Comprehensive Environmental Change Analysis In Tropical Area Using Remote Sensing Technique

Togi Tampubolon

Universiti Sains Malaysia (USM)
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Comprehensive Environmental Change Analysis In Tropical Area Using Remote Sensing Technique

by

Togi Tampubolon

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LIST OF ABREVIATIONS

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BPS	Badan Pusat Statistik (Central Bureau of Statistics)	3
Landsat	Land Satellite	8
TM	Thematic Mapper	8
ETM+	Enchanced Thematic Mapper Plus	8
OLI	Operational Land Imager	8
LST	Land Surface Temperature	8
NDVI	Normal Difference Vegetation Index	8
GNP	Gross National Product	20
GPS	Global Positioning System	24
NOAA	National Oceanic and Atmospheric Administration	27
AVHRR	Advanced Very High Resolution Radiometer	27
SPOT	Satellite Pour l'Observtion de la Terre	41
GIS	Geographic Information System	56
WGS	World Geodetic System	32
UTM	Universal Transverse Mercator	32
RMS	Root Mean Square	34
DN	Digital Number	36
DEM	Digital Elevation Mode	37
MODIS	Moderate Resolution Imaging Spectroradiometer	40
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer	40
PVI	Perpendicular Vegetation Index	40
DVI	Difference Vegetation Index	40
AVI	Advanced Vegetation Index	40
WDVI	Weighted Difference Vegetation Index	40
NIR	Near Infrared	40
RGB	Red, Green, Blue	40
MSS	Multi Spectral Scanner	42

NASA	National Aeronautics and Space Administration	43
TIRS	Thermal Infrared Sensor	44
LSWI	Land Surface Water Index	44
NBR	Normalized Burn Ratio	44
USGS	United States Geological Survey	48
UHI	Urban Heat Island	51
NDBI	Normalized Difference Build-up Index	52
TVDI	Temperature-dryness Vegetation Index	53
SWIR	Short Wave Infrared	58
IM	Index Mangrove	60
LDCM	Landsat Data Continuity Mission	60
FAO	Food and Agriculture Organization	60
FCD	Forest Canopy Density	65
BI	Bare Soil Index	70
SI	Shadow Index	70
ISODATA	Iterative Self-Organizing Data Analysis Technique	71
TI	Temperature Index	71
VD	Vegetation Denxity	71
ASI	Advanced Shadow Index	71
TBE	Tingkat Bahaya Erosi	76
OBIA	Object based Classification System	77
ENVI	Environment for Visualizing Images	86
RAM	Random Access Memori	86
HDD	Hard Disk Drive	86
MSR	Multispectral Radiometers	86
RBI	Rupa Bumi Indonesia	87
BMKG	Badan Meteorologi dan Geofisika	87
BIG	Badan Informasi Geospasial	91
GCP	Ground Control Point	91
DOS	Dark Object Substraction	92
TOA	Top of Atmosphere	92
LCCS	Land Cover Classification System	125
ROI	Regent of Interest	141

LIST OF PUBLICATION

No	Name of Confferene / Seminar	Title of Scientific Article	Author	Time and Place
1	Map ASIA 2010 Kuala Lumpur	Application Of object based approach using ASTER Data of land use and land cover classification in coastal zone of Medan, Sumatera	Togi Tampubolon, Khiruddin Abdullah, Lim Hwee San	26-28 July 2010 Kuala Lumpur
2	International Journal of Tomography and Simulation (IJTS)	Comparison Of pixel and object based approaches using landsat data for land use and land cover classification in coastal zone of Medan, Sumatera	Togi Tampubolon, Khiruddin Abdullah, Lim Hwee San	29 December 2013
3	Badan Kerja Sama Perguruan Tinggi Negeri Wilayah Barat (BKS PTN -B)	Identifikasi Dan Hubungan Indeks Vegetasi Dan Suhu Permukaan Menggunakan Citra Satelit Landsat Di Wilayah Pesisir Langkat, Sumatera Utara	Togi Tampubolon, Khiruddin Abdullah, Lim Hwee San	12 May 2012 Indonesia
4	Medan Institude of technology	Land Use And Land Cover Classificaion Using Satellite Image In Coastal Area Of Medan For Disaster Mitigation Purposes	Togi Tampubolon, Khiruddin Abdullah, Lim Hwee San	23 Juny 2012 Medan
6	IRESGISWS-DLUCD ITB	Identification Of Land Degradation in Coastal Zone Based on NDVI In Mulltitemporal landsat Imagery	Togi Tampubolon, et al	29 November 2012 Bandung
7	Padjadjaran International Physics (PIPS), American Institute od Physics	Spectral characteristics Of land cover based on spectrometer cropscan MSR 16R (Case Study in Medan-Indonesia)	Togi Tampubolon, Khiruddin Abdullah, Lim Hwee San	7-9 May 2013, Jatinagor Indonesia
8	Medan State of University International	Spectral characteristics Of land cover based on spectrometer cropscan MSR 16R (Case Study	Togi Tampubolon, Khiruddin	Desember 2014

No	Name of Confferene / Seminar	Title of Scientific Article	Author	Time and Place
	Physics, Medan Indonesia	in Medan-Indonesia)	Abdullah, Lim Hwee San	
9	Jakarta State of University International Physics, Jakarta Indonesia	Aplikasi Pemanfaatan Citra Satelit Landsat untuk Mengidentifikasi Perubahan Lahan Kritis di Kota Medan dan Sekitarnya	Togi Tampubolon, et al	June, 2015
10	National Seminar of Innovation and Information Technology (SNITI) II	Pemanfaatan Citra Satelit Landsat Untuk Mengidentifikasi Perubahan Suhu Dan Vegetasi Di Kabupaten Samosir	Togi Tampubolon, Jeddah Yanti	September, 2015
13	Journal Einstein, State University of Medan	The Utilization of Landsat 8 OLI Sattelite Image to Identify Critical Land Areas in Pakpak Bharat Regency	Togi Tampubolon, Jeddah Yanti	December 2015

