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EFFECTIVE STRATEGIES FOR MITIGATING SOIL EROSION: STUDY OF THE ROUNDABOUT FIELD IN AKANU IBIAM FEDERAL POLYTECHNIC, UNWANA

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Abstract

The target of this research is to unravel the effective strategies for mitigating the environmental threat of soil erosion. In the fight against environmental degradation and harmful effects of greenhouse gas emission, the negative impact emanating from soil erosion cannot be overlooked hence the global call for environmental sustainability. The gradual displacement of topsoil and the attendant creation of rills and possible gullies have located itself within the largest roundabout in Akanu Ibiam Federal Polytechnic, Unwana. This research is an investigation into the strategies effective for the curbing of this menace as it affects the school's largest traffic cycle. The study adopted structured questionnaire as the tool for eliciting primary data from respondents on control of soil erosion (CSE) as the dependent variable and control of soil erosion with the use of: trees (CUT), shrubs (CUS), and granites (CUG) as the independent variables. From the population of 2,000 staff of the Polytechnic a sample size of 333 was drawn using Taro Yamane's formula. Three hundred and thirty-two (332) of the 333 administered questionnaires were duly completed, returned, and coded to make the responses amenable for econometric use. The Ordinary Least Square method results revealed that the three explanatory variables have significant relationships with control of soil erosion individually and collectively. The study therefore recommends among others that the planting of trees around the roundabout and environments be encouraged.

Keywords: *Soil Erosion, Mitigation, Effective Strategy*

Introduction

Soil Erosion is an environmental threat. It can put a community of people at the risk of forced migration. Soil erosion gradually creeps into a portion of land such that its presence may not be noticed initially and so, ignored. If left unchecked, its menace can cause huge losses to institutions, communities and individuals within its environment. Of recent, institutions and individuals across the globe are beginning to make pronounced commitments towards sustainable environment because erosion exacerbates the effects of climate change as the displacement of soil and its

organic carbon releases more carbon dioxide into the atmosphere leading to increased global warming. There are cases of soil erosion and its attendant effects in Sub-Sahara African Countries. In Nigeria for instance, soil erosion is witnessed in some parts of Anambra, Abia, Ebonyi and Cross River states. In Ebonyi state, erosion is predominant in Afikpo Local Government Area because of the steep slopes in its environment. With the location of Akanu Ibiam Federal Polytechnic in this area, it should be expected that the soil on which this tertiary institution stands will not be completely free from this environmental threat. A cursory look at the soil within the Polytechnic's largest rotary (Roundabout) shows the visible presence of soil erosion that if not quickly checked can extend to other parts of this beautiful traffic circle. This research therefore, targets the best strategies that can mitigate the seriousness and subsequent advancement of the existing erosion and put in check the rate of carbon dioxide emission emanating from the rotary as a result of erosion.

Statement of the Problem

Erosion possesses a natural force to destroy. That is why it is often referred to as a threat. It disrupts the soil, removing far away, its nutrients. The effect of erosion is neither friendly to humans nor biodiversity that inhabit the soil. Erosion whether caused by heavy rainfall, harsh wind or trampling by humans and animals, is difficult to be noticed initially. It will only be noticed when it has advanced to rill erosion that marks the ground with parallel lines. If rills are not tended to, the multiple narrow stripes of land that separate the rills will give way leading to formation of gully erosion. Gully erosion can cut deeper across a field making the field completely unusable. Remedying a gully caused by erosion involves huge economic cost. Above all, as carbon is located in the topsoil, eroding the soil means a release of carbon back into the atmosphere thereby contributing to greenhouse gas emission and exacerbating climate change. Soil erosion is a bane of aesthetical nature of a site like the largest rotary in this technological tertiary institution and must be eradicated.

Objectives of the Study

The general objective of this research is to unravel the effective strategy for mitigating soil erosion on the field of the largest roundabout in Akanu Ibiam Federal Polytechnic, Unwana. The specific objectives are:

1. To ascertain the extent to which planting of woody trees round within the rotary can increase soil erosion control on the field.
2. To discover the effect which the presence of perennial woody shrubs in the rotary will have on the control of the erosion spots in the site.
3. To unravel the potency of traffic lane construction in the roundabout field using granites as a means of controlling the soil erosion in the field.

Research Questions

The study will answer the following questions:

1. To what extent is planting of woody trees likely to control soil erosion?
2. What effect has perennial shrubs in a field on control of soil erosion?
3. How would construction of proper traffic lane with granites mitigate soil erosion?

Research Hypotheses

The study will address the research questions by testing the hypotheses stated below.

HO_1: There is no significant relationship between planting of trees in a field and control of soil erosion.

HO_2: The presence of perennial shrubs in a field has no significant relationship with control of soil erosion.

HO_3: The association between construction of proper traffic lane with granites and control of soil erosion is not significant.

Significance of the Study

The application of the outcome of the study will enhance the beauty of the environment of Akanu Ibiam Federal Polytechnic Unwana, and help to protect the health of the members of staff and students from effects of climate change produced by greenhouse gas from eroded soil. It will be a guide to government in making policies that promote soil conservation and funding of restoration projects with the aim of reducing high cost of late soil erosion control. On the global scene, knowledge from the study will add to global development and implementation of legal instruments on soil erosion control and to knowledge.

