

UTILIZATION OF OPTICAL SATELLITE DATA FOR MEASURING
CARBON DIOXIDE AT FELDA MAOKIL

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A project report submitted in partial fulfillment of the
requirement for the award of the degree of Master of
Engineering (Civil - Environmental Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER 2009

To my beloved mother and father

JUSOH JAAFAR
KAMARIAH CHE SOH

&

My loving brothers and sisters

MUHAMMAD NOOR HISYAM
MUHAMMAD NOR HANIF
NUR MADIHAH
NUR NADIAH SABIHAH
MUHAMMAD NOOR BAIHAQI
NUR HABIBAH SAFIAH
MUHAMMAD NOOR SUFFIAN

ACKNOWLEDGEMENTS

“In the Mighty Name of Allah, The Most Beneficent, The Most Merciful”

Firstly, I would like to express my sincere gratitude and love to my dear parents Jusoh Jaafar and Kamariah Che Soh and also my cherished brothers and sisters for the consistent support, guidance and encouragement during my study.

Secondly, a lot of thanks to my supervisor Dr. Mohd Badruddin Mohd Yusof for his attention and advice in order to ensure this thesis are completed. Not to forget sincere appreciation to my co-supervisor, PM. Dr. Ab. Latif Ibrahim from whom I received the necessary guidance throughout my final project. Thank you so much to both of you.

Lastly, I express very thankful to my friends who had shared ideas and knowledge that contributed on my writing. I also wish to thank all staffs of Environmental Engineering Laboratory, Universiti Teknologi Malaysia; Pak Usop, Mr. Azrin and Mr. Suhaimi because of their passionate and helpful I'm manage to make this Master's project much easier.

Thank you so much for all of you which I'm not mention here. Your contribution directly or indirectly I always keep in my heart.

Thank you...

ABSTRACT

Currently there are many developments especially in construction's sectors where a lot of air pollutants have been produced and resulted in the degradation of the environment. The issue has grown in importance in light of recent global warming. This study is based on a short term observation of carbon dioxide (CO₂) released due to a road construction at Felda Maokil in Segamat. The method that has currently been used to determine Net Primary Productivity (NPP) at global scale using satellite data known as Moderate Resolution Imaging Radiometer (MODIS). The purpose of this study is to measure the amount carbon dioxide (CO₂) that may be absorbed by oil palm tree for an area of about 450 hectares in Oil Palm plantation with low resolution MODIS satellite data. Several objectives have been carried out such as to determine the amount of Net Primary Productivity (NPP) in Felda Maokil, to assess the accuracy of MODIS data by validation process with *in-situ* data and lastly, to assess the correlation of NPP value from 2001, 2005 and 2009. The data were obtained through two sources which are *in-situ* as primary source and satellite data as secondary source. Data from four year interval had been chosen to insure more variations during the study period. Therefore the study was verified by the NPP values for year 2001, 2005 and 2009. The resulted acquired presented the mean NPP values for the three years processed were 468.169 g Cm²/y (2001), 560.685 g Cm²/y (2005) and 541.781 g Cm²/y (2009). Meanwhile, Normalized Difference Vegetation Index (NDVI) analysis had gave the resulted as 0.696 (2001), 0.863 (2005) and 0.716 (2009). As a conclusion, the mean NPP values for three years of MODIS images processed have shown similarities and road development had gave some impacts on these results.

