Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

Special Issue

ASSESSMENT OF RIVER PLAN CHANGES IN TERENGGANU RIVER USING RS AND GIS METHOD

M. K. A. Kamarudin[1,*], A. M. Nalado[1], A. Kasmuri[2], M. E. Toriman[3], H. Juahir[1], R. Umar[1], N. R. Jamil[4], A. S. M. Saudi[5], Z. I. Rizman[6], M. B. Gasim[1], A. R. Hassan[1], N. A. Wahab[1] and N. A. F N. Wan[1]

[1]East Coast Environmental Research Institute (ESERI), Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Nerus, Terengganu, Malaysia

[2]Faculty of Planning, Architectures, and Surveying, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

[3]School of Social, Development and Environmental Studies, Faculty of Social Sciences and Humanities, National University of Malaysia, 43600 Bangi Selangor, Malaysia

[4]Department of Environmental Science, Faculty of Environmental Studies, University Putra Malaysia, 43400 Serdang, Selangor, Malaysia

[5]Institute of Medical Science Technology, University Kuala Lumpur, 43000, Kajang, Selangor, Malaysia

[6]Faculty of Electrical Engineering, Universiti Teknologi MARA, 23000 Dungun, Terengganu, Malaysia

Published online: 08 August 2017

ABSTRACT

River is one of the most multifarious regular systems. The database can help in the appropriate understanding of river plan change and know the stand of Terengganu River, Malaysia. The data collected from Geographic Information System (GIS) and Remote Sensing (RS) database. Analysis of Types of Lateral Activity (TYLAT) techniques and Modes of Meander Movement (MOME) method utilized to identify the advancement of the river arrange changes.

Author Correspondence, e-mail: mkhairulamri@unisza.edu.my

doi: http://dx.doi.org/10.4314/jfas.v9i2s.3

Satellite images of 2010 and 2015 used in the study were sourced from USGS web. TYLAT was suitable in analyzing the advancement of the waterways plan changes where the river is an extensive and width river. The method for examination of MOME is more appropriate to be used in smaller categories of the river as for upper, middle and down ranges of the river. The result proved the recognition of features or classification of the main stream of Terengganu River.

Keywords: river plan changes; remote sensing; geographic information system; types of lateral activity; modes of meander movement.

1. INTRODUCTION

River is one of the most important elements in the ecosystem of Malaysia. However, several importance of river can be seen today in terms of physical, environmental and human survival. River has many benefits which include provision of water for agricultural practices, domestic purposes, efficient inland transportation system, industrial uses as a recreation park, a source of electrical energy also plays an important role of balancing the temperature of the climate area. However, river systems now are not manageable due to prevailing trends of extreme factors such as floods [1-3]. This is caused by both human and natural factors, which results to erosion and changes in the river or stream plan and also cause sedimentation among other consequences. Changes in river are forms or courses which usually have fundamental effects on the entire river environment. Thus, it is very important to bring understanding to the management of river channels and riparian lands to the dangers of the phenomenon which may result to destructions which includes destructions of river embankment, buildings, roads, bridges and other structures.

However, this justify the reason for aware of the scale and types of river plan change. In addition, the occurrence and formation of geomorphologic factors are closely related to fluvial processes. Fluvial processes are processes that occur naturally either by physical or chemical factors that cause the deformation of the earth surface by surface water, which is flowing in an integrate (river) or concentrated (sheet water). Fluvial process will produce a landscape that is typical; as a result of the behavior of flowing water on the surface. Landscape is formed by

erosion or even as the process of sedimentation carried by surface water [4].

Therefore, care management and river techniques must be closely controlled. The flow of the river system works from all aspects. River regulation and care system can be made through analysis and evaluation of the activities of the river. Evaluation are from changes in river geomorphology, river erosion and so on to find out more about the problems been faced by the river. Furthermore, data classification method can also help to identify and can help to solve the root problem been faced by the upstream, middle stream and downstream. This method also can ease the burden of designing and controlling the river, so that the river does not apply to extreme changes.

2. METHODOLOGY

Terengganu River Basin is positioned in Terengganu State which is in the East Coast Peninsular Malaysia. The river is placed (4^0 41'-5^0 20"N, 102^0 $3^{1'}$-103^0 9 ' E). A length of 100 km is calculated to be the length of Terengganu river basin with a total watershed area of roughly 500 km^2 (Fig. 1). Terengganu River Basin is a river that comprises Telemong River, Nerus River, Pueh River and Bereng River. Moreover, the river initiates from Lake Kenyir flows through Kuala Terengganu and drifts into South China Sea which is positioned in the delta of the river. Terengganu city center is situated at the mouth of the Terengganu River, overseeing the South China City in the east, and also bounded by sandy and gently sloping shoreline [5]. Other reason why Terengganu River has been decided for examination is the accessibility of good database and great maps covering the review regions for stream change grouping framework study [6]. In this, the primary concentration is just on principle Terengganu river waterway where is order can be analysis. To facilitate the research, a review was conducted on the principle of Terengganu River isolating 9 sub-plot, concurring 5km for the length and width of the plot.

