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## Integration of Indigenous and Scientific Technology in Disaster Risk Reduction Education in Kenya; A Framework for Sustainable Development

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**Abstract:**

*Vision 2030 aims at transforming Kenya into a newly industrialized, middle income country, providing a high quality life to all the citizens in a safe and secure environment by the year 2030. The vision stands on three pillars, social, political and economic with Science, Technology and Innovation as their foundation. Hydro-meteorological disasters in fragile ecological zones in Kenya have destroyed all the development made in a long time. Disaster risk reduction education is the inoculation to the havoc that these disasters cause. Disaster risk reduction is a multi-sectoral facet and aims at reducing peoples' vulnerability to disasters that exacerbate poverty, providing a just society, clean environment and upholding human rights. A lot of effort has already been put in place by state and non-state actors to reduce Budalangi flood plains community vulnerability to floods. However, indigenous knowledge on flooding and River Nzoia regime, the soil science has not been factored in the intervention measures. The scientific technological knowledge on early warning signs, vulnerability analysis, and mapping of the flooding given to the community is differentiated and does not integrate the indigenous technological knowledge. There seems to be a disconnect between the community's indigenous knowledge and modern scientific technology given to them in terms of early warning signs and development of resilience to floods. Furthermore, there is no framework for hybridization of indigenous and scientific technology in disaster risk reduction education. This study has recommended a nexus of indigenous and modern scientific knowledge and technology as the antidote to the continuous suffering of the communities in fragile hydro-meteorological climatic zones for sustainable development.*

**Keywords:** *Disaster risk reduction, hydro-meteorological climatic zones, indigenous knowledge, scientific technological knowledge, sustainable development*

### 1. Background to the Study

The relationship between Indigenous Knowledge (IK) and disasters has developed more interest in recent years. Due to the massive size of the Indian Ocean Tsunami, the experiences of communities such as the Simeuleans and the Moken, who both relied on IK for survival, received enormous international attention. Their stories continue to be disseminated and celebrated through UN publications, newspaper articles and television news programs. This has initiated some discussion on the possibility of improving disaster risk reduction (DRR) education and incorporating IK into early warning systems and DRR.

Specifically, the UN has triggered this consideration in several of its publications. For example, Priority 3 of the Hyogo Framework for Action 2005-2015 which focuses on education and knowledge, considers IK as a means of building a culture of safety and resilience. It designates one of its key activities to the importance of information management and exchange, and highlights the use of "relevant traditional and indigenous knowledge and cultural heritage" to be shared with and adapted to different target audiences. Further, as is stated in the UN publication on Lessons For a Safer Future: Drawing on the experience of the Indian Ocean Tsunami Disaster: "It is important to incorporate traditional wisdom and local knowledge into future disaster risk reduction strategies and to ensure that such knowledge continues to be communicated through generations and to migrants and new comers to the affected areas." In addition, the World Conference on Science – Framework for Action, held in Budapest 26 June - 1 July, 1999, emphasized the need for governments to support collaboration between traditional knowledge holders and scientists as a means of exploring the relationships between the different knowledge systems and foster mutually beneficial linkages.

In the Asia-Pacific region, the consideration of IK to inform and improve disaster risk reduction has accelerated in recent years, marked by the work of several organizations. UNESCO has performed substantial work relating to IK through their cross-cutting programme entitled Local and Indigenous Knowledge Systems (LINKS). Their Andaman Pilot Project aims to preserve IK of the Moken people living in the Surin Islands off the coast of Thailand and Myanmar, focusing on incorporating that knowledge into natural resource management and disaster risk reduction policies. UN/ISDR, in collaboration with Kyoto University have a

publication compiling cases from the region where IK was used to survive, cope or reduce risk from natural disasters. The publication is entitled *IK for Disaster Risk Reduction: Good Practices and Lessons Learned from Experiences in the Asia-Pacific Region*.

The SAARC regional center, in collaboration with ADRC, has begun an initiative which will collect valuable IK practices in the South Asian region. Finally, many NGOs throughout the region have been working to explore and document IK in an effort to better encourage the integration of this knowledge into disaster risk reduction policies. Despite the growing efforts and enormous achievements relating to IK and DRR, there has been a further demand for more synergy between organizations and researchers working on the topic, as well as a greater effort to integrate IK with Scientific technological knowledge then link practice to policy.

As Kenya strives to achieve the Vision 2030, the first five year medium term has just been completed and evaluation of the same is expected. Vision 2030 is the country's blue print covering the period 2008-2030. It aims at transforming Kenya into a newly industrialized, middle income country, providing a high quality life to all citizens in a safe and secure environment. It is expected that Vision 2030 through the social, economic and political pillars with Science, Technology and Innovation as their foundation, will lead to the realization of the Millennium Development Goals. The social pillar seeks to build a just and cohesive society with social equity in a clean and secure environment. The economic pillar aims at improving the prosperity of all Kenyans through economic development. The political pillar aims at realizing a democratic system founded on issue-based politics, respecting the rule of law and protecting the rights of every individual Kenyan society.

Disasters destroy all the developments that have taken years to build. Hydro-meteorological disasters are perennial in most parts of Kenya and cause massive destruction of lives and livelihoods exacerbating poverty. The communities that live in fragile ecological zones such as Budalangi flood plains are vulnerable to the disasters; floods in particular. If not put under check, hydro-meteorological disasters can make the realization of Vision 2030 a pipe dream. Disaster risk reduction education is a multi-sectoral facet and aims at reducing poverty, building a just society, a clean environment and upholds human rights. It is therefore the inoculation to the havoc that disasters cause. A nexus of indigenous and modern scientific technology through the culture of disaster risk reduction is the antidote to the continuous suffering of the communities in hydro-meteorological climatic zones like Budalangi flood plains.

