DETERMINATION OF SOIL EROSION FACTORS USING UNIVERSAL SOIL LOSS EQUATION AND GEOGRAPHIC INFORMATION SYSTEM IN IPOH CITY IN PERAK STATE, MALAYSIA

ABDALFETTAH ADDUKALI MOHAMED

UNIVERSITI PENDIDIKAN SULTAN IDRIS

2020

DETERMINATION OF SOIL EROSION FACTORS USING UNIVERSAL SOIL LOSS EQUATION AND GEOGRAPHIC INFORMATION SYSTEM IN IPOH CITY IN PERAK STATE, MALAYSIA

ABDALFETTAH ADDUKALI MOHAMED

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

DISSERTATION FOR A MASTER'S DEGREE IN SCIENCE

FACULTY OF TECHNICAL AND VOCASIONAL
UNIVERSITI PENDIDIKAN SULTAN IDRIS

2020

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

UPSI/IPS-3/BO 32
Pind : 00 m/s: 1/1

UNIVERSITI PENDIDIKAN SULTAN IDRIS
SULTAN IDRIS EDUCATION UNIVERSITY

Please tick (√)
Project Paper
Masters by Research
Master by Mixed Mode
PhD

INSTITUTE OF GRADUATE STUDIES

DECLARATION OF ORIGINAL WORK

This declaration is made on the ..11.....day of..a.2.....2020.

i. Student's Declaration:

I, Abdalfettah AddulKali Mohamed Tekhikh (PLEASE INDICATE STUDENT'S NAME, MATRIC NO. AND FACULTY) hereby declare that the work entitled Determination of Soil loss Equation Factor Using Universal Soil loss Equation and Geographic information System in Ipoh city and Surrounding Area in Perak State, Malaysia is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

Signature of the student

ii. Supervisor's Declaration:

I _____ (SUPERVISOR'S NAME) hereby certifies that the work entitled _____

_____

_____(TITLE) was prepared by the above named student, and was submitted to the Institute of Graduate Studies as a * partial/full fulfillment for the conferment of _____ (PLEASE INDICATE THE DEGREE), and the aforementioned work, to the best of my knowledge, is the said student's work.

_____ _____

Date Signature of the Supervisor

UNIVERSITI PENDIDIKAN SULTAN IDRIS
SULTAN IDRIS EDUCATION UNIVERSITY

INSTITUT PENGAJIAN SISWAZAH /
INSTITUTE OF GRADUATE STUDIES

BORANG PENGESAHAN PENYERAHAN TESIS/DISERTASI/LAPORAN KERTAS PROJEK
DECLARATION OF THESIS/DISSERTATION/PROJECT PAPER FORM

Tajuk / *Title*: **Determination of Soil Erosion Factors Using Universal Soil Loss Equation And Geographic Information System in Ipoh City And Surrounding Area In Perak State, Malaysia**

No. Matrik /*Matric No.*: M20161000989

Saya / *I* : Abdalfettah Addukali Mohamed Tekhikh
(Nama pelajar / *Student's Name*)

mengaku membenarkan Tesis/Disertasi/Laporan Kertas Projek (Kedoktoran/Sarjana)* ini disimpan di Universiti Pendidikan Sultan Idris (Perpustakaan Tuanku Bainun) dengan syarat-syarat kegunaan seperti berikut:-
acknowledged that Universiti Pendidikan Sultan Idris (Tuanku Bainun Library) reserves the right as follows:-

1. Tesis/Disertasi/Laporan Kertas Projek ini adalah hak milik UPSI.
   The thesis is the property of Universiti Pendidikan Sultan Idris
2. Perpustakaan Tuanku Bainun dibenarkan membuat salinan untuk tujuan rujukan dan penyelidikan.
   Tuanku Bainun Library has the right to make copies for the purpose of reference and research.
3. Perpustakaan dibenarkan membuat salinan Tesis/Disertasi ini sebagai bahan pertukaran antara Institusi Pengajian Tinggi.
   The Library has the right to make copies of the thesis for academic exchange.
4. Sila tandakan (√) bagi pilihan kategori di bawah */ Please tick (√) from the categories below:-*

