Status and Sustainability of Mangrove Forests: A Case Study from Merbok Mangrove Reserve, Kedah, Malaysia

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Abstract. Mangroves comprise of a complex combination of halophytic trees, shrubs and other plants that exist and grow in the coastal zone throughout tropical and subtropical regions. Mangrove ecosystems provide significant socioeconomic benefits to the local communities such as fish, timber and tourism opportunities. Understanding how they perceive on mangrove ecosystems and services is crucial for incorporating this information into decision making process and conservation, this study was conducted to study the awareness and knowledge of local community towards the trend and status of mangrove resources in Merbok Mangrove Reserve (MMR) and, to identify factors that influence the survival of mangroves in the study area. A survey was conducted in MMR using questionnaires as a main tool for data collection. A total of 300 respondents live near and around MMR were selected which involved a total of 10 villages. From the study, 95% of the respondents perceived that mangroves are very important resources to the local community. About 95.7% of respondents agree that the loss of mangroves will have negative impact to the environment and the economy of the livelihood. Furthermore, the majority of respondents perceived that illegal clearing and aquaculture practices have significant impact to the degradation of mangroves in the area. They agree that replanting of mangroves could be the best management option to ensure the survival of this ecosystem. The information from this study may provide useful input for future research and can be crucial tools for the government and stakeholders to pave way for an effective decision making for the sustainability of mangrove resources.

Keywords: Mangroves, Local Communities, Questionnaires, Merbok Mangrove Reserve.
1. Introduction
Since the great migration and cultural changes of the human race that took place in the mid-Holocene, the coastal area has always been an attraction to human being as it holds countless benefits that ready to be exploit for its resources. Generally, the coastal area that exists in tropical and sub-tropical regions is dominated by the mangrove ecosystem. This ecosystem can be considered as the dominant ecosystem in the coastal area as compared to other types of vegetation due to its adaptive ability and influence largely by the climate condition [1]. Located at the coastal area mangroves provided ecological benefits such as erosion control, protection against storm and tsunami and give shelter to many marine habitant [2-4]. Furthermore, the mangroves also act as a socioeconomic important for local community by providing wood products, source of protein and economic activities [5, 6].

Considering mangroves to be one of the highly productive biotopes, vibrant, rich with an endemic biodiversity while offered so many benefits both ecological and socio-economic, they continue to experience losses at the highest degree that caused by the calamity of global climate change and uncontrollable anthropogenic activities [7, 8]. However, in the 21st century the rapid anthropogenic activities such as aquaculture farming, human settlement, illegal logging, agricultural activities and land development seem to be the new menace that could be the catalyst that pushed the mangroves to the brink of extinction [9, 10].

Since the catastrophic tsunami in 2014, mangroves have received global recognition as they demonstrated resilient and durability during the event in protecting the coastal areas from the impacts. The mangrove ecosystem that been regarded to be a wasteful biome before, have been highly valued because of their traits in sheltering the coastal coast threats. Globally, conservation efforts for mangroves and their ecosystem have increased tremendously. The effort to ensure sustainable management of mangroves has been carried out by the government, many policies and legislation had been implemented for mangroves protection and sustainability. However, the implementation of the policies and legislation seem unable to stop the degradation of the mangroves due to high demand for mangroves land for aquaculture pond, agriculture activities and land reclamation.

According to [11], the sustainable management of mangroves cannot be achieved by the implementation of policy and legislation alone, the involvement of local communities are needed to be integrated into the framework to ensure the constant yield higher rate of success. This strategy is an important task that needs to be given serious attention by responsible authorities as it can be a new frontier in paving a new way for more sustainable policy for mangroves. Therefore, it is crucial to understand local communities’ awareness and knowledge regarding the trends and status towards the mangroves in the area to ensure effective mangroves planning and management for future sustainability. To gain a better understanding of the complex sectorial interaction that drive to land use/cover change, 1) this study was conducted to study the awareness and knowledge of local community towards the trend and status of mangrove resources in Merbok Mangrove Reserve (MMR) and 2) to identify factors that influence the survival of mangroves in the study area. The information from this study may provide baseline information and useful tool for stake holders and mangroves related agencies in making resource forecasts, and assist in the development of management of mangrove forests.

