

Socio-Cultural Vulnerability Index (SVI) Approach for Social Impact Assessment among the Coastal Community Management Due to Climate Change

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DOI: <https://doi.org/10.51584/IJRIAS.2025.100900083>

Received: 10 September 2025; Accepted: 17 September 2025; Published: 22 October 2025

ABSTRACT

Climate change is one of the effects of global warming that affects the social and physical environment. The effects of climate change on coastal communities are expected to have significant implications for society, culture, economic and their well-being. Coastal communities play an important role in sharing information and should be consulted and included in all efforts to promote climate action and adaptation. Local knowledge are an important component for climate planning and development programmes of action. Social-cultural assets and practices are valuable. The loss and damages of social-cultural parameters should be considered in valuations of climate change impacts. This paper is attempts to indicate the socio-cultural factors that may increase sensitivity to coastal areas. It is also to develop a comprehensive Socio-cultural Vulnerability Index (SVI) to determines the vulnerability of coastal areas to climate change phenomena such as coastal flooding and erosion due to sea level rise, heavy rain, storm surge, high tide, and wave action. Data collection to develop SVI are based on selected parameters indicate during the survey process. Finding indicate that housing characteristics and demographic vulnerabilities are the most significant factors influencing community sensitivity to climate impacts. In contract, cultural and historical components contributed the least. This research contributes a novel, locally contextualized methodology for evaluating social vulnerability and serves as a practical decision-making tool for municipal planners, policymakers, and climate adaptation stakeholders. Integrating SVI outcomes into development planning will support more equitable and effective resilience building among coastal communities.

Keywords: Socio-Cultural Vulnerability Index, coastal community, climate change, sea level rise, Malaysia

INTRODUCTION

The natural environment is strictly a living supporter of all human systems. Successful environmental management will be the basis for the success or failure of the economy and social system throughout the country [1]. Climate change is a global matter. Impact and adaptation of climate change might have a different effects on several countries, but nevertheless the changing of our climate is a problem that will influence the whole World. Climate change is one of the effects of global warming that affects the environment, especially coastal areas. This suggests that climate change has the potential to change the environment on a large scale. These changes will have an impact on human social and economic systems. Thus, climate change is considered one of the risks to the coastal environment. Among the potential climate change incidents are sea level rise and the increase will continue to increase during the 21st century. Visually, the global average sea level rise is expected to continue for several centuries reaching 2100, with the total increase depending on future greenhouse gas

emissions [2]. Therefore, it is clear that coastal areas are most susceptible to climate change impacts especially sea level rise [3]-[4]. The coastal area is one of the most densely populated areas with a high proportion of vulnerable groups such as women, the elderly and children [5]-[6]. Large numbers of residents and property have already been exposed to coastal risk. Improvements in terms of population growth, economic development and future urbanization processes also have the potential to further enhance existing exposure. The risk from climate change and extreme climate events have direct and indirect impacts on socio-cultural. According to [7], the loss and damage caused by climate change extends to cultural factors, including direct material losses as well as losses of mobility, displacement, loss of territory, loss of cultural heritage, or loss of local knowledge and language elements among others. The capacity and willingness to engage with socio-cultural change during the climate change or sea level rise impact is intimately tied to cultural beliefs and roles.

Most Asian countries, especially in the lower regions, face challenges and pressures according to the fourth assessment report (AR4) Intergovernmental Panel on Climate Change (IPCC). Malaysia as one of the countries located in the Asian region as well as developing countries must face many obstacles especially in terms of development resources to deal with this risk. The sea level rise is expected to affect coastal community especially those living on the coast of Pahang, East Malaysia. The position of Pahang, located on the east coast of the monsoon season each year, adds to the challenges facing the coastal communities of Pahang. Besides, facing the ongoing survival of the coastal community will also be further burdened by the challenge of the SLR phenomenon.

