https://dx.doi.org/10.22161/ijreh.1.4.4 *ISSN: 2456-8678*

A Review of Vegetation Cover as a Natural Factor to Soil Erosion

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Abstract— *Soil erosion is a major global environmental problem driven by a number of both natural and anthropogenic factors. The objective of this paper is to conduct a review of previous works on vegetation cover as a natural factor of soil erosion. The study made a review of academic/journal articles, internet materials, conference papers, books and publicly available materials on vegetation as a factor of soil erosion. From the review, previous authors had a unity of opinion that vegetation cover is an important index to evaluate the soils' sensivity to erosion. Uncovering the soil exposes it to the vagaries of erosion ranging from rainsplash to gully erosion that may be irreversible in forms of badlands. Recommendations of the study include: (1) making legislations mandating landholders to cover their soils using mainly economic trees as a source of livelihoods as well as protecting the soil against the forces of raindrops and runoff; (2) agroforestry by farmers and reforestation programme by governments to increase vegetation cover of soils so as to reduce the impact of raindrops and runoff that detach and transport soil particles; and (3) creation of awareness among the generality of the populace on the importance of vegetation in protecting the soil against erosion and maintaining the world's climate.*

Keywords—Plant Roots, Rainfall, Review, Soil Erosion, Sustainable Development, Vegetation Cover.

I. INTRODUCTION

Soil erosion is a major problem in the world (Lant, Kraft,Beaulieu, Bennette,Loftust and Nicklow, 2005). Godone and Stanche (2011) opined that soil erosion is one of the main soil threats comprising soil productive and protective function. Soil erosion is a serious environmental, economic and social problem; it does not only cause land degradation and soil productivity loss, but also threatens the stability and health of the society in general and sustainable development of rural areas in particular (Jing, Wang and Zheng, 2005).

Globally, it has been estimated that 1.1billion hectares of land are affected by soil erosion (Pathak,Wani and Sudi, 2005), with an annual global loss of agricultural land due to erosion estimated at 3million hectares (Woreka,2004). According to Morgan (2005), soil erosion is a hazard traditionally associated with agriculture in tropical and semi-arid areas, and is important for its long-term effects on soil productivity and sustainable agriculture. In Africa, 8.5 percent of the mean yield loss is associated with soil erosion (Eswaran, Lal and Reich, 2001). In Nigeria, Agulu-Nanka in Anambra State is an area badly affected by soil erosion; up to 250 tons per hectares have been lost (Kalu, 2001).

Adinna (2001) defined erosion as the gradual or forceful removal of weathered rock from the point of weathering. Ahnert (2003) asserted that soil erosion is the displacement of soil particles by agents of tillage, wind, water and snow, and down slope movement to gravity. Igbokwe, Akinyede, Dang, Ono, Nnodu and Anike (2008) saw soil erosion as an accelerated process under which soil is bodily displaced and transported away faster than it can be formed. Francis (2012) said that soil erosion is the removal of top soil than the soil forming processes can replace it due to natural, animal and human activities such as overgrazing, over cultivation, deforestation and mechanical farming. Eyankware, Eyankware and Effam (2015) opined that soil erosion is denudation process that involves three stages of rock decay decomposition, transportation and deposition. The factors that affect soil erosion could be natural or anthropogenic; natural factors influencing soil erosion are soil texture, rainfall intensity, soil type, climate, erodibility, slope and vegetation cover (Kirchlof and Salako 2008). Soil erosion is triggered by anthropogenic factors such as deforestation, slash-and burn agriculture, intensive cultivation for agriculture and overgrazing (Blanco and Lal, 2008). Both natural and anthropogenic factors contribute in different degrees to rainsplash- sheet- rill- gully erosion processes by the detachment and transport of soil particles, thereby creating on-site and off-site environmental and socio-economic impacts.

https://dx.doi.org/10.22161/ijreh.1.4.4 *ISSN: 2456-8678*

Vegetation cover is defined as the assemblage of plant species that provides cover to the ground, to control the harm and reduce the risk of soil erosion (Sharma, 2009). The natural vegetation protects the soil against impacts of rainfall. It improves infiltration and enhances the recharging of the ground water reservoirs. When vegetation cover is displaced, infiltration capacity is decreased (Zuazo and Plaguezuele, 2008; Vanoost, Govers and Desmet, 2008). Therefore, the issue of soil erosion deserves priority attention to mitigate its dire consequences on the land status and environmental quality. This paper focused on reviewing vegetation cover as a natural factor of soil erosion.

