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Assessing conservation efforts of mangrove forest in Delta Tumpat Kelantan

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Abstract. Mangrove forest hosts a variety of biodiversity and offers a great coastal ecosystem function. Despite the importance of mangrove ecosystems, they are being destroyed more quickly than all other types of forests around the world for development as predicted in many studies. The loss of mangrove areas due to aquaculture activities, rural settlements, and sediment accretion had caused the Delta Tumpat Mangrove Forest (DTMF), Kelantan in a dangerous state. Due to this alarming situation, many conservation efforts have been taken by both government and private agencies. This paper explores the impact of mangrove conservation efforts of DTMF from 2000 to 2019. Based on evaluation on the two decades data, more than 100,000 mangrove trees were planted within 31 officially recorded programs with a planting average of 3861 trees per program. *Rhizophora apiculata* and *Rhizophora mucronata* are the main species planted in the 42 ha of the area including small islands at DTMF. The conservation initiative and tree planting program have mainly gauged the Kelantan Forestry Department's work in partnership with other agencies as well as the involvement of the communities. Further research on human socioeconomic concerns on conservation priorities can help to ensure the long-term sustainability of mangrove forests in the future.

1. Introduction

Mangrove deforestation is occurring at the highest of any forest type. The majority factor of mangrove loss is due to human development [1,2]. As the human population expands, there is less space for mangroves to thrive. Thus, climate change impacts, such as storms and rapid sea-level rise, are also factors that lead to the reduction of mangrove forests [3,4]. However, there are still spaces and opportunities to take care of our mangroves so that it will continue to offer many benefits for humans, especially in disaster risk reduction and climate adaptation.

Following the effects of the tsunami disaster in December 2004, the Malaysian Government is committed to implementing efforts to preserve and conserve the coastal shoreline. Therefore, a Mangrove Tree Planting Program (MTPP) was initiated to ensure that the country's coastline is overgrown with mangrove forests that serve as wave breakers and minimize the devastating effects of the tsunami disaster [5]. This program is in line with the 4th thrust of the National agenda which is to ensure the quality of life in Malaysia can be continuously improved through sustainable economic development by more strongly integrating aspects of environmental protection and conservation of natural resources. Not only tree planting programs, other initiatives such as cleaning the beach near mangrove forests, environmental conservation-related programs, and love nature activities were also carried out in this area. Using Delta



Tumpat as the case study, we examined the mangrove conservation efforts that have been carried out between 2000 to 2019.

2. Material and Method

Delta Tumpat Mangrove Forest (DTMF) is located at a latitude and longitude of 6.197305N and 102.168938E, respectively. This area is one of the selected areas for the MTTP in Kelantan. The greening and tree planting activities are the long-term national programs aimed to ensure the coastal shoreline functions as a stable natural protection area, prevent the destruction caused by soil erosion, wave, and strong winds, and providing the place and habitat for conservation and biodiversity as well as a strong and stable buffer zone areas. During the planting program, the number of trees planted and the area covered are recorded by the Kelantan Forestry Department. Based on this data and other secondary sources including annual reports, published statistics, and newspaper stories, the frequency analysis and descriptive statistics we calculated and interpreted. These data were collected from agency offices and online websites.

3. Results and Discussion

The assessment of mangrove tree planting initiatives for 20 years showed that a total of 119,676 mangrove trees were planted within 31 officially recorded programs with a planting average of 3861 trees per program (Figure 1). *Rhizophora apiculata* and *Rhizophora mucronata* are the main species planted in the 42 ha of the area, including small islands at DTMF. On average, one or two tree-planting programs were initiated annually. The conservation initiative and tree planting programs are mainly executed by the Kelantan Forestry Department and work in partnership with other agencies, educational institutions, and private companies as well as the involvement of the communities.