A study done by Mukuna(2013) on evaluation of the integration and implementation of the disaster risk reduction education in Budalangi flood plains primary schools revealed that perennial floods that have made the community to become poor and vulnerable are caused by several factors. Among them is lack of knowledge on building resilience against floods so as to inculcate the culture of safety in the community, slow pace of implementation of the Education in Emergency policy on changing the primary school curriculum attributed to leadership and political will, no continuous professional development of teachers on integration of DRR into the curriculum, non-examination of DRR in national examinations, no specific policy by the Ministry of Education on integration of DRR into the primary school curriculum. It also emerged that a lot of effort has been put in place by state and non-state actors to reduce people's vulnerability to disasters and poverty.

However, indigenous knowledge on flooding, River Nzoia regime and the soil science have not been factored in the intervention measures. The scientific technology on early warning signs using Remote Sensing satellites, vulnerability analysis and mapping using Geographic Information Systems and Geographic Positioning Systems on floods, given to the community is differentiated and does not integrate the indigenous technology from the local community. There seems to be a disconnect between the community's indigenous knowledge and modern scientific technological knowledge especially on early warning signs on flooding. Furthermore, the IPCC report (2007) and Mutimba et.al, (2011) have warned that satellite reports on Climate change have indicated that the lake region will experience increased rainfall by 2015. Research on land use patterns along River Nzoia by Onywere (2011) and River Nzoia mouth morphology (2012) indicate that flooding will continue for a long time. Disaster risk reduction education therefore needs to be embraced by the community. There is a great need for hybridization of indigenous and scientific technological knowledge to enrich DRR education being given to the community. As for now, there is no framework to integrate indigenous and scientific technological knowledge in DRR education so as to reduce people's vulnerability and poverty for sustainable development. For sustainable development, Indigenous knowledge and scientific technological knowledge need to be integrated.

In Kenya, there is little or no documentation on the existence and importance of indigenous knowledge and strategies related to DRR education. This paper is suggesting a framework for the two technologies as an effective tool for DRR education and alleviation of poverty for sustainable development. The framework has used existing indigenous and scientific knowledge in Budalangi flood plains to enhance the ability creating a culture of safety and reducing the community's vulnerability to floods. It is hoped that this framework will lead to increased collaboration among stakeholders and lead to organized DRR planning.

## **2. Linking Indigenous Knowledge to Disaster Risk Reduction**

Due to the increasing threat from natural hazards, many local, national and regional organizations have devoted themselves to developing early warning systems, to encouraging governments to prioritize disaster management, and to increasing communities' resilience to the future threats from disasters. However, despite recent progress and accomplishments, organizations and governments are still looking to improve disaster reduction strategies by learning from current disasters and the experiences of affected communities.

In 2005, in Kobe, 168 Governments adopted the Hyogo Framework for Action to build resilience of nations and communities to disasters by 2015, underlining thus the urgent need to shift efforts from only preparing for disaster response to focusing on reducing risk and vulnerability, and spelling out the specific responsibilities of Governments, international and regional organizations on how to do so. The UN/ISDR, which serves as the centre piece of the United Nations efforts to reduce the growing impact of natural hazards, brings together governments, civil society groups, academics, regional institutions, and the private sector to ensure a coherent approach to disaster risk reduction.

The Priority 3 of the Hyogo Framework for Action (HFA) focuses on education and knowledge, which considers indigenous knowledge as well to build a culture of safety and resilience. As one of the key activities under the HFA Priority 3, the importance of information management, exchange and highlight the use of “relevant traditional and indigenous knowledge and cultural heritage” to be shared with and adapted to different target audiences. Examining additional communities who have also used indigenous knowledge to survive difficult situations will provide an in depth understanding of what indigenous knowledge can provide to disaster risk reduction and why it is so successful in reducing risk.

Increasingly, the importance of local knowledge and practices has been highlighted in relation to environmental hazards and disasters by many international scholars (Mercer et. al, 2007). However, while in theory the importance of such work has been recognized, within the international community, the practical application generally only occurs on a small scale within communities of developing countries. This has resulted in NGOs and other organizations working with communities threatened by environmental hazards to promote indigenous knowledge as a great contribution to DRR education (Mercer et.al, 2007).

Indigenous knowledge is referred to as a number of ways of including but not limited to indigenous knowledge, local knowledge, traditional knowledge, indigenous technical knowledge and traditional environmental knowledge. It is a body of knowledge existing within or acquired by local people over a period of time through the accumulation of experiences, society-nature relationships, community practices and institutions and by passing down from one generation to another.

Indigenous knowledge is composed of technical, ecological and historical knowledge. Practices are done at the individual, household and community level and dependent on sociocultural belief systems of respect, reciprocity, sharing and humility. All these processes are influenced by state and non-state actors. Indigenous knowledge uses observation, forecasts, and adaptation and communication strategies. Indigenous knowledge is oppressed in a number of ways as a result of marginalization, powerlessness, violence and denial of existing knowledge. Indigenous knowledge is qualitative and geographically specific in contrast to scientific knowledge which is quantitative and more general (Dekens, 2007). On the other hand, scientific knowledge is global and very dynamic in nature. In most cases, indigenous knowledge is hidden and dismissed by scientific knowledge as inferior.

A deeper understanding of indigenous knowledge, its characteristics and controversial elements are essential if this knowledge is to be used to improve Disaster Risk Reduction education. The relationship between the local community and its specific natural environment is crucial when discussing natural disasters. Furthermore, the extended period of time a community has existed in a given environment expands the knowledge that comes from experience and practice. Indigenous knowledge and scientific knowledge provide a more “rounded understanding of natural and cultural environments and sustainable development potentials (Siltoe, 1998). DRR experts, practitioners and the international aid community as a whole have slowly come to the realization that the standard approaches to DRR, which focus on technological solutions (e.g. better surveillance techniques, high tech warning systems and stronger infrastructure), could be improved by taking indigenous knowledge into account.

