Mitigating Erosion Challenges with Landscape Planning in Oke-Ogba Residential Community, Akure, Nigeria

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Abstract: Erosion is one of the natural hazards threatening the physical environment and lives of residents in developing nations of the world due to poor landscape planning and environmental abuse. This study, therefore, investigates the level of awareness of Oke-Ogba residents on the use of landscape in controlling soil erosion with a view to assessing the environmental situation in the study area. A structured questionnaire was employed to elicit information from 200 residents of the study area using the simple random sampling technique. Empirical analysis shows that majority of the respondents are not aware of the use of landscape in erosion control; most building surroundings are bare, with poor drainage system influencing rate of erosion; the environmental situation is also poor due to poor waste disposal methods. The study recommends: environmental education for residents on the use of landscape planning for erosion control and advocates active involvement of governments at local and state levels in the provision and coordination of infrastructural facilities (roads and drainages) to ameliorate erosion challenges and enhancing landscape planning in the study area.

Keywords: Erosion, Landscape, Planning, Environment, Oke-Ogba, Akure, Nigeria
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1. Introduction:

Erosion is a problem of land use in the urban areas of developing nations, [2]. It is the gradual washing away of the top soil which produces harmful effects on the environment. Naturally, weathering precedes erosion as the loosened materials from weathered rocks are removed by erosive agents like wind and water, thus, resulting in untold damage that must be controlled. Erosion control as defined by [38], 'is the practice of preventing or controlling wind or water erosion in agriculture, land development, coastal areas, river banks and construction. Effective erosion controls handle surface runoff and are important techniques in preventing water pollution, soil loss, wildlife habitat loss and human property loss'. Urban residents of developing nations particularly in Akure mitigate erosion by filling potholes on roads and unconventional channeling of storm water which in most cases compound the problems.

Landscape Planning (LP) generally, remains an effective means of erosion control and entails setting of goals and courses of action for the application and maintenance of landscape elements. [14], identified three types of landscape as primary, natural and cultural landscapes; primary landscapes are virgin areas where the existing land and vegetation have not been altered by man; a natural landscape on the other hand has been influenced and altered by man but with no significant effect on both man and the

environment; while the cultural landscape has been greatly influenced by man such as the cityscape.

Residents of Oke-Ogba community in Akure, Nigeria are quite aware of erosion problems and seek for means to prevent and control it within their premises and streets. Some of the landscape practices employed in the area include total concrete overlay of undeveloped plot areas; uncoordinated individualistic construction of drainages on access roads; channelization of streams and rivers; and construction of culverts and bridges among others. Despite these measures, erosion problems persist; concrete overlay of un-built areas increases storm water which aggravates the menace of erosion. Drainages are irregularly constructed on individual basis at different levels; culverts are constructed by non-experts with substandard materials due to lack of adequate fund resulting in frequent collapse of such structures.

The community members occasionally come together as Landlords' and/or Youths' Associations to address issues of gully erosion using local approach which has been unsuccessful due to limited knowledge on sustainable landscape practices and lack of adequate fund to erect and maintain appropriate landscape elements. Practical landscape planning supports health and well-being of the people, integrates suburbs into the landscape settings of towns and cities; and safeguards the environment through proper landscape green infrastructure. On this note, a local institutional framework for land use and landscape management is inevitable. Besides, the tenet of citizen participation in the planning and implementation of landscape plans also appears to be a desirable approach. This paper, therefore, examines: the landscape planning and management framework in Oke-Ogba; the individualistic and communal erosion control measures adopted; government landscape planning; and Private-Public-Participation efforts at combating erosion in the study area.

2. Review of Existing Literature:

Soil erosion is one of the most challenging global environmental problems. Unfortunately, gully erosion is often far more severe in developing countries than in industrialized countries, as a result of the lack of financial, technical, and institutional capacity, [38]. Gully erosion is defined as the erosion process whereby runoff water accumulates in narrow channels and removes considerable amount of soil from this narrow channel over a short time period. [8], opine that gully erosion is geographically a widespread problem and is the worst stage of soil erosion.

[16], opines that soil erosion can affect any type of area from residential to forests. It occurs when the soil shifts as a consequence of very heavy rain or wind. Rain running off a roof or across paved areas at home can cause substantial erosion in residential areas because it can flow too quickly for proper absorption. Soil erosion is detrimental to the land because it removes nutrients from the soil, which means plants and trees cannot grow easily or in a healthy way. The Landscape Planet, therefore, suggests planting of trees, matting and mulching to prevent soil erosion. [12], concludes that erosion can be controlled innovatively using landscape elements with compost for soil stability, healthy plant production and protection.

