinary, comprehensive, environmental and locally integrated approach by indigenous authorities and organisations will be more effective for disaster mitigation than partial, sectoral, mono-disciplinary, policy separation by exogenous agencies [and government bodies]". Yet contemporary ideas of disaster risk reduction continue to advocate the Western approach, ignoring the significance of indigenous knowledge. Chambers (1980) in discussing tropical agricultural research and development recognises "the most difficult thing for an educated expert to accept is that poor farmers may often understand their situations better than he does. Modern scientific knowledge and the indigenous technical knowledge of rural people are grotesquely unequal in leverage. It is difficult for some professions to accept that they have anything to learn from rural people, or to recognise that there is a parallel system of knowledge to their own which is complementary, that is usually valid and in some aspects superior".

In response to the 2004 Indian Ocean tsunami and the survival of the Sea Gypsies in Yan Chiak, Myanmar UNESCO's Regional Advisor for Culture in Asia and the Pacific, Richard Engelhardt, stated "the fact that the sea gypsies survived, while many others did not, points to certain lessons to be learned from traditional, indigenous knowledge. Twenty years ago, beachfront construction was light and made of bamboo and thatch that, if it collapsed, would not kill the occupants. The use of such traditional construction "rules" should be part and parcel of village rehabilitation work" (UNESCO, 2005, p.22). While among many large organisations such as UNESCO, the need to learn from and incorporate indigenous knowledge has been recognised, in practice very little is being done about it. As Derek Elias of UNESCO's Bangkok bureau goes onto observe with regret that "in the Surin Islands and elsewhere in Thailand, a multitude of aid bodies are bringing in project money and "staking their claim" to certain areas for providing reconstruction assistance that often does not consider practical matters of sustainability" (UNESCO, 2005, p.22). Citing the example of a newly reconstructed Moken coastal village in Thailand's Ko Surin National Park, he reports that "new houses have been laid down into the forest too far from the water's edge, lined up on a grid, built too low to the ground and too close together. The result is poor ventilation and sanitation, as well as obstructed views to the sea, even though clear visibility is essential both for monitoring sea conditions and for daily activities along the coast" (UNESCO, 2005, p. 22). Similarly, Paz (2005) reports on how aid agencies have built new homes in the aftermath of the tsunami without consulting local communities, resulting in new homes often alien to local tribal or fishing styles. Even with a desire to use indigenous knowledge within disaster risk reduction, most have not known how. So, how is it that this could be achieved? The basic concept is simple—there needs to be a constant process of 'collaboration and exchange' i.e., communication at a level perhaps not experienced before both within and between indigenous groups, disaster managers and hazard scientists.

As a direct result of environmental processes and the intrinsic effects of these, it is not feasible for indigenous communities to revert back to traditional measures of disaster risk reduction in their entirety. However, this said, indigenous disaster risk reduction systems if (where necessary) appropriately modified and adapted, and then further complemented by appropriate Western strategies could form the basis of suitable and sustainable disaster risk reduction strategies. As Johannes (1978) explains, indigenous systems are often ingrained within daily life and at times so simple that the virtues of such strategies go unnoticed by outsiders until it is too late, and the practice has been diminished. Communication is essential for mutual respect to be developed, which in turn is central to being able to learn from others' knowledge. Aside from the need for communication is a need to entail both 'top-down' and 'bottom-up' strategies. From the 'top-down' perspective, strong leadership is necessary to guide the process, engage and connect with the community. Simultaneously the 'bottom-up' perspective requires community initiatives and liaison with necessary authorities.

5. Conclusion: the future of the past within disaster risk reduction

This paper has reviewed the impacts of environmental processes and their intrinsic effects upon rural indigenous communities in SIDS and examined how such communities coped with environmental hazards in the past. It is clear the knowledge of the past is essential if the future threat of environmental hazards upon indigenous communities in SIDS is to be adequately addressed. For centuries, indigenous populations have learnt to adapt to gradual change and adjust their livelihood strategies. It is this knowledge that now needs to be drawn upon in addressing the accelerated pace of change in today's global world, its impacts upon environmental hazards, and the consequences for rural indigenous communities situated within hazard prone areas. Failure to utilise such knowledge within disaster risk reduction is a grave mistake and one which has contributed to the current circumstances where indigenous communities are increasingly vulnerable to environmental hazards. However, indigenous strategies alone cannot be expected to successfully address the problems that have arisen as a result of environmental processes. It is imperative that indigenous knowledge should be integrated or utilised alongside relevant Western disaster risk reduction strategies in mitigating against the intrinsic effects of environmental processes and thereby reducing the vulnerability of rural indigenous communities in SIDS to environmental hazards. A framework identifying how indigenous and Western knowledge may be combined within disaster risk reduction is a necessary step towards this and should be the next step forward in ensuring the right people are reached with the correct strategies for disaster risk reduction.

Recognition, recording and promotion of traditional coping mechanisms alongside culturally compatible Western strategies can only contribute to enhancing the capacity of rural indigenous communities to mitigate, prepare for and recover from environmental hazards. Only then will disaster risk reduction practices be seen to successfully address the vulnerability of rural indigenous communities within SIDS to environmental hazards.

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