Several studies have emerged which examine the value of indigenous knowledge for DRR in different situations. Some of these studies examine the specific knowledge of the community, extracting particular strategies to be used in other communities. Other studies make general arguments for the importance of indigenous knowledge as a whole, citing the benefits all indigenous knowledge has for the community and DRR projects working in that community. DRR now considers the value indigenous knowledge provides for the field.

First, a shift in thinking about DRR introduced the vulnerability approach to reducing risk, taking into account specific elements of the affected community. Secondly, DRR has increased its ties with the international development and sustainable development discourses, which have already recognized the value of indigenous knowledge (as early as the 1970s). Finally, several cases have emerged from large disasters (such as the Indian Ocean Tsunami in 2004) which show the success indigenous knowledge has had for reducing community vulnerability to disasters. Experts agree that the links between DRR and indigenous knowledge have seldom been made in either literature or practice (Denkens, 2007a). The consideration of social science perspectives i.e. knowledge originating within the communities, conflicts with the accepted position that advanced geophysical knowledge and technical systems are the most effective disaster response mechanisms (Denkens, 2007b). Specific practices and strategies which indigenous knowledge teaches can have added value to existing strategies.

Secondly, indigenous knowledge increases the participation of the affected community and empowers them to take the leading role in DRR. Thirdly, the knowledge contained in indigenous knowledge can help improve DRR project implementation and, finally, indigenous knowledge is disseminated by non-formal educational means which provides a successful model for other education on DRR. The role of indigenous knowledge in the participatory approach has two main values. First, using indigenous knowledge employs information the community already possesses, which is valuable to DRR. In most disaster-prone areas, the community has a history of experience with disasters, leading to an accumulation of information regarding how to predict, react to or recover from their impacts (Battista & Baas, 2004).

Further, recognizing indigenous knowledge is part of a shift from emergency management done for (and sometimes to) indigenous communities, to emergency management done in partnership with indigenous communities (Denkens, 2007a). Second, the recognition and use of indigenous knowledge can provide improved self-confidence for the community and allow it to deal with disasters on its own. Recognizing and sharing indigenous knowledge will confirm that its knowledge is valuable and will give its members’ authority over the process of risk reduction. This, in turn, will provide the enhanced security needed to respond immediately to incoming threats from disasters, since local community members are the first-responders.

A third argument for the value of indigenous knowledge for DRR is its help in improving project planning and implementation (Denkens, 2007b). Respecting and accounting for indigenous knowledge provides an understanding of local practices and context. A

project will be more effective if it takes into account the local peoples' economic, political, social and cultural understanding, to know what is acceptable and what is needed (Denkens, 2007a).

Thus, in order to successfully educate and communicate with an affected community, local beliefs, perceptions, knowledge and understandings must be considered through an examination of their indigenous knowledge and views of disasters (UNESCO, 2005). Further, the HFA asserts that indigenous knowledge is important in the context of information management and exchange. The one reference to indigenous or traditional knowledge in the text encourages nations to include indigenous knowledge in any information used in DRR education material (UNISDR, 2006). Indonesia and Lao PDR have integrated indigenous knowledge into DRR education so as to make curricula flexible and relevant to their contexts (UNISDR, 2011). This study investigated if indigenous knowledge has been integrated in the formal and informal curriculum development in Budalangi flood plains primary schools.

### **3. Methods of Integrating Indigenous Knowledge into DRR Education**

Indigenous knowledge is often passed down orally through stories and songs. This method of dissemination has proven to be very successful and emphasizes the importance of non-formal education, the dissemination of information through alternative methods outside of formal schooling, such as songs, stories, art and theatre (Baumwoll, 2008). DRR education, however, is often done by integrating information on disasters, vulnerability, and response strategies into formal education via school curricula. In recent years, DRR information has been increasingly disseminated in non-formal ways as well, including the use of stories, songs, folk art and performances as well as utilizing community leaders, religious organizations, community organizations and extra-curricular clubs.

Several international organizations and NGOs are involved in promoting the inclusion of DRR into the non-formal education sector. Examples from the Asia Pacific region include UNDP's work in India (UNPFII), Red Cross programs in Indonesia and Vietnam (UNISDR) and projects by Action Aid, Thailand (UN, 2004). CDBM is also a method of non-formal education since it educates the community about DRR policies and strategies outside of the formal education sector. Each of these arguments illustrates an important value of indigenous knowledge for DRR and more work is still needed to determine how to better integrate them into existing policies and practice. Nonetheless, the arguments do not provide a specific way to use the knowledge to help all communities affected by disasters.

Older members of the society who are respected by their community, often referred to as elders, are considered key knowledge carriers since many have extended experience in a location and have observed changes that have occurred throughout their lifetimes. Along with the memory of past events, elders provide the wisdom to interpret rare events. Their knowledge does not simply reflect the existing environment, but also grasps its historic development and its interaction with social and cultural changes within the community (Battista & Baas, 2004; UNESCO, 2005).

Many indigenous communities have a strong oral tradition, representing a primary way its knowledge is passed down through generations. One way this oral tradition manifests itself is in the form of these cultural traditions which often contain lessons and teachings. Cultural traditions can include stories, legends, songs, proverbs, ceremonies or rituals which both represent and are encouraged by the culture of a society. For example, many indigenous communities have creation and re-creation stories which relay the legend of how everything began (Siltoe, 1998). These stories often contain lessons about human behaviour or explanations of why certain things are the way they are. Indigenous knowledge systems often provide a sense of belonging to a location, an identity which involves the place and an ability to relate specifically to that place (Baumwoll, 2008). These characteristics allow for a more integrated approach to the environment, in that social and environmental relationships are interlinked and there is a deep kinship between the people and their local environment. In this study, the strategies of imparting the indigenous knowledge were established.