1.1 Statement of the Problem

Soil erosion is a natural geomorphological process resulting from water and land interactions but accelerated to become an environmental hazard by human activities such as clearing of forest for cultivation, poor farming practices and encroachment into marginal lands (Farayi, 2011). Accelerated soil erosion is a major ecological problem in the tropics (Hartemink, 2002). Human induced soil erosion and associate damage to all agricultural land over many years have resulted to the loss of valuable agricultural land. Due to abandonment and reduced productivity of the remaining land which is partly made up for, by addition of nitrogen and phosphate fertilizer (Pimentel, 2006). For instance, increased rates of soil erosion are directly associated with nutrient loss, which may reduce agricultural productivity, (Bakker, 2007) and cause water bodies' eutrophication (Istanovics, 2009). Soil erosion reduces the general productivity of terrestrial ecosystem (Pimentel, Petrotra, Riley, Jacquet, Honigman and Valero, 2006). It increases runoff thereby decreasing water infiltration and the water storage capacity of the soil (Troeh, Hobbs and Donahue, 2004). For example loss of soil organic matter increases water runoff which reduces the soil's water storage capacity that diminishes nutrient levels in soil and also reduces the natural biota, biomass and biodiversity of soil ecosystem (Brevik, 2013). Lack of vegetation cover exposes the soil to high intensity rainfall resulting to poor structure and increases the rate of runoff, which detaches soil particles and causes soil erosion (Egbai, Eric and Ogogo, 2012). When vegetation cover is displaced, infiltration capacity is decreased (Zuazo and Plaguezuele, 2008; Vanoost , Govers and Desmet, 2008).

1.2. Objective of the Study

The objective of this paper is to review vegetation cover as a natural factor of soil erosion.

II. CONCEPTUAL FRAMEWORK: SUSTAINABLE DEVELOPMENT

This research is based on the concept of sustainable development. In the opinion of World Conference on Environment and Development (WCED) (1987), sustainable development is development that meets the needs of the present without compromising the ability of future generation to meet their own needs. Morelli (2010) saw sustainable development as meeting the resources and service needs for current and future generations without compromising the health of the ecosystems that provide them and more specifically as a condition of balance, resilience and interconnection that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity. Vegetation cover is a major factor of soil erosion which this research focuses on so as to build sustainability into soil erosion management.

III. METHOD

This research made use of academic articles, journals, conference paper, textbooks and internet materials on soil erosion and vegetation cover as a natural factor. The researchers had (43) materials for the research but summarized (10) that centered more on vegetation cover as a natural factor of soil erosion. This enabled the researchers to make a synthesis of various researchers' views on vegetation cover as a natural factor of soil erosion.

IV. REVIEW OF RELATED LITERATURE

Rey (2003) carried out a study on influence of vegetation distribution on sediment yield in forested Marly gullies in France and stated that plant cover protected soil against erosion by reducing water runoff. Gyssel, Poesen, Bochet and Li (2005) conducted a study on the impact of plant roots on the resistance of soil erosion by water and asserted that plant stabilized the soil with their roots. Kateb, Zhang, Zhang and Mosandi (2013) carried out a study on soil erosion and surface runoff on different vegetation cover and slope gradients in Southern Shaanxi Province China and claimed that the amount of erosion was considerably influenced by changes in vegetation cover. A study conducted in China on effect of vegetation cover on grassland on runoff and sediment yield in loess hilly region by Zhao, Chen, Huang, Wu and Helmer (2013) revealed that runoff and sediment yields are meaningfully influenced

https://dx.doi.org/10.22161/ijreh.1.4.4 *ISSN: 2456-8678*

by vegetation. Bochet and Garcia-Fayos (2004), in their study on the factors controlling vegetation establishment and water on motor way slopes, in Valencia Spain noted that vegetation reduced water-caused erosion by intercepting rainfall, increasing water infiltration on associated soil- fertility islands, intercepting runoff at soil surface level and stabilizing the soil by root. In China, Zhou and Shangguan (2007) studied effects of dry grass roots and shoots on loess erosion under simulated rainfall and stated that increasing the amount of vegetation can lead to runoff generation and erosion control. In their research on soil erosion and runoff response to plant cover strips on semi-arid slopes in Spain Martinez, Duran and Francia (2006) asserted that the role of vegetation is summarized by introducing water runoff and increasing soil infiltration.

Moreira,Silva, Righetto, Medeinis (2008) conducted a research in Brazil on sediment and overflow of soil erosion, in undisturbed Brazilian North-Eastern semi-arid experimental plot, and reported that vegetation cover protects soil surface from splash, increase surface roughness and enhances soil structure and macro- porosity. In his research in England on runoff generation in semi-arid areas Beven (2002) noted that runoff generation and soil loss in semi-arid regions are affected by non-linear and complex interdependency among rainfall properties, soil moisture and vegetation characteristics. Furthermore, he observed that vegetation has an important effect on infiltration and soil water storage capacity. Eshghizadeh,Talebi, Dastorani and Azimzadeh (2015) investigated the effect of land cover on runoff and soil loss at hill-slope scale in Mashad Iran and reported that increase in land cover reduces soil loss and results in the increase of permeability in canopy and litter. Additionally, they opined that litter and plant cover caused overland flow, velocity reduction, and surface roughness increase, enhancing soil infiltration through greater macro-pore density and improving soil structure by contributing organic matter.

