Indigenous Knowledge, Insights and Strategies of Disaster Risk Reduction and Resilience of Coastal Blocks of Purba Medinipur District, West Bengal: The Paradigm Shift from Vulnerability to Strength

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ABSTRACT

'Indigenous knowledge' of disaster risk management means the traditional skill and techniques practiced by the local rural folks. Such knowledge is undocumented and transferred orally through generations. Purba Medinipur district is the southernmost severe tropical cyclone prone coastal district of West Bengal bounded by Bay of Bengal. People of this district fight against this natural disaster almost every year, so that they have to adapt their own coping strategies for disaster risk reduction and resilience to their livelihoods. This paper mainly aims to scout the vulnerability and risk of the coastal inhabitants and their indigenous knowledge on disaster awareness, preparedness and adaptation strategies. This research also tries to prescribe some possible policies to exhibit local knowledge in disaster management in a scientific way. Simple snow ball sampling technique has been used with the help of 15 key informants of 10 villages among 450 target respondents selected on the basis of fragile ecosystem situation and poor economic base. Information has been collected through personal interview, interactive group discussion through open ended semi-structured questionnaire schedule. Various statistical techniques, mapping techniques, charts, models and indexes have been used for analysis. The outcome

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Indian Studies Review 4(2) [2023] 81-118
Journal of Centre for Study of Politics and Governance, Delhi

shows that the cyclonic vulnerability is transformed from disaster to risk, great relevance of indigenous knowledge and practices and unparallel importance of their own coping strategies particularly for resilience of assets and sustainable livelihoods. An effective pathway of resilient management planning for disaster risk reduction for these severe cyclones prone areas is also recommended.

Keywords: *Indigenous knowledge, coping strategies, disaster risk reduction, resilience, snow ball sampling technique, vulnerability.*

INTRODUCTION

In recent times, coastal Bengal has been severely affected by the occurrences of multiple cyclones. High storm surge, coastal floods, coastal erosion, water logging and salinity left a tremendous footprint on the lives and livelihoods of the rural folks who lived in the coastal areas. People who reside in the disaster-prone areas of coastal Bengal are extremely vulnerable. Back-to-back cyclones in the last two decades have badly impacted the infrastructure, household assets and livelihood opportunities in the area. It is true that the occurrence of natural disaster is somehow unavoidable but the impact of the disaster could be minimized when there will be an active participation of local people, their culture, traditional knowledge and practices in disaster management. The survival capacity could be enhanced by giving importance to the traditional knowledge of the native inhabitants. The increasing adaptive capacity of the local people of cyclone prone areas helps in moving forward the resilience capacity and reducing the level of vulnerability.

The traditional knowledge is also termed as 'local knowledge' or 'indigenous knowledge'. Traditional knowledge can be outlined as the unique local knowledge that have been traditionally practiced and developed by men and women from a specific geographical area (Grenier,1998). The word traditional knowledge or indigenous knowledge has been used on the basis of the knowledge of the local inbabitants about their locality-based history of disaster management. Indigenous knowledge is the synonymous of traditional knowledge or local knowledge that has originated from local communities (Kelman et al., 2012). Generally, indigenous knowledge is transferred from generation to generation, enriched from environmental inferences through their basic instincts, fantasy and imagination (Agrawal, 1995).

Indigenous or traditional knowledge is a set of cumulative knowledge, practice and belief which has been resulted through adaptive process of the local communities and culturally transmitted through generations (Berkes, 2007). Traditional knowledge described by UNESCO (2002) as accumulated knowledge that has been practiced, maintained and engineered by the people

with a history of the correspondence with their environment. Indigenous knowledge is termed as local or traditional knowledge which has been developed beyond the conventional education system (World Bank report, 2005). It is unique in terms of location and society as well. Indigenous knowledge acts as an important part of the lives and livelihoods of the impecunious people in village areas and help in decision making regarding human and animal health, food security and managing natural resource. Indigenous knowledge was identified by Flavier et.al. (1995) as the information base of the society which accelerates the decision of a community during disaster events. He also found that such knowledge is very much dynamic in nature and is continuously shaping past experiences. Indigenous knowledge is informal, locally bounded, orally transmitted across the generation and culturally specific in nature (Shaw et.al., 2008). As per the International Institute of Rural Reconstruction (1996), indigenous knowledge is the set of knowledge which has been developed over time and continuously developing through experience.

The indigenous people gather the perception and knowledge about disaster from their experience through monitoring of various biological events and observations of sky. Their beliefs, social and cultural taboos, customs, economic needs, adaptation capabilities, environmental situations actually motivate them to act as per (fig 1).

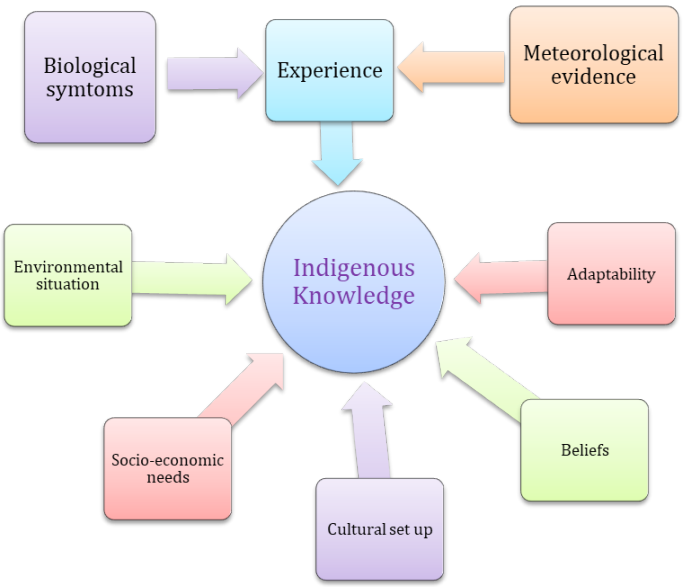


Fig 1: Sources and motivations of indigenous knowledge

Indigenous knowledge can be termed as the functional knowledge of rural inhabitants of a specific ethno-cultural condition. Such knowledge matured through sharing of experience and generally passes through generational orally and is an important part of the rural folks usually found in unwritten forms (Haque, 2013). It is usually said that undocumented or unwritten knowledge is at risk of being lost. Local wisdom of the rural inhabitants is generally restricted to the villages, markets and old towns where people continuously practice such techniques. Indigenous knowledge is holistic system of knowledge which includes beliefs, concepts, values and perception of the people usually practiced in a rural environment (Warner 1991; Sillitoe et al., 1998). In the opinion of Walker et al. (1991) indigenous knowledge is the accumulated knowledge of a rural community.

Sillitoe (2000), identify indigenous knowledge as the result of 'grass root' participation by the rural folks rather than 'top-down' imposition of interventions. He differentiates indigenous knowledge from the scientific or modern knowledge of disaster management. Scientific knowledge is more formal and found in written form where indigenous knowledge is informal, socially and culturally more specific, generally developed by the experimental practice of the local dwellers in the case of survival and coping strategies for natural disaster.

Indigenous knowledge and practices are now considered as an important contributor for better understanding and disaster preparedness (Shaw et al., 2009; Mercer et al., 2010; Howitt et al., 2012; Lambert, 2014; Athayde et al., 2015). In parallel times, indigenous knowledge is acknowledged and valued. Such knowledge is under perpetual risk of being eroded or lost (Mead, 1994; Drahos, 2014).

Several scholars of disaster risk reduction acknowledge that traditional knowledge of local inhabitants is significant towards saving human and animal lives and prevent property from the negative effect of natural disaster (McAdoo et al., 2006; Hiwasaki et al., 2014). Scholars further argue that local authorities should give priority to local or indigenous knowledge from the grass root level because it is more influential to prepare, prevent, mitigate and recover from the hazardous impact (G'Nece, 2012). Shaw et al. (2009) opined that indigenous knowledge builds the capacity among the local people over the centuries to combat with natural disaster and tested over time and proven as a sustainable tool of disaster risk mitigation. Taking a look in the history of disaster

management in different countries, number of evidence suggested that those countries became successful in disaster management by giving importance to indigenous knowledge of the local inhabitants as basic tactics of disaster risk reduction (Iloka, 2016; Rahman et al., 2016; Sethi et al. 2011). The successful implementation of indigenous knowledge in disaster management has been experienced in Zimbabwe and also examined in Africa's Sahel region where survival of local people lies truly on the traditional knowledge to cope with climate change (Nyong et al, 2007).

