



International Strategy for  
Disaster Reduction



European Union



# Indigenous Knowledge for Disaster Risk Reduction:

Good Practices and Lessons Learned  
from Experiences in the Asia-Pacific Region

2008

“The European Union is made up of 27 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms.

The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.”

Disclaimer

“This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of UN/ISDR secretariat and can in no way be taken to reflect the views of the European Union.”

Editorial Team: Rajib Shaw, Noralene Uy, and Jennifer Baumwoll  
Graphic Design by Mario Barrantes

The cover photo illustrates a Dhani, a traditional family dwelling in the district of Barmer in Rajasthan, India. The Dhani has been improved using modern technology called Stabilized Compressed Interlocking Block technology (SCEB). For more information, see “Indigenous Knowledge and Modern Science Give Environment Friendly Shelter Solution in Flood Affected Desert Region of India” in this publication.

(Cover Photo Source: SEEDS)

Please send your feedback and suggestions (including further case studies for consideration) to:

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Bangkok, July 2008



Photo by Steve Evans, Thailand, Hill Tribes

# Foreword

Development research tells us that the success and the sustainability of interventions at the community level depend, among a number of factors, on the availability of relevant local culture, knowledge and indigenous practices that can combine with new ideas to generate innovation. The importance of indigenous knowledge contributes not only to the success of intervention, but more importantly to its sustainability in the longer term. Considering the participation and integration of these communities in all disaster-related processes as a necessary means for pursuing the Hyogo Framework for Action highlights the importance of indigenous knowledge in assisting to mainstream disaster risk reduction policies and practice.

Even before we came up with high technology based early warning systems, or standard operating procedures for response, numerous local communities worldwide have prepared, operated, acted, and responded to natural disasters using indigenous methods passed on from one generation to the next. The United Nations already considers indigenous knowledge within Priority 3 of the Hyogo Framework for Action, which focuses on education and knowledge. One of the key activities identified under this priority action focuses on 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.

In order to fulfill this objective, we all need to understand, acknowledge and respect indigenous knowledge as a valuable source of information and as a key contributor to reducing risk in many parts of the world.

This publication, “Indigenous Knowledge for Disaster Risk Reduction: Good Practices and Lessons Learned from experiences in the Asia-Pacific Region” aims to build awareness for indigenous knowledge as an effective tool for reducing risk from natural disasters. By improving the understanding of indigenous knowledge and providing concrete examples of how it can be successfully used, I hope this publication will inspire all practitioners and policy makers to consider the knowledge held by local communities and act to integrate this wealth of knowledge into future disaster-related work.

Jerry Velasquez  
Senior Regional Coordinator  
UN/ISDR Asia Pacific



Photo by Maureen Keogh, Cambodia

## Preface

This publication presents a collection of 18 indigenous practices which were developed over time in the communities in the Asia-Pacific region. Types of disasters include earthquake, cyclone (typhoon), drought, landslides, river bank erosion, tsunami and zud. The cases were chosen based on the following criteria: origin of the knowledge, its relative level of adaptation over time, its relationship to local skills and materials, its success in surviving or coping with disasters over time, and its applicability to other societies facing similar situations.

Each of the cases found in this publication follow the same general format including a brief abstract, background information to orient the reader to the community demographics and location, an explanation of the specific story or event in which the community successfully used its knowledge, a description of the indigenous knowledge held by the community, and finally the lessons which can be learned from the specific case. While each contribution is distinct, this uniform organization allows the cases to be analyzed and discussed as a group, comparing and contrasting these different elements.

Indigenous knowledge is culture specific, and represents people's lifestyle. Thus, the dissemination and wider practices of the knowledge is often a challenging issue. The publication emphasizes that the principles of indigenous knowledge can be applicable to different locations, which needs local cultural calibration. Application is a process and needs both participation of wider stakeholders and policy support. That part remains as the future focus area.

I would like to convey my sincere thanks to all contributors, and hope that readers will gain insight into how the values of indigenous knowledge should be recognized and practiced to reduce disaster risk for different types of hazards.

Rajib Shaw  
Kyoto University



Photo by Sean Hawkey, Bangladesh

# Introduction

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. While these two cases stole the limelight in recent years, there are many less conspicuous examples of communities who have also used indigenous knowledge to survive disastrous events and cope with difficult environmental conditions. These communities' use of indigenous knowledge to reduce risk, cope and survive recent natural disasters provides many lessons for practitioners and policy makers on the value of indigenous knowledge for disaster risk reduction.

Indigenous knowledge refers to the methods and practices developed by a group of people from an advanced understanding of the local environment, which has formed over numerous generations of habitation. This knowledge contains several other important characteristics which distinguish it from other types of knowledge. These include originating within the community, maintaining a non-formal means of dissemination, collectively owned, developed over several generations and subject to adaptation, and imbedded in a community's way of life as a means of survival.

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. Throughout disaster risk reduction literature, four primary arguments have been made for the value of indigenous knowledge. First, various specific indigenous practices and strategies embedded in the knowledge, which prove valuable against natural disasters, can be transferred and adapted to other communities in similar situations. Second, an incorporation of indigenous knowledge in existing practices and policies encourages the participation of the affected community and empowers its members to take the leading role in all disaster risk reduction activities. Third, the information contained in indigenous knowledge can help improve project implementation by providing valuable information about the local context. Finally, the non-formal means by which indigenous knowledge is disseminated provides a successful model for other education on disaster risk reduction. While this publication focuses on collecting specific indigenous strategies and mechanisms which can be transferred and adapted to other communities, the lessons learned emphasize all of these four areas.

This publication has been compiled to build awareness for the value indigenous knowledge holds for reducing risk against different types of hazards in different environmental and cultural settings throughout Asia and the Pacific. It is part of a

broader initiative in the region which aims to analyze the importance of indigenous knowledge and develop ways for this knowledge to be further integrated into disaster risk reduction policy and practice. This publication is the first step, providing a forum for knowledge sharing such that the experiences and strategies of various communities throughout the region are communicated to important disaster risk reduction stakeholders. In addition, this collection will also trigger further analysis on the importance of indigenous knowledge, which can feed into policy-making and inform curriculum development. Finally, this publication intends to encourage other regions to also invest in gathering cases in their countries and contribute to exploring the global importance of indigenous knowledge for disaster risk reduction.

Many of the communities discussed in this publication have been given little attention by other disaster planning mechanisms and have employed their knowledge as a way to help themselves in difficult times. Much of the knowledge embedded in these communities has been dismissed by outsiders as inferior and often ignored as belonging to “backward” and “less-educated” people. Yet many of these communities have developed successful lessons and strategies for managing recurring disasters and surviving extreme events which even high tech instruments are unable to help. All of these communities share a common ability to depend on themselves during disasters and a similar understanding of local threats and how to reduce these risks. There are many lessons to be learned from these communities.

Jennifer Baumwoll  
Co-editor

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## Turpan, Xinjiang, Northwestern China

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# Karez Technology for Drought Disaster Reduction in China

*Weihua Fang, Fei He, Jingning Cai and Peijun Shi*

### Abstract

Karez is a traditional irrigation water system which is able to make use of underground water efficiently. The Karez system has a long history in the Xinjiang area of China. As a comprehensive system, Karez is composed of four primary components: vertical wells, underground canals, a surface canal and small reservoirs. Because of the Karez system, Turpan, a basin located in the arid area of Northwestern China, is well-known for its wide variety of agricultural products. In the Turpan area of Xinjiang, Karez is still being used to supply water resources for irrigation and domestic uses. At present, modern technology has been integrated into the traditional Karez system to further reinforce the successful traditional practice.

### Background

The Turpan depression, with a height of 32.8m, is located in the Turpan basin which is the second lowest basin in the world. It is surrounded by several high mountainous areas (3500~ 5000m) which are covered with glacier or permanent snow. The minimum height of Aiding Lake, at the south of the basin, is around -155m, which represents the lowest lake in China. Underground water is abundant in the shallow underground water-bearing layer. The terrain of the mountains around Turpan basin is mainly formed by hercynian movement at the end of the Paleozoic period. It is hard and fractured and therefore fissured water is easily formed. The exposed rocks of Flaming Mountains mainly consist of sandy conglomerate and mud stones of Jurassic, cretaceous as well as Tertiary. Therefore, the geological condition of Turpan district is fit to construct an underground canal with little reinforcement for amassing sufficient water resources. The Turpan area is famous for its wide variety of fruits such as grapes, watermelons, and Hami muskmelons.

### Story/Event

Turpan is very dry in all seasons and very hot during spring, summer and autumn. The highest temperature recorded is 47.7°C in summer. High temperature and strong solar radiation result in high annual evaporation amounting to 2800~ 3000 mm.<sup>1</sup> Turpan is in an inner land with total annual precipitation of only around 16~ 17 mm. Because of strong evaporation or the evapotranspiration process, precipitation (rain or snow) falling on the slope of the mountain would evaporate or seep underneath sand and soil before it can converge into a stream and reach the flat agricultural area along the foot of the mountain. Surface water is scarce in most areas. Under such tough circumstances, few plants or animals survive.

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<sup>1</sup> Ji ZHAO (2001).

# Indigenous Knowledge

Karez is a traditional irrigation water system with a long history in Xinjiang area of China which makes use of underground water efficiently. Where farmland is located in the mountainous area, it is built on an alluvial fan or plain. Most existing Karez systems were mainly constructed between the 17th and 20th century. The currently functioning Karez systems are distributed in the dry areas of the southern slope of Mountain Tianshan in eastern Xinjiang, in the Hami district as well as the Turpan, Shanshan and Toksun districts of Turpan Basin. In the Turpan district, 1,016 Karez systems still exist of which 686 are operational. The total length is about 3,000 kilometers. The average depth of the underground canal is 20 meters whilst the utmost depth is 90 meters. The total outflow of the karez systems in Turpan Basin is about 10 cubic meters per second accounting for about 20% of the total diversion water of the basin.<sup>2</sup> At present, modern facilities such as electromechanical wells are integrated into the system.

The structure of a complete Karez system can be complex but its basic structure is essentially composed of four main components: vertical wells, underground canals, surface canal, and small reservoirs (Figure 1).

## Vertical Well

The length of the underground canal varies from around 3 km to 30 km. It is almost impossible to dig such a long underground canal without digging a vertical well, especially in the past agricultural period

when no modern equipment was available. Hence, the vertical well is primarily used to assist in digging the underground canals. When the wells are dug, sand and soil are excavated with the help of animals.

The major functions of vertical wells are for ventilation, proper orientation of the canal during construction and examination and repair of canals after construction. The distance between vertical wells is generally around 60~ 100 meters in the upper reaches, 30~ 60 meters in the middle, and 10~ 30 meters in the lower reaches. The depth of wells is approximately 40~ 70 meters, 100 meters in the upper reaches, 30~ 40 meters in the middle, and 3~ 15 meters in the lower reaches. Vertical wells are utilized not only to aid in digging underground canals, but also to take out water from these canals after the whole Karez system is completed. An aerial image of vertical wells is presented in Figure 2.

## Underground and Surface Canals

Of the two types of canals, the majority of them are underground. The canals under the surface are generally part of a network which enables underground water to accumulate (as illustrated in Figure 3a). Usually the deep soil around the underground canal is very strong and does not collapse easily. However, when the canal is close to the surface, the soil is loose. To prevent the underground canal from collapsing, it is usually reinforced with wooden pillars. At the bottom of the well, both sides are excavated for the underground canal. When the underground canal reaches the farmland, it becomes a surface canal and is linked to a small reservoir or directly connected to a system of water channels for

<sup>2</sup> ZHONG and CHU (1993); www.karez.org

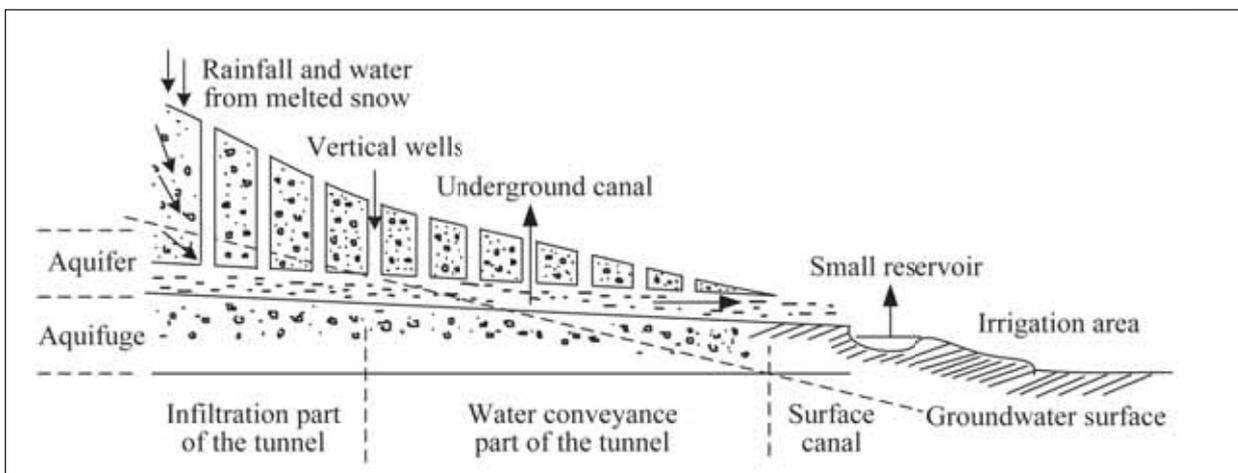


Figure 1. The components of a typical Karez system

irrigation (Figure 3b). Usually the surface canal is short to limit evaporation.

### Small Reservoir

Water resources are collected in small reservoirs which can be adjusted for water level and temperature. Constructing reservoirs increase the water level so that a larger area of farmland is irrigated. Moreover, the water stored in reservoirs receives sunlight which increases their temperature. The warmer water is more appropriate for irrigation, since the low temperature of water due to snow melting or because of its underground source may do severe harm to crops.

A variety of simple tools are employed for building Karez systems. These include an excavating hoe, a planning hammer, a basket, a winch and an oil lamp (as displayed in Figure 4). The excavating hoe and planning hammer are used for digging passages underground. The basket and winch are used for carrying soil and sand. Iron oil lamps with an arrow for orientation are used for digging underground canals. The lamp can also be conveniently fixed on canal walls. Currently in Hami city of China, a sunlight reflecting mirror is also used for orientation.

In constructing the different components of the Karez system, it is vital to ensure that along the underground canal, water resources are sufficient. A crucial first step is to find water sources in the upper reaches and the depth of water estimated in accordance with the location of farmland. The location for digging the well can then be decided. Subsequently, wells and canals can be built gradually from the lower to the upper reaches following the water source.



Figure 2. Aerial image of vertical wells in Turpan area of China. Source: [www.sunnynchina.com](http://www.sunnynchina.com)



Figure 3. (a) underground canal reinforced with wooden pillars. Source: [www.chinahw.net](http://www.chinahw.net); and (b) outreach of underground canal to surface canal. Source: [www.travelchinaguide.com](http://www.travelchinaguide.com)

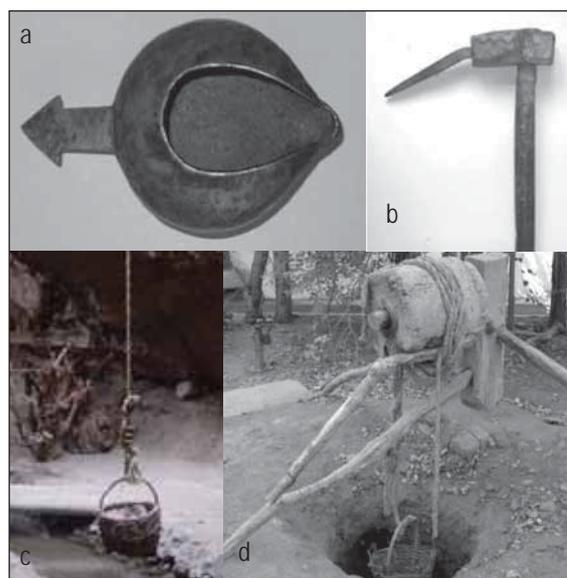


Figure 4. (a) traditional oil lamp with side-arrow, (b) excavating hoe, (c) basket and (d) a modern sheave used in building the Karez system. Source: [www.karez.org](http://www.karez.org), and [cersp.com](http://cersp.com)

## Lessons Learned

The Karez system is a proven and effective indigenous drought reduction technology that is still in use. This traditional knowledge has several advantages as follows:

1. **Support by Earth's Gravity.** Since Karez takes advantage of topography to divert deep subsurface flow through an underground canal to land surface for gravity irrigation, the cost for water-lifting equipment and its maintenance are almost negligible.
2. **Stable Outflow.** The major water sources of the Karez system are melting snow and underground water. The underground canal can minimize high evaporation in the windy Turpan district hence, the impact of climate change is small. In addition, problems with sand blast can be avoided in the underground canal. All this makes the Karez system able to provide stable water resources, though total water volume may not be very large. As observed, there has been a very stable population for thousands of years in Karez areas, regardless of environment changes.
3. **High Water Quality.** Melting water from snow enters the system and the soil provides a very good filter to remove polluted materials. Unlike water channels on land, the underground canal minimizes water pollution and at the same time is rich in minerals. The water quality is suitable for drinking and domestic use.
4. **Construction with Simple Tools.** Most Karez systems are built with simple tools and do not require complex equipment.

Conversely, the Karez system has constraints. There is a spatial limitation on its construction and use. It is only applicable in areas with stable underground water supply and hard soil. Some Karez systems were built around Guanzhong Plain in Central China in the Han Dynasty which did not last because the underground canals collapsed. Furthermore, the volume of water in the Karez system may change with the season although there is little variation in the volume daily. In the summer, there are sufficient water resources if the water source is from melting snow. In the spring, Karez water is limited, while in autumn and winter it is substantial. This is sometimes in discord with water demand for agriculture.

There is thus a need to strengthen the traditional Karez system with modern technology. Its value as an efficient indigenous drought reduction technology should not be ignored. Instead, this traditional knowledge should be improved and reinforced with modern technology. Its widespread use promoted in the face of severe drought disaster in the future.

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## State of Jammu & Kashmir, Northern India

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# Earthquake Safe Traditional House Construction Practices in Kashmir

*Amir Ali Khan*

### Abstract

Due to the frequent occurrence of earthquakes in the Kashmir region, the people of this area have developed indigenous construction practices for earthquake safe housing. The techniques, known as “Taq” and “Dhajji-Dewari” system, have been found to have earthquake resistant qualities. This case study examines the indigenous knowledge of earthquake safe housing construction practices prevalent in the rural and urban areas of the state of Jammu and Kashmir in northern India.

### Background

The state of Jammu and Kashmir, with a total area of 222,236 sq. km., is located in the northern part of India. It is different from other parts of the country in terms several characteristics, including topography, climate, economy, and social setting, among others. The region is essentially mountainous, where population density is high in the valleys and low in the hill slopes. Administratively, the state is divided into three distinctive parts namely the Jammu region in the south and southeast, the Kashmir valley in the west and the Ladakh region in the north and northeast. With regards to topography, the state is divided into four geographical areas, specifically: mountainous and semi mountainous plains, lower hills (Shiwalik Range), mountains of Kashmir valley and Pir Panjal Range and Ladakh and Kargil Mountains on the Tibetan tract.

Climatic conditions vary from arctic cold desert of the Ladakh region to temperate in the Kashmir Valley and subtropical in the Jammu region. Similarly, there are variations in the annual rainfall pattern from 92 mm in Leh in the Ladakh region, 650.5 mm in Srinagar in the Kashmir region and 1,115.6 mm in Jammu in the Jammu region. Soil condition in the Kashmir valley is poor and affords very inferior condition for building construction.

### Story/Event

The Kashmir region lies in a high seismic hazard zone, where destructive earthquakes take place at regular intervals. On October 8, 2005, the Mw 7.6 earthquake occurring at a depth of 26 km, with epicenter at 34.6 0N, 73.0 0E near the town of Muzaffarabad, was felt throughout Pakistan and India. In Northern India, the most severe impact of the earthquake was felt in the state of Jammu & Kashmir. The worst affected districts were Poonch in the Jammu Division and Baramula and Kupwara in the Kashmir Division. The earthquake paralyzed standard daily living for a considerable time due to the damage and destruction of houses and infrastructure in the area, as well as the disruption in communications and other essential services. A population of more than half a million was affected due to the earthquake. About 90,000 households in the Kashmir Division and 8,000 households in the Jammu Division were greatly affected. Regardless of this destruction and devastation, indigenous construction techniques helped to save the lives of many individuals.

# Indigenous Knowledge

The Kashmir region is known for its traditional earthquake safe construction practices, where two types of construction practices are prevalent: Taq system (timber laced masonry) and Dhajji-Dewari system (timber frame with infill walls).

## Taq System

In the Taq system, large pieces of wood or timber are used as horizontal runners embedded into the masonry walls. These runners are located at floor level and at the top of windows. These runners tie together all of the elements of the building or house and keep the entire structure in concert, thus preventing spreading and cracking of masonry. The runners are joined together with small pieces of timber, giving the shape of a ladder laid over a wall covering two exterior faces of the wall. Figure 1 shows houses built using the Taq type of construction.

In the local language Taq means window. This generally refers to a modular layout of the piers and window bays which make up this type of construction. Piers are almost 1.5 – 2.0 feet square and the bays are about 3.5 feet wide. There is no practice of putting a complete frame of timber. The timber runners act like horizontal reinforcement which ultimately holds the masonry together.



Figure 1.  
Houses with typical Taq type construction in Srinagar. Photo: Amir Ali Khan

### Dhajji-Dewari System

In the Dhajji-Dewari system, timber frames for confining masonry in small parcels are used. The timber frames, not only have vertical elements, but also have cross members, which divides the masonry infill into various small panels. The most important characteristic of this type of construction is the use of lean mud mortar. A common practice in the region is to use the Dhajji-Dewari system in the upper story walls, especially for the gable portion of the wall. Some of the houses built using the Dhajji-Dewari type of construction are shown in Figure 2.



Figure 2.  
Houses with typical Dhajji-Dewari system of construction in Srinagar.  
Photo: Amir Ali Khan

## Lessons Learned

After the Kashmir Earthquake in 2005, existing construction practices of the Region were assessed to find appropriate earthquake resistant features. The following are some of the observations:

1. Building conditions were found to be quite poor due to the lack of earthquake resistant features in the existing houses and buildings. In cases where traditional knowledge had been applied, using either Taq system or Dhajji-Dewari technique, the houses and buildings were able to withstand the earthquake. There were numerous instances where a portion of a house or building having the Dhajji-Dewari and Taq system sustained the shock of the earthquake, even when the portion without such system had given away (Figures 3 a & b).
2. Houses, constructed using quality material like load bearing masonry with stone in cement and lime mortar and bricks in cement mortar, performed poorly when built without proper and adequate professional knowledge. In the absence of proper professional guidance, reinforced cement concrete structures became highly hazardous and resulted in the complete collapse of the structure during severe shaking. The Kashmir earthquake clearly demonstrated the advantages of traditional practices for house or building construction over modern techniques, which were employed without proper application of professional know-how.
3. The traditional techniques of Dhajji-Dewari and Taq system for house construction have not been popularly employed in recent times. These techniques need to be reintroduced in order to demonstrate their advantages over modern techniques. More Kashmiri masons should be imparted training in constructing houses using these techniques.

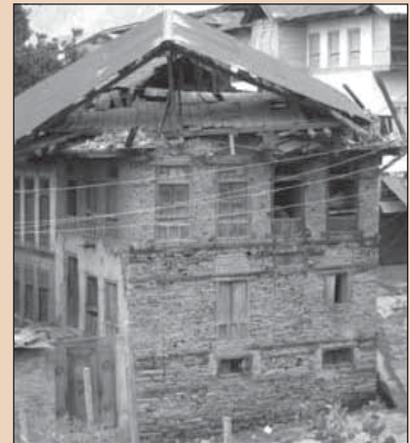


Figure 3. a) Portions where Dhajji-Dewari system (gable portion) and b) Taq system (entire structure except gable portion) survived the destruction of the 2005 earthquake.

