Journal of Tropical Resources and Sustainable Science

journal homepage: jtrss.org

Impact of Flood on Dynamics of *Mimosa pigra* Populations in Affected Kelantan River Basin

Muhammad Zharif Jasni, Noor Janatun Naim Jemali, Syafinie Abdul Majid*

Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, Jeli, Kelantan, Malaysia

Received 10 April 2017
Accepted 6 June 2017
Online 16 November 2017

Keywords:
Flood, Kelantan River Basin, *Mimosa pigra*.

☒*Corresponding author:
Syafinie Abdul Majid
Faculty of Earth Science,
Universiti Malaysia Kelantan, Jeli,
Kelantan, Malaysia.
Email: syafinie.am@umk.edu.my

Abstract

Kelantan is one of the east coast states of Malaysia, which has faced yearly flooding catastrophe especially during north-east-monsoon season. Most of the land use from upstream to downstream of Kelantan River Basin was affected after December 2014 when the worst flood was recorded for decades. Due to the immense flood, *Mimosa pigra* is spreading forming dense thickets belt along the riparian vegetation area. It has transformed the river water regime. *M. pigra* is identified as the worst invasive species in Malaysia and caused massive threat to riverine ecosystem. It's considered to be a colonizer of mainly wetland and seasonally flooded areas. The dispersal process by which this rapid colonization was achieved has yet to be fully documented. The study was done in three sampling areas along Kelantan river basin (upstream, downstream, outfall) focusing on the distribution of *M. pigra* after the recent flood. Based on Landsat TM image classification analysis and ground thruting, result showed 60% (upstream), 40% (downstream) and 70% (outfall) of accuracy assessment respectively. For each of the 30 sampled point (a 7.5m radius circle), *M. pigra* has covered an average of 23.04% of the area with a total of 2,309.58 m^2/ha.

1. Introduction

Mimosa pigra has been a major problem of invasive species in Malaysia which had caused many downsides to the ecosystem and biodiversity. During the end of year 2014 flooding, vast areas within the Kelantan River Basin system were severely affected due to the extensive widespread of the flooding. Most of the riparian vegetation along the riverbank also affected and did not thrive. Whereas, the population of noxious species such as *M. pigra* had colonized most part of the riparian zone. The chances of being dispersed by high rapid current are very high which lead to even greater increase of the plant's population. There are few studies (Onrizal et al., 2017; Mansor & Crawley, 2011) related to the species regarding its distribution along the Kelantan river basin. However, how large is the dispersal area by which this rapid colonization achieved has yet to be fully documented. Thus, these leads to the uncertainty of the current distribution which will help manage to help with the river basin hydrological system.

This study aims to analyse the distribution of the species as one of the ecological assessment in order to help with the flood mitigation processes. Furthermore, the data can be used in forecasting on the future growth of the invasive species which can help in preventing further spread. Information gathered also can help in spotting the exact location of the invasive species in the future as the research provides the coordinate of the *M. pigra* along the Kelantan River Basin.

The recent flood in the year 2014 had caused the seeds of invasive *M. pigra* to disperse along the Kelantan river basin which increase its spread in Kelantan. It is still uncertain about the fact regarding the latest distribution of *M. pigra* after the flood as there is little information that can be found. Above and beyond, it is still unclear about the estimated area invaded by the plant after the flood along the Kelantan river basin as the flood will definitely alters its population. If the invasive plant is left unstudied and spreading, there will be many problems that will occur as the plant invades a place. The prickly mimosoid may interrupt the biodiversity and ecosystem of a habitat and cause high competition in obtaining the basic necessities. Some agricultural activities may also be affected by this plant such as paddy field as some of the irrigation methods use water from the river which is one of the best dispersal methods of *M. pigra* as the invasive plant grows easily, the agricultural site definitely decreases the crop yield.

eISSN Number: 2462-2389

M. pigra was found in Peninsular Malaysia in 1980 which was recorded and surveyed by Department of Agriculture (DOA) (Mansor & Crawley, 2011). Initially, the plant was originated from tropical South America and it was brought to other parts of the world to be used as green manure and cover crops (Mohd Shariff & Abu Bakar, 2006). The spread of *M. pigra* in Malaysia had caused problems including to the life of Native People as it creates problems in food collection from the forest (Karim & Mansor, 2013). It also affects the tourism sector in Malaysia as it limits and reduces the tourism activities (Karim & Mansor, 2013). The problem worsened when the recent flood had caused the seed to spread widely. It will most likely to survive as it didn't need any specific condition to grow.