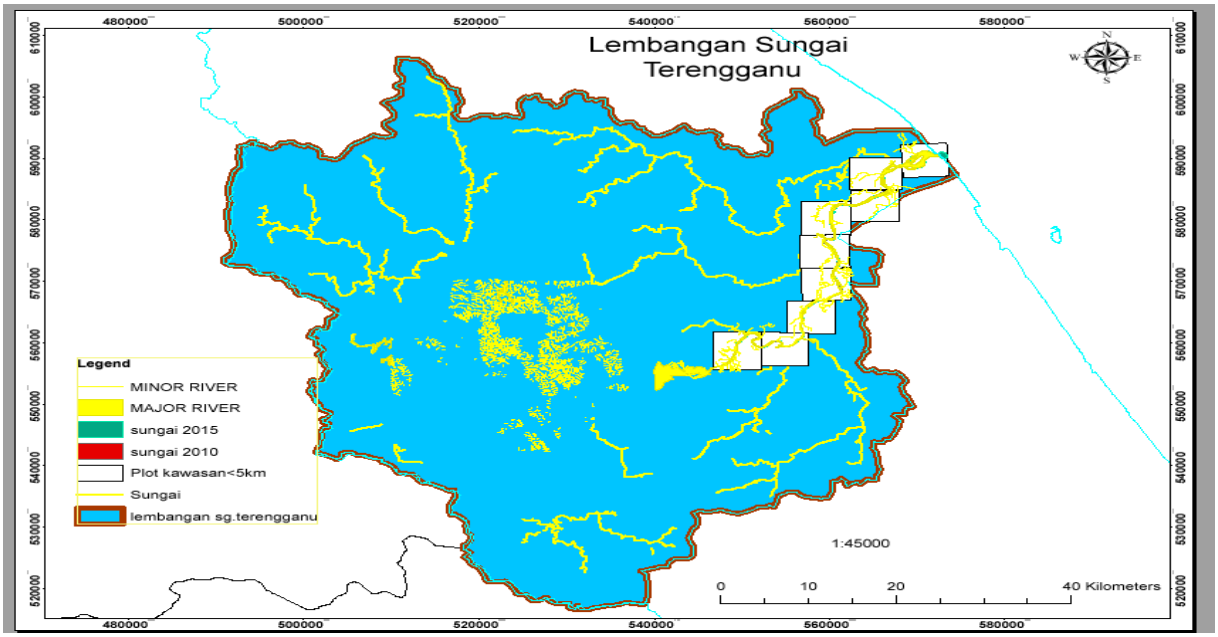


Fig.1. Location of the plots at Terengganu River, Malaysia

Firstly, in this project image satellite of year 2010 and 2015 was used sourced from USGS website. From this two different image satellite, it shows the changes in river with digitizing from ArcGIS software. Then, from ArcGIS also we can easily analyze the data with more accuracy from digitizing the river and compare the changes that happen in 2010 and 2015. While, the use of Remote sensing method was by the use of ERDAS software which also can gives a good result from two image satellite in years 2010 and 2015 to easy identify the changes of the Terengganu River [7]. By this result, many changes have been endure by the river from 2010 to 2015 because of many factors such as human activities and natural environmental factors. Furthermore, in this review, 2 methods to analyze changes river have been used which are Types of Lateral Changes (TYLAT), alludes to stations that show to change because of parallel action at standard of the Terengganu River. TYLAT has 6 types which are Meander Progression, Avulsion, Increasing Amplitude, Braiding, Irregular Erosion, Progression and Cut-Offs according to Fig. 2. Moreover, referring to Fig. 3 of MOME method changes in the wind circle at various satellite images. With MOME types which is Extension, Translation, Rotation, lateral movement, complex change and Enlargement. The 6 sorts of TYLAT and MOME were outlined.

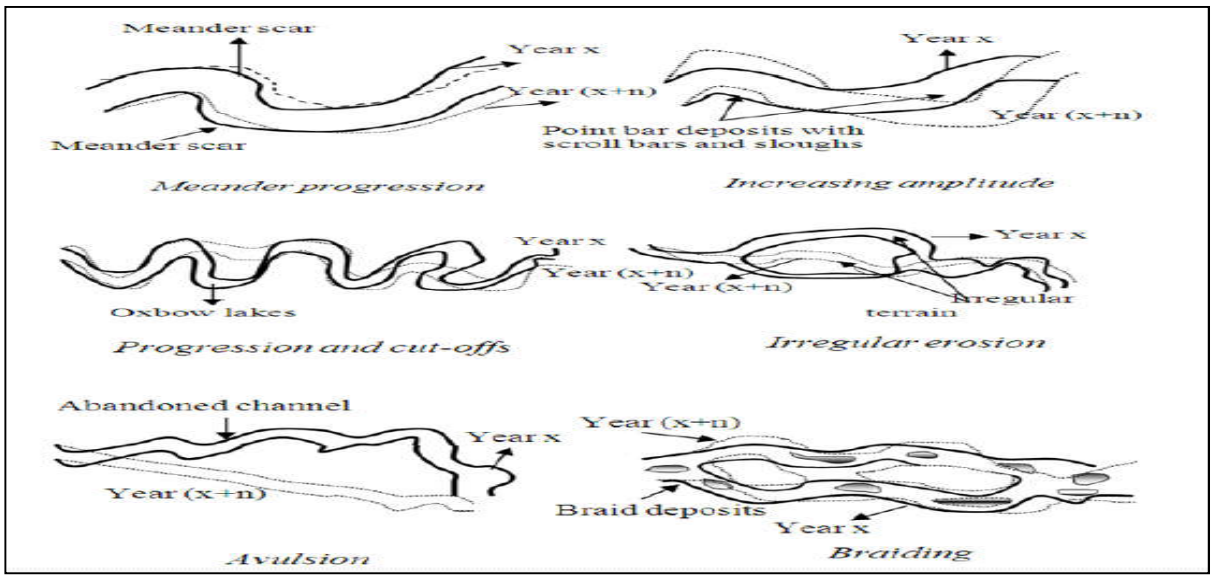


Fig.2. TYPES of Lateral Activity (TYLAT)