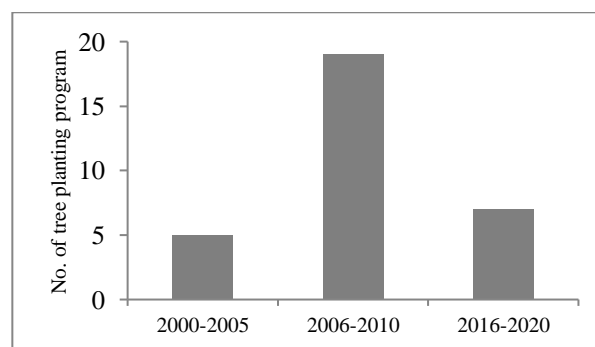


Figure 1. The number of mangrove tree planting programs in Delta Tumpat, Kelantan

Figure 2 presents one of the examples of MTTP in DTMF. Meanwhile, the details of 31 completed mangrove tree planting programs are shown in Table 1. The mean area of each MTTP is 1.35 ha. Pulau Kambing and Pulau Layang-layang recorded the highest number of trees planted within 10 ha and 20 ha of area respectively. In a previous study [2], the growth performance and tree canopy development of planted mangrove species in Kelantan are about 80% compared to Selangor with less than 49%. Studies conducted in the DTMF recorded a high percentage of life expectancy rates and canopy cover was due to the existence of stable mudflats and the area is protected from erosion and waves [5].



Figure 2. The example of mangrove tree planting program executed by Kelantan Forestry Department collaboration with Malaysia Airport Berhad

Table 1. The location, area, and numbers of mangrove trees planted in Delta Tumpat

Location	Area (ha)	Total tree planted	Initiative
Pulau Mas	2.0	5000	1
Pulau Tujuh	4.3	7610	3
Pulau Bedal	4.7	19098	11
Pulau Layang-layang	10.0	25000	2
Pulau Kambing	21.0	62978	14

In reports by [5], the carbon stock assessment for mangrove species was also calculated based on the secondary data collected from the State Forestry Department's census. The record captures only trees with a diameter size (DBH) of > 5 cm. Pulau Kambing presents the highest carbon stock value for mangrove species at 83.35 tC/ha and the highest carbon sequestration rate at 9.26 tC/ha/year. Besides planting trees, there are also efforts to monitor the mortality of mangrove trees. In the first and second years after planting, the number of survival trees is surveyed and recorded. From this data, the estimation of saplings for the next planting program will determine based on location, area, and surrounding environment. The mangrove conservation effort in Delta Tumpat is one of the success stories for mangrove conservation as reported in [5]. Figure 3a and Figure 3b showed the growth changes of mangrove trees planted in Pulau Bedal. It was planted in 2008 and revisited in 2017 to evaluate the growth performance of planted trees.

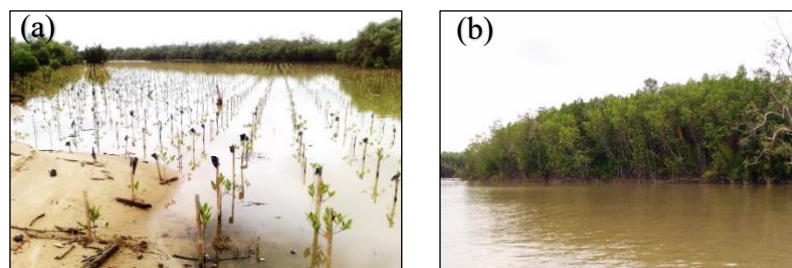


Figure 3. a) mangrove tree planting programs in 2008 and b) the mangrove trees after nine years of planting

The implementation of the MTPP in Tumpat has mobilised the energy and expertise of all parties and it gave benefits to many target groups such as the coastal population, local and state governments as well as civil community. The conservation of coastal areas through this program has tremendous benefits and had helped to increase the area of green space and create protective buffers around beaches and coastlines.

Hence, it also helps in the restoration of marine resources and benefits the socio-economic welfare of fishermen around the Delta Tumpat [6,7,8]. Meanwhile, the restored mangrove area has the potential to be enjoyed by residents and tourists alike as a recreational area. For the local government, the rehabilitated areas will provide a new source of income and revenue for the state and country.

4. Conclusion

The result of this study can highlight the importance of mangrove conservation in Delta Tumpat Mangrove Forest through tree planting initiatives. The conservation efforts carried out by diverse agencies from 2000 to 2019 should be appreciated and this is expected to be in the mainstream of conservation efforts in Malaysia's coastal forests in time front. It is hoped that these kinds of conservation activities will continue in the future and the outcome of this program will be more significant to the well-being of society and environmental stability.

Acknowledgment

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