The involvement of local coastal community knowledge and practices are an important component of climate planning and adaptation process. Local knowledge must be recognized as valuable, identified and documented. It is also included in the climate change and disaster risk management planning processes. Social and cultural changes can result from many co-occurring factors in addition to climate change. Generally, this study aims to identify the socio-cultural factors that may increase susceptibility to coastal areas and discusses the process of developing a comprehensive Socio-cultural Vulnerability Index (SVI). SVI is calculated by integrating the parameter value difference. Each SVI parameter has been identified by weighted scores regarding its importance and relevance in determining coastal vulnerability to flooding, erosion and coastal flooding due to sea level rise, heavy rainfall, storms, tides, and tidal action. This study was conducted along the coast of Kuantan in Pahang, in the East cost of Malaysia (**Fig.1**).

SOCIO-CULTURAL VULNERABILITY INDEX (SVI)

The vulnerability can be defined as the state of the system before a catastrophic event. The vulnerability can also be defined as the likelihood of systemic losses measured in the form of economic or human losses [8]. Contextual vulnerability looks at how the current contextual situation of a system can affect its vulnerability to current and future climate change [9]. Measuring vulnerability to natural hazards in general and flood hazards in particular is not an easy task [10]. Index production is one of the most widely used methods of measurement by many researchers. The vulnerability index has been developed as a fast and consistent method for characterizing the relative vulnerability of different regions [11]. The various indices are derived from different methods such as Physical Vulnerability Index (PVI), Economic Vulnerability (EVI), Social Vulnerability Index (SoVI) and Coastal Vulnerability Index CVI as a result of the combination of two indices, the Physical Vulnerability Index (PVI) and Socioeconomic Vulnerability Index (SVI)[12],[13]-[14]. Economic susceptibility (EVI), used to assess relative degrees The vulnerability of the National economic structure as a result of increasing concern among the international community on the Susceptibility of developing small island countries [12]. It clearly shows that the Vulnerability Index has been developed in different ways to measure vulnerability to natural hazards. However, the focus of this study is on the Socio-cultural vulnerability index is the vulnerability index that focuses on the social and cultural aspects of coastal communities along the coast of Cherating to Tanjung agas. The resulting Vulnerability Index can generally reflect the current state of the community in responding to the effects of coastal flooding, erosion, and erosion caused by sea level rise, heavy rainfall, storms, high tides, and waves.

The use of parameters is required in the calculation of the Socio-Cultural Vulnerability Index. Parameters are essentially a way of including complex realities in one construct [15]. To determine the Socio-Cultural

Vulnerability Index among the measured parameters are Demographic Characteristics, Family Structure, Education Level, Occupation, Health, Residential Features, Neighborhood, Culture and Historic Sites and Access to Social Media

MATERIALS AND METHODS

Study Area

Socio-cultural Vulnerability Index to coastal flooding, erosion, weathering caused by SLR, heavy rainfall, storm surges, high tide, and wave action have been conducted in Pahang. Position of Pahang on the East Coast of Malaysia. Pahang is the largest state in the north of Malaysia with a population of 1,501,900 [16]. The study area is focused on villages within 1 Km of the coastline. Data collection was carried out in 36 villages (from Cherating Beach to Tanjung Agas) involving 2 districts in Pahang and Pekan and Kuantan. Most of the villages involved in this study are traditional villages that still retain a lot of local cultures. The study area was divided into 18 Management Unit (MU). Fig. 1 shows a map based on MU where MU is the length of the slope that has a relationship between the characteristics of the natural processes of the beach and land use [17].

Pahang's coastal zone is particularly vulnerable due to its exposure to the northeast monsoon, sea level rise, and recurring storm surges. Many of the villages rely on coastal resources for income and maintain strong cultural identities, making them ideal for assessing socio-cultural vulnerability.

