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National Mangrove Restoration Project in Malaysia

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Abstract

Mangrove forests are unique ecosystem in the world. The importance of mangrove forests in providing invaluable goods and services in economics, social and environmental terms are well understood. However, there is a trend that the mangrove forests were lost due to human activities such as direct conversion of mangroves to aquaculture, agriculture and urban land uses. In realizing the importance of mangrove and the threat towards mangrove forests, there is a need to restore and conserve mangrove areas. This paper highlights the overview, progress and challenges in the implementation of national mangrove restoration projects in Malaysia through "Tree Planting Program with Mangroves and Other Suitable Species Along National Coastlines", which has been implemented since 2005 and involved a strategic integrated approach. As of December 2015, a total area of about 2,605 hectares had been planted with more than 6.3 million trees. To ensure the sustainability and success of this project, a continuous financial support is needed to help in implementing and maintaining the existing restoration areas. Realizing that this project will enhance the livelihood and socioeconomic well-being of the local communities, the paper recommends that the areas involved in mangrove restoration project to be gazette as a Permanent Reserve Forest.

Keywords: mangrove forest, mangrove Malaysia, mangrove restoration project.

1. Introduction

Mangrove is one of the important and unique ecosystem in the world. It can be found in tropical and subtropical environments where the minimum sea surface temperatures are more than 16˚ C (Hamilton and Snedakar, 1984). It consists of plant communities that usually found among the lowest and the highest tide level, among the species are *Rhizopora sp*., *Sonneratia sp*., *Avicennia sp*. and *Brugiera sp*. Mangrove are inundated by the tides two times in a day and possess a range of features such as salt tolerant to adapt with stressful environment.

Mangrove ecosystems is significant economically and socially. Despite many benefits provided by mangrove for timber production such as charcoal, poles, fuel wood and other non-timber forest products, mangroves also very well known for their high biological productivity to provide many ecosystem services. Among others, to provide important habitat for the life cycle of flora and fauna including endangered species and migratory birds. Many aquatic lives such as fish, prawn, crustacean and micro fauna depend on mangrove areas for their breeding and spawning area. Most of the fish and shrimp catch are totally rely on mangrove forest. Local communities located in, or near, mangrove areas are depending heavily on mangrove forests for their daily used or commercial purposes. Mangrove resources can be as their economic resources through activities such as firewood collection, fishing, collection of timber and fuel wood, aquatic products for food, production of handicrafts and collection of medicinal herbs (Ong & Gong, 2013). Mangrove forests also play a vital role to sequestrate carbon and mitigate climate change. It is an important ecosystem for carbon reservoir known as carbon sinks and as an integral part of the global biological system. Findings from post-tsunami environmental assessment have shown that healthy ecosystems of mangrove forests survived better and had a greater protective role to be a vital buffer zone or barriers through preventing or at least reducing damages caused by tsunami and high tidal waves (FAO, 2007).

Considering the importance of mangrove ecosystem to the human beings as well as to the environment, the 38th Session of United Nations Educational, Scientific and Cultural Organization (UNESCO) which was held in November 2016 in Paris, proclaimed that 26 July every year is celebrated worldwide as the International Day for the Conservation of the Mangrove Ecosystem (UNESCO, 2016). Based on the findings of the protective function of mangrove forests from natural hazards such as tsunamis in the future and the critical need to conserve the mangrove ecosystem, the Government of Malaysia has initiated a national mangrove restoration project namely "Tree Planting Program with Mangroves and Other Suitable Species Along National Coastlines" in 2005. This paper is concerned with the overview, progress of the implementation as well as issues and challenges of

national mangrove restoration projects in Malaysia.

2. Mangrove in Malaysia

Malaysia retains a large tract of natural tropical forest which covers about 18.01 million ha or 54.5 percent of its total land area (NREa, 2014). The forest types in Malaysia range from montane and hill forest, hill dipterocarp forest, lowland dipterocarp forest, freshwater and peatlands and mangrove forests. Most of mangrove distributions in Peninsula Malaysia, located along the west coastline. Compared with the South China Sea, which next to the east coast of the Peninsula, the west coastline in the Straits of Malacca is relatively calm seas due to the sheltering effect from the island of Sumatra. Therefore, rivers that flow and release into the Straits of Malacca consists of fine silt and clay, and forms the alluvial plains from the deposited mud along the coast. This mud gives the necessary substrate to the mangrove species to grow in the area. While, the mangrove distributions are generally small along the east coast, which facing the South China Sea. The mangroves only covered the river mouth and extend from 0.5 to 1 km inland. In Sarawak, mangrove forests, mostly found at the river mouths of the Rajang, Sarawak and Trusan-Lawas Rivers, while in Sabah, they largely dominate on its east coast facing the Sulu and Sulawesi Seas (Chong, 2006).

