Soil Erodibility Assessment at Ibu Pejabat Polis Kontinjen (IPPK) Shah Alam, Selangor

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ABSRACT

Rapid developments of the slopes and hill tops have resulted high rates of soil erosion. Soil erosion is a continuing long term problem and has become a very serious problem in Malaysia. As the awareness on the impact of soil erosion increased, a research has been carried out to determine the soil erodibility at Ibu Pejabat Polis Kontinjen (IPPK) Shah Alam, Selangor. IPPK has been chosen for the study of soil erosion since most the developments are on the hilly area. The research was carried out by physical reconnaissance around IPPK area so as to give an indication of soil erosion features presents. In addition, laboratory testing on the particle size distribution of the samples collected at the respective locations around the IPPK area were analyzed so as to establish the soil erodibility index using 'ROM' Scale method. From research finding, soil sample no.7 from site D has the highest value of erodibility index. This site is the most critical area to soil erodibility as compared to the other sites. Hopefully, the information and research findings would assist the authorities taking action and remedial works should be done to control soil erosion problem at this area.

Keywords: *soil erodibility, hilly area, 'ROM' Scale method*

Introduction

The rapid process of soil erosion is considered one of the most critical environmental problems facing our world today. Currently, it is widely recognized as a serious global problem. Morgan (2005) explained that soil erosion is a two-phase process, consisting of the detachment of individual particles from the soil mass and transported by erosive agents such as wind and water. It is a natural process, and erosion had begun before the history of man's existence on earth. However, disturbance from human activities further aggravates the soil erosion process especially at steep slopes. Bocco (1991) stated that soil erosion can be triggered or accelerated by climatic changes, tectonic activities, human influence or a combination of them.

Soil erosion phenomenon is basically the function of the rainfall erosivity and the soil erodibility. Soil erodibility defines the resistance of the soil to both detachment and transport. It is an important index to measure soil susceptibility to water erosion, and an essential parameter needed for soil erosion prediction. The soil erodibility represents the effect of soil properties and soil profile characteristics such as soil texture, aggregate stability, shear strength, infiltration capacity, organic and chemical content on soil loss. Many attempts have been made to devise a simple index of erodibility based either on the properties of the soil as determined in the laboratory or the field, or on the response of the soil to rainfall. Soil erodibility has been satisfactorily described by the soil erodibility nomograph (Wishmeier et al., 1971). Rousseva (1987) showed that the differences between soil erodibility estimates, calculated by the first approximation of the soil erodibility nomograph and those evaluated as the average annual soil loss from field plot measurements, did not exceed 20% of the mean measured value. Furthermore, to estimate the soil erodibility for non-concentrated flows, soil erodibility is rated for each soil material using the SOILOSS erosion prediction program (Rosewell, 1993). The program follows the Universal Soil Loss Equation of Wischmeier and Smith (1978). The erodibility factor (K) is based on a series of laboratory tests including particle size analysis and organic carbon test data as well as field assessment of soil structure and permeability. The K factor is first calculated from laboratory data using SOILOSS and provided for each material. Morgan (1986) stated that the soil erodibility index that is causing slope failure. It's based on Bouyancos formula, as in Equation 1.

$$\text{Erodibility Index} = \frac{\%\ \text{Sand} + \%\ \text{Silt}}{\%\ \text{Clay}} \qquad (1)$$

Roslan and Mazidah (2001) stated that the soil physical properties (percentage of sand, slit and clay) have influence on the risk of slope failure. Based on the study conducted by Roslan and Mazidah (2001), the formula for soil erodibility index was modified, as in Equation 2.

$$\text{Erodibility Index}_{(ROM)} = \frac{\%\ \text{Sand} + \%\ \text{Silt}}{2 \times \%\ \text{Clay}} \qquad (2)$$

In this study, the selected soil samples taken from IPPK Shah Alam areas were analyzed by using the Erodibility Index $_{(ROM)}$ formula.

Problem Statement

The aim of this study is to determine the soil erodibility of the selected soil samples from Ibu Pejabat Polis Kontinjen (IPPK) Shah Alam areas using 'ROM' Scale method. Soil test were carried out in the laboratory to determine their physical properties in term of particle size distribution to obtain the most critical area at IPPK based on the soil erodibility assessment.