2. Materials and Methods

2.1 Study Area
The area selected for this study was Merbok Mangrove Reserve (MMR) and it vicinity that connected to the mangroves. The study area is situated at Kuala Muda district, Kedah Malaysia, and located in the north-western part of Peninsular Malaysia (Figure 1). The study area is located within the coordinates of 5° 41’ 36” N and 100° 25’ 22” E. The area is reported to be the fourth largest mangrove area in Peninsular Malaysia with a total size of 4,534.18 ha. The main river flows through Merbok Mangrove Reserve is approximately 35 km long. During tidal, saline water can stretch up to 30 km and varies in-depth 3 – 15m. The weather is humid all year round with an average temperature of 26.1
°C and the mean monthly rainfall about 234.6 mm. The surrounding area of MMR were habitat by local community that heavily depending to surrounding mangroves as source of livelihood.

Figure 1: Location of Study Area in Merbok Mangroves Reserve, Kedah, Malaysia

2.2 Pilot Study and reliability test
Prior to full survey, a pilot study was conducted where a total of 30 respondents were selected to obtain an initial response from the questionnaires. During the pilot study, feedback from the respondents such as the clarity, sequence and overall validity of questionnaire were taken into consideration in order to produce the right instrument for the study. For this purpose, the Cronbach’s alpha reliability test was performed. According to [12], Cronbach’s alpha reliability test is a common test used to report reliability estimates in social science study and symbolized by the lower case Greek letter “α”.

2.3 Questionnaire Instrument
A closed-ended questionnaire was used for this survey in order to answer the objectives of this study. The subjects included in the questionnaires were based on the observation from the field, primary data, and secondary data and adopted from the literature. The questionnaires were divided into four main sections 1) Section A: Contains a list of questions on respondents’ background and demographic features, 2) Section B: Contains a list of questions to test the knowledge of respondents about the mangroves, 3) Section C: Contains a list of questions that inquired the awareness of respondents on the current status of mangroves in the study area and 4) Section D: Contains a list of questions related to the management of the mangroves.

2.4 Data Collection
Data were collected through field visits near the MMR based on structured questionnaires that was filled in by the respondents. To ensure unbiased, the enumerator carefully explained and provided guidance in the answering process. To avoid confusion among the respondents, the questionnaires were prepared in two languages, English and Malay. For this study, a total of ten villages were visited (i.e., Segantang Garam, Merbok, Tanjung Dawai, Sungai Gelam, Tukang Jusuh, Pengkalan Bujang,
Keda Che Bema, Teluk Wang Besar, Sungai Petani and Sungai Jagung) and 300 respondents were selected as the respondents for this study. Data gathered from the survey were analysed using a Statistical Package for Social Science (SPSS Version 22) software.

3. Result and Discussion

3.1 Reliability Test
Data from the questionnaires were tested for their reliability. From the analysis, the internal consistency coefficients were determined using the Cronbach’s alpha (α) value from a pilot study that contains 30 respondents. Results from the test indicate that the instrument for this study is reliable to be used with all Cronbach’s alpha (α) values more than 0.7 as shown in Table 1.

| No | Variables                                | No of item | Cronbach’s alpha value |
|----|------------------------------------------|------------|------------------------|
| 1  | The important of mangroves to local communities | 10         | 0.71                   |
| 2  | Activities that contribute to the loss of mangroves | 12         | 0.79                   |
| 3  | Changes in the mangrove forest resources | 8          | 0.82                   |
| 4  | How to ensure the survival of mangroves | 9          | 0.92                   |

3.2 Socio-Demographic Characteristics
This section investigates the socio-demographic characteristics of the respondents. Variables used were gender, age, ethnicity, occupation, level of education, duration of living in adjacent to MMR and monthly income. Table 2 shows the socio-demographic profile of the respondents from the survey. From the table, among of the total 300 respondents, 74.7% were male and the remaining were female (25.3%). The reason for higher number of male compared to female was because of the male usually engaged with outside work for the family while the female usually stays at home either as a housewife or responsible for sorting out mangroves resources such as shrimp, fish and crab collected by the male from the mangroves.

In terms of age of respondents, the highest was between the range of 31 – 40 years (27%) followed by 41 – 50 years old (25.3%), 51 – and above (22%), 21 – 30 years old (21.7%), below 20 years old (4%). Based on the age distribution, the majority of respondents were classified as middle aged, which may suggest that the majority of respondents are in working age group. According to [15], age is considered to be crucial variable in a demographic survey as it indicates their experience and activities in mangrove area that leads to social and economic status.