The mechanisms for upland erosion and acceptable soil loss rates are well understood. However, the processes controlling gully erosion are still not well understood [21]. Soil erosion is one of the major problems confronting agriculture worldwide. It is a major threat to the soil resource, soil fertility, productivity, food and fiber production, mainly on farm and range lands [9]. [36], noted that, gullies are characteristic feature of degradation and dismembering of slopes, especially in areas without dense vegetation cover. These are the products mostly of heavy rains, during which processes of linear erosion, piping and mass movements are active. Improper land use, forest and grass fires, overgrazing/free grazing, road construction and trails/footpaths are the major manmade factors affecting gully erosion; while rainfall, topography, shape and size of watershed, soil properties and vegetative cover are the major physical factors [9].

The problems of gully erosion cannot be overemphasized, for instance, [10], observed in their study in Gombe, Nigeria that the expansion of gully erosion breaks down communication and power lines, results in churches and schools collapse, roads are washed off and water schemes are damaged; farmland and farm produce are washed off while families are displaced as refugees. [11], argues that gully erosion disrupts the entire social and economic lives of communities where they occur. However, gully erosion is mostly concentrated around cities and roads where land use change exists and different signs of human impact on gully formation and development are available [34].

2.1 Factors of Gully Erosion

2.1.1 Man-made

Human impact on land degradation is well documented in literature, ([35], [33]; [32], [5], [4]. The main causes of gully initiation and development worldwide include: land use change from rangeland to cropland and occurrence of severe floods; over grazing specially in drought periods; ecosystem destruction by road construction and vegetation clearance [35], [17], [13], [33], [32]; overexploitation of land and coincidence with severe rainfalls. [5], [34], record that gully erosion has a direct and positive correlation with the area of bare land, area of rain fed farms and the length of roads but a negative correlation with the area of range land.

2.1.2 Physical:

It is obvious that gullies are formed by increased surface run-off which acts as a cutting agent. [8], opine that rainfall, topography, soil properties and vegetative cover are the main physical factors affecting the rate and amount of runoff. They maintain that: intense rains coupled with soils prone to sealing and crusting, generate high runoff volume and concentrated flow. The force generated by the runoff flow causes gully erosion especially in semi-arid regions characterized by scanty vegetation cover. The size and shape of a drainage area, as well as the length and gradient of its slopes have an effect on the run-off rate and amount of surface water. The shape of the watershed has strong relationship with the time of concentration and peak runoff rate. If the time of concentration is high, pick runoff rate is low. The steeper the slope, the higher the velocity and erosive power of the run-off.

2.2 Estimating the Rate of Runoff

There is a relationship between rainfall intensity, rate of run-off, density of vegetative cover, and the size of a gully catchment area. This relationship is generally expressed in equations. [8], identify two simple methods of estimating runoff rate which are: the rational formula and Cook's method.

Mathematically, the Rational Formula is expressed as follows: $Q = CIA/360$

Where:

Q = runoff rate (m^3/s)

C = Runoff coefficient (between 0 and 1)

I = Rainfall intensity (mm/hr) = Rainfall amount over time taken.

A = Area of the catchment (ha)

In using the above formula, some important variables such as runoff coefficient, runoff intensity and area of the catchment must be accurately measured in order to get an unbiased outcome.

On the other hand, the Cook's method was developed by the United States Conservation Service, and adapted for African conditions by Prof. Norman Hadson, [8]. In this case, three variables are considered important, namely: area, shape and characteristics of the catchment. The shape of the catchment is relevant because a short wide catchment will generally produce a higher pick runoff than a long narrow catchment of the same size. The shape of the catchment also affects the time of concentration and hence the design intensity and ultimately the peak runoff. Generally, the amount of surface water and the rate of runoff are affected by the size, and shape of a drainage area as well as the length and gradient of its slope. These topographic characteristics are essential and peculiar to specific drainage areas; and should be studied in detail before drainage works begin.

