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Effects of Land Use Patterns on Soil Erosion; A Case Study in Rural Areas of Sri Lanka

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Abstract:

Land use is one of the key factors affecting soil erosion in rural agricultural areas in Sri Lanka. Wewere Grama Niladari division is selected for this study as there is high consumption of land for various land use patterns in Sri Lanka. The main objective of this study is to identify the most influential land use patterns which accelerate the natural soil erosion process and provide the solution for conservation soil erosion. Consequently, to achieve the target, the study area was divided into 7 land units according to the several land use patterns in the area and obtained 1 kg of soil from each land units through the simple random sampling method. Further, experiments were conducted in the laboratory and the final results were analyzed. The results were represented with maps using Arc GIS and charts, graphs, tables using MS Excel. 100g of soil from each soil samples were taken, 2mm sieved each sample, and obtained 2 fractions to determine their particle sizes. The fraction which is more than 2mm (+2mm) is selected as the results of each samples. Scrub represented 4.82 %, crop cultivation represented 41.36% of soil particles(+2mm). The result substantiated high soil erosion was represented in crop cultivation due to human activity and less was represented in scrub areas. The mismanagement of land, over weeding, use several types of machinery to looseness the soil, maximum tillage and lack of knowledge are the causes of accelerated soil erosion in Wewere GND. Practice cover crops, mulching methods, minimum tillage, Practice selective weed control, Practice using organic fertilizer are suitable conservation methods to study area. Additionally, introduce cover crops is a sustainable method for rural agricultural areas in Sri Lanka.

Keywords: land use pattern, soil erosion, rural area

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I. INTRODUCTION

Soil is one of the world's most important natural resources and formed under various ecosystems (FAO,2015). It has many important functions which are essential for life and provides more intangible services for maintenance of the biosphere (Groot,1994). Soil is under threat due to various anthropogenic activities as a result of technological advancement and industrialization. Since the agricultural development and increased population growth in Sri Lanka has modified land use patterns and thus, increased the runoff process and soil degradation induced by water erosion.

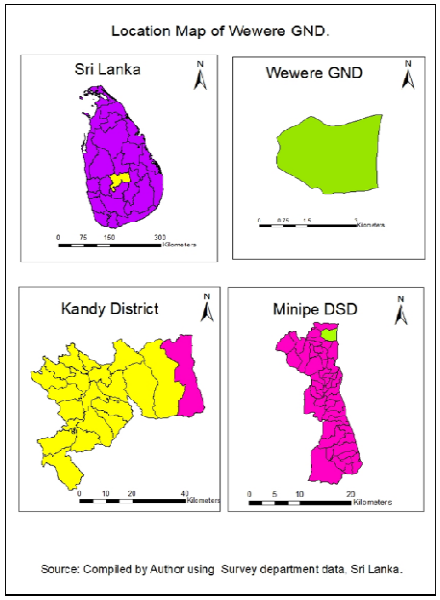
Jayasekara, Kadupitiya and Vitharan study revealed that 11.8% of the area in Sri Lanka is under high hazard level of erosion and 4.8% of the area is under very high level of hazard which are intolerable for any land use with respect to the sustainable productivity (Jayasekara et al. 2018). Additionally, named six districts as Badulla (36.5% high erosion hazard), Kandy (32%), Kegalle (38.5%), Nuwara Eliya (40.7%),

Rathnapura (38.7%) and Matale (20.3%) represented substantial susceptibility for soil erosion mainly due to the topography and the land use. Also named four other districts, Galle (20% high erosion hazard), Matara (20%), Kaluthara (20%) and Colombo (9%) also represented high propensity for soil erosion due to the land use changes with the urbanization, agricultural advancement and settlements.

According to above literature evinced that Kandy district also has high tendency to soil erosion. So Wewere GND is situated in Kandy district (map 01) and the study area is a rural agricultural area. The main objective of this study is to identify the dominant land use pattern which accelerate the natural soil erosion process in the Wewere GND, Kandy District, Sri Lanka.

Map 01

Location of Study Area



II.METHODOLOGY

The research approach is important in conducting research, and the human ecological approach used for the study. The study area was selected under the judgment sampling method because it was an area with a growing population and slopewith $<15^0$ with abundant water sources and a large area of agriculture and various anthropogenic activities. Also, sampling methods were used to collect soil samples from the study area of 7.7957km^2. The study area was divided into seven land units under the judgment sampling method according to the most common land use patterns in the area. Later, a simple random sampling method was used for obtaining 7 soil samples for further experiments. The month of November was selected for soil sampling, because the study area receives rainfall with the onset of northeast monsoon. As a result, soil samples were collected on 2nd of November 2019 at 9-12 am.

Used primary data for quantitative analysis to achieve the main objective of the study. Particle size distribution (PSD) in the soil profile is strongly related to erosion. Characteristics of soilparticle size distribution have a good relationship with the changes of soil structure, which is affected by management practices, erosion and desertification (Zhai et al. 2020). 100g of soils were taken from each soil samples and sieved under 2mm diameter sieve. Subsequently, obtained 2 fractions to determine their particle sizes. The fraction which is more than 2mm (+2mm) is selected as the results of each samples. Afterwards use geographic information system (GIS) software to analyse the results. Inverse distance weighted spatial analysing tool used to interpretation of the results.