Source: Durgesh C Rai and C V R Murty (IIT Kanpur, India) -Preliminary Report on the 2005 North Kashmir Earthquake of October 8, 2005.

## Barmer, Rajasthan, India

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# Indigenous Knowledge and Modern Science give Environment Friendly Shelter Solution in Flood Affected Desert Region of India

*Anshu Sharma and Mihir Joshi*

### Abstract

August 2006 saw unprecedented heavy rains and flooding in several villages of the otherwise drought stricken Barmer District of the desert state of Rajasthan in western India. Over one hundred hours of continuous rains inundated several villages in up to thirty feet of water. Such rains and floods had never been witnessed in this region in over 200 years of recorded history and the local communities and administrative system were not prepared for such an emergency situation.

SEEDS, a national NGO, immediately visited the affected areas and carried out a damage assessment along with a study of the local natural and built environment. The team examined the traditional construction practices in the area, which were based on mud walls and thatch roofs, with circular shelter designs. The houses had many benefits to the existing environmental conditions. Nonetheless, while the traditional mud structures were appropriate for other types of disasters, such as earthquakes and sandstorms, they did not have a high water resistant capacity and had therefore suffered severe damage during the floods.

While traditional wisdom has provided a very high level of performance for generations, it needed the support of some technological intervention and reinforcement, so as to help it face the challenges posed by unprecedented disasters linked to climate change which will become more frequent in the future. SEEDS and its partners helped to develop a new technology which integrated indigenous knowledge with limited scientific inputs. With the help of Village Development Committees, several new buildings were developed and constructed to adapt to current disaster threats.

## Background

The district of Barmer is the westernmost district of the state of Rajasthan, India. Located along the border of India and Pakistan, this district falls completely under the Thar Desert region. SEEDS worked in Sheo block of Barmer district where 300 shelters were constructed for the worst of the flood-affected families, specially targeting those from socially excluded groups who had no capacity to rebuild their houses on their own.

The local community is characterized by sparse and scattered living. There are four to five circular structures in one cluster bound by a low boundary wall, which forms a family's abode and is called a Dhani in the local language. Each structure is used for a different activity such as sleeping, storage, cooking and daily activities. A cluster of Dhanis constitutes a village. These communities are living in very harsh climatic conditions and making judicious use of the sparse resources available within their surroundings for both their day-to-day requirement and for construction of houses. The population density of Barmer district is among the lowest in India. Water is a major problem in this area. Village women walk long distances with headloads of pots to fetch drinking water, sometimes making more than one trip a day. Life in this region is full of hardships. Means of livelihood are severely limited.

## Story/Event

Incessant rains in the desert state of Rajasthan gave rise to one of the worst floods in Rajasthan in two centuries. Heavy monsoon rains that started on 16 August 2006 engulfed about a hundred villages of the 12 odd districts of Rajasthan. By midnight of 21 August 2006, Barmer had received 577 mm of rainfall in three days, 300 mm more than the annual average rainfall. Some of the worst affected villages were Kavas, Malua, Bhadkha and Shiv. The water level reached close to thirty feet above the ground level. It is officially reported that 103 people died, with about 95 percent of the families in the affected villages (over 50,000 people) were rendered homeless. The impact was felt more because the region is very sparsely populated and has very low level of infrastructure facilities, thus making access to services very difficult.

The floods caused additional damage since most houses in this region are normally built in depressions in between sand dunes so as to protect them from sandstorms. This worked to their disadvantage as these low-lying pockets got flooded worst, and due to the impervious sub-soils, the water stagnated for weeks. Even in many places where parts of houses were standing, they were rendered uninhabitable. In addition, since the structures were mostly made of mud, many were badly damaged and destroyed by the flood. As the local people had never experienced this kind of disaster before, they were shocked and did not know how to handle the situation. Some local people thought that it was an act of displeased gods, while those linked to the scientific world pointed fingers at climate change.

# Indigenous Knowledge

## Indigenous knowledge for shelter comfort and sustainability

Communities living in rural Rajasthan are used to constructing houses with local materials and indigenous technology for many generations. For construction of their dhani, all the family members play a major role and have assigned responsibilities. While the men of the family collect soil of good quality from nearby places, the womenfolk gather cow dung, which they mix with the mud to prepare the basic construction material. The women of the family do the plasterwork for the new house, as well as for regular maintenance of the walls and floor. The roof is made by tying and weaving the dried stalk and by-product of the local Jowar crop.

The house is oriented in such a way that the wind direction and sun path ensure good ventilation and thermal comfort, which is very critical since summer temperatures in this region reach about 50<sup>o</sup> C. Normally the size of the openings is very small as it reduces heat gain and also gives less exposure to sand storms, which are a common local threat.

The people generally produce houses that are circular in plan and opt for lower heights. This is usually due to the location in the High Wind Velocity Zone where there are heavy winds especially during the summer. The circular plan helps to streamline the airflow with the least amount of resistance. A diagram of the dhani is illustrated in Figure 1.

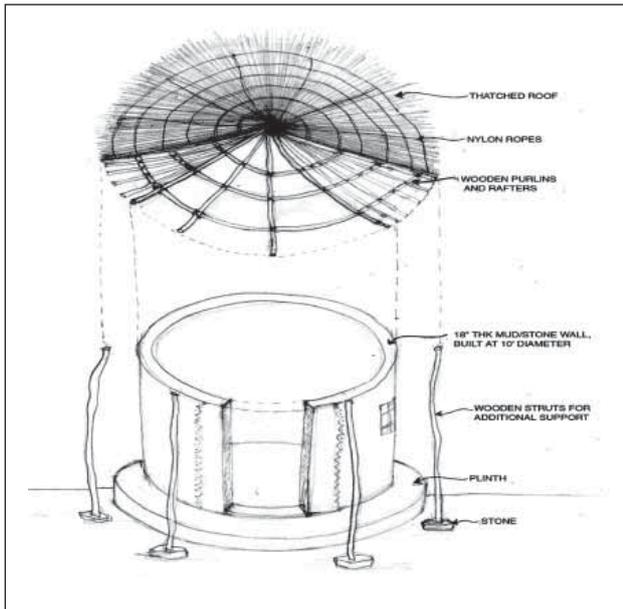


Figure 1. A diagram of the dhani

Since this area is also located in the moderate to high seismic zone, based on the Earthquake Vulnerability Map of India, the circular shape can also give good lateral resisting strength to the houses. During the 2001 earthquake in Kutch, Gujarat, which is very near to Barmer, very less damage was observed in houses with similar designs.

### Survival and propagation of indigenous construction knowledge

The indigenous technology for constructing shelters is widely used in the area. The community members themselves are the messengers for transferring this technology to the next generation. As all members of the family are part of the construction activity, they have a sense of ownership of the shelter and an understanding of the materials and processes.

There are five main factors why this technology of shelter construction is still surviving in the remote desert areas and how it is disseminated to other communities in the larger region. These are shown in Figure 2 and elaborated below.

#### 1. Community leaders set an example by using this technology

One very common and important tradition followed in most rural communities in India is to have a group of respected people who set an example for the rest of the community. Members of the community will often follow these leaders with regards to their behavior, choices, and general way of life. In Barmer villages, most of the respected

people in the community live in Dhani. Seeing this, therefore, other community members are encouraged to follow.

2. **Community involvement in construction of shelter**  
All of the community and family members are involved in various activities of shelter construction. Involvement of family members as well as relatives eases the burden of construction and strengthens community spirit. This is also one of the reasons this technology has survived and continues to be used in this rural and tradition-centered area.
3. **Extreme climatic conditions**  
In Barmer, summer temperatures reach as high as 50° C and in winter the night temperature is near the freezing point. Concrete houses become ovens in the heat and chillers in the cold. There is no electricity and fuel is very scarce and unaffordable for thermal control. In order to survive in these extreme conditions, an appropriate house is required. Though some people have started opting for modern materials, they are not as comfortable in these modern houses as they are in traditional ones.
4. **Availability of local materials at no cost**  
Availability of local materials, which is free of cost and transportation, is a major attraction for a community already impoverished by inadequate livelihood options and a harsh climate.
5. **Good design for safety and comfort**  
A circular shape is capable of resisting wind pressure created by sand storms and wave pressure created



Figure 2. Factors for the survival and propagation of indigenous shelter technology.

by earthquakes. The walls are of insulating quality and are thick, giving good thermal comfort inside the house for both temperature extremes. Roofing is also properly connected to the walling system, giving higher structural safety to the shelter as a unit. The combination of safety and comfort has resulted in a time tested shelter technology that is respected locally for its immediate as well as long term benefits.

### The Support of Science

SEEDS visited the affected areas immediately after the floods and carried out a damage assessment along with a study of the local environment, both natural and built. The team assessed and documented the traditional construction practices in the area, which proved to have several benefits. The structures were found to be very environmentally friendly as the materials created no ecological or carbon footprint; the houses were very conducive and thermally comfortable in the extreme weather conditions prevalent in the area; the circular design protected the structures from strong winds and earthquakes; and the construction processes were simple and suited to local skill levels.

SEEDS and their various partners intervened in the construction of 300 shelters under the Barmer Ashray Yojana (Barmer Shelter Program). Research was carried out on appropriate technologies for supporting the traditional construction system, which led to the

Stabilized Compressed Interlocking Earth Block (SCEB) technology. In SCEB technology, local mud is stabilized with five percent cement, and compressed into blocks that have high structural strength and water resistant capability.

In partnership with Christian Aid, and with funding from the Humanitarian Aid Department of the European Commission, the shelters were built using this appropriate technology, which was a mix of indigenous knowledge and limited scientific inputs to make it further resilient in the face of new threats (Figures 3a & 3b). Village Development Committees (VDCs) were formed in each village to make decisions and to guide and monitor the construction process. The VDCs comprised of men, women, local leaders, school teachers, NGO representatives and project team personnel working closely with local government officials. The traditional circular designs and the `breathing` thatch roofs were retained. An efficient system was established to mass-produce the SCEBs very quickly to provide housing to the affected families in a span of six months. The house-owning families mainly did the construction with limited support from the project team. The knowledge and skills were left with local construction workers so that they can be replicated and scaled up in the region. Upon completion, local families preferred these traditional structures far more than the modern concrete technology based houses provided by other sources, which turned into ovens under the scorching desert sun.



Figure 3. The traditional dhani

# Lessons Learned

The lessons learned through project intervention and documentation of this case are related to construction technologies, material sciences, as well as social systems and processes. The main lessons learned are summarized as follows:

1. Post-disaster shelter programs must capitalize on existing traditional wisdom on construction materials and technologies, since it has been tested over generations and is best suited to the local environment and culture.
2. Technology should be introduced where necessary, but in minimalistic ways, so as to add value to the traditional systems and make them more resilient in the face of new threats such as those posed by climate change
3. Materials used for construction should be eco-friendly and local to the extent possible. This keeps the cost low, and also minimizes the carbon footprint of the intervention.
4. Participation of the beneficiaries in decision making regarding the site, design and construction details is critical to their involvement and ownership of the process.
5. Participation of house-owning families in the construction process is very useful in cutting costs, enhancing the sense of ownership, and keeping the design and construction process flexible enough for each family to be able to customize small elements to suit their preference and convenience.
6. Transfer of technology to local construction workers is very useful to ensure the sustainability of the construction approach, its replication and improvement in the area.
7. Linkage with local stakeholders including governments, academia and the private sector is useful for the smooth completion of such projects, and also for creating a local buy-in for the approach, which will help for its sustainability in the long term.
8. Linkage with other sectors such as water, sanitation, livelihood and education helps create a more comprehensive package around shelter, habitat and lifestyle and provides value added benefits to the local community.

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## Nandeswar Village in Goalpara District, Assam, India

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# Soil and Water Conservation through Bamboo Plantation: A Disaster Management Technique Adopted by the People of Nandeswar, Assam

*Irene Stephen, Rajiv Dutta Chowdhury and Debashish Nath*

### Abstract

Bamboo plantation along canal bunds by the local people of Nandeswar Village in many ways has benefited their village. With plantation of bamboo, one of Assam's most prevalent vegetation, canal bunds (embankments) are kept from being breached and soil is kept from further erosion. Although floods occur every year in Assam, this technique has maintained and protected embankments and has kept bridges and roads from damage during heavy rains.

### Background

Nandeswar Village is located in Goalpara District (Gram Panchayat–Karipara under Matia Development Block), Assam, India. Most of the people of Nandeswar Village are farmers. Their livelihoods depend on the land and agro-based activities. Assam and other northeastern states frequently experience floods during the monsoon months from June to September.

### Story/Event

While severe floods were experienced in 2002, 2004 and 2007, the years from 1953-1998 were the worst. The area's physical conditions and factors such as deforestation, land use pressure, rapid population growth and river channel stresses have caused constant shifting of river courses and channels, as well as erosion of river banks within the Brahmaputra river basin. During heavy rains, large areas surrounding Assam are submerged, forcing many villages and towns in Assam to become isolated. In particular, breached embankments and roads, broken bridges and landslides typically leave people stranded. For years, people in this region repeatedly face prolonged flooding days.

# Indigenous Knowledge

People have learned to prevent losses by using viable methods that have been practiced for generations. Certain traditional techniques can help rivers and channels from getting silted and prevent excessive run offs during heavy rains. Floods often breach bunds (embankments) and damage roads that are important links between villages. Planting bamboo helps to protect the bunds from being breached and prevent rapid run off from the river channel when the river overflows during heavy rainy days (Figure 1). Moreover, planting bamboo along fish ponds and paddy fields prevents soil erosion and stops water from submerging low areas during peak flooding days.

In preparation of the arrival of monsoon days from December to February, people in Nandeswar Village usually clear the river channels from silt and sand. Removed matter is then used to build bunds along the river and channel. Grass is grown to pad the bund surface and keep the soil from being eroded (Figure 2). Grassroots help bind the top soil. After a month, bamboo shots are planted in pits that are spaced 24 inches over the bunds. The process is done through a local planting method known as bamboo root pressure technique. As bamboo grows, its deep-seated roots exert pressure in all directions of the main shoot allowing newer shoots to grow and the roots to bind the soil. Bamboo roots run on the surface (i.e. near the top soil) to 2.5 to 3 feet and on deeper soil to up to 5 feet.



Figure 1. Bamboo planted along the river in Assam.



Figure 2. Bunds are built out of silt and sand and padded with grass.

The local people obtain many benefits from this plantation technique. While soil erosion is checked, the bamboo grown within a period of 5 years is also used as material for construction, crafts making and paper making. These activities provide additional employment to the community. Cost for repairing and maintaining the bunds remains low. De-silted soil from river channels are put to good use in various agriculture activities.

## Lessons Learned

The people of Nandeswar Village have learned how to cope with flood and soil erosion. They have utilized the planting of bamboo to prevent major damages. As opposed to the past, where bamboo was grown simply for commercial purposes, this technique is a cost effective way to help local people conserve water, and stop soil and bank erosion. The method requires less investment for repairs and maintenance of bunds, reduces siltation during heavy rains and prevents river channels from overflowing. People have benefited from the multiple uses of bamboo through this locally developed conservation technique. Bamboo plantation has played an important role in the livelihood and survival of the people of Nandeswar, Assam.



Figure 3. Bamboo planted along the river protects a major bridge.

## Simeulue, Nias and Siberut, Indonesia

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# Legend, Ritual and Architecture on the Ring of Fire

*Koen Meyers and Puteri Watson*

### Abstract

Indigenous practices have proven to reduce the impacts of natural disasters in three islands in Sumatra, Indonesia, namely Simeulue, Nias and Siberut. Though culturally different, all three islands have within the last five years experienced earthquakes and tsunamis and have brought to light indigenous practices previously unremarked by the international community concerned with disaster risk reduction. These practices include traditional communication, human-settlement planning and building methods and associated rituals. These practices will be examined in detail to fully understand their impact and consider what relevance these indigenous practices and knowledge have for modern development.

### Background

#### Simeulue

Part of the Province of Aceh, Simeulue is an island district which consists of 1 large island, i.e. Simeuleu Island, and approximately 40 small islands. The islands cover a total area of 205,148.63 ha and are located approximately 155 km from the mainland Sumatra.

#### Nias

Nias consists of a group of islands located between Simeulue and the Mentawai islands, approximately 100 kilometers off the west coast of North Sumatra, Indonesia. The islands cover an area of 4,771 km<sup>2</sup>. Administratively, Nias Island group belongs to the North Sumatra Province and is divided into two districts, Nias and Southern Nias. According to the population census of 2006, the total population of Nias

is estimated at 713,045<sup>1</sup>. A view of a village in Nias is shown in Figure 1.

#### Siberut

With an area of 400,030 ha, Siberut is the largest of the Mentawai islands which encompasses more than seventy islands and islets. It is located off the west coast of the province of West Sumatra. The more than 35,000 indigenous inhabitants of Siberut, belonging to the Mentawai ethnic group, represent one of the few remaining communities in Southeast Asia whose way of life is still to a large extent dependent on the natural environment. Many parts of Siberut still feature a semi- subsistence economy in which indigenous environmental management and related belief systems play an important role in the daily lives of peoples. A typical Siberut village is displayed in Figure 2.

<sup>1</sup> Badan Pusat Statistik Sumatera Utara

## Story/Event

Within the last five years, Simeulue, Nias and Siberut have borne the brunt of several earthquakes and tsunamis. The December 2004 Tsunami affected both Simeulue and Nias. Simeulue, however, only suffered a small number of casualties compared to other areas. The official report issued by the district government declared only seven casualties out of a total population of over 78,000, nearly 95% of whom live in coastal 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. Besides the indigenous knowledge, the hilly topography of the island was also another important factor that contributed to a small number of casualties. The hills are located only a few hundred meters from the villages and the shoreline.

Nias Island was strongly affected by the 26 December 2004 earthquake and by the following tsunami that killed 140 islanders and rendered hundreds homeless<sup>3</sup>. The earthquake that hit a few months later, on 28 March 2005, measured a devastating 8.7 on the Richter scale and claimed 839<sup>4</sup> lives. The impact of the earthquake was so enormous that some areas of the island were uplifted by more than 2 meters, exposing coral reefs and other areas as much as 100 meters seawards. The earthquake affected the lives of 90% of the population, leaving 15,000 houses needing rehabilitation and 29,000 needing reconstruction<sup>5</sup>.

<sup>2</sup> UNORC (2005).

<sup>3</sup> Badan Rekonstruksi dan Rehabilitasi (BRR) NAD – Nias, (2005, October)

<sup>4</sup> BRR (2005, October).

<sup>5</sup> BRR (2005, October).



Figure 1. A village in Nias.



Figure 2. A Siberut village.

On 12 September 2007, an earthquake measuring 7.9 on the Richter scale occurred near Siberut. On the entire island there was only one casualty. One of the reasons for the low death toll was that most people left their houses as soon as they felt the earthquake and took refuge in an open space. Such collective reaction to earthquakes can be attributed to the public knowledge communicated through legends.

# Indigenous Knowledge

## Simeulue

The low death toll on Simeulue Island can be attributed to the community's indigenous knowledge. According to local people, this knowledge can be traced back to an "ancestral experience" in 1907, when an earthquake generated a tsunami and killed a large number of the island's dwellers. Stories from the disastrous 1907 event were translated into stories, testimonial monuments and reminiscence, which were then transferred to younger generations in an unstructured and ad-hoc pattern.

The Simeulue community uses the word *smong* to describe this event, which has the same meaning as tsunami. The existence of a local name to depict a tsunami event shows that the local community possesses a certain level of knowledge in regard to the phenomenon. Though it is unclear whether the word *smong* existed before the tsunami event of 1907, many people on Simeulue believe strongly that it did and that it is derived from *ni semongan* or splashing (of water) in one of the three local languages. The current

interpretation of smong by the local islanders is that it consists of a linear series of natural events that start with strong earthquakes, a receding sea and then followed by giant waves and flooding.

The events occurring during the 1907 tsunami were transferred orally through stories within the community without an outlined structure. The story telling was not aimed at preparing new generations for future similar events, but instead gave a description of a historical event. The event was so deeply traumatic that it was translated into a series of individual stories, which were transferred at both the family and community level. Each story covered the event in its own way and often referred to the suffering or death of family members. Since the 1907 tsunami happened on a Friday, at the time the men were coming back from the mosques after their Friday prayers, the event took on a symbolic significance which led the Islamic community of Simeulue to also perceive the 1907 event as the wrath of God. The event is often referred to as a means by God to rectify behavior of family members which depraved the existing social and religious norms. The stories also refer to natural tsunami monuments such as the presence of coral in the inland rice fields.

## Nias

The earthquake of 28 March 2005 had a huge impact on Nias island's inhabitants and infrastructure. Amidst this devastation a solid example emerged of how indigenous practice can reduce the impact of disaster. After the earthquake, most of the few remaining traditional wood houses had resisted the impact of the earthquake.

As shown in Figure 3, the traditional houses in Nias are built of wood, where the structural members are slotted together rather than nailed. This technique adds to the flexibility of the house. The houses are supported by vertical pillars (enomo), which rest on stone blocks and a number of diagonal beams (ndriwa). The ndriwa are placed between the enomo both across and along the building, functioning as longitudinal and lateral bracing. They lean against each other at their base and top where they fit into the horizontal beams located under the floor of the building. The technique of

diagonally bracing the ndriwa in both directions allows the structure to withstand the strongest of tremors.

The roof of the building has a similar construction as the understructure of the house. Depending on the size of the building the roof will have several layers of diagonal beams which are placed in a lateral position and lean against vertical and horizontal beams at both ends. Both the understructure and the roof provide a three-dimensional structure that enhances the elasticity and stability of the house when an earthquake occurs. This feat of engineering is still considered to be the most effective example of a tried and tested earthquake resistant architecture on Nias Island.

## Siberut

The Mentawai community's past individual and collective experiences with natural phenomena like earthquakes have been translated into tangible and intangible strategies that reduce the impacts of earthquakes. For example, one of the intangible strategies is a legend highlighting the metaphysical relationship between peoples and earthquakes. The legend provides a detailed description of the first earthquake ever to occur. Besides raising the awareness regarding the dangers of the earthquake, it also reminds the listener of the human origin and emotions of the earthquake.

The following is a version of the legend as heard in Attabai, a small settlement in southern Siberut:



Figure 3. The traditional house in Nias, a time-tested and effective earthquake resistant structure.



Figure 4. Shamen are the instruments by which traditional belief is passed on.

*“Once upon a time in one of the valleys in the west coast of Siberut Island lived an extended family that planned to build a big new ‘longhouse’ (uma). Preparations and efforts were made to build the uma: large trees were cut down for the pillars, sago-palm leaves were weaved for roofing, timber was cut for the flooring, and rattan vines were made into ropes. To ensure that there was enough manpower to construct the uma, the extended family invited many relatives and neighbours living in other valleys to help.*

*After all the preparatory work was finalized, it was time to dig the hole for the first pillar. After the whole was dug, the owner of the uma dropped his chisel into the hole and asked his brother-in-law to pick it up. The owner of the uma did not like his brother in law and when his brother-in-law was in the hole, the owner ordered other members of his extended family to entrench the huge pillar into the hole. A faint moan of tremendous pain was heard and after a strong thrust on the huge pillar, only silence remained.*

*The construction of the uma was finalized and was renowned for its beauty all over the island. The time had come for inaugurating the house through a big ceremony and festivity, and the owner of the uma invited many relatives and neighbours to participate in the feast. Many pigs and chickens were slaughtered and cooked for a large meal.*

*The spirit of the brother-in-law who could not rest in peace was very angry at the owner and the people participating in the feast. Before the celebration, he came to warn his sister and her children that during the party, they should not eat in the uma and instead hide under a banana tree.*

*When everyone started eating, the ground suddenly shook extremely strong, and a thundering noise came from below the ground. The earthquake was the vengeance of the spirit. The newly built uma collapsed and all people were killed, except from the family of the spirit. They were the only survivors.*

*From that day on, according to the story teller, the Mentawaiers named the earthquake “Grandfather” (teteu).”*

There are actually two words for earthquake in Mentawaiian language, sigegeugeu and teteu. Sigegeugeu can be translated as “a shaking” and has very much the same connotation as the word earthquake in English. The other name ‘teteu’, or grandfather has clearly a metaphysical meaning. It reflects an anthropomorphization of a possibly lethal natural phenomenon that needs to be approached with a certain level of respect and fear. According to the traditional belief system, each time a new house is built, people must give offerings to the spirits of the earth (Taikabaga) to avoid the teteu (grandfather) from becoming upset and angry. The offerings are put near the important pillars of the house to appease the earth spirits and prevent the house from collapsing if teteu strikes again. The act of making the offering serves to subconsciously reinforce the community’s collective awareness of the risk of earthquakes and keeps it alive in the consciousness. Figure 4 illustrates the shamen at a ceremony.