Indigenous knowledge on disaster management is in practice since 1970s and shaped by the interaction of the people with their local environment while in 1990s, it gained acceptance and valued in the sphere of disaster risk mitigation (Dekens, 2007; Hiwasaki et al., 2014). However, it is very unfortunate that indigenous knowledge has not promoted in the policy and science of disaster management even after the recognition of the value of such knowledge in enhancing adaptation of the rural folks in climate change (Adger et al., 2011).

Few scientists are still in dilemma regarding the acceptability and effectiveness of indigenous knowledge. According to their opinion this knowledge has no such scientific base. These are mostly abstract, crude, narrow and emotional (Mitchel, 1995; Herbert, 2000). Many researchers couldn't rely this knowledge because of lack of faith and confidence (Shizha, 2006; Mawere, 2010; Ngulube et al., 2011). It is not at all proved that this type of knowledge is only means of survival in a balanced way and appropriate measures for risk reduction management of devastating tropical cyclone (Naidoo, 2007).

Value of local or indigenous knowledge is significant and cannot be ignored. Although, in modern time's technology opened up new dimensions of disaster management but that does not mean the exercise of indigenous knowledge by the rural folk could be tagged as unscientific, primitive or constraints to development. Rural community acquired such knowledge through many generations and they proudly followed their indigenous knowledge even after greater exposure to modern technologies. There is no doubt that local knowledge of disaster management is eroding rapidly and many of it has been already lost by the introduction and flying spread of modern foreign technologies of disaster management. There is a clear call to document such knowledge and practices before they extinct from the rural societies. This research has the scope to reinforce local coping strategy that could be effective for the people and community for better disaster preparedness in future. Thus,

this paper mainly aims to mine the indigenous knowledge of the immediate inhabitants of coastal Bengal on disaster awareness, disaster prediction, disaster preparedness, disaster adaptation and disaster risk.

Keeping in mind of all the above discussion few specific objectives have been set for the smooth analysis of this research. These objectives are:

Identification of the practices of indigenous knowledge regarding disaster mitigation.

- Documentation of coping strategies adopted by indigenous people.
- Assessment of the risk and vulnerability of the coastal villagers.
- Evaluation of the effectiveness of the indigenous resilience strategies of coastal villagers in disaster risk reduction.
- Scaling up the validation and replication of indigenous practices.
- Recommendation of few measures for the betterment and sustainable livelihood of indigenous people.

STUDY AREA

Purba Medinipur district is recognized as the southernmost coastal district of West Bengal. Tamluk is the head quarter of the district. The district is bordered by Bay of Bengal in the south. Geographically, Purba Medinipur district is the part of the Eastern Coastal Plain and lower Indo-Gangetic plain. Being a coastal district, maximum elevation of the district is only 10 meters from mean sea level and with a coastline of 65.5 km (Purba Medinipur, 2022). Total geographical area of the district is 4736 sq.km with a sum population of 5095875. Population density of the district is 1100 per sq.km. This district is also known for the highest literacy rate (87.66 percent) in West Bengal (Census of India, 2011).

Deshopran, Khejuri II, Contai I, Ramnagar I and Ramnagar II are the most disaster-prone blocks of the district because the blocks are immediately located at the coast (fig 2). Coastal floods and high tides are quite frequent in those blocks. Villages of those blocks which are located near the shoreline are extremely vulnerable due to high population density, poverty, frequent cyclonic events and floods. Local inhabitants are continuously struggling against such extreme events.

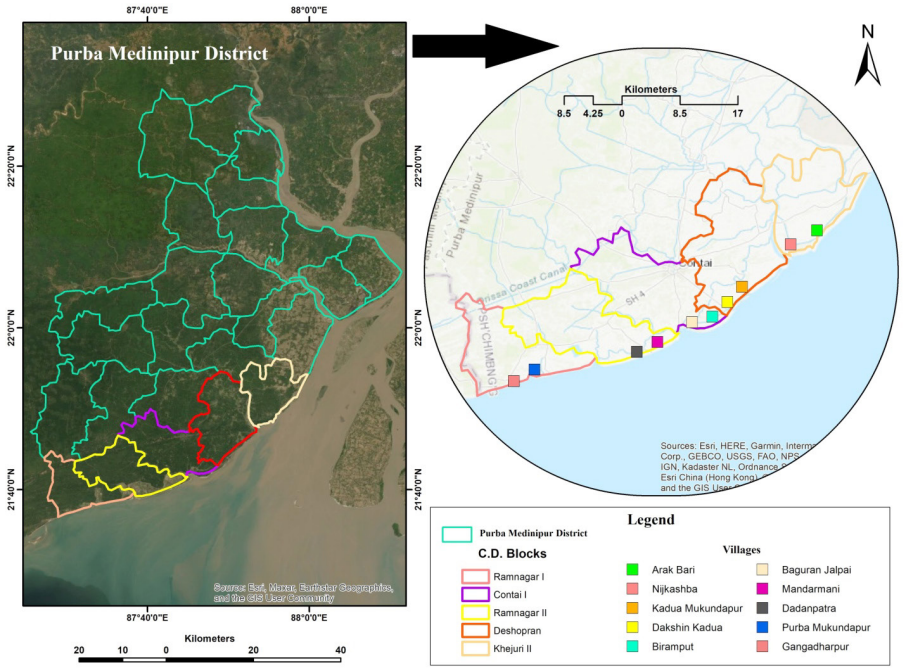


Fig 2: Location map of the study area

Source: Prepared by authors by using Google image 2022 and Arc GIS 10.7 (licensed version).

Table 1: Village profile and target respondents

Name of the block	Name of the village	Jl.no	Total Area (sq. km)	Total population	Total literacy	Total main workers	Total marginal workers	Total non-workers	No of respon-dents
Ramnagar- I	Purba-Mukandapur	346990	3.565	2766	2193	804	183	1779	83
	Gangadharpur	346982	0.702	359	287	104	NA	255	10
Ramnagar-II	Dadanpatra	347131	2.667	1391	1095	528	41	822	41
	Mandarmani	347093	1.70	507	347	142	61	304	15
Contai-I	Baguran-Jalpai	346249	3.03	1573	1218	432	124	1017	47
	Biramput	346261	1.663	2370	1335	517	343	1510	71
Deshopran-I	Dakshin-Kandua	346383	1.568	1131	905	80	275	776	34
	Kadua-Mukundapur	346415	1.43	1116	829	298	232	586	34
Khejuri-II	Nijkashba	346036	1.357	2435	1674	611	186	1638	73
	Arak-Bari	346016	2.094	1389	919	138	235	1016	42
Total									**450**

Source: Census of India, 2011

One specific fact has to be pointed out that the working status of all the villages under study is very poor. Majority of people have either no work or engaged in unorganized sectors (table 1). The poor economic status actually throws them into the dangerous disaster like tropical cyclone in these areas.