Paddy field in Kelantan is one of the major cultivation sites which depend on the river for irrigation. It is somehow helps carry the seeds to the site through the irrigation system. Generally, there are four major irrigation schemes that use the water of Kelantan's river which are Kemubu, Salor, Lemal and Pasir Mas. Each location is located in the lower reaches of the Kelantan's river and there are about 31,000 ha of irrigable area for these schemes (Ibbitt et al., 2002). This explains the immense distribution of *M. pigra* in those crops growing site. The spread is rarely noticed in the early stage when it still has low number of populations (Solsky et al., 2006).

The control of invasions is usually targeted when the plants are already extensive and becoming one of the ecosystem components. Generally, most favourable management approach and success measure become difficult as there are almost no baseline data from plant surveys which cause complexity in quantifying the population changes as a result of invasion. In this case, the use of Geographic Information System (GIS) is important in gaining the geo-referenced maps to assist related agencies in monitoring and managing resources as it provide lower cost and risk as well as giving reliable result. However, there are only few and recent studies which considered spatial distribution of exotic, invasive plant species by using GIS as a way of analysis (Murray, 2009) especially in Kelantan. This study is done to provide reliable data and beat the purpose.

2. Materials and Methods

The study sites were located along the riverbanks and floodplains of Kelantan's river which covers Tanah Merah (downstream), Dabong (upstream), and Kota Bharu (outfall) (Figure 1). In each sample area, 10 random sampling points were taken to estimate the percentage distribution of *M. pigra* in the area. Landsat Thematic Mapper (TM) satellite images were analysed using ENVI 4.5, Erdas IMAGINE and ArcGIS 10.2 to obtain high information data. Two different satellite images were used. One is taken on 11th May 2014 (before flood) and the second image was on 28th April 2015 (after flood).

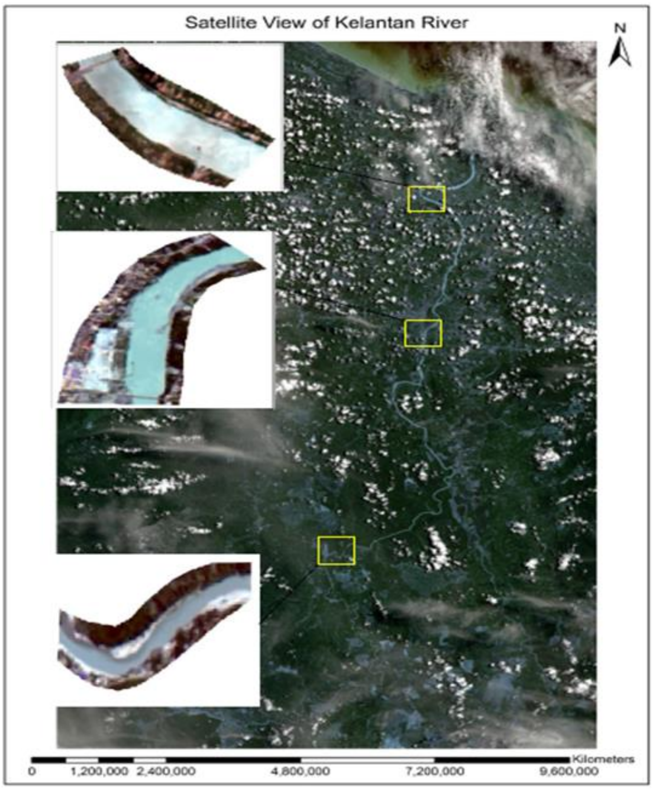

Figure 1: Study area (28th April 2015)

Both images come in raster type as to observe the actual view of the site in each study area and possessed 15 x 15 m resolution. The columns and rows for the image from the year 2014 was 10,266 and 12,849 respectively while for the year 2015, the value was 15,220 and 15,574 respectively. Both images were formatted in IMAGINE image and their source type were generic with the pixel depth of 16 bit. Each image was set to Kertau (RSO) spatial reference to align with the coordinates used from Global Positioning System (GPS).

Each image was classified using supervised classification into four categories which are water body, open area, dense vegetative and less dense vegetative classes. In each sample point tagged with GPS coordinate.A 7.5 m radius circle was established to estimate the distribution of *M. pigra* in each site. Percentage of *M. pigra* in each sampled area was determined using percentage abundance estimation chart by Terry and Chilingar (1955) (Figure 2).