☐	**SULIT/*CONFIDENTIAL***	Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub dalam Akta Rahsia Rasmi 1972. / *Contains confidential information under the Official Secret Act 1972*
☐	**TERHAD/*RESTRICTED***	Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan ini dijalankan. / *Contains restricted information as specified by the organization where research was done.*
☑	**TIDAK TERHAD / *OPEN ACCESS***	

(Tandatangan Pelajar/ Signature)

(Tandatangan Penyelia / *Signature of Supervisor*)
& (Nama & Cop Rasmi / *Name & Official Stamp*)

Tarikh: 18/02/2020

Catatan: Jika Tesis/Disertasi ini **SULIT @ TERHAD**, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan ini perlu dikelaskan sebagai **SULIT** dan **TERHAD**.

Notes: If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the related authority/organization mentioning the period of confidentiality and reasons for the said confidentiality or restriction.

ACKNOWLEDGEMENTS

I am most grateful to Allah almighty for giving me patience and making it possible for me to complete this work.

I would like to express my deep gratitude and thanks to my supervisor *Dr. Pedram Kashiani* and *Assoc Prof Dr. Ridzwan Che Rus* for given me advice and learned from them to achieve this great work.

I would like to thank The Department of Agriculture and Department of Irrigation and Drainage of Malaysia for providing me all data that were used to complete this research.

I would like to thank also Ministry of Education in Libya and Embassy of Libya in Kuala Lumpur for their financial support to complete this work.

Last but not least, special thanks to my wife, my father, my mother for their prayer for me also their supporting, understanding, pushing and for helping me during the course of the study.

ABSTRACT

Soil erosion is among of the most acute issues faced in the world, from the loss of soil to natural resources and crop farmers. Malaysia is a tropical country with high yearly rainfall affecting the loss of the outermost layers of soil. The main objectives of this study was to examine the areas mandatory for the evaluation of soil corrosion in Ipoh city and surrounding areas in Perak state, Malaysia for Year 2000 and Year 2015, and to evaluate the mean yearly soil loss proportion using the USLE model. The total area covered in this study was 1267.83 km2. Results showed that the proportion of agriculture land in the study area increased significantly from 2000 to 2015 (30% to 34.35% of the total study area, respectively). Similarly, urban area also showed increase from 14.34% in 2000 to 17.93% in 2015 with values of 183.1 km2 to 216.16 km2of study area, respectively. Contrary, open area showed significant reduction in size from 118.76 km2 (8.30% of the study area) in 2000 to 48.80 km2 (3.82% of the study area) in 2015. Forest area also decreased from 45.1% in 2000 to 42.5% in 2015. These reductions resulted to an overall decrease in total areas with very low probability of soil erosion from 90.96% in 2000 to 76.42% in 2015. On the other side of the spectrum, the areas with very high probability of soil erosion increased from 36.78 km2 of the study area in 2000 to 94.85 km2 in 2015, showing 4.58% increase. In conclusion, decrease in forest and open areas significantly contributed to increase in agriculture and urban areas with higher soil erosion probability. Urban planners and land developers exploited the potential land at maximum rate by building residential, commercial and industrial areas. Even though the soil erosion rate in the study area was found not to be at a pressing stage, it can increase in the future if the development activities are done without conservation planning program in the Ipoh city and surrounding areas in Perak state.

PENILAIAN FAKTOR EROSI TANAH MENGGUNAKAN SISTEM MAKLUMAT GEOGRAFIK SISTEM GEOGRAFIK SISTEM MAKLUMAT KEHILANGAN (USLE) PADA IPOH AREA, MALAYSIA

