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ADAPTATING TO SEA LEVEL RISE AND ITS BEHAVIOURAL MODEL OF COASTAL COMMUNITY IN SELANGOR, MALAYSIA

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ABSTRACT

One of the challenges in disaster management of coastal communities in Malaysia is to strengthening resilience among the vulnerable residents which exposed to environmental hazards. The discussion regarding community environments' on adaptation capabilities are still in debate by the social researchers, both local and oversea. Thus, the study aims to determine the adaptation behavioural model of coastal community in Selangor so that factors can be identified and properly controlled in order to achieve the goal of sustainable development. Theoretically, adaptation behavior is determined by four main factors, namely knowledge, awareness, perception of sea level rise and also socio-economic factors of coastal community. The study involved 1050 respondents determined by stratified random sampling. Data obtained through structured interview were analyzed using the Structured Equation Model (SEM) method. The findings show that aspects of community's education background, awareness and population as well as socioeconomic aspects have a positive impact on the adaptation practices of the coastal population. RMSEA, RMSR and CFI values have also shown good model criteria and are considered to be appropriate and acceptable. It is found that the construct of knowledge, awareness and perception has shown a high correlation value ($r > 0.900$, $p = 0.05$). The socioeconomic factors of population are considered very important in giving a positive impact on adaptation practices towards action to the catastrophic sea level rise. It is proposed that the level of knowledge and socioeconomics of the community should be improved by the authorities to reduce the level of their vulnerability.

KEYWORDS: *disaster management, climate change, sea level rising, floods, groundwater*

INTRODUCTION

Sea level rise is the greatest hazard resulting from the global climate change. Malaysia is a maritime country in South East Asia that is exposed to such disaster. With a substantial elongated coastline, Malaysia has a high potential of vulnerability due to sea level rise. According to Nor Aslinda and Mohd Radzi (2013), Malaysia may experienced the rising in sea level which is above from average value of global forecast. Hence, study on the implications of sea level rise among coastal communities is considered very significant.

Although, the state of Selangor is not severely susceptible to the sea level rising as compared to other states in the Peninsular (NAHRIM, 2010), however, it is better to plan effective programme due to uncertainty of climate change in future. It is timely to study the level of understanding and community's adaptation to the disaster of sea level rise in order to increase resilience towards the impact. The purpose of this study is to determine the relationship between the perception and attitude of the coastal community, and their adaptability to minimize the adverse effects of the disaster. The Structured Equation Model (SEM) analysis that incorporates factor analysis and multi regression analysis will be used in this study to identify community's adaptation towards sea level rise in Selangor.

RESEARCH BACKGROUND

Greenhouse gases such as carbon dioxide, methane and ozone that released into the atmosphere cause the earth's surface temperature to rise over time. Uncontrolled increment of these gases enhanced atmospheric heat absorption that lead to global warming. The atmospheric warming will also increase the thermal energy of the ocean that ultimately rising the sea level (Hansen, 2013). Sea level rise is occurring faster than expected, and even a small or minor increment of sea-level poses devastating effect on ecosystems and coastal settlements. The overflowing seawater will certainly cause coastal erosion, polluting groundwater system and loss of habitat of birds, fish and inundating lowland agricultural area.

Hundreds of urban settlements as well as agricultural areas will be exposed to floods and possibly causing millions of people to lose their homes and jobs. The recent scientific prediction has confirmed that global warming will continue to worsen and adversely affecting the world (The Lancet, 2017). The sea level is expected to continue to increase over time and the change is unpredictable. The impact study of sea level rise on coastal settlements is important effort in order to safeguard this densely population region as well as to maintain fishery and maritime

activities. Studies done by IPI (2015) found that the sea level rise could have negative impacts such as damage to transport networks, residential buildings and natural ecosystems, especially mangrove vegetation coverage. According to UNDP (2004), countries located in the Asia Pacific region are vulnerable to climate change disasters such as flash floods, droughts and sea level rise. Approximately by the year 2100, the number of Malaysians affected by sea level rise is about 1.5 million people, including in Sabah and Sarawak (Ahmad Jamaluddin 2008). The impacts, threats and risks of rising sea levels not only affected to the nearby population, but these could also affected natural and mad made ecosystems.