In Malaysia, mangrove vegetation covers an area of about 537,686 ha, whereby Sabah and Sarawak make up to 78 percent of the country's mangroves. Sabah has the most extensive coverage of mangrove area, accounting for 61.6 percent or 331,325 ha of the country's total, whereas, Sarawak has 88,575 ha (16.5 percent) and Peninsular Malaysia 117,786 ha (21.9 percent) (NREb, 2016). Table 1 show the mangrove forest areas by state in Malaysia.

Table 1: Mangrove forest areas by state in Malaysia

State	Mangrove forest (ha)	Area gazette as permanent reserve forest/protected area (ha)
Johor	32,301	31,915
Kedah	11,729	6,201
Kelantan	744	-
Melaka	136	136
Negeri Sembilan	101	101
Pahang	2,416	2,416
Pulau Pinang	1,045	1,045
Perak	43,669	42,232
Perlis	10	-
Selangor	23,648	18,998
Terengganu	1,987	1,037
Sabah	331,325	280,002
Sarawak	88,575	25,400
Total	**537,686**	**409,483**

Source: NRE, 2016

The data from the Food, Agriculture Organization (FAO) reported that about 3.56 million ha of the mangroves in the world was lost between 1980 and 2005, where the annual rate is about 142,000 ha per year. The main factor of the decreasing of the mangrove forest is due to human actions, which include direct conversion or reclamation of mangroves to aquaculture, agriculture and urban land uses (FAO, 2010). A similar trend also happening in Malaysia and estimated that the annual mangrove least in some major states in Peninsula Malaysia is about 1,282 ha or about 1% a year since 1990 (Hamdan et al., 2010). Some of the main factors contributing to the mangrove loss include direct conversion to aquaculture, agriculture land, urbanization, infrastructure development and natural cause mainly from coastal erosion. However, most of the loss due to land conversion is occurring in the state land forests. While, the mangrove areas in the Permanent Reserve Forests which are being managed based on Sustainable Forest Management practices are relatively safe from being converted to other land uses.

The tsunami on 26 December 2004 in Acheh, Sumatera Island, Indonesia affected not only Indonesia, but also countries around the Indian Ocean, including Bangladesh, India, Malaysia, Myanmar, Thailand and Sri Lanka. Despite of 68 people reported dead in Malaysia during this severe tsunami which affected the west part of Peninsular Malaysia, the communities, especially the fishing villages and squatter settlement also suffered high casualties and costly destruction of the tsunami. The estimated total economic lost in Penang State are MYR33.91 million from the fisheries and tourism sector (Khor & Lim, 2005). It has been reported in several

studies and assessment reports of the affected tsunami areas (e.g. Danielsen et. al., 2005 and Kathiresan & Rajendran., 2005) that coastal areas which had dense with mangrove forests or other coastal forests can reduce the high waves of natural hazard such as tsunamis or suffered fewer human losses and less damage to property.

2. Mangrove in Malaysia

The Tree Planting Program with Mangroves and Other Suitable Species Along National Coastlines has been started in 2005 until now. The decision to implement this project within the country were made during the Second National Biodiversity and Biotechnology Council Meeting and the Meeting of the Chief Ministers of Malaysia chaired by Prime Minister on 13 January 2005 (NREd, 2010).

2.1 Objectives of Project

This national project is not only focusing on planting activities in the tsunami affected areas, but also extended to other states in Malaysia with the ultimate aims to conserve and rehabilitate the designated affected coastline areas. In particular, the objectives of this project are to restore coastal forest ecosystem through integrated approaches along the coastline for effective defence mechanism, stabilization of the coastal area and creation of an ecological corridor for biodiversity conservation, and to provide significant benefits to socioeconomic and protecting coastline communities (NREc, 2014).

2.2 Institutional arrangement and modalities

The implementation of this project has led by the Ministry of Natural Resources and Environment Malaysia (NRE) and has involved multi stakeholders comprising of federal and state governments, technical agencies, research and institutions of higher learning, Non-Governmental organizations (NGOs) as well as civil and local communities. To achieve the objectives of the project, the National Task Force Committee was set up at the federal level chaired by Secretary General of Ministry of Natural Resources and Environment, to monitor the progress of the projects and assist in the financial allocation for the implementation of the projects. The members of the National Task Force Committee are consisting of relevant ministries and agencies such as Economic Planning Unit, Department of Prime Minister Office, Ministry of Finance, Ministry of Agriculture and Agro-Based Industry, Ministry of Tourism, Department of Irrigation and Drainage, National Hydraulic Research Institute Malaysia, Remote Sensing Agency, Department of Fisheries, State Planning Unit, State Forestry Department, universities and institutions of higher learning and NGOs.