Objective

The objectives of this study are:
1) To identify types of soil erosion features around the area of IPPK.
2) To determine the soil erodibility using 'ROM' Scale method.
3) To obtain which area at IPPK is the most critical to soil erodibility.

Scope of Study

The scope of the study is to cover the following aspects:
1) Identification of the types of soil erosion around the IPPK areas.
2) Identification of the soil physical properties in term of particle size distribution using laboratory test of ten soil samples for comparison.
3) Identification the soil erodibility at IPPK Shah Alam using 'ROM' Scale method.

Research Methodology

Study Area

The study area was done at Ibu Pejabat Polis Kontinjen (IPPK) Shah Alam. IPPK area is located in Section 9, Shah Alam, Selangor. It was built in 1978 and the area covered is about 50 acres. All the information related to the area such as geological data was collected. The observation was done by recognizing the various features of erosion and their types. Three main types of erosion, namely; sheet, rill and gully erosion, are to be identified and plotted. Other than that, the examinations of the photographs were carried out, plotting as much detail of the erosion features and related factors as possible.

Field Work and Laboratory Testing

The determination of soil erodibility is carried out by taking soil samples from areas of IPPK Shah Alam. In this study, ten samples of soil were taken at five selected test sites around the IPPK area (Site A, B, C, D and E) as shown in Figure 1. For each test site, two soil samples were taken at a depth of 300 mm from ground surface using hand auger. The samples of soil were analyzed by carrying out sieve analysis test and hydrometer test in order to determine the soil physical properties in term of particle size distribution to obtain the percentage of sand, silt and clay. These values were used to calculate the erodibility index by using Equation 2. Furthermore, the most critical area, at IPPK, to soil erodibilty was identified based on Table 1. Table 1 below shows the classification of soil erodibility scale using ROM Scale method. The flow chart of research methodology is illustrated in Figure 2.

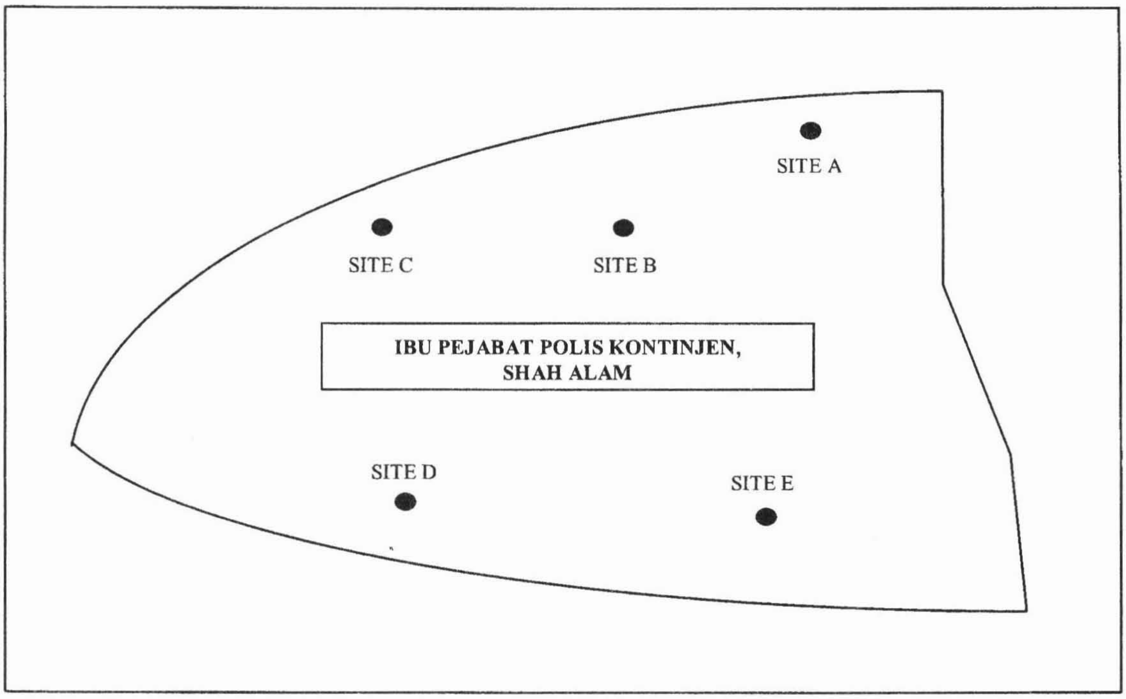

Figure 1: Five Selected Test Sites around the IPPK Area (Site A, B, C, D and E)

