LAND USE/LAND COVER CLASSIFICATION AND CHANGE ANALYSIS BY MULTITEMPORAL REMOTE SENSING DATA

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ABSTRACT

Kuantan is a one largest district in Pahang. Kuantan have rapid development in every aspect. By using Multi-temporal satellite images and application of remote sensing and GIS for land use and land cover change detection were used. The main challenge in land use and land cover changes using the remote sensing data which how to provide the accurate and timely geospatial information. The production of thematic map from this classification by using an image classification is one of the most common way application of remote sensing. This research briefly reviews the background, methods of accuracy assessment that commonly used and recommended in the research literature.This research also for to access the accuracy of multi-temporal classification and change detection. Process that involve in this research are selection data satellite, data correction, classification process, accuracy assessmen

ABSTRAK

Kuantan adalah sebuah daerah yang terbesar di negeri Pahang. Kuantan mempunyai pembangunan yang pesat dalam setiap aspek. Dengan menggunakan imej satelit Multi-temporal dan aplikasi penderiaan jauh dan GIS bagi penggunaan tanah dan perlindungan tanah pengesanan perubahan telah digunakan. Cabaran utama dalam penggunaan tanah dan perubahan permukaan tanah dengan bagaimana menggunakan data penderiaan jauh dalam memberikan maklumat geospatial yang betul dan tepat pada masanya. Pengeluaran peta tematik dari klasifikasi ini dengan menggunakan klasifikasi imej adalah satu cara aplikasi yang paling biasa untuk penderiaan jauh. Kajian ini mengkaji secara ringkas latar belakang, kaedah penilaian ketepatan yang biasa digunakan dan dicadangkan dalam penulisan penyelidikan. Penyelidikan ini juga untuk mengakses ketepatan multi temporal klasifikasi dan perubahan yang dikesan. Proses yang terlibat dalam kajian ini adalah pemilihan satelit data, pembetulan data , proses klasifikasi, dan penilaian ketepatan.

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LIST OF ABBREVIATIONS

ETM	**Enhanced Thematic Mapper**
NIR	**Near Infrared**
R	**Red Reflectance**
NDVI	**Normal Difference Vegetation Index**
PCA	**Principal Components Analyses**
VI	**Vegetation Indices**
RGB	**Red Green Blue**
GIS	**Georgraphic Information System**
SLC	**Scan Line Corrector**

CHAPTER 1

INTRODUCTION

1.1 Introduction

The main challenge in land use and land cover changes using the remote sensing data which how to provide the accurate and timely geospatial information. Urban growth has been long considered a sign of regional economic vigor, but its benefit are increasingly gave negative impacts, to ecosystem, environment, also including about the road traffic, air quality, loss of farming area, social fragmentation and infrastructure cost. Natural Resource Management, Planning and Monitoring programs depend on accurate information about the land cover in a region.

The growing of population and the increasing of socio-economic had create pressure on land use/land cover which lead to unplanned and uncontrolled changes in LULC (Seto, K.C ,2002). Its also give a big impact in biodiversity loss, global warming, and increase the percentage of natural disaster-flooding can be happen. Available data on LULC changes can provide critical input to decision making of environment management and planning the future more better (Seto K.C,2002,Prenzel, B, 2004).

Methods for monitoring vegetation change range from intensive field sampling with plot inventories to extensive analysis of remotely sensed data which has proven to be more cost effective for large regions, small site assessment and analysis. Satellite remote sensing is an evolving technology with the potential for contributing to studies for land cover and change detection by making globally comprehensive evaluations of many environmental and human actions possible.

Satellite image data enable direct observation of the land surface at repetitive intervals and therefore allow mapping of the extent and monitoring. This problems lead to using classification detection by using optical remote sensing data, assess the accuracy of multi temporal classification and change detection and then, analyze urban growth patterns of the study area. The study area of this research will be Kuantan City, Pahang Darul Makmur.