MATERIALS AND METHODS

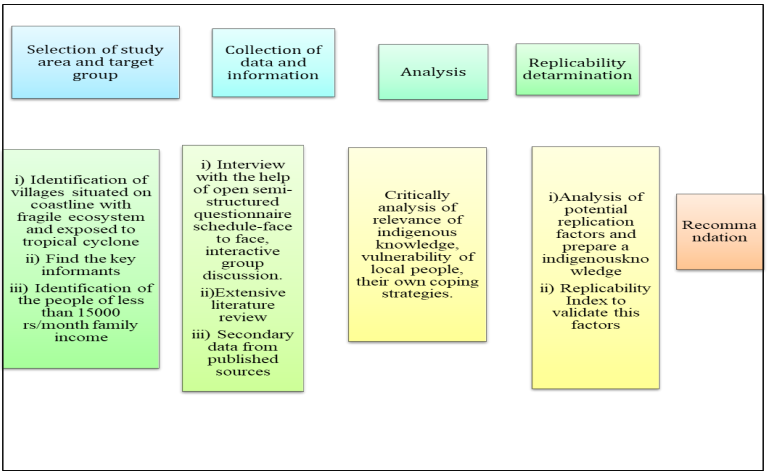
People resides in the disaster leaning areas generation after generation have accumulated knowledge of their local environment. Such knowledge helps to identify some unique techniques to minimize or mitigate hazardous impact. Such techniques which are purely practiced in the local level are referred as "Indigenous knowledge" in this research. Indigenous knowledge is one of the valuable sources of information which is also significantly effective to minimize disaster risk in the local areas. The traditional techniques and skill to combat with the natural disaster is the result of man environment interaction through the generations. People of the coastal areas of West Bengal gained practical knowledge or indigenous knowledge to cope with natural disasters through their enormous struggle with natural calamities.

On the basis of above discussion, the following methodological framework has been selected to gather the knowledge of the local people

The primary data bases obtained from door-to-door perception survey have been used in this research. The main source of secondary data of this research is the census handbook. Personal interviews, Interactive Group Discussion (IGD) are used to know the indigenous knowledge, practice, beliefs regarding cyclonic activities and their own coping strategies. Ten villages are selected on the basis of coastline situation and direct exposure to sea. Total number of sample respondents are 450 (3% people in each village) on the basis of poor economy and fragile ecosystem.

Simple snowball technique has been applied to search the target population because majority of the study villages were not familiar to the researches.

The study framework is essential for faming it in a scientific way (fig 3). It has been discussed below-Fig 3: Study framework



The survey has been executed in three phases such as 25th March to 5th April-2021, 29th July to 5th August -2021 and 5th October to 13th October-2021. Three sets of Interactive Group Discussion (IGD) sessions had been arranged during field visits to cross examine the personal interviews.

Mean, Standard Deviation (SD) are used for statistical analysis to validate the collected data.

Indigenous Knowledge Explicability Index (IKRI) is calculated to quantify the qualitative perception of the coping strategies adapted by the target respondents. To assess the impact of disaster risk reduction issues adapted by the indigenous people for the quick resilience of their livelihood, Likert scale (Likert, 1932) has been adapted.

Various models have been constructed to show the interaction between different dependent variables over independent ones. The vulnerability of progression: Wisner's Pressure and Release model (PAR) (Wisner et al, 2004) has been adapted to assess the vulnerable situation of local people in the study area for the regular insurgences of tropical cyclones.

The modified version of the Sendai Framework for Disaster Risk Reduction 2015-2030 which has been already adopted in the Third United Nations Conference on Disaster Risk Reduction in Sendai, Japan, held on March 18, 2015 to investigate the knowledge, awareness, readiness, adaptation, perception and insecurity of the local residents.

Generally, there is no written record of indigenous knowledge anywhere in formal language. Mostly it continues to exist in verbal form and forwarded orally from one generation to another generation. Indigenous knowledge

includes perception, concepts, values and faiths of a native community that is locally significant in disaster management. It is a multifaceted knowledge system with different expressions.

RESULT AND DISCUSSION

This section has been dividing into three sub-systems, firstly, assessment of vulnerabilities, secondly, evaluation present relevance of the indigenous knowledge and lastly, investigate the coping strategies to overcome their vulnerabilities. Actually, their coping strategies are the strength for resilience their economy, society and livelihood their strategies are experiences-based knowledge which was transmitted through generations.

4.1 VULNERABILITY ANALYSIS

Vulnerability is a situation created by a set of factors which enhances the susceptibility of a person, community and society to the harmful impacts of a hazard or disaster physically, economically, environmentally or mentally. Physiographical location of this study area is itself in a vulnerable situation. Every year these areas face the awful face of disastrous tropical cyclones. In this sub-section, the vulnerable situation of this place as well as of the residents has been discussed thoroughly.

4.1.1 FACTORS OF VULNERABILITY

The factors which are responsible for increasing the vulnerability of the residents of these areas are depicted in the figure 4.

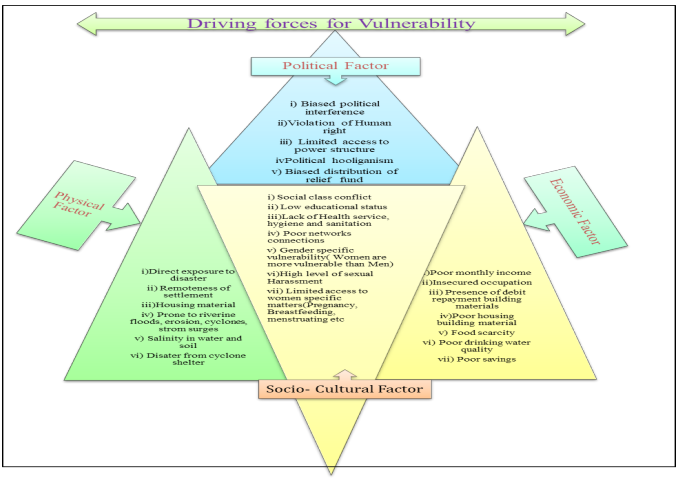


Fig 4: Factors of vulnerability

Actually, nature only cannot make people vulnerable. Along with nature, other several factors such as economy, society, culture and above all the politics accelerated people's vulnerability at a greater extant. The identified major driving forces of vulnerability of the people of this study area are depicted in the figure 4 (Cannon, 2008; Chaudhury, 2017; Benson & Clay, 2003).

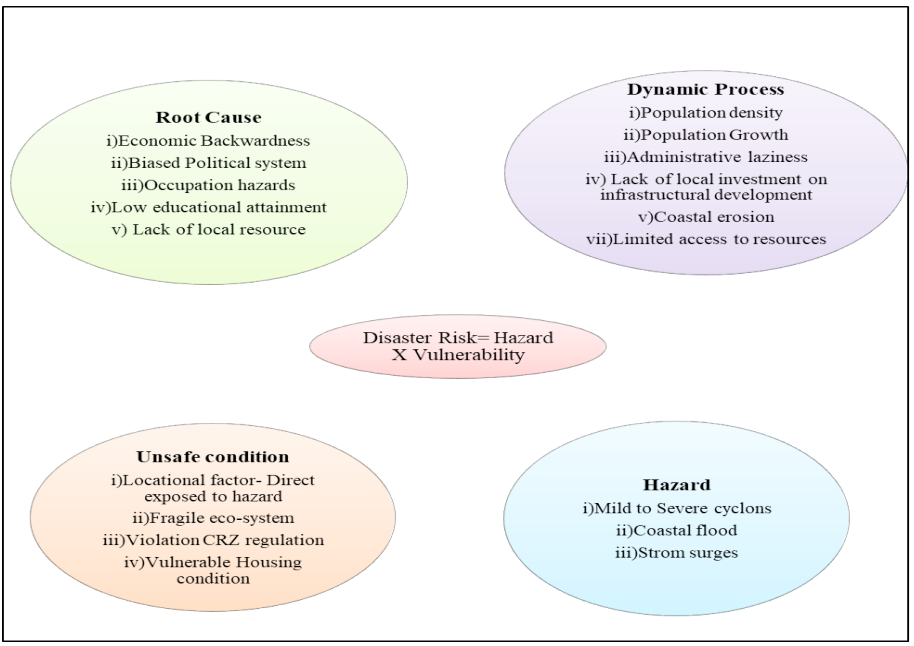


Fig 5: The vulnerability of progression: Pressure and Release model (PAR)

Source: Adapted from Wisner et al, 2004

Vulnerability is actually a human centric aspect of disaster. It is the outcome of various factors depicted in the above figure (Fig 5). It shows the progress of vulnerability which will ultimately turn as disaster. With the help of the hazard, this vulnerable situation is converted into risk through root cause, dynamic pressure and unsafe environmental situation (Wisner et al, 2004; Alexander, 1993).