In societal context, there are three key elements that could be affected the degree of vulnerability; namely the sensitivity to disaster, the resilience and ability to adapt to the disasters. The vulnerability to disaster is highly dependent on the frequency and magnitude of disasters, for example the occurrences of extreme climate events. According to Cutter (1994) and Dombrowski (1998), the level of sensitivity, resilience and community adaptation to the disaster is an abstract and difficult to measure.

Hence, the most ideal measuring device is to design appropriate questions to identify their individuals and communities' perceptions and responses to climate change issues and these are very significant factors in determining policy planning and environmental disaster preparedness programs. The aspect of community's adaptation is totally different from one place to another (Blaikie et al., 1994). It relies heavily on the three elements mentioned above, i.e. the relationship between sensitivity-resistance-adaptability. Measurements of these three elements are subjective and sometimes the measurement is done by combining various items or variables that form an index. Sometimes, researchers are required to develop a detail survey framework to produce sufficient data in order to assess the vulnerability of the community.

Rasch (2015) states that perception of environmental risk plays a crucial role in understanding and interpreting the community's views in adapting to catastrophic conditions such as sea level rise. According to Cutter et al. (2009) and Rasch (2015), the socioeconomic factors of population could be also affect the aspect of their adaptability. Nor Haniah et al. (2017) has discussed details of socio-economic elements of the communities that are able to influence the level of vulnerability and the ability to adapt to the disaster in Malaysia.

STUDY AREA AND METHODOLOGY

The approach of this study is based on explorative perspective, i.e the measurement of human perception of knowledge and awareness and in-depth assessment of the main groups of coastal fishermen on adaptation due to sea level rise. The general survey method is used with specially designed questionnaires as well as the technique of interviewing the selected informants in the study area. A total of 1050 respondents were selected randomly in a survey within

ten main coastal zone areas, from Bagan Nakhoda Omar, Sabak Bernam to Tanjung Sepat, Kuala Langat Selangor (Table 1 and Figure 1). A field survey was conducted in mid-March until early April 2017 and a pilot study using 35 early respondents, especially in areas around Kuala Langat, Selangor, was used to identify the reliability of information collected. The Cronbach Alpha value derived from the pilot study was CA = 0.823.

Table 1. Distribution of respondents in the study area

No	Area Name	No of Respondent	Percentage
1.	Tg Sepat	296	28.2
2.	Kg. Batu Laut	224	21.3
3.	Bagan Sg Janggut	39	3.7
4.	Pantai Jeram	40	3.8
5.	Bagan Pasir	80	7.6
6.	Sungai Nibong	70	6.7
7.	Kg. Hj. Dorani	122	11.6
8.	Bagan Sungai Burong	45	4.3
9.	Sungai Burong	94	9.0
10.	Bagan Nakhoda Omar	40	3.8
	Total	1050	100

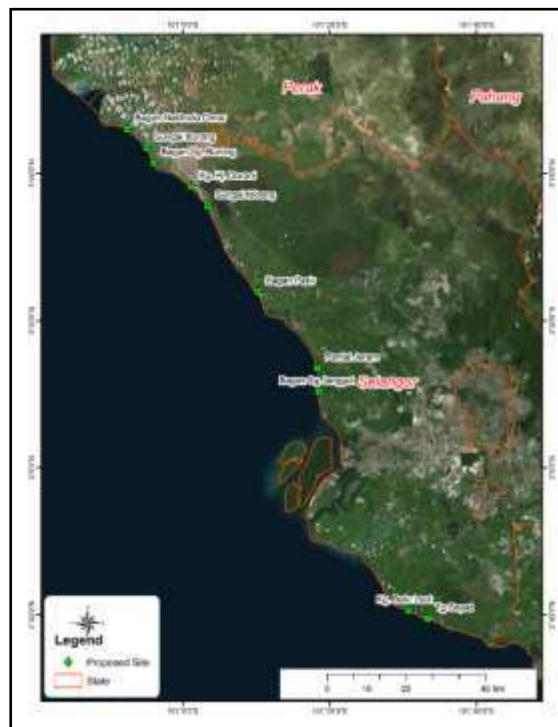


Fig 1. The study area

Before heading out to the field, several meetings have been held with the research team to identify items, questions and expected constructs based on the objectives of the study. Key constructs that are being discussed take into account on the level of knowledge, awareness, response and adaptation by the coastal community to any aspect of climate change and sea level rise. The questionnaire design has been made to suit local conditions. There are several scales used in this survey including Likert scale (5 points), agreement scale (yes/no) and open ended question statement.