### **4. Types of Indigenous Knowledge Necessary for Integration into DRR Education**

Baumwoll (2008) has categorized the various forms of indigenous knowledge that need to be integrated into DRR education. Ecological knowledge holds particular value for DRR because it provides an ability to recognize and interpret warning signs, which can help to predict incoming disasters. Through identifying impending disasters, people can adapt to the changing circumstances and respond to disasters before it is too late. In the context of disasters, respecting and preserving the environment allows communities to reduce potentially harmful actions leading to disasters. By maintaining an awareness of the environment and not exploiting it or causing degradation, the potential for disasters to occur is much lower. She reports that the strong cultural and oral tradition of indigenous communities, manifesting itself in the form of stories, proverbs, legends and songs. These traditions reduce community vulnerability by educating the people on local risks, how to recognize warning signs, the impact of disasters and how to respond to impending disasters.

A second category of cultural traditions which can help reduce vulnerability to disasters include ceremonies and rituals. Ceremonies and rituals educate people about local environmental threats, can further foster an environmental ethic and help create social resilience within a community. Cultural traditions are important ways to share information about disasters because they receive more emphasis, more authority within the everyday lives of most people, and there is a stronger commitment to continue disseminating this knowledge. Ceremonies and rituals can also help encourage an environmental ethic. Many indigenous communities perform ceremonies which honour the spirits of the plants, animals and supernatural creatures, such as offerings. Ceremonies and rituals can also strengthen the social resilience of a community, maintaining close ties between community members who can depend on one another when a disaster strikes. If a community's identity is closely linked to place, there is more incentive to care for this place (Turner, 2005).

A strong commitment to remain in that place is also an advantage to DRR education. A commitment fosters a desire to dedicate time and energy to finding solutions to the problems posed by disasters. Communities may be more willing to invest in strategies to reduce risk or may even develop their own innovative ways given the long-term commitment. If there is no feeling of a connection to place, the community may move somewhere else where the disaster threat might not exist. In many cases today, communities do not have the choice to move away from their disaster-prone home, due to economic or social obstacles. However, several important challenges to keep in mind when exploring transferable IK. The value of IK is affected by changing environments due to climate change or development. Much IK is being lost since it is held solely by elders or men who are migrating away from the locality. Much of this knowledge is site specific and cannot be replicated in other contexts and many of the traditional strategies are less valuable for regional hazards, such as earthquakes, droughts and epidemics, which produce widespread and lagged interactive and cascading effects.

In management of River Nzoia basin, several factors have to be put in place in regard to indigenous knowledge; Climate, river regime and geo morphology, experience of particular type of disaster, Cultural context, socio economic context and the globalization. Key elements which belong to IK, include housing, food, environment, health, livelihood and land use. Both modernization and climate change have and will contribute to many shifts in the environment which will effect IK related to DRR education. Examples of these changes include increasing rainfall, higher temperatures, globalization, seasonal fluctuations, flash floods and increased information technology.

In regard to DRR policy emphasis needs to be put on hybridization of two different stakeholders, those of IK (individual, community, civil society, CBOs and local government), and those of scientific knowledge (scientists, researchers, technicians, government, institutions and external agencies). These two groups of stakeholders will need to work together in order to incorporate both types of knowledge into DRR policy. A dialogue is needed between the two in order to determine the best strategies. In addition, a community as a whole does not always hold the IK, sometimes there are specific groups or rural experts which are the only holders of this knowledge. These people must be identified in order to manage disasters IK for water resource management.

## 5. Methodology

This study adopted a qualitative methodology with a case study design. It employed various data collection tools such as Focus Group Discussions for parents in schools, In-depth interviews for NGO representatives, government officers and head teachers. Document analysis on school documents, textbooks, minutes of staff meetings, notices and memos, stakeholders' meetings. Data was collected on the Budalangi community's engagement in disaster risk reduction, vulnerability factors such as land use practices along the R.Nzoia, livelihoods, history of floods, housing. More data was collected on the type of indigenous and scientific knowledge available in the community especially on early warning signs to floods and social protection.

## 6. Results and Discussion

### 6.1. Indigenous Knowledge on Disaster Risk Reduction

The primary school teachers were asked to identify indigenous knowledge that can be useful in DRR education in Budalangi flood plain. Their responses were: history of floods and the river pattern of River Nzoia; early warning signs such as croaking of frogs, types of fruits, presence of ants, shedding of leaves of some trees and wind patterns; informal social protection measures like harmonious relationships with relatives who live on higher grounds, this relationship is a safety net for the safe keeping of documents, food and shelter during flooding; swimming lessons, especially for boys before flooding; food types, i.e early maturity seeds and flood resistant crops like sorghum; food storage i.e. high/raised granaries and finally, type of houses, i.e. simple temporal structures that can be rebuilt any time.

When asked if the indigenous knowledge is documented, 100% (n=96) answered in the negative stating that the knowledge is passed down from generation to generation through stories, myths and parables. A further explanation given was that there are special elders in the community who have this knowledge and that they train young people close to them to be specialists in the river's temperament. They are the ones who predict the weather and give early warnings signs. About 48% (n=46) of the teachers were not sure if the indigenous knowledge had been documented but 52% (n=50) accepted that the indigenous knowledge had been documented by researchers and NGOs working in the area. The only problem was that there wasn't a single book or report that had been published on the same. This implies that transferability and preservation of this IK is at risk. Most 86 % (n=83) of the teachers felt that indigenous knowledge on floods in Budalangi should be published in a book for all curriculum stakeholders to use while 64% (n=61) of the teachers agreed that integrating indigenous knowledge on floods with scientific knowledge would enrich the DRR curriculum taught to pupils in primary schools.