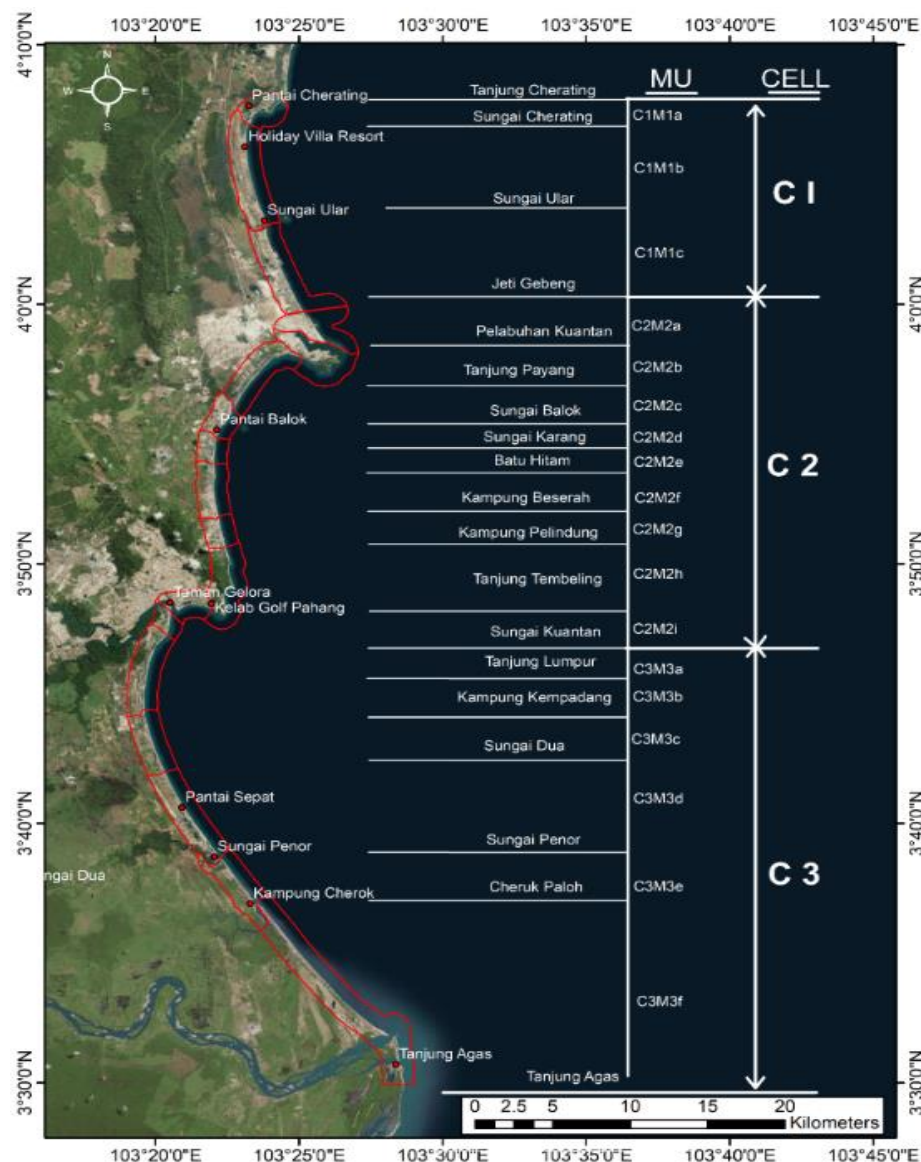


Fig. 1 Map of Study Area by MU

Data Collection and Analysis

The method of questionnaire survey among the head of households has been conducted face-to-face interview. A sample size of 400 respondents was selected using [18] formula for a population of approximately 11,466, ensuring a 95% confidence level. Pilot studies based on a set of questionnaires were tested and modified before being used in actual field studies. The questionnaire design based on information such as demographics, family structure, occupation, health, housing, neighborhood relationships, cultural and historical sites, and access to social media. Using this criteria collected from the survey, SVI parameters had been developed. Fig. 2, show the SVI calculations and the output for vulnerability distribution analysis.

