Indigenous Knowledge and Modern Technology in the Management of Natural Disasters: Exploring the Linkages

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Abstract

The increasing frequency of disasters, coupled with a number of emerging threats and trends, are leaving more people vulnerable to the effects of disasters and inflicting greater damage, loss, and dislocation on vulnerable people worldwide. According to the Centre for Research on the Epidemiology of Disasters (CRED), in 2008, more than 235,000 people were killed by disasters, 2.14 million affected, while the cost of disasters was over 190 billion US$. In developing the Hyogo Framework for Action 2005-2015, a review of progress made in implementing the Yokohama Strategy adopted in 1994 stressed the importance of disaster risk reduction being underpinned by a more pro-active approach to informing, motivating and involving people in all aspects of disaster risk reduction in their own local communities. After the 2004 Indian Ocean Tsunami, two success stories emerged, bringing new interest to the concept of indigenous knowledge. The Simeulueans living off the coast of Sumatra, Indonesia and the Moken, living in the Surin Islands off the coast of Thailand and Myanmar both used knowledge passed on orally from their ancestors to survive the devastating tsunami. According to Shaw et al. (2008), in spite of increased investments in the area of disaster management in recent decades, the losses continue to mount. There is an evident gap between practice and policy. The need to bridge this gap with adequate recognition of the domain of indigenous knowledge and local coping capacities is very urgent. Shaw, et.al. (2008), avers that there is a strong need to recognize the potential of community knowledge and actions, and of switching to a bottom-up approach that uses appropriate community practice as the base for policy formulation. This paper will review secondary sources of data related to areas such as use of modern technology and indigenous knowledge in natural disaster management. The relationship between indigenous knowledge and natural disasters has developed more interest in recent years. The new discussions around indigenous knowledge highlight its potential to improve disaster risk reduction policies through integration into disaster education and early warning systems. Modern technology has also been employed in disaster risk reduction with its own level of success. However, the questions that this paper begs to ask are; what are the linkages and how can the two approaches interlink in enhancing disaster risk reduction? This is the crux of this paper that

looks at natural disasters by arguing that both the application of modern technology and indigenous knowledge can present a viable option as an effective approach to disaster management.

Key words: Indigenous knowledge, Hazard, disaster, disaster risk reduction, disaster management and mitigation.

1. Introduction

According to the World Risk Index, six out of the world's ten highest disaster risk countries are in Asia and the Pacific. In the first decade of the 21stcentury, more than 200 million people were affected and more than 70,000 people were killed annually by disasters caused by natural hazards in the region, which represent 90% and 65% of the world's total, respectively (Hiwasaki. et. al., 2014)

A hazard is defined as a “source of danger that may or may not lead to an emergency of disaster and it is named after the emergency/disaster that could be so precipitated. Each hazard carries an associated risk which is represented by the likelihood of the hazard leading to an actual disaster event and the consequences of that event should it occur (National Governors Association,1982).

The World Conference on Disaster Reduction held in 2005, observed that in Africa, disasters are a major obstacle to the African continent’s efforts to achieve sustainable development, especially in view of the region’s inadequate capacities to predict, monitor, deal with and mitigate disasters. This is the key concern of this paper that seeks to explore how indigenous knowledge and modern technology can be harnessed in order to mitigate the consequences of disaster.

Espesor J. C (undated) argues that people in developing countries are particularly vulnerable to disasters as they are more exposed, have lower coping capacities and are less prepared.

Huho and Angawa (2008) adds that in developing countries, any disaster can interrupt essential services, such as health care, electricity, water, sewage/garbage removal, transportation and communications. The interruption can seriously affect the health, social and economic networks of local communities and countries. Additionally, disasters have a major and long-lasting impact on people long after the immediate effect has been mitigated.

Therefore, local, regional, national and international organizations are all involved in mounting a humanitarian response to disasters by preparing disaster management plans. These plans cover prevention, preparedness, relief and recovery.