4.1.2 FREQUENCY OF SEVERE CYCLONES

Table 2: Occurrences of severe Tropical Cyclones

Serial no	*Year*	*Name of the severe cyclone*	*Landfall (month)*
1	2011		
2	2012		
3	2013	Phailin	May
4	2014	Hudhud	October
5	2015		
6	2016		
7	2017		
8	2018	Titli	October
9	2019	Phani/Fani	May
		Bulbul	November
10	2020	Amphan	May
11	2021	Yash	May
		Jawad	December

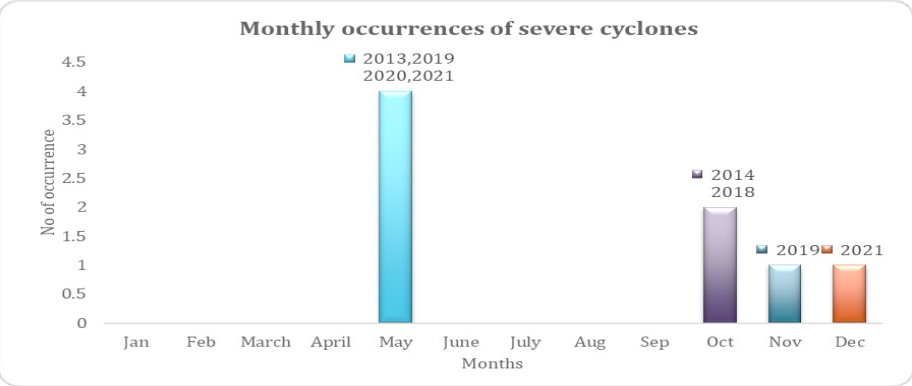


Fig 6: *Monthly occurrences of severe cyclones*
Source: imdkolkata.gov.in, 2022

In last ten years between 2011 to 2021, frequencies of tropical cyclone over coastal Bengal have been phenomenal and impacted hardly on the lives and livelihoods of the coastal villagers. Situation gets more intense when three cyclones made their landfall in the study area just within three years of span

(between 2018 to 2021) (table 2). It has been observed that May, October, November and December are the riskiest months in the study area (fig 6). Disaster management preparedness has been started by the coastal dwellers from the month of April every year.

4.1.3 POPULATION DENSITY

Higher population density means higher demands of resources per unit of area, hunger, unhygienic environment, increasing number of death toll etc. due to disaster.

Table 3: Village wise population density

Name of the block	Village code	Village name	Area (sq. km)	Population	Population density/ sq.km
Contai I	346249	Baguran-Jalpai	3.03	1573	519
	346261	Biramput	1.663	2370	1425
Deshopran I	346383	Dakshin-Kadua	1.568	1131	721
	346415	Kandua-Mukundapur	1.43	1116	780
Ramnagar I	346990	Purba-Mukandapur	3.565	2766	776
	346982	Gangadharpur	0.702	359	511
Ramnagar II	347131	Dadanpatra	2.667	1391	522
	347093	Mandarmani	1.7	507	298
Khejuri I	346036	Nijkashba	1.357	2435	1794
	346016	Arak-Bari	2.094	1389	663

Source: Field survey, 2021

It has been observed that all studied villages are densely populated (table 3). High population density puts them in serious threat and makes them vulnerable because the devastation caused by the cyclones is higher in high populated areas.

4.1.4 INCOME STATUS

Table 4: Monthly income status of the respondents

Monthly income (Rupees)	*No of respondents (%)*
<2000	9
2000-4000	11
4000-6000	18
6000-8000	27
8000-10000	21
10000-12000	6
12000-15000	5
>15000	3

Source: Field survey, 2021

Actually, the people become vulnerable due to their poor economy (table 4). The respondents are mainly engaged as small & marginal farmers, auto, toto, van driver, wage laborers and small fishermen of subsistence type. They don't have such capacity to make a cyclone resistant house. Natural environment creates a barrier for their livelihood earning. Soil is salt encrusted and water clogged crop cultivation is not so easy. Few of these have small fishery boats but they could not compete with these big boats' fishermen with large fishing trawler. Moreover, they do not have much alternative occupational facilities.

4.1.5 POOR HOUSING CONDITION

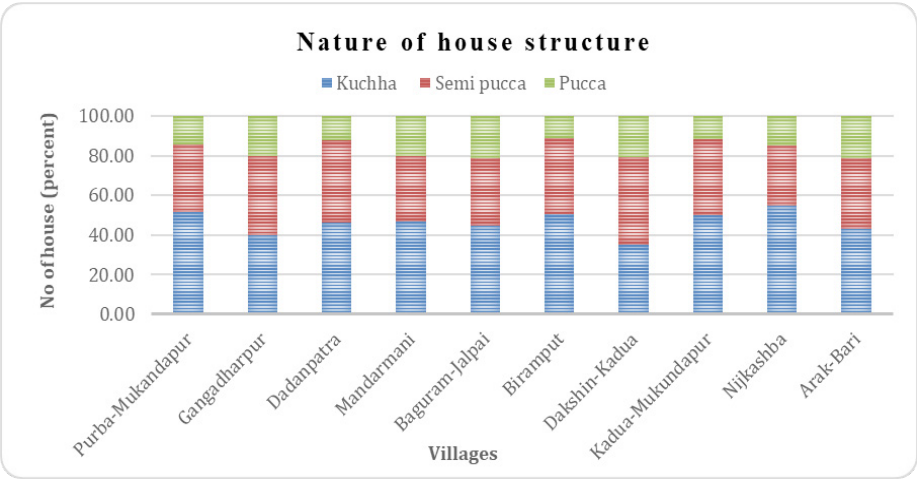


Fig 7: Nature of house structure

Source: Field survey, 2021

Unsafe permanent shelter is the serious threat to the people who live in disaster prone areas. People living in kuccha houses are mostly vulnerable. It has been experienced that most of the people of the studied villages are under great risk as they mostly lived in kuccha houses or to some extent semi pucca houses. Existence of pucca houses is proportionately low (fig 8). This is extremely unfortunate because pucca houses considered as the safest living condition from all around the corner. This is very shocking to witness that almost half or even more than half of the houses in coastal villages are kuccha in nature and always severely damaged in any catastrophic events particularly in cyclonic events (fig 7). Poor economic base and lack of all season job opportunity accelerate them towards risk and vulnerability. Thus, such uncertainty regarding living condition always put them in serious trouble and makes them vulnerable in disastrous events.

Fig 8: Housing condition

Source: Field survey, 2021

4.2 STRENGTH ANALYSIS

Although the local residents are living in a naturally vulnerable situations but they could not give up or shift to another places. They are still now living here. One of the most important aims of this paper is to analyze their strength which can reduce this type of natural disasters.

4.2.1 RELEVANCE OF INDIGENOUS KNOWLEDGE

Any disaster risk can be reduced with the spontaneous participation of common people and administrations (Alam & Collins, 2010). Without recognition of the local risk reduction strategies, any type of risk reduction

planning cannot be fruitful or sustainable. Coping capacity of local people can help in the reduction of vulnerability (Shaw & Krishnamurthy, 2009). Accounting the local knowledge is beneficial to administration for better planning. These measures are cost-effective and deep rooted and what is better for a particular area can be identified through indigenous knowledge system. This knowledge is also relevant in social aspects for building social trust, self confidence and acceptability (Thomalla & Schumuck, 2004).

The local people observe various biological symptoms and monitor meteorological phenomena for preparedness of the disaster (fig 9). The following figure shows the weather forecasting system of indigenous people by observing the various symptoms, both biological and meteorological.