Analisis komprehensif mengenai perubahan alam sekitar di kawasan tropika dengan menggunakan kaedah penderiaan jauh

Abstrak

Pertumbuhan penduduk yang semakin meningkat setiap tahun menyebabkan masaalah alam sekitar yang berterusan seperti keperluan untuk penempatan tanah, pertanian, perladangan, dan lain-lain. Peningkatan permintaan untuk mendapatkan tanah tidak diikuti oleh ketercukupan tanah . Ini mencetuskan beberapa isu , seperti banjir, kebakaran hutan, tanah yang teruk, dan lain-lain yang boleh membawa kepada perubahan persekitaran. Kajian ini bertujuan untuk menganalisis perubahan alam sekitar, pemantauan berkala dan meramalkan perubahan yang akan berlaku pada masa akan datang.

Perubahan dalam persekitaran yang boleh dikaji dengan menggunakan data imej satelit Landsat berada di lintasan 29 dan Sektor Barisan 057 dalam 4 tempoh masa iaitu tahun 1989, 2005, 2011 dan 2014. Kaedah yang digunakan dalam kajian ini adalah kaedah survei lapangan bagi titik sampel, suhu dan spektrometer untuk mengesahkan penggunaan guna tanah / litupan tanah serta sistem maklumat geografi digabungkan dengan teknik penderiaan Jauh yang bertujuan menganalisis perubahan alam sekitar. Analisis perubahan iklim dapat dilihat melalui perubahan yang diwujudkan pada suhu, tumbuh-tumbuhan atau NDVI (Normal Different Vegetation Index), klasifikasi, kelembapan tanah atau TVDI (Thermal Vegetation Density Index), hutan tumbuh-tumbuhan bakau dan tanah tahap kritikal.

Parameter NDVI pada tahun 1989, 2005, 2011 dan 2014 mempunyai nilai urutan iaitu : 0,236, 0,192, 0,185 dan 0,172 yang menunjukkan penurunan dalam tahap kehijauan tumbuh-tumbuhan ke kawasan tropika, terutamanya Bandar Medan dan kawasan sekitarnya. Nilai suhu pada tahun 1989, 2005, 2011 dan 2014 masing-masing adalah 29 °C,521 °C, 29 °C,821 °C, 30 °C,589 °C, 34 °C,163 °C yang menunjukkan peningkatan dalam suhu bagi kawasan tropika, khususnya Bandar Medan dan kawasan sekitarnya. Penukaran tanah pada tahun 1989, 2005, 2011 dan 2014 dalam titik 50 (Lapangan Terbang Antarabangsa Kuala Namu) menerangkan perubahan hutan, tumbuh-tumbuhan, dan tanah lapang. Indeks hutan bakau tahun

1989-2014 mempunyai graf persamaan linear yang telah menurun sebanyak 0.0045 Ha, kelembapan tanah dari tahun 1989-2014 juga menurun sebanyak 0.043357 Ha dan peningkatan tanah kritikal dari tahun 1989-2014 meningkat sebanyak 562.5 Ha. Dan keputusan 51 titik pemantuan menunjukkan bahawa alam sekitar berasakan kepada enam parameter. Dua contoh yang diambil daripada titik pemantuan adalah Lapangan Terbang Antarabangsa Kuala Namu dan Jabatan Walikota Medan. Dari keputusan kesemua parameter, model persamaan untuk meramalkan alam sekitar pada masa akan datang boleh dilakukan, sebagai contoh pada tahun 2020. Menurut ramalan jumlah keseluruhan tanah degradasi akan berada pada 810.45 Ha. Enam parameter itu boleh dikatakan bahawa terdapat perubahan dalam alam sekitar. Keputusan jangkaan berlaku jika tidak ada tindakan susulan dari segi fizikal. Sumbangan hasil daripada kajian ini boleh digunakan dibidang sains fizik, terutamanya geofizik, menyokong polisi pemerintah untuk perubahan alam sekitar, dan sebagai alat bagi memantau perubahan dalam tanah untuk meramalkan keputusan masa hadapan.

Comprehensive on Environmental Changes Analysis in the Tropical by Using Remote Sensing Techniques

Abstract

Population growth which is increasing every year causes ongoing problems such as the need for land for settlements, agriculture, plantation, etc. The increasing demand for land is not followed by the availability of land. This triggers some **issues**, such as floods, forest fires, severe land, etc. which can lead to environmental changes. The review aims at analyzing the changes in the environment, emphasize to environmental changes, periodically monitoring and predicting changes that occur in the future.

Changes in the environment can be examined by using Landsat satellite imagery data on Path 129 and Row 057 within 4 periods of time, i.e 1989, 2005, 2011 and 2014. The method used in this study is field survey for sample point, temperature and spectrometers to verify the land use / land cover and geographic information system combined with remote sensing technique that aims to analyze the changes in the environment. The analysis of climate change can be seen through the existed change in temperature, vegetation or NDVI (Normal Different Vegetation Index), classification, soil moisture or TVDI (Thermal Vegetation Density Index), mangrove forest vegetation and soil critical level.

