
Curbing Land Degradation through Sustainable Landscaping and Building Resilient Cities.

Emmamoge Orewere¹, Bilkisu Hassan², Mustapha Faiza²
Ayodele Owonubi (Ph.D)¹, and Michael Olabode Ogunrayewa (Ph.D)³

¹Department of Horticulture and Landscape Technology,
Federal College of Forestry, Jos.

²Department of Architecture, College of Environmental Studies,
Kaduna Polytechnic.

³Department of Architecture, Faculty of Environmental Sciences,
University of Jos, Plateau State.

emmamoge3603@gmail.com
bilkisuh@yahoo.com

Abstract

The Sustainable Development Goals adopted by the United Nation particularly sustainable cities and communities development (goal eleven) and life on land (goal fifteen) targeted for year 2030 and Nigeria's Vision 20:2020 (NV 20:2020) Economic Transformation Blueprint cannot be overemphasized. Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Land degradation is induced by human and natural activities. This paper focuses on the human induced land degradation as they can be prevented. This includes mining activities, erosion, bush burning, and loss of agricultural land among others. The productivity of some lands has declined by 50% due to soil erosion and desertification. Landscaping as an emerging field seeks to enhance and curb land degradation to certain aspects within cities and Nigeria in general. It focuses on Jos, the capital of Plateau State situated in the North-Central geopolitical zone of Nigeria. The methodology employed for this study is physical site survey, case study and review of related literature. The paper submits by way of conclusion that implementing sustainable landscaping measures i.e. soft landscaping and hard landscaping in curbing land degradation will help create more resilient cities that can survive and thrive amidst these environmental challenges and working closely with slum dwellers, allied professionals, and the government to ensure a sustainable development is achieved.

Keywords: Building, Curbing, Land degradation, Resilient cities, Sustainable landscaping

1.0 INTRODUCTION

Mankind's activities on the environment in his quest for development have resulted in a continuous and serious degradation of the ecosystem, thus posing a threat to both his present and future living. Human beings use the environment in three basic ways: as a *resource bank*- the environment supplies them with raw materials needed to maintain their existence, and their social and technological structures; as a *habitat* – people require more space per individual than any other

species and as *sink* for *wastes*- human beings produce more waste than other species (Babanyara, et al., 2010). The world population is expected to reach nearly 10 billion people by 2050. They will need to be fed, clothed, and housed. They will need clean water, and energy for their homes and vehicles. Meeting those needs will require healthy and productive land, the foundation for all life-sustaining processes on the planet (Eswaran, et al., 2001). Yet just as the demand for productive land has never been higher, and so are the risks to that land. About a quarter of the Earth's land surface, roughly 2 billion hectares, has already been degraded (Sample, 2007). Globally, 1.5 billion people are affected by land degradation, especially rural communities, smallholder farmers, and the very poor (Sample, 2007).

Contextual to this paper, Land degradation refers to the wearing down of land to an impoverished state. This is caused mainly by deforestation. The tropics and sub-tropics share a large part of this activity with over 11 million hectares of tropical forest cut yearly (Adeola, 2015). Furthermore, it is described a process, when land is destroyed; its character is changed for the worse damage is done (Ladan, 2004). According to him, it is a particular problem in parts of Asia and Africa where most of the degradation is caused by accelerated soil erosion which is a serious problem in the humid tropics. Land degradation occurs in different parts of Nigeria, a country with contrasting environments. Land degradation is induced by human and natural activities. The human induced activities includes deforestation, overgrazing, pollution, bush burning, mining activities among others.

However, the need to control land degradation in Nigeria is to achieve a sustainable environment which is in line with Goal 15 in the newly developed Sustainable Development Goals (SDGs) so that Nigeria will also conform to the global quest for developing nations sustainably. Sustainable development as stated by Ayeni, (2012), incorporates all aspects of human interactions with the earth's environment and the concept explores the importance of meeting the needs of the present generation without compromising the ability of future generations to fulfil their own needs. Also, Dipeolu, et al., (2016), submitted that the idea of sustainable development involves enhancing the quality of life, thus allowing people to live in a healthy environment, with improved social, economic and environmental conditions.

In Nigeria, the challenges in poor urban settlements are intensified in many areas by the mounting hazards associated with extreme weather, lack of urban continuum and planning tools to make cities sustainable and resilience to shocks and stresses (Oduwaye, et al., 2018). The notion of a resilient city is one that has developed capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures so as to still be able to maintain essentially the same functions, structures, systems, and identity (Working Definition, Resilient City.org (n.d.)). Within the confines of ecology however, resilience is described as the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary (Working Definition, Resilient City.org (n.d.)). The two definitions imply that resilience is an important trait society and environment should possess to be able to flourish before and after disasters. Oduwaye, et al., (2018) opines the emergence over recent years in recognition of the challenges posed by climate change, disaster events, rapid urbanization and the economic downturn (Oduwaye, et al., 2018).