# Lessons Learned

## Simeulue

It is important to highlight some key characteristics of the traditional story telling in Simeulue that saved so many lives in 2004. Firstly, the stories are concerned with local information. Secondly, the story-telling takes place in the home from one family member to another. These two factors together serve as an effective communication method to inform a community about the risk of disaster in their locality. Modern communication methods are less focused on information pertaining to the local area and disseminate information in a much broader manner. With the introduction of modern communication channels, such as radio, television and telephone comes a broadening of horizons and a wider scope of information. Lessons are taken from the world beyond instead of from the past or the specific local context. In this instance, new means to inform communities about the threats of disaster in their localities must be found. These means must carry relevant information and must also replicate the effectiveness of the oral story-telling tradition in dissemination and immediate relevance to local communities. In Simeulue, a bedtime story about an event in local history saved hundreds of lives. Modern development programs, which seek to prepare communities through brochures and focus-group discussions, may yet have something to learn from indigenous story telling traditions and practices.

Also it is important to remember the part played by the topography of the island of Simeulue. Villagers, armed with their advanced knowledge of the threat of a tsunami, were able to access hills to where they escaped to safety. This indicates the importance of the role of human settlement planning in disaster risk mitigation. Had there been no access to safe areas, knowledge of the legend in 1907 would not have saved so many. This is a key lesson for future disaster risk reduction efforts – a holistic approach needs to be taken towards protecting communities from disasters. Furthermore, risk reduction strategies must be integrated in all aspects of the community's existence.

## Nias

Since the March 2005 earthquake, the indigenous practices used to construct traditional houses in Nias have been studied and have gained a reputation for their earthquake resistant quality. However, whilst this example of indigenous practice is celebrated, the devastating impact of the March 2005 earthquake on Nias Island, its population and its economy, must not be forgotten. This seems ironic given that Nias Island was at the time and still is home to one of the world's best examples of earthquake resistant architecture. This irony shows us firstly that isolated examples of indigenous practice alone cannot contribute significantly to disaster risk reduction. Secondly, it demonstrates that as the traditional is given up in favor of the modern, communities can be left exposed to the risk of disasters. Modernization has played a big part in the rapidly disappearing traditional architecture of Nias. The status symbol which is represented by this shift to modern design and lifestyle is an adequate reason for most people to choose the less resistant Malayan houses over the traditional wooden structures. Deforestation has exacerbated the situation. The hardwood needed to build traditional houses is in scarce supply. As a consequence many of the methods and techniques used to build traditional houses are slowly being forgotten since concrete and bricks have replaced timber as construction material.

## Siberut

The story of teteu is part of the traditional belief system of the Mentawai people. The local communities make frequent reference to traditional legends and songs which had shaped their reactions to the earthquake when it was felt. In many cases, people were saved because of the knowledge they had gained from listening to these legends and songs.

The legend which helped reduce the casualties resulting from the earthquake may not be considered a disaster risk reduction method in itself, since its impact is inextricably linked to traditional house building rituals;

however, the traditional belief system and related legends do contribute to disaster risk reduction. With the pressure of development, these may lose significance and impact within the local communities. The adoption of monotheistic religions has started to erode people's belief in spirits, including teteu, and the ritual offerings made to such spirits are not as frequent as before. It was seen how the act of making offerings serves to reinforce knowledge of earthquakes in the collective memory of the communities. Yet as these practices are replaced by the introduction of more modern beliefs, this knowledge is on the brink of being forgotten. Therefore, in order for this knowledge not to be lost, there is a need for modern alternatives which emulate the same transfer of knowledge with similar significance to the local communities.

The three examples of indigenous practices in disaster risk reduction illustrated here have one important common thread: they are all found in remote, underdeveloped areas, which is often but not always the case with indigenous practice. In the cases of Simeulue, Nias and Siberut these examples still exist in practice today precisely because the islands have been cut off from the more developed main land and they have largely been exempt from modern development. They have all been minimally touched by modern infrastructure, education, communication and transportation methods. Development has only just begun to make inroads into the three islands, but already the effects can be seen on indigenous disaster risk reduction practices and knowledge. The question that poses itself here is how will development and modernization affect indigenous practice as progress continues? With regards specifically to disaster risk reduction, what is role of indigenous practices in the modernization of these three islands? Should efforts be made to preserve these isolated examples of indigenous practice or is it naïve to think of these practices as easily packaged solutions that can be reproduced for the benefit of future generations?

The pace and nature of modern development does not always leave room for indigenous practices. When indigenous practice is not replaced by a modern alternative, communities can become more vulnerable to disasters. Indigenous practices have allowed many communities over the centuries to live alongside disaster, but when modernization progresses too rapidly the value of these indigenous practices within this new, modern context is not always understood. It is only when development progress is interrupted by nature in the form of devastating disasters that examples of indigenous practices are once again thrown into the spotlight and it will be remembered

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## Gifu Prefecture, Japan

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# Traditional Flood Disaster Reduction Measures in Japan

*Yukiko Takeuchi and Rajib Shaw*

### Abstract

Indigenous knowledge for flood mitigation in Japan has been developed and tested over time, and has been found to be effective. A combination of flood prevention, erosion control and damage reduction technology is examined in the flood-prone Gifu prefecture in central Japan. Through the documentation of this experience, it is argued that proper utilization of indigenous knowledge and technology requires on one hand, appropriate policy support and awareness by researchers, and on the other hand, recording, verification and testing of technology.

### Background

Japan, an island arc which belongs to the monsoon region, is under the influence of warm and moist air masses in summer and cool air masses in winter. The moisture in the air masses from the sea is absorbed and is emptied over the country by typhoon in summer, by snowfall in winter, by the “Bai-u” front in June and July, and by depressions and fronts in all seasons. The average amount of precipitation is 1,800 millimeters (70 inches) a year. This is two or three times the amount received in other areas of the same latitude. In the southern Pacific coast areas, precipitation amounts to 4,000 millimeters (160 inches). Owing to Japan’s slender shape and complex landform, aerial differences in climate are considerable.

Three-quarters of the land is mountains at generally high relief. Chains of spinal mountains, some reaching 3,000 meters (10,000 feet) above sea level, run through the center of the long and narrow country. Consequently, the rivers are generally short with steep gradient. Erosion and devastation in the mountain

areas are very rapid. Rivers are flooded soon after a heavy rain. In addition, Japan is situated in the circum-Pacific seismic zone and suffers from severe seismic and volcanic activities. Active volcanoes in Japan make up one-tenth of the world total. The greater part of the population of more than 100 million lives in the narrow plains with exceedingly high densities. Inappropriate land use prevails as a result of rapid and disordered urbanization. Artificial changes in natural environments are rapid and large, accompanying the sizable increase in economic activity and exploitation.<sup>1</sup> Most cities in Japan are concentrated on coastal plains. Considering that 10% of the country’s land area is flood prone, about 50% of the population and almost 75% of property is situated in flood plains.<sup>2</sup> Specifically, the Gifu prefecture, one of the most flood-prone areas of Japan, is located in the junction of three rivers: the Kiso, Nagara and Ibi Rivers. These three rivers surround the Noubi plain, a low altitude flood plain.

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<sup>1</sup> T. Nakano et al. (1974).

<sup>2</sup> Japan Water Forum (JWF) (2006).

## Story/Event

Flood disaster happens every year in the alluvial plain and delta area of the Gifu prefecture. Owing to its location and topography, the Noubi plain experiences a number of flood disasters as a consequence. For over 200 years, people have struggled to protect lives and assets from flood disaster.

# Indigenous Knowledge

In the past, people had no control of the rivers; yet life and assets were protected through small scale technology, knowledge, tradition and cooperation in the community. For example, in the early 19th century (Edo period), flood mitigation activities were mandated through the practice of “goninggumi”, a system of mutual assistance, cooperation and monitoring consisting of five families in a given community. There were several other programs including bamboo planting to prepare for and mitigate flooding and forest management in the flood plains.

During the late 19th century (Meiji period), many flood control technologies were implemented by engineers from the Netherlands. People were able to safeguard life and assets better by technological interventions such as concrete dikes, check dams, water gates and pump facilities, among others.

In earlier times, flooding from the river was considered a natural phenomenon in which people never tried to block the flood but rather developed some knowledge-based tool to reduce the damage. Three important types of traditional knowledge and technology in the Gifu prefecture are depicted in Figure 1 and discussed below.

## Flood Prevention

To reduce the impacts of flood, traditional ring dykes have been built in the area, protecting several houses and cultivated land areas (Figure 2). This is known as Waju (inside ring). In historical maps, these types of ring dykes can be observed in several locations, interconnected in many places. A key point of the ring dyke is its maintenance by communities. Every village maintains special committees that look after the ring dykes. This cooperation helps to develop self-esteem and strengthen local community ties. As a result of the countermeasures undertaken by the government in the Kiso, Nagara and Ibi watershed areas in the 18th century, the frequency of flood in these areas has been reduced. After which the importance of the ring dike became low and some were brought down so land can be put to other use.

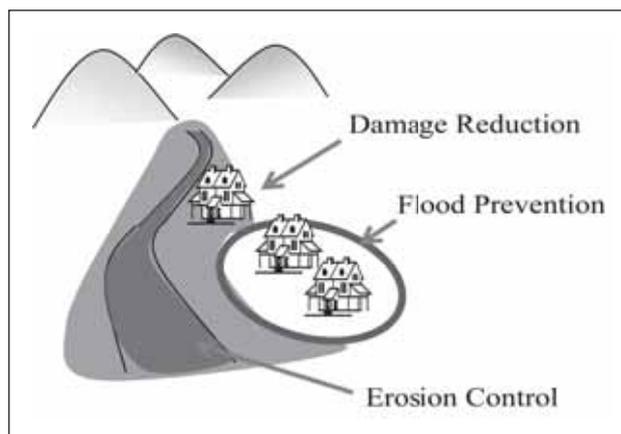


Figure 1. Types of traditional knowledge and technology



Figure 2. The Waju protects the community from floods (Photo by Iwanami Co., Ltd., 1956)

### Erosion Control

To minimize erosion, simple structures have been built on river banks, especially on the winding portions of the river. This structure is called Hijiri-ushi, meaning Grand Ox, possibly due to its similar form to the ox. The objective of this structure is to reduce the force of the water in the river to lessen the impact of erosion. There are several types of Hijiri-ushi based on the kind of material used. The most common types are shown in Figures 3 & 4. Typically, a set of hijiri-ushi consists of 5 structures. In each winding portion of the river (depending on the length of the winding portion), 13-15 sets are usually placed (Figure 4).



Figure 3. Hijiri-ushi made of concrete (Photo by NIED-KU, 2007)



Figure 4. Hijiri-Ushi at Nagara River (Photo by NIED-KU, 2007)

It is notable that the same technology is still practiced today with only a slight modification in the type of material. Nowadays, concrete is used instead of wood to give the structure a longer life span.

### Damage Reduction

To reduce damages from floods, elevated houses called Mizuya have been built (Figure 5). Well-off families commonly have the Mizuya in addition to the main house to use in case of flooding. Initially, the Mizuya was built as a storage room to protect household assets. When a severe flood disaster occurred in 1896, the Mizuya's plinth height was only 2 m. When the flood destroyed the Mizuya, house owners had the

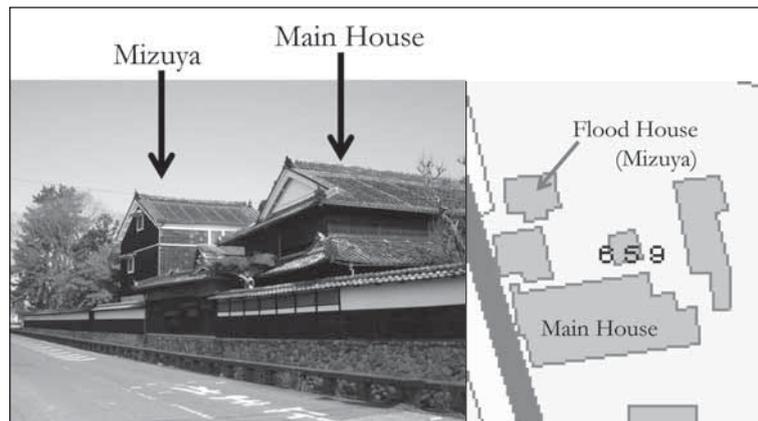


Figure 5. Mizuya, the flood house (Photo by NIED-KU, 2007)

Mizuya reconstructed by raising the plinth level 1.3 m higher than the previous level (Figure 6). The Mizuya was further modified so people can stay inside for a longer period. The modified Mizuya consisted of two rooms, a storage room and a toilet. Well-off families also have an emergency boat for evacuation (Figure 7).

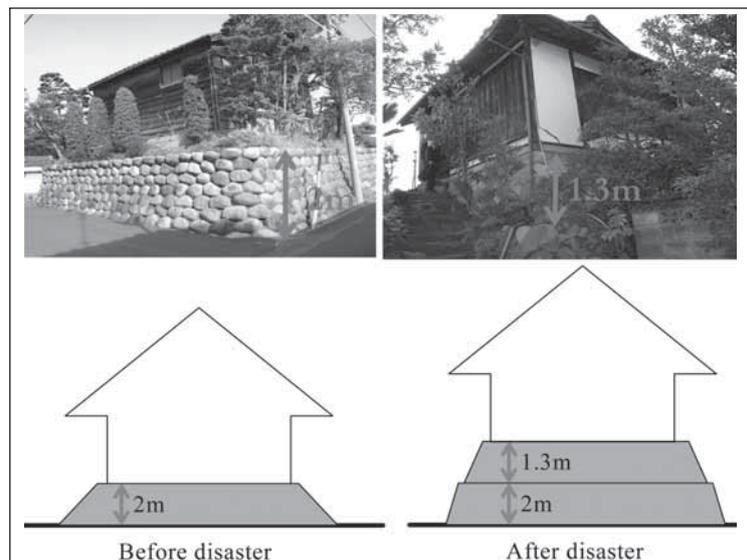


Figure 6. The Mizuya's plinth height was increased after the 1896 flood disaster (Photo by NIED-KU, 2007)



Figure 7. Emergency boat  
(Photo by NIED-KU, 2007)

## Lessons Learned

Although the existence and application of traditional knowledge and technologies have gradually diminished in most parts of Japan, there are several shortcomings in being solely dependent on modern disaster reduction technology. Traditional knowledge has proven to be useful in local cultural and socio-economic contexts, maintaining traditional principles, though modified over time, to develop higher resiliency. Moreover, the community's involvement is a key to indigenous knowledge practice. Relying on modern technology makes people too dependent on external forces, thus reducing the community's capacity and ability to help themselves. Many of the recent disasters have demonstrated the failure of the system to support affected communities, making people helpless and causing greater damage. Therefore, an ideal disaster reduction measure should incorporate a balanced mix of modern technology and traditional knowledge.

On one hand, it is necessary to focus on the development of disaster reduction technology. On the other hand, it is important to focus on the implementation of technology, to walk through “the last mile” and bridge the gap between theory and practice. For this, traditional and indigenous knowledge plays a crucial role, since this is directly linked to the communities. For effective use of traditional knowledge, there should be clear policy at different levels, in both disaster reduction and research and education, to support its use. It is important to document the traditional knowledge in a systematic way. The steps for documentation include: (i) collection of basic information, (ii) verification of strengths and weaknesses, (iii) examination of applicability in different contexts (physical, social, culture and economic) and (iv) classification of the technology based on certain criteria.

Risk communication is a two-way interactive tool for sharing risk information among government officials, researchers and the local people. To reinforce risk communication, government, researchers and the local people must build upon one another's knowledge. Government departments and the research community usually possess a much higher level of ‘risk information’ compared to local communities. Nonetheless, local communities are rich in terms of local knowledge. Available risk information needs to be well complemented with local wisdom and traditional knowledge to effectively reduce disaster risks in local communities. Even if there is a need to implement new technology for disaster reduction, the local people must be involved to allow them to understand the advantages as well as the shortcomings of the technology (i.e. with specific details pertaining to new materials used, investment required, time consumed and others). Governments, as well as academia, need to appreciate existing traditional practices and techniques to be able to propose context-based improvements most appropriate for a particular area.

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## Shiver Herder Community, Mandal, Selenge, Mongolia

# Indigenous Knowledge for Disaster Risk Reduction of the Shiver Herder Community

*Bolormaa Borkhuu*

### Abstract

The herder community “Shiver” of Selenge aimag (province) in Mongolia is continually exposed to hazards brought by disasters in the form of zud (Mongolia-specific winter disaster), drought, forest fire, rainstorm and infestation of harmful forest insects. The community collectively brought together indigenous knowledge that can be used for disaster risk reduction. The community’s land use map, knowledge of disasters, seasonal calendar and social organization comprise some areas of indigenous knowledge which help the community prepare for disasters throughout the year, especially in winter.

### Background

Mongolia is divided into the capital city and 21 aimags or provinces, with further divisions of aimags into soums, soums into bags, capital city into districts, and districts into horoo. The community members of the herder community “Shiver” belong to the Mandal soum. The center of Mandal soum is located in the northern part of the country, 160 km away from Ulaanbaatar (the capital of Mongolia), 200 km away from Selenge aimag’s center.

The herder community Shiver in Mandal soum of Selenge aimag consists of nearly 30 herder households. Since ancient times, herders in Mongolia used to join in khot ails - groups of 4-5 families by family and kinship.

### Story/Event

The rural people in Mongolia are highly dependent on climatic conditions and are often exposed to hazards brought by natural disasters of which zud, drought, forest fire, rainstorm, and infestation of harmful forest insects are the most widespread. Due to climatic and ecological changes, the incidence of droughts and zuds has become more frequent. Zud is the most common natural disaster. Zud is a Mongolia-specific winter disaster which undermines the welfare and food security of the herding community through large-scale death and debilitation of livestock. The direct cause of a zud disaster is the build up of damaging natural phenomena including (i) severe widespread drought in summer, (ii) unusually cold temperatures in autumn and winter (below  $-40^{\circ}\text{C}$ ), (iii) deep snow (more than 70 cm), (iv) ice layers on the land and (v) low nutrient value of grass. These conditions, along with the increase of other natural disasters, all considerably affect the country’s economy and the livelihood of the rural population.

# Indigenous Knowledge

The herder community “Shiver” collectively identified the indigenous knowledge useful for disaster risk reduction (Figure 1). Several important groups of knowledge emerged, including land use map, knowledge of disaster causes and impacts, seasonal calendar and social networks.

## Land Use Map

Through a survey, herders produced a map of the place where they lived with a description of the land under use (Figure 2). Areas on the map designated seasonal quarters, hay fields, reserved pastures, rivers, springs, forests, burnt forests, roads, bridges, cultivation, areas of high snowfall during zuds, among others. The map shows that herders’ territory is surrounded by forest in the east and north. The herders’ winter quarters are sparsely located in mountain valleys including Chavgants valley, Urtuunii am, Khuurai Shaazgait, Marz, Shar Khad, Tsagaan chuluut, Nariin pass. Summer quarters can be found in the sides of Ar bulag, Galsan bulag and Saalinch rivers. Autumn quarters are densely located close to winter quarters of herders.

The map indicates 30 households living in 13 winter quarters with 1-5 households in each winter quarter and 43 households in 8 summer places with 2-9 households per summer quarter. The number of households in the summer quarters exceeded that in winter quarters because many families from urban settlements come to the area to spend the summer and return in the autumn. Hay fields cover the areas of the Shiver river basin and are close to the autumn quarters.

## Knowledge of Disasters and their Causes and Impacts

Herders name zud, drought, forest fire, rainstorm, and infestation of harmful forest insects as the most widespread of natural disasters in the area. They recognize the causes of these disasters as various conditions, such as poor implementation of laws, pastureland problems, deforestation and climate change. The impacts are likewise varied such as animal loss, changes in flora composition and shortage of pastureland.

## Seasonal Calendar

A seasonal calendar is used to identify the seasonality and duration of disasters. The following are observed and acknowledged by the herder community:



Figure 1. Collecting indigenous knowledge for disaster risk reduction

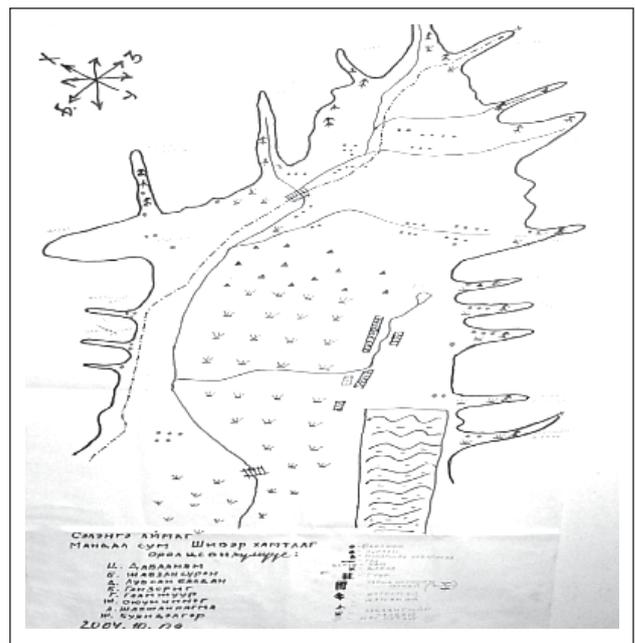


Figure 2. Mapping the land surrounding Mandal Soum.

Zud and Drought: June-September  
Forest fires: April – June in Spring, September  
– October in Autumn  
Heavy rains: June – August  
Infestation of harmful forest insects – May (beginning  
of growing season) – September

### Social Organization

In rural areas, herders and residents form many self-help units and cooperatives in order to collectively solve problems related to drought, zud, forest and steppe fires. During disasters, neighbors, family members, relatives and soum authorities provide the most assistance. Moreover, the local Red Cross and Member of Parliament elect also give aid and support.

The main objectives of the herder communities are to ensure rational use of pastures, prevention and mitigation of natural disasters and a shift to a market economy. Grass-root level initiatives that extend beyond water and pasture protection to a broader scope including environmental protection, sustainable use of natural resources and disaster management are encouraged.

Indigenous practices are prevalent due to a need to mobilize disaster management actions at the grass-root level. It is the local community that is hit by disasters and therefore its members must directly understand local disaster risks and undertake measures to mitigate the consequences of impending disasters.

## Lessons Learned

There are several key lessons learned with regards to indigenous knowledge for disaster reduction from the case of the Shiver community:

1. In Mongolia, herders in rural areas have already developed the initiative and built up enthusiasm to join groups in order to work, conduct business activities and overcome problems and difficulties through a collective effort.
2. The Shiver community is able to recognize and identify common natural disasters in Mongolia such as zuds, droughts, forest and steppe fires, storms and heavy rains. Special characteristics of the disasters include: relatively long duration, enormous scope and large amount of damages. Rural communities should be able understand their vulnerability to these continual and economically destructive disasters.
3. Livelihoods of Mongolian herders, their settlement and occupation are considerably different from other countries. Therefore, a disaster management system should be adapted to specific local conditions.
4. Local disaster management systems at the grassroots level are needed to enable herders to overcome disasters with minimal losses.
5. Disaster management should not focus only on availability of good pastures and hayfields to enable herders to overcome winter successfully. It is important that management also involves sustainable utilization of natural resources of the area.
6. Use of indigenous knowledge of rural communities for disaster risk reduction is a cost-effective and efficient method and is vital for reducing risks of most frequent, continuous and economically destructive disasters such as zud, drought, and forest and steppe fires.
7. State institutions should implement comprehensive measures aimed at increasing awareness of “disaster mitigation” among the population, especially among the poor. Moreover, grass-root initiatives should be promoted. People’s perceptions on vulnerability to disaster should be altered and the understanding of disaster management as limited to post-disaster relief assistance should be broadened to include disaster risk reduction and prevention from disasters.