The methodology used in this paper is mainly a review of secondary sources of data. The materials selected as a source of secondary data reviewed both indigenous and modern/scientific knowledge in disaster management and to some extent disaster risk reduction. They were majorly drawn from expert articles, reports and materials from UNEP and UNESCO. Therefore the information gathered was relevant to the objective. The material finally collected and used is captured in the references.

1.1 Justification/Rationale

Hiwasaki, et.al. (2014) points out that the 2004 Indian Ocean tsunami has been credited with sparking interest in integrating indigenous knowledge with science for disaster risk reduction, and many such efforts have been undertaken worldwide. In Vanuatu, participatory volcanic hazard awareness and education that incorporates traditional knowledge with volcanology has been developed for disaster-preparedness planning. In Washington State, USA, Native American oral history has also been incorporated into earthquake and tsunami hazard education.

By relying on indigenous knowledge, the communities are able to anticipate most of the disasters that afflict them. Disaster prediction and early warning leads to preparedness and other responses, and when the disaster impacts are brought under control recovery starts (UNEP, 2008). However, Nakashima, et.al (2012) argues that in recent years there has been a growing awareness that scientific knowledge alone is inadequate for solving the climate crisis. In particular, the indigenous or traditional knowledge is increasingly recognized as an important source of climate knowledge and adaptation strategies. This is the interest of this paper which reviews literature on both indigenous and modern/scientific knowledge in disaster management to establish the linkages.

2. Literature Review

2.1 Indigenous Knowledge

Mascarenhas (2004:5) cited in Maferetlhane (2012) gives a definition of Indigenous Knowledge as the total sum of the knowledge and skills which people in a particular geographical area possess, and which enables them to get the most out of their natural environment. Such knowledge and skills are passed down from previous generations. The passed-on knowledge and skills are then adapted and added to by the new generation, in a constant adjustment to changing circumstances and environmental conditions. Such knowledge when it is well preserved can be of great use especially in a time like now when the effects of climate change has made weather prediction a challenge. However, with indigenous knowledge, it is still possible to predict an oncoming disaster. However, according to UNEP (2008), indigenous knowledge is much more complex. In fact, a variety of terms have been used to describe this form of unique knowledge. These have included such terms as "local knowledge," "traditional knowledge," "indigenous traditional knowledge," "indigenous technical knowledge", "traditional environmental knowledge", "rural knowledge", "traditional ecological knowledge", and so forth. However, these terms have similar meanings.

Nakashima, et al. (2012) refers Indigenous or traditional knowledge as the knowledge and know-how accumulated across generations, and renewed by each new generation, which guide human societies in their innumerable interactions with their surrounding environment. Therefore indigenous knowledge can be referred to as that localized knowledge, which has been passed over from generations and has enabled the local communities to cope with various natural disasters. Indigenous knowledge may not be replicated in other areas since it may not be applicable in a different context but at the same time a lot can be borrowed to inform modern technology especially in disaster preparedness.

2.2 Use of indigenous Knowledge in Disaster management

Since the 1990s, local and indigenous knowledge has received increasing attention in the fields of natural resource management, disaster risk reduction, and climate change adaptation. In the disaster risk reduction field, the 2004 Indian Ocean earthquake and tsunami has been recognized as a turning point, when specialists and scientists began to show interest in such knowledge. However, local and indigenous knowledge is yet to be included in policies on disaster risk reduction or climate change adaptation, and the wealth of documented knowledge and practices have not led to increased efforts to make use of this knowledge to enable communities to increase their resilience (Baru, 2014).