1.2 Problem statement

In an urban environment natural and human-induced environmental changes are of concern today because of deterioration of environment and human health. The study of land use/land cover (LU/LC) changes is very important to have proper planning and utilization of natural resources and their management. Remote sensing has become an important tool applicable to developing and understanding the global, physical processes affecting the earth. The first challenge in remote sensing on how to derived land use map by using optical satellite image data. In order to classified the image, it will using the optical remote sensing data that capture the desired image and easy in developing to the tools.

A variety studies may have addressed to identified the accuracy of land use map, but in this study, one of the method been selected for to determine the accuracy. Other than that, problems that might be faced are on how to calculate the accuracy of derived land use map. By using remote sensing data, there some of algorithm that can be used to provide accurate and timely geospatial information of image being captured. By

histogram equalization that also can improve the image quality and achieve better classification accuracy.

Lastly, that might be a issue in this research are how to calculate land use changing of multi temporal optical satellite image data on Kuantan City. There will cause some errors in the classification of the land use changing.

1.3 Objective

The aim of the project is about research on land use / land cover classification and change analysis by multitemporal remote sensing data. The aim will be supported by 3 objectives. the objectives are:

-To derive land use map from optical satellite image using classification method.
-To access the accuracy of derived land use map.
-To calculate land use changing by using multi temporal optical satellite image.

1.4 Scope

In this research, have its own scope that can be the limitation. My research area are Kuantan city, Pahang Darul Makmur. Classification method that been used only are optical satellite data. The urban growth analysis are just only between two land use data.

1.5 Thesis Organization

This thesis consists of six (6) chapters. Chapter 1 will discuss on introduction to system/research.

Chapter 1: Introduction

This chapter are consist of introduction, problem statement, objective, scope and also thesis organization

Chapter 2: Literature review

Purpose of this chapter is to explain about the selected project, which is land use / land cover classification and change analysis by multi temporal remote sensing data. Review consist of two parts are divided into two sub research, where the student needs to get related information with regards to the project.

Chapter 3: Methodology

This chapter will discussing about the overall approach of the research and framework of this research, land use/land cover classification and change analysis by multi temporal remote sensing data. It should cover method, technique or approach to be used in PSMI, and also describing method that will be use in PSM II. Explain on the method during design and implementation phases then justify their importance. It will also explaining on the method during design and implementation phases and also will justify their importance.

This will covered the introduction in describing on how the project was done, explaining the activities to consider during research development. In methodology, it will discussing about the selected methodology during development of research, describe the activities during research process and also explaining method/techniques/tool/instrument etc. that will be used in the research. Other than that, it will also tell about hardware and software, describing hardware and software that will be use in the project, and justify the importance of the chosen hardware and software. Lastly is the Gantt chart will have to be provided as to show the research phases starting till the project are complete.

Chapter 4: Design and Implementation

The purpose of this chapter is to develop the framework and model through flow work. Continuously designing the research which include any planning of data analysis. It will

discuss the process and data gathering for research process and sketching the work flow and model using software that be choosen.it also will explaining how the data/model/ process/ hardware been implemented into selected algorithm.

Chapter 5: Results and Discussion

The purpose of this chapter is to explain about findings or the results from data analysis. It will covered the result analysis, research constrains

Chapter 6: Conclusion

The purpose of this chapter is to made a conclusion for research that have been done. Its consist of conclusion of the research, all data that retrieve and observe how far its fit on the research and objectives, methodology and research implementation conclusion, future suggestion and enhancement of the research or technique.

CHAPTER 2

LITERATURE REVIEW

2.1 **Literature Review**

Land cover are more refers as the vegetation which is natural and planted, water, bare rock, sand and similar surface and also man-made construction on earth surface. Land use are also refers to a series of operation of lands and carried out by humans, with intention to obtain products and benefits through land resources which including soil resources and vegetation resources(Debie et al. 1996). Land use are often influences the land cover. In context, change were defined to alteration of the surface component of the landscape and only considered to occur if the surface has a different appearance when viewed on two successive occasions(Lemlem,2007).