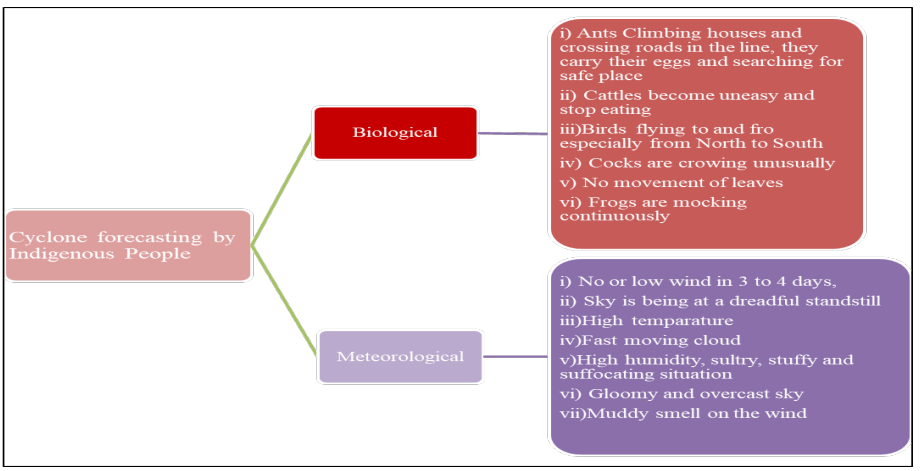


Fig 9: Cyclone forecasting symptoms by indigenous people.

The people of these areas are living with natural hazards. They have prepared their own measures to protect their assets and livelihoods. They gather their perception from biological, meteorological evidences and symptoms. Their beliefs, cultural set ups, myths, literatures etc. construct their knowledge. This indigenous knowledge is related to significant dimensions such as surveillance through experience, prediction, identifying and monitoring the symptoms, adaptation through trial-and-error processes, and communication among community members through generations (fig 10). This understanding can ultimately regulate their efforts towards sustainable management and resilience disaster risk. All these aspects of disaster risk reduction preparedness are depicted in this following figure.

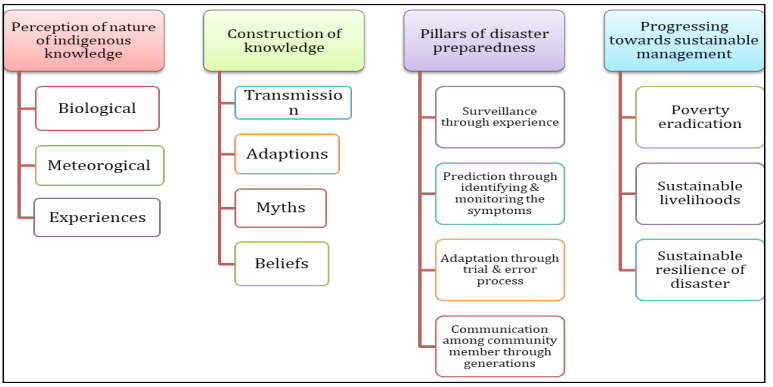


Fig 10: Disaster preparedness processes of indigenous people

4.3 ANALYSIS OF KEY DISASTER RISK REDUCTION ISSUES ADAPTED BY INDIGENOUS PEOPLE FOLLOWING SPACE-PEOPLE FRAMEWORK:

It has been found that the disaster mitigation measures are space and peoples specific, therefore it is required to analyze the responses of people about key Disaster Risk Reduction (DRR) issues like knowledge, awareness, readiness, adaptation, perception and insecurity. The output of each issue has been explained in the following sub sections

4.3.1 KNOWLEDGE OF PEOPLE

Table 5: DRR issue: knowledge

Name of the villages	***Perception of the respondents (%)***				
	Strongly understood	***Understood***	***Not clear***	***Confusion***	***No idea***
Purba-Mukandapur	34	28	11	7	3
Gangadharpur	3	4	3	0	0
Dadanpatra	11	17	8	4	1
Mandarmani	6	8	0	1	0
Baguram-Jalpai	19	22	4	2	0
Biramput	29	32	3	6	1
Dakshin-Kadua	14	16	1	2	1
Kadua-Mukundapur	18	14	2	0	0
Nijkashba	26	33	8	4	2
Arak-Bari	17	20	2	2	1
Mean	17.7	19.4	4.2	2.8	0.9
SD	9.86632	9.65171	3.58391	2.39443	0.99442

Source: Field survey, 2021

Knowledge means how much the local people have the knowledge about cyclone related matters. Only 79 respondents (17.56%) among 450 have no such clear idea. More than 80% of them have the knowledge about the severity, landfall, preparedness, risk, risk reduction processes etc. (table 5). Every year they have faced these cyclones. So, they are very well familiar to this incidence.

4.3.2 AWARENESS OF PEOPLE

Table 6: DRR issue: awareness

Name of the villages	*Perception of the respondents (%)*				
	Strongly aware	*Aware*	*Not aware*	*Confusing*	*No idea*
Purba-Mukandapur	27	33	9	11	3
Gangadharpur	4	6	0	0	0
Dadanpatra	14	19	3	4	1
Mandarmani	5	9	1	0	0
Baguram-Jalpai	19	23	3	1	1
Biramput	27	34	4	4	2
Dakshin-Kadua	17	16	1	0	0
Kadua-Mukundapur	12	20	1	0	1
Nijkashba	27	36	7	2	1
Arak-Bari	18	21	2	1	0
Mean	17	21.7	3.1	2.3	0.9
SD	8.07465	9.67522	2.73678	3.25729	0.94339

Source: Field survey, 2021

Only 63 (14%) people are not aware about cyclone related activities. Most of the people show positive response which indicates their capability to fight against these natural calamities. Few people do not know about the modern DRR issues (table 6).

4.3.3 READINESS OF PEOPLE

Table 7: DRR issue: readiness

Name of the villages	*Perception of the respondents (%)*				
	Very well	*Well*	*Not ready*	*Confusing*	*No idea*
Purba-Mukandapur	21	33	18	7	4
Gangadharpur	2	5	2	1	0
Dadanpatra	11	13	11	4	2
Mandarmani	4	7	2	1	1
Baguram-Jalpai	19	17	6	3	2
Biramput	16	37	12	3	3
Dakshin-Kadua	9	12	7	4	2
Kadua-Mukundapur	7	13	11	3	0
Nijkashba	21	27	21	2	2
Arak-Bari	8	14	10	6	4
Mean	11.8	17.8	10	3.4	2
SD	7.00476	10.85049	6.18241	1.95505	1.41421

Source: Field survey, 2021

This is to the preparedness capacity of the people. About 136 (30.22%) people are not ready to take preventive measures (table 7). This is because of their poverty, poor housing condition, living in hazardous habitat. They don't have such access to resource which can provide the tools to their hands to take preparedness measures which indicate their vulnerability. Another fact is also there, this is the belief in their fate so, that they could not be motivated.

4.3.4 ADAPTATION OF PEOPLE

Table 8: DRR issue: adaptation

Name of the villages	*Perception of the respondents (%)*				
	Very well	*Well*	*Not adapted*	*Confusing*	*No idea*
Purba-Mukandapur	28	30	14	7	4
Gangadharpur	2	4	1	1	2
Dadanpatra	12	14	8	3	4
Mandarmani	6	4	2	1	2
Baguram-Jalpai	11	14	8	8	6
Biramput	19	23	10	13	6
Dakshin-Kadua	7	11	4	8	4
Kadua-Mukundapur	5	15	4	7	3
Nijkashba	21	26	16	6	4
Arak-Bari	9	18	7	5	3
Mean	12	15.9	7.4	5.9	3.5
SD	8.20568	8.63391	4.92612	3.63470	1.398412

Source: Field survey, 2021

Only this capacity is means of their way of living in this geo-environmental situation. The study shows that about 165 (37.33%) people are assured negatively which indicates that there are also such people who are not in adapt state of disaster in this community (table 8). So, there is a necessity to implement more DRR programs & campaigns.