Communicating knowledge and information on disaster risks, prevention mitigation, interventions or adaptations is the nerve centre of DRR education. Early warning of the impending disaster saves lives and destruction of property. An open-ended question was posed to instructional supervisors seeking to know how they get information about the impending floods in the community. Some of the responses were as follows:

There is monitoring of the river flows on R. Nzoia by Kenya Meteorological department. When the water rises up to a certain level, KMD reports to the radio station called Bulala FM to communicate to the local community as a warning of impending floods. Secondly, the district commissioner works in conjunction with the meteorological department and they have established a local weather station for monitoring weather indicators for flooding. Thirdly, the community elders monitor the flow of the river and warn the community of impending floods. They have their indigenous knowledge on warning signs too. This information is usually

communicated to us when the DEOs office writes a memo to schools and instructing them to prepare to evacuate and move to designated primary and secondary schools that are on higher grounds so that learning continues. Such schools include Sigiri, Bulanda, Bulenica and Budalangi primary schools plus St. Anne's secondary school. (DEO Bunyala District).

We get to inform the community about flooding through the local leaders for example, when there is funerals in the community, the local leaders take the opportunity to warn people about floods. Bulala radio station also does the same. There are special people in the community with indigenous knowledge in the community who also monitor the water level and warn us to move." (Head teacher Sigiri primary school).

These responses indicate that knowledge and information sharing on early warning signs in Budalangi flood plain takes various forms that combine both scientific and indigenous technology. These include: monitoring of the water level on river Nzoia by both the local leaders and the Kenya Meteorological department; use of the local radio station (Bulala radio station) to announce the early warning; local leaders, including the District Commissioner, announcing the weather changes from the District weather station at Budalangi and DEO writing memos to schools warning about the onset of floods and preparation for evacuation to higher ground schools, this corresponds with what other researchers found out on information sharing on early warning signs, such as (Wisner, 2004; ISDR, 2010; Izadkhah, 2008).

### 6.2. Role of NGOs in Disaster Risk Reduction Education in Budalangi Flood Plain

The in-depth interview with some of the NGOs' officials on the theme on knowledge base and gaps regarding DRR education in Budalangi flood plains revealed that the NGOs were the pillar of DRR education. Non-state actors all over the World have played a very important role in disaster risk reduction education. There are several NGOs in Budalangi flood plain, each with its own Vision and Mission but all geared towards the same goal of reducing people's poverty and vulnerability caused by the flooding disaster and increasing their resilience or adaptation to disasters. The teachers, QASOs, DEOs head teachers and PTA representatives had all indicated that NGOs are the ones that had trained them on DRR education. The in-depth interviews gave an insight into the indigenous and scientific technological knowledge on disaster risk reduction in Budalangi flood plain.

- In regard to IK on early warning signs on impending floods, the BUCODEV officer reported that:  
Yes ... particularly when it comes to flooding. All over the world in flood prone areas, the communities have a wealth of knowledge in this disaster. However some of the scientists do not value this knowledge. But I can tell you, indigenous knowledge is the most reliable information you can rely on in disaster management. In 2011 a population of about 25,000 people was marooned in floods but we did not lose any life because of indigenous knowledge. Our people have done drills and they know how to swim, they know how to walk when it has flooded for example they can gauge the depth of the water using a walking stick. They also know that when a current is moving in one direction you have to move to the opposite direction. We also have a council of elders that monitor the river regime and sound early warnings of impending floods. We also have other monitoring indicators like fruits, stars appearing in February to March in a single line called "nyajinja". This also indicates that we are going to have a bumper harvest. Fruits that flower but don't bear seeds indicate a bumper harvest, thus the flooding water brings alluvial to the floodplain to add fertility to our soil. When we have a lot of mangoes, it is an indicator that God is going to supplement our food. There are some species of trees too that when they shade their leaves, it indicates that rains are coming. Voices of frogs too indicate the river will rise or fall. We also have certain species of birds that when they migrate to Budalangi it indicates that there is going to be heavy rains (crested crane). The council of elders also watches "Masaba" (Mount Elgon) and if they cannot see it when they climb on top of dykes then it means we shall have floods. It means that it is raining heavily upstream of River Nzoia. The United Nations incorporate the indigenous knowledge of the community with the Kenya Meteorological departments' information on early warning. They have point persons in several places along the river channel whom they liaise with. For example, they watch, if the river waters submerge some particular stones upstream in Mumias (Mr Thomas Mango, Programme Officer BUCODEV). Budalangi floods plain's community has indigenous knowledge on flood preparedness and adaptation. Community elders own this knowledge and transmit it informally to the next generation. The community members combine the indigenous knowledge with the scientific knowledge, especially on flood preparedness and early warning signs. This finding resonates with deliberations at the Global Platform (2009) conference on integration of indigenous knowledge into disaster risk reduction. This practice ensures the sustainability of DRR education strategies.
- Concerning housing as a major factor in disaster risk reduction, indigenous housing includes local materials, locally available technology and artisans, evolved over time, and influenced by local conditions such as culture and climate. Influences on housing can be local, including local resources, culture, the community's lifestyle and existing skill/technologies, as well as external, perhaps relating to the economy. Housing does not stand alone. With regards to preservation of this IK, its holistic property may make it difficult to transfer from place to place, and even from generation to generation, given the changing environments, the impacts of modernity and the way people live in their house over time. IK on housing is done with an objective of reusing existing local wisdom in order to reduce community vulnerability which may be increased with changing conditions. It helps promote sustainable development, especially with the integration of indigenous and modern technologies. It also allows for successful transition into modern societies. Finally, this knowledge is part of a cultural identity which should be preserved and celebrated.

However, IK on housing also faces certain challenges. These challenges include: the limited knowledge of disaster-safe practices among communities; the influence of modern material usage without professional knowledge; and the inability of local people to afford disaster-safe houses. That a multi-hazard approach must be taken for housing, utilizing the post-disaster phase for improving existing housing practices. There is need for research and development to improve performance further, proper documentation of all techniques, and education in communities about the importance of local traditional approaches for disaster-safe construction practices. Emphasis should be put on the importance of community control over their natural resources in order to allow inhabitants to adapt to changing environments.