The selected number of respondents (n = 1050) is based on the pre-requisite for Structural Equation Model (SEM) analysis. According to Hair et al. (2010), the complexity of factors and the basic features of model need to be taken into account in the analysis. Zainudin (2013) views the characteristics of the population and the number of constructs in a model is an element that can not be diminished. Some researchers also highlighted that the large sample size (i.e. more than 500) could influenced the accuracy of the model in SEM analysis (Kline 1998; Hair et al., 2007). The Structural Equation Model (SEM) apply multiple variable statistical analysis technique that combine aspects of factor analysis, path analysis and multiple regression analysis in a mathematical procedure, by enabling several series of equations interconnected and estimated simultaneously (Hair et al., 2007). SEM modeling is actually based on hypothesis, thus it can be described through the path that links between latent variables or between latent variables and their indicators. Hence, the SEM procedure is said to be more towards confirmatory analysis.

The analysis of SEM incorporates three main analyses which are descriptive statistics (mean), Confirmatory Factor Analysis (CFA) and goodness of fit analyses. The mean value was used to clarify the average average value of respondents' agreement level towards the presented variables. By using the five-point likert scale, min scales which is below than 2.5 are categorized as insignificant, while those over 2.5 scales will be considered significant

Many researchers have used chi-square tests in the analysis of the SEM for model compatibility. This

is because large sample sizes tend to produce large chi-square values (> 2.0). However, the value is still acceptable if it's less than 5.0 (Hair et al., 2007). To solve the problem of model validity, researchers use the appropriate index. Comparison of model measurements with research data can be examined with various indices. To find out the compatibility between the theoretical model and the empirical data, a good model should meet the criteria of the acceptance level that has been set. Among the commonly used indexes are goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), comparative fit index (CFI) root mean square residual (RMSR) and also root index square error of approximation (RMSEA) (Hair et al., 2007). All SEM analysis was carried out through AMOS 18 applications, while the analysis of Exploratory Factor Analysis (EFA) was done through the SPSS Version 20 platform.

There are four hypotheses to be tested in SEM modeling, as follows:

H1: There is positive relationship between the community's knowledge factor and the behavior of adaptation.

H2: There is positive relationship between community awareness and disaster's adaptation behavior.

H3: There is positive relationship between the perceptions of the community towards sea level rise and the behavior of adaptation.

H4: There is positive relationship between the population and socio-economic factors of the community with the behavior of adaptation.

RESULT AND DISCUSSION

Table 2 shows the demographic profile of respondents involved in this study. About 1050 respondents have provided their feedback for the survey. In terms of gender, the proportion of male respondents was higher (67%) than women (33%). As for race, Malay respondents recorded the highest number at 65.5% , while Chinese respondents at 25.5%. The Malays were the majority in this study as the ethnic is the most dominant in coastal settlement in Selangor.

Table 2 Respondent Demographic Profile

Information	Item	Total	Percentage (%)
Gender	Male	703	67.0
	Female	347	33.0
Ethnic	Malay	688	65.5
	Chinese	268	25.5
	India	34	3.2
	Others	60	5.7
Marital status	Bachelor	180	17.1
	Married	827	78.8
	Divorced	29	2.8
	Widow	14	1.3
Age	18-30	192	18.3
	31-64	714	68.0
	64 and above	144	13.7
Education Level	No formal education	144	13.7
	Primary School	311	29.6
	SRP/PMR/PT3	182	17.3
	MCE/LCE/SPM	269	25.6
	Diploma	101	9.6
	Degree	40	3.8
	Masters/PhD	3	0.3
Occupation	Self employed	574	54.6
	Housewife	167	15.9
	Government	50	4.8
	Private	133	12.7
	Retiree	72	6.9
	No occupation	54	5.1
Income	No income	239	22.8
	<RM500	56	5.3
	RM501 - RM2000	586	55.8
	RM2001 - RM3000	121	11.5
	RM3001 - RM8000	42	4.0

