
**UNIVERSITI PUTRA MALAYSIA**

# *USING GPS TECHNOLOGY AND GIS DISTANCE MEASUREMENT ANALYSIS TO EXAMINE THE PHYSICAL FEATURES OF ROAD ACCESS AND TRAILS IN SISFEC*

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**UNIVERSITI PUTRA MALAYSIA**

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# USING GPS TECHNOLOGY AND GIS DISTANCE MEASUREMENT ANALYSIS TO EXAMINE THE PHYSICAL FEATURES OF ROAD ACCESS AND TRAILS IN SISFEC

**By**

**MOHAMAD AFIQ BIN AMRAN**

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**2016**

## DEDICATION

**This final year project especially dedicated to my supervisor**:

Dr. Norizah binti Kamarudin

**To my beloved family:**

Amran bin Shamsudin

Siti Ramlah binti Mohd Taib

Mohamad Alif bin Amran

**To special one:**

Siti Aisyah binti Yaacob

Arnold Anak Danney @ Bagley

Mohd Fakhrullah bin Mohd Noh

Mohd Ikhsannuddin bin Mohammad Tinggal

Rhyma Purnamasayangsukasih binti Parman

## ABSTRACT

Forest road has been used in many kinds of forest classification and each forest road has their function and purposes based on forest class have been set. SISFEC is one of the research and education forest classified in Permanent Forest Reserve (PRF) that give benefits to the local community, especially in Puchong area. SISFEC provides a lot of interesting places used for education and recreation activities which can be accessed by using existing forest roads and trails. In this study, physical features of existing forest road access and trails in SISFEC was spatially located and examined using GPS technology and GIS Distance Measurement Analysis. Through this study, there are 75 stations was categorised as damaged road and most of damaged road was caused by gully with 36 stations was recorded. Distance Measurement Analysis was used to propose and measure the distance of most interesting places for existing forest roads or trails. This analysis helps to determine the best road access with shortest distance to the nearest selected features, giving more options for better decision making. However, constrains like slope and river have been used as cost surface prior to Distance Measurement Analysis conducted. The final output of this analysis is map with details of new proposed trails in SISFEC. The results of the study showed that the nearest distance from existing forest road and trails to the nursery site with the distance of 20.124m and the longest distance from the existing forest road to Permatang Kuang with the distance of 1097.379m. Based on the result, the new proposed trails give better road accessibility by considering slope evaluation and terrain topography compare to the existing road with the shortest distance. Hence, it is useful for decision making for planning forest road access.

## ABSTRAK

Jalan hutan telah digunakan dalam pelbagai jenis klasifikasi hutan and setiap jalan hutan mempunyai fungsi dan tujuan yang tersendiri berdasarkan pengkelasan hutan yang telah ditetapkan. SISFEC adalah salah satu hutan penyelidikan dan pendidikan yang dikelaskan di dalam Hutan Simpan Kekal (HSK) yang memberi manfaat kepada masyarakat setempat khususnya di kawasan Puchong. SISFEC menyediakan banyak tempat-tempat menarik yang digunakan untuk aktiviti pendidikan dan rekreasi yang boleh diakses oleh jalan raya hutan dan trail yang sedia ada. Dalam kajian ini, ciri fizikal akses jalan hutan dan trail di SISFEC telah spatial terletak dan diperiksa menggunakan teknologi GPS dan Analisis Pengukuran Jarak GIS. Melalui kajian ini, terdapat 75 stesen itu dikategorikan sebagai jalan rosak dan kebanyakan jalan rosak disebabkan oleh parit dengan 36 stesen dicatatkan. Analisis Pengukuran Jarak digunakan untuk mencadangkan dan mengukur jarak kebanyakan tempat menarik untuk jalan hutan atau trail yang sedia ada. Analisis ini membantu menentukan akses jalan yang terbaik dengan jarak paling pendek kepada ciri-ciri terdekat dipilih, memberi lebih banyak pilihan untuk membuat keputusan yang lebih baik. Walau bagaimanapun, kekangan seperti cerun dan sungai telah digunakan sebagai kos permukaan sebelum Analisis Pengukuran Jarak dijalankan. Hasil akhir analisis ini adalah peta dengan butir-butir jalan baru yang dicadangkan di SISFEC. Keputusan kajian menunjukkan jarak yang terdekat dari jalan hutan dan trail sedia ada ke tapak nurseri dengan jarak 20.124m dan jarak yang paling jauh dari jalan hutan yang sedia ada ke Permatang Kuang dengan jarak 1097,3788m. Keputusan kajian menunjukkan laluan baru trail yang dicadangkan memberi akses jalan yang lebih baik dengan mengambil kira penilaian cerun dan kawasan topografi berbanding dengan jalan sedia ada dengan jarak singkat. Oleh itu, ia sangat berguna dalam membuat keputusan untuk merancang akses jalan hutan.