However according to Shaw et al. (2008) cited in Baru (2014), points out the four primary arguments for including local and indigenous knowledge in disaster risk reduction policies. First, indigenous knowledge can be transferred and adapted to other communities in similar situations. This is applicable in situations where communities are living in a similar situation but use different ways in managing disasters. For instance communities living along shore lines can share indigenous knowledge of how to predict and recover from tsunami. A case in point is the December 2004 Tsunami that affected both Simeulue and Nias. The Simeulue, however, only suffered a small number of casualties compared to other areas. When the earthquake occurred on 26 December 2004, the inhabitants of Simeulue knew that they had to evacuate to higher ground, as there was the possibility of a tsunami. This reaction to the earthquake minimized the potential devastating impact of the tsunami. Secondly, incorporating indigenous knowledge encourages community participation and empowers communities in reducing disaster risk especially in situations where communities use trees and animals to predict drought and floods; third, indigenous knowledge can provide invaluable information about the local context and more so the capacities of the communities in dealing with disasters; and lastly the non-formal means of disseminating indigenous knowledge can serve as a model for education about disaster risk reduction. This paper focuses on indigenous knowledge that is evidence supported rather than just use of myths which are passed from one generation to the other. The examples cited below have been relied upon by communities in predicting weather patterns and hence being able to manage disasters in the affected areas.

2.3 Examples of Local and indigenous knowledge from selected communities in East Africa

Drought and floods associated with heavy rains are some of the disasters which are experienced in East Africa region. Traditionally, the local communities depended on indigenous knowledge in predicting the weather patterns. As indicated earlier, Indigenous Knowledge includes experience, information and the insights of people. It is about how people experience and use this knowledge in their everyday lives and therefore goes beyond mere folklore as seen in the examples cited below from Kenya and Tanzania.

Mulenga (2010:22) cited in Maferetlhane (2012), in a study in Kamaroja, Uganda, reported the use of Indigenous Knowledge in Disaster Risk Reduction by citing various examples;
Cluster of six stars: cluster-relationships with the moon can be used for the prediction of bad years.
Birds: migratory patterns of birds are good sources of information on seasons, for example, the arrival of a certain group of birds signifies that rains can be expected shortly, and that there will be a good harvest.
Rats: when rats are plentiful, it is an indication of drought the following year.

Trees: if trees flower/produce a lot during a dry season, this is an indication/prediction of drought the following year; and animals “kneeling”, when drinking water is an indication of a bad year. These specific observations can be easily passed from one generation to the other and can also be shared with meteorological departments to compliment the use of modern technologies.

The Nganyi clan of Bunyore in western Kenya is known for their powers in predicting rain. The clan has been associated with community rainfall activities for over 100 years, and they have three shrines where they worship and communicate with their ancestors and gods for the purposes of monitoring and predicting rain. Within the shrine there exist certain plants, reptiles, birds and insects that benefit from the conserved environment. The shrines are sanctuaries for nature conservation and they have been gazetted by the Kenya government as protected shrines.

People believe that the Nganyi clan can make or stop rains, lightning and hailstorm. They take their weather advisories seriously and pay some fees to the family at the end of each season in the form of a share of their harvest. The clan perfected their rain-prediction art through observation of vegetation, trees, reptiles, birds and insects in the shrines. The Bunyore people and surrounding communities depend more on weather advisories from the clan than from the meteorological department. They are widely consulted. They provide the community with information, for instance, on when to start preparing the land for planting, and when to undertake certain ceremonies such as burials and weddings (UNEP, 2008). The above examples show that by relying on indigenous knowledge, the communities are able to predict most of the disasters that afflict them. Disaster prediction and early warning leads to preparedness and other responses, and when the disaster impacts are brought under control recovery starts. For example, using indigenous knowledge to divine water, the community might dig wells to reduce its vulnerability to drought in future (Ibid.).

A study by Elia et al. (2014), in Tanzania found that the local farmers use the morphological features of trees locally known as Mgole to predict weather. Apart from being used to predict rainfall, the Mgole tree is used to indicate a good or bad year; with either sufficient or inadequate rain. The study further established that the Mgole tree possesses a unique feature that indicates the onset of rain as the tree grows upright in the dry season and, when it bends, it signals the imminence of rainfall.

Similarly, Msonankanga is a seasonal plant which has an exceptional feature observed by the locals that indicates the change of season: the plant grows tall at the start of rain and is short when there is no rain. Such kind of observations are very handy in dealing with disasters especially when the tree does not grow tall, the local community starts preparing for a drought season by ensuring they have ways of getting more food and hence reducing the effects of drought.

