UNIVERSITI TEKNOLOGI MARA

STUDY ON SOIL EROSION USING ^{137}Cs AS ENVIRONMENTAL TRACER IN FRASER'S HILL, PAHANG, MALAYSIA

AHMAD SANADI BIN ABU BAKAR

Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Applies Sciences

September 2018

ABSTRACT

The use of ^{137}Cs as tracer for soil erosion and redistribution studies is possible due to the fact that ^{137}Cs does not occur naturally and its affinity to adsorb to fine soil particles. Fraser's Hill is selected as the study area as there is no prior research of using ^{137}Cs as environmental tracers for soil erosion studies. The analysis of ^{137}Cs on surface soil and core soil was performed using gamma spectrometry. The gamma spectrometer was calibrated, checked for background and tested for accuracy and precision. The accuracy of the spectrometer was a mean z-score of 0.3 and the precision was 5.20 ± 1.82 when tested against the IAEA-414 Standard Reference Material. The sampling was divided into two areas namely Developed Area and Undeveloped Area. Surface and core soils were sampled from both areas and tested for their physical properties. Their lithology, soil type, soil pH, bulk density, organic matter content, carbonate content, sand portion and caly portion were compared and found no statistically significant difference in the soil from both areas. The comparison however did find statistically significant difference in the water content and silt portion in the soil from both areas. The measurement of surface dose at 0 m and 1 m found statistically significant difference in both areas with the Undeveloped Area exhibiting higher surface doses at 0 m and 1m. The analysis of ^{137}Cs in surface soil found them to range from 0.26 Bq/kg to 5.14 Bq/kg. The Undeveloped Area was found to have higher ^{137}Cs in surface soil compared to the Developed Area and this difference is statistically significant. The analysis of ^{137}Cs in core soils found the ^{137}Cs activity in soil cores can be divided into three profiles. From data of ^{137}Cs activity in core soils, the total ^{137}Cs inventory was calculated. The total ^{137}Cs inventory was found to range from 198.42 to 763.45 Bq/m^2. The mean total ^{137}Cs inventory in the Developed Area is higher than those in Undeveloped Area. However, the differences are not statistically significant. From the results of total ^{137}Cs inventory, the soil redistribution was calculated using Mass Balance Model. It was found that both the Developed Area and Undeveloped Area showed net soil erosions. The differences between both areas however are not statistically significant. Three slopes were identified as higher risk of soil erosion. Two of the slopes have history of landslides while one slope has no history of major landslides. Several recommendations were made for further study and research in Chapter Five. In conclusion, the method of using ^{137}Cs as environmental tracer is a reliable method to assess soil erosion and can give results in a timely manner.

ACKNOWLEDGEMENT

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1   PREAMBLE

This chapter consists of the background of the location of the study area, namely Fraser's Hill is also discussed. The discussion the proceeds to introduction of caesium-137 (^{137}Cs), its origin, its use in soil redistribution calculations and previous research on ^{137}Cs. The measurement of ^{137}Cs using gamma spectrometry is also discussed.

This chapter also discusses the rationale on why this study was performed. The background, the objective, scope and limitations, an d the significance of this study are the main points discussed in this chapter.

1.2   FRASER'S HILL

Fraser's Hill in Raub, Pahang, is one of the most frequented highland tourist destination about 103 km north of Kuala Lumpur as shown in *Figure 1.1*. At 1200 m, the temperature is pleasantly cool with a daily average of 24°C and night average of 17°C (Shafri, Zahidi, & Bakar, 2010). This contrast with the hot and humid weather of the lowland areas making Fraser's Hill a favourite spot for weekends retreats by city dwellers.

The maximum rainfall in Fraser's Hill between the year 2000 – 2007 was 126.5 mm and there was no history of flooding in Fraser's Hill (Shafri et al., 2010). However there were many records of landslides in Fraser's Hill. A landslide event in 1994 threatened one of the blocks of the Silverpark Holiday Resort (Malaysian Meteorological Department, 1994; Shafri et al., 2010). There were also more than 55 landslide events in Fraser's Hill between November 1997 and January 1999 (Shafri et al., 2010). These landslide occurrences show that there are risks of soil erosion in Fraser's Hill. These risks could affect the well being of the population in Fraser's Hill and could adversely affect the economy of Fraser's Hill.