3. Data and Methods

3.1 Research Site

Akure is the local government headquarter of Akure South Local Government Area (ASLGA) and the capital city of Ondo State, Nigeria. It is the major town in ASLGA which, situates 311 kilometers North-East of Lagos. Since the creation of Ondo

state in February 1976, the population of Akure has been growing at an alarming rate. Akure had a population of 38,852 in 1952 which increased to 71,106 in 1963 at a growth rate of 5.5% per annum [27]. In the 1991 census count, Akure population was 239,124 which was projected by the National Census Board to 269,207 in 1996. The 2006 estimated population of Akure was 413,060, [18].

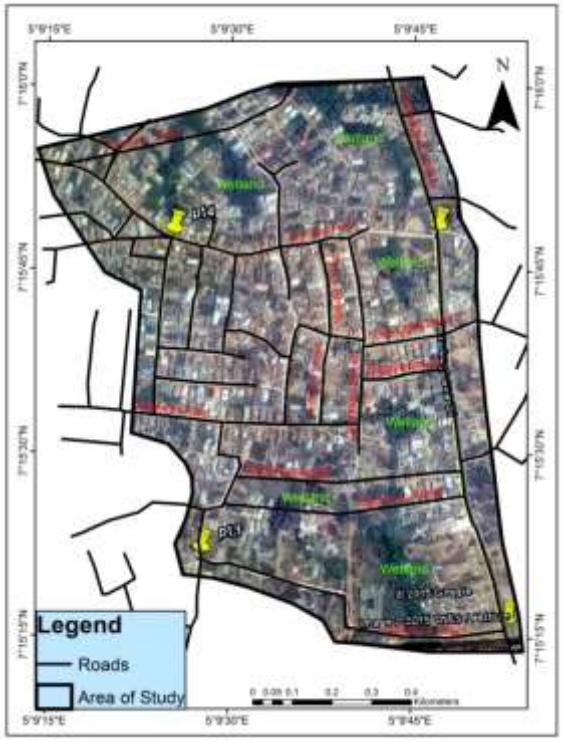

Figure 1: Street Guide Map of Oke-Ogba Community Superimposed on the Google Imagery
Source: Authors' Fieldwork (2018).

Basically, Akure has an agrarian economy with prevalent low productivity. [3], observes that the major industrial activities in Akure are saw-milling and furniture making. As a result of its weak economic base, there is high unemployment, low per capita income and poor standard of living all affecting negatively the ability of the populace to support urban utilities, municipal services, community facilities including sustainable landscape management.

The land use pattern in Akure is a replica of most traditional *Yoruba* cities which have the Oba's palace, the city market, and the traditional place of worship at core area. The share of population living in Akure urban areas increased from 20.2 per cent in 1971 to 23.7 per cent in 1981 and to 26.1 per cent in 1991, [7]. Oke-Ogba, (study area) is a residential community located between latitude 7^0 14^l to 7^0 19^l; and longitude 6^0 12^l to 5^0 12^l south of Akure. The topography is a mixture of rugged and gentle terrain orchestrated by outcrop of granite rocks which increases storm water speed in an unplanned environment. Oke-Ogba is a peri-urban settlement with mixed land uses between the city's continuously built up area and its rural hinterland where economic and social activities are directly affected by the expansion of the city, [20]. Fig. 1 is the superimposed street guide map on the google imagery of Oke-Ogba Community. The community is bounded by Ondo Road to the east; Awule Road to the west and Agagu road to the North. At the southern part is Yeosta-Alphine residential community.

The climatic condition of Oke-Ogba follows that of Akure which is a replica of south-western Nigeria climate influenced mainly by the rain bearing monsoon winds from the ocean and the dry northwest winds from the Sahara Desert. High temperatures and high humidity also characterize the climate. Raining season lasts between April and October while the atmospheric temperature ranges between 25^0C and 31^0C. The community is characterized by infrastructure under severe stress as a result of rapid growth in population, inadequate supply of housing units, and improper coordination of physical development due to poor planning, [28]. [2], reveals that, peri-urban zones in Akure such as the study area were developed contrary to planning regulations, lacking essential facilities such as schools, clinics, play areas, markets, library, places of worship, police post and postal agencies among others.