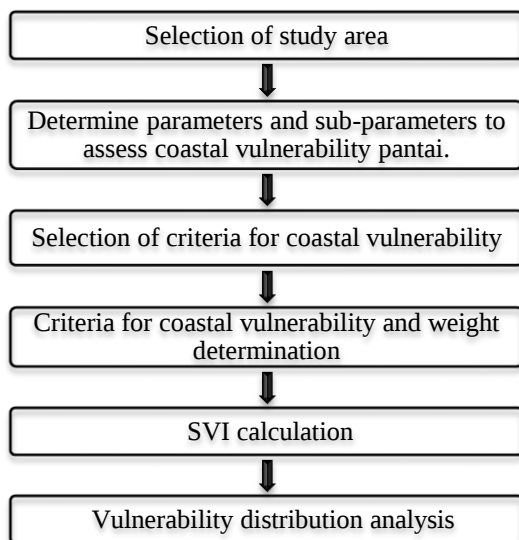


Fig. 2. Methods

The first step is to select the study area. The selection of this area takes into account the area in accordance with the study conducted. Area selection also identifies locations according to MU. Next is to define parameters and sub parameters to assess coastal vulnerability. The selected parameters and sub parameters are based on studies by previous researchers who have produced vulnerability indices. In addition, the parameters selected are in accordance with the study area or represent the current situation of the community in the study area. The selection of parameters and sub parameters takes into account the actual state of the study area to ensure that the resulting index truly reflects the Vulnerability of the study area. The next step is to select the criteria for the position of coastal vulnerability. This selection is intended to set the criteria for each sub parameter on a scale of 1-5 where 1 is the lowest position value and 5 is the highest position. The selection of criteria for this sub parameter is carefully done so that the criteria laid down for each position value are to be fully compliant. Next is the most important part of the SVI calculation performed after the results of the questionnaire were analyzed? This SVI calculation is based on the equation that the researcher has chosen. Vulnerability distribution analysis is the final step in which the resulting analysis is presented in the form of a vulnerability map to show the vulnerability values of each MU involved.

RESULTS

Socio-Cultural Parameters

The selection of parameters to measure Vulnerability is based on several selection features that guarantee the importance of each of these parameters. Transparency is the first feature that comes to mind during parameter selection. Objectivity and transparency are issues that cause vulnerability researchers. Transparency is intended to justify action based on the underlying subjective vulnerability [9]. Next, the selected parameters must be representative. Emphasize that each of the parameters selected in the socio-cultural study should represent the current state of the community in the study area. The parameters to be selected must also be measurable by both

quantitative and qualitative methods. Besides, the selected parameters are easy to accept and explain to policymakers. The parameters selected in this study are:

- a. Demographic Features
 - i. Age: This study takes into account the age of the respondent and the age of the householder in the study area. The most vulnerable ages are children (0-12 years) and the elderly (61 and older).
 - ii. Distance of Residences: Distance of the respondent's residence from the beach. Where there are 4 positions (Rank) which are determined namely the highest vulnerability (0-200 m), high vulnerability (201-600 m), simple vulnerability (601-800 m) and lowest vulnerability (801-1000 m).
 - iii. Density of Population: The total number of people living within one square kilometer (km / sq.).
- b. Family Structure
 - i. Family size: The number of household members per household, where large family sizes are households with large family members and more at risk (Rasch 2015).
 - ii. Dependency: The number of householders who depend on working-class households, with low-income households is often poor and vulnerable compared to low-income households [19].
 - iii. Gender: Number of women in the household compared to men. Women belong to vulnerable social groups other than children and the elderly [20]-[21].
 - iv. Level of Education: Respondent's education level. Education. The higher the number of contents of houses with higher education the less vulnerability [22].
- c. Occupation
 - i. Type of Occupation: Respondent's occupation. The work owned by the respondent determines the quality of life of the respondent. Therefore, the lower the quality of life of respondents the higher their vulnerability
 - ii. Dependency on coastal resources: Respondents and householders rely on beach resources for their source of income. The impact of the deterioration of climate change on the community is related to the extent to which the community relies on local resources. Climate change can affect the ecosystem in terms of physical and biological components. The components can be added, subtracted, lost, and modified. These changes can have a negative or positive effect on society depending on the components [23].
- d. Health: The physical health of respondents and household members. Individual physical health also contributes to the ability to escape and / or recover from floods [10].
- e. Housing features
 - i. Type of house: respondent type of house. The type of home affects vulnerability through two approaches - whether the house type determines the age and severity of the house or is viewed from a population density standpoint. For example, terrace type houses and apartments show higher population density than traditional bungalow and traditionally built houses.
 - ii. Type of building structure: The type of building materials used in home construction. The quality of the home walls determines how easily the home is damaged by the flood. Such as Blocks, Zinc and Wood [16]. The materials are divided into wooden, wooden and brick, brick without plaster and brick with plaster.
- f. Neighborhood Relationships
 - i. Neighborhood relationships: the connection and friendship of the community in the neighborhood. Close neighborhood relationships can help to disseminate information effectively.
 - ii. Participation in community activities: frequency of respondents to community activities. Community activities became an effective medium of information dissemination such as village meetings. The frequency of respondents in community activities increases the potential for respondents to obtain such information.
- g. Cultural and Historical Sites
 - i. Cultural events: Frequency of cultural activities such as water festivals, water festivals, folk sports and fishing festivals are held on the coast. These cultural activities have become local identities by assuming that the more often these activities are carried out, the higher the probability
 - ii. Historical sites: the existence of a historical site in the area studied is the existence of a high cultural heritage unit, the higher the threat [11]. Assuming that the beaches have heritage sites, the higher the risk.

