IMPACT OF FLOOD INUNDATION ON AGRICULTURE LAND USE: A CASE STUDY IN GUA MUSANG, KELANTAN

NURLIZA AZAH BINTI IBRAHIM

FP 2016 77

IMPACT OF FLOOD INUNDATION ON AGRICULTURE LAND USE: A CASE STUDY IN GUA MUSANG, KELANTAN

BY

NURLIZA AZAH BINTI IBRAHIM

A project report submitted to Faculty of Agriculture, University Putra Malaysia, in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of bachelor of Agricultural Science

Faculty of Agriculture

Universiti Putra Malaysia

2015/2016

CERTIFICATION

This project report entitled Impact of Flood Inundation on Agriculture Land Use: A Case Study in Gua Musang, Kelantan is prepared by Nurliza Azah binti Ibrahim and submitted to the Faculty of Agriculture in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of degree of Bachelor of Agricultural Science.

Student's name: Student's signature:

NURLIZA AZAH BINTI IBRAHIM ……..

Certified by:

……..

Assoc. Prof. Dr. Siva Kumar Balasundram

Department of Agriculture Technology

Faculty of Agriculture

Universiti Putra Malaysia

Date: ……..

ACKNOWLEDGEMENT

In the name of Allah, The Most Gracious, The Most Merciful

Praise to the Allah Almighty for His Blessing which enabled me to complete this thesis. My deepest gratitude goes to Assoc. Prof. Dr. Siva Kumar Balasundram for his guidance and wide knowledge given to me throughout the duration of the project. Without his guidance, this project may not have reached its objective within the period time. Thanks a lot for your patience towards me during the preparation of this project.

A very warm appreciation towards my beloved parents and my family Mr. Ibrahim bin Hj Yaho and Mrs. Suwarni binti Umar who gave me strong encouragement and inspired me to complete this task.

To all my friends and classmates especially Noor Janatun Maqwa binti Jemali and Matan Iskandar bin Matan Ibrahim for their ideas and help during handling this project. Thanks for all your support and ideas.

I would like to thank En. Syed Faisal from Department of Agriculture, Putrajaya who help us to get the important data that can make our project succeed. Last but not least, I would like to thank all the generous people for being part of this project. I could not have finished this project and report writing without them. Thank you.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Conventional methods of assessing flood hazard are unable to provide quick, efficient and effective solutions. In recent years, risk based approaches that feature geospatial tools such as remote sensing and geographical information system have been pursued as a viable means to manage flood hazard. Over the past 30 years, floods have been the most tragic natural disaster affecting about 80 million people per year causing economic damage worth over USD11 million annually around the world. Increasing human activity at downstream and upstream of river systems results in greater flood damage in terms of size and frequency. In Malaysia, the National Security Council (NSC) had classified the recent flooding in Kelantan as the worst in the history of the state. Apparently, the water level of the Kelantan River at Tambatan Di Raja, which had a danger level of 25 m, reached 34.2 m in December of 2014 compared to 29.7 m in 2004 and 33.6 m in 1967. Two main reasons for the unusual flooding magnitude are changing climatic patterns and uncontrolled land management and increased exploitation of land resources. This study explore the use of ArcGIS and Digital Elevation Model (DEM) to provide geospatial data to assess flooding effects on agricultural land use in Gua Musang, Kelantan. The changes of agriculture landuse shown clearly in rubber and oil palm plantation as they are the main contributor of agriculture area in study area. Findings from this work provide the necessary benchmark (especially in terms of agricultural land use) for a more comprehensive approach to manage the impact of flood disasters in the near future.