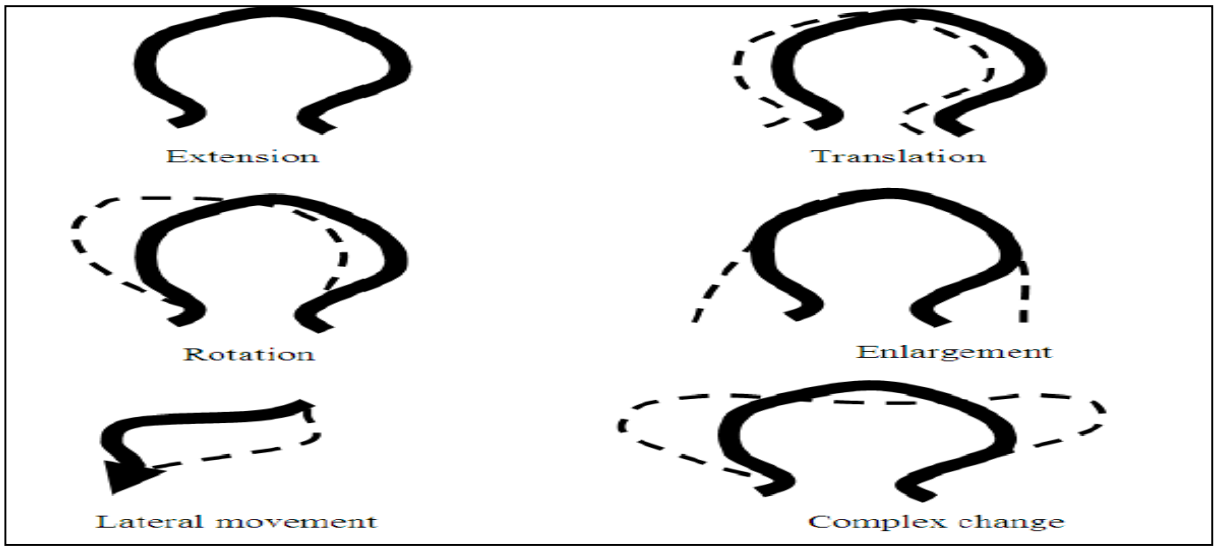


Fig.3. Modes of the Meander Movements (MOME)

Moreover, experiment on Geographic Information System (GIS) and Remote Sensing (RS) were utilized to distinguish the historical wandered changes and it provides a fundamental database for the entire Terengganu River. Giving us a satellite images on 2010 and 2015, which have been analyzed to get the data. The procedure for remote sensing is need to process the image satellite with mosaic image to get the whole image in the Terengganu of 2010 and also for 2015. Furthermore, the projection was change to RSO (Kertau Malaya Meters) using Reprojection Toolbox Menu. Next, insert to ArGis Software and add the data satellite image for 2010. Then, set of the image satellite through the procedure of Geo- referenced with

Projection of the National Grid (RSO Malay Meters for Malaysia). As the review requires high accuracy, the approval of the geo-reference process was led before the digitization procedure. To geo-references, the value of the coordinate must be under ±0.05 to give more accurate to the maps. The equation can be defined as (1) for the provision of the systematic errors (2) which is defines as:

$$s = \frac{\sum x}{n} \tag{1}$$

where X = error at n reference point if s = 0. Then, the errors are random. Besides that, RMSE also can be calculated with this equation.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n}} \tag{2}$$

where Xi = the errors at reference point and RMSE = Provides the average error by the coordinates of the same point or more deviate.

Furthermore, the RMSE need to be under tolerance ±0.05 to such mistakes must be considered when measuring a move in the channel arrangement over the perception time frame [8-9]. With GIS software also, the precision of the redressed maps could be measured against the base guide by settling a few Geo-reference points. The directions were resolved in both X and Y coordinates [8]. Besides that, used the polygon for digitizing process the river for 2010 and 2015 satellite image. After digitizing, the image of that have been digitize must be overlay to each other and start analyzing the characteristic of the river. However, the analysis has identify the more suitable method between TYLAT and MOME techniques that can be used to do research. Subsequently, do the legend, map title, scale bar and North arrow. And for the scale that has been used in these maps is 1:45000 in 2010 until 2015 years.

3. RESULTS AND DISCUSSION

Based on the data analysis study, the types of Upstream river changes in (Table 1) are been managed by the Progression and cut-offs which in 9 cases has reflect changes based on the result of water flow. While, for Meander progression types is 5, Braiding is 6 and 3 for types

of creasing amplitude occurring on the 2010 to 2015. The river flow on upstream of Terengganu River has undergone tremendous changes and also will have affect other factor such as plain flood, discharge and so on [10-12].

Table 1. Types of river plan change based on the TYLAT for upstream Terengganu River

Sub-Plot	Meander Progression	Increasing Amplitude	Progression and Cut-Offs	Irregular Erosion	Avulsion	Braiding
	*5	*5	*5	*5	*5	*5
P1	2	1	3			
P2	2	1	3			4
P3	1	1	3			2
∑	5	3	9			6

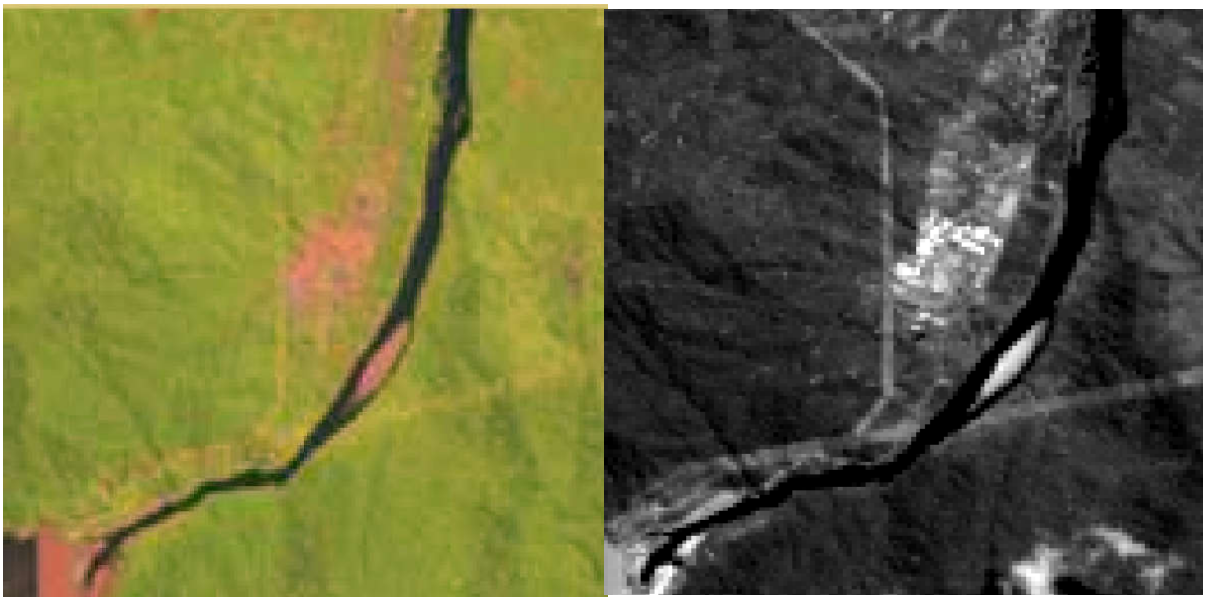
*5 years for 2010-2015 *data sin = Number of cases