- h. Access to Social Media: Frequency of use on social media such as Facebook, YouTube, Instagram, Twitter, Wechat, Whatsapp, Online blogs and more throughout the day. The frequent use of social media is considered to be that individuals will have quick access to disaster-related information.

Based on the parameters described in Table 1 shows the determination of criteria based on the position of the vulnerability. Where position 1 is a very low vulnerability position and 5 is a very high vulnerability position.

TABLE 1 DETERMINATION OF CRITERIA

Sub Parameter	1 Very low	2 Low	3 Moderate	4 High	5 Very High
Age		20-40 years old	41-60 years old	13-19 years old	<12 years and > 61 years old
Distance of residence		801-1000 m	601-800 m 801-1000 m	201-400 m 401-600 m	0-200 m
Population density	<50 person/sqkm ²	50-79 person /sqkm ²	80-200 person /sqkm ²	201-300 person /sqkm ²	>300 person /sqkm ²
Family size		1-3 person	4-5 person	6-7 person	>7 person
Liability		0-2 person	3-4 person	5-6 person	>6 person
Gender	There are no women in the household		Women who have stable employment, education and good health.	Women who do not have stable employment, education and good health	Old woman
Education	University level	Certificate and Diploma	Secondary school	Primary school	No formal education
Type of Profession			Government and private workers	Farmers, retired, fishermen, traders, taxi drivers and trucks and self-employed	Unemployed, housewife and student
Health	Be healthy		Be healthy with minor illnesses	Unwell with major illnesses	Sick and disabled people
Type of house		Bungalows	Shop house	Condo / Apartment	Traditional house and terrace
Types of home construction materials		Brick with plaster	Bricks without plaster	Wood and brick	Wood
Neighborhood relations	Very good	Good	Moderate	Not Good	Not to Good
Participation in community activities		Always	Moderate	Rarely	Very rarely
Cultural event	Never held		Rarely do	Regularly	Very often
Historic site	No historical sites available			401-600 m 601-1000 m	0-200 m 201-400 m
Frequency of social media usage		> 5 times a day	3-4 times a day	1-2 times a day	No social media

SVI Calculation

The SVI calculation method is carried out by involving the use of equations constructed from the adaptation of the DID Report equation (NAHRIM) and also used by [24]. The final SVI score for each Management Unit (MU) is calculated using the following formula used in the equation below:

Equation:

$$SVI = \frac{a(w1)+b(w2)+c(w3)+d(w4)+e(w5)+f(w6)+g(w7)+h(w8)+i(w9)}{9}$$

Where:

[a] to [i] are parameter values (averaged sub-parameters scores)

[w1] to [w9] are weights (based on VIV values)

a = demographic characteristics

b = family structure

c = education level

d = occupation

e = health

f = home features

g = neighborhood relationships

h = culture and historical sites

i = access to social media.