In terms of marital status, 78.8% of respondents were married, 17.1% were single, while the remaining 4.1% had divorced or widowed. Almost 68% of the respondents are from the age category between 31 to 64 years, while 18.3% are age categories between 18 and 30 years and the rest (13.7%) are respondents aged over 64 years old. The majority of respondents have low educational attainment or qualification, ie from SPM

downwards (72.5%), while almost 14% of respondents do not have any educational qualifications. This shows that most respondents are from low income group. This is supported by respondents' income information where nearly 84% of respondents are below RM2000 per month.

Table 3 shows the result of reliability analysis (Cronbach Alpha, CA) based on four constructs. The

CA analysis produced high CA values ($CA > 0.847$) and proves the suitability of the item to form the four main constructs. According to Ghazali (2005), the result of

the pilot study (Cronbach Alpha, α) which exceeds the value of 0.75 indicates item or question presented has an acceptable level of reliability.

Table 3. Reliability analysis (Cronbach Alpha, CA)

Constructs	Total Item	CA (α)
Knowledge	12	0.917
Awareness	10	0.847
Perception	15	0.878
Adaptation	12	0.930

Table 4 shows the mean score of the four constructs. The mean value of the score was high and this proved

that the items or indicators used were considered good and significant in modeling disaster's adaptation.

Table 4. Average score mean of constructs

Construct	Score mean value
Knowledge	3.65
Awareness	3.60
Perception	3.63
Adaptation	3.71

Based on literature reviews, the community's adaptation behaviors to environmental disasters include various aspects of livelihood. The SEM model of

adaptation behavior and the elements/factors involved in this study is shown in Figure 4.

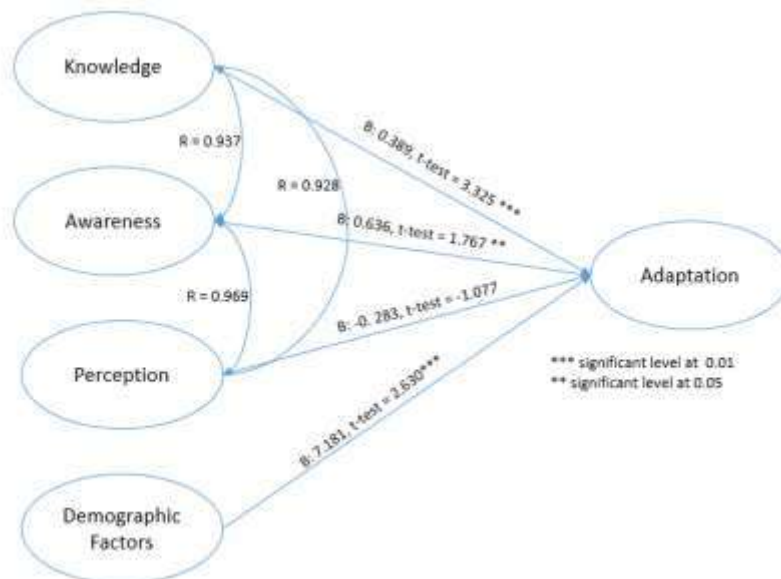


Fig 2. Standardised theoretical path coefficients

The measurement of model is done by evaluating the relationship between the latent (construct), the indicator and the variance error (Chua 2009). Thus, this study consists of four measurement

models formed from the relationship between each latent variable with each of its indicator variables. It is found that the knowledge and awareness constructs have a high correlation value ($r = 0.937$, $p = 0.05$),

constructs awareness and perception towards sea level rise also produced strong correlation value ($r = 0.969$, $p = 0.05$). The construct of knowledge and perception towards sea level rise also produced strong correlation value ($r = 0.928$, $p = 0.05$).