Table 2 shows the types of the MOME method for upstream changes plan in Terengganu River which is ranging from 2010 to 2015. The types of Extension and Rotation of the river plan changed is in 3 cases for extension and 2 cases, change of the Translation is only 1 cases and Lateral Movement types is also 1 cases. This figure can show the changes in Fig. 4(a) and (b).

Table 2. Types of river plan change based on the MOME for upstream Terengganu River

Sub-Plot	Extension	Translation	Rotation	Enlargement	Lateral Movement	Complex Change
	*5	*5	*5	*5	*5	*5
P1	1	1	1			
P2	1		1		1	
P3	1					
∑	3	1	2		1	

*5 years for 2010-2015 *data sin = Number of cases



(a) (b)

Fig.4. The evolution of the changes at Terengganu River at Upstream River in (a) 2010 (b) 2015

Referring to the results, the lowest cases in Middle stream in 3 cases is Braiding, increasing Amplitude and for Meander cases is 4 cases Meander Progression phenomenon happen when flow of river into rocklike which related to homogeny and resistance for erosion unless. For arch of meander has two parts which can get sedimentation until causes move which called undercut. Besides that, faster flow of the river to the outer side of the curve compare to side the curve, so that the curvature of the result of erosion deposited on the inner side (Table 3 and Table 4) [13-14].

Table 3. Types of river plan change based on the TYLAT for middle stream Terengganu River

Sub-Plot	Meander Progression	Increasing Amplitude	Progression and Cut-Offs	Irregular Erosion	Avulsion	Braiding
	*5	*5	*5	*5	*5	*5
P4	1	2	4			1
P5	3	1	3			
P6	1		2			2
∑	4	3	9			3

*5 years for 2010-2015 *data sin = Number of cases

Table 4. Types of river plan change based on the MOME for middle stream Terengganu River

Sub-Plot	Extension	Translation	Rotation	Enlargement	Lateral Movement	Complex Change
	*5	*5	*5	*5	*5	*5
P4	2		4		1	
P5	2	2	1		1	
P6	2	2	2	1		
∑	6	4	7	1	2	

*5 years for 2010-2015 *data sin = Number of cases

In addition, for MOME types highest in Middle stream has rotation which is in 7 cases. Rotation has been causes because of faster river flow or slow which results to rotation. Enlargement also has 1 cases. The occurrence of such change occurs due to land. This is the case of soil erosion in the area. Besides that, Extension has 6 cases which has no error subject in that area. Types of River plan changes was explain based on the TYLAT method index for Downstream of the Terengganu River. The highest of the number caused based on the (Table 5 and Table 6) is progression and cut-offs which is in 10 cases of the 5 years period which is from 2010 to 2015. Changes in river causes by types of Progression and cut-offs was a little change at the coast of the river. This is caused by soil erosion that often occurs in that region or maybe because of human active which are not uncontrollable such as forestry, agriculture, urban and so on [15-17].

Table 5. Types of river plan change based on the TYLAT for downstream Terengganu River

Sub-Plot	Meander Progression	Increasing Amplitude	Progression and Cut-Offs	Irregular Erosion	Avulsion	Braiding
	*5	*5	*5	*5	*5	*5
P7	1	1	5	1		1
P8	1		4	1		2
P9	1	1	1	1		1
∑	3	2	10	3		4

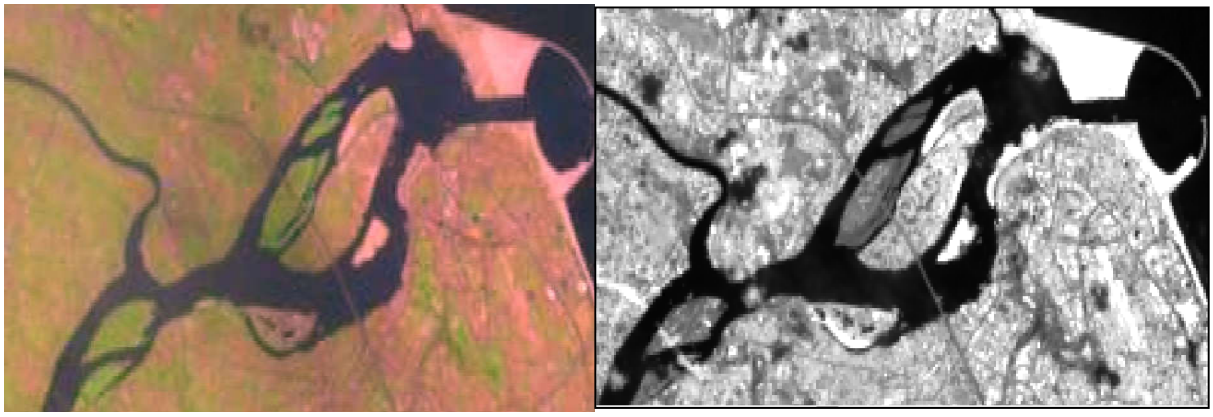
*5 years for 2010-2015 *data sin = Number of cases

Table 6. Types of river plan change based on the MOME for downstream Terengganu River

Sub-Plot	Extension	Translation	Rotation	Enlargement	Lateral Movement	Complex Change
	*5	*5	*5	*5	*5	*5
P7						
P8	3	1		2		
P9	3	2				
∑	6	3		2		

*5 years for 2010-2015 *data sin = Number of cases

Besides that, using satellite image data based on Fig. 5 (a) and (b) in years 2010 and 2015 is easy to get analysis with accuracy. For types of Braiding is in 4 cases and 13 cases is Meander Progression, cut-offs and Irregular Erosion that changes based on 2010 to 2015.