Housing should be seen as a process rather than a product, where indigenous people build together and the knowledge develops into the house itself. Some participants emphasized the need for a national standard or building code, which would take into account IK. Since modern housing has a high status in many communities there is no respect for the traditional life styles. In addition, indigenous artisanship to carry out these IH techniques is fading. In many cases, a traditional form is being transferred, but it is either incompatible with the materials and technologies used or it is not applied in the correct way (such as applying the wrong orientation or location). There is a need for an increase in research and development as well as training and education relating to IH. Local tourism should be encouraged, which could help develop an interest in IH and generate good employment for local artisans who hold indigenous techniques. There is a need for increased awareness about this knowledge and its value. Local resource management and decentralization of many of these processes should be improved in order to support the cultural identity of IH and utilize the indigenous techniques.

An NGO representative from LABET Kenya reported the following on housing and DRR education in Budalangi flood plains.

Our role is to empower individuals and small neighbourhoods on disaster risk management. We concentrate on community participation so as to build a culture of safety and ensure sustainable development for all. We therefore train the community through our capacity building programme on community based risk assessment, mitigation, planning and implementation processes, including building confidence and pride in being able to make a difference, pursue a disaster preparedness, mitigation as well as development issues at the local level. We also do resource mobilization and innovative mitigation solutions that are cost effective and sustainable. We do this by using traditional organizational structures, i.e. formal and in-formal. We involve local leaders in the capacity building activities. We also do public awareness in the local dialect. The CBOs and FBOs in Budalangi flood plain have been helpful in this regard.

Our other objective is to resettle the community back to their homes from the IDP camps. We have embarked on a housing construction project that is sustainable. We focus on people's knowledge more than physical infrastructure. The knowledge we have given to the community has brought confidence on house construction. The local masons have been trained on flood resistant building technology. We have gone further and established a mason's guild as an alternative livelihood option. We have incorporated indigenous knowledge on soil science and river regime in the construction process. We have incorporated local leaders and government practitioners in this endeavour.

Other than this we encourage community members to build the dykes because the government sometimes takes long to repair them. We embrace the indigenous and scientific technologies in flood forecasting and warning. We also build the community members capacity on disaster preparedness, planning, response and evacuation. We have plans for embarking on a land use project together with the ministry of agriculture and lands. (Programme officer, LABET-KENYA)

LABET-Kenya is involved in various disaster risk reduction activities in Budalangi flood plain, ranging from capacity building of the community to building confidence in them that they can manage the situated at hand to reconstruction of dykes by the community members. They are also involved in building safe environments by training masons on resilient housing. They integrate indigenous and scientific knowledge in early warning, planning, response and evacuation. This NGO has also not specifically targeted the school community to create awareness on Disaster Risk Reduction but housing construction as well.

### *6.3. Integration of Scientific Technological Knowledge into DRR Education*

Another in-depth interview with the program officer of Community Disaster Management Initiative (CODMI) sought to find out the role that CODMI had on disaster risk reduction education in Budalangi flood plains. This NGO integrated indigenous knowledge and scientific technological knowledge in DRR. The officer narrated;

CODMI started in 2007 with a desire to assist the Budalangi community members to reduce their vulnerability to the current floods and increase their resilience in the presence of disasters. We work with Western Kenya Community Driven Development and Flood Mitigation Programme (WKCDD&FMP) to do a vulnerability and capacity analysis of floods on the community using GIS and GPS. We also do mapping on flood preparedness in collaboration with Map Action (UK). We are heavily engaged with flood awareness campaign in partnership with the provincial administration. We do this through Bulala radio station and also public bazars (Mr. Canute Agwanda, Programme Officer).

From the foregoing in-depth interview, community vulnerability analysis on the impact of floods on them has been made a priority. The identification of risks through mapping the flood prone areas leads to flood awareness campaigns. This strategy has been used in India and America (Katrina) (Wisner, 2004).

Further interviews with the Map Action NGO on their role in DRR education revealed the following;

Our NGO focuses on Geospatial methods for disaster risk reduction in Budalangi flood plain. We have taught communities at the village level. We work in conjunction with WKCDD&FMP to implement a flood warning system which was initially based on reading from a network of gauges to build forecasts. Today, we have Bulala and RANET radio stations which offer warning signals and disseminate any other relevant information on flooding in the flood plain. Map Action has also trained community members on

fundamentals of Geographic Information Systems (GIS) and Geographic Positioning Systems (GPS). This is guidance on geospatial techniques for disaster risk reduction and response to disaster. This has helped the most vulnerable villages like Makunda, Najodi, Ragunga, Sibuka, Udeti, Naliasyong'o and Sigingi to be well prepared for the flooding disaster. The training has helped them to investigate the nature of the flooding, study vulnerabilities of the community and form strategies of mitigating the risks. It has helped to make village disaster response strategies to be more efficient and proactive. Restoring the community back to normalcy has also been made easier due to the baseline data before every flood and after floods. This data has helped to map out the most vulnerable villages (Program Officer- Map Action).

This revelation points out that the most vulnerable villages have been targets of capacity building in scientific technology as an early warning sign to flooding. These villages have people trained in GIS, GPS and in weather forecasting as well. They have village weather stations. There is however no mention of the site of the weather stations nor training of school community members in DRR education. This strategy has been used in Cambodia in DRR awareness and advocacy (RCC, 2009).

Another NGO working in Budalangi flood plain on disaster risk reduction is the Western Kenya Community Driven Development and Flood Mitigation Project (WKCCDD&FMP). This NGO focuses on Remote Sensing.