4.3.5 PERCEPTION OF PEOPLE

Table 9: DRR issue: perception

Name of the villages	*Perception of the respondents (%)*				
	Strongly perceived	*Perceived*	*Not perceived*	*Confusing*	*No idea*
Purba-Mukandapur	14	8	35	19	7
Gangadharpur	2	3	3	1	1
Dadanpatra	9	12	14	4	2
Mandarmani	3	7	2	2	1
Baguram-Jalpai	11	16	8	4	2
Biramput	15	21	17	12	6
Dakshin-Kadua	6	12	4	7	5
Kadua-Mukundapur	9	14	7	2	2
Nijkashba	14	19	14	17	9
Arak-Bari	9	12	7	8	4
Mean	9.2	12.4	11.1	7.6	3.9
SD	4.51663	5.48128	9.80306	6.41525	2.76686

Source: field survey, 2021

It is the thinking variability of the victims of cyclonic hazards. About 207 (46%) people's perception vary on various issues (table 9). Actually, these local people who believe in their own risk reduction processes are not accustomed with the new technologies of DRR.

4.3.6 INSECURITY OF PEOPLE

Table 10: DRR issue: insecurity

Name of the villages	*Perception of the respondents (%)*				
	Strongly insecure	***Insecure***	***Not insecure***	***Confusing***	***No idea***
Purba-Mukandapur	20	34	9	12	8
Gangadharpur	6	3	1	0	0
Dadanpatra	18	17	2	3	1
Mandarmani	9	5	0	1	0
Baguram-Jalpai	19	23	3	1	1
Biramput	22	37	6	4	2
Dakshin-Kadua	14	14	2	3	1
Kadua-Mukundapur	11	16	2	4	1
Nijkashba	23	27	10	9	4
Arak-Bari	15	18	4	3	2
Mean	15.7	19.4	3.9	4	2
SD	5.69697	11.14749	3.38132	3.74165	2.40370

Source: Field survey, 2021

Although the local people have faith on their DRR measures but they feel insecure in front of the severity of the disaster. Only 39 (8.67%) people feel secured about cyclonic devastations (table 10). This is because of their well economic condition and protective infrastructure particularly housing.

4.4 COPING STRATEGY

People living with natural hazard have their own coping strategy to combat their vulnerabilities. These coping strategies in pre hazard, within hazard and post hazard phases are discussed in the following.

4.4.1 PRE HAZARD PHASE

Based on the previous experiences, people usually cultivate their own hazard preparedness strategies to save lives and properties as they can (Jha & Jha, 2011; Shaw et al., 2008, Howell, 2003). The problem is that there is no such documentation of their traditional knowledge, wisdom & mechanism. The following table shows the adaptive measures taken in pre hazard phase.

Table 11: Measures taken by indigenous people in pre-hazard phase.

Measures	***Perception of the respondents (%)***		
	Yes	***No***	***Confusing***
Harvesting of crops	89.25	10.75	00
Keep domestic animals in safe places	86.31	12.27	1.42
Arrangement of the safe shelter	71.54	19.20	2.26
Gathering sufficient food & storage of safe drinking water	52.13	35.44	12.43
Plant herbal medicines in the homestead & arrange necessary medicine	51.37	29.22	19.41
Bury the available seeds, crops underground at the time to go safe places	68.39	25.92	5.69
Wrap with polythene of all essential documents and valuable materials & bury it underground	78.42	20.00	1.58
Plant banana trees for food & fodder	58.59	33.18	8.23
Submerge boats for safety	71.23	26.71	2.06
Hanging weight from corner of the roof & tying roofs to wall	85.69	12.57	1.74

Source: Field survey, 2021

Local people know very well that if they do not take any preventive measures to protect their lives, assets, livestock etc. then the result will be devastating. So that they take preventive measures as much as possible (fig 11, 12 and 13). Table 11 shows their measures which are truly very effective. In their own way they take their measures without any help of others. They protect their houses, arrange food, water and medicine, save their valuable assets as much as they can.

Fig 11: Covering ponds by net to protect out flow of the fishes.

Source: Field survey, 2021

Fig 12: Protective measures for kuccha houses

Source: Field survey, 2021

Fig 13: Preventive measures for fodder and fuel wood and other assets

Source: Field survey, 2021

4.4.2 IN HAZARD PHASE

Table 12: Measures taken by local people during hazard.

Measures	***Perception of the respondents (%)***		
	Yes	***No***	***Confusing***
Stay together at one corner of house or shelter homes	63.58	30.20	6.22
Cut off electricity supply	91.67	7.02	1.31
Keep extra floats for saving fishing boats & lives	82.32	13.33	4.35
Untying live stocks	65.21	29.34	5.45
Submerge household items into the pond	58.92	22.56	18.52
Keep in touch with neighbors	71.11	20.65	8.24
Take updates from media	75.62	17.00	7.38

Source: Field survey, 2021

People become absolutely lonely during the hazard period. At that time nobody can stand before the severity of the cyclone. The local victims then make sure to protect their families, livestock, assets and even their houses. Table 12 represents the measures taken by the victims during hazard period.

4.4.3 POST HAZARD PHASE

Table 13: Measures taken by indigenous people in post hazard resilience.

Measures	*Perception of the respondents (%)*		
	Yes	*No*	*Confusing*
Reconstruct the houses	95.67	3.31	1.02
Gather survived domestic animals	100	00	00
Clear the broken trees	78.53	19.06	2.41
Rescue all submerged & buried materials	100	00	00
Repair the banks of pond or drains	83.76	11.11	5.13
Treatment of minor injuries by herbal medicines	68.23	18.48	13.29

Source: Field survey, 2021

Without waiting for any administrative help, the local people try their best to recover their assets. Even they try to clear the roads which got blocked due to fallen trees. They also help their relatively more distressed neighbor by giving shelter, food, water etc. Basically, these poor people seek to back to their work for survival of other livelihoods (table 13). Many people get involved in fishing in post disaster phase by using traditional methods (fig 14). Running water, over flow of ponds and lakes open up an opportunity to them to collect fishes and sustain their livelihood for the instant time phrase.

Fig 14: Traditional fishing traps

Source: Field survey, 2021

4.5 VALIDITY ANALYSIS OF THE INDIGENOUS KNOWLEDGE AND PRACTICES

The researchers have presented various forms of knowledge and practices of local people regarding the preparedness of pre hazard, in hazard and post hazard phases of cyclones and flooding of coastal Purba-Midnapur Blocks. Now it is very much necessary to validate those practices, so that these will be helpful for wider community to improve their coping strategies. For this a set of tactics were applied to judge the feasibility of these replication.

4.5.1 VALIDATION FACTORS

The following five parameters have been selected for analysis of validity of the local knowledge and practices.

Preparedness: To evaluate the extent of readiness of these practices which are not dependent on any type of special situation.

Acceptability: To examine the extent of acceptance of these beliefs to the society.

Fund: To investigate the necessity of any fund or material or skill to fulfill these practices.

Threat: To judge the risk factor of application as well as rescue of these beliefs

Profit: To estimate the effectiveness of these practice in other location and community.

The average score of 65.50 clearly indicates that the measures adapted by the indigenous people are effective not only for these specific study areas but also applicable in other areas where people used to face such disasters (table 14). Their risk reduction measures are financially beneficial, profitable and have low risk.

RECOMMENDATIONS FOR SUSTAINABLE RISK REDUCTION PLANNING AND MANAGEMENT

Recently the trend of occurrences of severe cyclonic storm with heavy rainfall causes severe disruption of livelihood of people particularly in the coastal poverty ridden people of West Bengal. This natural hazard is usually converted into disaster due to land use change, faulty planning & administrative negligence. These will be avoided if policy implementation worked with due recognition of the disaster risk reduction activities of local people, their knowledge, practices, culture and overall, their adaptive capacity. Linking between governmental effects and the indigenous knowledge can only reduce the vulnerability and risk of hazard and bring back to their resilient livelihood (UNISDR, 2009).

The respondents were asked about the risk reduction planning and management. Their spontaneous responses have been reflected in the following table.

Table 15: Perception of local people about risk reduction planning.