(a) (b)

Fig.5. The changes identified with the Extension and Translation using satellite image at the downstream of Terengganu River (a) 2010 (b) 2015

Furthermore, for Table 4 and pie chart of Fig. 6 show the value of area and the changes of the river plan in 2010 to 2015. Firstly, the large area (hectare) that increasing in 2010 and 2015 is 154.67 in P2. Then, the percentage of the changes in river plan is 5% for upstream river. According to result, the changes in river braiding are 10% based on change under types of TYLAT method. Braiding happen when high flow stages happen, major changes will take place due to rapid rates of the stream migration facilitated by high stream power and unstable banks [18].

In addition, there also can be extensive changes in stream situation like subdivided streams which are abandoned or earlier stream are reactivated. Even in a braided reaches, a single dominant stream in some cases will be distinguishable from the surroundings of Terengganu River from early years of 2010 to 2015. For meandering river changes is because of the shape and sinuosity of meanders is influenced by bank and slope of energy of the river. This is because of sinuosity which is always greater than the unity increase in valley slope and also close to unity when braiding forms. In low flow stages, high energy meandering river have a tendency to cut across the point bars [19]. This along with over-widening of meandering bends in low flow stage may initiate to the development of the braiding. Moreover, the flow in meandering rivers is to reduce the excess energy of the flow by increasing its traveling length [20].

According to [21] express meandering is caused by large-scale eddies. For the second highest is 129.51 which in P4 for middle stream evolution and the percentage of the P4 is increasing for the width river in 8%. The lowest area values decreased goes to (-) 5.06 that is P1 for upstream stream river and the changes of the percentage river plan is 10% which is the width area of the river are getting smaller and have been cut-off [21]. Area of upstream river has changes because of human activities in the river such as town center, recreational park and tourism in Kenyir Lake area. According to Fig. 7, types of the changes in river plan at the Middle Stream River of 2010 to 2015 showed the highest changes is Progression and cut-offs which is in 9 cases followed by Meander Progression in 4 cases, Increasing Amplitude and Braiding in 3 cases. Thus, meandering changes of the river is because of the meander bend erosion which is the combination of both hydraulic and geotechnical process [22-23]. On the other hand, Fig. 8 has showed the evolution of the changes of river plan in Middle Stream River for P4, P5 and P6 on 2010-2015.

Table 7. The value of area and the changes of the river plan in 2010-2015(%)

Sub-Plot	Area (Hect)	Area in 2010 Years	Area in 2015 Years	Changes River Plan 2010-2015 (%)	Changes of River Plan
P1	(-)5.057847	614.24816	609.190313	10%	decreased
P2	154.669705	218.188155	372.85786	5%	increasing
P3	(-)15.481571	241.053753	225.572182	10%	a few decreasing
P4	129.508963	200.466713	329.975676	8%	a few increasing
P5	(-)14.259689	260.627194	246.367505	10%	decreasing
P6	3.648899	275.653618	279.302517	20%	a few increasing
P7	17.383912	176.595388	193.9793	18%	a little of increasing
P8	77.947332	213.112724	291.060056	13%	a little of increasing
P9	(-)17.9049928	216.670306	198.765378	7%	a little of decreasing