Madi, Mouzai and Bouhadef (2013) studied plant cover effects on overland flow and on soil erosion under simulated rainfall intensity in Algeria and asserted that vegetation is an effective way of fighting erosion and is important in soil conservation. In a research on runoff and soil loss under individual plants of semi-arid Mediterranean shrub land: Influence of plant morphology and rainfall intensity in Spain by Bochet, Poesen and Rubio (2006), it was observed that vegetation influences soil erosion mainly by intercepting rainfall and protecting the soil surface against the raindrops and by intercepting runoff. They further stated that vegetation influences the fluxes of water and sediment by increasing stability and cohesion and by improving water infiltration. Zuazo, Tajero, Martin and Fernandez (2011) carried out a study on soil erosion; causes, processes and effects in Spain and was of the assertion that vegetation influence soil erosion by interception of rain water. Zuazo and Plaguezuele (2008) carried out a study on soil erosion and runoff prevention by plant cover in Granada Spain and reported that when vegetation cover is displaced, infiltration capacity is decreased. Rehman, Rashid, Kausar, Alvi and Hussain (2015) in their research in Paskistan on slope gradient and vegetation cover effect on runoff and sediment yield in hill slope, noted that increase in vegetation cover results in a significant reduction in discharge of sediment. De-Baets, Poesen, Knappen, Babera and Navorro (2007) studied root characteristics of representative Mediterranean plant species and their erosion reducing potential during concentrated runoff in Murcia Spain and was of the opinion that plant cover played an important role in reducing erosion and protecting soil from degradation. In his research on role of vegetation pattern in structuring runoff and sediment fluxes in dryland in Almeria Spain, Puidefabregas (2004) was of the view that plant canopies play a role in shielding the soil from radiation and rainfall.

Table.1: Summary of Characteristics of Some of the Studies that described Vegetation as a Natural Factor of Soil Erosion

S/N	Author(s)	Topic of Research	Method(s)	Result(s)	Recommendation(s)	Conclusion
1.	Eshghizedeh, Talebi, Dastorani and Azimzadeh (2015).	Effect of natural land covers on runoff and soil loss at the hill slope scale.	Field observation and Experiment.	Increase in the land covers reduces the soil loss.	Planting of land should be encouraged because removal of land covers increases the rate of soil loss.	Identifying the importance of land covers that influence runoff and soil loss is necessary in management strategies.

https://dx.doi.org/10.22161/ijreh.1.4.4 *ISSN: 2456-8678*

S/N	Author(s)	Topic of Research	Method(s)	Result(s)	Recommendation(s)	Conclusion
2.	Gyssel, Poesen, Bochet and Li (2005).	Impacts of plants roots on the resistance of soil erosion.	Field observation and Measurement.	It shows that Plant roots have the largest effects on soil erosion resistance in the top layer of the soil.	For reduction of rill and ephemeral gully erosion rates the use of plant species that develop a dense root network should be planted.	The effect of plant roots on increasing the resistance of the soil to concentrated flow erosion mainly depend on the presence and distribution of effective plant roots.
3.	Kateb, Zhang, Zhang and Mosandi (2013).	Soil erosion and surface runoff on different vegetation cover and slope gradient.	Field experiment.	There is no significant difference between low and high forest for both runoff and soil loss.	Well-designed land use plans based on scientific information are crucial to support reducing soil erosion.	Soil loss is more sensitive than runoff to changes in vegetation cover.
4.	Rehiman , Rashid, Kausar, Alvi and Hussian (2015).	Slope gradient and vegetation cover effect on the runoff and sediment yield in Hill slope Agriculture	Experimentation.	It showed that vegetation distributions were strongly influenced by the pattern and sediment loss.	Planting of crop in the sloping land helps in the resistance of soil erosion.	Topographic gradient has an important influence on crop yield.
5.	Rey (2003).	Influence of vegetation distribution on sediment yield in forested marly gullies.	Physical Measurement.	The key result of this study is that trenches carried out on gully floor and on slope of vegetation barrier revealed deposit of movable sediments.	There is need to establish total vegetation cover in a gully to stop the sediment yield at the outlet.	Vegetation distribution in gully is important in reducing sediment yield at its outlets.
6.	Zuazo, and Pleguezuele (2008).	Soil erosion and runoff prevention by plant.	Literature review of journals articles.	It showed that most of the terrace developed variation in crop production.	Changes in plant cover have a greater impact on both runoff and erosion.	A reduction in plant cover can intensify erosion processes that diminish soil quality.