ABSTRAK

Kaedah konvensional menilai bahaya banjir tidak dapat menyediakan penyelesaian yang cepat, cekap dan berkesan. Dalam tahun-tahun kebelakangan ini, pendekatan berasaskan risiko yang mempunyai alat geospatial seperti penderiaan jauh dan sistem maklumat geografi telah dilaksanakan sebagai satu cara yang berdaya maju untuk menguruskan bahaya banjir. Sejak 30 tahun yang lalu, banjir telah bencana alam yang paling tragis yang melibatkan kira-kira 80 juta orang setiap tahun menyebabkan kerosakan ekonomi bernilai lebih USD11 juta setiap tahun di seluruh dunia. Meningkatkan aktiviti manusia pada keputusan hilir dan hulu sungai kerosakan banjir yang lebih besar dari segi saiz dan kekerapan. Di Malaysia, Majlis Keselamatan Negara (MKN) telah mengklasifikasikan banjir baru-baru ini di Kelantan sebagai yang paling teruk dalam sejarah negeri ini. Rupa-rupanya, paras air Sungai Kelantan di Tambatan di Raja, yang mempunyai tahap bahaya 25 m, mencapai 34.2 m pada bulan Disember 2014 berbanding 29.7 m pada tahun 2004 dan 33.6 m pada tahun 1967. Dua sebab utama magnitud banjir yang luar biasa adalah perubahan pola iklim dan pengurusan tanah yang tidak terkawal dan eksploitasi meningkat sumber tanah. Kajian ini meneroka penggunaan ArcGIS dan Model Digital (DEM) untuk menyediakan data geospatial untuk menilai kesan banjir ke atas penggunaan tanah pertanian di Gua Musang. Perubahan penggunaan tanah pertanian ditunjukkan dengan jelas dalam ladang getah dan kelapa sawit kerana mereka adalah penyumbang utama di kawasan pertanian di kawasan kajian. Hasil daripada kerja-kerja ini menyediakan penanda aras yang diperlukan (terutamanya dari segi penggunaan tanah pertanian) untuk pendekatan yang lebih menyeluruh untuk menguruskan kesan bencana banjir di masa akan datang.

Chapter One

Introduction

1.1 Background

The total land area of Peninsular Malaysia is almost 13.2 million per ha which is 45.3 percent or 5.97 million per ha is a forest (Oldeman, 1982). The total area of Kelantan State is about 14,922 km^2 and is situated in the north-eastern part of Peninsular Malaysia. It consists of fourteen districts which are Gua Musang, Kuala Krai, Jeli, Tanah Merah, Machang, Pasir Puteh, Kereteh, Bachok, Rantau Panjang, Pasir Mas, Tumpat, Pengakalan Chepa, Kota Bharu and Kubang Kerian as shown in Figure 1 and the total population is about 1,288,362.

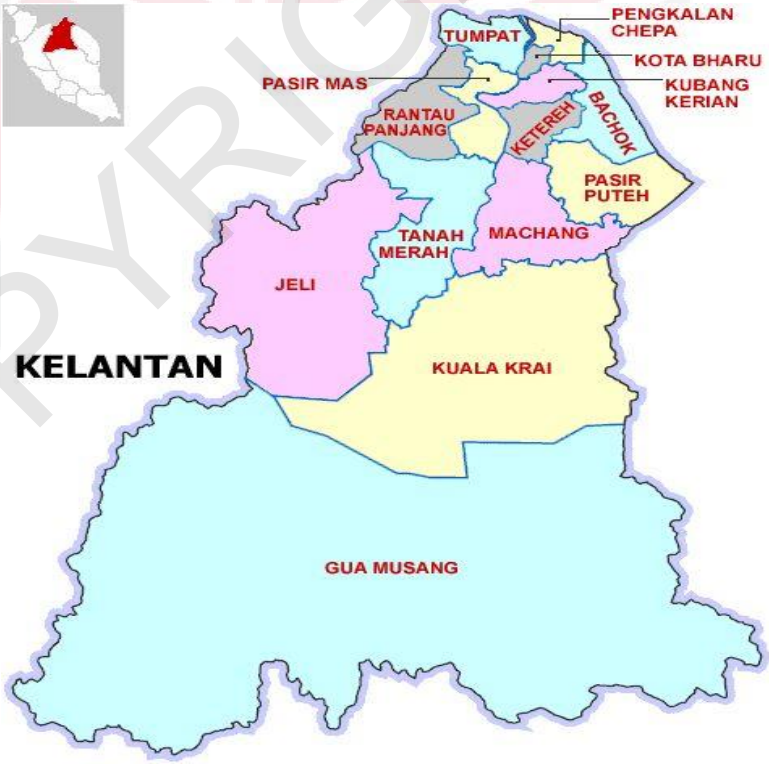

Figure 1: Map of Kelantan state (Source: https://saripedia.wordpress.com/2011/12/28/belajar-penerapan-syariat-islam-dari-negeri-kelantan-malaysia/peta-negeri-kelantan/)

Gua Musang is one of the districts with a population of about 100,400 people covering a total area of 8,177km^2. Agriculture is the main land use in Gua Musang and they have plantation area which covers an oil palm plantation (56,002ha), rubber plantation (22,320ha) and have fruits and other crops which cover 8,922ha.