Scope of the Study

The study analyzes the use of trees, shrubs and construction of footpaths with granites as effective strategies for mitigating soil erosion with particular reference to the roundabout field of Akanu Ibiam Federal Polytechnic, Unwana. The choice of the field is justified by its location as bordering many gigantic buildings in the polytechnic and being the ceremonial field of the institution. The study is limited by quality of data, cultural bias of respondents, time, and high cost of materials due to the high rate of inflation prevalent in the country.

Literature Review

There are many scholarly literatures on the need for soil and erosion management. These are in attempt to checkmate the myriad causes of climate change and to sustain the global environment. In doing this, strategies are adopted. Freedman (2013) defined strategy as means by which goals and priorities are achieved. It refers to how goals will be achieved by the use of available resources (Simeone, 2020). A strategy is effective if the set objective(s) are specific, measurable, achievable, relevant, and time bound (Planivore, (2023). Mitigating soil erosion relates to lessening or minimizing its adverse or hazardous impacts (UNDRR, 2015). Environmental economists advocate for the early detection and management of soil erosion because it is a natural disaster that portends risks to humans, biodiversities, ecosystem, etc. Soil erosion moves soil faster than the forming processes can replace it. Economics sees the physical loss in topsoil and productivity following reduction in rooting depth, removal of plant nutrients and loss of water as soil erosion. Youmatter (2020) defined soil erosion as a gradual process of movement and transport of the upper layer of soil by different agents such as water, wind and mass movement causing its deterioration in the long run.

Robert (2020) in the theory of erosion states that erosion occurs when the energy of water, wind or weight of soil is more than the cohesive forces that bind the soil particles together thereby displacing them as sediment. In empirical investigation of soil erodibility estimation under different tillage systems in the rain forest climate of Osun state, Nigeria, Johnson (2013) using Universal Soil Loss Equation (USLE) and for variables: relationship between percentage of farmers that retain trees within and around farm lands and percentage of farmers with erosion problems, ascertained that Ife Central that had the lowest percentage of tree retention on farm had the highest percentage erosion problem while Irewole site with the highest tree retention had the lowest percentage erosion. Dahanayake, Webb, and Brookes (2024), in the study of how plants reduce erosion, used Economic evidence approach and hypothesized among others that an increase in plant abundance would result in reduced soil erosion. The study revealed that plant roots bind particles and increased stem density and leaf area reduce surface run-off. Natarayan (2023) used Revised Universal Soil Loss Equation to discover that 56% increase in the soil erosion on Pettimudi Hills of Kerala-India emanated from heavy rainfall in the area. To control soil erosion, Shaw (2021) observe that the many characteristics of woody plant such as expansive root system, large canopies and transpiration process make it the most natural measure of maintaining healthy soil and preventing its erosion. This view is corroborated by Sheers (2020) that trees prevent wind from blowing soil away, and by retaining the carbon in the soil, fights climate change.

Planting of shrubs have also been recognized as one of the measures for reducing soil erosion. Haripriya (2023) informed that shrubs can help to break up hardpan soils that are often associated with erosion. They reduce the impact of wind and water erosion. They absorb carbon dioxide from the atmosphere and store it in their biomass and soil thereby mitigating the effects of climate change. The opinion has been supported by Roundy (2023) adding that the excellent features of shrub such as perennial, strong roots and thick blooming help in the protection of soil from harsh wind, sun and rainfall that are some of the agents of soil erosion. Giving what seemed a conclusion to the positive effect of woody plants on erosion control, Vannoppen, Baets, Keeble, Dong and Poesen (2017) in Indoor Artificially Simulated Rainfall Experiment on how roots and soil characteristics affect the erosion – reducing potential of plant species shows that plant roots are efficient in reducing concentrated flow erosion rates in sandy soil. In addressing the importance of the use of gravel in erosion control, Roundy (2023) opined that when rocks are placed strategically, it helps to maintain positive and restorative effects of other soil erosion control methods. This is because gravel allows water to soak through the tiny capillaries within the rock and gives the soil the heft and weight it requires to allow water filter through easily and still hold soil in position. In line with the above, Tigard (2019) noted that gravel is tough by nature, offers a rugged but attractive look, and beyond the visual benefits, is the best option for maintaining and adequately drain landscape while controlling erosion.

Though much have been said on the use of trees, shrubs and granites in control of soil erosion, not much empirical research have been conducted in that direction and for Akanu Ibiam Federal Polytechnic, Unwana specifically. This study is an attempt to fill this gap.