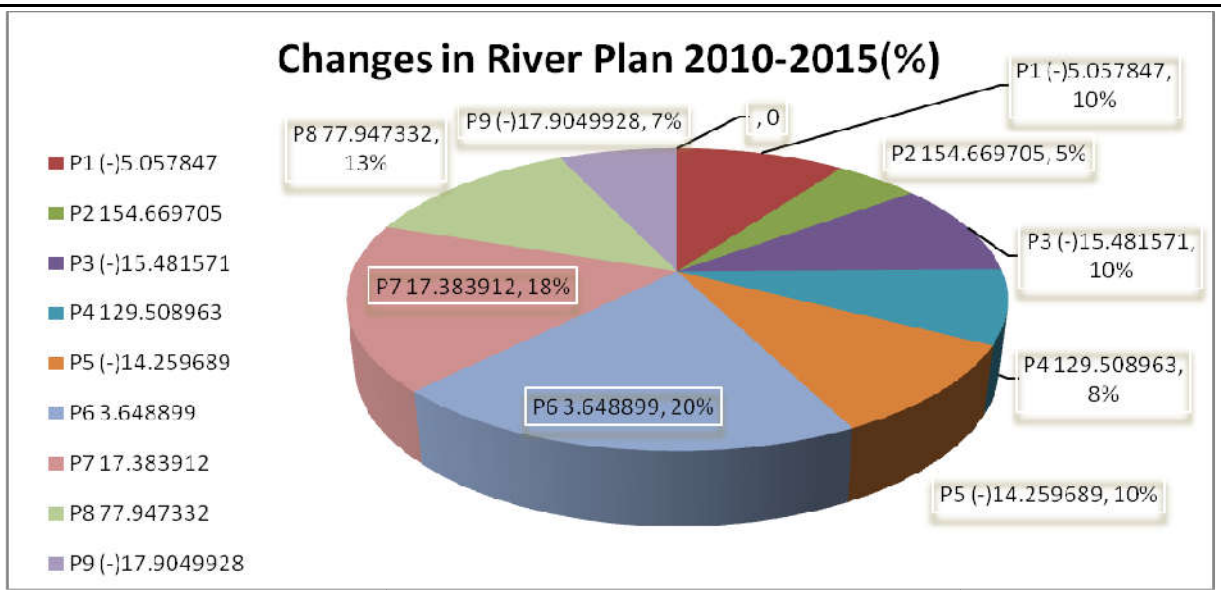


Fig.6. The pie chart about the changes of the river plan in 2010 until 2015

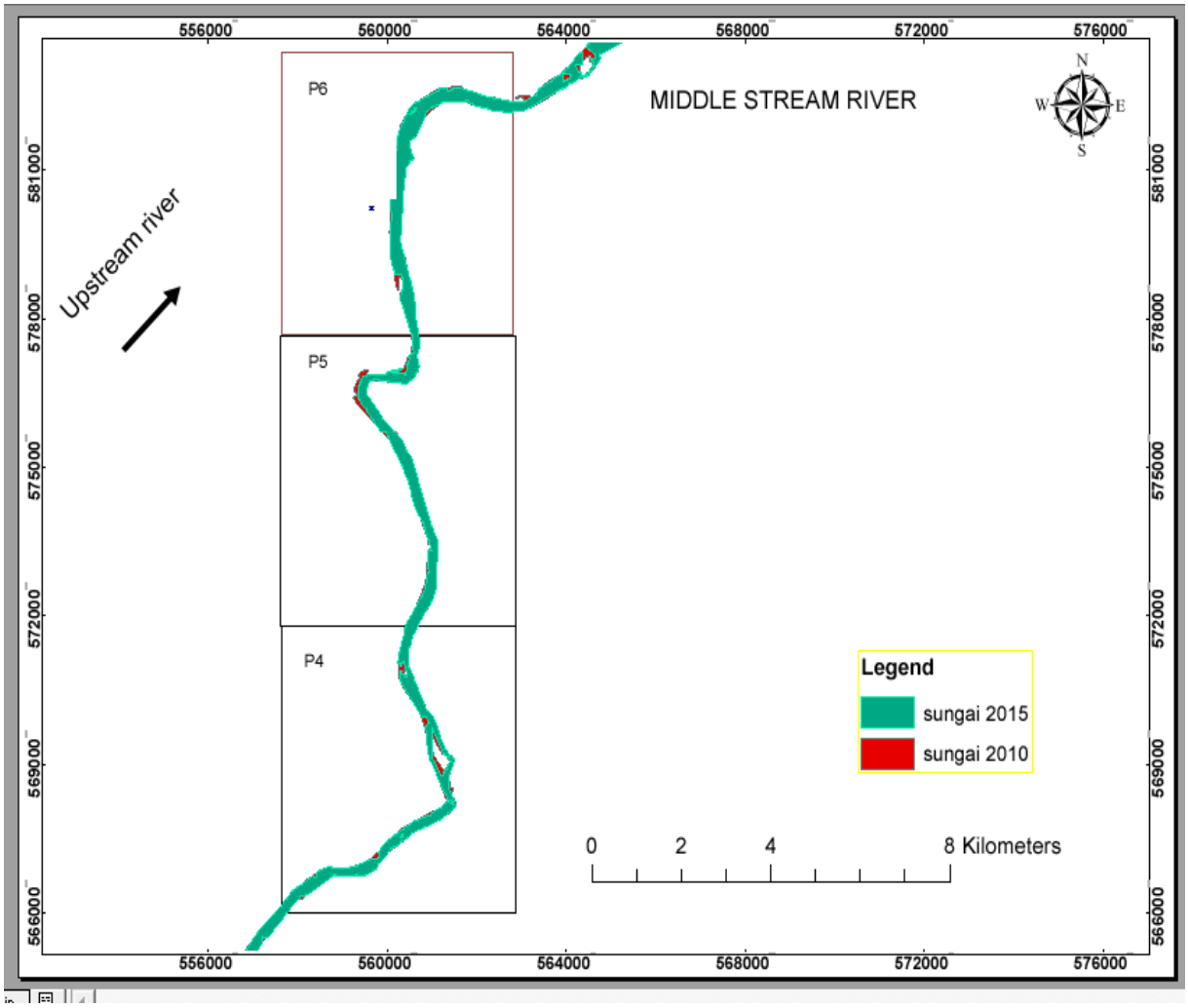


Fig.7. Middle stream river

Furthermore, Fig. 8 shows the evolution of the changes in upstream of Terengganu River for sub-plot P1, P2 and P3. Based on the analysis of the MOME index is better and easy to identify compared to TYLAT method used for upstream reach and downstream area of the river. While, Fig. 9 showed the river changes at downstream river which sub-plots P7, P8 and P9. Then, meander progression and cut-offs has changes because of cut-off shortens the length of the river cause the disturbance of regime upstream and downstream till readjustment is made. However, erosion in meander bends is a common process responsible for local bank retreat and for initiating a bank stabilization program.

Moreover, erosion bends is much greater than in straighter reaches, tractive force is also greater in bends than larger one [22-23]. The river has change because of human activity is increasingly more in urban areas, agricultural, recreation, illegal forestry and other. This can enhance serious river soil erosion which is as a result of uncontrollable human activity.