NDVI parameters in 1989, 2005, 2011 and 2014 have a sequence value that is 0.236, 0.192, 0.185, and 0.172 which shows a decrease in the greenness level of vegetation to the tropics, especially the city of Medan and its surrounding areas. Temperature values in 1989, 2005, 2011 and 2014 are respectively 29.521, 29.821, 30.589, 34.163 ° C which shows an increase in temperature for the tropics, especially the city of Medan and its surrounding areas. The land conversion in 1989, 2005, 2011 and 2014 within point of 50 (Kuala Namu International Airport) describes the changes of forest, vegetation, and vacant land. Mangrove forests index of the year 1989-2014 has the linear equations graph which have decreased by 0.0045 ha, soil moisture from the year 1989 to 2014 is decreased by 0.043357 Ha and the increasing of critical lands from the year 1989 to 2014 is increased by 562.5 ha. And the results

of the 51 observation points show that there have been environmental based on six parameters. Two examples taken from the observation point are Kuala Namu International Airport and Medan Mayor Office. From the results of all parameter, the equations model to predict the environment in the future can be made, for example in 2020. It is predicted that total of critical land will be 810.45 ha. Among the six parameters, it can be said that there has been a change in the environment. The prediction results occur if there is no follow-up in terms of physical. Contributions resulting from this study can be used as physical science, especially geophysics, supporting of government policy to environtmental changes, and as a tool for monitoring changes in land to predict future results.

CHAPTER I

INTRODUCTION

1.1 Background of Study

Climate of a region is closely related to the location of the latitude and altitude on earth. Based on the location of the latitude and altitude, the climate can be divided into two kinds, which are sun climate and physical climate. Sun climate is based on the extent of the sunlight received by the Earth's surface. This climate is divided into: tropical, sub-tropical, moderate and cold climates. What becomes the next discussion is a tropical climate.. The tropical climate is characterized by the high average air temperature since the sun is too vertical, temperatures are generally between 20-23° C. Even in some places, the average annual temperature reaches 30° C, the air pressure is low and changes slowly, the rainfall intensity is higher than the other parts of the world (Meteorology and Geophysics, 2013). Several countries in Asia, Africa, America and Australia are tropical. Whrereas the tropical areas can be defined as an area that lies between the isotherm line to the north and south or the area that lies between 23.5° north latitude and 23.5° south latitude.

Some countries with the tropical climates are all countries in Southeast Asia, Hongkong, Taiwan, India, Bangladesh, Sri Lanka, Maldives, Saudi Arabia, Oman and Yemen. Indonesia is one of the countries in Southeast Asia, while Medan and the surrounding areas are one of the big cities in Indonesia.

Medan is situated between 3º.27'- 3º.47' north latitude and 98º.35 '- 98º.44' east longitude with a height of 2.5 to 37.5 meters above sea level. Medan borders on the Deli Serdang regency in North, South, East and West. Medan has an area of approximately 265.10 km^2. Medan as one of big city in Indonesia has two station that measure the temperature in this city. Polnia station and Sampali station. According to the Polonia station Medan has a tropical climate with the minimum temperatures of 23.99º C in 2013 and the maximum temperature of 32,11º C according to Polonia station. While according to the Sampali station, the minimum temperature is 21.8ºC and the maximum temperature is 32º C (Central Bureau of Statistics, 2014).

Climate change occurs because of the changes in temperature, air pressure, wind, rainfall and humidity. The above changes are related to the changes in the environment, the changing environment issue in Indonesia and in the world is a very sensitive matter, such as forest fires (which continued until now), floods, air pollution, waste disposal plant, land use change, including the implementation of spatial plans that is not accordingly, so that the land use changes. The number of mangrove forests has been exploited out due to the supply of residential land, tourism and timber.

Medan is traversed by three (3) major rivers namely Sungai Belawan Sungai Deli, and the Sungai Denai, which are spread throughout the city of Medan. Sungai Belawan upstream comes from Karo district, while Sungai Deli and Sungai Denai are located in Deli Serdang. Hundreds of houses in the outskirts of Sungai Babura in Tuntungan were flooded up to as high as 2 meters on 1 April 2011. The floods that hit neighborhoods in

Kelurahan Mangga, Perumnas Simalingkar, occurs due to the water delivery from Sungai Belawan upstream in Sibolangit, Deli Serdang. Sungai Babura which is a tributary of Sungai Deli could not accommodate the high water flow due to the heavy rain in Medan and Deli Serdang. The floods which inundated hundreds of homes maderesidents be forced to evacuate to higher place (National Search and Rescue Agency, 2013).

Fires in Medan, based on the data from the Office of Fire Prevention (P2K) from 1999 to 2011 shows numbers of single-fire, which would be caused by personal negligence. While mass fires generally occur because of the proximity between the building and the other buildings. One of them is dozens of homes burned in Medan Area (21 September 2012) and Medan Denai (June 10, 2012) (National Search and Rescue Agency, 2012).

The number of natural disasters over the years is rising, for instance an earthquake which were 72 cases in 2009, 122 cases in 2010, 120 cases in 2011 and becomes 92 cases in 2012. The earthquake causes the land to change. Land changes in terms of geography (Climatology Meteorology and Geophysics, 2013).

Changes in the region based on the development of urban areas can be characterized by the imbalance of the areas development and the unevenly spread of regional service centers for the community, so it caused these following problems: the tendency of over-concentration in the specific area of the region; the development of mixed land use; the occurrence land conversion upon the open space, conservation land, green space which

turn into an intensively developed areas (residential, industrial, offices, infrastructure) and the existenceurban sprawl on suburb. Medan is included as one of the cities with a quite high level of development. The area development in Medan iswidened instead of upwards, so that it caused an increase over the land conversion of green areas into settlement.

The development of agriculture, settlements and others led Medan into one of the cities with a quite high number of population. An increase in population is predicted to continue by around 1.7% from 5.7 billion annually (Blackett, 1996). The population continue to increase every year that more land is required for settlements. This leads to the increased land shift or change in land use such as forests to residential areas. For example,the land shift in the suburb of Medan which is initially mangrove forests into settlement. The population growth causes the land conversion so it causes the increasing of the Earth temperature due to the increasing number of open land that caused the absorption of heat from the sun is getting low. Thus, the population growth leads to the increased of the Earth's surface temperatures. This is supported by a statement from NASA, that by 2100 the Earth's surface temperature would feel like hell, one of them is Indonesia, especially Medan (National Aeronautics and Space Administration, 2016).

