

Local Knowledge of Coastal Community to Sea Level Rise and Climate Change

Zaini Sakawi

Assoc. Prof. Dr. (PhD), Head of Environmental Management Program, Faculty of Social Science and Humanities
Universiti Kebangsaan Malaysia

Abd Hair Awang

Assoc. Prof. Dr. (PhD), School of Social, Development and Environmental Studies
Universiti Kebangsaan Malaysia

Abstract

Climate change has the potential to substantially affect risk of flooding and associated impacts to infrastructure, agriculture, fisheries and human health in coastal communities. The effects of climate changes are not only on physical aspects such as sea level rise and inundation, but will affect individuals and communities mainly at coastal areas. Due to this scenario, this study will focus on local knowledge of coastal community to sea level rise and climate change. Specifically, the objectives of the study is to identify the level of knowledge, and awareness of coastal community related to sea level rise and climate change. Finding showed that 66.7 percent of the coastal community have a knowledge of climate change, and 59.3 percent agreed that sea level rise scenario as part of impact of climate change. Furthermore, 77.8 percent of them aware and agreed that sea level rise have an impact on their economic, infrastructure and recreation activities. They also aware that potential of climate change because of naturally phenomenon (63.0 %) and human activities (59.3 %) such as open burning and agriculture activities. Generally, this study to provide insight into the communities knowledge on and adaptation strategies towards the treat of sea level rise.

Keywords: Climate change, sea level rise, coastal community, inundation, perception

INTRODUCTION

Climate change is a change in climate quantities attributed directly or indirectly to natural inconsistency such as human activity including anthropogenic increases in greenhouse gases that alter composition of the global atmosphere. Global warming leads to thermal expansion, which causes sea level rise. The increases in sea level rise are consistent with warming. Global sea level rise is also a result of the exchange of water between oceans and reservoirs (IPCC AR-4, 2007)

Sea level rise is an increase in the mean sea level of the ocean. According to Thurman and Burton (2000), sea level rise has been rising since the end of the glaciations about 15,000 years ago. Also, The Intergovernmental Panel of Climate Change has high confidence that the rate of global mean SLR increased between the mid-19th and 20th centuries. Based on IPCC AR-4 (2007) prediction, the average rate of SLR was 1.7 +/- 0.5 mm/yr for the 20th century, 1.8 +/- 0.5 mm/yr for 1961-2003, and 3.1 +/- 0.7mm/yr for 1993-2003. Finally, study by Patz (2000), stated SLR is expected to rise 56 cm by 2100. These scenarios are expected to rise at a greater rate this century due to melting and loss of ice and thermal expansions of the ocean due to warming.

Sea level rise can change locally and globally due to change in the shape of the ocean basins, and change in the total water mass and density (Delpla et al., 2009). According to Fitzgerald et al. (2008), the low-lying coastal area infrastructure and their stock is at an increasing risk due to damage from sea level rise inundation, extreme astronomical tides, storm surge flooding, erosion, and others coastal hazards. Bates et al. (2008) state that hazards from sea level rise are threatening the infrastructure, local resources, settlements and facilities that are the livelihood of coastal communities along the

shorelines. The risk also continues to increase due to the continuing growth of coastal cities and tourism. Overall, sea level rises can considerably influence human populations in coastal and island regions and natural environments like marine ecosystems, plantation, and many other. In another hand, sea level rise can increase the height of storm waves, inundate and flood low lying areas, causing losses to tidal wetlands, habitat, and agricultural areas. Its also can cause higher water tables and salt water intrusion, interfering with septic systems, drinking water and irrigation water. Finally. Sea level rise also is expected to continue for centuries.