Table 1: Classification of Soil Erodibility Scale (Roslan & Mazidah, 2001)

ROM Scale	Degree
< 1.5	Low
1.5 – 4.0	Moderate
4.0 – 8.0	High
> 8.0	Critical

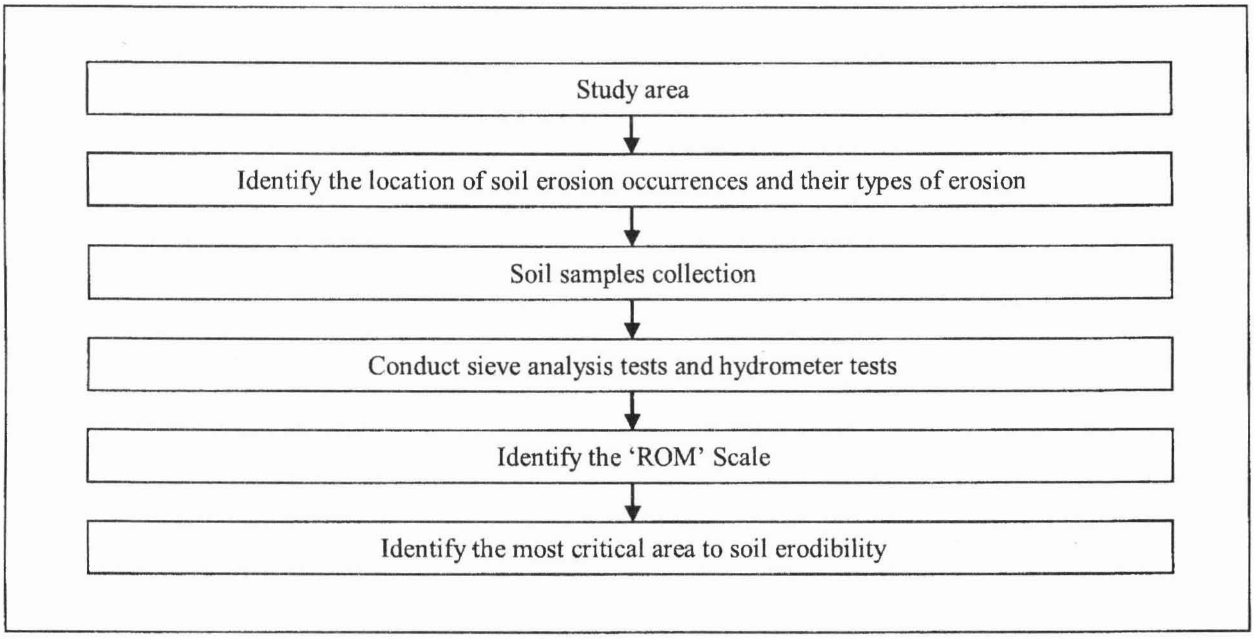

Figure 2: Flow Chart of Research Methodology

Results and Discussion

Soil Erosion Features

Generally erosion features spotted at the study area (around IPPK) could be classified into 3 main types namely; sheet, rill and gully erosion. From the results acquired, IIPK area does not show significant variation types of erosion features. Most of the erosion features were gully erosion. Gully features were observed in several places especially at steep slopes. The examples are shown in Figure 3 and 4.