ABSTRAK

Hakisan tanah adalah di antara isu yang kritikal untuk ditangani, baik dari isu kehilangan tanah kepada sumber asli dan para petani. Malaysia merupakan negara tropikal dengan kadar hujan tahunan yang memberi kesan kepada kehilangan lapisan atas tanah. Objektif utama kajian ini adalah untuk menilai kadar hakisan tanah di kawasan mandatori di bandar Ipoh dan sekitar negeri Perak Malaysia tahun 2000 dan 2015, dan untuk menilai purata kehilangan tanah tahunan menggunakan model USLE. Jumlah kawasan yang dikaji adalah 1267.83 km2. Hasil kajian menunjukkan dari tahun 2000 ke tahun 2005, kadar tanah pertanian meningkat (30% ke 34.35% dari jumlah kawasan kajian). Kawasan bandar juga menunjukkan peningkatan dari 14.34% pada tahun 2000 kepada 17.93% pada tahun 2015 dengan nilai 183.1 km2 to 216.16 km2 dari jumlah kawasan kajian. Sebaliknya, kawasan terbuka menunjukkan penurunan saiz dari 118.76 km2 (8.30% dari jumlah kawasan kajian) pada tahun 2000 kepada 48.80 km2 (3.82% dari jumlah kawasan kajian) pada tahun 2015. Peratusan kawasan hutan juga menurun dari 45.1% pada tahun 2000 kepada 42.5% pada tahun 2015. Pengurangan ini meyebabkan penurunan keseluruhan kawasan kebarangkalian rendah untuk hakisan tanah dari 90.96% pada tahun 2000 kepada 76.42% in 2015. Dari sisi lain, di kawasan kebarangkalian tinggi untuk hakisan tanah meningkat secara drastik dari 36.78 km2 dari jumlah kawasan kajian pada tahun 2000 kepada 94.85 km2 pada tahun 2015, dengan peningkatan sebanyak 4.58%. Kesimpulannya, penurunan peratusan di kawasan hutan dan kawasan terbuka membawa kepada peningkatan peratusan di kawasan pertanian dan kawasan bandar dengan kebarangkalian hakisan tanah yang tinggi. Perancang bandar dan pemaju menyalahgunakan kawasan yang berpotensi dengan memaksimumkan pembinaan bangunan residensi, komersial dan perindustrian. Walaupun kadar hakisan tanah di kawasan kajian berada pada tahap yang tidak membimbangkan, tidak mustahil ia akan meningkat di masa hadapan sekiranya aktiviti pembangunan dijalankan tanpa program pemuliharaan di bandar Ipoh.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DEM	Digital Elevation Model
GIS	Geographic Information Systems
MSS	Multi-Spectral Scanner
USLE	Universal Soil Loss Equation
NDVI	Normalized Different Vegetation Index
TNDVI	Transformed Normalized Different Vegetation Index
USGS	United States Geological Survey
DOA	Department of Agriculture
TM	Thematic Mapper
IFS	Integrated Farming System

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

A form of soil degradation and commonly associated with supplementary issues such as inadequate degree of organic matter in the soil, deprivation of acidity in the soil, and imbalance soil structure is regard as soil erosion. According to Singer and Munns (1999) and Cutler (2006), soil erosion is scrutinized as merely natural activity that includes accommodating and unloading particles of soil from one section to another (Gregersen et al., 2003; Mir, Gasim, Rahim, & Toriman, 2010; Said, 2008).

As mentioned by Morgan (Lu, et al ., 2004), due to land conservancy, soil erosion in the tropical zones with humid climate is traditionally associated with agricultural activities such as decreasing the crop yield, decreasing the water quality, increasing carbon and biodiversity. This occurs mostly due to high rainfall intensity, improper land use management and poor soil conditions (Oldeman, et al., 1990;

Reich, Eswaran, et al., 1999). Recently, soil erosion is regarded as among the most severe deficiency in natural assets. Following studies done by Marsh 1984 (Beuchle et al., 2015), within the previous decades, the three most intense soil erosion complications occurred due to deforestation, excessive vegetation, firewood, and industrial as well as agricultural activities.