3.2 Data Base

Data was collected through structured questionnaire which was administered on household heads in the community. The questionnaire contained close-ended questions with pre-coded alternatives meant to elucidate information on: socio-economic characteristics of respondents; respondents' level of awareness on the use of landscape; environmental condition in the study area; factors influencing erosion and the landscape elements used in erosion

control among others. Questionnaires were administered by field assistants through face-to-face contact with residents of Oke-Ogba community in March 2018. The use of research schedule assisted in the process of data collection. For instance, the questionnaires were read and interpreted by the field assistants to the respondents in their homes. The field assistants along with the questionnaires approached respondents, put to them the questions in the order the questions were listed and recorded the replies in the space meant for the same in the questionnaire. At this instance, respondents were limited to a set of alternatives and were free to supply additional information where necessary. The trained field assistants administered the questionnaires under the supervision of the authors. A total of 200 respondents were randomly selected for interview due to homogeneity permeating the study area. Other relevant information was retrieved from texts, seminars, reports and the internet among others. The observation method of data collection was also a veritable means of data gathering for the study. Data was processed by computer using Statistical Package for Social Sciences version 16. Univariate analysis of data was utilized for easy description of the phenomenon investigated.

4. Analysis and Discussion of Findings

4.1 Socio-economic characteristics of Residents

The socio-economic characteristics of the people show that about 60.0% of Oke-Ogba residents were males while 40.0% were females. The modal age of respondents falls between 36 and 65 years; constituting about 40.0% of the population and the median age between 25 and 35 years of age, representing approximately 25.0%. The age grade comprises mostly the educated but employed people who have lived in the area for more than 10 years and were able to give required information on the subject matter based on experience.

4.2 Residents` Level of Awareness on the Use of Landscape Planning in Erosion Control.

The effects of erosion are made worse due to over population and it can be minimized with improved techniques such as the construction of terraces, tree planting, the use of cover crops and minimal deforestation, [15]. A meagre percentage (10.0%) of the residents are 'very strongly' aware of the use of landscape planning in erosion control, 12.5% are 'strongly aware'; while the majority (51.0%) have 'no opinion' on the issue. About 11.5% and 20.0% are 'slightly aware' and 'not aware' of the use of landscape planning in erosion control respectively. Obviously, over 80.0% of respondents do not use landscape planning to control erosion in the study area as a result of lack of awareness. As expected, people are unwilling to adopt the procedures deemed necessary to heal the land, [24], particularly in residential communities because of lack of communication between the government and the people; inadequate knowledge of the environment and exploitative excesses of the people, [25].

It has been proved that re-vegetation is the best means to control erosion as it allows for easy water percolation into the soil, thus, reducing both the erosive speed and volume of storm water outflow. [15], opine that landscape is degraded due to mankind actions which render land unprotected and vulnerable, making erosion a huge environmental issue. One-on-one interaction with respondents, shows that erosion negatively impacts on both onsite (where the soil has become detached), as well as offsite (where the eroded soil goes); which result in continued degradation of the environment. Other specific human activities that lead to erosion include: poor solid waste management practices; poor road construction practices; construction of undersized and inappropriate drainage systems; and, poor infrastructural development practices.

4.3 Environmental Condition

The type of refuse disposal method in the study area impacts negatively on the environmental condition. Fig. 2 shows respondents' opinion on the method of waste disposal in Oke-Ogba.

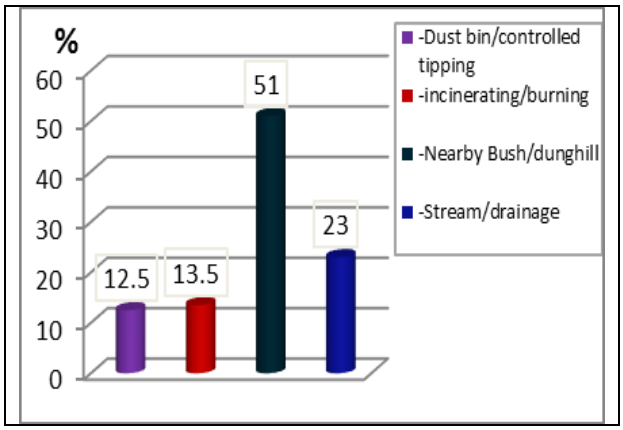

Fig. 2: Waste disposal methods in Oke-Ogba
Source: Authors' fieldwork, 2018.