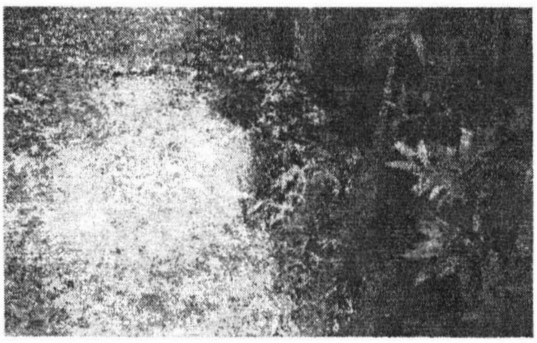

Figure 3: Gully Erosion at Site A

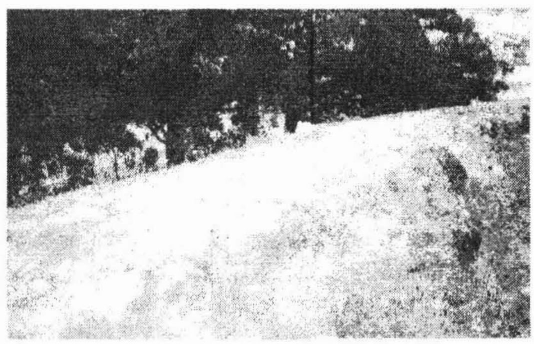

Figure 4. Gully Erosion at Site D

Soil Erodibility Assessment

Soil erodibility index is calculated based on the result of the soil report produced from the soil classification test. Using the sieve analysis and hydrometer result, the input parameters (i.e. sand, silt and clay) are used for the analysis of the erodibility index. From the results acquired, it is found out that the soil sample number 7 from site D has the highest value of erodibility index. This clearly indicates that the site D soil erodes more easily than the other soils thus leading to a higher erosion risk potential.

It is also seen that soil sample number 7 from site D has the highest percentage of sand and smallest percentage of clay. It can be said that the erodibility factor of a soil can be affected by the quantity of sand and clay. High composition of sand means that the soil can be easily eroded since they are fine in size and can be easily carried away by surface runoff. However, if clay is added to these soils, the erodibility is reducing due to the binding effect of the clay. Clay acts as a binder of soil particles.

Using the 'ROM' Scale method, it is found that the soil samples within this study have high and critical risk potential for erodibility. Therefore, several remedial measures should be taken for controlling this problem. There are many ways in which soil erosion may be controlled. The choice depends on the conditions such as slope, soil type, topography and crop cover. Table 2 below shows the type of erosion and results of erodibility index, 'ROM' Scale and degree of soil erodibilty using 'ROM' Scale method for the soil samples within this study.

Table 2: Erodibility Index, 'ROM' Scale and Degree of Soil Erodibilty using 'ROM' Scale Method

SITE	SOIL SAMPLE NO.	TYPE OF EROSION	SOIL GRADING (%)			ERODIBILITY INDEX	'ROM' SCALE	DEGREE
			SAND	SILT	CLAY			
A	1	Gully	90.00	8.93	0.47	105.24	> 8	Critical
	2	Gully	87.85	6.50	5.50	8.58	> 8	Critical
B	3	Gully	86.45	6.76	4.49	10.4	> 8	Critical
	4	Rill	85.50	5.26	6.89	6.59	6.59	High
C	5	Rill	84.65	6.97	8.28	5.5	5.5	High
	6	Gully	88.35	7.96	3.59	13.4	> 8	Critical
D	7	Gully	94.20	5.13	0.27	183.94	> 8	Critical
	8	Gully	92.50	6.56	0.35	141.51	> 8	Critical
E	9	Gully	84.55	7.84	0.41	112.67	> 8	Critical
	10	Gully	91.65	7.17	0.38	130.03	> 8	Critical

Conclusion

From the observation, even when the IPPK area consists of forest and vegetative cover, there are still occurrences of soil erosion features. The most erosion features found were gully erosion and were observed in several places especially at steep slopes. Thus, it shows that there is a need for more comprehensive protection measures on the affected slopes.

Based on results of the soil erodibility using the 'ROM' Scale method, it has been concluded that the soil samples within this study have high and critical risk potential for erodibility. Soils with a high percentage of silt or fine sand in their composition are more erodible than clays. Fine particles can be lifted and deposited, while coarse particles can be blown along the surface.

From the results acquired, it can be concluded that the soil sample number 7 from site D has the highest value of erodibility index. This site is the most critical area at IPPK Shah Alam to soil erodibility as compared to the other sites. However, it is too early to conclude the actual ranking of the erodibility potential of those soil samples since observations were carried out for only six months. Essentially, a longer period of measurement of within 1 to 3 years should be more confirmative to determine the soil erodibility of the selected soil samples.

The following are the recommendations for future works to be carried out:

1) Small quantity of soil sample does not give satisfactory results. Therefore, it is advisable to add more quantity of soil samples to achieve consistency of result.
2) In the future, a study needs to consider other factors such as rainfall and shear strength of soil to see their relationship with soil erodibility scale (ROM Scale).
3) A longer period of measurement of within 1 to 3 years should be more confirmative to determine the pattern of the soil erodibility behavior of the selected soil samples.

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