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## APPROVAL SHEET

I certify that this research project report entitled “Using GPS Technology and GIS Distance Measurement Analysis to Examine the Physical Features of Road Access and Trails in SISFEC” by Mohamad Afiq bin Amran has been examined and approved as a partial fulfillment of the requirements for the degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.

Approved by:

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AHFR | Ayer Hitam Forest Reserve |
| $CO_2$ | Carbon Dioxide |
| ESRI | Environmental Science Research Institute |
| FDPM | Forestry Department of Peninsular Malaysia |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| LIDAR | Light Detection and Ranging |
| NGO | Non-Governmental Organization |
| $O_2$ | Oxygen |
| PRF | Permanent Forest Reserve |
| SISFEC | Sultan Idris Shah Forestry Education Centre |
| TIN | Triangulated Irregular Network |
| UPM | Universiti Putra Malaysia |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Forest road is a necessary networking for forest harvesting operations, managements, recreation activities, educations, and research programmes. In forest harvesting, forest road connects compartment and concession areas with public road for logs transportation to mills. Although the functions of forest roads are varies, the same guidelines are applied according to what has been issued by Forestry Department of Peninsular Malaysia (FDPM). Forest road is important in managing forest management such as protection and rehabilitation in harvesting areas (FDPM, 2010). The efficiency of forest harvesting practices depends on the appropriate forest road network that has been constructed (Ezzati & Najafi, 2009).

There are four types of forest roads in Malaysia known as primary road, secondary road, feeder road and skid trail. Each type of forest road has different functions and specifications according to the guidelines provided by FDPM. The proper construction of roads by following specific guideline could help in reducing adverse impact to the forest environment (Ismail, 2008). The failure in following the guidelines may cause major impacts such as soil degradation, vegetation loss, affect water and the environment quality. According to Cerda (2007), soil erosion still happened even through natural vegetation recover at lower rate.

Road banks are the main source of sediments on forest roads and this had been proven by analysis of runoff and sediment loss from unpaved forest roads (Jordan & Martinez, 2008). Road banks contribute large potential of the erosion compared to other parts of the roads. Although runoff coefficients are high on the road bank and the roadbed, sediment yield is much lower on the latter. Most of the new roads builds into new site concession areas and cause some effects on the sediment yield. As what have been stated in Akay et al. (2008), forest roads produce the highest amount of sediment yield to streams from forest lands.

According to Luce (1999) and Akay et al. (2008), majority of the sediment yield from a new road is produced during the first two years. This condition will continue until cut-slope, fill-slope and ditch areas are properly covered by vegetation to the empirical observation. In recent decades, the use of powerful and heavy machineries in forest management has increased exponentially, especially in forest harvesting and operations. By using the machineries in the process of timber harvesting, it will be easier and faster. Although mechanized harvesting allows for high productivity and yield, it may also seriously damage the forest soils with direct and indirect effects.