Fig.2 reveals that about 12.5% of respondents use dustbin/controlled tipping for disposing solid waste. Nearly 13.5% dispose their refuse through burning, while 51.0% and 23.0% dispose their wastes on dunghills and stream/drainages respectively. The implication of this is environmental pollution and flooding hazards in the community. This trend shows that the use of dust bin and controlled tipping is not popular in Akure unlike in advanced countries where controlled tipping is the dominant method of waste disposal because of its advantage as a medically and scientifically benign mode of disposal that was reconcilable with the needs of sanitary science and landscape preservation, [6].

Furthermore, the availability and type of drainage facility is another determinant of environmental landscape condition in the study area (Fig. 3).

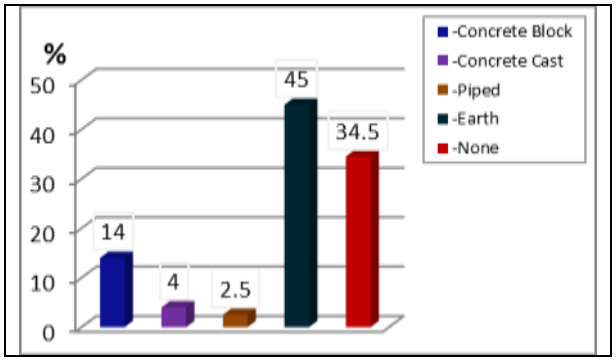

Fig.3: Type of drainage facilities in the study area
Source: Authors' fieldwork, 2018.

Fig. 3 shows that 14.0% and 4.0% of respondents respectively identified concrete block and concrete cast as the type of drainage facility servicing their residences; while piped and earth drainages were identified by 2.5% and 45.0% respectively. About 34.5% claimed there was no form of drainage facility in their areas. Cumulatively, about 20.0% of drainages are good, while the remaining 80.0% are bad. which implies that the area is susceptible to erosion and flood hazards.

The type of landscape in the study area is another factor of concern (Fig. 4).

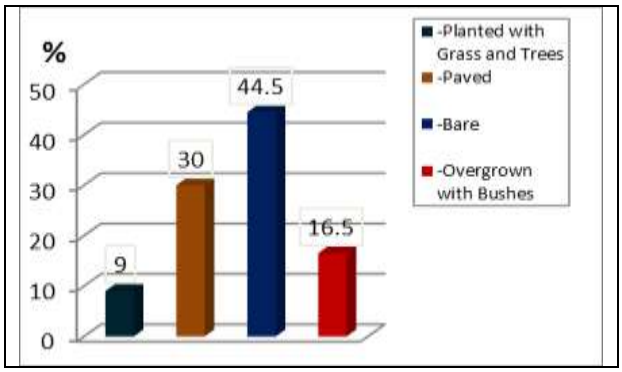

Fig. 4: Type of landscape in Oke-Ogba
Source: Authors' fieldwork, 2018.

Fig, 4 shows that only 9.0% of the buildings were planted with grass and trees; while 30.0%, 44.5% and 16.5% are paved, bare and overgrown with bushes respectively. Usually the paved surfaces increase the volume and speed of runoffs; bare surfaces are susceptible to erosion; while bushes around buildings breed mosquitoes and other dangerous insects and reptiles. Generally, urban and suburban sites typically contain large expanses of impermeable surface causing a host of problems, such as: pollution and flooding of surface water; erosion of stream banks; inadequate recharge of water table; and formation of stagnant water puddles and heat island effect, [31].

4.4 Factors Influencing Rate of Erosion

About 74.0% of respondents in this study attributed poor drainage system as a major factor influencing

erosion in the study area. However, 10.0%, 7.8% and 7.7% ascribed unsustainable physical development practices; indiscriminate dumping of refuse and deforestation are factors that greatly influence rate of erosion respectively (Table 1).

Table 1: Factors influencing rate of erosion at Oke-Ogba

Factors	Freq.	%
Poor Drainage System	148	74.0
Poor waste Disposal Practices	15	7.8
Poor Development Practices	16	8.0
Deforestation	14	7.7
Others	7	2.5
Total	**200**	**100**

Source: Authors' fieldwork, 2018.

All the factors, especially poor drainage, cumulatively contributes to degrade the landscape. This trend encourages concentrated runoff which is a prerequisite for gullying [25], while other land use activities such as road construction, urbanization and industrialization and general infrastructural development deprive the soil surface of its vegetation and also contribute directly to sliding, [22], slumping, sheet erosion and gullying, [23].