Air temperature rises in India and Thailand reaching its peak above 40 ºC, this has caused more than 1000 casualties (BBC, 2015). In Singapore, the air temperature can reach 36 ºC in the day-H, and 33-34º Celsius in the other days, it can even rise to 9 ºC than usual on the date of the equinox, which is March 20, 2016. Equinox occurs as much as twice in a year. But Equinox this year is called differently as it's affected by El Nino.

Equinox is a phenomenon in which the sun is exactly on the equator that the sun is really overhead at noon. On March 21, the sun crosses the equator from south to north. At that time, the both southern and northemhemis sphere receive sunlight (National Institute of Aeronautics and Space, 2016).

The Earth's environmental surface have change in local, regional and also global scale. The increasing environmental changes not only lead to an increase in temperature, land conversion, but cause a variety of natural disasters, such as: flood, fire, etc. Fires in Indonesia takes place annually such as forest fires in Sumatra and Kalimantan. It becomes one of the things that accelerate the Earth's surface temperature. As a result of the overall negative effects of any comprehensively occuring changes, the potential for degraded.

Large areas of the region's cropland, grassland, woodland and forest are now seriously degraded. Water and wind erosion are the major problems but salinity, sodicity and alkalinity are also widespread; water tables have been over-exploited; soil fertility has been reduced; and where mangrove forest has been cleared for aquaculture or urban expansion, coastal erosion has been a common result. Finally, urban expansion has become a major form of land degradation, removing large areas of the best agricultural land from production. The effect of these forms of land degradation on cereal production has so far been masked by the increasing levels of agricultural inputs that are used. However, production of other crops, such as pulses, roots and tubers, has now begun to decline. It is no coincidence that these crops arc grown on land with low production

potential, where rates of land degradation are highest (FAO 2016). Within Indonesia, Sumatra Island stands out due to the intensive forest clearing that has resulted in the conversion of 70% of the island's forested area through 2010. We present here a hybrid approach for quantifying the extent and change of primary forest in Sumatra in terms of primary intact and primary degraded classes using a per-pixel supervised classification mapping followed by a Geographic Information System (GIS)-based fragmentation analysis (Margono, 2012).

The environmental changes caused by several parameters, among others NDVI, LST, Land Use and land Cover, mangrove Index, TDVI, pH, and Land Degradation. Same research have been used to 2 parameters to calculate environmental changes(can be seen in Table 2.22). Nowaday, There has not been any comprehensip and specific research conducted to observe the environmental changes involving the enviromental parameters.

The breadth of Indonesia land makes it not easy for Government to prevent the damaged. So it is important to the goverment to find any solutions to solve the problem. The manual monitoring or direct monitoring of environmental is not efficient for the example of field survey to observe and determine the location of the observation point with GPS. So the technology development can be advantage such as quickly process, relatively cheap and rapid method of acquiring up-to-date information for monitoring the environmental change.

The solution provided from this study is that using the latest and updated technology which enables the fast, efficient, easy and cheap monitoring for the wide areas namely the remote sensing technology. Remote sensing is a new technology that can monitor a wide range of problems existing on the surface of the earth comprehensively, such as forest fires, land conversion and increasing of the Earth's surface temperature (USGS, 2014). The remote sensing method using Landsat's image satellite having metadata and image satellite calculating environmental changes issues. The Landsat Program is a series of Earth-observing satellite missions jointly managed by NASA and the U.S. Geological Survey.In 1972, the launch of ERTS-1 (Earth Resources Technology Satellite, later renamed Landsat 1) started the era of a series of satellites that have since continuously acquired space-based land remote sensing data. Remote sensing is extremely useful for understanding the spatiotemporal land cover change in relation to the basic physical properties in terms of the surface radiance and emissivity data. Since the 1970s, satellite-derived (such as Landsat Thematic Mapper-TM) surface temperature data have been utilized for regional climate analyses on different scale . Medan is a city with the large area, so that this technology is expected to assist and facilitate the institution or government in further surveillance or monitoring for problems that may occur in the city of Medan and surrounding areas.

Several previous studies that have used remote sensing technology for monitoring a region are the use of remote sensing in Yogyakarta by Dimyati et al. (1996), land use monitoring by using remote sensing technology in Tehran, Iran (Tayyebi et al., 2008), land use monitoring by using remote sensing technology in Rize, North-East Turkey

(Reis, 2008) and the increased land use for settlements that occurred in Tirupati, India (Mallupattu and Reddy, 2013). The results of these studies, spesifically the changes for each parameter help the researchers in conducting a study on the Comprehensive Environmental Changes using the analysis in the Tropics with Remote Sensing Technique.

1.2 Problem Statement

The prevailing environmental issues in Indonesia and around the glove are very sensitive matter that need to be addressed. The changes are caused by the negative effects of human activities on environtment such as a forest fire, floods, air pollution, waste disposal plant, land use change, including the implementation of spatial plans that are not accordingly. One of the examples of land use changes is the number of mangrove forests that has been exploited for residential, tourism and plantation purposes.

With environmental issues on the increase, Indonesia must made provision against this harmful effects on its environtment. Monitoring of environmental change can be used to reduce the land damage. The environmental change can be monitored by using the change in 6 parameters. The parameters are NDVI, LST, Land use/Land cover, TDVI, Mangrove forest and degraded land parameters. The environmental protection can be achieved using two methods including manual monitoring and technological monitoring.