The majority of the respondents are from Malay ethnicity (94.7%), followed by Chinese (2%), Indian (0.3%) and other (3%). Education is one of the fundamental tools that drive individuals to acquire knowledge, expend the power of knowledge and drive for further success. Among the literate group, the majority of the respondents manage to complete their study at the secondary school (47%), some of the respondents only manage to complete their study only at the primary school (23.7%) and the rest of the respondents were college graduates (29.3%). Financial constraints could may be one of the factors that explained why the as majority of respondents were the primary and secondary school leavers. Some of them may need to assist their parents to venture into business or work gathering mangroves products.
Table 2: Socio-Demographic Profile of Respondents in MMR

| Variables                        | n   | %  |
|----------------------------------|-----|----|
| Gender                           |     |    |
| Male                             | 224 | 74.7|
| Female                           | 76  | 25.3|
| Age                              |     |    |
| 20 years old and below           | 12  | 4.0 |
| 21-30 years old                  | 65  | 21.7|
| 31-40 years old                  | 87  | 27.0|
| 41-50 years old                  | 76  | 25.3|
| 51 years old and above           | 66  | 22.0|
| Ethnicity                        |     |    |
| Malay                            | 284 | 94.7|
| Chinese                          | 6   | 2.0 |
| Indian                           | 1   | 0.3 |
| Other                            | 9   | 3.0 |
| Occupation                       |     |    |
| Government worker                | 23  | 7.7 |
| Fisherman                        | 222 | 74.2|
| Student                          | 22  | 7.3 |
| Business owner                   | 8   | 2.6 |
| Tourist                          | 10  | 3.3 |
| Farmer                           | 11  | 3.6 |
| Other                            | 4   | 1.3 |
| Level of education               |     |    |
| Primary School                   | 71  | 23.7|
| Secondary School                 | 141 | 47.0|
| Tertiary education               | 88  | 29.3|
| Monthly income                   |     |    |
| RM 0 – 1000                      | 203 | 67.7|
| RM 1001 – 3000                   | 81  | 27.0|
| RM 3001 – 5000                   | 12  | 4.0 |
| RM 5001 – 10000                  | 4   | 1.3 |
| Duration living adjacent to Mangroves |     |    |
| Below 10                         | 64  | 21.3|
| 11-20 years                      | 25  | 8.3 |
| 21-30 years                      | 48  | 16.0|
| 31 year and above                | 149 | 49.7|
| Others                           | 14  | 4.7 |

Table 2 shows approximately 74.2% of the respondents were fishermen, followed by government workers (7.7%), students (7.3%), farmers (3.6%), 3.3%, tourists (2.6%) business owners (2.6%) and other (4%). The highest proportion as fishermen were expected, as they live in mangroves vicinity and rely on mangroves as source of income. Previous studies have reported that mangroves provide the local communities with multiple products such as charcoals firewood, poles, pilings, timber products, seafood products and many more that can be a source of income [14, 15].

The duration of respondents live in the area may correspond to their knowledge and experience on mangroves. Around 49.7% of the respondents have been living near or in vicinity the mangrove area for more than 31 years, 21.3% was below than ten years, 16% between 21 – 30 years, 8.3% between 11 – 20 years and others about 4.7%. Majority of the respondents earned their household income from mangrove forests (76.7%) while others gain their household income from other sources such as agriculture, business and government offices. In the study area, about 67.7% of the respondents earn their monthly income in the range of RM 0 – 1000, followed by 27% between RM 1001 – 3000, 4% between RM 3001 – 5001 and 1.3% between RM 5001 – 10,000. The majority of the respondents with the house hold income below RM 1000 were from mangrove-dependent groups which totally dependent on mangrove resources such as wood and fisheries products. The
respondents with household income between RM 1001 – RM 3000 could be those who were depending on both mangroves resources and other types of activities such as agriculture and business. Whereas, for the respondents that received monthly income more than RM 3001 are usually considered as a non-mangrove dependent communities.

3.3 Level of Knowledge about Mangroves

Majority of the respondents in MMR knows the presence of mangroves in the area. Figure 2 illustrates mangrove ecosystem services that are directly important to respondents.