ABSTRAK

Pada masa kini terdapat banyak aktiviti pembangunan yang melibatkan sektor pembinaan telah menyebabkan pembebasan udara tercemar ke atmosfera. Fenomena pencemaran ini secara tidak langsung telah membawa kepada berlakunya pemanasan global. Oleh itu, kajian ini dijalankan di Felda Maokil, Segamat bagi menentukan kandungan karbon dioksida (CO_2) yang disebabkan oleh pembinaan jalan. Kaedah yang digunapakai adalah data satelit yang turut dikenali sebagai Moderate Resolution Imaging Radiometer (MODIS). Selain itu, pengukuran CO_2 dapat diketahui bilangannya berpandukan terma Net Primary Productivity (NPP). Tujuan kajian ini dijalankan adalah untuk mendapatkan kandungan CO_2 yang mampu diserap oleh pokok kelapa sawit di dalam kawasan ladang kelapa sawit berkeluasan 450 hektar. Kajian ini mengandungi beberapa objektif iaitu menentukan jumlah kandungan NPP di Felda Maokil, menilai ketepatan data MODIS dengan melakukan proses pengesahan data dari tapak kajian dan menilai hubungan bagi data NPP untuk tahun 2001, 2005 dan 2009. Terdapat dua kaedah dalam mendapatkan data kajian iaitu persampelan data di tapak kajian (sumber utama) dan data satelit (sumber kedua). Perbezaan 4 tahun bagi tahun kajian dipilih supaya banyak perubahan dapat dilihat bagi tempoh kajian dijalankan. Keputusan kajian akan disahkan berdasarkan nilai NPP bagi tahun 2001, 2005 dan 2009. NPP bagi tiga tahun data proses ialah $468.169 \text{ g C m}^2/\text{y}$ (2001), $560.685 \text{ g C m}^2/\text{y}$ (2005) dan $541.781 \text{ g C m}^2/\text{y}$ (2009). Sementara itu, analisis untuk Normalized Difference Vegetation Index (NDVI) memberikan keputusan 0.696 (2001), 0.863 (2005) dan 0.716 (2009). Sebagai kesimpulan, nilai purata NPP telah menunjukkan persamaan untuk tiga tahun data MODIS. Disamping itu, aktiviti pembinaan jalan turut memberi impak terhadap keputusan kajian.

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LIST OF SYMBOLS

CO ₂	-	Carbon Dioxide
CFC	-	Chlorofluorocarbons
CH ₄	-	Methane
K	-	Potassium
N ₂ O	-	Nitrus Oxide
N	-	Nitrogen
P	-	Phosphorus

LIST OF ABBREVIATIONS

CCS	-	Carbon Dioxide Capture and Geologic Storage
DOE	-	Department of Environmental
EOS	-	Earth Observing System
EOR	-	Enhanced Oil Recovery
ECBMR	-	Enhanced Coal Bed Methane Recovery
GHG	-	Greenhouse Gas
GPP	-	Gross Photosynthetic Products Produced
IEA	-	International Energy Agency
LUC	-	Light Use Efficiency
MODIS	-	Moderate-Resolution Imaging Spectroradiometer
MRSO	-	Malaysian Rectified Skew Orthomosaic
NPP	-	Net Primary Production
SBRS	-	Santa Barbara Remote Sensing
UNFCCC	-	UN Framework Convention on Climate Change
WEC	-	World Energy Council

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CHAPTER 1

INTRODUCTION

1.1 General

Recently, human activities have contributed more critical problems to the environment. There are a lot of environmental issues that arise since last decade such as water quality, solid waste, air pollution, noise pollution, etc. Besides that, the climate change that occurred has some side effects from this matter.

As example, acid rain where emissions of sulphur oxides, nitrogen oxides and hydrocarbons are transformed in the atmosphere into sulphate and nitrate particles. Combination of sunlight and water vapour will produce a complex chemical reaction in mild sulphuric or nitric acid. This acid rain will occurs when pH levels falls below 5.6. Another effect that arise is global warming where solar radiation that come to earth is not fully release from atmosphere and the results it increase the earth temperature since more radiation is absorbed by the earth's surface; melting the ice at Antarctic and Antarctica which lead to increase water level. The situation happen where more greenhouse gas; carbon dioxide (CO₂), chloroflorocarbons (CFC), methane (CH₄), nitrus oxide (N₂O) and tropospheric ozone in atmosphere

In order to maintain the quality of environment and prevent before it become worst, some affords has been taken out in order to cater this environment issues. Solid waste can be control by several measures such as open dumping, landfill, incinerator, transfer stations and shrinking waste stream. However, this prevention cannot be successful as there are some factors affecting waste generation such as location, seasons, eating habits/lifestyle, etc. Meanwhile, for noise pollution can be control by management during construction phase, planning on construction sites activities, prevention from design stage of machine and additional control after machine is built. Lastly is air pollution which comes from natural sources, stationary and vehicles. Usually, air pollutants can be dividing into several types which are particulate (PM₁₀), nitrogen oxide (NO_x), sulphur oxide (SO_x), carbon (CO_x) and hydrocarbon (HC). Since stationary produces more pollution to atmosphere, it can be cater by using cyclone separator, baghouse filter, electrostatic precipitator and wet scrubber.