Flooding is a natural phenomenon and has occurred for millions of years. Flood disaster happens every year in Malaysia, but in the recent December 2014, flooding becomes a hot topic around the world because it was the most tragic natural disaster that happens in previous year (Chan, 2015).

The worst flood disaster in history of Malaysia is on December 2014 until January 2015. The water level of the Kelantan River at Tambatan DiRaja, which had a danger level of 25 m, reached 34.2 m in December of 2014 compared to 29.7 m in 2004 and 33.6 m in 1967. This happen because of the Northeast Monsoon (November to March) brings heavy rainfall, particularly to the east coast states of Peninsular Malaysia and western Sarawak (Murty, 2015).

Flooding is costly to agriculture because they cause delays in crop production and reduce crop productivity. If the soil is too wet, it will give the poor condition for the crops to grow. While when soil is well-drained, the oxygen, nutrients and trace elements that the plant needs are available.

The increased of human activity at downstream and upstream of the river systems results in greater flood damage in terms of size and frequency. Two main reasons for the unusual flooding magnitude are changing climatic patterns and uncontrolled land management and increased exploitation of land resources (Hasan, and Ghani, 2006).

Traditional methods of assessing flood hazard are unable to offer quick, efficient and effective solutions. In recent years, risk based approaches that feature spatial tools such as remote sensing and geographical information system have been pursued as a viable means to manage flood hazard. Figure 2 shows the chronology of flood events that happens in Malaysia.

Figure 2: Flood events happened in Malaysia from 2007 until 2011

1.2 Problem statement

In Malaysia, land use has undergone many changes particularly after the country achieved its independence. Land use changes were driven by a number of economical, sociopolitical and biophysics factors. Over the last two decades, the evolution of land use became drastic in the urban and rural areas. Especially, more land areas have been displaced or converted to non-agricultural activities particularly for industry, housing and commercial activities.

Land use and land cover are continuously changing, both under the influence of human activities and nature resulting in various kinds of impacts on the ecosystem. These impacts have the potential to significantly affect the sustainability of the agricultural and forest systems. The most important factor in the modification of the land cover and its conversion is the human activities.

Floods become the most tragic natural disaster affecting about 80 million people per year and The National Security Council (NSC) classified the recent flooding in Kelantan in December 2014 as the worst in the history of the state. Nowadays, traditional methods of assessing flood hazard are unable to give quick, efficient and effective solutions. In recent years, risk based approaches that feature geospatial tools such as remote sensing and geographical information system (GIS) have been pursued as a practical means to manage flood hazard. Thus, these tools will help in assess the flood severity of the agriculture land use in Gua Musang, Kelantan.

1.3 Hypothesis and objective

H_O: There are no changes in agriculture land use in Gua Musang, Kelantan before and after flood inundation.

H_A: There are changes in agriculture land use in Gua Musang, Kelantan before and after flood inundation.

Objective of this study is:

- To assess the effect of flood severity on agriculture land use in Gua Musang, Kelantan.

REFERENCES

Anderson, J.R., Hardy, E.E., Roach, J.T., Witmer, R.E. (1976). A land-use and land-cover classification system for use with remote sensor data. US geological Survey Professional Paper 964, Washington, DC.

Apel H, Aronica G.T, Kreibich H, Thieken A.H. (2009) Flood risk analyses—how detailed do we need to be? *Nat Hazard*, Vol.49, 79–98

Arnold M.I, Chen R.S, Deichmann U, Dilly M, Lerner-Lam A.L, Pullen R.E, Trohanis Z. (2006). Natural disaster risk hotspots case studies, disaster risk management series, No. 6, World Bank

Baker V.R, Kochel R.C, Patton P.C. (1988). Flood geomorphology. *Wiley Interscience, Toronto* (Canada), 503pp

Berz, G. (2000). Flood disasters: Lessons from the past: Worries for the future. Proc. ICE-Water Marit. Eng., Vol. 142, 3-8.