3. Modern/Scientific technologies in disaster management/ risk reduction

Science is knowledge obtained through study or practice. For disaster risk reduction, scientific capacities are interpreted broadly to include all relevant matters of a scientific and technical nature, where science is considered in its widest sense to include the natural, environmental, social, economic, health and engineering sciences (Southgate, et al., 2013). The Scientific and Technical Advisory Group considers it essential to demonstrate by 2015, which apparently is coming to a close, that science is routinely used to inform disaster risk reduction and therefore holds a key place in the Post-2015 Hyogo Framework for Action. According to Southgate et al. (2013) science can be applied to mitigate risk and vulnerability throughout the whole of the risk reduction cycle: through prevention (where possible), prediction and early detection to resilient systems for response and recovery. Sahu (undated) argues that information, communication, and space technologies (ICSTs) provide vital support for disaster management in many ways: observation, monitoring, data collection, networking, communication, warning dissemination, service delivery mechanisms, GIS databases, expert analysis systems, information resources, etc. ICSTs, especially remote sensing, have successfully been used to minimize the calamitous impact of disasters in all phases of disaster management. Fabiyi et al. (2013) further supports this as he argues that one of the approaches approved by the United Nations is the use of space technologies for disaster reduction and management.

In flood management the modern dominant approaches which have been used include engineering/structural approach and non-engineering flood management approach. Fabiyi (ibid) asserts that engineering management approach entails the construction of dams, embankments, drainage channels and regular evacuation of the water ways including dredging of the river beds. The non-engineering approach to flood disaster management includes but is not limited to: flood plain management, flood plain zoning, flood forecasting, flood disaster preparedness plan, flood proofing and flood insurance.

3.1 Examples of Modern knowledge for selected Disasters in the United States

In mitigating disaster, the United States have made great strides in reducing the number of deaths that occur in natural disasters. Through building codes, warning systems, and public education, the number of deaths and casualties from natural disasters in the last century has significantly declined.

According to George (2013), in recent years, significant advances have been made in hurricane tracking technology and computer models. The National Hurricane Center in Miami, Florida now tracks tropical depression. Once the tropical depression grows to the strength of a tropical storm mph, the storm officially becomes a hurricane. The National Hurricane Center uses aircraft to observe and collect meteorological data on the hurricane and to its movements across the Atlantic Ocean. It also uses several sophisticated computer models to predict the storm's path. These predictions are provided to local and state emergency officials to help them make evacuation decisions and to pre-deploy response and recovery resources.

Additionally (ibid.), the National Hurricane center operates a computerized model, called SLOSH (sea, lake and overland surges from Hurricanes) to estimate storm surge heights and winds resulting from historical hypothetical or predicted hurricanes. When making calculations, SLOSH takes into account pressure, size, forward speed, track and wind. The model's output is a colour-coded map indicating storm surge heights for defined areas in feet above the model's reference level. These calculations are applied to a specific location shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads and other physical features. When SLOSH is used to estimate storm surges from predicted hurricanes, forecast data are entered every 6 hours over a 72 hour period and updated as new forecasts become available.

However, technological disasters, such as the Oklahoma city bombing and the terrorist attacks of September 11, 2011, are not as easy to analyze. There is much speculation about how improved intelligence and security could reduce the human effects of these disasters from a prosperity perspective; many people believe that some reduction in impacts could be achieved through application of traditional mitigation techniques such as improved building construction for blast effects like in the case of Blaan in Philippines. In Africa, such information on traditional techniques can be obtained from the local residents (indigenous) and then modern technology that has been applied elsewhere can be adopted accordingly.