Land use/land cover are mostly be pressured on growing population and the increasing socio-economic necessities. Its result the unplanned and uncontrolled changes in land use/land change(Seto,2002). It generally caused by mismanagement of agricultural, urban, range and forest lands. This also can lead to severe environmental problems such as floods, landslides, earthquake, wild fire and etc.

Earth surface has it's own unique which in the cover of it possesses. Land use and land change are more distinctly linked characteristics. This are the use that can put

land could gazing, agriculture, urban development, logging, and mining and any others. Meanwhile the land covers could be cropland, forest, wetland, pasture, roads, urban areas among others. According to Meyer (1995), the term land cover originally referred to the kind and state of vegetation, such as forest or grass cover but it has broadened in subsequent usage to include other things such as manmade structures like building, soil type, biodiversity, surface and ground water.

Land cover can also be altered by forces, natural events, such as, wheather, flooding, fire, climate fluctuations and also ecosystem dynamics that also initiate modifications on land cover. Land cover mostly use by agriculture and livestock raising, forest harvesting and management and urban and suburban construction and development.Some of incidental impacts that can be have on land cover from other human activities are crops near cities damaged by troposphere ozone which is resulting from automobile exhaust.

For to use the land optimally, not need to have the information on existing land use/ land cover but must have the capability to monitor the dynamics of land use resulting out of both changing demands whether can increase the population anf forces of nature that acts on shape of the landscape(Meyer,1995). Changes in the area of urban per se, therefore, do not appear to be central to land-cover change. This claim appears to support a misconception that urbanization can be ignored in land change studies. In reality, urbanization affects land change elsewhere throuh the transformation of urban-rural linkages.

According to Morgan(2005) Ground cover exerts a strong moderating impact on dissipating the energy supplied by agents of soil erosion especially rain drop. Soil erosion potential is increased if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff and allows excess surface water to infiltrate. The erosion reducing effectiveness of plant and/or residue covers depends on the type, extent and quantity of cover. Vegetation and residue combinations that completely cover the soil, and which intercept all falling raindrops at and close to

the surface are the most efficient in controlling soil erosion (e.g. forests, shrubs and permanent grasses).

2.2 Role of Remote Sensing in Land Use/ Land Cover Change Detection

Most of the planners and resource managers are need an reliable mechanism to access the consequence of changes by the stress imposed on natural resource by detecting, monitoring and analyzing land use changes quickly and more efficiently. Remote sensing are more likely refers to the technique in order to obtaining about the feature or the information through the analysis of data that required by a device that is have no contact with the object or feature under research (Lillesand and Kiefer, 2000). Remote sensing technology play a vital role in providing accurate and reliable information with more cost effective and more lesser time compared to other method that can be used.

More than that, it also provide a viable source of data which updated land cover information that can be extracted efficiently and cheaply in order to inventory and monitor these changes. Its also has become a major application in remote sensed data because of the repetitive coverage at short intervals and consistent of the image quality(Mas, 1999).According to Lillesand et.al(2005), remote sensing data has helped in the development of various environmental management methodologies. Some of advantages that are synoptic view that facilitate the remote sensing to study the various between type of features of earth's surface and the relation of the spatial. The accessibility of remote sensing data makes its possible to gather the information about areas that impossible to be accessible for ground surveys such as mountains or foreign lands. Since the information can be gathered quickly by using this method, these techniques are more save the time and the effort.

Satelite imaginery has been used for measuring qualitative and quantitative terrestial land cover changes(Cambell, 2002). Qualitative changes in landscape occur either as natural phenomena or can be human induced. Quantitative land cover change are the wholesale categorical transformation of the land and can occur as natural phenomenon that be caused by fires and storms, another that usually induced by human

activity are the forest clearing, agricultural expansion and urban growth. Both of qualitative and quantitative changes in land cover successfully monitored by remote sensing, which dominated by efforts at monitoring change at vegetation and forest canopies(Cambell, 2002). Urban areas refer a both a type of land utilization and a particular land cover. These are two concept that essentially identical.