The WKCCDD&FMP has developed an elaborate system of floods warning for Budalangi community. Flood bulletins are produced on a daily basis and disseminated immediately to various stakeholders including the community. Hydromet data is collected from the field by the community data monitors and is relayed to the project headquarters daily for flood forecasting and archiving. The data monitors are provided with mobile phones and monthly airtimes to enable them communicate with the project data analyst everyday at 9.30 am. This data is received at the project flood diagnosis and forecasting centre situated at Kenya Meteorological Centre (KMD) headquarters in Nairobi where modeling and analysis is done to produce the flood warnings. The warnings are packaged in a bulletin and sent to stakeholders who include the provincial administration, government ministries, humanitarian organizations and community based organizations etc. These bulletins are sent at 12 noon on daily basis during the rainy season since 2008. These bulletins have helped stakeholders to prepare for impending floods.

The system is being upgraded with state of automatic data transmission equipment for monitoring the weather and river levels. This will help provide efficient warnings with the required lead time to warn the community to prepare. Weather patterns from 20 stations, 15 run by the project community monitors and 5 by KMD and river level data from three gauging stations run by the Ministry of Water and Irrigation, report data daily to flood forecasting centre. To produce warnings, additional evaporating data and rainfall forecast are provided by the KMD. The data collection is done between 8.30 to 9.30 am. A daily and monthly bulletin is then produced.

To reach stakeholders, the project is still designing and developing more especially on how to package the warnings to the affected community. Currently the project is using the KMD radio installed at Budalangi (RANET) emailing system to all stakeholders displaying on the World Wide Web emailing to the Bunyala DC office and direct emailing to the Lake Victoria North Water Resources Management Authority (LVNWRMA).

Presently the project and KMD are upgrading the data collection and transmission in the region with the procurement and installation of automatic telemetric gauges for weather and river levels for reporting the condition in the basin in real time. The automatic telemetric river gauging stations and an acoustic Doppler Current Profiler (ADCP) are sending data to the forecasting centre by use of General Packet Radio Services (GPRS) technology. The flood warning team evaluates and calibrates the equipments. WKCCDD&FMP has formed a stakeholders forum for Budalangi together with UN agencies (UN-OCHA, UNICEF and World Food Programme) international and local NGOs. They have also trained Trainer of Trainers (TOT) in disaster risk reduction for Budalangi community at Fair view hotel Busia in 2009 (WKCCDD&FMP-Early Warning Systems Officer at Kakamega).

From the above in-depth interviews, it is clear that NGOs have taken a leading role in training the Budalangi flood plain community's members in DRR education but they have not particularly zeroed-in on primary schools. It is also true that different NGOs have disseminated different knowledge on DRR. This could probably be due to their policies and funders. Sponsors of NGOs target specific problems. In as much as all of them aim at reducing people's poverty and vulnerability and increasing resilience and sustainable development, their work is not uniform. None of the NGOs has used schools as stipulated in the Hyogo Framework for Action's article 3. This means that DRR education in the community is inadequate, scarce and sporadic. The NGOs do not have a uniform curriculum that they are using. Addressing this problem through schools is the best solution to perennial floods that have made Budalangi flood plain's communities very vulnerable and poor.

A visit to the Kenya meteorological department also revealed very positive measures towards disaster risk reduction. The document analysis revealed that there is an established flood forecasting and dissemination mechanism. This network encompasses the National Disaster Management Authority (NADIMA), Disaster Operation Centers (DOCs), water management authority, chief flood forecasting office in Nairobi, Kenya Meteorological Department (KMD), rainfall stations, the national meteorological department on River Nzoia, disaster management committees and Bulala radio station. Various scientific technological knowledge are employed.

#### *6.4. Recommendation: The Framework*

This study has recommended a framework that will alleviate the suffering of the Budalangi flood plains community to flooding if adopted and implemented in totality. We realize that floods don't just happen but are as a result poorly managed interactions between the environmental hazards and the community that does not have adequate knowledge and skills on coping with the risks. Other vulnerability aspects emerge from the interaction with external pressures such as climate change, land use practices, topography of the flood plain, the River regime, the soil science, general education of the community, political will to implement environmental management policies, political will to recommend change of the primary teacher training and primary school curriculum to integrate



disaster risk reduction. The hybridization of indigenous and scientific knowledge will identify strengths in both arms so as to empower the communities in fragile ecological zones affected by hydro-meteorological disasters to build resilience and in turn reduce their vulnerability and poverty. This will lead to sustainable development and achievement of Vision 2030.

The framework has identified four steps;