According to George (2013), to be comprehensive, a hazard risk management effort must look not at each hazard individually and irrespective of the others but rather at the entire hazards portfolio as interconnected and as each hazard having an influence on the effects and risks of the other. This is the crux of this paper that seeks to explore the link of both indigenous and modern technology. Indigenous knowledge will provide historical and current disaster events which will in turn determine the most appropriate technology to be adopted in a contextualized version. This calls for disaster managers to adopt the bottom up approach by getting first-hand information from the local residents as a basis of determining the appropriate technology that the locals can identify with as it is more sustainable.
The relationships between hazards and their associated risks are incorporated into the risk assessment and analysis processes in order to ensure that communities or countries employ a comprehensive risk management programme that results in greater reduction in lives lost and property damaged. There are various approaches to developing a risk assessment methodology ranging from qualitative to quantitative as well as several computer-based models for natural hazard risk assessment that have been developed for individual hazards such as earthquakes, floods, hurricanes and landslides.

For instance, three months following the devastating Indian Ocean tsunami in 2004, scientists worked together with policymakers to form an international commitment to develop an Indian Ocean Tsunami Warning & Mitigation System (IOT WS). Computer models were developed that simulate tsunami impacts on communities; and satellites could now transmit signals to high-speed computers, empowering humans to issue local and pan-oceanic tsunami warnings in minutes. The gains in tsunami preparedness were demonstrated during the 12th April 2012 magnitude 8.5 earthquakes offshore of northern Sumatra, Indonesia. Although no tsunami eventuated, due to the large magnitude and location, a tsunami warning was issued in several countries. In Banda Aceh, where most of the tsunami-related deaths occurred in 2004, over 75% of the population started to evacuate soon after the earthquake (Southgate , et al., 2013).

4. The linkage

The vital role that local knowledge and practices can play in reducing risk and improving disaster preparedness is now acknowledged by disaster risk reduction specialists, especially since the 2004 Indian Ocean earthquake and tsunami. Nevertheless, they have yet to be customarily used by communities, scientists, practitioners and policy-makers. Local and indigenous knowledge needs to be integrated with science before it can be used in policies, education, and actions related to disaster risk reduction and climate change.

This involves a process for integrating local and indigenous knowledge related to hydro-meteorological hazards and climate change with science, developed through a project implemented among coastal and small island communities in Indonesia, the Philippines and Timor-Leste. The process involves observation, documentation, validation, and categorization of local and indigenous knowledge, which can then be selected for integration with science.

This process is unique in that it allows communities to :
(1) identify knowledge that can be integrated with science, which could then be further disseminated for use by scientists, practitioners and policy-makers, and
(2) safeguard and valorize those that cannot be scientifically explained. By introducing a process that can be used in other communities and countries, it can promote the use of local and indigenous knowledge to enable communities to increase their resilience against the impacts of climate change and disasters.

Local indigenous knowledge, observations, and practices related to disaster risk reduction and climate change adaptation have been well documented. It is, however, only in recent years that both scientists and practitioners have paid serious attention to actually using local and indigenous knowledge and practices to increase communities′ resilience against the impacts of climate change and disasters, and to fully integrate such knowledge into scientific research, policy-making, and planning.

Indigenous knowledge is already seen as pivotal in fields such as sustainable development, agro forestry, traditional medicine, applied anthropology, biodiversity conservation and natural resource management, and many are expecting this knowledge to play a prominent role in climate science and in facilitating adaptation to climate variability and change (Nakashima, et al. 2012).

In order to engage indigenous knowledge productively in development, Agrawal (1995) cited in Mercer et.al, (2009) argues that there is a need to move beyond the dichotomy of indigenous versus scientific and work towards building bridges across the indigenous and scientific divide. This requires parity and integration between traditional and scientific knowledge systems, demanding a mutual understanding of the cultural, material and epistemological basis of each.