![Mangrove Ecosystem Services](image)

**Figure 2: Mangrove Ecosystem Services That is Directly Important to Respondents**

The results in the Figure 2 show that almost all variables recorded the means score greater than 4.0 except for medicinal usage (3.47) and cultural/religious (1.54) that exhibited two lowest scores. The respondents regarded mangroves as very important ecosystem for fish habitat with the mean score of 4.65. This is expected as the vast majority of respondents were fishermen and have long experience living in the study area, therefore they know how crucial the mangrove ecosystem in providing suitable habitat for commercial fishery industry. The second highest ecosystem services of the mangroves that highly regard by the respondents are shoreline protection and source of food (4.56). The catastrophic tsunami occurred in 2014, have been an eye opener for many respondents regarding the effectiveness of mangroves in reducing its impact and help save countless life and property. The existence of mangroves at the coastal area acts as barrier and reflects part of the tsunami wave current backward to offshore have reduced the destructive impact [16]. Moreover, the unique roots structure some mangroves species as the *Rhizophora apiculata* that tangle with each other can bind sediments and trap leaves while limiting sediment exposure can play an important role as a natural engineer in the coastal area [17, 18].

The lowest mean score recorded by respondents were the importance of mangroves as cultural religious (1.54). Almost 88.3% of the respondents felt mangroves were less importance for cultural/religious purposes. This can be explained by the demographic of the respondents where the majority are Malays. They are considered as dominant ethnic group in the area and practice Islamic religion.

3.4 Activities that contribute to the loss of mangrove

From the survey, the respondents acknowledged that mangroves in the area have experienced changes where 95.7% of respondents felt that the changes have negative impacts to their community whereas the remaining 4.3% disagree with the above statement. Figure 3 shows the activities that contribute to the loss of mangroves from the respondents’ perspectives.
Figure 3: Activities That Contribute to the Loss of Mangroves According to the Respondents

The respondents perceived that illegal clearing is the main activity that has contributed to the loss of mangroves in the study area. Some respondents have expressed their concerns and felt that the authority should enforce the policy of mangrove conservation to avoid further resources depletion. According to [21], at the global scale, mangroves have lost more than 26% of their area because of over exploitation of timber. Aquaculture ranked the second highest with the mean score of 4.47. According to [22], the demands of aquaculture product has led to a total of 950.8 ha of MMR have been converted into aquaculture ponds. To cope with the entire aquaculture product such as shrimp, crab and fish due to the massive implementation of aquaculture activities in the Merbok area, another 25.19 ha of mangroves area was converted into office building and boat jetty for aquaculture product landing site. Poor management of aquaculture activity was regarded as the main factor to the loss of mangroves. Several previous studies indicated that the poor management of aquaculture in mangroves area has resulted in almost half of mangroves worldwide perished [21].

For the least activities that perceived by the respondents contributed to the loss of mangroves is the sea level rise (3.48) followed by the recreational vehicle used (2.52). For the former, 25% of the respondents thought that sea level rise has no impact to the mangrove sustainability. More than 50% disagree that the use of vehicle can harm the mangroves. For the respondents’ perspective, increases in vehicle to the mangroves means more tourists come to visit the mangrove area. This can be a good omen to the local as it will not only promote the mangroves as an idle place to take a vacation but also can be source of income generation.

3.5 Changes in mangroves resources

The respondents anticipated that the loss of mangroves due to above factors have a significant impact to the resources availability. Figure 4 presents the means score of perceived effect of changes in mangroves to forest resources and product according to the respondents.

The outcome from this analysis shows that fish, bivalve, crab and shrimp are among the resources from mangroves perceived by respondents as resources that decrease in the area. As discussed earlier, most of the respondents work as fishermen therefore they experience a decrease in catchment from time to time. During the field survey, several respondents indicated that fishing in MMR was getting more difficult as compared to ten years ago.
Several respondents that own a small shrimp paste business indicated that shrimps are becoming a problem to acquire this day due to the loss of mangroves in the area. Another factor that perceived by the respondents responsible for depletion of forests resources are due to rapid development in Sungai Petani town and Laguna Merbok town for human settlement, factories and many road constructions project. The development of these two big scale projects saw a reduction to mangroves area and therefore affects the resources in the area.