The resulting SVI scores were classified into five vulnerability levels:

- a. very low (1.0 – 1.8)
- b. low (1.81 – 2.6)
- c. moderate (2.61 – 3.4)
- d. high (3.41 – 4.2)
- e. very high (4.21 – 5.0)

Weighting of Parameters

The purpose of the SVI is to be comprehensive, requiring a broad set of indicators in each sub-index category. Even in the context of the induction theory, each indicator has a strong foundation. However, there is no reason to suggest that their roles are the same. Therefore, the weighting is appropriate. Weight estimation is intended to determine the parameters of importance. This study uses the Weighted Average Model. The model is where the average significant score (ASSi) of parameter i, Xj is the parameter value of parameter i, assuming positions 1-5 where 1 is very low, 2 is low, 3 is position while moderate, 4 is high and 5 is highly susceptible to vulnerability. Socio-cultural. Nij is the number of respondents that falls in the Xj position of parameter i and N is the total number of respondents.

This calculation is done by converting the position score to a numerical value. For example, position 5 is an equation with value 5, position 4 is an equation of value 4 and so on positions 3, 2 and 1 to parameter i. Next is to determine the parameters involved by importance. This study used a combination of the weighted average and coefficient of variation. The coefficient of variation measured with the Vulnerability Index Value (VIV) model is: where VIV_i is the coefficient of variation for the vulnerability parameter i, ASS_i is the average significant score of the vulnerability parameter i and δ_i is the standard deviation of the important score for parameter i. After the VIV calculation, the study shows the significant position of the vulnerability between the parameters (RVIV).

Equation of Weightage:

$$ASS_i = \frac{\sum_{j=1}^5 X_j N_{ij}}{N}$$

$$VIV_i = ASS_i + \frac{ASS_i}{\delta_i}$$

Source: Customized and processed from [25]

The summary results of the weighting calculations for each parameter are shown in Table 1 below. The use of significant average scores (ASS) is considered to be less suitable for determining the position of all socio-cultural vulnerability parameters. This is because the ASS is a weighted average value calculation that is often identified as weak, which does not take into account the degree of variation between individual responses. Therefore, a combination of weighted average values and coefficient of variation is appropriate to determine the position of socio-cultural vulnerability parameters. Typical techniques are used to reduce the weakness of the attribute level by weighted average value and apply it to a measure called variance coefficient, obtained through weighted average distribution by the standard deviation [25].

The calculation of parameter values for vulnerability index value (RVIV) values is as shown in Table 2. The lowest significant average score (ASS) value was recorded by cultural and historical parameters with a value of 1.43. This indicates that cultural parameters and historical sites are the lowest contributors to socio-cultural vulnerability. The highest significant average score (ASS) was for the home feature parameter with a value of 4.03 and the second highest significant average (ASS) score was the demographic feature parameter with a value of 3.46. The high mean values (ASS) of these two parameters indicate that household characteristics and demographic characteristics are the most significant contributors to socio-cultural vulnerability. Whereas the results show that the value of VIV is the home feature parameter with a value of 7.54 and the lowest value of VIV is the cultural and historical parameter with a value of 2.84. The results of the study between VIV and ASS did not show significant differences in determining the socio-cultural vulnerability parameter.