Brivio P.A., Colombo R., Maggi M. and Tomasoni R. (2002). Integration of remote sensing data and GIS for accurate mapping of flooded areas. *Int. J. Remote Sensing*, Vol.23 (3), 429–441.

Burrough, P.A. and McDonnell, R.A. (1998). Principles of geographical information systems. Oxford University Press, Oxford, 327

Chan, N.W. (1995). Flood disaster management in Malaysia: an evaluation of the effectiveness of government resettlement schemes. *Disaster Prevention and Management*, Vol. 4 (4), 22- 29.

Demirkesen, A.C., Evrendilek, F., Berberoglu, S., and Kilic, S. (2006). Coastal Flood Risk Analysis Using Landsat-7 ETM+ Imagery and SRTM DEM: A Case Study of Izmir, Turkey. *Environmental Monitoring and Assessment,* Vol. 131, 293– 300, Springer Science + Business Media B.V. 2006.

Ghani, A.A., N.A. Zakaria and R.A. Falconer, (2009). River modelling and flood mitigation: Malaysia perspectives. Water Manage. Vol. 162, 1-2.

Hassan, A.J., Ghani, A.B ., (2006). River and floodplain Modeling for the development of flood risk map: A case study of Sungai Selangor. Msc Thesis, Penang : Universiti Sains Malaysia.

Islam, M. M., and Sadu, K. (2001). Flood damage and modeling using satellite remote sensing data with GIS: Case study of Bangladesh. *In: Remote Sensing and Hydrology 2000, edited by Jerry Ritchie et al.,* IAHS Publication, Oxford, 455-458.

Islam MM, Sado K. (2000). Development of Flood hazard maps of Bangladesh using NOAA/AVHRR images with GIS. *Journal of Hydrology Science,* Vol. 45(3): 337-355.

Jusoff K, Senthavy S. (2003). Land use change detection using remote sensing and geographical information system (GIS) in Gua Musang district, Kelantan, Malaysia. *Journal of Tropical Forest Science,* Vol. 15(2), 303-312.

Ketting, R.L., and D.A. Landgrebe. (1976). Classification of multispectral image data by extraction and classification of homogeneous objects, *IEEE Transactions on Geoscience Electronics, GE,* Vol. 14(1), 19–26

Lastra, J., Fernández, E., Díez-Herrero, A. and Marquínez, J. (2008). Flood hazard delineation combining geomorphological and hydrological methods: an example in the Northern Iberian Peninsula. *Natural hazard*, Vol. 45 (2), 277-293

Liu, Z.L., F. Huang, L.Y. Li and E.P. Wan, (1999). Dynamic monitoring and damage evaluation of flood in northwest Jilin with remote sensing. Proceeding 20th Asian Conference of Remote Sensing, Hong Kong, 22-25 November

Marcus, W.A., Legleiter, C.J., Aspinall, R.J., Boardman, J.W. and Crabtree, R.L. (2003). High spatial resolution hyperspectral mapping of in-stream habitats, depths, and woody debris in mountain streams. *Geomorphology*, Vol 55, 363–380.

Martinez J.M, Toan T. (2009). Mapping of flood dynamics and spatial distribution of vegetation in the Amazon floodplain using multi temporal SAR data. Remote Sens Environ, Vol. 108, 209–223

Mertes L.A.K. (2000). Flood processes and effects: Inundation hydrology. Inland flood hazards: human, riparian and aquatic. Wohl EE, Cambridge University Press, UK.

Millward, A. A., & Mersey, J.E. (1999). Adapting the RUSLE to model soil erosion potential in a mountainous tropical watershed. Catena, Vol. 38, 109–129.

MMD. (2007). Malaysian Meteorological Department (MMD). Report on heavy rainfall that caused floods in Kelantan & Terengganu. Unpublished report. Kuala Lumpur: MMD.

MMD. (2009). Malaysian Meteorological Department (MMD). Climate change scenarios for Malaysia 2001-2099. Scientific report January 2009. Unpublished report. Kuala Lumpur: MMD.