Research on the climate change issue and sea level rise impacts is still lacking in Malaysia. Therefore, the purpose of this study is to identified the perceptions of local knowlegde on sea level rise issues, investigate the socio-economic impact of sea level rise and to propose potential adaptation options for solve this problem. Coastal communities along the shorelines of Malaysia are already feeling the impacts of coastal flooding and sea level rise in the form of flooded businesses, overflowing sewers and crumbling infrastructure. One of the impacts of global climate change for the shoreline in Selangor is an increase of sea level rise and hazards to the vulnerable communities. This change will impact both biological and cultural resources located along the coastline

MATERIAL AND METHODS

Study area

Malaysia has long been recognised as tourist hotspots due its beach attraction. Not only that, with the coastline spanned to a total of 4083 km, Malaysia offers the most bio-productive area for marine associated life, fish and wildlife. However, due to the dynamic environment, including high intensity waves and anthropogenic activities, the coastline is experiencing severe shoreline erosion. The government took serious concern on this matter and carried out a continuous assessment on the coastal erosion since 1984. Climate change will interact differently with the variety of human activities and other drivers of change along Coastlines. Changes in weather and climate extremes and sea level rise may impact the demand for fisherman and farmers, including critical infrastructures such as transportation, jetty and place of interest. The population and assets exposed to coastal risks as well as human pressures on coastal ecosystems will increase significantly in the coming decades due to population growth, economic development and urbanization.

Coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding and coastal erosion due to relative sea level rise. The sea level rise does not only gives significant impact to the livelihood of the coastal communities but also has direct influence on the disruption of national economics, destruction of valuable assets and most importantly the irrecoverable lost of land. As most of the cities in Malaysia are situated near to the coast, immediate actions are needed to minimise the undesired outcome from the sea level rise.

In Malaysia, more than 70% of the coastline is facing erosion problem. Climate change and sea level rise can give rise to high impacts such as destruction of assets and disruption to economic sectors, loss of human lives, mental health effects, or loss on plants, animals, and ecosystem and their severity depends on their extremes, exposure and vulnerability (Md. Sujahangir et al., 2014). Sea level rise was identified as one of the factors leading to coastal erosion (Bruun, 1962). Sea level rise may reduce the size of an island or state and its' infrastructure i.e. airports, roads, and capital cities, which normally predominate in the coastal areas; worsen inundation, erosion, and other coastal hazards; threaten vital infrastructure, settlements, and facilities; and thus compromise the socio-economic wellbeing of the island communities and states (Jeofry & Rozainah, 2013)

Methods:

This study analysed both primary and secondary data. The primary data were obtained through observation and interviews. Observations were conducted at residential areas of the coastal community including the fishing villages such as Bagan Nakhoda Omar, Batu Laut, Jeram and Tg. Sepat. Overall, the study area encompassed the coastol community along the southern Selangor coast stretching from Tg Sepat to Bagan Nakhoda Omar at the Northern Selangor coast. **Figure 1** shows the settlements involved along the study area.

Social survey and interviewing was conducted door-to-door over a 10 days period by four part-time interviewers who are postgraduate student and well trained in the particular interviewing techniques used in this research. A total of 100 sets of questionnaires were randomly administered to get the comprehensive data on the perception of the coastal community

on sea level rise and climate change. The sample consisted of respondent of differents educational and background etc. Data obtained in thus study were processed within statistical package of SPSS. Whereas, statistical analyzes that were used are:- descriptive statistical methods (frequencies).

RESULT AND DISCUSSIONS:

Demographic Characteristic

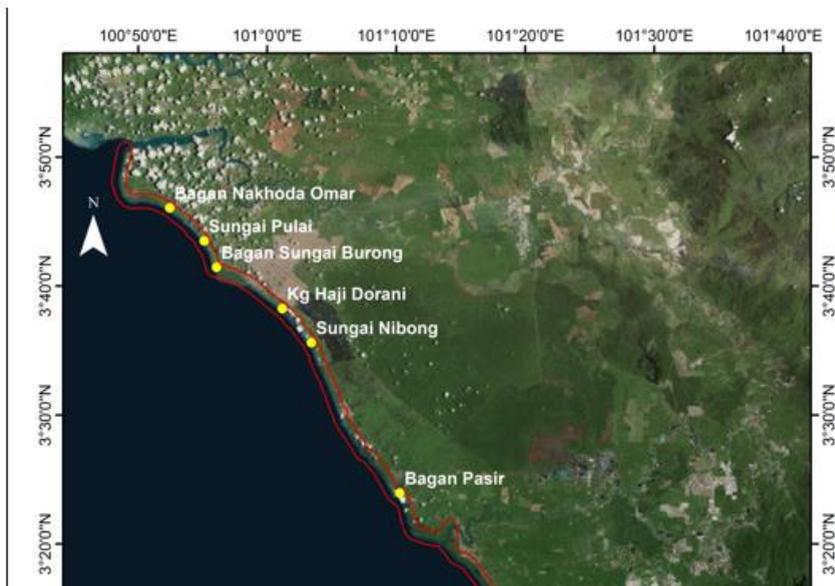
Overall respondents age range was between 21 and 60 years. Age of the respondents is one of the most important characteristics in understanding their views about the particular perceptions. Due to ethnicity, 66.7 percent of them are Chinese community, followed by Malays (29.6 %) and Indian (3.7 %). Majority of the respondent indicated that they have intended Upper secondary education, with portion of 40.8 percent. In term of household member, the alanalysis showed that almost half of the respondents have a number of households in a range of 1 to 2 (44.4 %) and 3 to 4 members (37.0 %) respectively. Only 18.6 percent of the respondents consisted of more than 5 members (Table 1).

Table 1: Respondents' Demographic Background

Type of respondents	Percentage (%)	Household member's	Percentage (%)
Husband	70.4	Less than 2	44.4
Wife	14.8	3 – 4	37.0
Son/daughter	14.8	More than 5	18.6
	100.0		100.0
Education levels	Percentage (%)	Age	Percentage (%)
No formal education	33.3	21 – 30 years	7.4
Primary scholl	25.9	31 – 40 years	11.1
Upper secondary	40.8	41 – 50 years	22.2
	100.0	More than 51 years	59.3
			100.0

Source: Field survey, Jan. 2017

Employment status of the respondents within the study area is influenced mostly by their educational level, expertise and surrounding employment oportunites. Based on Figure 1, less than 20 percent of the respondents are unemployed (18.6 %) who are comprised of uneducated, housewives and the elderly. The numbers of respondents engaged in business sectors as well as in the private sectors are 29.6 percent and 22.2 percent respectively.



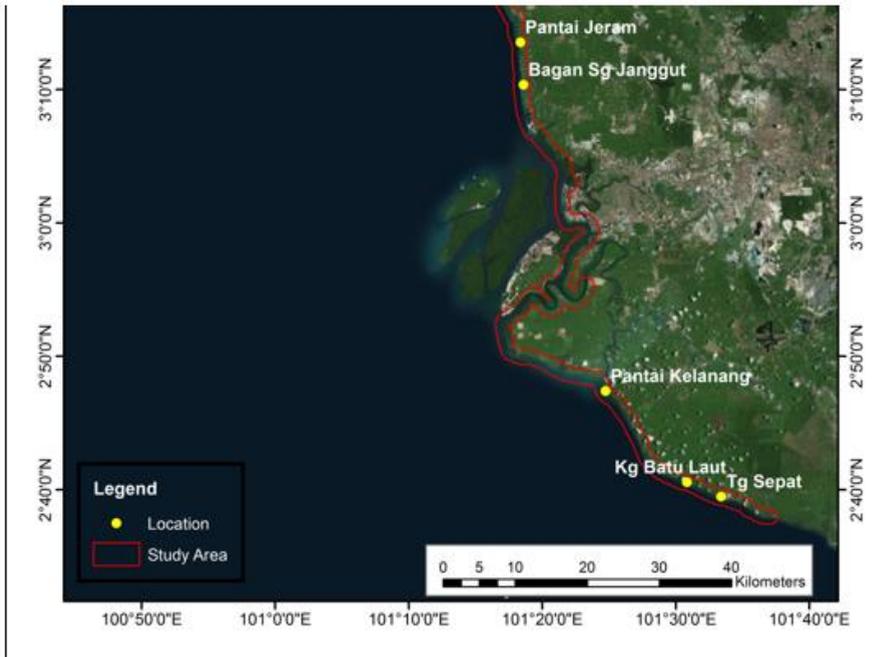


Figure 1: Study area along the Selangor shoreline from Kg Tg Sepat to Bagan Nakhoda Omar (BNO)