Issues	***Perception of the respondents (%)***
i) Recognition of the opinion of local people about cyclone	70.27
ii) Collaborating local people in the early warning system	67.38
iii) Emphasis given on the opinion of local people about infrastructural development in hazard prone areas	77.67
iv) Give chance to the local people to participate in hazard preparedness	68.98
v) Encouraging local people for participating in post hazard mitigation process	81.28

Source: Field survey, 2021

More there 60% people have agreed on the all issues presented in the table 15. They actually want to be a part of hazard mitigation planning. It is true that majority of the researches are advocating for engagement of local people in disaster risk reduction process. Local people are those people who have actual knowledge about the natural catastrophes. Authorities cannot stay always with these in all situations. Local people would have to combat these calamities in their own way for surviving.

The Sendai Framework for Disaster Risk Reduction, 2015-2030 recommended for the inclusion of indigenous knowledge with the scientific process of DRR (UNISDR, 2015). Disaster Risk Reduction paradigm has been already shifted (fig 15). The old thinking of various parameters of DRR has wider implications. The Sendai Framework also presented these new thinking. This paradigm shift is presented below.

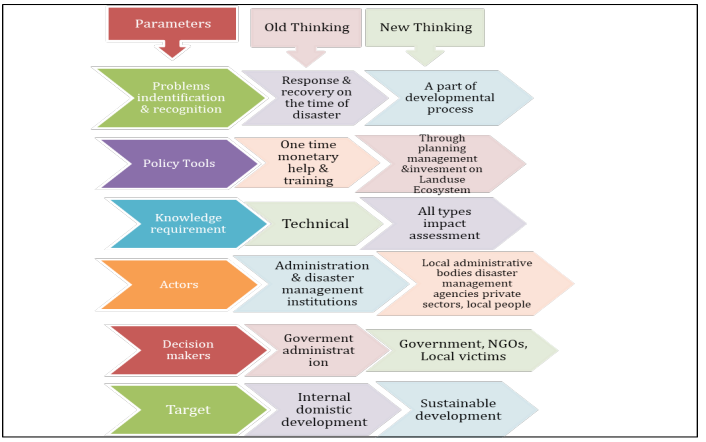


Fig 15: Paradigm shift of disaster risk reduction

Source: Adapted from UNISDI, 2014 TABLE 1, p.p. xv

After thorough analysis of this research, the authors recommend little specific necessary suggestions which will be helpful in sustainable planning of disaster risk reduction for this study area.

Indigenous knowledge is precious as an immediate alternative of disaster management that have traditionally practiced since the time in memorial, but unfortunately such knowledge is not documented yet. Therefore, it is strongly recommended that such knowledge should be formally documented before it has been lost.

It would be more beneficial if there is an inclusion of such knowledge in disaster management policy by the local and state administration in an integrated way.

Information center at community level is to be set up to reduce the gap between weather forecasting by personal instincts and forecasting through modern technologies. All other information related disaster events should be available and highly accessible in those centers.

To building up awareness among the villagers, courtyard session between villagers and local administration through videos, charts and posters is highly recommended.

Employing persons or NGOs for reformatting the indigenous practices to reduce disaster risk and demonstrating the processes with explanation is importance.

Need to upgrade land use planning in collaborations with local dwellers so that vulnerability and risk of the coastal villagers could be minimized.

Some beliefs in traditional disaster management practice are based on prejudice. That orthodoxy should be axed in the very initial stage of the transmission across a generation. In this regard, scientific awareness and training programs at school level should be implemented without a delay.

Respect should be given to this opinion of local people for building the alliance between administration and local communities (Lambert & Scott, 2019).

Allot a budget to promote the indigenous methods of DRR.

The protection of natural barriers such as mangroves, natural levees to prevent storm surge and flood.

The scope should be given to indigenous people to raise their voice against unnecessary administrative delay.

CONCLUSION

Since the time immemorial, the local people usually have practiced their own indigenous knowledge for preparing the coping strategies and sustain their lives and livelihoods from the evil hands of these devastating disasters. Every year more than one or two times they have to face this cyclone which has disastrous impact on the society, local and national economy as well.

This research properly identified, analyzed and documented the vulnerability of disaster generated from severe tropical cyclones, relevance of indigenous knowledge and practices and measures adopted for coping in pre-hazard, in-hazard and post-hazard phases. Although their knowledge has not so much strong scientific base but these are generated from experience through generations. All the practices are not always working but these are helpful to reduce the risk. People believe in this trial and error-based effectiveness of practices. These practices are interwoven with their beliefs, customs and taboos, so that these have not so much replicable use.

Most frequently the policy makers disregard this indigenous knowledge for the making of disaster risk reduction policies. They usually used scientific and technology-based methods. Many researchers already started to advocate for merging both the indigenous knowledge and modern methods for understanding the impact of cyclone and strategy formulation to combat these disasters. Usually planning designs and implementations of policies

are made by the non-indigenous authorities under national and regional level administrations where local people have no chance to participate.

If the decision makers ignore the indigenous knowledge in disaster prevention and mitigation planning then all the developmental efforts will be turned as developmental disasters. For better disaster risk management, it is now utmost necessary to blend this local knowledge into state or national DRR planning strategies by reducing Local-State or State-Nation conflicts. If all stakeholders take part and perform accordingly then this vulnerable situation and disaster risk can be eliminated. So, the indigenous knowledge is a crucial tool for empowering the capability of local people.

ACKNOWLEDGEMENT

We the authors are extremely grateful to the respondents for their kind cooperation during the survey. They shared their knowledge and perception with us without any hesitation during the hard time of COVID-19 Pandemic. We are really thankful to our beloved students who helped us a lot in field survey. Finally, we acknowledge the kind cooperation of officers, employees of different institutes, organizations to carry out this research. We are indebted to the authors of different books and journals as well.

DECLARATION OF INTERESTS

We the authors declaring that there is no conflict of interest regarding the data, images used in this research. There is no conflict of interest in terms of financial assistance as well.

REFERENCES

Adger W.N., Barnett J., Chapin F.S. & Ellemor H. (2011). This must be the place: Underrepresentation of identity and meaning in climate change decision-making, *Global Environmental Politics 11*(2), 1–25. https://doi.org/10.1162/GLEP_a_00051

Agrawal, A. (1995). Dismantling the divide between indigenous and scientific knowledge. *Development and change*, *26*(3), 413-439.

Alam, E., & Collins, A. E. (2010). Cyclone disaster vulnerability and response experiences in coastal Bangladesh. *Disasters*, *34*(4), 931-954.

Alexander, D. (1993). The study of natural disasters, 1977–97: Some reflections on a changing field of knowledge. *Disasters*, *21*(4), 284-304.

Athayde, S., Baudoin, M. A., Lambert, S., Okerie, V., & Yin, L. (2015). Developing an international network on Indigenous Peoples and disaster risk reduction. *Gainesville:*

Tropical Conservation and Development Program, Centre for Latin American Studies, University of Florida.

Benson, C., & Clay, E. (2003). Economic and financial impacts of natural disasters: an assessment of their effects and options for mitigation: synthesis report. *Overseas Development Institute, London*.

Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural hazards*, *41*(2), 283-295.

Cannon, T. (2008). *Reducing people's vulnerability to natural hazards communities and resilience* . WIDER Research Paper, No. 2008/34, The United Nations University World Institute for Development Economics Research (UNUWIDER), Helsinki

Census of India. (2011). Retrieved from www.censusindia.gov.in

Chaudhury, M. (2017). Strategies for reducing vulnerability and building resilience to environmental and natural disasters in developing countries. *United Nations Department of Economic and Social Affairs, Division of Social Policy and Development*.

Dekens, J. (2007). *Local knowledge for disaster preparedness: A literature review*. International Centre for Integrated Mountain Development (ICIMOD). Kathmandu, Nepal.

Drahos, P. (2014). *Intellectual property, indigenous people and their knowledge*. Cambridge University Press.