https://dx.doi.org/10.22161/ijreh.1.4.4 *ISSN: 2456-8678*

S/N	Author(s)	Topic of Research	Method(s)	Result(s)	Recommendation(s)	Conclusion
7.	Zuazo, Plaguezuele, Martin Peinado, De- Graaf, Martinez and Flanagan(2010).	Environmental impact of introducing plants cover in the taluses of terraces	laboratory analysis.	It shows that plant cover softened the mechanical impact of the raindrops on the soil surface of the taluses, diminishing the surface runoff.	It was recommended that, To protect structures (taluses of orchard terraces), use of plant cover avoids soil loss and environmental pollution.	Implementation of aromatic plant covers in the taluses of subtropical orchard terrace to substantially reduce soil erosion and runoff.
8.	Madi, Mouzai, and Bouhadef (2013).	Plant covers effect on overland flow and on soil erosion under simulated rainfall intensity.	Experimentation.	The result found shows that the mean flow velocity decreases with increasing stem density.	It was recommended that plant cover should be planted to improve water and soil conservation and reduce runoff and eroded sediments.	It concluded that the stem of plant could effectively control erosion on a sandy-loam soil.
9	De-Baet, Poesen, Knappen, Babera, and Navorro(2007).	Root characteristics of representative Mediterranean plant species and their erosion reducing potential during concentrated runoff.	Field measurement.	It shows that the depth at which there is high density of roots is most probably linked to the availability of soil water.	Species with dense ground cover and a root system that promotes macro-porosity of the soil to re-vegetate degraded soil in Mediterranean environment	Desirable root characteristics for reducing potential of vegetation depend both on the process of interest and environmental characteristics.
10.	Puigefabregas (2004).	The role of vegetation patterns in structuring sediment fluxes in dryland.	Field observation and experimentation.	it shows that generally exponential decrease in erosion occurs above certain level of plant cover	When there is increase in vegetation cover erosion decreases	Vegetation canopies modification functions affects the soil.

Source: Researchers' Design, 2017

https://dx.doi.org/10.22161/ijreh.1.4.4 *ISSN: 2456-8678*

V. RESULTS AND DISCUSSION

Vegetation cover provides a blanket cover to soil against raindrops and runoff that detach and transport soil particles. From Table 1, the researchers' topics are concerned with investigating vegetation cover as a very important factor of soil erosion. The methods used in collecting data are standard, ranging from measurement to laboratory analysis. From the review of previous works by researchers (for example Eshghizedeh, Talebi, Dastorani and Azimzadeh, 2015; Rehiman, Rashid, Kausar, Alvi and Hussain, 2015; Puigefabregas 2004), plant cover reduces the impact of raindrops on soils and soil erosion. Similarly, plant roots increase the resistance of soil to erosion (Gyssel, Poesen, Bochet and Li, 2005; De-Baet, Poesen, Knappen, Babera and Navorro, 2007). All previous researchers whose works were reviewed agreed that increase in vegetation cover would lower water-induced soil erosion in many ways, including intercepting rainfall and stabilizing the soil through the plant root system. The implication is that plant cover protects the soil to a large extent against the influence of other factors of soil erosion as any area with thick vegetation cannot suffer serious accelerated soil erosion as it was before the anthropogenic activities of man began to uncover the soil. Generally, the studies made recommendation aimed at covering the soil to reduce soil erosion.

VI. RECOMMENDATIONS

The specific recommendations emanating from this paper are:

1. Creation of awareness among the generality of the populace on the importance of vegetation cover in protecting the soil against erosion and maintaining the world's climate.
2. Agro forestry by farmers and reforestation programme by government to increase vegetation cover of soils so as to reduce the impact of raindrops and runoff that detach and transport soil particles.
3. Researchers should review more works regularly on vegetation cover as a natural factor to soil erosion to enable the general public have a broad knowledge on the topic.
4. Legislations should make landholders cover their soils using mainly economic trees that provide a source of livelihoods to them and protect the soil against the forces of raindrops and runoff.

VII. CONCLUSION

This paper reviewed works done by previous authors on vegetation cover as a natural factor of soil erosion. From the review of many studies on vegetation as a natural factor of soil erosion and based on the results, this study concludes that for the survival of the global environment which is the survival of man, maintenance of existing vegetation cover and planting of trees where the soil has been devegetated provide the needed panacea for soil erosion management.

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