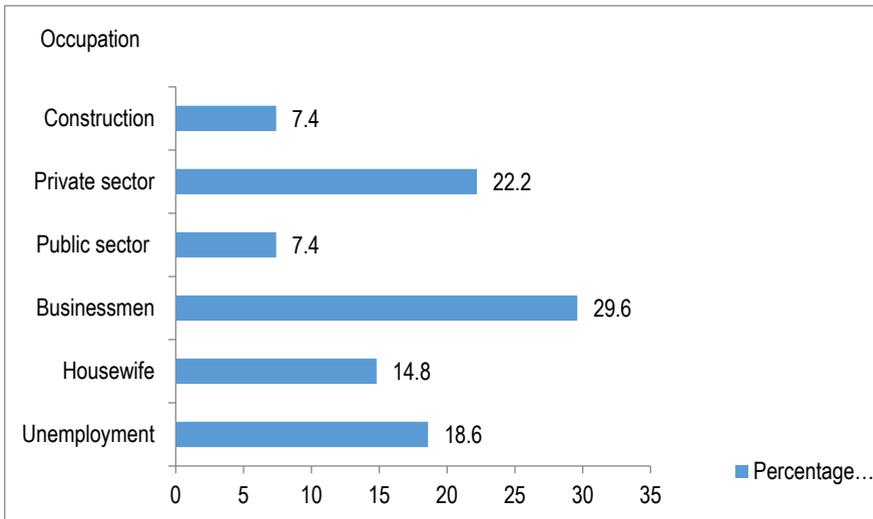


Figure 2: Respondents' Occupational profile

Figure 3 shows the income distribution of the respondents. On a whole, the income profile of the respondent showed that 29.6 percent earn less than RM1000 per month and less than 20 percent a month earning income between RM1,001-

RM2,000 and above RM3,001 and above. Overall, level of household income in the study area is considered low where almost half families living in the area earn less than RM2,000 per month.