eISSN Number: 2462-2389

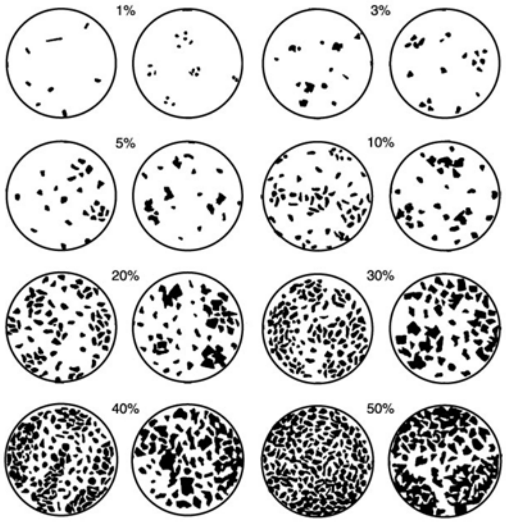

Figure 2: Percentage abundance estimation chart (Terry & Chilingar, 1995)

3. Results and Discussion

The supervised classification images (Figure 3) show a definite change on the vegetation in each area targeted. The less dense vegetation area in Kota Bharu decreases while the dense vegetation increases considerably after the flood. Meanwhile in Tanah Merah and Dabong area, there is an increment of open area and decrease of vegetative area.

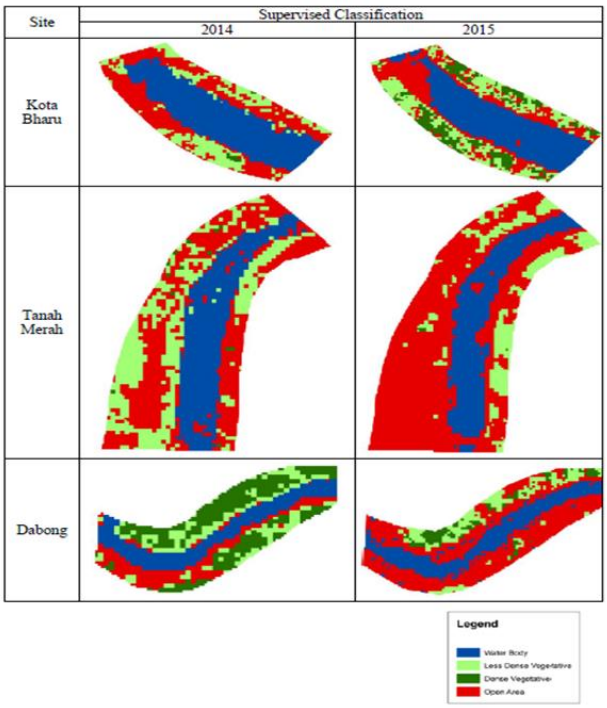

Figure 3: Supervised classification

3.1. Comparative Adsorption

3.2.1. Ground Truthing

Less dense vegetative class was assumed to have a high potential population of *M. pigra*. A total of 30 sample points were chosen randomly for ground truthing work. This method aids in the interpretation and analysis of what is being sensed. In addition, confusion matrix was also calculated to access the accuracy of analysed image. Table 1 shows the result of the accuracy assessment for image classification in the respective study site.

Table 1: Accuracy assessment for image classification in three study sites

Site		Accuracy (%)
Outfall	Kota Bharu	70
Downstream	Tanah Merah	40
Upstream	Dabong	60

Outfall and upstream site gave a high accuracy which is 70% and 60% respectively. This might due to the location targeted is more accessible to the downstream site which only gives 40% of accuracy. Moreover, data misinterpretation can also contribute to a lower percentage of accuracy.

Half of the sampling areas in Kota Bharu (outfall) showed the availability of *M. pigra*. The average percentage of the availability of this species is 31% which consist of every 274 m² in area. This situation showed that there were moderate growth activities of this plant in the area after the flood. Meanwhile, in Tanah Merah (downstream) area, it was available in eight out of 10 sampling points (80%). The average availability was 23% with an area of 327m² which is lower than in Kota Bharu. This is maybe particularly due to other competitors such as *Acacia spp.* or *Imperata cylindrica* (Cogongrass) which are also an invasive species.

Furthermore, there is a lot of flood debris such as sediment load, mud, tree trunk, logs, houses and building material which were carried from the upstream then discarded in most of the area in Tanah Merah as the downstream site. Most of this flood debris still remaining at the location even though the flood event has already passed for many months. Thus, *M. pigra* seed cannot penetrate the soil and grow well.