Methodology

The study adopted survey research design in a bid to elicit data from primary source. The main instrument for the information gathering is structured questionnaire. The item questions are structured in 4-point Likert scale format in which each respondent is required to select by ticking only one response from the four categories: SA = strongly Agree, A = Agree, D = Disagree, and SD = strongly Disagree. Numerical score is assigned to each degree of response viz: 4, 3, 2, and 1 respectively. The scores from all the respondents on each item question were summed up to obtain the total score for that question. The questionnaires are in segments according to the research questions. For the dependent variable, the maximum score for each respondent is 40 if such selects "SA" consistently. For the independent variables, the maximum expected score for each respondent is 20 if such selects "SA". Experts in the department of Horticulture and Landscape, Akanu Ibiam Federal Polytechnic, Unwana will validate the questionnaire to ensure that the item statements synchronize with the objectives of the research. Cronbach Alpha served to determine the reliability of the questions. The population of the study is the 2,000 members of staff of the Polytechnic from which a sample size of 333 staff was chosen using Taro Yamane's formula. The questionnaires were purposefully but randomly administered to the members of staff that have spent more than five in the service of the school. These members of staff are those that can tell when soil erosion started in the roundabout field.

Model specification

The study e mitigation of soil erosion is modelled after that of Dahanayake, Webb, and Brookes (2024) on how increase in plant abundance reduces soil erosion. However, this research is modified to ascertain the effectiveness of trees, shrubs, and granites in the mitigation of soil erosion thereby specifying the model as:

$CSE = a_0 + a_1CUT + a_2CUS + a_3CUG + u.$

Where:

CSE = control of soil erosion

CUT = effect of trees in soil erosion control

CUS = effect of shrubs in soil erosion control

CUG = effect of granites in soil erosion control

a_0 = constant (intercept of the model)

a_1, a_2, a_3 = unknown parameter estimates of the model

u = stochastic error term.

It is *a priori* expected that all the independent variables will have direct relationships with the soil erosion control.

Data Presentation, Analysis and Interpretation of Results

The qualitative responses of the respondents were coded to get the quantitative data used for regression analysis. The Ordinary Least Square statistical technique was applied to the coded questionnaire responses for the testing of the stated hypotheses. The multiple regression results are shown in the table below:

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	cug, cut, cus[b]	.	Enter

a. Dependent Variable: cse

b. All requested variables entered.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	535.021	3	178.340	16.182	.000[b]
	Residual	3614.786	328	11.021		
	Total	4149.807	331			

a. Dependent Variable: cse

b. Predictors: (Constant), cug, cut, cus

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	19.611	1.414		13.869	.000
	Cut	.108	.035	.162	3.067	.002
	Cus	.224	.089	.146	2.531	.012
	Cug	.298	.092	.191	3.243	.001

a. Dependent Variable: cse

R-Squared = 0.786 Adjusted R-Squared = 0.720

D. W. Statistic = 1.796

Source: IBM SPSS Version 20 Computation

CSE = 19.611 + 0.108*CUT + 0.224*CUS + 0.298*CUG

The estimated equation above shows that all the variables are in line with the *a priori* expectation of the study. This is an indication that the use of trees, shrubs and granites are effective strategies for the mitigation of soil erosion and especially in the biggest roundabout in the Polytechnic.

Major Findings and discussion

The factor of use of use of trees (CUT) is found to have significant relationship with soil erosion control. The result of the OLS reveals that a unit increase in the number of trees planted in the soil is capable of increasing mitigation of soil erosion by 0.108 percent. The null hypothesis of no significant relationship is therefore rejected and the alternative accepted. The result is in line with the observation of Sheers (2020) that trees prevent wind from blowing the soil away thereby preventing the erosion. The roundabout field has few trees and could be the reason for the emergence of soil erosion in there. The same significant association was found for control of soil erosion using shrubs. This outcome negates the null hypothesis of no significant link between the variables and accepts the alternative hypothesis. It is in tandem with the position of Roundy (2023) that the excellent features of shrub help in the protection of soil against erosion.

The link between control of erosion and the use of granites was also significant thereby rejecting the null hypothesis in favour of the alternative hypothesis. A unit increase in the use of granites in erosion control was found to increase erosion mitigation by 0.298 percent. Tigard (2019) observed the importance of the use of gravel in control of erosion stating that the tough nature of gravel makes it the best option for maintaining and adequately drain landscape while controlling soil erosion.

Conclusion and Recommendations

Soil erosion is a cause of worry to people in the landscape with sloppy terrain such as Ebonyi state. Gullies and rills are visibly observed in such areas. The cost of controlling soil erosion when it develops to gully is high, often competing with necessities of life over the scarce resources available to households, firms, and government. It destroys the aesthetic nature of environments and would need to be mitigated when at its early stage. The state of the biggest roundabout in Akanu Ibiam Federal Polytechnic, Unwana Afikpo Local Government Area of Ebonyi state calls for immediate mitigation before it escalates to gully. The study therefore is a research on effective strategies for the control of this menace. Adopted in the research is structured questionnaire that elicited responses from 332 respondents which were coded and used in the regression analysis testing for the relationship between the use of trees, shrubs and granites in control of erosion in the Polytechnic. The results of the analysis show that they are effective strategies for the mitigation of soil erosion.

Recommendations

Given the findings in this research, the following are recommended:

1. Trees should be planted in erosion prone areas especially in the polytechnic.
2. The planting of shrubs around fields environment should be encouraged.
3. Walkways should be created where necessary, using granites instead of random walk on open field especially in the Akanu Ibiam Federal Polytechnic, Unwana biggest roundabout.

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