## Bardiya, Chitwan, Syangja and Tanahu Districts, Nepal

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# Indigenous Knowledge on Disaster Mitigation: Towards Creating Complementarity between Communities' and Scientists' Knowledge

*Man B. Thapa, Youba Raj Luintel, Bhupendra Gauchan and Kiran Amatya*

### Abstract

Nepal is prone to several natural disasters, including landslides, floods, earthquakes, fire and droughts, due to topography, unplanned development and rapid population growth, among other causes. As a result, many remote and isolated communities have made use of different indigenous mitigation and preparedness practices to minimize the negative impacts of disasters to life and property.

Systematic and in-depth studies on indigenous knowledge for disaster management are rare in Nepal. Nonetheless, the experiences of the UNDP-supported project Participatory Disaster Management Program on indigenous knowledge for disaster management focuses on landslide mitigating techniques that exist and are practiced in the districts of Bardiya, Chitwan, Syangja and Tanahu in Nepal. The project aims to encourage policymakers to incorporate a diverse range of indigenous knowledge in the disaster management initiatives of the country.

### Background

The Participatory Disaster Management Program (PDMP) was implemented in 2000 in eight villages spanning four districts of Nepal. The targeted villages included Bhandara and Kathar of Chitwan District, Risti and Kyamin of Tanahu District, Kahule and Oreste of Syangja District and Guleria and Padnaha of

Bardiya District. The program, based on the experience of a similar earlier program called Upgrading Disaster Management Capacity in Nepal, aims to combine modern knowledge and indigenous knowledge in disaster preparedness and mitigation with the goal of building community capacity in a participatory, sustainable and cost-effective manner.

## Story/Event

Landslides are common in many parts of Nepal. Landslides can occur both downstream (i.e. of a watershed system) and upstream (i.e. mountains). Several conditions and practices exacerbate the problem of landslides. For example, the growing extraction of boulder and sand from or along the riverbeds in a massive scale intensifies the problem. The increasing level of riverbeds downstream, due to debris deposition, can also lead to landslides .

The lack of proper forest management also contributes to landslides. Actions such as not trimming the trees and not cutting down the old trees in proper time augment the problem. Heavy deforestation and poor agricultural practices also amplify the problem. Dandhelo (forest fire) increases the depletion of forest resources. Dandhelo happens not only because of human negligence or error in the dry season but also because it is done deliberately due to the myth that it helps regenerate the vegetation. The practice of khorja (slash-and-burn cultivation) system also intensifies the depletion of forest resources.

Furthermore, gully erosion may cause landslides. Gullies emerge due to overgrazing, regular grazing (i.e. in the same field), insufficient or improper natural drainage system for monsoon water and increasing road works (e.g. trails, roads, etc.) that are not friendly to the local environment. Lastly, in many cases, landslides cause floods. Therefore, there is a close relationship between landslides and floods.

# Indigenous Knowledge

Local communities possess a range of traditional measures to mitigate landslides. In addition, the local people observe signs in the environment which allow them to take precautions before a disaster occurs.

## Agro-Forestry

Instead of heavy trees, communities in the hills prefer to grow shrubs, bushes and grasses in and around the villages. Farmers perceive that small trees, shrubs and grasses in bounds and steep areas protect their farms from soil erosion and landslides. Their experience shows that such shrubs and bushes prevent topsoil loss and do not have the risk of falling down during a heavy rainfall. Farmers in Terai plant such species on marginal lands not suitable for cultivation. In addition, farmers plant amriso (bouquet grass) and babiyo (eulaliopsis) to protect the terrace riser. These plants have deep roots scattered around the area thus firming up the soil. Likewise, bamboo is planted in gullies and shady areas to control water runoff. The bamboo's widely spread roots intermingle in such a way that they act as a natural interlocking system for soil conservation. Agro-forestry practices such as these not only provide fodder, firewood and bedding materials for livestock but also supply cash income.

## Improving terrace riser

In areas where arable land is scarce, people have no option but to cultivate on marginal and steep lands. Most often such lands are vulnerable to landslides. However, for centuries farmers have been developing terraces on steep slopes to reduce water runoff and topsoil losses and to make crop cultivation easy. They are also able to build and manage terraces that have a slight slope on the corner rather than at the end in hills and mountains. By putting stones and mud blocks at the edge of the terrace, the water retained in the terrace is able to pass through the corner. With this practice, land in steep slopes is converted into terraced plain land (Figure 1). Although the primary objective is to enlarge the size of cultivated land, this technique results in minimizing topsoil losses and reducing water runoff which ultimately reduces the probability of landslides.

Additionally, farmers also allow grasses to grow on the terrace riser. Grasses grown on the terrace riser keep the soil intact and reduce the rate of rain and irrigated water run off. Consequently, growing grasses helps control topsoil loss and reduces the vulnerability of the terrace riser from landslides.

## Fencing

Fencing has been one of the most popular ways to protect standing crops from animal damage and allows plants and grasses to grow on marginal lands. Mature plants and grasses help prevent soil erosion and landslides. Two common types of fencing are dry wall fencing and bio fencing,

Dry wall fencing. In the hill districts, farmers construct dry stone walls on the side of the farm or near streams, gullies or trails. Construction of such dry walls is an effective practice in minimizing the effect of floods, landslides, soil erosions, side cuttings and slope failures. It also diverts floods and keeps animals off the farmland. The structure consists of big boulders and rocks set



Figure 1. Terrace riser in Tanahu with bamboo matting as landslide protection.



Figure 2. Stone fencing for river control and to keep animals off the farmland.

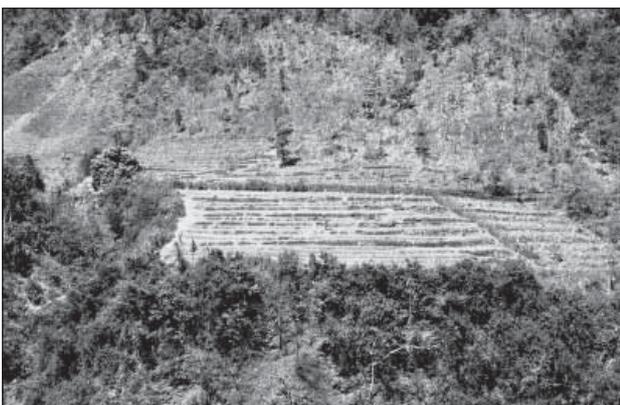


Figure 3. Bio Fencing with plants in Chitwan.

upon an excavated foundation, with smaller stones stacked on the soil surface. Usually, farmers plant bamboo and other tree species beside the wall to make the structures stronger and more durable.

In areas near farm land where rocks and boulders are available, farmers place these structures on the sides of streams with strong currents. Since working with big rocks is difficult, groups of people are often mobilized to carry out the task of construction. Although stone wall fencing is an expensive practice and needs regular maintenance, it is an effective practice since it diverts the flow of the stream or river from the cultivated lands.

**Bio Fencing.** Bio fencing is practiced by a large number of farmers in Terai and other hill villages. It serves as an alternative for dry wall fencing when stones in the desired size and quantity are unavailable. Commonly used fencing plants include sajiwan, neem tree, khirro, and simali. Some species of fodder trees are also grown (alone or mixed with fencing trees) such as badhar, dabdabe, gindari, koiralo, kutmiro, phaledo, siris, and tanki for fencing purposes. These are deciduous and deep-rooted plants which lose their leaves during winter thus providing sunlight for seasonal crops. The dead leaves also serve as organic matter that enriches the soil. Furthermore, these deep-rooted plants do not compete with cereal crops for nutrient and moisture.

### Mixed and Inter Cropping

Farmers in the hills as well as in Terai increase crop intensity through mixed and inter-cropping. In the hills, they plant maize with soybean or cow-pea; finger millet with masyang (black gram); wheat with potato, and so on. One of the primary objectives of intensifying crops is to increase and diversify harvest. It is also an effective method of reducing topsoil loss since it breaks the rate of surface run-off. Keeping one crop at a time means not leaving the farm fallow and uncovered. Farmers' years of experience have shown that bare fields are prone to soil erosion due to wind, water and landslides.

In addition to these various mitigation techniques, the communities also have the ability to recognize warning signs for impending landslides, for which they can prepare before the disaster occurs. For instance, if new faults appear in the earth's surface, it can be an indication of landslides in the immediate future. Water sprouting in new places can be another indication. Furthermore, a change in the posture of the tree in any vertical or horizontal angle may be an indication of landslides in or around the area.

## Lessons Learned

Nepal is a small but vastly mountainous and highly disaster prone country. The country's capacity to cope with floods and disasters has been terribly weak, both at national and community levels. Several reports are available on the value of indigenous knowledge for natural resource management in Nepal; however, literature on indigenous knowledge for disaster mitigation and preparedness is scattered and scarce. Systematic and in-depth studies on disaster mitigation in general and indigenous knowledge in particular virtually do not exist..

Further, a review of the existing literature reveals that the indigenous knowledge and practices held by these communities are neither taught in the classroom nor recorded. For the most part, such knowledge continues to exist for two reasons: First, the knowledge has a functional utility in the communities concerned; Second, such knowledge has a strong and dynamic nature of inter-generation transmission through practice and oral tradition.

After almost a year of observation and interaction with the local people in the eight villages, it becomes apparent that not all communities hold an equivalent range of knowledge on disaster mitigation, as can be expected. Such knowledge has been found to be stronger in homogenous and tribal communities than in migrant communities (such as Brahmin and Chhetri in Terai districts). Communities that have a strong sense of solidarity and harmony, such as Gurung and Tharu, possessed more knowledge on disaster mitigation. The more self-reliant and relatively endogenous a community is, the higher the chance that it possesses a rich stock of indigenous knowledge. For all communities, however, there is the increasing threat of erosion of traditional wisdom due partly to the effects of modernization.

Communities have a large and diverse body of knowledge on disaster mitigation based on traditional wisdom. Since they live in remote, isolated and inaccessible hamlets on the ridges or on the foothills, they have their own coping strategies in times of disaster. Cross-fertilization and blending of this indigenous knowledge with modern scientific knowledge would strengthen the communities' capacity in disaster mitigation and preparedness. Detailed, systematic and intensive studies on indigenous knowledge would contribute to a more comprehensive understanding and appreciation of their overall contribution for better and safer living conditions of the people. It is therefore highly imperative to collect, compile and systematize the diverse range of indigenous knowledge before it disappears. A record of such knowledge will show if more can be done to make the efforts of building disaster management capacity in the communities not only cost-effective but also sustainable and harmonious to the nature-culture interface.

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## Eastern Terai of Nepal and Chitral District of Pakistan

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# Local Knowledge on Flood Preparedness: Examples from Nepal and Pakistan

*Julie Dekens*

*Extracted and adapted from “The Snake and the River Don’t Run Straight. Local Knowledge on Disaster Preparedness in the Eastern Terai of Nepal” and “Herders of Chitral. The Lost Messengers? Local knowledge on Disaster Preparedness in Chitral District, Pakistan” Kathmandu: ICIMOD, 2007.*

### Abstract

Local knowledge on flood preparedness was documented through two case studies in various rural communities of Eastern Terai of Nepal and Chitral District of Pakistan. Information was collected in regards to people’s capacity to observe, anticipate, adapt to, and communicate about flood risks. The examples demonstrate that over time people generally develop considerable local knowledge and practices on flood preparedness which contribute to improve survival and mitigate property losses. However, this local knowledge is often overlooked by external agencies, both national and international, which tend to focus on external, scientific knowledge. Local knowledge is also getting eroded due to rapid change in environmental and socio-economic contexts. The case studies demonstrate the need to further assess local knowledge and practices in order to strengthen good local practices (those which are sustainable and equitable) and attenuate unsustainable ones. Ultimately, understanding local knowledge and practices is a pre-condition for integrating local contexts and needs into DRR programs. DRR projects would benefit in combining external, scientific knowledge with local knowledge in order to create innovative and sustainable solutions.

### Background

The case studies were done in the districts of Dhanusa, Mahottari, Rautahat and Sarlahi in Eastern Terai in Nepal and in the Chitral district of the North Western Frontier Province in Pakistan. The rural communities in both case studies often combine subsistence farming and off-farm activities. Like throughout the Himalaya, communities are facing rapid changes in environmental and socio-economic contexts which influence their vulnerability to natural hazards risks and the way they respond to it.

### Eastern Terai

Compared to the rest of Nepal, most communities in the Terai are more conservative and the Hindu caste system influences people’s socioeconomic relationships more strongly. In the study area, the few high-caste persons in the village were mostly landowners and moneylenders. Poorer, lower-caste people are therefore often dependent on the higher castes for survival because of their lack of access to assets. Important differences exist in social vulnerabilities among different castes and socioeconomic levels, among different age groups and within each

household. Moreover, gender vulnerability is more pronounced in the studied districts as women in the Maithali culture, which predominated in the villages, mainly stay and work at home. Following increased male migration, however, more and more men are working outside the village or the country and more women must undertake work outside their homes.

### Chitral District

Socio-economic disparities between people in the Chitral district are not as pronounced as in Nepal. What is more unique about this case is the physical context of those remote mountain communities. The physical geography of Chitral district does not, in general, provide many safe places to live. Barely 3.5% of the Chitral area is suitable for farming. The mountain slopes often consist of steep, barren land unsuitable for settlement. The river plains are exposed to recurrent floods making them equally unsuitable for settlement. People are often in a situation in which they have to find the least vulnerable spot within the alluvial fans. In general, such places are at the sides or at the very edges of the fan. Those fans are transformed into oases when people construct irrigation channels. These rain-fed irrigated lands are very fertile because of the constant deposition of eroded sediment. Farmers grow cereals, fruit trees, and some vegetables mainly for subsistence purposes, using buffaloes to plough the land.

### Story/Event

Floods in both case studies are recurrent events occurring almost every year. Loss of life due to floods is low, but physical damage to agricultural land and domestic property is high with important consequences for people's livelihoods, because most people mainly depend on farming.

The eastern Terai of Nepal has a tropical monsoon climate characterized by hot, wet summers and mild, dry winters, resulting in wide seasonal variations in amount of water discharged. Most of the rainfall is concentrated during the months of June to August. Any continuous and heavy rainfall during the monsoon season can provoke inundation in the already saturated soil. Similarly, heavy rainfall higher up in the mountains can trigger a flash flood or a riverine flood downstream. People can easily draw a boundary between normal yearly flooding and exceptional floods that are more destructive and that happen at greater intervals than normal ones.

## Indigenous Knowledge

The local knowledge used by the community which contributes to their capacity to reduce disaster risks includes at least the following aspects:

- **Local environmental and historical knowledge:** Local people have knowledge about the history and nature of floods in their own locality through observation and experience of floods, based on daily observation of their local surroundings, close ties with their environment for survival, and an accumulated understanding of their environment through generations. This is important because past experience and understanding of floods is going to influence current ones. One example relates to people's capacity to observe their local surroundings in Chitral District. There, one of the most important adaptation strategies to flash floods based on local knowledge is the ability to "read" the landscape, and thereby to make interpretations on where to build, or not to build, houses and homesteads. As a result, houses in Chitral are normally built in relatively safe places despite the extremely high risk for flash floods and other natural hazards in the districts.
- **Local organizational knowledge:** People planning, monitoring, and assessment capacities are based on various trade-offs, perceptions, beliefs, and past experiences of floods. People often anticipate floods through observing and interpreting local, environmental warning signals (e.g., color of the water, color of the clouds). They also manage to identify safe places for human and cattle and time thresholds (i.e., when it is time to store firewood and food in advance, remove important belongings and leave the house).
- **Knowledge about development projects:** People's beliefs about regional, state, and international actors

likely to intervene in disasters influence how people are going to respond to the interventions of those actors.

- **Technical local knowledge:** Examples of technical adaptation strategies to floods include measures related to house construction and protection measures for walls, elevated stores, drinking water and transportation, and measures taken to divert streams. For example, in eastern Terai of Nepal people have adopted various simple strategies related to house construction (e.g., increasing the house plinths, consolidating and protecting walls with piled up mud, bamboo fence and mud etc.), constructing elevated food stores and platforms to keep small items, food, small livestock and people themselves away from water (Figure 1).
- **Non-technical local knowledge:** Examples of non-technical adaptation strategies include measures related to spatial and social mobility (e.g., ability to rely on relatives and neighbors, economic diversification strategies), food security, micro-finance arrangements, natural resources management (e.g., community regulations on grazing and deforestation, reorganization of cropping patterns and landholdings,



Figure 1. Circular mud repository 'chakka', with unusual "pigeon hole" design to keep valuable belongings during floods in Katarait VDC, Dhanusha district, a flood-prone Terai region of Nepal (Photo: Julie Dekens)

adopting new cropping strategies such as planting along the river, or planting vegetable on the riverbank to reduce the impact of flood, beliefs and attitudes towards change such as the ability to learn from past mistakes and flood events, and developing institutional linkages outside of the community).

- **Local communication strategies:** These include oral and written communication about past and upcoming floods and local early warning systems (e.g., whistling, shouting, running downhill).

Everybody has local, everyday knowledge about the environment. The degree of local knowledge also depends on the nature of the community (e.g., migrant communities have less knowledge than a community who has been settled in a specific area for generation and generation. At the same time, communities like nomads might have local knowledge about more than one area). Some community experts and some specific social groups also have local, specialist knowledge; that is, they have key skills that are not known to every community members and which can be useful for flood preparedness. Examples include fisherman community whose everyday life is in close relation with water. As such, they can often notice any changes in water availability and quality and they often know how to swim. Other groups may have knowledge related to carpentry and bamboo weaving, a useful skill for the construction of the elevated platform against floods found in the Terai of Nepal. Some informal leaders may also be respected and have communication skills which enable them to speak in public and convey warning messages about time thresholds (e.g., "it is time to leave your houses!") which people trust and follow.

The communities in Chitral have also developed several other adaptation strategies in order to increase their resilience to flash floods. For example, locals have learned to interpret early signs of potentially destructive flash floods. Such signs may be the color, smell and behavior of mountain streams as well as meteorological forecast skills. In 2005, 106 houses were destroyed in Brep village due to a Glacial Lake Outburst Flood (GLOF). However, not a single life was lost since the interpretation of the stream behavior acted as an early warning and the village was evacuated in time (Figure 2).

Knowledge about flood preparedness is transmitted orally through learning by doing, daily observation of their local surroundings, story telling, and the internalization of certain practices over generations. The dissemination of this knowledge occurs at two levels: among community members (i.e., early warning



Figure 2. A glacially derived debris flow destroyed 106 houses and large areas of agricultural land in Brep, Chitral District, Pakistan. (Photo: Arun B. Shrestha)



Figure 3. Part of the ICIMOD research process was to record and document local songs and proverbs relating to disaster, letting the people hear their own recording. Local songs and proverbs can be used in preparing communities for disaster (photo from Shreepur VDC, Sharlahi district, Nepal). (Photo: Julie Dekens)

of upcoming floods) and between generations (i.e., transmitting knowledge and lessons learnt of previous flood events). In the case studies, as in the rest of the Himalaya, communities do not record history in books and the past is transmitted orally by elders through story telling. As such, the role of elders is crucial as they often are the social memory of a community and/or a certain group. In many societies based on oral tradition, past events, including flood crises, are embedded in memory through storytelling, songs, poems, proverbs, worshipping activities and ceremonies, rituals and so forth. For example, traditionally, songs and poems are an important part of the Nepali and Terai culture. One such example is the proverb: “the snake and the river don’t run straight”. The shape of the rivers in the Eastern Terai of Nepal can be compared to the movement of a snake referring to the nature of the rivers in the study sites: the water channels are very unstable, taking new directions and changing the landscape on a regular basis. Some of the songs collected in the Nepal case study focus entirely on floods, whereas others mention floods among other important issues the villagers are facing. In some cases, songs and proverbs become the repository (as much as the relay) of past floods event and can help stimulate people’s learning, memory and creativity (Figure 3).

Songs and proverbs also contribute to the transmission of flood-coping strategies, create common knowledge, and share a common understanding of change related to frequent and infrequent flood events. Songs and proverbs can also help to build a sense of community and solidarity within the village and/or within the different groups affected. Local singers or composers are key knowledge carriers and change agents who play a vital role within the community in terms of building awareness. Some worships, sacrifices, and ceremonies help the community to understand and remember past floods and relieve the anxiety related to the threat of future disaster risks. For example, in the Kalash community, one ethnic minority of the Chitral District, Pakistan, a collective ceremony called “lavak natek” seems to stimulate elements of floods through symbolic actions (i.e., running down from the hills and shouting) and acts as cathartic events for the whole community.

# Lessons Learned

Overall, the two case studies demonstrate that indigenous and local practices often, but not always, have at least the following advantages compared to most external, top-down strategies:

- Low cost strategies using local resources and know-how
- Well-accepted, trusted and understood (internalized)
- Community ownership
- Culturally sensitive
- Continuous monitoring
- Time tested reliability
- In tune with local contexts and needs
- Empower the community, including the most vulnerable and disadvantage groups, to take action instead of relying on external help only
- Holistic (takes into account other stresses or priorities which affect the vulnerability of social groups, households or individuals)

Based on the two case studies, the following conclusions can be obtained:

- Over time local people generally have developed considerable local knowledge and practices on flood preparedness which contribute to improve survival and mitigate property losses
- Social relationships, and especially caste arrangements, are important elements that help in the understanding of local knowledge

Many limitations and barriers to the use of local knowledge in disaster management exist. These include at least the following:

1. the belief that conventional or scientific knowledge is 'superior' to local knowledge is still dominant
2. local knowledge is difficult to identify, use, assess, validate, generalize and replicate
3. local knowledge is often monopolized by dominant groups in the community
4. some local practices, beliefs, and adaptation strategies are unsustainable and/or not socially equitable
5. due to rapid changes, local knowledge and practices are becoming inappropriate, irrelevant or inaccessible over time
6. local knowledge lacks accountability within the communities themselves especially with the younger generations
7. the focus on local knowledge can be perceived as a threat to national interests and political structures especially in authoritarian regimes
8. natural hazards and disasters have been conceived primarily as an issue pertaining to national defense and security, which makes decentralization efforts in this sector difficult
9. the documentation and use of local knowledge can be used by outsiders against local people themselves to maintain control over communities and their resources

More data and technology alone will not contribute to improve people's lives unless it is combined with an understanding of local contexts and needs. Many external interventions are ignoring local knowledge (that is, they do not understand and account for local contexts and needs). In doing so, they are creating new vulnerabilities/disasters due to the lack of a holistic picture and deeper analysis of the local vulnerability context.

Therefore, indigenous and local knowledge, if combined with external, scientific knowledge, can enable implementing organizations to create innovative and sustainable solutions to reduce disaster risks. Examples of potential applications of local knowledge in disaster preparedness include the following:

1. Combining local knowledge with conventional knowledge for hazard mapping, surveys and other inventories in order to verify information
2. Accounting for local advice about safe locations, construction sites for buildings and roads – as local knowledge can provide information related to local environmental variability and specificities
3. Understanding and accounting for local perceptions of natural hazards which influence how people perceive and respond to natural hazards, risks, and disasters
4. Understanding and accounting for people's risk tradeoffs in the context of multiple stresses
5. Identifying, understanding and accounting for vulnerable groups and individuals, local elite and power relations
6. Understanding and accounting for changes in people's vulnerability to natural hazards over time
7. Identifying what mechanisms can be promoted at the local level (e.g., which coping strategies are sustainable, equitable and need to be strengthened), how to attenuate unsustainable practices, and how to foster people's participation in disaster risk reduction activities. The focus on local knowledge and practices helps to identify and capitalize on people's existing strengths and local institutions (instead of creating parallel institutions)
8. Learning from local knowledge in order to create new concepts, methods, or strategies for improved disaster management and to strengthen relevant and sustainable local coping mechanisms
9. Building community confidence as communities themselves need to be convinced that some of their local knowledge and practices are of relevance to disaster preparedness. The current systems of education should be reconsidered in order to clearly link local communities with schools so that school curricula are adapted to local needs and realities and incorporate and foster local knowledge and practices
10. Adapting communication strategies to local understanding and perceptions, and integrating local values into decision-making processes (e.g., early warning systems)

The rapid environmental and socio-economic changes faced by most communities are as much a source of new vulnerabilities as of new opportunities for exploring new ways of risk adjustment. The extent to which local knowledge and practices can contribute to improving disaster preparedness at the local level is not white or black and in any case cannot be ignored.