The manual monitoring or direct monitoring of environmental change is not efficient, s technology can be used for monitoring the environmental change, for example by using remote sensing. Integration between remote sensing and field observation data is able to provide excellent result to meet those needs. Therefore, detection of changes in land and other parameters uses the various combination of remotesensing methods such as a multispectral and thermal satellite sensors. The result for environmental change in future can be predicted using model of land degradation that can be obtained from the calculated changes of vegetation, humidity and mangrove forest of every period.

1.3 Research Objectives

1. To analyze the changes of vegetation, temperature, land use/land cover, mangrove forest, humidity and degraded land by using multi-temporal Landsat TM/ ETM + /OLI satellite data since 1989 to 2014.
2. To find correlation between NDVI and LST, NDVI and degradation, LST and degradation, degradation and land use/land cover since 1989 to 2014.
3. To estimate/predict use model degradation land for the environmental change future from degradation land.

1.4 Research Scope

This research is mainly focus on environmental change using 6 parameters such as NDVI, LST, Land use/Land cover, TDVI, Mangrove forest, degradation in tropical area. Spatial data of environmental change used in this study were collected from images of Landsat for 3 types such as Landsat TM ETM+ and OLI with recording date March 17,

1989, July 10, 2005, August 05, 2011 and July 28, 2014. The tropical area is medan and coastal. This research is aimed at estimating the environmental change using a model. The model isuse to predict the change in Land degradation in tropical area.

1.5 Research Contribution

The contributions of the research are helping governments and communities to monitor and prevent environmental damage and to predict future environmental damage.The comprehension of this study contributes to the science devoted to the physics. Results of this research will be publicly published and can be used by Governments to anticipate the negative effects of environmental change. The results could contribute to the planning of the suffered region because of environmental damage. Moreover, the results of this study can also be used for the development of science and technology.

Research contribution can be classified into two categories,

1. Physical contribution, used by application, applied with model prediction to predict how about environment change in future. Its had benefits such efficient, quickly, cheap.
2. Contribution to the body of knowledge based on your finding from the literature.

1.6 Outline of The Thesis

Generally, the dissertation chapters contain an outline of the subjects discussed followed by a presentation, analysis and discussion of the research results. The dissertation begins with the introduction, research literature, research methodology, result and discussion, conclucion. In the Chapter 1, The work present are introduction what your background for research, problem statement, research objectives, research scope, novelty of study,

research contribution and structure of the thesis. Then, chapter 2 provides field spectral data measurement as well as gives an overview of the application of remote sensing data for vegetation, temperature and degradation mapping explaining the pixel and object-based classification system. Furthermore, Chapter 3 provides field of work, tools and material research, research methodology and model prediction. However in Chapter 4, The result and discussion about the process and calculation of vegetation index, temperature, degradation, land use and land cover classification including the accurate assessment itself, describes a correlation between NDVI and temperature as well as a correlation between degradation and land use. Finally, Chapter 5 further summarizes the overall research outcome, gives recommendations for its implementation and suggestion for future research activities.

CHAPTER II

LITERATURE REVIEW

This chapter will discuss the various theories and other supporting information data used in this study. In general, this chapter will be divided into several sub-sections including: characteristics of the study area; theories and various applications of satellite remote sensing data in a variety of existing research; application of multispectral remote sensing satellite data on vegetation cover, temperature, degradation estimation and land use-land cover classification; theories, concepts, as well as a variety of applications from field measurements using a spectrometer is used as supplementary information and spectral validation.

2.1 Characteristics of Research Area (Tropical Area)

The tropics are the part of earth between 23.5’ degrees north and 23.5 degrees south of the equator. The tropics (from the Greek – turning circle) may be (and are) defined in scientific literature in several different ways. Purely geographical definition locates the tropical zone between the Tropical of Cancer (230.27 N) and the tropical of Capricon (230.27 S). From the astronomic point of view, these are the latitudes where the Sun once a year is situated stricly in the zenith. This occur on 22 June in the Northern Hemisphere and on 22 December in the Southern Hemisphere (the so-called summer and winter solstices). Meteorologically the appointed of a (special) tropical zone is easily expained by the fact that the weather types all over that zone are homogeneous. The huge subtropical Highs (as the Azores and

Honolulu Highs) are situated at its poleward sides, with the very steady (especially over the oceans) trade winds are in between. In former times sailors made good use of the trades to reach America from the Old World (hence the origin of the term). The above definition was introduced in the 1960s by Palmen and Newton. Alternative definitions of a line dividing the moderate and tropical tropopause and the equatorward tropopause of middle latitudes in the corresponding month and season (Petrossiants). The details of the atmospheric general circulation in the tropical and subtropical zones are given in Section .

The main function of the tropical circulation in the heat engine of the atmosphere is to transfer the excess of heat being accumulated in low latitudes because of the intensive absorption of solar radiation, to other parts of the atmosphere. Permanently

maintained temperature difference between the equatorial area and the subtropics is thusthe main driving force of air currents in the tropical circulation. This results in the large-scale circulation systems which are either very steady (trade winds) or exclusivelyperiodical (monsoons). These systems form the basic flow of the tropical atmosphere.

Equatorward flow near the ground spread from the subtropical Highs is deflected by the Coriolis force to the right in the Northern Hemisphere and to the left in the Southern Hemisphere making the trade winds, respectively, blow from the northeast and southeast. With moist and warm air rising at the equator (in the equatorial trough) anddry warm air sinking at about 30° N or S, it creates the so-called Hadley cell outlinedalready in 1735 by George Hadley, the simplified circulation model in the tropical zone.

This cell explains why there is so much precipitation in the equatorial regions called the dol drums, meaning much rain and light winds. On the other hand, at latitude 30° northor south, the air sinking results in skies being clear most of the time. There is littleorganized motion near the ground here; sailors have often been becalmed in this area.As there is also almost no rain, most of the world's deserts are found here. This latitudeband is often called the horse latitudes because sailors sometimes threw overboard (orperhaps ate) horses they could not feed.