According to Jansson and Johansson (1998), Alakukku et al. (2003), Bygdén et al. (2004) and Cambi (2015), the soil compactions become more serious without proper maintenance. Furthermore, the severity of soil compactions can be influenced by several factors, such as vehicle mass, axle/ wheel/ track load, contact area of the vehicle with the soil, slope of the terrain, tire pressure,

dynamic shear forces, and soil characteristics and moisture. This can be proven with skid trail that is highly disturbed during the construction phase and as a result of subsequent traffic of heavy logging machinery (Rab, 1999; Croke et al., 2001; Modry & Hubeny, 2003; Najafi et al., 2009; Akbarimehr, 2013).

Forest soil can be characterised with high level of $CO_2$ storage in the soil due to decrease in soil diffusivity with depth (Certini et al., 2003; Bekele et al., 2007). Apart of that, mechanised harvesting produce complex impact on both $CO_2$ production and soil diffusivity (Fernandez et al., 1993; Bekele et al., 2007; Goutal et al., 2012). Once compacted, topsoil characteristically shown higher $CO_2$ and lower $O_2$ concentrations compared to uncompact conditions because of decreased gas diffusivity (Goutal et al., 2013).

However, forest road in education and research forest produces less impact compare to forests harvesting operation. Most of transportation systems in forest education and research are using four wheel drives and trucks. Thus, the loaded of the transportation was not heavy. Furthermore, less frequent uses of forest road and the usage of forest road depends only on requirement can help to reduce road damage. Sultan Idris Shah Forest Education Centre (SISFEC) is classified as research and education forest in Malaysia. There was not many changes in structure of forest road, although once it has been logged. In SISFEC, four wheel drive is used for transporting visitor to study sites while security guard uses motorcycle to monitor the areas around SISFEC.

The purposes of forest roads in research and education forest are to help students and researchers to make management which involves harvesting, silviculture treatment and protection for their study areas. It ease for the visitors, local communities, foreign researcher, government agencies and NGO to conduct outdoor activities such as jungle tracking, tree planting and others. Other than that, these roads can be used to access into the most interesting area within SISFEC. This significant to identify the existing networks of access roads into SISFEC to monitor and maintenance works for education and research purposes. Thus, it is important to ensure that forest roads are in safe condition, comfort and easy operations passing through the road for any vehicles (Abeli et al., 2000; Abdi, 2009). The distance is the most influential factor in transport, accessibility, monitor and maintenance in forest area.

Nevertheless, using Geographic Information System (GIS) application in distance measurement analysis, it helps to analyse what factors influenced the frequently use of road and trails to the most interesting places in SISFEC. GIS is a system that can be used by people who rely on geographical information in decision making process. The result from this application showed the data analysed and interrogation debated about the forest roads that will be used which help in improve the existing condition to become better (Phua & Minowa, 2005).

## 1.2 Problem Statement

SISFEC has been logged and most of the road was established as road access for transporting timber (Bawon & Yaman, 2007). These road still exist however, it was used as road access for education, research and recreation activities. Some of the roads access were located near to steep areas and has high degree of slope evaluation. Hence, the occurrence of landslide might happen during unpredictable weather. The safety and good forest road designs can result to the smoothness of activities to be conducted. To have a good road condition in terms of safety and good road design, regular road monitoring and maintenance need to be conducted.

At SISFEC, road access are irregularly maintained due to less traffic passes and are mostly occupied by students and researcher without heavy vehicle. The condition of the road access need to be periodically evaluated to ensure the safety of users, especially when the road access are not frequently used. Available road access information in digital format could be an effective way in term of fast, cheap and less labour cost.

There is no specific research on physical features in SISFEC were conducted to evaluate the condition of forest road. This evaluation will conduct regular monitoring and maintenance work during any condition in effective way. Through this application, the shortest distance will minimize the time and energy during activities in SISFEC. The significance of this study is to examine the existing networks of road access in SISFEC with better road accessibility by considering slope and terrain.

## 1.3 Objectives

The aim of this study is to spatially locate the existing road access in SISFEC.

The specific objectives are:

i. To examine the physical features of existing forest road and existing trail access in SISFEC by using ground survey method and GPS technology.

ii. To spatially plan the least cost distance to the most interesting places in SISFEC by using distance measurement analysis of GIS.

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