- STEP 1; Community engagement to establish their knowledge base and gaps on disaster risk reduction. This will encompass the involvement of all stakeholders including government and non-governmental actors, schools, Ministry of Education and other related ministries. The community involvement will also assess their interest and aspirations in developing resilience to floods.
- STEP 2; Do a vulnerability analysis of the community. This involves finding out factors in the community both internal and external that exacerbate their vulnerability. These factors include a study of the land use patterns, soil science, availability of indigenous knowledge on early warning signs and adapting to flooding, the community livelihoods, informal social protection and community cohesiveness, topography of the land and morphology of R.Nzoia mouth, Climate change, quality of houses, proximity to hazards and risks, limited education of the community, construction of homesteads in dangerous places, waterborne diseases among others.
- STEP 3; Identification of indigenous and scientific technological knowledge on disaster risk reduction. The indigenous knowledge includes building simple houses, food storage techniques including planting early maturity crops, informal social protection, thus moving to higher grounds and keeping valuables for relatives who are affected by flooding, merry go rounds and sending children to work in urban places so as to send cash home. Early warning signs to floods like the croaking of frogs, appearance of certain stars in the sky, appearance of mangoes, clouds on Mt.Elgon, and the elders knowledge on the history of floods and River Nzoia regime. Adaptation measures like water storage and purification techniques, innovative energy saving techniques, walking with a stick to know the depth of water, learning to swim, evacuation drills among others.
- Scientific technological knowledge includes all knowledge that is not local, and use of Information Communication Technology (ICTs). This knowledge includes modern land use practices to prevent soil degradation, improved building technology for flood resistant houses, introduction of high breed short-season crops, vulnerability mapping using GPS and GIS, use of Bulala radio station to warn the community to evacuate, use of satellites in the Kenya Meteorological Department for forecasting and dissemination of information on early warning, establishment of village weather stations, Bulletins on early warning that are emailed to various destinations, use of automatic telemetric gauges for weather and river levels, Acoustic Doppler Current Profiler and use of general packet radio services.
- STEP 4; This is the final step in this framework. It involves integrating the indigenous and scientific knowledge best practices to reduce the community's vulnerability. The recommended best practices include use of formal and informal education. For formal education, the strategy is to integrate DRR education into the primary teacher training and primary school curriculum. This will lead to revision of the current curricular and development of new syllabus and textbooks. There will also be capacity building workshops for all stakeholders on the integration of DRR into the curriculum. As for the informal curriculum, co-curricular activities will have DRR as the main theme. These include drama and music festivals, sports days, open days to display pupils work on various themes on DRR education, invite guest speakers from the community to schools to talk to children about the indigenous knowledge, digitalize and document these events for future reference. Other strategies include training the community on the use of GPS and GIS for vulnerability mapping analysis and establishing weather stations. Train the community on constructing flood resistant houses, water purification techniques, innovative energy saving techniques and constructing modern toilets. Train the communities to harmonize use of both indigenous and scientific technological knowledge for early warning signs and adaptation to flooding so as to reduce their vulnerability to flooding and build resilient communities.

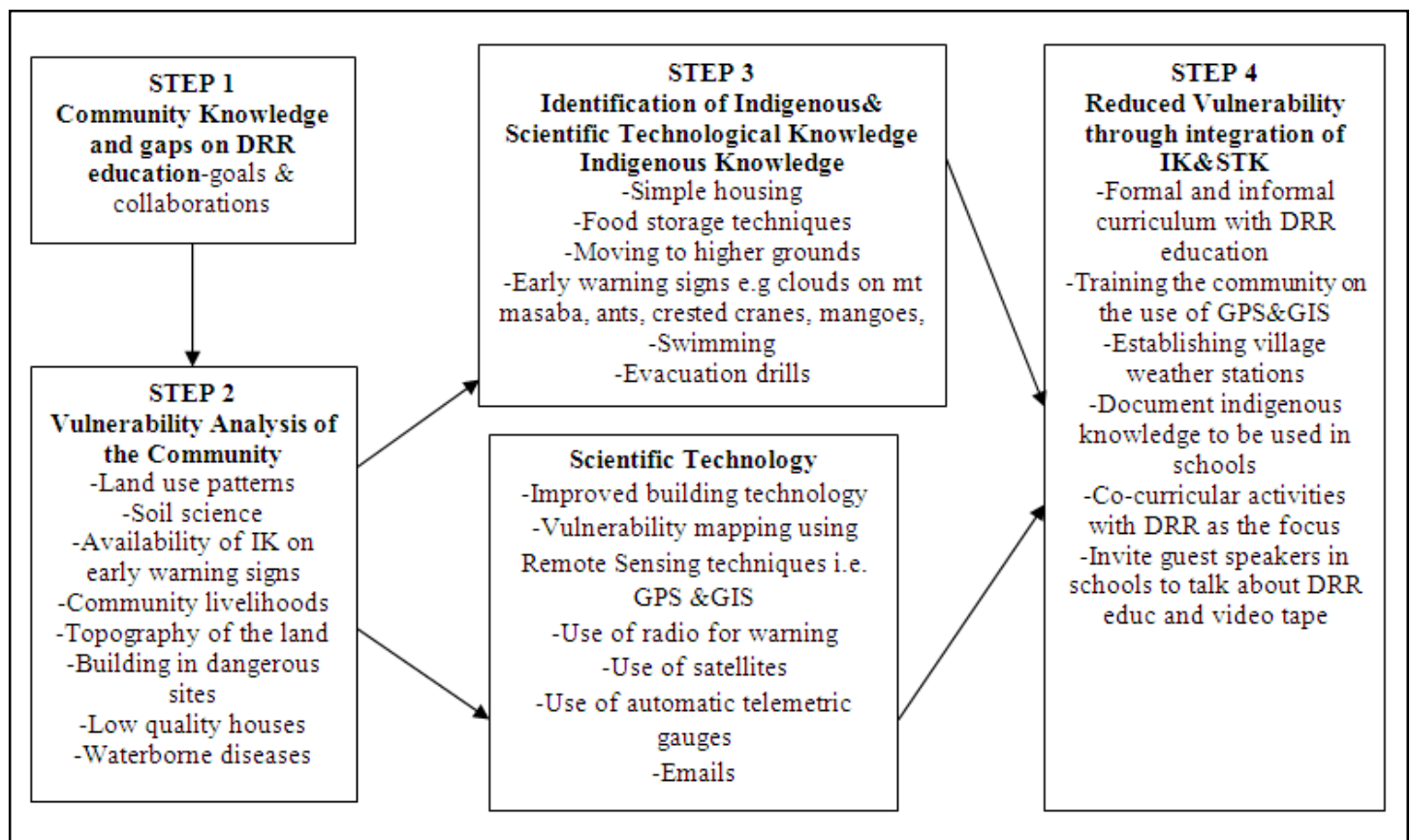


Figure 1: Model of the Framework Showing Integration of Indigenous and Scientific Technological Knowledge in DRR education

I highly recommend further research on this model in Kenya and beyond for all the other hydro-meteorological disasters. Remote sensing data should be combined with the traditional early warning signs for floods. Budalangi flood plain was a case study but can be adopted and tested in other fragile ecological zones. There is compelling evidence for Kenya to recognize and strengthen its wealth of IK for providing local solutions to global problems of increasing disasters and climate change impacts.

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