Actually, the above picture is too idealized. The maximum rainfall often occurs justnorth and south of the equator. It is closely connected with the apparition of the Intertropical convergence zone (ITCZ) thoroughly studied, in particular, during GATE.As common in the tropical circulation system as trade winds and subtropical Highs are,the ITCZ migrates extensively from season to season (Sitnikov, 1975). Salah satu wilayah di Indonesia yang termasuk dalam kategori tropis yakni Kota Medan.

2.1.1 Medan History

Kota Medan or Medan City, which the capital of North Sumatra Province, is one of four largest cities in Indonesia known as a forest with many trees and plants. Guru Patimpus formed a village located in this area, named Tanah Deli. Later, Guru Patimpus sent his children to studied Al-Qur'an and Islam to Aceh. According to the history, around 1612, Sultan Iskandar Muda sent Gocah Pahlawan as the delegation from Aceh Kingdom for Tanah Deli. Gocah Pahlawan gave remarkable success for expanding the area and formed Deli Palace after married with daughter of Datuk Sunggal. Gocah Pahlawan died in 1653 and be replaced by his son, Tuangku Panglima Peringgit.In 1863, the Sultan of Deli (king of Deli Palace) gave 0.74 ha

area to the Firma Van Keeuwenen Mainz & Co, a Netherlands company. This was used as tobacco plantation. Thus Medan City was famous as Deli or Medan-Deli during the colonial era because of its good tobacco quality. The tobacco plantation also made Medan-Deli as the center of economic and center of governmental in North Sumatra Province. Besides tobacco plantation, Medan-Deli was also famous with its high quality brick. The Netherlands occupied Medan-Deli for about 78 years from 1864-1942. Soon after Indonesia's independence, its named to Medan City (Central Berau Statistic, 2013).

2.1.2 Geographic Positions

The Geographic position of Medan City is $3^{o}30'$-$3^{o}43'$ N and $98^{o}35'$-$98^{o}44'$ E. It takes one hour from Kuala Namu International Airport to Medan City with Medan Railway station. Medan is bordered by the Strait of Malacca on the north and surrounded by Deli Serdang District (bordered the west, east, and south area of Medan City). The Strait of Malacca gives opportunity for Medan City to develop international relationship and trading port with other countries such as Penang Island in Malaysia and Singapore. The location of Medan City is near Deli Serdang, LabuhanBatu, Simalungun, Tapanuli Utara, and other rich natural resources area which also give opportunity for Medan City to make a good and beneficial relation and partnership. There are seven rivers in Medan city such as Belawan River, Badra River, Sikambing River, Putih River, Babura River, Deli River, and Sulang-Saling River.Medan City area coverage is about 265.10 km^2 or 3.6% from North Sumatra Province area. The topography characteristic is tilt to the north with 2.5-37.5 meters above the sea level. Climate condition of Medan City under the Koppen climate classification is a tropical climate which there is no real dry season. From the

Polonia weather station in 2001. The maximum temperature of Medan City range is 30.8^{o} C-33.9^{o} C; minimum temperature range is 23.2^{o} C-24.3^{o} C and the humidity rate of Medan City is 84%-85%. The average amount of precipitation in 2001 is 226 mm.

Administratively, there are twenty-one districts in Medan City namely Medan Amplas, Medan Area, Medan Barat, Medan Baru, Medan Belawan Kota, Medan Deli, Medan Denai, Medan Helvetia, Medan Johor, Medan Kota, Medan Maimun, Medan Marelan, Medan Perjuangan, Medan Petisah, Medan Polonia, Medan Selayang, Medan Sunggal, Medan Tembung, Medan Timur and Medan Tuntungan (Central Berau Statistic, 2013). The administrative map of Medan City is shown in Figure 2.1.

2.1.3 Land Cover and Land Use

From the 265.10 km^2, the land cover and land use percentage of Medan City for other sector such as for settlements, agriculture, service area, wet rice field, industry, mixed crop field, company, and swamp, in 2006, is shown on Table 2.1.

Table 2.1 Percentage of land cover and land use of Medan City
(Source: Directorate General of CiptaKarya, Ministry of Public Works)

No.	Sector	Percentage (%)	Area (km^2)
1	Settlements	36.3	96.231
2	Agriculture	3.1	8.218
3	Service area	1.9	5.037
4	Paddy field,	6.1	16.171
5	Industry	4.2	11.134
6	Mixed crop field	45.1	120.355
7	Industrial Estate	1.5	3.976
8	Swamp	1.8	4.772