Flavier, J. M., Jesus, A. D., & Navarro, C. S. (1995). The regional program for the promotion of indigenous knowledge in Asia. *The cultural dimension of development: indigenous knowledge systems.*, 479-487.

G'Nece, J. (2012). The importance of indigenous knowledge and good governance to ensuring effective public participation in environmental impact assessments. *Maryland, USA: ISTF News*.

Grenier, L. (1998). *Working with indigenous knowledge: A guide for researchers*. IDRC.

Haque, M. (2013). *Environmental governance: Emerging challenges for Bangladesh*. AH Development Publishing House. Dhaka.

Herbert, S. (2000). For ethnography, *Progress in Human Geography 24*(4), 550–568. https://doi.org/10.1191/030913200100189102

Hiwasaki, L., Luna, E., Syamsidik., & Shaw, R. (2014). Local & indigenous knowledge for community resilience: Hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. United Nations Educational, Scientific and Cultural Organization Jakarta Office, UNESCO House.

Howell, P. (2003). *Indigenous early warning indicators of cyclones: potential application in coastal Bangladesh*. London: Benfield Greig Hazard Research Centre.

Howitt, R., Havnen, O., & Veland, S. (2012). Natural and unnatural disasters: Responding with respect for Indigenous rights and knowledges. *Geographical Research*, 50 (1), 47-59. https://doi.org/10.1111/j.1745-5871.2011.00709.x

Iloka, N. G. (2016). Indigenous knowledge for disaster risk reduction: An African perspective. *Jàmbá: Journal of Disaster Risk Studies 8*(1), 272. doi: 10.4102/jamba.v8i1.272

Jha, V., & Jha, A. (2011). Traditional knowledge on disaster management: A preliminary study of the Lepcha community of Sikkim, India. *Indian Journal of Traditional Knowledge, 10*(1), 173-182.

Kelman, I., Mercer, J., & Gaillard, J. C. (2012). Indigenous knowledge and disaster risk reduction. *Geography*, *97*(1), 12-21.

Lambert, S. J., Scott, J. C. (2019). International Disaster Risk Reduction Strategies and Indigenous Peoples. *The International Indigenous Policy Journal, 10*(2). 10.18584/iipj.2019.10.2.2.

Lambert, S. (2014). Indigenous Peoples and urban disaster: Māori responses to the 2010-12 Christchurch earthquakes. *Australasian Journal of Disaster and Trauma Studies*, 18 (1), 39-48. Retrieved from http://www.massey.ac.nz/~trauma/issues/2014-1/AJDTS_18-1_Lambert.pdf

Likert, R. (1932). A technique for the measurement of attitudes. In R. S. Woodworth(Eds), *Archives of Psychology* (pp. 1-55). New York.

Retrieved from https://legacy.voteview.com/pdf/Likert_1932.pdf.

Mawere, M. (2010). Indigenous knowledge systems' (IKSs) potential for establishing a moral, virtuous Society: lessons from selected IKSs in Zimbabwe and Mozambique. *Journal of Sustainable Development in Africa*, *12*(7), 209-221.

McAdoo, B. G., Dengler, L., Prasetya, G., & Titov, V. (2006). Smong: How an oral history saved thousands on Indonesia's Simeulue Island during the December 2004 and March 2005 tsunamis. *Earthquake Spectra*, *22*(S3), 661-669. https://doi.org/10.1193/1.2204966

Mead, A. (1994). Ngā Tikanga, Ngā Taonga: Cultural and Intellectual Property: The Rights of Indigenous People. *University of Auckland*.

Mercer, J., Kelman, I., Taranis, L., & Suchet-Pearson, S. (2010). Framework for integrating indigenous and scientific knowledge for disaster risk reduction. *Disasters*, *34*(1), 214-239. https://doi.org/10.1111/j.1467-7717.2009.01126.x

Mitchel, T. (1995). The object of development: America's Egypt. In J. Crush (Eds.), *Power of development* (pp. 129–157), Routledge, London.

Naidoo, N. (2007). *Indigenous knowledge in the national curriculum statement-from policy to practice for environmental education* (Dissertation). University of the Witwatersrand, Johannesburg.

Ngulube, P., Masuku, M., & Sigauke, D. T. (2011). The role of archives in preserving

indigenous knowledge systems in Zimbabwe: Is (re) inventing themselves the answer? *ESARBICA Journal*, *30*, 261.

Nyong A., Adesina F. & Elasha B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel, *Mitigation and Adaptation Strategies for Global Change* 12, 787–797. https://doi.org/10.1007/s11027-007-9099-0

Rahman A., Sakurai A. & Munadi K. (2016). Indigenous knowledge management to enhance community resilience to tsunami risk: Lessons learned from *Smong* traditions in Simeulue island, Indonesia, *Journal of Physics: Conference Series* 755, 6–18. https://doi.org/10.1088/1742-6596/755/1/011001

Regional Meteorological Centre Kolkata, India Meteorological Department, Ministry of Earth Sciences, New Delhi, India. Retrieved from https://mausam.imd.gov.in/kolkata/

Sethi S.N., Sundaray J.K., Panigrahi A. & Chandi. (2011). 'Prediction and management of natural disasters through indigenous technical knowledge, with special reference to fisheries', *Indian Journal of Traditional Knowledge* 10(1), 167–172.

Shaw, R., & Krishnamurthy, R. R. (2009). *Disaster Management: Global Challenges and Local Solutions.* Universities Press.

Shaw, R., Sharma, A., & Takeuchi, Y. (2009). *Indigenous knowledge and disaster risk reduction: From practice to policy*. Nova Science Publishers, Inc.

Shaw, R., Takeuchi, Y., Uy, N., & Sharma, A. (2009). *Indigenous knowledge: Disaster risk reduction, policy note*. UNISDR Asia and the Pacific, Bangkok

Shaw, R., Uy, N., & Baumwoll, J. (Eds.). (2008). *Indigenous knowledge for disaster risk reduction: Good practices and lessons learned from experiences in the Asia-Pacific Region*. United Nations, International Strategy for Disaster Reduction.

Shizha E, 2006, Legitimizing indigenous knowledge in Zimbabwe: A theoretical analysis of postcolonial school knowledge and its colonial legacy, *Journal of Contemporary Issues in Education* 1(1), 20–35. https://doi.org/10.20355/C5RP4J

Sillitoe, P. (2000). *Indigenous knowledge development in Bangladesh: present and future*. Intermediate Technology Publications.

Sillitoe, P., Dixon, P., & Barr, J. J. F. (1998). Indigenous knowledge research on the floodplains of Bangladesh: The search for a methodology. *Grassroots Voice*, *1*(1), 5-15.

Thomalla, F., & Schmuck, H. (2004). 'We all knew that a cyclone was coming': disaster preparedness and the cyclone of 1999 in Orissa, India. *Disasters*, *28*(4), 373-387.

United Nations International Strategy for Disaster Reduction (UNISDR). (2015). *Sendai Framework for Disaster Risk Reduction 2015-30*.

United Nations International Strategy for Disaster Reduction (UNISDR). (2009). *Global assessment report on disaster risk reduction.*

Kazuko Ishigaki, & Vicente Azzellini. (2014). Progress and challenges in disaster risk reduction: A contribution towards the development of policy indicators for the post-2015 Framework on Disaster Risk Reduction. *Progress and Challenges in Disaster Risk Reduction*. United Nations International Strategy for Disaster Reduction (UNISDR). Retrieved from http://www.unisdr.org/files/40967_40967progressandchallengesindisaste.pdf

Walker, D. H., Sinclair, F. L., & Muetzelfeldt, R. (1991). Formal representation and use of indigenous ecological knowledge about agroforestry practices: a pilot phase report. *School of Agricultural and Forest Sciences, University of Wales, Bangor, UK*.

Warner, K. (1991). Shifting cultivators-local technical knowledge and natural resource. *Management in the Humid Tropics*.

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2004). *At Risk. Natural hazards, People's Vulnerability and Disasters* (2nd ed.). Routledge, London.