Researchers today concur that Indigenous knowledge and modern science complement each other. In Dondeyne et al., (2003), for example, bridging local farmers' and scientists' knowledge through participatory research led to the use of more appropriate technologies. The knowledge of local and indigenous peoples is increasingly recognized as an important source of climate knowledge and adaptation strategies. Nakashima, et al. (2012), avers that indigenous observations and interpretations of meteorological phenomena have guided seasonal and inter-annual activities of local communities for millennia. This knowledge contributes to climate science by offering observations and interpretations at a much finer spatial scale with considerable temporal depth, and by highlighting elements that may not be considered by climate scientists (Nakashima, et al., 2012)

A report by World Bank (2009) indicates that early warning systems combine tools to collect and evaluate weather or other data and communication networks to disperse warnings about imminent hazards, such as rainfall-induced flooding or tsunamis. However, in developing countries means of disseminating hazard warnings are limited as communication systems such as use of mobile phones held by few residents become overloaded and unusable after major hazard events due to high call/text volumes; radios are likely the most feasible and widespread communication method. In such situations, indigenous knowledge is likely to be used in complementing the modern early warning systems which in this case do not meet the needs of the community.

Modern science is therefore more acceptable to the indigenous communities if it is integrated with what they are familiar with. Modern weather forecasts, for instance, may be more credible to the communities if ways are found to integrate them with indigenous knowledge that they have relied on for generations to predict and cope with droughts, floods, and other natural hazards. A case in point is the experience with peasant farmers who listen to weather forecasts on radio by the meteorological department but at the same time still prefer to rely on their own traditional knowledge of when to start planting. The more the “scientific” forecasting deviates from traditional knowledge the less it is used for planning purposes by the indigenous communities

Southgate (2013) cites an example from Bangladesh where flooding is common during the yearly monsoon rains and has significant impact on health, the economy and development. A project to develop and apply such monsoon flood forecasts was undertaken between 2000 and 2009. In 2007, six flood-prone unions were developed as pilot sites for community-level use of the forecasts. Community leaders were trained to receive forecasts by cell phone and to use local landmarks to express the likely level of flooding in terms that are clear and useful for villagers. Community leaders advise action such as telling farmers to harvest their crops or take cattle to safety, and telling households to store water, food and personal

belongings ahead of a flood. This example shows a clear link between indigenous and scientific knowledge, where use of local landmarks is used as a support system.
The World Conference on Disaster Reduction in 2005, resolved that it is important to develop early warning systems that are people centered, in particular systems whose warnings are timely and understandable to those at risk, which take into account the demographic, gender, cultural and livelihood characteristics of the target audiences, including guidance on how to act upon warnings, and that support effective operations by disaster managers and other decision makers. This kind of system is possible where indigenous and modern/scientific knowledge complement each other. This is because, for many years, indigenous communities have learnt to adapt to gradual change and adjust their livelihood strategies. It is this knowledge that should 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. Indigenous knowledge can thus provide contextualized information through the established channels of communication as a way of complimenting each other. Failure to make use of such knowledge within disaster risk reduction has continuously contributed to the current circumstances where indigenous communities are increasingly vulnerable to environmental hazards.

5. Conclusion

From the discussion above, both indigenous and scientific knowledge in disaster management are important given that both types have been used and different levels of results achieved. Both indigenous knowledge and modern/scientific knowledge can also be context specific, be applied in similar situations and achieve the same results. With the current climate change, in some situations indigenous knowledge may be said to be unreliable but at the same time modern scientific knowledge can learn a lot from the indigenous people who understand the natural signs prevalent in the area in a better way. A case in point is a scenario in Kenya where rain is generally not expected in January but a different scenario was experienced this year. Consulting indigenous knowledge experts will go a long way in dealing and predicting disasters associated with climate change. An example is the use of specific groups like fishermen to predict weather patterns and women who are mainly farmers in Africa
Contemporary ideas of disaster risk reduction continue to advocate the scientific approach, ignoring the significance of indigenous knowledge and this can be detrimental to the process of disaster risk management. It is important that the gap between these two approaches is closed and integrated in a culturally compatible and sustainable way which benefits both

hazard scientists and the indigenous communities. Engaging the local community in discussing their vulnerabilities to the environment and how they apply indigenous knowledge is a key step in building the linkage between indigenous and modern knowledge.

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