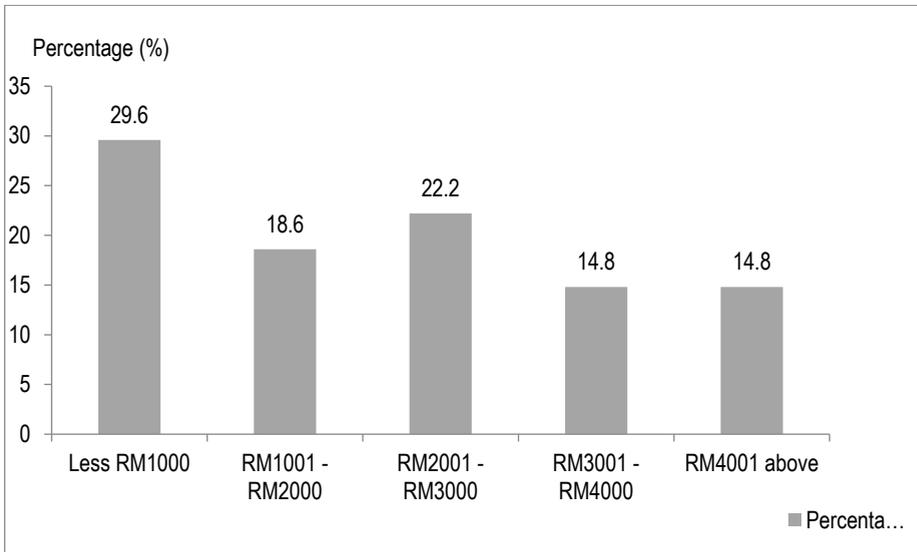


Figure 3: Respondents' Income in Study area

Source: Fieldwork survey, Jan. 2017

Awareness and Perceptions

Table 2 shows the current issues related to the physical and human environment. Based on table 2, two items such as climate change and the impact of sea level rise is the current issues that are not the main discussed among respondent. With respect to main sources of climate change and sea level rise issues and indicators (Figure 4), most of the respondents (85.2 %) that have been interviewed knew about it through television (news, film and documentary). Others additional sources were obtained from radio (44.4 %), head of villager (40.7 %), spread by family members (33.3%), internet and newspaper (29.6 %), and local authority (11.1 %).

Table 2: Current issues discussed among the respondent

Items	Yes	No
Education opportunities	48.1	51.9
Decreased on health quality	11.1	88.9
Quality of life decreased	29.6	70.4
Environmental pollution increased	18.5	81.5
Climate change issues	29.6	70.4
Impact of sea level rise	0.0	100.0

Source: Fieldwork, Jan. 2017.

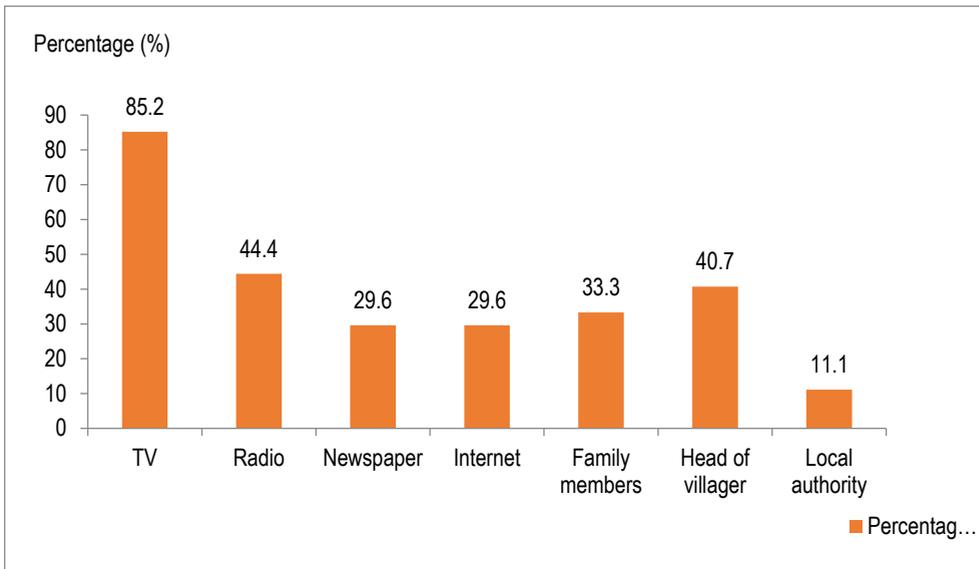


Figure 4: The sources of knowledge on Climate change and sea level rise

Source: Fieldwork, Jan. 2017.

Experienced and knowledge to climate change and sea level rise

According to Figure 5, most of the respondents have their own meteorological experienced on climate change and sea level rise such as drought, storms, flooding/flash flood, and coastal erosion. Based on Figure 5, majority of respondents have seldom experienced due to climate change and sea level rise indicators. For example, indicator flooding/ flash flood showed that more than one-third of the respondents have their own experienced.