2.3 Basic Concept in Image Analysis

Remote sensing change detection techniques can be classified as pre-classification or post-classification change methods.A pre-classification process are more refers to operations that carried out to bring satellite images to the desirable geometric and spectral standard by correcting the errors, and performed prior to image classification.Pre-classification methods can be characterized as being spectral or phenology based. While for post-classification methods are more refers to activities that done after classification of images like computation of class statistics, accuracy assessment, and map preparation.

Post -classification approach was considered to be the most reliable approach and was used to evaluate emerging methods. Factors that can limit the application of post-classification change detection techniques include cost, consistency, and error propagation.Numerous pre-classification change detection approaches have been developed and refined to provide optimal performance over the greatest possible range of ecosystem conditions.

Remotely sensed data provides an operational GIS with timely and synoptic data. Image analysis techniques are commonly utilized to perform regional vegetation mapping and to update existing vegetation maps. The utility of a sensor system for the detection of surface must be assessed in four dimensions that is spatial resolutions which area or size of features that can be identified, spectral resolution which number and width of electromagnetic bands for which data are collected, radiometric resolution which is the detector sensitivity to various level of incoming energy and the lastly are temporal resolution which is the frequency of satelite overlaps.

Satelite digital sensor collect and store data values for discrete units of the surface of the earth, they are composed of large matrix of cell which referred to a picture element or pixel that may correspond to a square meter, hectare or square kilometer, and depend on the sensor. The spatial resolution are usually expressed as the length of one side of the cell.

A major attribute to landscape is the spatial pattern and structure. It is shown that the detection of land-cover change processes by remote sensing is improved when both spectral and spatial indicators of surface condition like slope and topography are used. Temporal aspects of natural phenomena are important for image interpretation because of the factors as vegetation growth and soil moisture that may vary during every year. The changes in landscape spatial pattern are more likely to reveal long term and long lasting land cover changes.

2.4 Common operations in Digital Image Processing of Satellite Images

Digital image processing are commonly refers to the interpretation and analysis by a computer system where to prepare for display aand ectracr useful information from the choosen image. Its are largely concerned with four basic operations which is, image retification, image transformation, image enhancement, and image classification(Lillesand et al 1998).

2.4.1 Pre-Processing

Raw satelite image are full of errors and cannot directly utilized for features indentification or used for any applications.Pre-processing are done before the main data analysis and extraction of information. This process involves of two major processes: geometric correction and radiometric correction or haze correction. Remote sensing imageries the subjected to the geometric distortions. This may be due to the perspective of the sensor optics, the motion of scanning system,the terrain relief, and the motion of the platform which is the platform of altitude, attitude and velocity.

This process are aim to correct the distorted data in order to create more clear representation of the original scene, this more involves the initial of raw image data to be correct for geometric distortions, to calibrate the data radiometrically and eliminate noise present in the data.

2.4.2 Image Enhancement

This process are used to increase the detailness of image by assigning the image maximum and minimum to display the values and done in pixel values. This visual interpretation easier by increasing visual discrimination between features in scene and assist human analyst.

Image enhancement techniques can be divided into two broad categories:

1. Spatial domain methods, which operate directly on pixels
2. Frequency domain methods, which operate on the Fourier transform of an image.

2.4.3 Image transformation

According to Richards(1999) transformation are involves processes that are similar in concept to the processes of image enhancement, but unlike image enhancement these process are normally applied on multi channel (band) images. Principal Components Analyses (PCA) and Vegetation Indices (VIs) are among image transformation processes. The multispectral or multidimensional nature of remote sensing image data can be replaced by constructing a vector space with as many axes or dimensions as there are spectral components that associated with each pixel(Richards, 1999).

2.4.4 Image classification

Based on Bakker et al (2000),Image classification is the thematic characteristics of an area. Example of Thematic characteristic such as land cover, land use, soil type and etc that can be used for further analysis and input to models. In addition, image

classification can also be considered as data reduction that is a number of multispectral bands resulted in a single value raster file.