The most habitual factors of soil erosion all over the world are shown in Figure1.1 Overgrazing is the main causes of soil erosion, the second is deforestation and the third is agricultural activities. Degradation is caused by overgrazing by the result of soil is deprived of its productivity and thin crops layer. Such circumstances will let raindrops to corrode the expanse of soil and intensify erosion and slides. According to (Pimentel, 2006), in the US soil depletion occurs 10 times quicker than the rate of natural regeneration whilst China and India experience soil depletion 30 to 40 times quicker. Due to soil erosion that occurs for the past four decades, 30 percent of the fertile area has been reduced to being unproductive. Following a report done by the United Nations Food and Agricultural (2008), approximately 2 million people around the world live in danger owing to the issues of soil erosion (Fao, 2008).

.

Depending on the United Nations Food and Agriculture Organization (2008), around 2 million people all over the world considered unsafe owing to land corrosion issue. Surging of land declination due to erosion can reduce crop yields and this will fulminate food of the world population. The growth of land erosion occurred is able to curtail crops and this somehow jeopardizes food supply for world population.

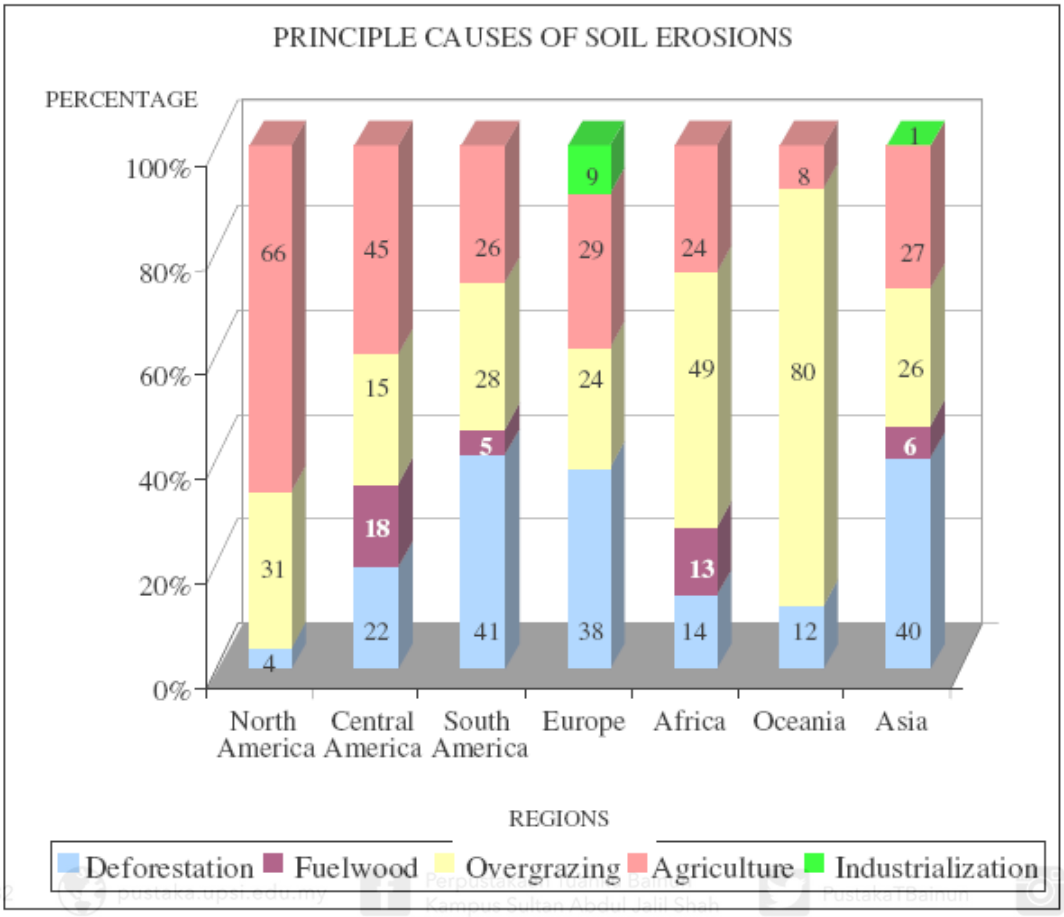

Figure 1.1. The main causes of soil erosion in different parts of the world. Source: International Soil Reference and Information Center (http;//www.isric.ni)

As seen above from this figure, agricultural activity and overgrazing are one of the main causes of soil erosion in North America, where agricultural activities are considered to contribute to soil erosion by about 66%, while overgrazing has recorded about 31%, in addition to previous studies that 49 % Of agricultural activities contribute more than 24% to erosion and soil degradation, while deforestation contributes 14% to soil degradation.