A strong correlation relationship between the three constructs of knowledge, awareness and perception is in line with the study that has been done by Kollmus and Agyeman (2002). The individual knowledge of environmental issues affects the awareness and perceptions of the ongoing disaster. Both (knowledge and awareness) attempt to establish a person's belief (Spaagaren 1997). According to him, the elements are also categorized as motivation and encouragement which will further enhance one's confidence level towards action measures to adapt any changes.

Confirmatory Factor Analysis (CFA) test has been conducted to determine the validity of the developed model. Based on Table 5, the value of X^2

(8137.926) with a dF value of 1752 has the level of significance of 0.00. This statistical model supports statements where there is no significant difference between the real model and the expected value. However, the X^2 value of the model (4.645) is greater than the value of 2, i.e. a suggestion the use other model indicators.

The recommended models for GFI, AGFI, NNFI, PNFI, IFI and RFI show values as follows; 0.731, 0.700, 0.787, 0.719, 0.810 and 0.767. All values of the model corresponds to the value of 0.700 indicating the appropriate model criteria (Joreskog & Sorbom 1989). RMSEA, RMSR and CFI values have also shown good model criterion values based on Turner and Reisinger (2001). This means that the model is considered to be appropriate and acceptable. The structured equation model is successfully formed based on the integration between dependent variables and independent variables.

Table 5. Goodness of fit indices of measurement model and the structural model

Info	X^2 test	Alternative indicators			Fit indices					
	CMIN/DF	RMSEA	RMSR	CFI	GFI	AGFI	NNFI	PNFI	IFI	RFI
Criteria	< 5.000	< 0.080	< 0.080	> 0.800	> 0.700	> 0.700	> 0.700	> 0.500	> 0.700	> 0.700
Model Result	4.645	0.079	0.050	0.809	0.731	0.700	0.787	0.719	0.810	0.767

Note: CMIN = 8137.926, dF = 1752

Figure 2 shows the relationship between the impact of knowledge, awareness, perceptions on sea level rise as well as the socioeconomic factors of the community on the aspect of adaptation in the study area. Hypothesis 1 has been proved to be true by demonstrating causal relationships between significant community adaptation and knowledge factors (0.389, $t = 3.325$, $p < 0.01$). Hypothesis 2 has also been shown to be true by demonstrating causal relationships between community awareness and positive impact on significance of community adaptation (0.636, $t = 1.767$, $p < 0.05$). The results of Hypothesis 1 and Hypothesis 2 are in parallel with past studies that have proven the positive impact of community knowledge and awareness on the impact of community adaptation towards the sea level rise.

Hypothesis 3 has been proven to be statistically insignificant, where the relationship and impression of sea level rise perceptions on adaptation is not significant (-0.283 , $t = -1.072$, $p > 0.05$). However, the relationship between socioeconomic factors and the disaster's adaptation (Hypothesis 4) has proved to be true (7.181, $t = 2.630$, $p < 0.01$). The community's

population and socioeconomic factors are considered very important in giving a positive impact on adaptation practices or community actions towards the disaster. This is also stated by Nor Haniah (2017), Cutter et al. (2009) and Rasch (2015). The result of this study is similar to the study by Sulong et al. (2012) where Lembing River's marginal community exposed to flash floods only performs permanent adaptations of their home structure if their financial factors are stable. However, most of the vulnerable communities are unable to change their residential premises to adapt to the flooding in the river system.

CONCLUSION

Climate change adaptation is an appropriate effort or response taken to prevent or minimize the damage that could be caused by the adverse effects from any form of disasters. It involves concrete actions to manage risks from climate impacts and protect communities. It also helps to strengthen the resilience of the economy. Previous studies have proved that such adaptation initiative can save money and people's lives. The results of this study have shown that knowledge and socioeconomic background factors of the coastal

communities are very significant in influencing any initial adjustment actions towards the onset of sea level change.

It is necessary and urgent to implement experiences of the developed countries in adapting climate change in Malaysia. Findings in present study are essential and can be utilised to create a sound environmental protection programme in Selangor. Without serious adaptation response, climate change is likely to have a significant impact on the coastal communities and the poor are likely to suffer most.

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