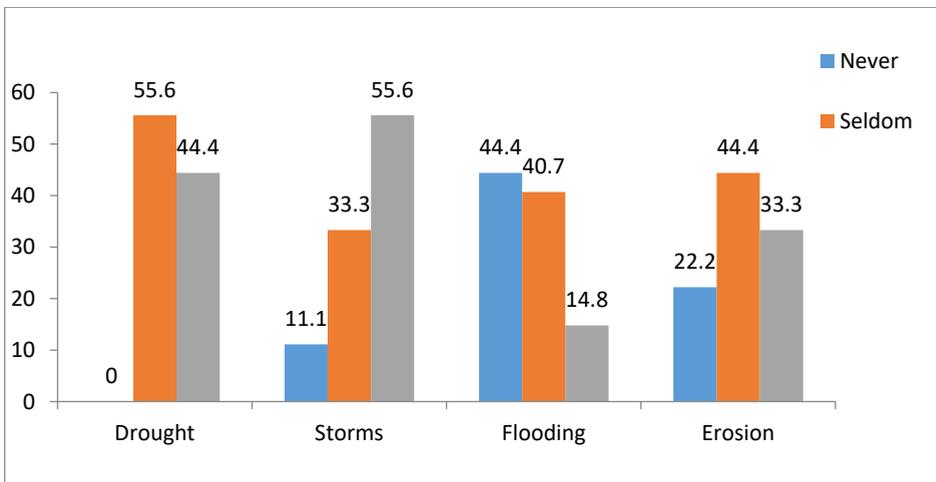


Figure 5: Experienced and knowledge to climate change and sea level rise, Source: Fieldwork, Jan. 2017.

Knowledge on Climate Change

An analysis of the perception of knowledge on climate change revealed that almost two-third (66.7 %) of the respondent knew about climate change and impact of sea level rise of the study area. Impact of climate change to sea level rise indicated that 55.6 percent of respondent knew about the issues. The evidence of sea level rise mentioned by respondent consisted of flooding (33.3 %), “*Laut makan darat*” (41.7 %) and level of coastal tidal (25.0 %). The study also attempts to gauge the perceptions of the local’s community regarding the impact of climate change. 63.0 percent of the respondent agreed the climate change occur because of natural hazards and another 59.3 percent because of human activities (Table 3).

Table 3: Perception of coastal community on sea level rise and climate change

No	Items	Yes	No
1.	The temperature is getting hot lately	100.0	0.0
2.	Water and glaciers melting cause in global sea level rise	30.0	70.0
3.	Climate change impact of human activity	59.3	40.7
4.	Climate change is a natural process	63.0	37.0
5.	Reduction of land area (beach)	44.0	57.0
6.	Increased of sediment in some coastal areas	25.9	74.1
7.	The shallow of estuary	74.1	25.9
8.	Less of mangrove	74.1	25.9

Source: Fieldwork, Jan. 2017

Impact of Sea level rise

Global climate change is expected to cause sea level rise, which will have major effect on human and physical environment along the coastal area in Selangor because part of the shoreline is a low-lying area. According to Cohen et al. (1997) and Gommès et al. (1998), human environment could be affected significantly, as nearly 20 percent of the world’s population lives within 30 km of the sea, and approximately 40 percent live within 100 km of the coast. In case of coastal along the study area, its was found that sea level rise impact on human and physical environment toward up to 1000 meters to the mainland. Table 3 shows part of impact of sea level rise in study area on human and physical environment.

Table 3: Impact of sea level rise in study area on human and physical environment.