TABLE 2 COMPARISON OF PARAMETER VALUES FOR POSITIONING OF VULNERABILITY INDEX VALUES

Parameter	Significant Average Score (ASS)	Standard Deviation (δ)	Vulnerability Index Value (VIV)	Significant position of the vulnerability between the parameters (RVIV)
Demographic Characteristics	3.46	0.97	7.02	2
Family Structure	2.75	0.78	6.27	5
Level of Education	3.11	0.87	6.68	3
Occupation	2.92	1.65	4.68	7
Health	1.15	0.51	3.41	8
Housing features	4.03	1.15	7.54	1
Neighborhood relationship	2.67	1.30	4.72	6
Cultural and Historical sites	1.43	1.01	2.84	9

Access to social media	3.62	1.24	6.54	4
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Finally, to accurately capture the relative importance of each parameter in the construction of the Socio-Cultural Vulnerability Index (SVI) a Weighted Average Model was employed. This model integrates two key components:

- Average Significance Score (ASS):** This metric was derived by aggregating the frequency of responses associated with each sub-parameter and their corresponding vulnerability levels. It represents the central tendency of perceived significance across respondents.
- Vulnerability Index Value (VIV):** To complement the ASS, the VIV was calculated using the coefficient of variation (CV), which quantifies the degree of dispersion in responses. The VIV thus reflects both the relative importance and the consistency of each sub-parameter across the surveyed population.

This dual-weighting approach addresses the limitations inherent in using the ASS alone, which fails to account for variability in the data. By incorporating the VIV, the model ensures that parameters with higher response variability often indicative of localized sensitivities of differential exposure are appropriately weighted. This methodological refinement enhances the robustness and contextual sensitivity of the SVI (Rawshan et al., 2007).

Overall the SVI results show significant variation in vulnerability levels across the 18 MU along the coastal zone of Kuantan and Pekan. The calculated SVI values fall within a range from 2.84 (low) to 7.54 (very high), indicating both low-risk and high-risk communities within the same coastal corridor (refer Table 2).

Most and Least Vulnerable Parameters

The analysis revealed that housing features represent the most significant contributor to socio-cultural vulnerability within the study area, with a Relative Vulnerability Index Value (RVIV) of 1.00. This high weighting reflects the prevalence of substandard building materials, aging infrastructure, and informal housing designs, all of which increase physical exposure to climate-related coastal hazards such as flooding and erosion.

Demographic characteristics, particularly age distribution and the proximity of residential areas to the coastline, also emerged as critical determinants of vulnerability. These factors influence both physical exposure and the ability of residents to respond effectively to environmental stressors. In addition, low levels of formal education were identified as a limiting factor in community adaptive capacity, reducing the uptake of early warnings, hazard awareness, and disaster preparedness initiatives.

In contrast, cultural and historical sites were found to contribute the least to overall SVI scores. This outcome may suggest either lower direct exposure to climate-related threats or a general lack of integration between cultural heritage considerations and physical risk assessments. Similarly, health-related parameters showed relatively low influence on the index. However, this result should be interpreted cautiously, as it may reflect issues such as underreporting of chronic health conditions or limited access to healthcare facilities, rather than a true indication of community resilience.

Spatial Distribution of Socio-Cultural Vulnerability

The spatial distribution of the Socio-Cultural Vulnerability Index (SVI), as derived from Geographic Information System (GIS)-based mapping, indicates a clear pattern of vulnerability clustering along the coastal margin.

- High-vulnerability zones** are predominantly located within 0–400 meters of the shoreline, with particular concentration in Management Units (MU) 03, 07, and 11 in the Kuantan district. These areas are characterized by older, traditional housing structures, limited flood protection measures, and underdeveloped infrastructure, all of which significantly heighten exposure to coastal hazards such as sea level rise, storm surges, and coastal erosion.
- Moderate-vulnerability zones** are generally found in semi-urbanized villages that exhibit a transitional housing landscape, comprising both traditional and modern structures. These areas tend to have

comparatively better access to public services, early warning systems, and information dissemination channels, contributing to a moderate level of adaptive capacity.

- iii. Low-vulnerability zones are typically situated in inland MUs located 800 to 1000 meters from the coastline. These areas are often associated with improved socio-economic indicators, including higher education attainment, more durable housing structures, and better access to basic infrastructure and services. As a result, communities in these zones exhibit a relatively lower degree of socio-cultural vulnerability to climate-related coastal impacts.

IMPLICATIONS FOR COMMUNITY RESILIENCE AND POLICY

The findings of this study offer several important implications for enhancing community resilience and informing evidence-based policy interventions in coastal regions vulnerable to climate change.