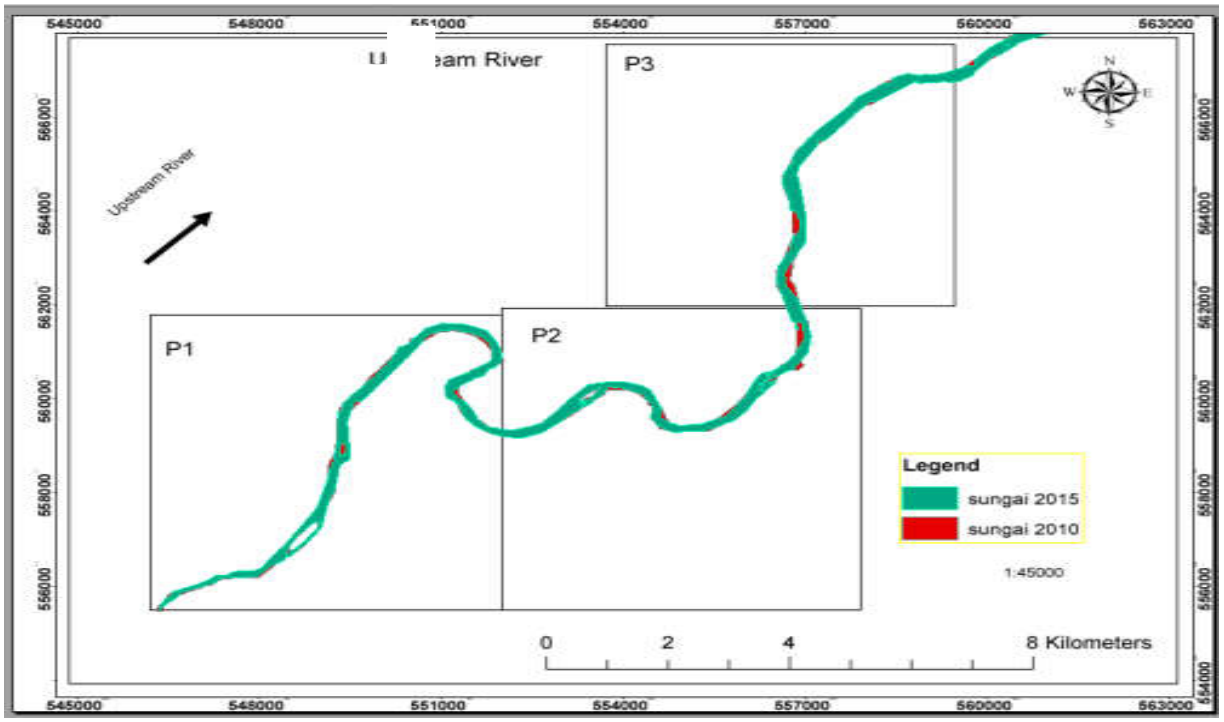


Fig.8. Upstream stream river

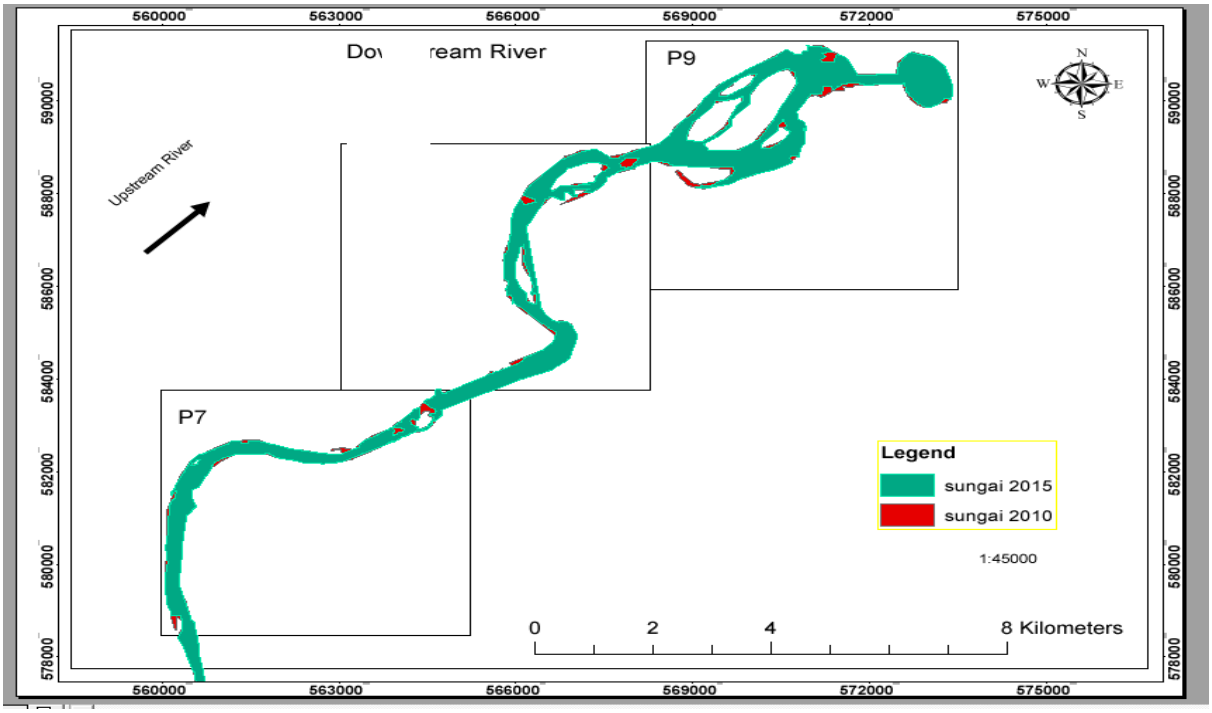


Fig.9. Downstream river

Based on Fig. 10a and 10b, it shows the river changes that can be seen decreasing compared to the middle reaches of the river and the changes in that area which also is caused by soil erosion. This is because of the improvement of the urban, city and village in that area that had led to change in the river.

(a) (b)

Fig.10. The changes of the types of irregular erosion identified at the mainstream river in (a) 2010 and **(**b) 2015

4. CONCLUSION

In this study, different GIS and Remote sensing software techniques have been used to achieve the classification of the Terengganu River flow and acquire more understand and identify about the changes that happens in the river area. In other hand, TYLAT and MOME method techniques also has proven change in the classification of the river. Analysis with TYLAT and MOME method show relationships that can give significant importance to the use of classification. TYLAT and MOME have been used in this study to get a better analysis about the changes river plan for the extensive, smaller and width of the rivers. Besides, this study MOME index is more suitable because of smaller area likewise found in the upper, middle and also downstream of the Terengganu River. However, with using of this methods time and energy be saved. The classifications of Terengganu River are very useful for the more understanding of river plan changes systems. On this apportionment results which is also useful to the local authorities in order appropriately manage the river with effectiveness and also will serve as a referenced for further researches.