In the past few years, the global MODIS (Moderate Resolution Imaging Radiometer) NPP (Net Primary Productivity) has been measured using small scale on-ground flux tower measurements using the eddy covariance method. So far this method is limited to implement due to a number of flux tower worldwide. Until now only about 450 sites flux tower distributed worldwide. Based on previous research by Cohen *et al.*, (2003) and Turner *et al.*, (2005) several issues have arise regarding the appropriateness of the variety of product scale such as to match the low spatial resolution of MODIS satellite data with plot scale flux tower measurements on the ground.

Vargas *et al.*, (2007) and Falgae *et al.*, (2001) have mentioned that although there a lot of flux tower such as AsiaFlux in Asia, KoFlux in Korea, OzFlux in Australia and others seems insufficient for the validation of the global MODIS NPP, thus cannot produced an accurate measurement of global NPP. Besides that, MODIS NPP comes in various models such as initiated by MOD17 (Running *et al.*, 1999), “continuous field model” (Rahman *et al.*, 2004) and “Carnegie-Ames-Stanfor Approach model” (CASA) (Jinguo *et al.*, 2006).

1.2 Problem Statement

Over the past century there has been a dramatic increase in the amount of gases that releases from several sources have contributes air pollution to the environment. So far, however, there has been little discussion about greenhouse effect that increases the earth temperature.

In Malaysia basically, awareness among publics about air pollution are still lacking since not too much campaign and activities that related to this environmental issues. Besides that, poor of monitoring from government agencies have make the quality of gases that releasing are higher than allowable in air quality standard. At construction site especially, most of air quality at this locations are not taken seriously. Enforcement will take place only when there are complains make by local people or it become serious issues.

As mention earlier, the global warming is the process whereby the earth's temperature is getting increases. The most primary factor that cause of global warming is carbon dioxide emissions. This significantly occurs due too many sources which producing this gas such as natural activity, power plants, cars, trucks, aircrafts and others sources which not mention here. According to the report, 8 billion tons of CO₂ have been release into atmosphere in year 2008. In records, 40% of all CO₂ emissions are cause by power plants, 33% of all the CO₂ sent forth is the product of cars and trucks and 3.5% are released from aircraft. Therefore, based on this facts it show that CO₂ gases playing major role in increasing temperature which known as global warming.

Therefore, plants play in either sequestering atmospheric carbon or releasing carbon into the atmosphere. This study is conducted to measure carbon in the atmosphere that will absorb by plants. Since Malaysia is located at rain forest region, the amount of CO₂ should be low.

1.3 Aim and Objectives

This study is conducted in order to assess the efficiency of MODIS data using ERDAS software. Therefore, to achieve the aim several objectives are needed as a guideline;

- i. To determine the amount of Net Primary Productivity (NPP) at road construction in Felda Maokil, Segamat.
- ii. To assess the accuracy of MODIS data by validation process with *in-situ* data.
- iii. To assess the correlation of NPP value for years; 2001, 2005 and 2009.

1.4 Scope of the Study

Main focus in this study is involve the use MODIS satellite data at propose location. The implementation for this data is decided because it easy to obtain by downloads from website at <http://ladsweb.nascom.nasa.gov>. Besides that, MODIS data also is free to get and since the MODIS views the entire surface of the earth every one to two days, the current data is available.

The MODIS satellite will be analyze using ERDAS IMAGE V9.1 from Leica Geosystems Geospatial Imaging. The use of this software because of it is practical to apply and well known product.

Besides that, the propose location for this study is situated at Felda Maokil in Segamat, Johor Darul Takzim. Several points will be allocated in order to measure CO₂ concentration. This parameter is observed by using special equipments like Carbon Dioxide (CO₂) Meter for gaseous concentration.

Then, CO₂ concentration data will be assessing using ERDAS IMAGE V9.1 from Leica Geosystems Geospatial Imaging. An Addition, these values between MODIS satellite data and insitu data will be compare in order to measure the quality of both data.

1.5 Expected Finding

The study would be expected to find that the NPP values are low since the surrounding area was palm oil trees. Besides that, the propose location is less developed which lack gasses released into the atmosphere. Although there are must be some error between MODIS satellite data and insitu data, the differences between both data are in small amounts. The NPP value for MODIS satellite data is more accurate than *in-situ* data. This is because of the influence by surrounding areas such as wind faster, respiration rates by human and animals, activities by local people and others.