In Dabong site, there are five sampling points which have *M. pigra*. The average percentage of it is 15% which covers 132.53 m² of the area and become the lowest among the other study sites. This event occurred as the result of high competition with other species living in the same area. Dabong is located in a very high vegetative area which consisted of many different species. Each species has its own unique survival abilities and competes with each other to maintain their population in the area but this plant cannot compete with other species which are dominant in that area, thus resulting in low availability of the plant. Table 2 shows the coverage area dominated by *M. pigra* in all sampling point.

eISSN Number: 2462-2389

Table 2: Area dominated by *Mimosa pigra* L. at the study areas based on 10 sampling points at each site

Site	Coverage (%)	Total Area (m^2)
Kota Bharu	31.00	273.90
Tanah Merah	23.13	326.91
Dabong	15.00	132.53
Average	23.04	73.35

This finding has supported with research by Karim & Mansor (2013), Binggeli (2005) and Indira (2007) which stated that there is a high availability of *M. pigra* population along the floodplain and riverbanks. This species is most likely can be found in the open area and less dense vegetative area.

According to the supervised classification image analysis, it resulted that the less dense vegetative area decreased in each study site. The decline of less dense vegetative area in Kota Bharu, Tanah Merah and Dabong were 94.763, 686.800 and 32.237 km^2 respectively. The decline is expected due to the enlargement of open area and high competition with other species. It is also expected that other vegetation are still in the state of recovery process from the flood which require more time to obtain the optimum population. Yanosky (1982) stated that the survival of woody plants near the streams or rivers is not depended only on flood frequency and duration alone but also depends on the channel characteristics at a specific location. Also, the size of the plants and growth habits are key factors in this situation.

This research had obtained and indicated the availability of small and new grown as well as large grown (shrub) *M. pigra.* This shows that the strong and large population of *M. pigra* can survive during the flood while smaller population of this species indicates the new growth as a result from the seed dispersal. Thus, flooding will definitely affect the distribution of the vegetation on flood plains directly or indirectly.

4. Conclusion

Based on the supervised image classification analysis and ground truthing, the result showed 60% (upstream), 40% (downstream) and 70% (outfall) of accuracy assessment respectively. For each of the 30 sampled point, *M. pigra* has covered an average of 23.04% of the area with a total of 2,309.58 m^2/ha. The image analysis also showed that the less dense vegetative class in each site decreased in 2015 compared to 2014. This allows for *M.pigra* to grow and populated the open area which is escalated after the flood. Therefore, the estimation of *M. pigra* covered in the study area in 2015 is higher than the previous year. The availability *M. pigra* is considered highly moderate as it can be found in most of the designated point of sampling at each study area. This concludes that *M. pigra* is still a successful invasive species since they can easily grow and populated on most open area and less vegetative area.

Acknowledgment

The author would like to acknowledge Faculty of Earth Science, Universiti Malaysia Kelantan for research facilities provided**.**

References

Binggeli, P. (2005). Crop Protection Compendium - *Mimosa pigra L.* 1-14.

Ibbitt, R., Takara, K., Mohd, N. M., and Pawitan, H. (2002). Kelantan River. (T. U.-I. Committe, Ed.) Retrieved March 20, 2015, from http://flood.dpri.kyoto u.ac.jp/ihp_rsc/riverCatalogue/Vol_04/06_Malaysia-3.pdf.

Indira, T. J. (2007). Mapping and Modelling of *Mimosa pigra* Expansion in Lochinvar National Park, Zambia.

Karim, S. and Mansor, M. (2013). Invasion of Mimosa pigra in Tasik Temenggor Lake and Riverside Area, Perak, Malaysia. International Journal of Biology, Pharmacy and Applied Sciences, 2 (5), 1203-1207.

Mansor, A. and Crawley, M. J. (2011). Current Status of *Mimosa pigra* Infestation in Peninsular Malaysia. Tropical Life Sciences Research, 22 (1), 37-49.

Mohd Shariff, M. K., and Abu Bakar, S. (2006). Invasive Plant in Malaysian Landscape. Alam Cipta International Journal on Sustainable Tropical Design Research and Practice, 1 (1), 41-48.

Murray, D. P. (2009). Spatial Distribution of Four Exotic Plants in Relation to Physical Environmental Factors with Analysis using GIS. Blacksburg.

Onrizal, Ahmad A.G., and Mansor M. (2017). Assessment of Natural Regeneration of Mangrove Species at Tsunami Affected Areas in Indonesia and Malaysia. IOP Conference Series: Materials Science and Engineering 180 (1): 012045.

Solsky, R., Bugbee, G. J., and White, J. C. (2006). Using GIS to Map Invasive Aquatic Plants in Connecticut Lakes. ESRI User Conference, ESRI.

Terry, R.D. and Chilingar, G.V. (1955). Summary of ‘Concerning some additional adis in studying sedimentary formation’s by M.S. Shretsor. Journal of sedimentary Petrology, 25 (3), 229-234.

Yanosky, T. M. (1982). Effects of Flooding Upon Woody Vegetation along Parts of the Patomac River Flood Plain. Alexandria: Geological Survey Professional Paper.

eISSN Number: 2462-2389