In Asia, deforestation is one of the main causes of soil erosion (40%), while agricultural activities account for 27% of the region's soil degradation and overgrazing (26%).

In Europe, deforestation is one of the main causes contributing to soil erosion, accounting for 38%, while agricultural activities are considered one of the main causes of soil erosion by 24%.

1.2 Soil Erosion Types

There are a variant of soil erosion types that are considered in this study:

- Rainfall Erosion
  This type of erosion occurs when large amounts of rain fall, which may lead to separation of the soil molecules and expose them to erosion.

- Sheet erosion
  It denotes thin it denotes spare, constant erosion of the outermost layers in the soil.

- Rill erosion or wind erosion
  It trails layer corrosion as the volume and momentum of liquid escalates, and liquid is now manage to both disengage and carry soil particles.

- Gully erosion
  As streams excavate and broaden, gullies are constructed. In brief, gullies are streams that are too expanded to be fixed with regular tillage equipment.

- Channel erosion
  This erosion is resulted from concentrating and confining the erosive forces of water. It includes both manmade and natural channels.
- Mass Wasting

Large failures usually as a result of gravitational forces. It can cause landslides, pot slides, slumps, debris torrent (Reich, Eswaran, & Beinroth, 1999).

Figure 1.2. Channel erosion. Source: https://greentumble.com

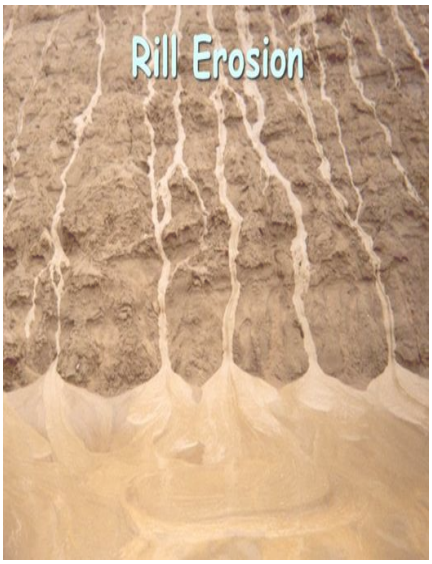

Figure 1.3. Rill Erosion. Source: https://greentumble.com

Figure 1.4. An example of Gully erosion. Source: https://greentumble.com

1.3 Research Importance

Due to rapid climate changes, the constant monitoring of soil erosion becomes the most important challenge for government and organizations. Many studies had been executed throughout many areas around the world for monitoring of soil losses and possible prevention or reduction.

Malaysia with a tropical environment as the amount and ferocity of the raindrops are immense and is more vulnerable to land erosion. This study provides the comprehensive understanding of the relationship between universal soil loss equation

(USLE) factors and the environmental circumstances in Ipoh area such as contour, climate, crops, and soil forms. Thus, it helps to develop and enhance integral predictive ideas to reduce the erosion. The outcomes of this study will help State Department and/or universities to prepare short-, mid- and long-term plan for managing the soil erosion and sedimentation of rivers in the Perak State especially in Ipoh area. This study will also provide essential information for reducing erosion sources and helps to find proper solutions to reduce the sedimentation of Sungai Perak, the second longest river in Malaysia.

1.4 Problem Statement

The study area selected is Ipoh in the state of Perak which is the second largest state in Peninsular Malaysia. The total of the study area is 1267.83 km². Perak is generally mountainous in the eastern part and flat in the western part. There are four main rivers in the state which the systems stream towards the west and conclusively flow into the Straits of Melaka. Sungai Perak is known as the second most enormous river basin within Peninsular Malaysia. It includes a catchment sector of approximately 14.908km² that encloses around 70% of Perak state.