Mooney, H. (2010). More than 100,000 children under 5 are at risk of death in Pakistan. BMJ, Vol. 341. 10.1136/bmj.c5288

Murty, M., (2015, January 13) Wrong to blame logging as the main cause of floods in KelantanMalaysia. The Rakyat Post Retrieved from http://www.therakyatpost.com.

Nico, G., M. Pappalepore, G. Pasquariello, A. Refice and S. Samarelli. (2000) Comparison of SAR amplitude vs. coherence flood detection methods a GIS application. Int. J. Remote Sensing, Vol. 21 (8), 1619-1631.

Nirupama and S.P. Simonovic. (2002). The Role of Remote Sensing in Disaster Management. *ICLR Research Paper Series*- No. 21.

Olderman, F.R., Frere, M., (1982). The study of agriclimatology of the humid tropics of Sout East Asia.

O'Connell, P. E., Ewen, J., O'Donnell, G. and Quinn, P. (2007) Is there a link between agricultural land-use management and flooding? Hydrol. Earth Syst. Sci., Vol. 11 (10), 96-107

Olayini, A.O, Ramli, M.F, Sood, A.M (2013). Agricultural Land Use in Malaysia: An historical overview and implications for food security, *Bulgarian Journal of Agricultural Science,* Vol. 19 (1), 60-69

Oya, M., (2002). Applied geomorphology for mitigation of natural hazards, *Natural Hazards, Springer Netherlands,* Vol. 25, (1) ,17-25.

Pandey, A., Chowdary, V. M., and Mal, B. C. (2007). Identification of critical prone areas in the small agricultural watershed suing USLE, GIS and remote sensing. *Water Resource Management*, Vol. 21, 729–746.

Pradhan, B. & Shafie M. (2009). Flood hazard assessment for cloud prone rainy areas in a typical tropical environment. *Disaster Advances*, 2 (2), 7-15

Pradhan, B. (2009). Flood susceptible mapping and risk area delineation using logistic regression, GIS and remote sensing. *Spatial hydrology*, Vol. 9, (1-18).

Reusing, M., T. Schneider and U. Ammer. (2000). Modelling Soil Loss rates In the Ethiopian Highlands by Integratation of High Resolution MOMS-02/D2-Streao-data in a GIS. Int. Journal of Remote Sensing. Vol.21 (9).

Reynard N.S, Prudhomme C, Crooks S.M. (2001). The flood characteristics of large U.K. Rivers: Potential effects of changing climate and land use. *Climatic Change,* Vol. 48(2), 343-359.

Somkhit, S. (2000). Monitoring land use changes using remote sensing and geographical information system (GIS) in Gua Musang, Kelantan, Malaysia. *Universiti Putra Malaysia*, 1-141

Townsend, P. A. and Walsh, S. J. (1998). Modelling flood plain inundation using integrated GIS with radar and optical remote sensing, Geomorphology, Vol. 21 (98), 295–312

Uddin, K., Gurung, D., Giriraj, A., Shrestha, B. (2013). Application of remote sensing and GIS for flood hazard management: A case study from Sindh Province, Pakistan. *American journal of Geopraphic Information System, V*ol. 2 (September 1988), 1-5

Umitsu, M, Hiramatsu, T., and Tanavud, C. (2006). Research on the flood and micro landforms of the Hat Yai Plain, Southern Thailand with SRTM Data and GIS. *Geomorphological Union,* Vol. 27 (2), 205-219.

Wang, Y., (2004). Using Landsat 7 TM data acquired days after a flood extent on a coastal floodplain. *International Journal of Remote Sensing*, Vol 25 (5), 959 – 974.

Wang, Y., Colby J. D, and Mulcahy K. A., (2002). An efficient method for mapping flood extent in a coastal flood using Landsat TM and DEM data. *International Journal of Remote sensing*, Vol. 23 (18), 3681–3696.

Werner M.G.F. (2001). Impact of grid size in GIS based flood extent mapping using 1D flow model. *Phys Chem Earth*, Vol. 26, 517–522

Wohl E.E. (2000). Inland flood hazards: human, riparian, and aquatic communities. Cambridge University Press.

Wolman M.G (1971) Evaluating alternative techniques of floodplain mapping. Water Resour Res 7:1383–1392

.