- i. **Municipal Planning and Land Use Management.** Management Units (MUs) identified as highly vulnerable should be prioritized in local development planning. Specific measures may include the designation of coastal buffer zones, retrofitting of critical infrastructure, and, where necessary, the provision of relocation incentives for at-risk populations. Furthermore, housing policies must incorporate climate-resilient building standards, particularly in traditional settlements that are currently characterized by aging structures and informal construction methods.
- ii. **Community Awareness and Education.** The relatively high scores associated with education levels and access to social media present both a risk and an opportunity. These factors suggest a strong potential for implementing targeted digital awareness campaigns aimed at improving preparedness and adaptive behavior, particularly among younger populations who are more digitally engaged. Strengthening climate literacy at the grassroots level can significantly improve anticipatory responses to coastal hazards.
- iii. **Localized Adaptation Programming.** The SVI provides a critical tool for guiding community based adaptation efforts. Interventions should be tailored to the needs of the most at risk groups, notably the elderly, low income households, and informal sector workers. These groups exhibit reduced adaptive capacity due to limited economic resources, mobility, or access to institutional support mechanisms. Local adaptation programs must therefore prioritize social inclusivity and equity.
- iv. **Integrating Local and Traditional Knowledge.** Although cultural and historical site parameters contributed minimally to the composite vulnerability score, they remain essential components of sustainable adaptation strategies. Local knowledge systems, communal practices, and intergenerational memory serve as valuable assets in strengthening early warning mechanisms, fostering risk communication, and promoting social cohesion during periods of environmental stress.

CONCLUSIONS

Overall, this study developed and applied a Socio-Cultural Vulnerability Index (SVI) to assess community level vulnerability to coastal hazards in Kuantan and Pekan, Malaysia. The conclusion of the selected parameters is based on several characteristics of transparent selection and is based on the suitability of the study area. Vulnerability is a non-static thing because individuals who are considered 'exposed' at this time do not mean they will remain. On the contrary, the same thing applies to 'exposed' people. This is because the person may be exposed to forces or processes such as aging, disease or redundancy, which have nothing to do with adverse events such as natural hazards. Therefore, Vulnerability analysis can be seen as an overview of dynamic processes [8].

The methodology based on socio-cultural vulnerability is recognized to quantify and evaluate social vulnerabilities that have been validated by many authors and has been recognized for use in coastal areas and many developing areas as it is a relatively simple method. The weighting analysis results show that home characteristics are the most contributing parameters to the socio-cultural Vulnerability Index while cultural and historical parameters are the least contributing to vulnerability values. The resulting SVI describes local heterogeneity in social and cultural aspects. SVI can be used for municipal planning to address the effects of climate change on local communities. Economic and social factors are among the factors that influence the

community at large and support the impact of dangerous events. Therefore awareness of adaptation and mitigation of natural hazards is essential.

The findings reveal significant spatial and social disparities levels across 18 coastal management units. Notably, parameters such as housing conditions, demographic composition, and education levels emerged as the most critical determinants of vulnerability, while cultural heritage and health factors had relatively lower contributions. The novelty of this research lies in its multi-dimensional approach that integrates both quantitative assessments and spatial analysis, enabling a more nuanced understanding of socio-cultural vulnerability. By applying the SVI at a localized scale, this study provides a practical tool for identifying priority areas for adaptation planning and resource allocation.

Finally, the methodology and index developed here can be adapted for use in other coastal regions globally, especially in developing countries facing similar challenges of uneven development, rapid urbanization, and increasing exposure to climate related hazards. This study contributes to ongoing efforts to localize climate adaptation and build socially inclusive resilience strategies.

ACKNOWLEDGEMENT

This research was supported by Universiti Kebangsaan Malaysia and funded under Ministry of Higher Education Malaysia Grant No. **ZF-2025-009**. This support is gratefully acknowledged. The authors would like to thank others researchers, lecturer and friends for ideas and discussion.

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