The upper reaches of the basin where the Perak River Hydro Scheme is located is covered by forest land. The agricultural lands consist of main rubber and oil palm plantation predominate the alluvial plain in the center and lower spans of the basin. The main river is populated with reverie settlements which are highly affected by the consequences of soil erosion which can cause great flooding. In addition, there

are four hydropower plants along Sungai Perak which are highly affected by sedimentation of the river. This cause the depth of river decrease and the stream does not have enough force to generate power. Unconstrained logging and haphazard land gap for farming, development and building within the state will widespread corrosion over the land surface, resulting in deposit of the rivers and of the Sungai Perak. Hence, with relevance speedy climate changes, estimation of annual soil loss, eroding and deposit mapping is crucial and pressing. Estimation on how briskly soil is being scoured should be taken into consideration before any implementation like conservation or designing ways is enforced in any space. Corrosion model will predict soil loss below a good vary of conditions. As the result of Tew in 2003 he studied his researcher in Cameron Highlands, Malaysia, the Agricultural activity in the study area have the highest soil erosion than any other activity. The second parts of erosion in the study area were the urban activity because the fastest developed and changed the forest area to urban area in recent years. This model is outlined as a group of rules and procedures for representing a development or a method of simulation, prediction and generating new results. Recently, the speed of surpasses the speed of soil formation over wide areas leading to the depletion of soil. Rate of soil loss will determined by in-sit measuring of annual precipitation, elevation, and crop cowl and practiced erosion management factors by utilizing USLE model and ArcGIS 10.3 Software in this study.

1.5 The Study Area

Ipoh is inside the province of Perak that is inside the northern a piece of dry land

Malaysia is set by the Kinta conduit, it's about one hundred eighty metric straight unit (110 mi) north of capital of Malaysia and 123 metric direct unit (76 mi) southeast of Georgetown in close Penang. Ipoh contained a populace of very 657,892, making it the third biggest town in Malaysia by populace. The size of town is with respect to 643 sq. metric straight unit (Figure 1.5).The city is inside the center of the Kinta vale, on the bank of the Kinta conduit and furthermore the Sungai Perak, the second longest waterway in Malaysia, Kledang scope of mountains extends from the north toward the west of town. This fluctuate runs parallel to the Bintang scope of mountains with the Perak conduit streaming to its left side edge and furthermore the Kinta waterway on its right side. Ipoh sees high precipitation during the time with a middle of two hundred metric direct unit (7.9 in) of rain each month and averaging to, 427.9 mm (95.59 in) of rain every year. The wettest month is Gregorian date-book month wherever on the normal 297.2 mm (11.70 in) of rain is seen. Ipoh's driest month is October which records 132.3 mm (5.21 in) of rain fall on the normal. With high power of tropical precipitation and brief spans erosivity of rain and run-off are fundamental driver for slackening the dirt, debilitating inclines and eventually bringing about mass developments of strong and semi-strong materials like soil creep, landslips and avalanches. Conjointly, the study space has several mountain areas already being developed and a few different hills are future development plans (Ismail, Harun, & Zin, 2006).