III. RESULTS AND DISCUSSIONS

According to the United States Department of Agriculture (USDA) and International Society of Soil Science (ISSS) soil particle sizes classification as follows (Claude, 2002).

Table 1

Soil paricle siize classification

Particle fraction name	USDA (mm)	ISSS (mm)
Gravel	>2	>2
Very coarse sand	1-2	
Coarse sand	0.5-1.0	0.2-2.0
Medium sand	0.25-0.50	
Fine sand	0.10-0.25	0.02-0.20
Very fine sand	0.05-0.10	
Silt	0.002-0.05	0.002-0.020
Clay	<0.002	<0.002

(Source: Aquaculture pond bottom soil qualtiy management, 2002).

The above classifications indicate that soil particles greater than 2 mm are gravel. And particles which are less than 2mm are sand. Accordingly, if soil erosion is high, the area will have more than 2 mm soil particles (gravels) due to the washed away of top soil layer in soil erosion process. And soil erosion is less, the area will have less than 2mm soil particles(sand).

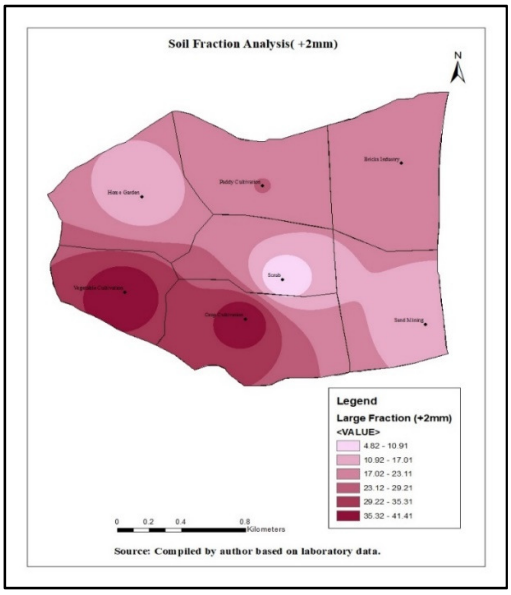
The results of the fraction analysis of the soil particle size distributions represented the highest soil erosion in the crop cultivation land. This is confirmed by the abundance of gravel in the area. According to the analysis, 41.36g of soil particles are represented as gavels (map 02). And 58.64g are represented as sand. And the least amount of gravel is represented in the scrub areas. It can be identified as 4.82g and it contained 95.18g of sand particles. The study area has less than 150 slope area. So soil erosion occurs naturally in the scrub area. Hence soil erosion is accelerated other land use patterns than the scrubs areas.

Secondly highest soil erosion represented in vegetable cultivation. It contained 39.85g of gravels and 60.15g of sand particles. Weeding methods, maximum tillage, burning, not using organic fertilizer, lack of mulching has contributed to the increase in soil erosion. Paddy cultivation represented 23.29g of gravel particles and 76.81g of sand particles. Soil erosion in paddy cultivation is fairly low when compared to vegetable cultivation. Ploughing, uses of harvesting machines have contributed the soil erosion in paddy cultivation. Compared to other land use patterns, lower soil erosion can be detected in the home garden. It represented 11.71g gravels and 88.29g of sand particles.

When compared the brick industry and sand mining industry soil erosion is high in brick industry. The result of the gavels amount in the brick industry represented as 19.14g and in the sand industry it was 13.90g. Due to overgrazing, weeding, deforestation, and use of machinery for soil toppling are the main reason for the soil erosion in industrial areas.

Accordingly, land use patterns in the area will increase the natural soil erosion process. As a result, sand particles in the soil are washed away and only gravel remains.

Map 02
Fraction analysis of the soil particles sizes larger than 2mm



According to the results there is a significant change in the soil erosion in study area among several land use patterns. Soil is a living organism (Soil Sciences Society in America, 2021). It is the most valuable natural resource after the water resource in the world. Soil formation process is a complex and long term process.So conserve the soil is an investment to the future.

IV CONCLUSIONS

Soil erosion is one of a serious agricultural problem that posed severe threat to current and potential food production and the livelihood of peoples in Sri Lanka (Tsegaye, 2019). Land use patterns such as vegetable cultivation, crop cultivation, paddy cultivation, home garden, small scale industries, bricks and sand mining accelerate soil erosion in the study area. Although, the soil erosion is minimal in the scrubs in the study area due to the less human influence. Inappropriate plant control, tillage pattern, use of inorganic fertilizer, overgrazing, weeding methods, ploughing methods have contributed to this problem. Improper land use pattern and illegal activities also affected to the soil erosion in the study area. Less awareness about soil erosion and conservation methods are the major drawbacks in rural areas, Sri Lanka. Introduce on-farm soil conservation measures and off farm soil conservations are appropriate to minimize this phenomenon. Mechanical measures, biological measures and agronomic measures are major conservation methods can establish in the rural areas in Sri Lanka (Dharmasena, 1992). Stone bunds, live hedges, cover crops, mulching methods, practice minimum tillage, selective weed control, use organic fertilizer are some measures to overcome this challenge. Consequently, awareness programs are the best methods to maintain a healthy soil in the area. Mostof villagers haven't proper education, so these programs should be conduct in simple language to understand them. All living being depend on the soil and it is the backbone of world's food security. So at the small scale it is valuable to conserve soil erosion. Because soil loss and degradation is not recoverable within a human lifespan.

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