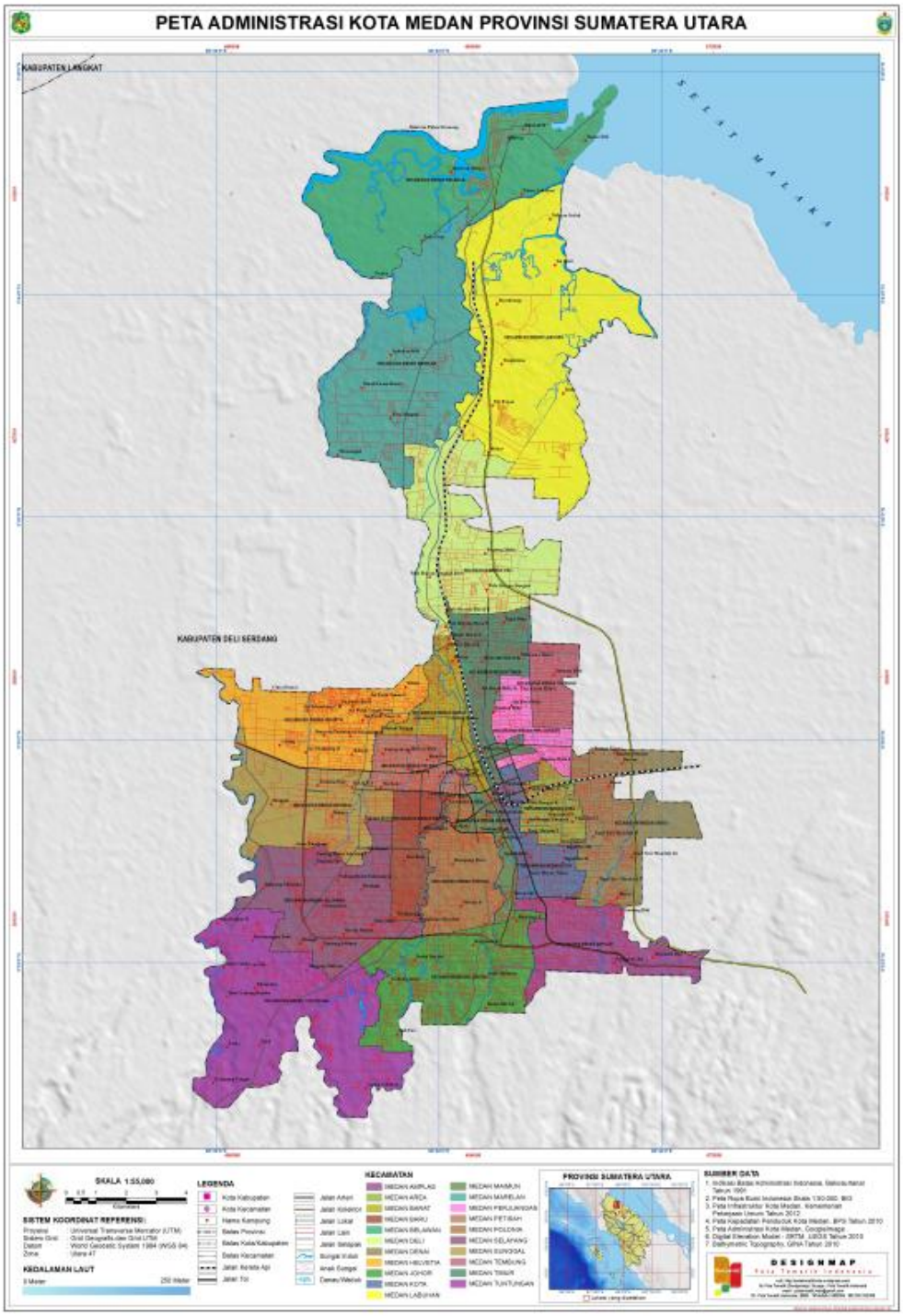

Figure 2.1Administrative Map of Medan City
(Central Bureau of Statistics, 2013)

2.1.4 Demography and Population

According to Central Bureau of Statistics / BadanPusatStatistik (BPS) or Indonesian Statistics of North Sumatra Province data, population of Medan increases significantly in 1996-2003. In 1996 the Medan City population was 1,730,725 people and in 2003 the population of Medan City was 1,993,601 people. The average rate of population growth is 0.68%. The highest population growth occured in 2002 (1.94%). The population density of Medan City in 2003 is 7520 people/km^2. The densest populated sub district in Medan City is Medan Perjuangan with population density 22813 people/km^2.

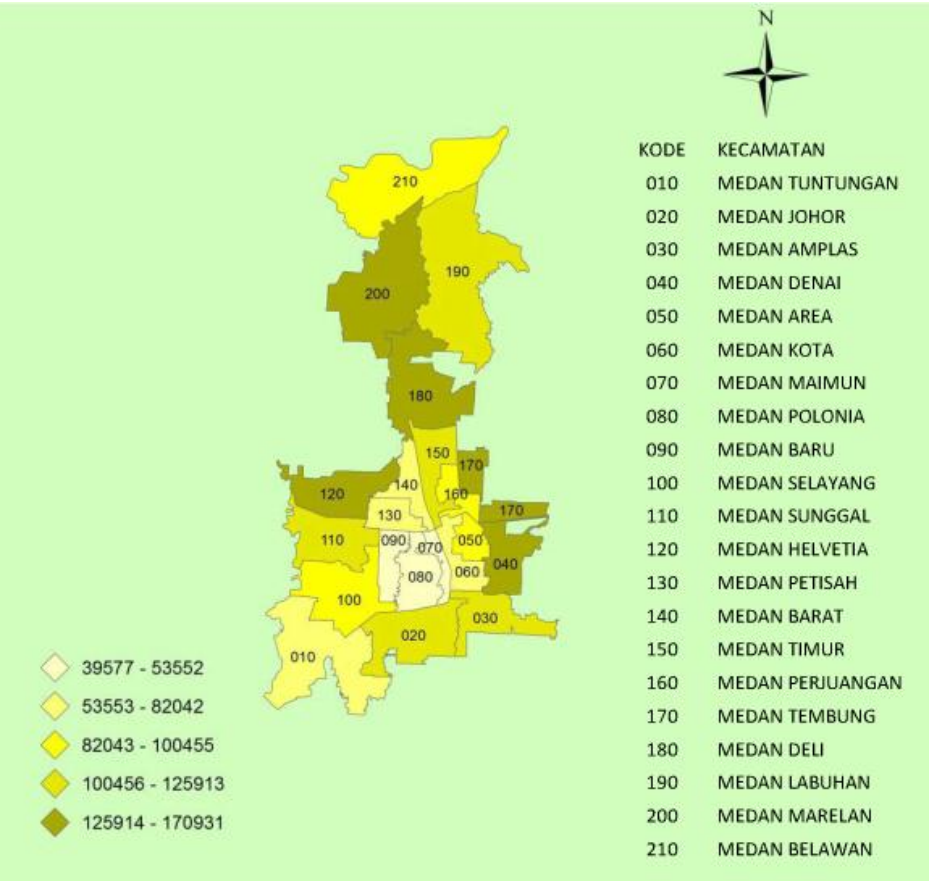

Figure 2.2 The population range for Medan City districts
(Source: Central Bureau of Statistics, 2013)

The population in Medan City is increased from the 2010 until 2012. From the 2010, the census data of population in Medan City reached 2,109,330 people and the population of Medan City in 2012 is estimated 2.122.804 population. Thus, the population density of Medan City from 2012 population data is 8008 people/km^2 (Medan city in Figure 2015). According to Medan city in Map 2015's information the population range in Medan City districts is shown on Figure 2.2.