This classification are the operation to replace the visual analysis of the image data with quantitative techniques for automating the identificatin of features.Image classification is the process of creating thematic maps from satellite imagery. A thematic map is an informational representation of an image that shows the spatial distribution for a particular theme.

Based on to Diday(1994),Unsupervised classification is computer-automated and it enables user to specify some parameters that the computer uses to uncover statistical patterns that are inherent in the data meanwhile, supervised classification the image analyst supervises the pixel categorization processes by specifying, to the computer algorithm, numerical descriptors of the various land cover types present in a scene.

For Land use/land cover data needed for planning and management purposes, the accuracy of interpretation at the generalized first and second levels is satisfactory when the interpreter makes the correct interpretation 85 to 90 percent of the time. According to Jensen (1996) and Landgrebe (2003), each pixel in the data set is then compared numerically to each category in the interpretation key and labeled with the name of the category. There are different algorithms under this classification type, which minimum distance, variance and covariance of the classes are considered during classification.

2.4.5 Accuracy of image Classification

The accuracy are measurement of how many ground truth pixels that were classified correctly.Its important to remember that no map that perfect representation of reality . There always have error in maps and need to keep in mind how to accurate the errors and know whetheher the level of accuracy are sufficient for the ways that want to use the map information(Awotwi, 2009).

The result of an accuracy assessment provides with an overall accuracy of the map based on average of the accuracies for each class in the map.

$$\text{Overall accuracy} = \frac{\text{Number of pixels correctly classified}}{\text{Total number of pixel}} \quad [2.1]$$

Kappa is used to measure the agreement or accuracy between the remote sensing derived classification map and the reference data as indicated by the major diagonals and the chance agreement, which is indicated by the row and column totals (Jensen 2003). Producer's accuracy is the total number of correct pixels in category that divided by the total number of pixels of that category as derived from the referece data.
The Kappa factor is given by the formula(Jensen 2003):

$$\text{Kappa(K)} = \frac{Po - Pe}{1 - Pe} \quad [2.2]$$

Where:
Po = is the proportion of correctly classified cases
Pe = is the proportion of correctly classified cases expected by chance.

The user's accuracy or reliability is the probability that a pixel classified on the map actually represent that category on the ground (Jensen 2003). User's accuracy is when the total number of correct pixels in a category divided by the total number of pixels that were actually classified in that category (row total), the result is a measure of commission error.

2.4.6 Change detection approach

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times. It involves the ability to quantify temporal effects using multi temporal data sets(Singh, 1989). This detection

can be broadly divided into post-classification, and spectral change detection approaches (Chen, 2000).

- Post classification approach

This techniques are most widely being used for change detection purpose. Its approach two images from different dates that be classified and labeled. The are of changes are the extracted through the direct comparison of the classification results. Main advantages are its more detailed information. The main disadvantage of the post classification approach is the dependency of the land cover change results on the individual classification accuracies. This approach can produce a large number of erroneous change indications since an error on either data gives a false indication of change (Singh, 1989).

- Spectral change detection approach

According to Chen (2000), a large number of techniques are in the spectral change identification category. This technique are more rely on the principle that land cover changes the result in persistent changes in spectral signature of the affected land surface. These also involves the transformation of two original image into a new single band or multiband image which area of spectral change are highlighted. Its mostly based on some type of image diffrencing.According to Singh, 1989, identified image differencing as the most accurate change detection technique. This technique is performed by subtracting images from two dates pixel by pixel. Then threshold boundaries between .change. and .no-change. pixels are determined for the different image to produce the change map.

Among spectral change detection methods, Normalized Difference Vegetation Index (NDVI) image differencing emerges as one of the most widely used. NDVI is a measure derived by dividing the difference between near infrared (NIR) and red reflectance (R) measurements by their sum (Singh, 1989):

$$\text{NDVI}=\frac{(NIR-R)}{NIR+R} \qquad [2.3]$$