Under the National Task Force Committee, three technical committees were formed, namely the Technical Committee on Planning and Implementation chaired by the Director General of Forestry Department Peninsular Malaysia, Technical Committee on Research and Development, chaired by the Director General of Forest Research Institute Malaysia and Technical Committee on Monitoring chaired by Undersecretary of Biodiversity and Forestry Management Division, NRE. These technical committees had their specific tasks to implement and monitor, to undertake research and development, and to evaluate the implementation of the planting projects along the coastal area.

From 2005 until 2015, the Government of Malaysia had allocated MYR45.3 million to implement this project, which covered planting of the mangrove and other suitable species, research and development as well as capacity building and promotion (FDPM, 2016). The funding allocated through development expenditure under Malaysia Plan, from the Ninth Malaysia Plan, Tenth Malaysia Plan and Eleventh Malaysia Plan. Despite of the funding from federal government, the state governments also use their own budget to implement this national project.

2.3 Planning and Planting Activities

One of the main objectives of this national project is to restore coastal forest ecosystem with mangrove and non-mangrove species. The Forestry Department Peninsular Malaysia, who lead the Technical Committee on Planning and Implementation is responsible for planning, identify the area to be restored or rehabilitated and monitor the progress of the project on the field level.

The selection of suitable area is one of the most important aspect to ensure the sustainability of the project. According to the National Land Code of Malaysia, the land status in Malaysia can be classified into three categories, namely Federal Land which is belonging to the Federal Government, State Land which is belong to the state government and Alienated land which is belong to private or individual. The most priority areas are the coastal area which situated near to the settlement area. If the selected area is under the State Land or Alienated Land, the forestry department will engage the land authorities before proceeding with the planting. After having clearance in the selected area, the site preparation will be conducted based on the condition of the area, whether

low risk or high risk which depend on the seriousness of the coastal erosion (NREc, 2010). An area with low risk will be planted using conventional methods, while the risk area will be further evaluated by the Research and Development Committee.

The species selection will be based on the pioneer or local species of the area, in order to maintain the diversity of the ecosystem and to reduce the mortality rate of the planting trees. There are two categories of tree species that allow to be planted under this project, namely mangrove tree species or non-mangrove tree species, among others, *Rhizophora apiculata*, *R. mucronata, Avicennia spp*., *Xylocarpus spp*., *Sonneratia spp.*, *Nypa fruticans*, *Casuarina equisetifolia*, *Callophyllum inophyllum*, *Fragrae fagrans* and *Syzygium grande* (Abdul Rahman, 2016). Table 2 shows the cumulative planting trees by species from 2005 until 2015.

Table 2: Cumulative Planting Trees by Species (2005-2015)

Year/ species	Mangrove		Casuarina sp.		Other species		Total	
	Hectare	No. of trees	Hectare	No. of trees	Hectare	No. of trees	Hectare	No. of trees
2005	152.20	468,750	37.10	9,052	0	0	189.30	477,802
2006	91.49	525,354	21.96	13,665	0	0	113.45	539,019
2007	342.10	1,000,120	53.54	34,933	7.55	15,970	403.19	1,051,023
2008	523.43	1,400,757	72.98	53,282	23.90	53,081	620.31	1,507,120
2009	371.23	1,183,474	89.96	81,307	65.68	92,652	526.87	1,357,433
2010	339.95	877,221	72.72	40,824	16.19	12,950	428.86	930,995
2011	72.00	191,063	8.28	4,640	5.00	2,500	85.28	198,203
2012	42.31	49,281	9.78	4,720	0.52	325	52.61	54,326
2013	42.00	45,345	22.17	12,270	4.43	11,314	68.60	68,929
2014	33.50	54,023	14.30	10,173	11.50	8,232	59.30	72,428
2015	28.20	43,430	19.20	12,332	10.00	10,888	57.40	66,650
Total	2038.41	5,838,818	421.99	277,198	144.77	207,912	2,605.17	6,323,928

Source: FDPM, 2016

A total area of about 2,605 hectares had been planted with more than 6.3 million trees under this project throughout the country. The mortality rate of the planted tree is depended on the area and the silvicultural activities. Thus, the forestry department will monitor the growth of the tree, conduct routine silvicultural activities and monitor from the encroachment or vandalism from wildlife (eg. Macaca fascicularis) or human being, especially during the early stage of the planting.