Evidently, the provision of drainage facility is left in the hands of individual property owners who are financially incapacitated. If governments (at local, state and federal levels) had made adequate provision of roads and drainages, the erosion situation would have been better off in the area. [26], argues that such infrastructural facilities are better provided on communal basis or rather funded by government. When individuals take such responsibility without government coordination, environmental problem in the form of erosion occurs. Another effect is that drainages are dug at different levels hindering the flow of water and leaving it stagnant on the roads during rainfall with consequential health and environmental hazards.

The absence of waste disposal facilities in the area makes residents to dump solid waste in streams and drainage channels which are often blocked to cause flooding in the environment whenever it rains, thus, intensifying the rate of erosion. The burning of bushes around the premises, cutting of trees and destruction of grass with herbicides render the soil bare to worsen the situation.

5. Institutional Framework and Erosion Control in Nigeria.

Physical planning activities have been growing in Ondo State since 1999 at a slow and uneven pace, due to inadequacies of legal and institutional backing for planning activities. It is an observable fact that most developmental activities of the State Government and her Local Governments are not situated in policies but on successive government's goals and whims. However, the present administration in the State created a Ministry of Physical Planning and Urban Development in March 2008. [29], discovered that the new Ministry inherited the existing planning laws, subdivision regulations, planning standards, and other ministerial circulars to administer physical planning in the State. Each of the eighteen Local Government Areas of the State has Planning Authorities (PA) charged with the responsibility to administer physical planning activities. Nevertheless, most physical planning activities, staff capability and funding are concentrated in State Ministries in Akure (state capital). This phenomenon results in slow decision making process due to bureaucracy, poor funding of PAs, inadequate manpower and poor level of participation of the local people in the physical planning activities that affect their local areas, [3], [27]. [1], noted that since the domestication of the 1992 National Urban and Regional Planning Law in Ondo State in 1999, limited efforts have been made to evolve policies on environmental management.

The Ondo State Ministry of Environment and Natural Resources (OMENR) is a product of the split of the State Ministry of Transport, Lands and Housing in 2005. The Ministry is saddled with the responsibility of erosion control among other numerous activities. The Ecology Department (ED)

of the Ministry is directly responsible for erosion and flood control. The activities of ED include tree planting, donation of tree seedlings to individuals and communities, channelization projects, re-vegetation exercises and environmental education among others. Investigation shows that ED activities have not been extended to most residential communities in Akure including the study area (Oke-Ogba) after decades of its establishment. [30], maintains that the Ministry is yet to domesticate the National Flood and Erosion Control Action Plan of the Federal Government introduced in 2005. The implication is that there are no clear cut goals on erosion prevention, control and strategies to identify flood prone areas such as Oke-Ogba.

[3], opines that the Ondo State Ministry of Physical Planning and Urban Development (OMPPUD) has very little influence over the process of land management in the city and argues that changes in land use patterns are the results of a series of ad-hoc solutions. This apparently shows that there is no institutional cooperation between OMENR and OMPPUD to evolve landscape plans for erosion control and other environmental problems. The fallout of the current institutional framework is poor erosion control and landscape management evident in the un-tarred roads dotted with potholes and gullies. Other environmental problems include indiscriminate dumping of refuse and waste in river courses and drainage channels and inappropriate individual management of erosion problems.

6. Conclusion

This study has been able to establish that majority of the residents of Oke-Ogba are ignorant of the use of landscape planning in controlling erosion. Many of them dump wastes in nearby bushes, streams/rivers and drainages which complicate the menace of erosion with the few drainage facilities. Generally, the poor drainage system, poor waste disposal practices and deforestation have been identified as the major causes of erosion in the study area.

7. Recommendations

Remarkably, the planting of trees, grasses, herbs, vegetables and other types of vegetation cover on the affected areas is inevitable. Landscaping the area can help absorb excessive water, thereby decreasing erosion. Plants that spread low across the ground are good for this purpose, particularly ornamental grasses like dwarf Japanese garden juniper, which is low to the ground and has dense foliage that stays all year. In addition, planting of eucalyptus trees on locations where the original forest has been removed and matting over the eroded area is desirable to protect it from excessive water runoff. The matting in particular will help absorb water while the root systems will stabilize the soil. Above all, public education and enlightenment campaign programme on the use of landscape planning to control erosion is required. The Akure South Local Government Authority is expected to champion this course to mitigate erosion challenges in the study area.

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