## Mansehra and Battagram Districts, North West Frontier Province, Pakistan

# Indigenous Coping Mechanisms for Disaster Management in Mansehra and Battagram Districts, North West Frontier Province (NWFP), Pakistan

*Takeshi Komino*

### Abstract

The people of the districts of Mansehra and Battagram in Pakistan have developed several social, functional and sequential coping mechanisms to face the impacts of recurring disasters, particularly landslides. These mechanisms depend on the capacities of the people. Therefore, the aim of disaster management should be to increase people's capacities to better deal with adverse events. This can be achieved by understanding the communities' perceptions and strengthening the existing coping mechanisms so that disaster impacts can be reduced.

### Background

The districts of Mansehra and Battagram in the North West Frontier Province (NWFP) of Pakistan (Figure 1) are highly vulnerable to hazards because of environmental, climatic, geographical and social conditions in the area. Vulnerabilities include (i) physical vulnerability from high altitude, harsh weather, mountainous terrain and non-fertile land for agriculture, (ii) architectural vulnerability manifest in poor buildings and infrastructure, (iii) economic vulnerability pertaining to poverty, unemployment and a decline in agricultural production, (iv) demographic vulnerability due to increasing population and health problems and (v) political and administrative vulnerabilities since there is neither a disaster management structure, nor a political will to implement disaster management in these areas. For centuries, these districts face many recurring disasters including landslides, flashfloods, earthquakes and

extreme weather events such as heavy rains, storms, severe snow, and hailstorms. Because of the frequency of these disasters, local people have developed a belief that disasters are part of their lives which cannot be avoided and may be a form of punishment from God. The impacts of disasters are severely felt by rural communities because of their long-term effects on livelihood.

Several other characteristics distinguish this region. The climate varies throughout the year, where December, January and February are the coldest months, and June and July are the hottest months. Rainfall and snowfall are common in these areas. The village topography is mountainous. There is hardly any plain except for small agricultural lands, which have been leveled off for cultivation.

Small-scale agriculture, shop keeping and non-government employment (e.g. school teachers and

bank employees) are the main sources of income for the people of Mansehra and Battagram districts. The entire population is Islam, yet they are separated into several different clans and lineages including gujjar, sayed, swati, tanuli and pashtoon. On religious grounds, family planning is not observed. As a consequence, boys and girls marry at a very young age, 18-25 and 15-22, respectively, contributing to a rapid increase in population. Unemployment and poverty are widespread. Male migration to big economic hubs of the country is also very common.

Communities have a strong social and organizational system. Along with local community based groups, four main social institutions exist: kinship, hasshar, jirga and village hood. First, kinship allows for the extension of support for a given problem or emergency. For instance, kin members help relatives in housing reconstruction through labor, food and material aid. Second, Hasshar is reciprocal labor arranged to solve problems and during emergencies wherein help is called in from relatives and other villagers. Third, Jirga is usually conducted to resolve local quarrels and find solutions to communal problems. Finally, village hood allows people to obtain things on credit from village shops.

## Indigenous Knowledge

The existing indigenous knowledge can be divided into three different categories: social, functional, and sequential coping mechanisms. Each of these categories is used by the communities in Mansehra and Battagram at several levels of society (individual, domestic and community levels) to manage disasters.

### Social Coping Mechanisms

There exists a variety of formal and non-formal structures and relationships that mobilize resources and help solve problems at the local level. These include internal or external structures such as social units, religious institutions, political organizations and economic systems. The Committee Bra-e-Tahaffuz-e -Jangalat, for instance, takes part in disaster management by coordinating with the forest department in deforestation issues to avoid floods, land erosion and losses from heavy rain.

Furthermore, community groups often monitor the level of water during heavy rains. In case of danger, people

### Story/Event

Landslides are a common phenomena in Mansehra and Battagram (Figure 1). The most recent disaster in the area occurred on 14 February 2004 when an earthquake struck the area, causing landslides and widespread damage in many areas in the NWFP.

There was no government disaster management plan in place in Mansehra and Battagram when the disaster occurred. Instead, the people used indigenous coping strategies passed on from generation to generation to cope with the impacts of the disaster.



Figure 1. Landslides are common in the area

residing in vulnerable houses are informed by shouts and knocks on their doors. When water level reaches a critical level, concerned households start moving things to relatives' or other villagers' houses. Family members, especially women, children and the disabled, withdraw to a safe location, preferably in the house of a relative or neighbor. In the village of Paras, this duty is rotated among community members throughout the duration of the rainy season.

During recovery, strong social ties help poor affected families by allowing them to borrow money and food items from relatives, friends, villagers and village shopkeepers. In some villages, performance of rituals like "khatam," or the recitation of the Holy Quran, and offering of prayers take place after big disasters.

### Functional Coping Mechanisms

To minimize risks from landslides, the communities have adopted several infrastructure techniques which have developed over hundreds of years.

Houses in many villages are constructed with a distance of 2 to 3 feet apart. Houses built adjacent to each other were found to be the most badly damaged from disasters and caused more deaths when rocks fall from the mountains. Furthermore, in the village of Gantar, wooden strips are used in stone wall construction to build resistance. Construction of a 2 x 2.5 foot wall of stones produces cohesion and causes less damage to infrastructure. People belonging to the upper class, especially in the village of Paras, have increased the number of wooden pillars and beams in their houses for further support.

In addition, roofs 1 to 2 feet wide are constructed with certain precautionary measures. They are first developed with wooden pillars for support. Thereafter, tons of soil is spread on the roof tops to stop water seepage (Figure 2). Some people spread plastic sheets, jute or nylon under the soil to further secure the roofs. Before the monsoon season, naturally growing grass is usually weeded off from the roofs because grass roots contribute to water seepage. The center of the roof is made slightly higher while all sides are diagonal from the edges to facilitate the flow of water. Half of a long metal strip is placed under the soil in edges for easy flow of water from the roof. Similarly, roof edges are also extended to prevent water penetration from the roof to the wall. Furthermore, stones are sometimes used in edges to keep roofs from being damaged. The roof and area along the walls are then hammered with a local wooden tool called 'dabkan' to prevent water penetration and secure the foundation of the house.

Due to recurring disasters, people are careful in selecting land for their houses. They choose to build houses on a plain, far from a water source, close to the road and on white soil, which according to local belief is good because it is more solid. To cope with the vulnerability of the land, they plant walnut, sheron and kinar trees around their houses. The roots of these trees extend far distances, thereby contributing to the firmness of the soil. Some people also construct stone foundations up to 2 feet deep, especially under the walls of houses.

For mud houses, people use traditional materials mixed in mud for stability of roofs and walls, which include cow dung, cotton, wheat chaff, goat hair, pine leaves, grinded jute sacks, sand and sawdust. For those who can afford them, zinc sheets are used for the roof in order to save on labor, time and maintenance (Figure 3). Sometimes, heavy stones are scattered on the zinc roofs to save them from being blown away during a storm. In the pre-earthquake architecture of mud houses, no joints were used between pillar and batar, or wooden strips in



Figure 2. Roof technique to prevent water seepage.



Figure 3. Zinc sheets used as roof

the roof. After the February 2004 earthquake, a specific iron object called 'kalab' is now used to join the pillars and wooden roof strips.

The government's Public Works Department visits the area often during the rainy season to monitor the risk of landslides. The department also constructs retaining walls along road sides which are at risk from landslides (Figure 4).

### Sequential Coping Mechanisms

During disasters, communities mobilize diverse resources following a sequence based on vulnerabilities and capacities. Since the primary concern is livelihood, they first adopt a strategy to secure livelihoods. Some dietary changes are made especially by the poor. Temporary migration to other villages has been observed

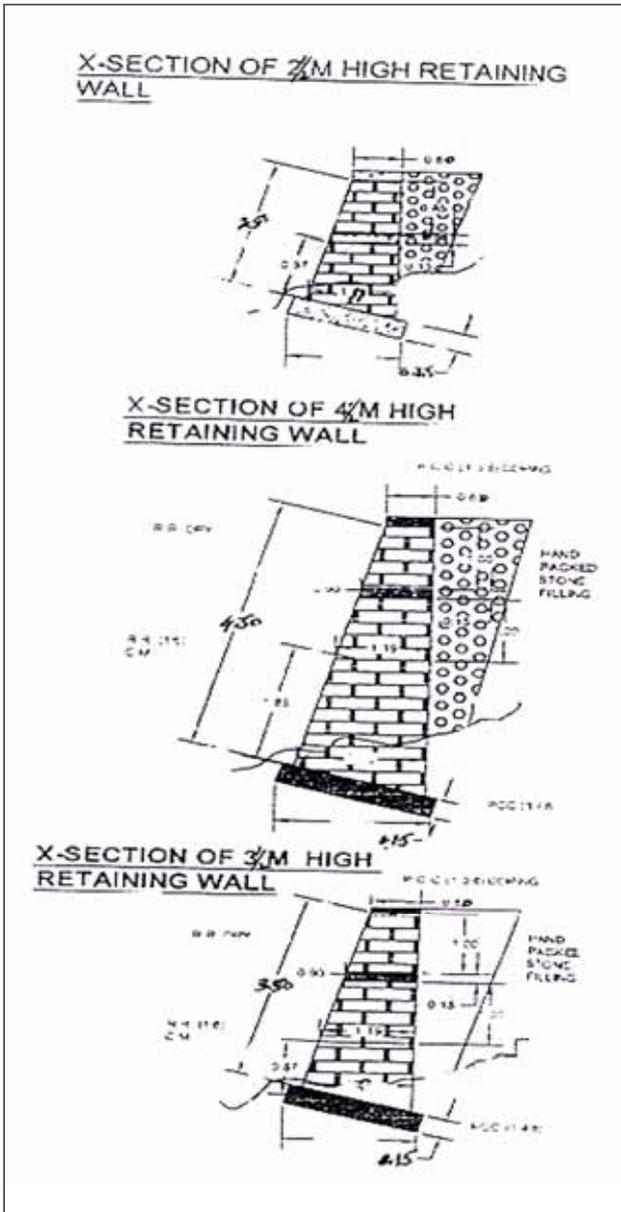


Figure 4. Specifications of retaining wall against landslides

in cases of severe disaster, especially when the affected family has not been offered help or prefers not to stay in houses of neighbors, relatives, or friends. Sometimes young boys are sent to the nearest urban centers and big cities for labor. When disaster impact is extensive, the poor families, as a last resort, sell their assets (e.g. animals, jewelry, and land).

As the community members themselves develop knowledge in these three categories through various experiences, they become imbedded in their culture and familiar and easy to implement. The knowledge evolves in situ and is dynamic and creative, constantly growing and adapting to meet new conditions. It is entrenched in a dynamic system in which spirituality, kinship, local politics and other factors are both connected and influence one another.

There is no formal system rooted in the community to disseminate this indigenous knowledge. However, this knowledge has been transferred informally from generation to generation through individuals in the community. No importance was given to the use of these coping strategies before the 2004 disaster, as there was no formal government structure working on disaster management. The community alone disseminates and employs indigenous knowledge techniques in different ways to cope with disaster.

## Lessons Learned

Indigenous knowledge, as illustrated in NWP, provides important mechanisms to reduce disaster risk, and is especially valuable for community level disaster management. Policy makers should consider preserving such effective, traditional coping mechanisms and improve on them to ensure that development does not increase vulnerability to natural hazards. Further, encouraging community involvement through the use of traditional practices provides a more realistic and local-specific strategy since the community understands the situation due to past disaster experience.

Indigenous coping mechanisms alone are not sufficient to manage disasters effectively. While this knowledge helps reduce risk, it is sometimes inadequate to cope with new disasters in the community. For example, the experience of the 2004 earthquake shows that the technique in preventing water seepage has resulted in more houses being damaged because of the heavy load of soil on roof tops. Traditional coping mechanisms may not always work as coping strategies and are always subject to internal and external environment changes. For example, changing social, political and economic conditions in the area will affect the mechanisms and their effectiveness. There is a growing need to improve these coping mechanisms in a way that they would not impact negatively on communities.

Coping mechanisms in Mansehra and Battagram mainly depend on the capacities of affected communities. While self reliance and solidarity of households and communities are invaluable in the face of disasters, capacity for social support is an unquantifiable factor; nonetheless, a strong support system constitutes the backbone of coping mechanisms in Mansehra and Battagram. The aim of disaster management should be to increase people's capacities to deal with adverse events. Development and disaster management programs should promote activities that mobilize and strengthen local resources and capacities at household and community levels. This can be achieved by understanding people's perceptions and strengthening existing coping mechanisms in a way that reduces the impact of disasters.

Limited resources and people's perception of hazards often influence the acceptance of a particular coping mechanism. Assessment and understanding of current practices, perceptions, and constraints are important for improving coping strategies. For instance, an understanding of indigenous livelihood systems is important in order for development initiatives not to result in the loss of self reliance, the destabilization of cultural values and the undermining of traditional livelihood systems.

A community based approach, which aims to understand the way communities deal with different disasters, their level of understanding of disaster, and their capacity to manage it in an effective and sustainable manner, would be the best way to implement disaster management programs. Community participation should not be viewed only as a consultation process but also as an effective empowering process to address the root causes of vulnerability. It would be helpful to develop a system to monitor the impact of disasters at community and national levels. Improved risk and vulnerability mapping, disaster awareness and early warning systems at community level would also be useful.

Above all, socio-economic analysis and a community-based livelihood approach should be integrated in disaster management planning and programs in affected communities.

## Singas Village, Papua New Guinea

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# Living with Floods in Singas, Papua New Guinea

*Jessica Mercer and Ilan Kelman*

### Abstract

The experiences of the members of Singas village, situated in Morobe Province, Papua New Guinea (PNG), illustrate how indigenous knowledge can contribute to disaster risk reduction. Singas village is a small community situated along the banks of one of PNG's major rivers, the Markham River. As a consequence, it is affected by yearly flooding following heavy rains experienced during the rainy season. The example holds particular significance as not only does the river represent a potential hazard but it is also the source of the community's livelihood and therefore holds great importance within the community. As a result the community is extremely pro-active in its efforts to mitigate the consequences of flooding. Indigenous knowledge in five specific areas, namely building methods, social linkages, land use planning, food strategies and environmental strategies, has proven to help contribute to the community's ability to mitigate the impact of regular flooding events.

### Background

Singas village is situated in an isolated enclave in the Markham District of Morobe Province along the banks of the Markham River in PNG.

The closest town is Mutzing Station, located across the river from Singas, which is the centre of Markham District. Mutzing Station contains the nearest government buildings, secondary school, health clinic and market to Singas. The Markham River varies in width from 3-8 km as it travels through its lower reaches, with the crossing by Singas village being one of its widest points. The walk across the river from Singas to Mutzing Station takes approximately one to two hours depending on the river flow (Figure 1). This route is only passable in the dry season and even then it is often still treacherous. During the rainy season, the villagers have to walk for two days to reach a point at

which they can cross via a bridge which is often broken and impassable.

The village population is 296 and divided into five family groups. The community previously depended on betel nut trees (the nut is chewed like tobacco) for their cash income. However, as a result of a recent disease that killed the trees, the community now depends heavily on selling garden produce, coconuts, mangos (when in season) and fish for their livelihood. Education levels within the village are low, as parents are unable to afford school fees, mainly as a result of the betel nut crop loss. Income sources are nevertheless diversifying with new cash crops being introduced to the area such as peanuts and coffee. There are three primary schools nearby which the children attend, though access to these schools is often restricted as a result of flooding and the need to cross the Markham River.

## Story/Event

Living alongside the banks of one of PNG's major rivers, the Singas community is constantly under threat from flooding, especially during the rainy season. Usually, the village is flooded to some extent each year, dependent on the amount of rainfall received. The last big floods remembered by the villagers were in 1998 and 2002 when water rose above the stilts and into the houses (Figure 2). It was during these years that their use of indigenous knowledge was especially important in reducing the risk of the disaster to themselves and their livelihood.

Singas villagers have been told to move their settlement away from the river banks to higher ground in the hills, as part of a 'top-down' solution to their problem of flooding. However, they never moved. There were multiple reasons for this including (i) the river was valuable for their livelihood in terms of fishing, agriculture, water supply and clay to make cooking pots, (ii) they were close to amenities (the main provincial buildings and medical facilities were located on the other side of the river) and (iii) they had resided there for years, coping with previous floods. Despite the risks, the community was very much aware of its situation and pro-active in its response to flooding in order to ensure its continued survival along the river bank.



Figure 1. Crossing the Markham River



Figure 2. Mud left behind by flood water

# Indigenous Knowledge

The main disaster risk reduction strategies practiced within Singas community to deal with flooding can be grouped into five general categories which include building methods, social linkages, land use planning, food strategies and environmental strategies. In many cases these strategies are embedded in community culture and daily life, unidentifiable by the community as specific strategies for disaster risk reduction. While such a situation is not unique to an indigenous community, in the case of Singas it was especially apparent as the community viewed the river first and foremost as a source of livelihood and only second as a hazard. This resulted in many of their indigenous risk reduction strategies being intertwined within their daily lives as they dealt with the river on a daily basis.

## Building Methods

Many village cultures have their own traditional type of house appropriate to local environmental conditions. Singas community is no exception. They use in-depth environmental knowledge to search for dry, strong places to build their houses. Aware of the possibility of flooding, the people build their houses on stilts, which have been gradually lengthened over the years to accommodate the rising flood water and increased incidence of flooding. They also build large mounds under the houses to stem the rising flood water. Land is cleared for houses in the area and then used as a rubbish burial pit where rubbish gradually builds up until it is a significant mound. This is then covered with soil and stabilised with plants before the building of the house begins (Figure 3). Houses are made of traditional bush materials which not only make them transportable and fixable but also cheap and accessible. Houses are built during the dry season to allow the posts time to settle into the ground, thus slowing the rotting process. Houses that are built on the ground contain kitchens which are made out of light and easy-to-dismantle bush materials to limit loss during floods.

## Social Linkages

Rarely in the past were communities under stress from flooding or other environmental hazards, as they were often not totally dependent on their own resources.<sup>1</sup> Despite the consequences of incorporation of rural communities into the global economy—including the impacts of increased population, poverty levels,

out-migration and new forms of trade rather than traditional forms such as inter-village bartering—Singas is very much reliant on its own resources. Whilst in the past importance was placed on land and land use planning by the community, today this is gradually declining with villagers growing gardens wherever they please rather than following traditional planning. Nevertheless, when gardens are destroyed during floods, the entire community participates, working together to dig and plant new plants for the community.

Singas is very much a cohesive community, assisting each other in times of need as with the disruption caused by a flooding event. Resources and experiences are shared at the community level, so in times of disaster all in the community are aware of the best action plans or where to re-group if necessary. The cohesiveness of the community is possible because of a strong and active community leader who ensures regular community meetings are held to discuss relevant issues and ways forward (Figure 4). There is also a strong positive attitude of wanting to ensure the community's own survival, since while assistance would be gratefully received, it may not be available.

## Land Use Planning

Location of villages and housing has often been influenced by hazard vulnerability. Communities, where possible, would locate 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.<sup>2</sup> Singas community, in recognition of the threat of flooding, has a comprehensive drainage system dug out by hand surrounding their gardens and land so that flood water is directed away from critical areas. Land use and planting times are planned to avoid the rainy season in order to minimise disruption and damage as gardens are planted alongside river banks to avail of the most fertile soil. There are also safe areas marked out to which the community can move in times of serious flood.

Trees, flowers and plants are regularly planted to protect and stabilise the soil, especially around houses. Careful planning and monitoring of surroundings

<sup>1</sup> Campbell (1990).

<sup>2</sup> South Pacific Applied Geo-Science Commission (2004).



Figure 3. Traditional housing in Singas village – photo depicts housing on stilts, with taller stilts used more regularly today seen on the newer house in the background and the beginnings of a mound surrounded by a drainage ditch in the foreground prior to house building.



Figure 4. Community meeting discussing flood risk reduction

for bush materials that can be used is also done. For example, only certain trees are cut, namely the strongest ones suitable for building and those which do not impact on soil stabilisation. This strategy gives the younger trees time to mature while ensuring that when materials are needed in times of flooding, they will be available.

## Food Strategies

Many rural indigenous societies have developed hazard resistant varieties of crops, contributing to community resilience in times of hardship or disaster. Among Singas village's disaster crop is the banana, a hardy crop which survives in flood water. Singas villagers wrap the bananas in leaves to protect them and keep birds away. For taro growth, drains are made to dry the soil out. Bamboo is used to store water and for cooking. A special plant is also used to collect rain water in the rainy season to avoid drinking flood water and becoming sick. Prior to the rainy season and potential flooding, food is preserved in traditional clay pots to ensure food availability when people cannot leave their houses. This food can last up to a few months in pots and still be edible. Food and seeds are also dried and preserved in the sun's heat until enough is saved for next year's crop. Traditional food in the area are also used in times of shortage, e.g. yam and taro are grown on the mountainside as disaster crops in case the villagers have to temporarily seek shelter in the hills.

Flooding precludes fishing in the river as a result of the fast flowing water so the village uses two inland lakes for their fish supply. The village women all cooperate, working in a large circle and driving the fish into the centre to catch with their hands. Within individual families, when food is scarce as a result of flooding, adults often limit their food intake to ensure children receive plenty. Village women have gone to the extent of tying belts made of cloth or bark tightly around their waists in order to restrict hunger pains.

## Environmental Strategies

Since the Singas community is dependent upon the environment for its livelihood, it has developed a vast amount of knowledge enabling it to identify signs of impending trouble. For example, if members of the community see a lot of rain in the hills they start to prepare for an impending flood by packing belongings and ensuring food supplies are plentiful. 'Spotters' are often sent upstream to determine the river's behaviour and report back through messages passed from person to person reaching the village quickly. Markers are used to determine the changes in height of the river itself and the villagers are constantly on alert with adequate plans in place in case flooding occurs. Within PNG, oral traditions passed down through generations in the form of legends, visions and stories are plentiful and reliance is often placed on these for guidance as to what to do when disaster strikes.

## Lessons Learned

The indigenous practices described above and used by the Singas community for disaster risk reduction have proved to successfully minimize the risks its members face whilst enabling them to continue using the river as a valuable source of livelihood. The indigenous knowledge used by Singas community for flood risk reduction is currently contained within the community. The sharing of resources and experiences at a community level ensures that, if a flood were to occur, the whole village will be able to help one another. The cohesiveness of the community and the willingness to help one another are strong underlying factors behind Singas's success in reducing flood risk. Further, this attitude and social coherence has enabled the dissemination of disaster risk reduction knowledge in the community through public meetings and sharing of experiences.

The experience of Singas is contradictory to many other communities in PNG. Typically within PNG, there is a highly defeatist attitude among indigenous communities resulting from lack of governmental support, a 'hand-out' culture and the perception that vulnerability levels are impossible to address. In the case of the Singas village, whilst to some extent there is an element of 'we can't do anything', the village has been proactive in their strategies for dealing with environmental hazards. What is needed now is for the experiences of Singas to be acknowledged by other communities, policy makers, government offices (such as the provincial disaster office) and non-governmental organizations. Acknowledging the success of the Singas community can allow its members to interact with appropriate stakeholders to further build upon these disaster risk reduction capabilities. Further, these interactions would make possible the dissemination of indigenous knowledge and enable other communities to identify with the lessons learnt and build upon their own existing disaster risk reduction knowledge.