Figure 1.5. Map of Peninsular of Malaysia

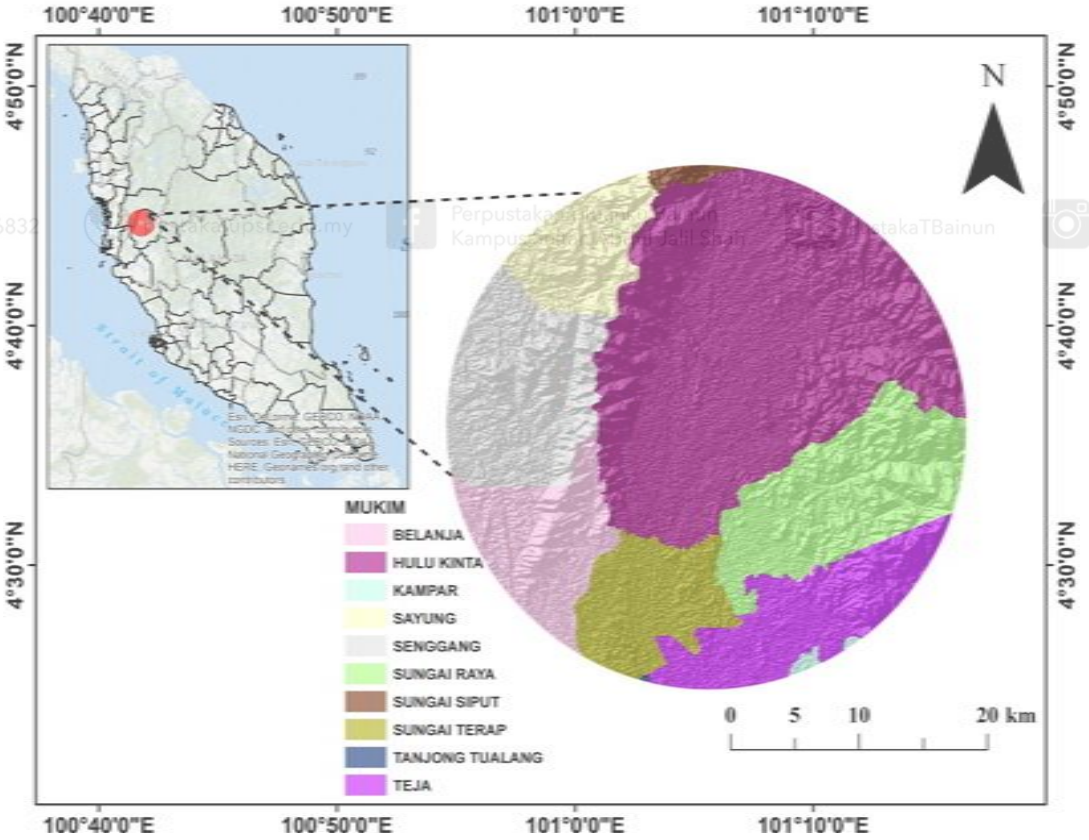

Figure 1.6. Location of the study area in Malaysia map

1.6 Objectives

This study carries principal purposes which are to identify the USLE for Ipoh area, to achieve this, the study consists four specific aims of the following:

1. To get the crop management (C) factor of USLE to be used in Ipoh city and surrounding areas to condition derived from satellite remotely perceived knowledge.

2. To determine and minimize 'systematic error to calculate slope length and steepness (LS) factor of USLE in terrain and slope areas.

3. To determine soil erodibility (K factor) of the USLE significantly in slanted and wooded areas of the State.

4. Assessment of annual soil loss using all parameters of the USLE using GIS approach of annual soil loss exploitation in all parameters of the USLE exploitation GIS approach.

1.7 Advantages of the Study

In many countries, the monitoring of soil erosion becomes the most important challenge for government and organizations. Many studies had been executed around the world for monitoring of soil losses and possible prevention or reduction. In this study, the comprehensive understanding of the relationship between USLE factors and the physical conditions in Ipoh area will be provided such as contour, climate, crop, and soil forms, thus, it helps to develop and enhance integral predictive ideas to reduce the erosion. The outcomes of this study will help State Department and/or

universities to prepare short- mid- and long-term plan for managing the soil erosion and sedimentation of rivers in the Ipoh area. This study will also provide essential information for reducing erosion sources and helps to find proper solutions to reduce the sedimentation of Sungai Perak, the second longest river in Malaysia.

1.8 Chapters Outlines

This study is comprised five chapters.

- **Chapter 2** gives the status of a Soil Erosion factors using universal soil loss equation on Ipoh area in references from the literature.

- **Chapter 3** describes the methods and materials that used in evaluating the Soil Erosion factors on Ipoh area and the procedure of these methods.

- **Chapter 4** describes all the result of evaluating an assessing the soil erosion of Ipoh area.

- **Chapter 5** gives the outcome of this study and recommendations for future studies.