Most of the area which has been restored since 2005 has now created a conducive ecosystem as a new coastal forest and the planted tree has become a mother tree, which can produce wild seedling for another generation. The assessment of the planted areas under this project was done in 2013, which covered the planted areas under this national project from 2005 until 2012. Among others, the summary of the assessment is (i) 78% planted areas has been stabilized and could be functioning as a natural protector while 22% planted areas expected to be stabilized in a period of 2 or 3 years; (ii) 28 the area planted with mangroves and 6 area planted with Casuarina sp. and other non-mangrove species have established as a buffer zone with a total length of more than 100 meters; (iii) 409 area has been conserved as a corridor for biological diversity; (iv) 6 areas has been rehabilitated, enhanced its quality of environment and esthetic value and has become as a recreation and ecotourism area (NREc, 2014). The full report entitled “Outcome Report Assessment on Tree Planting Program with Mangroves and Other Suitable Species Along National Coastlines” has been published in Malay language in 2014.

In order to monitor the progress and to enhance the management of this national project, The National Coastal Information Management System (e-PESISIR), a web-based Geographical Information System (GIS) based on the use of remote sensing, GIS and ICT technologies was developed. system “e-PESISIR” has been established. This system is using remote sensing technology with the cooperation of the Malaysian Remote Sensing Agency. The project, which was first implemented in 2012, aims to assist Forestry Department Peninsular Malaysia and the State Forestry Department in planning, implementing and monitoring the restoration activities under this project and conservation of the coastal forests throughout the country. The system serves as a database that records, stores and provides integrated information including high resolution and up-to-date satellite images to facilitate the procurement process of information required in the planning, implementation and monitoring of coastal conservation and conservation activities (http://fmrs.remotesensing.gov.my/pesisir). The concept and information of this system development is to assist in updating the mapping data on coastal stability based on the recovery rate of the tree species, the restoration of the restored coastal area and the buffer zone, the width of the

coastal area. This system helps the forest manager and researcher, especially for the forestry department to gather and record the information comprehensively and systematically.

2.4 Research and Development Activities

Research and development is one of important component for this national project. Thus, the Technical Committee of Research and Development was established and led by Forest Research Institute Malaysia. All related departments and research institution, including universities, are the members of this committee. Among others, the committee has the tasks to identify the scope of research and development activities, monitor the implementation of research and development activities, give technical advice to the Planning and Implementation Committee and Task Force Committee as well as coordinate and disseminate research related to this national project.

The main research and development component under the research and development committee can be divided into four components, namely (i) Producing planting materials, (ii) Innovative planting technique, (iii) Pest and disease control, and (iv) Assessment of the planted area. In addition, the research and development committee also involve in the assessment of the proposed planting area by the Planning and Implementation committee, particularly to assess the risk of the area from erosion, high tidal wave, etc., to know the suitable species with the type of soil, and the suitable planting technique whether using conventional method or innovative planting technique (NREd, 2010). The assessment before planting is important to ensure the trees planted growth well. The report of the assessment of the research and development committee will be used as a guidance for the state forestry department to undertake the planting in that area.

There are more than 30 research related to mangrove and non-mangroves species were undertaken under this national project since 2005. One of the significant achievement of research and development committee is the innovative planting technique which can help to plant mangrove species in the severe erosion areas. There are two innovative techniques, namely Comp-Pillow and Comp-Matt technique. Both techniques were successfully tested in the research and development plot area in Sg. Dorani, Selangor (Raja Barizan & Shamsudin, 2012). This area is some high severe erosion areas and the plot also was implanted with geo-tube, a soft structure which has specifically designed to reduce the high wave in that area. Furthermore, other research activities are hydraulic studies in some areas by using a hydrodynamic model to know the suitable parameter of wave for mangrove planting area, carbon stock assessment in mangrove area, regeneration study and establishment index, assessment of fire prone areas of plants coastal forest (non-mangrove species), macro-fauna and bird species in the plants mangrove area and socioeconomic study in some areas. The detail of each research can be referred in separate published materials.

2.4 Promotion and Awareness Program

One of the most important components in this national project is the promotion and awareness program. These activities have been done by all the technical committees (Technical Committee on Planning and Implementation, Technical Committee of Research and Development and Technical Committee on Monitoring), particularly by NGOs. As of 2016, eleven NGOs and local community organizations have been involved actively, namely Global Environment Centre, Malaysian Nature Society, Wetlands International, World Wide Fund for Nature, Mangrove Research and Conservation Unit, Institut Rimbawan Malaysia, Sahabat Alam Malaysia, Malaysian Inshore Fisherman Action Network, Pertubuhan Muafakat Warga Desa Negeri Kedah and Penang Inshore Fisherman Welfare Association. These NGOs, local community organizations also received a small grant under this project, based on a yearly proposal to implement their activities.