The community is keenly aware of its situation, yet it feels that it possesses the knowledge to deal with recurring hazards. A proposed 'top-down' solution considered neither the whole picture nor the needs of the community, so the community rejected it in favour of its own strategies. This reiterates the importance of existing disaster-related knowledge and demonstrates the need for ownership to occur at a local level. Increasingly, it has been advocated that populations directly affected by environmental hazards should be the ones to decide and develop policies to deal with these.<sup>3</sup>

This said, a paternalistic viewpoint is still frequently taken with the voices of the disadvantaged either buried or ignored. As this example shows, ownership needs to be directed from the 'bottom-up' rather than infiltrated from the 'top-down' by those who may not understand the community's situation. There should be a support system existing alongside community strategies in case more support is required. Whilst these are clearly relevant strategies in dealing with disaster risk reduction, anthropogenic and non-anthropogenic processes are increasing the likelihood of adverse effects of environmental hazards on indigenous societies.<sup>4</sup> Indigenous communities such as Singas could further reduce their vulnerability to flooding through integrating indigenous and scientific knowledge. The recognition, recording, and promotion of indigenous coping mechanisms with culturally compatible scientific strategies can only contribute to enhancing the capacity of indigenous communities to mitigate, prepare for and recover from environmental hazards.<sup>5</sup> Only then will disaster risk reduction practices be seen to successfully address the vulnerability of indigenous communities to environmental hazards.

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<sup>3</sup> Wisner et al. (2004).

<sup>4</sup> Hay, 2002; Wilbanks and Kates (1999).

<sup>5</sup> Mercer et al. (2007).

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## Dagupan City, Pangasinan, Philippines

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# Combining Indigenous and Scientific Knowledge in the Dagupan City Flood Warning System

*Lorna P. Victoria*

### Abstract

The kanungkong is a bamboo instrument which was traditionally used to call community members to assemble at the village hall for meetings, alert people or call children home. The flood early warning system set up in eight villages in Dagupan City, Philippines, has revived the use of the kanungkong along with staff gauges as flood markers in strategic locations in the villages of the city. The indigenous knowledge is combined with modern scientific knowledge and equipment for use in disaster risk reduction.

### Background

Eight flood-prone barangays (villages) in Dagupan City in the province of Pangasinan in northwestern Philippines, namely Mangin, Salisay, Tebeng, Bacayao Norte, Bacayao Sur, Lasip Grande, Lasip Chico and Pogo Grande, have incorporated the use of the kanungkong to relay warning messages to households in the communities, especially those living along the riverbanks. These villages prioritized flood preparedness and mitigation activities under the Program for Hydro-meteorological Disaster Mitigation in Secondary Cities in Asia (PROMISE) project. The community members held workshops to discuss the early warning system and had community drills.

### Story/Event

Dagupan City is prone to heavy flooding. In 2007, typhoons with monsoon rains hit Northern and Central Luzon in August and November causing swelling of the river system in Dagupan City. This event put the kanungkong based early warning system to the test. Because the Barangay Disaster Coordinating Council (BDCC) monitored the flood markers and reported these to the Emergency Operations Center of the City Disaster Coordinating Council (CDCC), the villages were prepared in case heavy flooding occurred. The system successfully allowed the entire community to prepare and respond to the disaster with sufficient time.



Figure 1a & b. The kanungkong is a communication medium in the village early warning system.

## Indigenous Knowledge

The kanungkong is a communication device which was used extensively in the past by the people of Dagupan City, nearby municipalities and provinces in Northern Luzon (Figures 1a & b). Its uses include calling the community to assemble at the village hall for a meeting, alerting citizens of a robbery incidence during the night, calling attention to midwives to assist a pregnant woman getting ready to give birth, and calling children to come home. With modern ways of communication, it has been forgotten.

Kanungkong comes from the word mangkanungkong which literally means to make a sound. The kanungkong is made of bamboo and when hit with a stick produces the sound kung, kung, kung. The village-level early warning system uses the kanungkong as a local relay and communication medium. For flood monitoring, and as the basis for the relaying of messages, staff gauges or flood markers have been put up and are monitored in strategic locations in the villages.

Presently, people have become familiar with the warning codes adopted in the city, which conform to international disaster warning color standards. In order to put the kanungkong into a system, an agreed upon rhythm and sound (i.e. number of strikes of the kanungkong at designated time intervals) were made to correspond to specific actions. One kanungkong for every 5 houses relays the warning to the households along the river banks. Table 1 explains the warning codes.

Staff gauges have been constructed at the lowest point in the barangays to correspond to the alert warning, based on information from past flooding in the communities (Figures 2a, b & c). A common zero point was initially suggested to be standardized by the city government but the system now operates with each barangay having

Table 1. Warning codes adopted in Dagupan City

Color	Alert Level	Warning Signal by the Kanungkong
White (Ready)	Normal	
Yellow (Get Set)	Alert (warning, there is danger)	5 strikes of the kanungkong at 20 minutes interval
Orange (Go)	Prepare for evacuation or proceed to holding area (heavy flooding approaches)	10 strikes at 20 minutes interval
Red	Full evacuation (evacuate from homes to designated safe areas) Forced evacuation	Non-stop (15 strikes at 10 minutes interval) Non-stop (20 strikes at 5 minutes interval)
Green	Back to normal	

its own agreed upon flood markings at strategic places in the barangay. The gauges show critical levels to determine when people have to prepare to move out and proceed to evacuation centers.

The monitoring and relay of information of flood level from the staff gauge is done by the barangay warning and communications team by hand-held radio to the BDCC. The kanungkong is then sounded and relayed from point to point (every 5 houses apart) (Figure 3). Each BDCC has a radio connection with the CDCC, and information is relayed from one to the other through its Emergency Operations Center by radio.

The flow of the early warning system is illustrated in Figure 4.

The Emergency Response and/or Disaster Risk Management Plan details the responsibilities of the CDCC and BDCC committees and personnel with regards to warning and evacuation. As part of the plan, the early warning system has been drawn up through a series of consultations, study visits and workshops.



Figure 3. The Barangay Disaster Coordinating Council gives out the initial warning using the kanungkung



Figure 2a, 2b & 2c. Staff Gauges showing warning levels monitored by warning and communications team

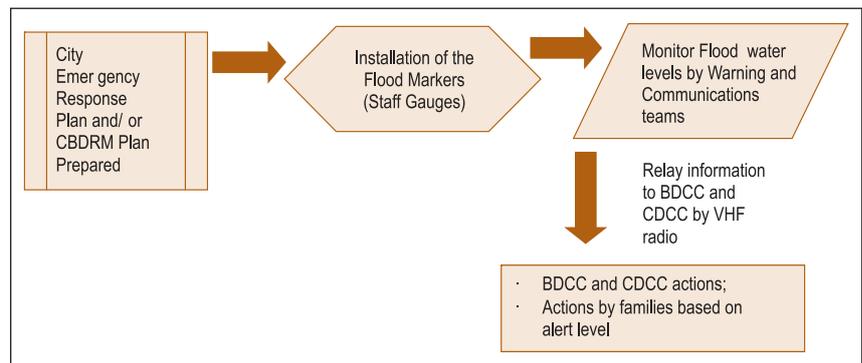


Figure 4. Relay of information to the community through the kanungkung.

## Lessons Learned

The Dagupan City flood warning system, a combination of indigenous and modern scientific knowledge, is an effective response to the perennial problem of flooding in the city. In formulating the system, some important lessons were realized which are as follows:

1. The use of the kanungkong has mobilized local capacity while reviving and maintaining a local practice which is now used in disaster preparedness.
2. It is important to involve the community in risk assessment (i.e. hazard, vulnerability and capacity assessments) and designing of the early warning system.
3. It is important to test the warning system and evacuation procedure through table top exercises and practical community drills.
4. “Learning from good practice” visits to the communities involved in community based disaster preparedness and mitigation encourages the communities as well as local government officials to continue the good work. Study visits by local officials and community members to similar projects afford critical reflection on how to improve their own preparedness and mitigation activities.

## Barangay Matanag, Legazpi City, Albay, Philippines

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# Indigenous Know-How on Mayon Volcano's Lava-Spittle Mysticism

*Gerardine Cerdena*

### Abstract

Residing near a volcano does not mean people cannot thrive on its surroundings. In the case of Barangay (village) Matanag, inhabitants stand defiant against volcano disasters and still call the volcano home. The local knowledge acquired within this community about warning signs and how to predict volcanic eruptions helps to minimize risk and cope with the dangers of the Mayon volcano.

*“If Mayon is spitting fiery sparks, that is the signal that it will erupt. Sometimes we worry about it, sometimes not. The volcano always makes low rumbling sounds and the farmers are the ones who hear it first.”*  
*Domingo Arias, Barangay Matanag resident*

### Background

One of the active volcanoes on the Philippine island of Luzon, Mayon is considered by some as the world's most perfectly formed volcano because of its symmetrical cone (Figure 1). It is one of the volcanoes in the “Pacific Ring of Fire” located around the lip of the Pacific Ocean where volcanic activity and earthquakes are common. The volcano is situated 15 kilometers northwest of Legazpi City, Albay, Philippines in the Bicol Region.

Mayon Volcano is a basaltic-andesitic volcano located between the Eurasian and the Philippine plate that was developed through alternate pyroclastic and lava flows spouting out ashes in the past 400 years (Figure 2).

The upper slopes of the volcano are precipitous and rugged, averaging 35-40 degrees, and are capped with a small crater. Its sides are layers of lava and other volcanic material. Magma is formed where the rock melts and eruption usually begins with lava flowing like a geyser from a long crack in the cone. Barangay (Village) Matanag in Legazpi City, a farming village which comprises of 1,400 residents, is one of the lava-prone areas flanking a slope of Mayon Volcano. It was declared a danger zone by volcanologists from the Philippine Institute of Volcanology and Seismology through the use of remote sensing and satellite relays.

## Story/Event

Mayon has had forty-seven eruptions in recorded history. The most fatal eruption of Mayon occurred on 1 February 1814 wherein 2,200 people were killed and volcanic ash buried the town of Cagsawa. In Mayon's last fatal eruption in 1993, pyroclastic flows killed 77 people, mainly farmers.

Mayon eruptions often trigger people's fear of losing their homes and crops. On the impact of Mayon's eruption, Bienvenido Belga Sr., Barangay Captain of Matanag shares, "An niyog tapos mga gulayon nagkakaaralang tapos nagkakagaradan pag nagtutuga an Mayon. Su mga gapo nagdadalagasan nin mga kalayo hali sa Mayon kaya minsan nagigipit kami sa negosyo pagmay eruption. – Coconuts and vegetables wilted and died due to Mayon's eruption. Hot rocks fall heavily from Mayon so our businesses were affected." The town solely depends on the locals' coconut and rice products for income and livelihood. In addition, mudslides of volcanic ash and boulders off of Mayon can kill hundreds and can cover a large portion in mud up to the village houses' roofs. In contrast, eruptions can also be viewed as favorable since many inhabitants know that eruptions of volcanic ash also enrich the soil, producing better crops. In fact, threats of volcanic activity and eruption over the years have not dampened the Matanag villagers' spirits.



Figure 1. Mayon Volcano with its perfectly symmetrical cone.  
Photo: Jenny Exconde



Figure 2. Pyroclastic flows descending from Mayon Volcano.

## Indigenous Knowledge

When asked about their indigenous knowledge relating to Mayon Volcano's eruptions, several villagers stated: Dakulon an palatandaan na aram mi tungkol sa pagtuga kang Mayon. – There are lots of warning signs related to Mayon's eruption." They mention that when rivers and creeks run dry, it is often an important forewarning of when Mayon will be scoffing down its dreaded lava. "Pag ubas an tubig na talagang direktso sa pirang bulan, aram mi na ma tuga na an Mayon. Tapos an lava an pighahaditan ming maray. – If the water runs dry for several straight months, we know that Mayon will be erupting soon. And lava forming from the volcano is the one we really worry about."

The villagers also talk about sparks coming from the volcano which rapidly create many sparkling rills among the crevices and signal the eruption of Mayon.

In addition, local farmers can hear roars and sense earthquakes unfelt by residents far from the volcano. As Domingo Arias, a barangay policeman, stated, "Pag may naguusok na kalayo hali sa Mayon, yan an señales na matuga na. Minsan nahahadit kami, minsan dai man. Sigeng tanog kang bulkan asin nakakadangog inot su mga para tanom ky maluyang daguldol. – If Mayon is spitting fiery sparks, that is the signal that it will erupt. Sometimes we worry about it, sometimes not. The volcano always makes low rumbling sounds and the farmers are the ones who hear it first." Totems are used to see if winds carry ashes.

Furthermore, animals such as baboy-damo (wild boars) and chickens live out their bionic senses too. Villagers have seen these animals scurry away from the volcano. When animals race recklessly from Mayon, it sends out

an alarm that it is time to evacuate because these animals can feel high temperature from the volcano.

According to its residents, native premonitions and superstitions regarding the eruption of Mayon Volcano have always been right. Queried about whether they worry about the approaching doom from the volcano when they see and feel these warning signs, they answer that they have gotten used to the situation. “Tuod na kami pagnagtutuga an Mayon, - We are immune to Mayon’s upsurge. “ coconut farmer Romeo Nantes, a father of three, commented. “We would not evacuate now unless it’s really urgent and there’s a big eruption,” Rosario Nantes, Romeo’s wife said, while tending to her little store. This is why in spite of mandatory evacuations, many of the villagers stayed put on their farms around Mayon to tend to crops and livestock while guarding homes and possessions.

A long-time resident of Matanag, Geronimo Toledo remarked, “Pag mauran, baha ang mas delikado pag nagtuga an Mayon. Pero pag maray an oras wara man dapat haditan. – If it rains, floods are more dangerous if Mayon erupts. But if the weather is fine, there is nothing to worry about.”

Such knowledge about the signs of the volcano’s spitting plumes of ash contributes to disaster risk reduction. By following these beliefs, locals have gathered warning signals from the impending threat and can be readily prepared. These locals are generally grateful that their elders have passed this knowledge to them.

“An mga gurang mi an nagturo samuya kang gabos na dapat ming maaraman. Maski aki mi aram an mga señales. – Our elders were the ones who taught us what we really ought to know. Even our children know the signals.” Arias affirmed.

When asked if they still pay attention to scientific announcements, Belga, another resident replies, “Dai kami nagtutubod sa awtoridad ta sala sinda minsan. Masabi na matuga pero wara man kaming napapansin na palatandaan o babala kaya dai kami mina hiro nangad hanggang sigurado kami. Pero pag aram ming tama, ma hali man sana kami siyempre. – We don’t really take note of what the authorities say sometimes. They tell us that Mayon will erupt but we don’t see any signals so we don’t really pull out unless we are really sure. But if we know that it’s true, we evacuate of course. “

“Mga para tanom sana kadkalan samo digdi pero aram mi kung ano an dapat gibuhan and tubodan. Sa pagtuga kang Mayon, sadiri ming kahiruan an kaipuhan. Aram mi yan, kaito pa. – Most of us are only farmers but we know what we should do and what to believe. Regarding Mayon’s eruption, we only rely on our own impulses. We have known that ever since.” Belga said almost stubbornly. With their indigenous knowledge, the villagers of Matanag do know to move out of harm’s way in case a major eruption occurs.

## Lessons Learned

Officials often have trouble persuading villagers to clear out of danger zones despite natural vulnerabilities and disasters. Instead of listening to officials, geologists and volcanologists, people rely on spiritual advisers and credulous beliefs for guidance. People’s failure to evacuate in the face of fury-spouting, lava guzzling volcanoes just because of stubborn standpoints sometimes equates to absurdity.

Nonetheless, not all cultures view volcanic eruptions as destructive. Instead, many of those living near Mayon view its eruptions as beneficial acts of creation and evolution. Being near a volcano does not mean people cannot thrive on its surroundings. The local people know that volcanoes do not disgorge things out without reason. Volcanoes are often thought of as significant entities that wreak vengeance and impartiality to the world, bringing justice to life’s misgivings and wrongdoings of its inhabitants.

The differing views on volcanic eruptions produce a disconnection between scientists and the people who are directly affected. These views confound the scientific community but they cannot be dismissed immediately. In truth, the indigenous knowledge that has been passed from generation to generation helps them to

minimize risk, cope with natural dangers and learn how to survive. The level of risk people are willing to take because of their indigenous knowledge may be disbelieving. But these irrational tales and rituals also help these people cope with disaster. Social scientists observe that these are no longer naïve views of nature. Superstitions and myths are still grounded in people's core beliefs. These beliefs make them hopeful and unrelenting in the face of danger.

Scientists who use the latest technology can bridge the gap between the people who stand to benefit from their work. However, they must not underestimate the indigenous capabilities that the people possess and should understand how their work will be received by people who intimately experience and cope with volcanic eruptions.

## The Ivatans of the Batanes Islands, Philippines

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# Shaped by Wind and Typhoon: The Indigenous Knowledge of the Ivatans in the Batanes Islands, Philippines

*Noralene Uy and Rajib Shaw*

*Extracted and adapted from Hornedo, Florentino H. 2000. Taming the Wind: Ethno-Cultural History on the Ivatan of the Batanes Isles*

### Abstract

The Ivatans of the Batanes Islands have a long history of struggle and adaptation to typhoons, rough seas and meager resources. Regardless of these hardships, the indigenous knowledge embedded in their traditional housing and watercraft construction techniques, as well as their social dynamics, prove successful in the face of these disasters. Their exceptional culture demonstrates the harmonious relationship of the Ivatan people with their environment as a means of surviving and coping with these various ecological stresses.

*Then comes the storm that breaks it  
Then comes the thunder rumbling,  
Then comes the lightning flaring,  
And then down pours the heavy rain,  
But the lightning is my torch,  
The thunder beats the cadence of my steps,  
And for my walking cane the rain.  
- Ivatan Folk Lyric*

### Background

The Batanes Islands are part of the northernmost cluster of islands in the Philippines. Located between 121° 45' to 122° 15' east longitudes and at 20°15' north latitude, it is closer to Taiwan (only 218 km away) than to the mainland of Luzon. Batanes is the smallest province in the country in terms of population (15,656 in 2000) and land area (230 sq. km.). It is composed of ten small islands of which only three are inhabited, namely Batan, Sabtang and Itbayat. It is bounded by the Bashi Channel on the north, by the Pacific Ocean on the east, by the South China Sea on the west and the Balintang Channel on the south.

The climate and topography in Batanes is different from any other province in the country. The weather is rather cool and windy. It has an almost temperate temperature which can dip as low as 7°C. The province is constantly battered by wind, rain and typhoons. It has no pronounced wet or dry season, while it is almost always raining, from a minimum of 8 days a month to

a maximum of 21 days a month. The islands also have very distinctive landscapes. Steep cliffs, rolling hills, deep canyons, undulating plains and boulder-lined shores characterize the land. In some way, the province is reminiscent of Ireland or New Zealand.

The people who inhabit the islands of Batanes are called Ivatans. About 75% of the Ivatans are farmers and fishermen. Garlic and cattle are major cash crops but rice, corn and other root crops are planted as well. Since all towns and villages lie along the coast, natural conditions favor fishing. The entire Ivatan culture is built on self-sufficiency due to its isolation from the rest of the country.

### Story/Event

Wind is a significant part of the Ivatan's life and has helped to shape the people's lifestyle, especially its most severe manifestations. The anin, or typhoon, is a common occurrence in the islands since Batanes lies along the typhoon belt. An average of 20 typhoons enters the Philippines every year, with 8 of those passing

through the Batanes Islands en route from southern Philippines in a northwesterly direction.

Every Ivatan has a remarkable typhoon story to tell. In 1905, strong winds suffocated cattle to death. In 1918, a fishing boat was swept away to Annam, which is located in present-day northern Viet Nam. In 1921, the cathedral was unroofed and the wireless tower twisted. In 1952, a citizen who was determined to recover his galvanized iron roof chased after it and eventually recovered it at the town plaza only to find it rolled into a ball, driven about like tumbleweed. In 1987, a Philippine Navy ship tank ran aground in Basco, the provincial capital, and a school building was blown away in Mahatao, one of the towns in Batan Island. Not so long ago, a fisherman was set adrift to Taiwan. Lastly, the provincial governor tells the story of one stormy night long ago when a family gathered in the living room to wait out the typhoon. The roof gave way, disgorging in their midst a cow. There was a feast the next day.<sup>1</sup>

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<sup>1</sup> Feleo (2006).

## Indigenous Knowledge

The architecture, boatmaking techniques, agriculture and social institutions of the Ivatans have all been adapted to the harsh and shifting weather. The Ivatan traditional houses are built with thick walls of stone and lime and thatched with thick layers of cogon to withstand the battering of typhoons. Sturdier boats called paluwas serve as the main mode of transportation between islands. Fields are often hedged with trees that break the wind's fury and allow root crops to grow. The Ivatan cooperative and self-help social institutions strengthen community ties. The Ivatan traditional house, watercraft and social dynamics are elaborated in the following.

### Traditional House

The evolution of what is called the traditional Ivatan house is a story of a people's perennial struggle to defend themselves against many types of weather. It is also an illustration of adaptation, assimilation and creative use of locally available materials.

In the Philippines, it is only in Batanes where traditional house architecture is of stone (Figure 1), as opposed

to the typical, tropical and impermanent materials (e.g. wood, bamboo and nipa palm roofing) commonly used throughout the country. Since centuries ago, the Ivatans have lived in their traditional stone dwellings in defiance of nature, using stone in response to the wind and monsoon stresses. An Ivatan house is built with limestone walls two to four feet thick and layers upon layers of reeds and cogon grass as roofing- a structure sturdy enough to withstand the numerous typhoons that ravage the islands. Windows and doors are small and narrow. These are closed with thick solid wooden aneb (shutters) hinged to the door frames with thick yembra y machu (hinges) and locked from the inside with panahtah (wooden bars). Only three walls of the house have windows wherein the wall that does not have one faces the direction where the wind usually blows strongest. The temperature within its interior is conditioned. It is relatively cool during the summer and warm during the cold stormy season.

Most Ivatan households have two separate housing units – the rakuh (living room) and the kusina (kitchen). The kusina, the most important part of the house, is built around a big stove likened to a campfire. It represents

warmth, safety and is a source of communal well-being. The Ivatans know that it is time to fill the kitchen with provisions when the aruyo trees grow unusually long, tender leaves. This is a sign that a typhoon will hit them in a few days. When the typhoon comes, the entire family stays inside the house.<sup>2</sup>

The layout of human settlement also responds intimately to nature. Villages consist of these low-slung, thick-walled stone houses capped by a thick thatch roof huddled in clusters to protect the homes of fellow villagers from strong typhoons. The streets that separate the houses are straight and narrow, sometimes barely wide enough to allow a vehicle to pass.<sup>3</sup>

### Unique watercraft and knowledge of the sea

The Ivatans are seafarers and boat builders. Boatmaking is a tradition and watercraft techniques had been kept for centuries with no technological change until the mid-20th century. These unique techniques are the result of endeavors to perfect the watercrafts in order to lessen lives lost at sea due to frequent turbulence especially during the typhoon season. The traditional Ivatan watercrafts are called tataya, chinarem, chinedkeran and paluwa, of which the paluwa is the most common. Since navigation between islands is difficult due to unpredictable and strong currents, the paluwa is unlike the typical Southeast Asian outriggered banca (motorized boat). The paluwa is a wooden boat with a rounded bottom that pitches and rolls with the waves and skims the rough seas. Nowadays, the paluwa used for transportation retains its traditional form but is motorized (Figure 2).

As well-educated seamen, the Ivatans read the face of the sea. They know the swiftness of the currents by its texture and rhythm. They observe the time of day and phase of the moon to forecast the ebb and flow of tides. When crossing the straits, they mark their progress by the appearance or disappearance of land features. By the direction and temperature of the wind, they forecast the temper of the sea. The idaud (north wind) is usually harsh and the avayat (west wind) is unsettled, and seas may be rough. The pangaditan (east wind) and sumla (south wind) are much gentler. This exceptional knowledge of the sea dissuaded people, especially fishermen, from venturing out during bad weather conditions, thus minimizing accidents at sea.



Figure 1. The Ivatan traditional house. Photo: Mario Babiera



Figure 2. The paluwa is a common mode of transportation to get from one island to another. Photo: Arnel Murillo

### Ivatan Social Dynamics

Batanes' isolation has made the Ivatans a close-knit community that is accustomed to hardship and deprived of the luxuries people elsewhere take for granted. Bayanihan<sup>4</sup> is clearly evident. While nature batters their islands, the Ivatans remain in close touch and help each other, whether it be communally repairing a neighbor's house, keeping villages clean, or harvesting crops.<sup>5</sup>

To assure a greater chance in winning the contest with the land, the Ivatans have created many forms of labor cooperatives based on one main principle: "Work you do not need today, when invested with a

<sup>2</sup> Feleo (2006).