The employment of Medan City for age 15 years old and above is divided into nine main industries e.g. agriculture, plantation forestry, hunting and fishery; mining and quarrying; industry; electricity, gas and water; construction; wholesale trade, restaurants and accommodations services; transportation, storage and communication; financing, real estate and business; community, social and personal services. From Medan city in Map 2013s, the highest employment is on the wholesale trade, restaurants, and accommodations services sector with 330,345 people.

2.1.5 Social and Economy Condition

The economy crisis in Indonesia which happened in 1997, decrease the economy growth. This condition also affected Medan City economy sector in 1998. The economy decreased dramatically to18.11%. But in 1999, the Medan City government strategy and policy succeded to increase and to stabilize the economy condition to reach 3.44% economy growth. The economy continued to grow, in 2001, Medan City reached 5.23% economy growth.

Medan City economy is dominated by four main sectors such as manufacturing; trade and tourism (hotels and restaurants); transportation and telecommunication; and finance, leasing and services. In 2000, manufacturing gave 14.28%; trade, hotels and restaurants gave 28.10%; transportation and telecommunication gave 19.38%; and finance, leasing and services gave 14.42%, for Medan City income. Medan City gross national product (GNP) has increased trend from 2000. The GNP increased (from 2009) to Rp 38.5 trillion in 2011 or rose 14.84%. According to the Government report in 2012, the growth of Medan City GNP is still supported by those four main sectors. Therefore, the economy development of Medan City is marked with the big scale trade center, hotels, restaurants and also transportation and telecommunication.

There are two main industry area locations, near the Port of Belawan, which named Industrial Area of Medan 1 and Industrial Area of Medan 2. This Industrial Area of Medan coverage area is 514 Ha and supported 86 national private companies and 17 international companies. In future plan, the government of Medan City also prepare for new industry area (650 Ha) in Medan Labuhan district. There are also several tourism destinations in Medan City such as Taman Buaya which has different species of alligator and crocodile, twentieth century historical buildings (such as Maimun Palace or Deli Palace in the past, which built in 1888,), and culinary place (such as Merdeka Walk). The transportation in Medan City, especially the direct train from Kuala Namu International Airport to Medan City, gives more income for Medan City and increases the potency of Medan City's tourism.

2.1.6 Agricultural Condition

According to Central Bureau of Statisticsdata, agriculture area and harvested area food crops in 2008-2012 has decrease trend. In 2008, the agriculture area was 7112 Ha and the harvested area was 6982 Ha, but in 2012, the total agriculture area was 6188 Ha and the harvested area was 4118 Ha. In 2011 there was a huge different between the agriculture area and harvest area. The agriculture area in 2011 was 6884 Ha; meanwhile the harvest area in 2011 was 3998 Ha (Central Bureau of Statistics,2013). The detail about comparison between agriculture area and harvest area in graphic from 2008 to 2012 is shown on Figure 2.3.

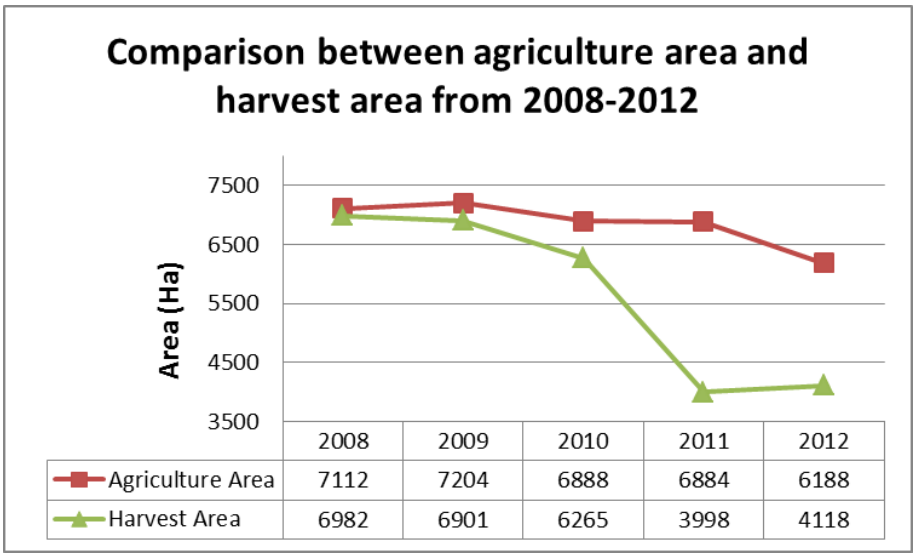

Figure 2.3 Comparison between agriculture area and harvest area (Central Bureau of Statistics, 2013)

The largest agriculture area in 2012 was located in Medan Labuhan district with 1543 Ha. The harvest area in Medan Labuhan district was 947 Ha. The districts without agriculture area were Medan Baru district and Medan Petisah district. The agriculture data from BPS consists of harvested area and total production of agriculture including paddy, second crops, vegetables and fruits were obtained by Agriculture Service of Medan City. The information of harvested area and total