5. ACKNOWLEDGEMENTS

The author would like to thank KPM for providing financial support for this research on the

RAGS 2015 *Siasatan Penghasilan Sedimen* Grant RAGS/ 1/2015 /WAB05/ UNISZA / 02/1, Department of Irrigation and Drainage Malaysia for the secondary data and East Coast Environmental Research Institute (ESERI), Universiti Sultan Zainal Abidin (UNISZA) give permission to use research facilities and supporting in this research.

6. REFERENCES

[1] Sulaiman W N, Heshmatpoor A, Rosli M H. Identification of flood source areas in Pahang River Basin, Peninsular Malaysia. EnvironmentAsia, 2010, 3(Special Issue):73-78

[2] Saher F N, Ali N B, Kadir T A, Teruggi G, Hossain M A. Environmental degradation in Malaysia's Pahang River Basin and its relation with river pollution: Strategic plan from assessment to mitigation using geo-informatics. In International Conference on Energy, Environment and Sustainable Development, 2012, pp. 1-8

[3] Jusoh J. Hydrological forecasting of the Pahang River Basin using the rainfall-runoff model HEC-HMS. Phd thesis, Selangor: Universiti Teknologi MARA, 2005

[4] Subhasish D. Fluvial processes: Meandering and braiding. Fluvial hydrodynamics-GeoPlanet: Earth and planetary sciences. Berlin: Springer, 2014, pp. 529-562

[5] Sultan K, Shazili N A. Geochemical baselines of major, minor and trace elements in the tropical sediments of the Terengganu River Basin Malaysia. International Journal of Sediment Research, 2010, 25(4):340-354

[6] Kamaruddin A F. Spatial characterization and identification sources of pollution using multivariate analysis at Terengganu river basin, Malaysia. Jurnal Teknologi, 2015, 77(1):269-273

[7] Gasim M B, Toriman M E, Idris M, Lun P I, Kamarudin M K, Azlina A N, Mokhtar M, Mastura S S. River flow conditions and dynamic state analysis of Pahang River. American Journal of Applied Sciences, 2013, 10(1):42-57

[8] Kamarudin M K, Toriman M E, Rosli M H, Juahir H, Aziz N A, Azid A, Zainuddin S F, Sulaiman W N. Analysis of meander evolution studies on effects from land uses and climate change at upstream reach of Pahang River, Malaysia. Mitigations Adaptation Strategies Global Change, 2015, 20(8):1319-1334

[9] Vyas V, Kumar A, Parashar V, Tomar S. Physical habitat assessment of River Denwa using GIS techniques. Journal of the Indian Society of Remote Sensing, 2013, 4(1):127-139

[10] Armaş I, Nistoran D E, Osaci C G, Braşoveanu L. Morpho-dynamic evolution patters of Subcarpathian Prahova River (Romania). Catena, 2013, 100:83-99

[11] Issaad O, Pierre S, Ivascu G I, Garcia O. A novel approach to modelling and flooding in ad-hoc wireless networks. Journal of Computer Science, 2008, 4(12):967-975

[12] White J Q, Pasternack G B, Moir H J. Valley width variation influences riffle-pool location and persistence on a rapidly incising gravel-bed river. Geomorphology, 2010, 121(3):206-221

[13] Seeber L, Gornitz V. River profiles along the Himalayan arc as indicators of active tectonics. Tectonophysics, 1983, 92(4):335341-337367

[14] Agarwal R P. Boundary value problems for higher order integro-differential equations. Nonlinear Analysis: Theory, Methods and Applications, 1983, 7(3):259-270

[15] Mohamed A A, Rahim S A, Aitman D A, Kamarudin M K. Analisis kandungan kabron organic tanah secara bermusim di Hutan Bukit Jeriau, Fraser Hill, Pahang. Malaysian Journal of Analytical Sciences, 2016, 20(2):452-460

[16] Rwooa M A, Juahira H, Roslanb N M, Torimana M E, Enduta A, Azida A, Che C N, Hasnama A S, Amri M K, Kamarudina S A, Mustafaa A D. The assessment of the variation of physico-chemical sources for drinking water quality using chemometrics: A case study at water treatment plants in Klang Valley. Jurnal Teknologi, 2016, 78(11):1-9

[17] Kamarudin M K, Toriman M E, Juahir H, Azid A, Gasim M B, Saudi A, Umar R, Sulaiman N H, Ata F M, Mustafa A D, Amran M A. Assessment of river plan change using RS and GIS technique. Jurnal Teknologi. 2015, 76(1):31-38

[18] Bristow C S, Best J L. Braided rivers: Perspectives and problems. Geological Society, London, Special Publications, 1983, 75(1):1-11

[19] Carson M A. The meandering-braided river threshold: A reappraisal. Journal of Hydrology, 1984, 73(3-4):315-334

[20] Schoklitsch A. Hydraulic structures: A text and handbook. New York: The American Society of Mechanical Engineers, 1937

[21] Yalin M. S., Da Silva A. F. Fluvial processes. Florida: CRC Press, 2017

[22] Das M K. Estuarine dynamics, processes and sediment transport-A case study from the Hooghly Estuary in the Ganges Delta. Phd thesis, Kharagpur: Indian Institute of Technology, 2014

[23] Jaafar O, Toriman M E, Mastura S S, Gazim M B, Lun P I, Abdullah P, Kamarudin M K, Aziz N A. Modeling the impacts of ringlet reservoir on downstream hydraulic capacity of Bertam River using XPSWMM in Cameron Highlands, Malaysia. Research Journal of Applied Sciences, 2010, 5(2):47-53

How to cite this article:
Kamarudin MKA, Nalado AM, Kasmuri A, Toriman ME, Juahir H, Umar R, Jamil NR, Saudi ASM, Rizman ZI., Gasim MB, Hassan AR, Wahab NA, Wan N A FN Assessment of river plan changes in terengganu river using rs and gis method. J. Fundam. Appl. Sci., 2017, 9*(2S), 28-45.*