<sup>3</sup> Villalon (2000).

<sup>4</sup> Bayanihan is a Filipino term which refers to a spirit of communal effort and unity.

<sup>5</sup> Villalon (2000).

townsman in need today, will be paid back to you when and where you need it in the future". This is the code from which permanent and occasional work groups such as the kayvayvanan, payuhwan, kapaychahwan, kapanidungan, among others, operate on. The community self-help cooperative called yaru, to which every household sent at least one able-bodied representative to render service to the community, is particularly important in times of disasters such as typhoons.

The education pattern by which indigenous knowledge is passed on, particularly in traditional house building and watercraft construction, is essentially by apprenticeship and participant observation. The skills for house building in the traditional way are not taught in school but learned from practice and apprenticeship to veteran community constructors. The same is true for the construction of the traditional Ivatan watercraft.

## Lessons Learned

Apart from the Ivatans, no other culture in the Philippines has successfully mastered the ravages of the seasonal typhoons. The Ivatan culture is a product of a long history of struggle and adaptation to typhoons, the rough seas and meager resources. It exemplifies the harmonious relationship of people with their environment.<sup>6</sup>

Several lessons can be learned and some conclusions can be drawn from the case of the Ivatans.

1. The rich stock of indigenous knowledge of the Ivatans draws on local resources and therefore is cost-efficient as only locally available skills and materials are utilized.
2. Despite its natural limitations, self-sufficiency was achieved by this group of tiny and isolated islands through the use of indigenous knowledge.
3. It is common custom for Ivatans to mutually help one another. In times of disaster, the existing social institutions make an organized and concerted community effort uncomplicated.
4. Kaalamang Bayan (community knowledge), the way of life, the method of doing things, and the beliefs all based on traditional knowledge and customs, are the core tenets of Ivatan culture. This traditional culture has served the Ivatans well in their struggle for survival over many centuries. Nevertheless, history and current conditions show that traditional culture assures survival but not much more as evidenced by the persistent poverty in Batanes. There is a need to affect a meaningful development program in Batanes recognizing its unique culture and providing support to its existing conditions, namely limited resources and severe weather conditions.
5. In many cases, the traditional knowledge of the Ivatans is regarded as primitive and therefore is often discouraged or disregarded. For instance, school buildings have been constructed which do not take native wisdom into account. The project became an exercise of futility since no building remained after the passing of just a few typhoons. It is important to recognize the value of traditional knowledge, especially that which is time-tested and effective, despite modern-day technology.

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<sup>6</sup> Datar (2002).

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## Western Province, Solomon Islands

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# Indigenous Knowledge Saved Lives during 2007 Solomon Islands Tsunami

*Brian G. McAdoo, Jennifer Baumwoll and Andrew Moore*

### Abstract

On 2 April 2007, an earthquake with a magnitude of 8.1 and its subsequent tsunami hit the Solomon Islands, killing 52 people. That number would have likely been considerably higher was it not for the appropriate reaction of the indigenous coastal populations. Immigrant populations died at disproportionate rates in comparably damaged areas because they did not recognize the signs of the impending tsunami. Both the indigenous and immigrant populations had little time to respond because their villages were very close to the earthquake's epicenter. While buoy-based early warning systems are necessary to mitigate the effects of trans-oceanic tsunamis that hit coastlines hours after an earthquake, they are limited in the near field regions close to the epicenter, especially those with developing infrastructure. Tsunami mitigation plans that seek to educate local populations must be cognizant of not only the physical environment of the region, but also economically and culturally diverse populations and their knowledge of the local environment.

### Background

Between 1955 and the early 1960s, the ethnic demographics of the Western Province changed when a group of ethnic Gilbertese emigrated from their native Kiribati, a country of remote, low-lying coral atolls located in the southwest Pacific Ocean, far from any active earthquake sources. Due to resource depletion and population increase there, they came to the region as part of a British colonial resettlement scheme.<sup>1</sup> According to a 2002 Solomon Island government census, the Gilbertese constitute less than 4% of the country's population (~ 4000 of 495,000). The Gilbertese are traditionally atoll-dwellers that rely heavily on ocean resources, thus the majority of their settlements are located adjacent to the lagoons. Since the Gilbertese moved to the region there have not been any tsunamigenic earthquakes.<sup>2</sup>

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<sup>1</sup> Matthew (1996).

<sup>2</sup> Fritz and Kalligeris (2008) report eyewitness accounts of small tsunamis on Ranongga generated by a local Ms=7.2 earthquake in 1959, and in Honiara on Guadalcanal in 1952 that likely resulted from a distant earthquake in Kamchatka in the far NW Pacific.

### Story/Event

On 2 April 2007 at 7:39AM local time, a magnitude 8.1 earthquake hit the Solomon Islands' Western Province.<sup>3</sup> The earthquake caused strong shaking (hard enough that most people had problems remaining standing) which lasted over 1 minute, damaging structures and shearing off coral reef colonies,<sup>4</sup> while at the same time warning the populace of the potential for a tsunami. Structures in the region were significantly damaged, and injuries resulted from falling building materials and burning water from cook stoves.<sup>5</sup> The earthquake also triggered over 1,000 landslides on the steep volcanic island of Ranongga- one occurred at the village on Mondo, killing 2 people.<sup>6</sup> Strong shaking and coseismic uplift also damaged the delicate coral reef in the lagoons, which will have lasting effects on the recovery of the fisheries on which both the indigenous Melanesian and immigrant Gilbertese populations rely.

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<sup>3</sup> USGS (2007).

<sup>4</sup> McAdoo et al. (2008).

<sup>5</sup> Fritz and Kalligeris, (2008).

<sup>6</sup> McAdoo et. al. (2008).

Almost immediately after the shaking stopped, according to eyewitnesses, water rushed out of the shallow coral lagoon, leaving the seafloor exposed. The tsunami came back in between 3 and 10 minutes after the shaking ceased. Anecdotal evidence, supported by geologic observations, describes two or three subsequent waves that came in as relatively low power, rapidly-rising tides rather than fast-moving turbulent bores.<sup>7</sup> Low density coral colonies with large surface areas that the earthquake sheared off at their bases landed near their original growth positions, and would have been moved in the presence of a strong current. The tsunami picked up vehicles and houses, floating them inland and dropping them with very little damage—more powerful bores tend to roll vehicles and dismantle structures. The tsunami was responsible for 50 of the 52 deaths caused by this disaster. Figure 1 illustrates the geographic distribution of runup heights as they relate spatially to deaths.

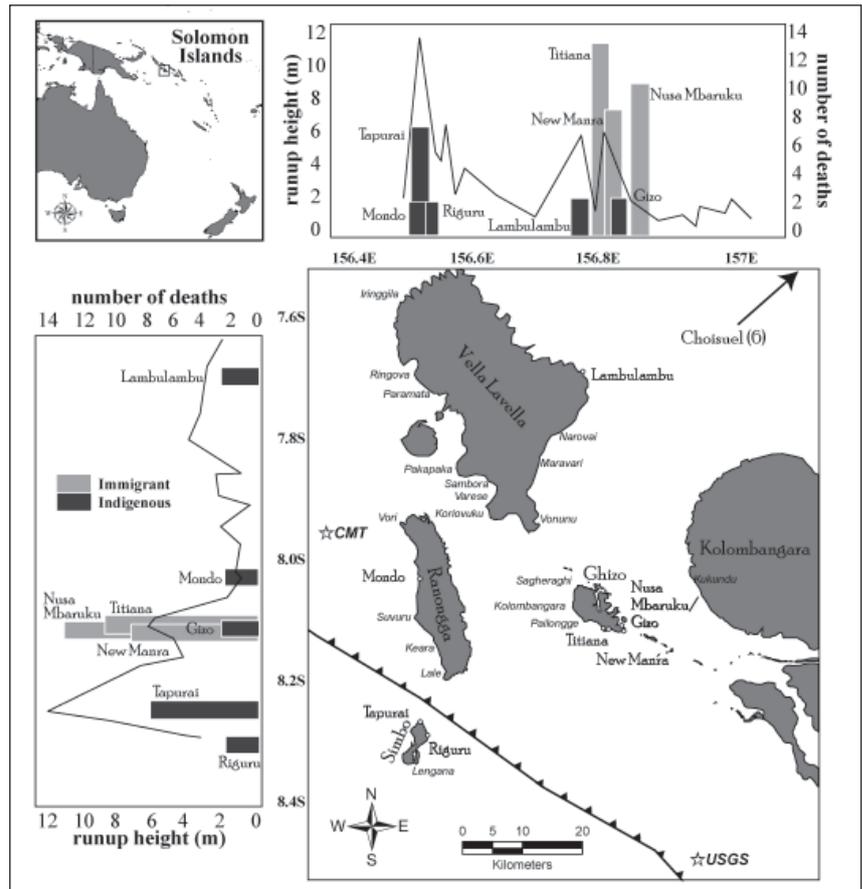


Figure 1. Geographic distribution of runup heights from the 2 April 2007 Solomon Islands tsunami as they relate spatially to deaths. Villages on the map are those that suffered significant damage, and those in larger bold type recorded deaths. There tend to be more deaths where the tsunami was larger, however most of those deaths occurred in the minority, immigrant populations. (After McAdoo et al., in press, *Natural Hazards*)

<sup>7</sup> McAdoo et al. (2008).

## Indigenous Knowledge

The geologic survey found that a tsunami that came ashore at the same height in similar physical surroundings in areas with different demographics produced inconsistent mortality patterns which could not be explained by the physical hazards alone- Gilbertese immigrants died at disproportionate rates compared to the indigenous Melanesians.<sup>8</sup> While the immigrant villages tend to have higher populations, their response to the earthquake, which was to investigate the emptied lagoon, demonstrated a lack of understanding of how tsunamis behave. Each of the villages had a good coral reef/lagoon buffer, and one of the affected immigrant villages (New Manra) even had an additional stand of mangroves that the indigenous communities

lacked. This evidence suggests that the primary factor contributing to increased mortality was a proper response based on generations accustomed to living on an active island arc adjacent to a subduction zone.

The immigrant community of Titiana is only 3 km east of Pailongge on the south coast of Ghizo Island that took the brunt of the tsunami. The broad lagoon (100-400 m wide) lies behind a steep coral reef front, like Pailongge, and reflected some of the wave energy back to sea.<sup>9</sup> According to survivors, however, when the shaking stopped and the ocean receded from the lagoon, curious children from the village went down to explore the exposed seafloor. In the Gilbertese villages of New

<sup>8</sup> McAdoo et al. (in press).

<sup>9</sup> McAdoo et al. (2008).

*There were a lot of heroic stories that emerged after the disaster; stories of women and men who dashed back into the raging sea to save their love ones. Some succeeded, most however lost their lives in their final act to save lives.*

*Gizo resident  
Robertson Szetu  
(Galathea Expedition)*

Manra, Titiana and Nusa Mbaruku, 67.7% of those that died were children. In Titiana alone, 8 of the 13 people that died were children who were not strong enough to swim against the incoming waves. As described in Figure 2, the immigrant villages recorded more deaths in Ghizo Island.

Anecdotal evidence suggests that many adults here were overwhelmed by the tsunami as they went to rescue their children-

On the other hand, there were no deaths in the indigenous Solomon Island village of Pailongge (population 76) on Ghizo's south coast. The sea withdrew almost immediately after the earthquake shaking ceased, according to eyewitnesses. The geologic evidence suggests that the steep reef front and broad lagoon (100-500 m wide) slowed the incoming tsunami,<sup>10</sup> however the wave was still quite large when it came ashore, flowing overland around 3 m deep.<sup>11</sup> After the shaking stopped, village elders noticed that the lagoon had emptied, helped direct everyone inland, and heads of households made sure that children were accounted for and evacuated.



Figure 2. Gizo has a population of indigenous Solomon Islanders (yellow) and immigrant Gilbertese (red) that live in largely segregated villages. The indigenous village of Pailongge lies on the south coast exposed to the brunt of the tsunami, as was the immigrant village of Titiana, and both villages have accessible high ground for escape. No one died in Pailongge, and only 2 died in the more populous Gizo, where each of the immigrant communities recorded deaths regardless of geography. New Manra, an immigrant community, had not only a protective reef, but also a stand of mangroves in front of the village, yet 8 people (of 206) died. (after McAdoo et al., submitted to Natural Hazards)

<sup>10</sup> McAdoo et al. (2008).

<sup>11</sup> Fritz and Kalligeris (2008).

# Lessons Learned

Of the 52 people that died during the Solomon Islands earthquake and tsunami, 31 (59.6%) were immigrant Gilbertese from Titiana, New Manra and Nusa Mbaruku that did not react properly because they had no memory in their culture of such an event.<sup>12</sup> Kiribati is a coral atoll nation, situated far from any regular earthquake sources. Because there have been no major, tsunamigenic earthquakes in the 50 years since their emigration, they simply lacked the indigenous knowledge of their adopted environment that could have helped save their lives. Gilbertese children were particularly vulnerable because not only were they too weak to swim against the relatively slow-moving yet deep tsunami, but they lacked the indigenous knowledge that would have kept them from exploring the emptied lagoons. The indigenous Solomon Islanders, on the other hand, in large part responded in a way that reduced their overall mortality.

Indigenous knowledge of the Solomon Islands, where active volcanoes and earthquakes are more common, mitigated the effects of this tsunami. In indigenous villages on hard-hit Ghizo Island, the effects of the tsunami were mitigated by the combination of 1) a healthy coral reef with a steep barrier front and wide, shallow lagoon that reflected and attenuated some of the tsunami's energy, 2) accessible and effective escape routes and high ground provided by the existing topography, and 3) an indigenous knowledge of what to do during a strong earthquake followed by an emptying lagoon.<sup>13</sup> Immigrant Gilbertese villages with both the same physiography and who were hit by a tsunami of equal intensity, lacked indigenous knowledge which led them to suffer more casualties. Many people died at the indigenous village on Tapurai, which lacked an effective coral reef barrier due to its natural morphology that evolved on the lee side of Simbo Island.

Indigenous knowledge is an effective tsunami mitigation tool when the right combination of education and physiography come together. Locations with broad coastal plains would have a hard time evacuating the coast, especially if population densities are high as is the case with Banda Aceh, Indonesia during the 2004 Indian Ocean tsunami. Nonetheless, a barrier reef, wide lagoon and stand of mangroves were not enough to protect the residents of New Manra since they had no knowledge of tsunamis in this region.

<sup>12</sup> McAdoo et al. (in press).

<sup>13</sup> McAdoo et al. (in press).

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## Purana Villages, Sri Lanka

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# Village Tank Cascade Systems: A Traditional Approach to Drought Mitigation and Rural Well-being in the Purana Villages\* of Sri Lanka

*C.M. Madduma Bandara*

### Abstract

There is a wide variety of social and technological adaptations to recurrent droughts by the indigenous communities inhabiting the dry zone of Sri Lanka. These include tank cascade systems, traditional water management practices, disaster forecasting systems, adoption of appropriate cropping calendars, use of drought compatible rice and other seed varieties, unique systems of land tenure and land use, institutional mechanisms, cultural adjustments and traditional systems of values and beliefs.

The experience of the communities has been hardly studied from a holistic and interdisciplinary perspective, despite some interesting work done on different individual aspects of their life. Attempts to duplicate their experience in other settings as in the case of the 'bethma system' sometimes failed due to lack of its understanding from the perspective of the existing systems. However, such systems continued to stay in the drought prone villages over hundreds of years due to their usefulness to rural society. With increasing drought proneness resulting from on-going global climate changes, the value of such practices and technologies has gained new currency.

'Cascade Systems' - an ancient, small-scale but widespread irrigation technology - is still observed in the Dry Zone of Sri Lanka. Some systems date back to over two thousand years, but still remain operational, providing a unique case of resilience and long-term sustainability. However, due to deforestation of catchments, changes in management systems, increasing external economic controls and the breakdown of old social order, their present functioning remains far below optimum levels. This may be rectified through certain improvements in land use planning, innovative management approaches and promotion of certain types of market-oriented agricultural systems.

\* Ancient Villages of the Dry Zone particularly in the North Central Province of the Anuradhapura District of Sri Lanka

## Background

Sri Lanka, an island nation located near the southern tip of India and in the core area of the South Asian Monsoon, has developed its own endemic forms of adaptation to recurrent disasters of droughts and floods. The rainfall is seasonal as governed by the monsoons. In the Dry Zone where the cascade irrigation systems prevail, annual rainfall exceeds 1000 mm on the average. However, due to high evaporation rates, serious seasonal water deficiencies occur, and therefore the term 'Dry Zone' came into usage. The natural vegetation is largely deciduous in consonance with the marked seasonality of rainfall. The rolling topography of the terrain in most areas, creating a myriad of small watersheds, provided the necessary natural setting for the evolution of tank cascade-based agriculture.

The North Central Dry Zone became the cradle of Island's civilization with the national Capital City of Anuradhapura, established there as far back in the 3rd Century BC. Civilizations whose agriculture and culture were dependent upon minor as well as large-scale waterworks for irrigation, flood control and water supply are referred to as "hydraulic civilizations" by many writers.<sup>1</sup> The villages that continued to remain from that great civilization are generally referred to as purana villages. These villages were traditionally dependent on rice fields, chena land (swidening) and home gardens. The village settlements are often located near the tank bunds and the rice fields. Home gardens benefiting from moisture in the tanks contain a wide variety of drought resistant tree crops. On average, each village has about 25-75 families with about 3-7 persons per household.

Communities of the purana villages still continue to be generally homogenous, often confined to a single caste group. They usually inter-marry people of the same caste spread out in a number of neighboring villages belonging to the same Variga or clan. The Variga system is now virtually defunct, but the caste system prevails. Due to the higher degree of homogeneity, the community spirit in these areas has been high, fostering the practices of

sharing, as reflected in the bethma (water sharing) system. In the village rice field for example, tail-enders of the irrigation ditches were related to those of the top-end either by descent or by marriage. This resulted in the scattering of land parcels insuring them against severe droughts or damage from wild life. The rice fields were laid out as elongated strips parallel to the tank bund so that water management would be more rational and economizing. With increasing family size, some strips became narrower and narrower due to sub-division over the years. Whatever was produced from the local resource base had been sufficient for an egalitarian life style, with rice for all meals supplemented with finger millets and vegetables from chena (swidden) farming and freshwater fish from the tanks. In the past, these villages have been virtually self-sufficient except for a few items like salt.

## Story/Event

Droughts are not dramatic disasters like earthquakes, tsunamis, cyclones, land slides and floods. However, droughts similarly generate serious stresses on society, particularly in the poor rural areas, by creating food shortages, mal-nutrition and ill health and which often lead to death. The total economic and social damage of droughts is sometimes even higher and more devastating than other disasters, as in the case of Sri Lanka.

During the period 1981-1995, droughts and related problems of water supply affected nearly three million families. It has been reported that the government had to incur over 2 billion rupees (around 49 million USD) for drought relief during this time.<sup>2</sup> This was primarily due to prolonged periods of extremely low rainfall. For instance, it has been reported that in the 1983 drought, almost 55% of the total land area on the island received less than 10% of the average rainfall for the January-March period - one of the worst in recent years. Economically and socially disastrous droughts recur once every 3-5 years. Some of the worst droughts hit the area in 1981 and 1983. The threat not only continues but also likely to be more acute due to global climatic change.

<sup>1</sup> E. R. Leach (1959).

<sup>2</sup> Madduma Bandara & Pathirana Assela (1999).

# Indigenous Knowledge

The purana (ancient) village communities of Sri Lanka, living in the drought prone areas of the dry zone, evolved their own strategies to combat drought impacts over the centuries. The unique character of this community is their self-reliance in response to recurrent droughts and long dry spells. Such strategies manifest themselves in the unique systems of hydraulic engineering, drought forecasting, land tenure, land use, cropping calendars, agricultural systems, animal husbandry, fresh water fishing, food processing, food habits, cultural traits and rites and rituals. There had been hardly any systematic effort to invent, analyze or extract the substance of the indigenous knowledge embedded in these communities. Further, this knowledge-base had been gradually eroded with the existence of economic, demographic and social changes. The 'cascade systems' that evolved had been effective in mitigating droughts as well as floods during high rainfall and dam breaches; they were also effective in soil erosion control and bringing about ecological and social harmony. The 'cascade systems' along with their other ramifications, reflect a holistic approach to water management and disaster reduction among the indigenous communities in the dry zone of Sri Lanka.

## The Village Tank Systems

In addition to its large-scale irrigation works, the drier areas of Sri Lanka are covered with thousands of man-made lakes and ponds, known locally as 'tanks' (after 'tanque', the Portuguese word for 'reservoir') that harvest rain water effectively to face the recurrent drought conditions. Some tanks are truly massive; many are thousands of years old, and almost all show a high degree of sophistication in their construction and design.<sup>3</sup>

Traditionally, several different types of tanks were built - some of which had nothing to do with irrigation per se, but all of which had a critical role to play in the practice of irrigation agriculture. It was, for example, traditional to build a forest tank in the jungle above the village. That tank, however, was not used to irrigate land. On the contrary, its express purpose was to provide water to wild animals and, hence, to reduce the likelihood that they would descend into the cultivation areas and destroy the crops in search for water. Other types of tanks included the mountain tanks that were built to

provide water for 'chena' or slash-and-burn agriculture in the more hilly areas.

The erosion control tank, or 'pota weti', was designed to gather any silt deposited from the upper slopes before entering the main water storage tanks. Several erosion control tanks were associated with each village irrigation system. All were built in such a way that they could easily be de-silted. The storage tank, of which, traditionally, there were two types - one being used whilst the other was being repaired. For that reason, such tanks were known as 'twin tanks'.

Village tank settlements have always been the backbone of the Hydraulic Civilization from ancient times. These small tanks find their best expression across the undulating landscapes of the North Central, North Western and Southern Regions reflecting the essence of traditional irrigation technology. At the same time, the small tank systems have always occupied a special place in the national consciousness and heritage of Sri Lanka. They represent some of the earliest sedentary human settlements with its well known cultural trinity - the Wewa (tank), Wela (rice field) and the Dagaba (religious monument).

## Tank Cascade Systems: Their Form and Substance

A 'cascade' is a connected series of tanks organized within a micro-(or meso-) catchment of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet.<sup>4</sup> It appears that the *raison d'être* for the emergence and continued existence of village tank cascade systems was the need for a sustainable irrigation and water management technology to meet the challenge of recurrent water shortages and drought conditions in a seasonally dry environment. Therefore, it was the need for more economical and rational use of water that led to the development of the recycling or re-use principle (Figs. 1a and 1b). Water from the upper parts of the cascade was used and re-used several times before it reached the outlet. It may be argued, therefore, that the village tank cascade systems only gave expression to King Parakramabahu's famous royal dictum of the 12th Century that states 'Let not a single drop of water go waste into the sea without benefiting the world' (Fig. 1a).

<sup>3</sup> R. L. Brohier, R.L (1934) and E.J. Tennent (1860).

<sup>2</sup> Madduma Bandara (1985).

The tank cascade systems are associated with a variety of ecological and socio-economic subsystems that include (i) the ecological system with catchment forests, aquatic habitats, and the commons (ii) land use zoning systems (iii) various crop combination systems (iv) elaborate water management systems including sluices, spills and water control weirs (Karahankota) with rotational water distribution systems and (v) institutional systems such as the Velvidane (irrigation headman) system that dates back to pre-colonial times.

Another principle that would have ensured the sustainability of cascade systems would have been ecological harmony. An impression of a tank village system is given in Figs. 2a and 2b. By trial and error the people would have discovered that they have to adhere to the laws of nature if they are to survive in a challenging environment. Therefore, the land use system became adjusted in such a way that the richer alluvial humic gley soils were used for rice fields, while the sloping areas of reddish brown earths in the upper segments of the catena, were devoted to shifting cultivation (chena) that allowed the soils to recuperate after several years of fallow. The most infertile areas of the watersheds were left intact under rocks and forests, except for being used for spiritual purposes such as temples. A third principle that may have governed the sustainability of cascade systems was the socio-economic harmony where the village society and its economy evolved and thrived on the wise utilization of the local resource base. This society retained a high degree of homogeneity through kinship and caste that ensured a higher community spirit and self reliance.