3.6 Management of Mangroves

According to the respondents, the management practice implemented in the study area is adequate enough to ensure the sustainability of the MMR. Majority of the respondents understand their reasonability and are committed and to protecting the mangroves. Figure 5 shows the best initiatives that need to be done to ensure the survival of mangroves ecosystem according to the respondents.

Majority of local communities respond that all the variables given were effective for the sustainability of mangroves in the area where all the mean scores are above 4.00. Among the variables, mangrove replanting was the most relevant strategies perceived by respondents in order to ensure the survival of mangrove in MMR (4.75).

The local communities regard replanting mangroves are crucial as an ecosystem services to provide erosion control, habitat for much marine life, source of income and protection against tsunami and storm. Since the tsunami incident, Malaysia also has initiated a program that was known as “Special National Force on Planting of Mangrove and Other Suitable Species in Coastal Areas”, where the purpose of this program are to formulate sustainable management strategies and identify coastal areas that require rehabilitation with mangroves [22, 23]. Since 2005, under this program, the Malaysian government with the help of local communities has already planted 6.6 million mangrove trees that covered almost 2887.63 ha along the coastal lines.

Increase the penalties for illegal activities in the mangroves is the second highest mean score (4.70) rated by the respondents. According to the respondents, the current fine given to the people that are operating illegal activities in the mangroves are too low and they will never learn from it. Some of the respondents recommended that the government must increase the fine so it could be a learning lesson for people in the community.
Two variables from this section share the level of importance in ensuring the sustainability of mangroves (4.63). These are to control the issuance of license approval for development/activities in or near the mangroves and an involvement of corporate association to secure sponsorship in CSR activities. Most of the respondents felt that by limiting the issuance of license approval will facilitate the authority task to monitor the access to the area.

The respondents felt that it also important for the private sectors to provide support of any conservation efforts via corporate social responsibility (CSR) activities and sponsorship. The involvement of the private sectors can be crucial as it not only show their commitment in ensuring the sustainability of mangroves, but also their involvement in the long term plan in adopting any rehabilitation programs by providing support either in cost and kind [24]. Furthermore, with financial support from this private sectors can be used to provide the local communities with the mangrove saplings for rehabilitation programs.

Variable number six in the list, i.e., encourage surrounding communities to participate in mangrove conservation ranked the lowest score 4.44 in this study. However, the participation of local communities in mangrove rehabilitation program has been practiced in many parts of the world as the knowledge and experience of local communities on mangroves can be advantageous for rehabilitation efforts. According to [26], it is wisely to incorporate local communities in every mangroves conservation efforts either for planning or implementing purpose as they can act as a gate keepers and agents that can adapt the national policy to local contexts through creating locally exclusive laws, customs and enforcement measures.
4. Conclusion
This study demonstrates the knowledge and awareness among the local communities toward trend and status of mangroves in MMR. From the study, it can be concluded that majority of the respondents worked as fishermen and benefited from the mangroves products and their ecosystem functions. Overall, the respondents aware regarding the mangrove ecosystem functions in the study area as indicated by the high mean score. The high mean score also recorded by respondents in the level of agreement for activities that contribute to the loss of mangrove in the study area. The high mean score produced in both cases are as a result from vast experience of the respondents live near the mangroves. With majority of respondents work as fishermen and have direct connection with mangroves, they agree that the resources in the area are declining from time to time. The current extent of mangrove areas are shrinking due to the illegal logging, aquaculture activities, agricultural activities and land development that occur in the area. Majority of the respondents strongly agree that the conservation efforts initiated by the government, private sectors and stakeholders may contribute to the survival of mangroves.

This study suggested that with proper knowledge regarding the mangroves not only can reduce the degradation of mangroves in MMR, but can also be crucial for the planning and management of these resources. It is hopeful that the findings from this study could provide inputs to the management and related authorities of MMR to pave the way to plan for an effective mangrove management strategy to conserve the mangrove ecosystems and biodiversity of MMR.

5. Acknowledgement
This study is funded by Research Acculturation Collaborative Effort (RACE) (RACE/F2/STWN2/UiTM/19) and Research Intensive Faculty (RIF) (600-RMI/DANA/5/3/RIF (391/2012). Authors also want to thank Universiti Teknologi Mara (UiTM) for supporting this study.

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