No	Human and physical environment	Impact
1.	Ecosystems & Critical species	Bay ecosystems, which provide habitat for many endangered and threatened species, are extremely vulnerable to inundation that is expected to result in habitat shift. These shifts could cause the loss of irreplaceable habitats for critical species in many areas. Upland areas are vulnerable to erosion, and sub-tidal ecosystems are threatened by erosion of upland areas when it results in degraded water quality. Vulnerable ecosystems along the coastal of study area has been indicated at Kg Batu Laut, Morib beach, Jeram beach, Remis beach and Bagan Nakhoda Omar
2.	Parks, Recreation & Public access	Shoreline parks and recreational facilities are extremely vulnerable to regular inundation due to extensive exposure around the Bay and high sensitivity to inundation impacts. For example the Bagan Lalang, Morib, Jeram, Remis and Bagan Nakhoda Omar beaches. The system is highly vulnerable to flooding because of extensive exposure and high sensitivity, but adaptive capacity to cope with flooding is higher than for most other systems
3.	Local transportation facilities	Access provided by local transportation facilities will be vulnerable to flooding and inundation. Roads and other facilities could also be vulnerable to flooding and inundation due to saturated soils and impacts on road substructure and pavement degradation
4.	Vulnerable populations	Many groups that are currently vulnerable – such as low income residents, fishermen, and ethnic minorities. Residents that work in sectors that could be adversely impacted by future flooding are also a key vulnerability. Example the coastal community (especially among the fishermen) at Tg Sepat, Kg Batu Laut, Bagan Sg Janggut, Jeram Beach, Bagan Pasir, Sg Nibong, Kg Hj Dorani, Bagan Sg Burong, and Bagan Nakhoda Omar.

Adaptations and Mitigating Plan

Adaptation measures are an important strategy in reducing the adverse impacts of sea level rise natural and human systems along the coastal area. The development and implementation of adaptation strategies will require the integrated active involvement of all parties in the country, government sectors, private sector and the community. According to Al-Jeneid et al. (2008), the significant challenges exist in developing these adaptation strategies due to uncertainties in climate change issues and in projections of possible future climate change at a regional or national level.

Currently, there are no current thoughts on the technical and institutional aspects of adaptation to sea level rise impact in Malaysia. At present no policy perspectives to include long-term evolution and associated sea level rise influence. A hard and long-term commitment has to be made in order to encourage coastal managers and general public to impacts of sea level rise and associated direct and indirect social and economical impacts, as changes related with sea level rise are slow and almost unnoticeable. Coastal managers should realize the need to begin advance planning for sea level rise.

Coastal access, Residentials, Fishermen Jetty and Recreational opportunity

Coastal access, residentials area and recreational opportunities are prevented when these facilities are flooded. Because this system cannot perform its primary function when exposed, it is considered to have a very high sensitivity to flooding impacts. Coastal area, residentials, fishermen jetty and recreational facilities would have a moderate capacity to adapt to flooding in the extreme events scenarios. Longer-term adaptive capacity to inundation is mixed. Such as coastal area, residentials, fishermen jetty and recreational facilities become flooded more regularly or inundated altogether, it likely will be very difficult to maintain coastal access or public road by developing new facilities that would themselves be highly vulnerable.

Decision-makers may also encounter resistance to spending funds on coastal and fishermen facilities that will be, by nature, vulnerable to future flooding. This vulnerability may also be an opportunity, however; as coastal land use evolves in the context of sea level rise, creating low- impact, passive open space in vulnerable areas may be appealing, since these uses require less investment and are more capable of coping with flooding than buildings and other infrastructure.

Coastal area, residentials, fishermen jetty and recreational facilities are highly vulnerable to flooding and inundation, due to their extensive exposure and high sensitivity. These uses will be more exposed to flooding and inundation than any other land use, and they are unable to serve their function when flooded. The following strategies are options for addressing the flooding and inundation vulnerabilities of residential, fishermen jetty and recreation space, as prioritized by the local stakeholder working group and technical advisory committee.

- Prioritize the development of passive, naturalized parks, open space, and habitat land in areas that are vulnerable to flooding, to minimize risk to higher-value infrastructure, and to promote low-impact development stormwater management.
- Evaluate site-specific vulnerabilities, identifying structures such as traditional housing and jetties that may be at risk. Identify adaptation responses as plans or projects are developed.