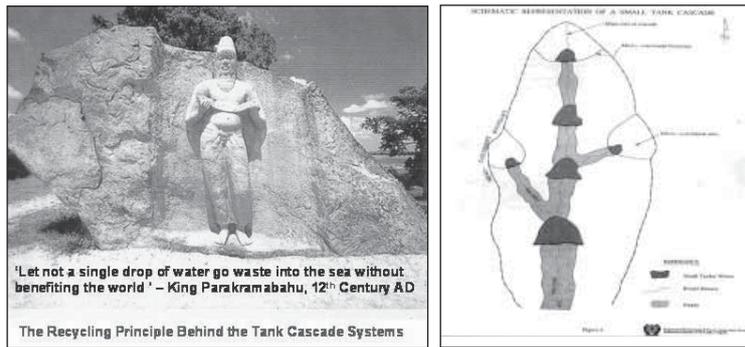


Figure 1a: The Royal Edict and 1b: Recycling Principle of Cascades

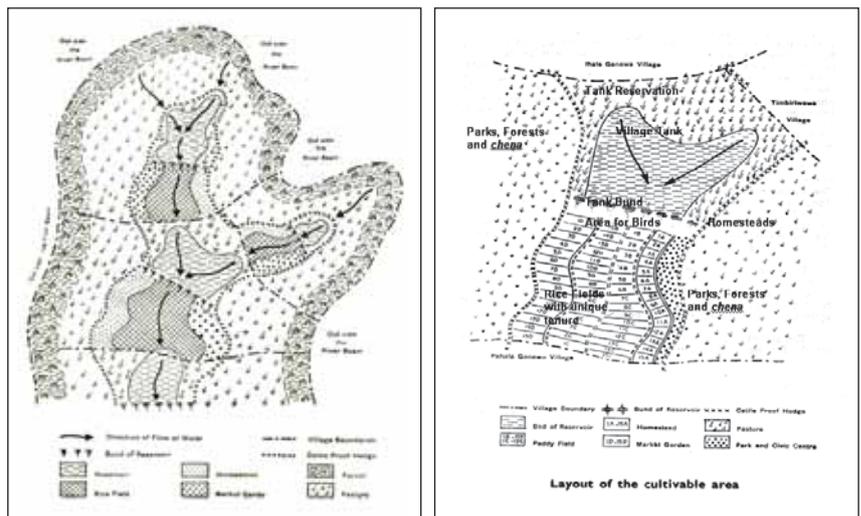


Figure 2a & 2b: Impressions of a Cascade-based 'Eco-Village' (Adapted from unpublished manuscript by P.U. Ratnatunge, the late Chairman, Freedom from Hunger Campaign Board, Colombo, Sri Lanka).

## Lessons Learned

Tank cascade systems undoubtedly improved the food security of rural communities while strengthening ecological and social harmony. The dissemination of this knowledge had taken place by word of mouth and through practice by successive generations, which also resulted in unique land use systems, animal husbandry and aquaculture.

The tank cascade systems reflect a unique adaptation to withstand devastating drought conditions. Their protection and improvement has the potential to ensure food security and ecological stability with relative low investments. The purana village communities that continue to use this technology harbor a unique knowledge base evolved through the centuries with untapped potential.

At present there are indications of increasing recognition of the value and potential of cascade-based development among regional planners and civil engineers. It is a time-tested technology verified by the local communities. Some initiatives have been made by international organizations such as 'Plan International' and the North Central Provincial Council to promote cascade-based rural development. These efforts, though commendable, lack vision, direction and leadership. Activities at the local level are often incoherent due to the lack of understanding the systems' principle and the elements of the cascade.

The tank cascade knowledge, when properly practiced, demonstrates the value of the principle of recycling in a challenging environment. An analysis of its deeper meaning would indicate that it can ensure not only social harmony and food security but also ecological sustainability.

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## Surin Islands, Thailand

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# Saved by an Old Legend and a Keen Observation: The Case of Moken Sea Nomads in Thailand

*Narumon Arunotai*

### Abstract

There is a lesson to be learnt in the case of the Moken sea nomads in Thailand – that the Moken have indigenous knowledge that enable them to reduce risk from disaster. It could be said that the Moken were saved by an old legend, a keen observation of the sea and a strong sense of precaution, their intimate knowledge of marine and forest environment, their clever selection of village site, and their boat maneuvering skill. This article explores lessons from Moken indigenous knowledge in risk reduction and the implications for applying these lessons to relevant policy and practices.

*“We call this big wave ‘laboon’. It is the cleansing wave that came to wash the dirty shore. It is the god of wave, a furious one that consumes and destroys. I had never seen such wave, only heard it from the ancient ones. They talked about the ‘seven roller waves’ that visits us once in every two generations.”*

*Salama Klatalay, Moken elder*

### Background

The Moken, the “sea nomads” or “sea gypsies” of the Andaman Sea, are a former marine nomadic group generally known in Thailand as Chao Lay (sea people). During the dry north-east monsoon season when the sea is calm the Moken lived in traditional boats called kabang, traveling to islands in the Mergui Archipelago in the Andaman Sea to make a living. The social structure consists of kin groups of about two to ten families traveling together. In the southwest monsoon season the sea is rough and unpredictable, so the Moken adapt to this by living in temporary huts in protected bays and making their livelihood close to their villages.

The large Moken communities in Thailand can be found in the islands of Lao, Sinhai, Phayam, and Chang in Ranong Province, the Surin Islands in Phang-nga Province, and in Rawai Beach in Phuket Province. The Moken from the Surin Islands remain relatively traditional compared to the other groups. Even though they have started living in the same place for a longer period, they still use forest materials for their huts

and occasionally move their village to another site. Nowadays there are about 2,000 Moken in the Mergui Archipelago in Myanmar and about 800 Moken in Thailand.<sup>1</sup>

The Surin Islands have been the home and the foraging ground for the Moken for centuries. The islands are located in the Andaman Sea, approximately 60 kilometers off the southwest coast of Thailand. Administratively, the Surin Islands are part of Khuraburi District in Phang-nga Province, which lies approximately 720 kilometers southwest of Bangkok.<sup>2</sup> Phang-nga is one among six provinces that received the most devastated impact from the tsunami.

The Surin Islands' main natural features are coral reefs and forests. The coral reef surrounding the Surin Islands is reported to be the largest and widest in Thailand. Tropical rainforest is the other major natural feature on the islands. It accounts for over 90 percent of the forested area. The forested areas are well preserved and play an important role in the Moken's traditional lifestyle.<sup>3</sup> The Surin Islands were declared Thailand's twenty-ninth national marine park in 1981. Facilities for tourists have been gradually developed and during 2003 the Park received over 36,000 tourists during their 6 months opening season (from mid November to mid May).

Prior to the tsunami, there were 2 Moken communities on the Surin Islands. One community, consisting of 16 households, was located at Sai-En Bay on North Surin Island. The other community, consisting of 30 households, was located at Small Bon Bay on South Surin Island. The Moken population on the Surin Islands fluctuated seasonally and annually. Some individuals and families migrated between the Surin Islands and other islands in Myanmar waters and between the two communities within the Surin Islands. During 2004, there were 184 Moken living on the Surin Islands. Of these, 77 were male and 107 were female. About half of the population is 18 years old or younger, and children under the age of ten constitute about one-third of the population.<sup>4</sup> As of February 2008, there are about 220 Moken on South Surin Island, living in one large village at Large Bon Bay.

## Story/Event

On the morning of Sunday December 26, 2004, the Moken of the Surin Islands observed a sudden change in the sea level. This occurred without any change of weather and it was considered a very unusual phenomenon. For several Moken elderly, it signaled the coming of "seven rollers", a legend that has passed down for generations. The whole community ran up to the hill behind the village very quickly, and all survived the tsunami disaster, though the entire village was swept away along with a few boats.

At the same time, over 20 Moken had been working at the National Park. Those who took tourists out for snorkeling noticed a change in the current and decided to steer the boats away from the shore. Due to their sharp instinct and outstanding boat maneuvering skill, they saved the lives of many tourists. Again, it was the Moken who took the National Park staff and tourists up their foraging trails to seek a safe place to spend the night while waiting for a bigger boat to take them all to shore.

After their two villages were swept away by the tsunami, the Moken of the Surin Islands came to shore to take refuge in the local temple. Within two weeks, they missed the islands and the sea, and felt confident enough to move back to the Surin Islands. Since they are a group that accumulates few material possessions, they did not dwell on the past, but continue with their daily lives as in pre-tsunami days.

<sup>4</sup> Arunotai, Wongbusarakum, and Elias (2007): 12.



Figure 1. The Moken and their kabang. Photo: Paladej Na Pombejra

<sup>1</sup> Arunotai (2006):140

<sup>2</sup> Arunotai, Wongbusarakum, and Elias (2007):8-9.

<sup>3</sup> Arunotai, Wongbusarakum, and Elias (2007):8-9

# Indigenous Knowledge

The Moken of the Surin Islands have become widely known in Thailand and internationally as the group of people who escaped from the tsunami unscathed. The Moken survived not only because of the old legend of the seven rollers, but also because of their keen sense of observation, their alertness and sense of precaution, their intimate knowledge of marine and forest environment, the clever selection of their village site, and their boat maneuvering skill. The details of their knowledge, keen sense, and relevant skills are as follows:

1. Legend of the seven rollers. The Moken are a non-literate group but their “oral literature” is creative and rich. Living on islands and coastal areas for centuries, their ancestors must have experienced tsunami incidents, and they cleverly encoded the danger of tsunami disaster in a legend of the laboon or giant wave. The legend teaches that the laboon which usually comes as series of waves, hence “seven rollers”. While openly talking about laboon was forbidden out of fear that it would bring the deadly wave upon them, everyone knew that when the water along the shore suddenly went dry, they had to run to higher ground to save their lives. This knowledge represents the most effective natural disaster warning system, without any help from modern technology.<sup>5</sup> The tsunami warning sign is imprinted in their cognitive system, so they are all able to survive even though most have not even seen a tsunami before.
2. Keen sense of observation and precaution. The Moken are very observant, especially regarding the change in weather and other unusual occurrences. They use the principle of precaution and are always alert. This is due to the risk encountered in everyday lives – from natural risks like unexpected storm, dangerous sea and forest animals, to human-related risks which can be traced from the Moken’s long history of being abused and exploited by outsiders – pirates, slave-raiders, robbers, bandits, etc.<sup>6</sup> Therefore, as soon as sea water receded in an unusual way on December 26, 2004, the Moken flagged one another to seek refuge on the hill behind the village, and those who were taking tourists out for snorkeling headed their boats away from the shore to avoid impact.
3. Intimate knowledge of marine environment. Being the “sea people” who live off, from, and by the sea, the Moken have a deep-seated knowledge of the natural rhythms, an ability to recognize natural signs and to distinguish between “usual” and “unusual” phenomena. For them, the mass of water receding very quickly was peculiar, and the incoming white breaker was definitely a sign of laboon as it occurred without any stirring wind or a changing sign in the sky.

<sup>5</sup> Arunotai (2006):143

<sup>6</sup> Hinshiranan (1996):131-133



Figure 2. Left: Tsunami sign seen throughout the southern coast of Thailand. Right: Such a sign can be “imprinted” in the young through indigenous knowledge.

4. Knowledge of forest trails and survival in the wild. After running uphill to seek refuge from the tsunami impact, the Moken know “where” to run to because they are familiar with the forest environment and terrain.
5. Clever selection of village site. The Moken who reside on different islands within Thailand’s Andaman Sea carefully select an appropriate site for their villages, that is, the area on the eastern part of the islands. A comparative analysis of indigenous settlements (Moken’s and Urak Lawoi’s) leads to the conclusion that each of the settlements are in a protected bay on the east. This is because the islands in the Andaman Sea are influenced by two monsoons, southwestern monsoon which brings rain, strong winds, waves, and storms; and northeastern monsoon which brings drier weather and milder winds. Having settlements on the eastern side of the island means being relatively well-protected from southwestern wind (and thus from tsunami from the high sea).<sup>7</sup> For the Moken of Surin Islands, the high mountain behind the village also provides enough high ground for evacuation.
6. Boat maneuvering and other marine-related skills. Moken men have very good boat maneuvering skills because they become familiar with rowing smaller boats and operating the motor for larger boats at an early age. In turbulent waters, the men can skillfully steer boats away from shore. Both men and women also have other marine-related skills such as swimming and diving. Furthermore, men and women, young and old, relatively maintain their physical fitness as their work usually involves physical strength. Even the elderly and children are able to run and climb up to higher ground without much difficulty.

With regard to the passing on of indigenous knowledge, there is no means of documenting or transforming knowledge into the textual form that people can read or follow because the Moken language has only verbal form, no script or written language. From a modern education perspective, this poses a limitation as there is no means to record the knowledge and no other “short-cut” to that knowledge except by learning it directly from those who know through, 1) observation, 2) memorization or bearing in mind, 3) trial or hands-on, 4) discovery-exploring-reinventing, and 5) practicing and reviewing.

Moken traditional settlement, village, and huts, including beliefs and practices about hut construction, all reflect traditional knowledge which enables the Moken to reside comfortably and safely in the coastal environment. In addition, a small village with long-stilted huts situated on the water has been a significant part of Moken cultural identity.<sup>8</sup> It should be noted here that their tsunami survival is partly due to “keen observation” – from traditional village layout, most Moken are able to observe the sea right from their hut.

In the eyes of the sedentarized land-based population of Thailand who have permanent homes, the nomadic and simple lives of the Moken seem to be outdated, backward, and without potential for progress.<sup>9</sup> This is likely to be a social representation that the Moken themselves have adopted from mainstream society.<sup>10</sup> As a result, the Moken indigenous knowledge is rarely recognized or valued.

<sup>7</sup> Arunotai and Elias (2005).

<sup>8</sup> Arunotai and Elias (2005).

<sup>9</sup> Arunotai (2003):116–117.

<sup>10</sup> Arunotai (2006):141.



Figure 3. Pre-tsunami huts, with entrance facing inland but with back porch overlooking the sea.

## Lessons Learned

The major lesson learnt here is that traditional Moken knowledge previously regarded as “common” or even “outdated” enabled the Moken (and others) to survive the tsunami disaster. It is unfortunate that these forms of knowledge are now limited only to the adults and the elderly. They are gradually forgotten and rarely passed on to the young generations.

As for the legend and folktales, “Some of the tales are merely short versions of longer tales, and oral literature no longer has much meaning for them.”<sup>11</sup> “The traditional indigenous knowledge of the Moken is not recognised as knowledge or science; thus the direction of change is towards the kind of development defined and induced by outsiders who see them as backward and poor.”<sup>12</sup>

There are several implications for applying these lessons to relevant policy and practices.

1. To value and promote indigenous knowledge through the development of relevant local curriculum and community participation in education management. Children should have a chance to learn from the elderly in the community, to absorb and practice “keen observation” and the “precautionary principle”, and to learn and cherish intimate knowledge of marine and forest environment. Formal education places an emphasis on “explicit” knowledge, but such “tacit” knowledge and skills have proved to be crucial to the Moken’s physical and cultural survival.
2. To “internalize” early warning signs and disaster preparedness plans like evacuation, escape routes, and getting to emergency shelter. For the Moken, the coming of laboon is actually imprinted in their cognitive system although it was previously half-myth and half-reality. Not only were they able to recognize warning signs, they were also familiar with the forest trails which they used as their escape routes and staying/surviving in the wild was not a problem for them either. For other communities, apart from having educational materials on natural disaster for communities and schools, there needs to be regular practices and drills for different kinds of possible disaster or occurrence in the area.
3. To learn important survival knowledge and skills like swimming, climbing, first-aid, etc. One should keep physically fit in order to be prepared. The Moken community is small, so they know one another well and know who needs special help. For other communities, there should be a mapping of the elderly, people with disabilities, and others who need special help so that they can be taken care of during the emergencies.

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<sup>11</sup> Ivanoff (2001):3.

<sup>12</sup> Arunotai (2006):148

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## An Hai Commune, Ninh Phuoc District, Ninh Thuan Province, Vietnam

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# Weather Forecasting through Indigenous Knowledge for Crop Cultivation in the Drought Prone Area of Vietnam

*Nguyen Ngoc Huy and Rajib Shaw*

### Abstract

The coastal area of Ninh Thuan province is the driest area of Vietnam. The annual rainfall is normally between 600 mm and 800 mm per year with uneven distribution throughout the month. Since weather forecasting is still limited in some low developed areas, the use of indigenous knowledge for weather forecasting is very useful in crop cultivation in the community. Specifically, the methods of moon observation and dragonfly observation for predicting weather changes have played an important role in agriculture activities in the An Hai community.

*“Dragonfly flies high, sunny sky  
Flies low, rain  
Flies neither high nor low, cloudy sky”*

*(Lyrics of a folk song used in weather forecasting)*

### Background

An Hai is one of several coastal communes located to the East of Ninh Thuan province. The total geographical area is 2,091.98 ha with 1,057.37 ha in agriculture, 4239 ha in forestry, 4833 ha in dwelling and the rest in aquaculture and other uses. In 2005, the total population of the An Hai commune was 12,890, divided into about 2,596 households in a total of 6 hamlets.

The main livelihood of the community is agriculture, with rice, grapes and short-duration vegetables (such as tomatoes, carrot, chili and potatoes) as main crops. Animal husbandry is another one of the strengths of the An Hai commune, focused mostly on raising cattle, sheep and goat.

There are three rice crop seasons in irrigated areas: Winter-Spring from early Dec to early April; Summer-Autumn from late April to early August and main cropping season from September to early December.

The primary sources of water in the dry season are river water and well water. In the rainy season, people mainly use rainwater for crop cultivation.

## Story/Event

Temperatures in inland Vietnam are rising and the weather is becoming extreme and unpredictable. Average temperatures are now 1° C higher than they were about 100 years ago. Changes in rainfall patterns are complex and vary depending on the location; however, the main trend is towards hotter, longer and more arid dry seasons and more intense rain in the wet season.

Ninh Thuan is one of the nine provinces that are most affected by drought in Vietnam. This province has experienced yearly drought since 2002. There are two seasons in this area: the rainy season from July to November and the dry season from December to June. Normally, the amount of rainfall received in the coastal regions is very low. The annual rainfall in the coastal town of Phan Rang – Thap Cham (very near the An Hai commune) is 712 mm. The rainy season is heavy during the three months of September to December.

The province was severely affected by drought in August 2004 with a 50% reduction in rainfall compared to the

norm. The drought continued in 2005 and 2006 with poor rainfall during the first two cropping seasons. Prolonged dry days have caused significant damage to agriculture and changed the salinity of groundwater thus damaging aquaculture. The increasing drought events in the Ninh Thuan province are major concerns for both government and local communities.

Whilst annual rainfall has been steadily increasing, the farmers experience droughts because rain now comes in intense, concentrated bursts. They have to change their crops and crop schedule to adapt to the hard weather and climate conditions. Communities are always seeking new ways to adapt. Farmers work together to grow crops and keep herds of goats and sheep of the Sultan breed from India, which can tolerate high temperatures. Farmers have switched from growing rice to maize or other short-time seeds and changed to more drought-resistant varieties. They have devised ways to economize on water use and reuse water. In particularly difficult times, family members migrate to the cities to find work. Some of these adaptation techniques are productive, but others carry a cost. Migration of young people increases the workload of the older people left behind. Women sometimes go without water in order to give it to their husbands or children.

# Indigenous Knowledge

Through weather forecasting, recommendations on planting dates and changing agricultural varieties can be given to make sure that rice and other crops will grow. Since weather forecasting systems were not available in the past, many farmers cultivated their crops based on moon observation and by watching the habits of insects.

## Moon Observation

The An Hai community has an old proverb that has been used in weather observation for drought forecasting and crop scheduling. The proverb is passed on to generations in the whole community. The proverb states:

*“Trăng quầng thì hạn, Trăng tán thì mưa”*

In English, it means,  
“Corona around the moon, there will be a drought year;  
Halo around the moon, rain soon.”

## Corona Moon

A corona is a type of plasma “atmosphere” of the sun or other celestial body, extending millions of kilometers into space, most easily seen during a total solar eclipse, but also observable in a coronagraph. The Latin root of the word corona means crown.

The high temperature of the corona gives its unusual spectral features, which led some to suggest in the 19th century that it contained a previously unknown element, “Coronium”. These spectral features have since been traced to highly ionized Iron (Fe (XIV)) which indicates a plasma temperature in excess of 10° Kelvin (Aschwanden, 2004).

## Halo Moon

A halo moon is a ring of light that surrounds either the sun or moon and typically appears as bright white rings.

However, some halos can also have color patterns. A halo is an optical phenomenon similar in concept to a rainbow but also very different. Halos form when the sunlight or moonlight is refracted or bent by ice crystals associated with thin-high level clouds, like cirrus or cirrostratus. The most common type of halo is the 22 degree halo. In this halo, a ring of light 22 degrees from the sun or moon is projected by hexagonal (i.e. six-side) ice crystals with diameters less than 20.5 micrometers.<sup>1</sup> Often, a halo around the moon or sun is an indicator of cloudy or rainy weather as high level cirrus and cirrostratus clouds that cause halos tend to drift ahead of frontal systems (especially warm fronts) that produce rainfall.

### Dragonfly Observation

The An Hai community uses another folk song for weather forecasting. They observe the habits of the dragonfly to know when it will rain and when there will be sunshine. The Vietnamese lyric of the folk song is as follows:

*“Chuồn Chuồn bay thấp thì mưa,  
Bay cao thì nắng,  
Bay vừa thì râm”*

In English, it is translated:  
“Dragonfly flies high, sunny sky  
Flies low, rain  
Flies neither high nor low, cloudy sky”

The farmers explained that when dragonflies fly a distance lower than 80 cm from the ground, it will rain soon. Based on that, the farmers prepare soil and seeds for the crops. Using the method of dragonfly observation, the farmers can decide the time to sow and plant, and make their crop schedule appropriately.



Figure 1. Corona Moon  
Source: [http://www8.ttvnol.com/forum/f\\_533/862476.ttvn](http://www8.ttvnol.com/forum/f_533/862476.ttvn)



Figure 2. Halo Moon  
Source: [http://www8.ttvnol.com/forum/f\\_533/862476.ttvn](http://www8.ttvnol.com/forum/f_533/862476.ttvn)

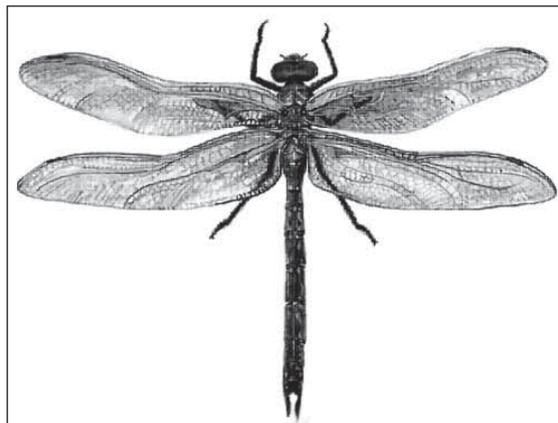


Figure 3. A dragonfly  
Source: <http://www.scientificillustrator.com/illustration/insect>

<sup>1</sup> NASA (2003)

## Lessons Learned

Observation of insects and atmospheric phenomena such as halos were used as an empirical means of weather forecasting before meteorology was developed. The indigenous knowledge is passed on through thousands of years and from generation to generation by the community. These are based on practical experience and have been in use for a long time. In some regions where the residents do not have access to high technology, traditional weather forecasting based on observation of the moon and insects play an important role in agriculture activities.

The main problem in the An Hai community is lack of fresh water for crop cultivation. Knowledge of the rainy season and forecast of the exact drought year helps farmers choose crops, seeds and the time to sow and plant. Since this traditional knowledge is very useful in regions which do not have access to meteorological methods of forecasting, these strategies can and should be disseminated to other communities in low developed regions.

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