The NGOs and local community organizations play an important role to create awareness among the local communities and students from school and higher learning institution through activities such as talk, awareness campaign, exhibition, planting trees, hands-on training and distribute flyers and kit about the importance of mangrove and other coastal forest. The involvement of NGOs and local community organizations are significant to this national project because they are based on the focus area, so that they are close and have better communication with local communities.

Despite of the awareness program organize by the NGOs and local community organizations, Forestry Department Peninsular Malaysia and Forest Research Institute Malaysia also publish an annual report on this program, seminar proceedings, guides and reference books, as well as posters. Among others, the publications are project's annual report, national seminar's proceedings, Guideline for Mangrove Planting in Malaysia, Guideline for Casuarina sp. Planting in Malaysia, Outcome Report Assessment on Tree Planting Program with Mangroves and Other Suitable Species Along National Coastlines, User Manual for e-PESISIR, Pest of Planted Mangroves in Peninsula Malaysia, Guideline for Innovative Planting Technique, Soil Assessment and Area

Monitoring, Coastal Plants: Phenology and Seedling Preparation and Muddy Substrates of Malaysian Coasts. In addition, NRE has also published a short animation video on this national program and importance of the mangrove conservation which has been aired on the national television.

2.5 Issues and Challenges

Malaysia has no experience and expertise at the beginning of project and implemented in its own way, more to the trial and error process. Overall, this project has succeeded particularly in raising public awareness on the importance of conserving mangrove forest ecosystems. However, there are some issues and challenges during the implementation of this project. Among others, the issues and challenges are, the threat of waves, strong winds and erosion that occurs naturally. This problem has affected many areas of mangrove forest, including planted areas under the project. Amongst the precautionary measures that can be taken is through the construction of wave breaking structures in high-risk areas experiencing a strong wave and erosion problems. However, the construction of the wave breaking structure such as Geo-tube, pillow-tube are very costly (Abdul Rahman, 2016). In addition, planting areas are often vulnerable to the threat of disease and pest infestation. Hence, further studies need to be done because different areas require different approaches. Among the challenges faced is the conversion of land use, especially the planted areas within state land into agriculture, aquaculture, and other land use. This problem will reduce the number of planted area especially the succeed areas which has established a new mangrove ecosystem.

There is leakage in terms of optimizing the expertise available among agencies, NGOs and universities involved in the mangrove planting program. In this regard, research and development activities need to be intensified through an integrated approach through the involvement of various research and development disciplines that are compatible with unique, challenging, fragile and dynamic coastal zone conditions. Moreover, evaluation of quantitative outcome measurement is a critical factor to assess the impact of program implementation based on the objectives set. There are weaknesses in the enforcement and monitoring aspects of program implementation where there are still issues, among others, vandalism and mangrove theft. Therefore, a management plan and enforcement of the coastal forests should be established to be a module and guidance for the restoration and conservation efforts of the mangroves. A more extensive and effective awareness campaign needs to be made so that information about the importance of restoration and conservation of the country's coastal zone reaches the target group. Besides, to ensure the sustainability and success of this project, there must be a continuous financial support to help in implementing and maintaining the existing restoration areas. Thus, there is a need to explore the probability of finding other financial resources and additional funds for continuously implement the project, among others, through levy funds and cooperation with local and international organizations.

3. Conclusion

The implementation of national mangrove restoration project in Malaysia has now 11 years. This project has been implemented through the adoption of a multidisciplinary and integrated approaches involving federal and state governments, research institutions, NGOs and local communities. The implementation of this project has resulted in the development of an integrated management, enhanced research and development findings on conservation, particularly in mangrove and coastal forest ecosystem as well as restoration towards sustainable forest management. In the long term, this project will enhance the livelihood and socioeconomic well-being of the local communities, as well as establishment of the continuous buffer zone along the coastline. The restoration project of the coastal ecosystem will enable the country to address the issues of depletion and degradation of the mangroves and coastal areas and finally increase the capacity in mitigating climate change. This project also parallels with Malaysia’s commitment to ensure that at least 50% of its land area is under forest and tree cover as pledged during the Rio Convention in 1992. Through this commitment, Malaysia has come up with strategies to achieve this through various ways that include sustainable forest management practices and restoration of degraded areas including coastal mangrove forests. In order to ensure the sustainability of the project areas, it is suggested that the areas involved in mangrove restoration project to be conserved and gazette as a Permanent Reserve Forest.

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