Basic Policy Initiatives - Basic policy initiatives are needed to protect investments in vulnerable areas, minimize coastland loss of vulnerable low-lying areas, conserve natural ecosystems, control coastal erosion, and protect groundwater resources. The basic policy initiatives should recognize the ever-continued pressures on coastal areas and the need of the coastal community for developing these sites including the vulnerable ones. These needs and major impacts of sea level rise are to be addressed in a plan composed of actions and processes. Specific arrangement should emphasize on:

- Integrate sea level rise considerations into national development plans and policies
- Spot coastal protection area - Vulnerable coastal areas contain industrial compounds, recreational facilities and human settlements. These areas are of high priority and public investment
- Public awareness, develop on knowledge capability and Stakeholder capacity on climate change process and sea level rise impact

CONCLUSIONS

In an attempt to relate the potential impacts of climate change, in particular sea level rise, the coastal community along the Selangor shoreline will be adversely impacted by the change. While this study only looked at local knowledge of coastal community of sea level rise impact on socio-economic aspect, the results provide a starting place in which to discuss and develop the long-term impact of climate change in particular sea level rise. Finding of local knowledge to sea level rise and climate change also a good starting to provide recommendation for educating and enhancing adaptive capacity on sea level rise and climate change and to produce guidelines and strategy to reduce impact and vulnerability of climate change in the coastal area. Further study is still required specifically focuses on storm damage, which could affect the desired height of sea walls and the resulting flood damages.

Acknowledgments

This study is part of research findings from the TRGS/1/2015/UKM/02/5/4 research grant. The researcher would like to thank the Universiti Kebangsaan Malaysia (UKM), CRIM and Faculty of Social Science and Humanities (FSSK) which provided the grant to fund this research.

REFERENCES:

- [1] Al-Jeneid, S., Bahnassy, M., Nasr, S. and El-Raey, M. 2008. Vulnerability assessment and adaptation to the impact of sea level rise on the Kingdom of Bahrain. *Mitig Adapt Strat Glob Change*, **13**: 87-104.
- [2] Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds. 2008. Climate change and water. Technical paper of the intergovernmental Panel on climate change, IPCC Secretariat, Geneva.
- [3] Bruun, P. 1962. Sea level rise as a cause shore erosion: Am. Soc. Civil Engineers Proc., *Jour Waterways and Harbor Div.*, **88**: 117-130.
- [4] Cohen, J. E. Small, C., Mellinger, A., Gallup, J. and Sachs, J. 1997. Estimates of coastal population. *Science* **278**: 1211-1212.
- [5] Gommès, R. Du Guerny, J., Nachtergaele, F. and Robert, B. 1998. Potential impact of sea level rise on populations and agriculture. Food and Agriculture Organization of the United Nations. SD (Sustainable Development) Dimensions/Special, available online at <http://www.fao.org/Eldirect/Elre0045.thm>.
- [6] Delpla, I., Jung, A. V., Baures, E., Clement, M., and Thomas, O. 2009. Impacts of climate change on surface water quality in relation to drinking water production. *Environment International*, **35** (8): 1225-1233.
- [7] Fitzgerald, Duncan M., Michael, S. Fenster, Britt A. Argow, and Ilya V. Buynevich. 2008. Coastal impacts due to sea level rise. *Annual Reviews Earth and Planetary Science*. February, 4 2008.
- [8] IPCC AR-4, 2007. Intergovernmental Panel on Climate Change. IPCC Plenary XXVII. 2007. Climate Change 2007. Synthesis Report: An assessment of the intergovernmental Panel on Climate Change. Valencia, Spain. 12-17 November 2007.
- [9] Jeffrey, M. H. and Rozainah, M. Z. 2013. General observation about rising sea level in Peninsular Malaysia. *Malaysia Journal of Science* **32**: 363-370.
- [10] Md. Sijahangir Kabir Sarkar, Rawshan, Ara Begum, Joy Jacqueline Pereira, Abdul Hamid Jaafar and M. Yusof Saari. 2014. Impacts of and adaptations to sea level rise in Malaysia. *Asian Journal of Water, Environmental and Pollution*. **11** (2): 29-36.
- [11] Thurman, Harold V. and Elizabeth A. Burton. 2000. Introductory oceanography. 9th edition. Prentice Hall. July, 2000.