Landscaping is a neighbourhood amenity which may be used to improve and sustain the quality of life whether in the city, suburbs or the country (Bello, 2016). The principles seek to reconnect urban residents to their natural environment by developing attractive green cities that promote environmental sustainability. Barmelgy, (2013) asserts sustainable landscape as a

development that is economically functional, ecologically sound and socio-cultural useful in a way that economic benefits can be gained without nature and resources being deployed (see Figure 1). Sustainable landscapes need to focus on damage occurring to the natural environmental not only to the present and past landscapes, but to the future landscapes as well. Hence, landscape design elements can be classified into two such as the soft landscape and hard landscape. The *soft landscape* describe the vegetative materials which are used to improve a landscape by design. The corresponding term *hard landscape* is used to describe construction materials (Siyabola, 2011; Ayeni, 2012).

The problem of negligence of most abandoned mining sites around the study area of Jos Plateau state Nigeria, has left many of the then mining sites across the state as an eye sow of gully eroded, less productive and continuous degrading land mass. As argued by (Haruna, et al., 2018), changes in global climatic patterns and growing occurrences of natural disasters affects both developed and developing countries. There is need to plan cities in accordance with nature or green infrastructure.

While previous works on the benefits of landscaping have not been directly linked to building resilient cities, this paper contends that it presents opportunities for cities, especially in Jos to enhance its urban resilience through the use of sustainable landscaping. Again going through existing literature, there is an apparent gap that this paper helps attempts to abridge by exploring the potential contributions of landscaping in curbing land degradation. The main thrust of this paper, therefore, is to curb land degradation through sustainable landscaping and demonstrate its potential contributions to building a resilient city in Jos, Nigeria. The objectives are to: (1) understand the concept and principles of resilient cities, (2) investigate the causes and processes of land degradation in Nigeria, (3) investigate the role of landscaping in curbing land degradation.

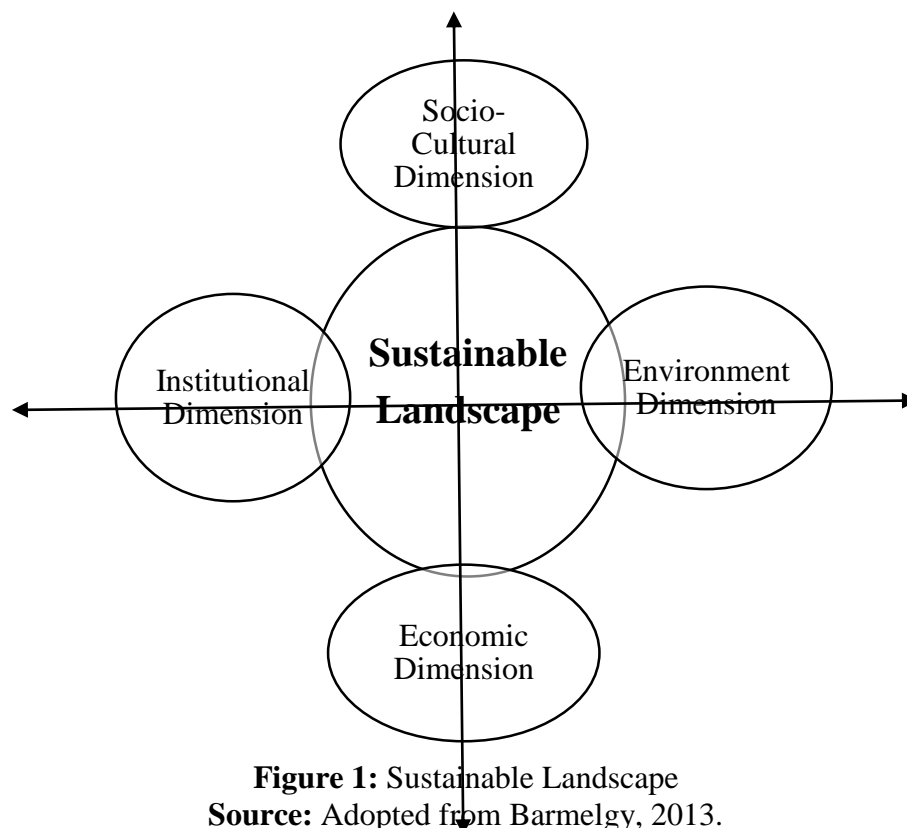


Figure 1: Sustainable Landscape
Source: Adopted from Barmelgy, 2013.

SUSTAINABLE DEVELOPMENT GOALS

On 25 September 2015, the 193 countries of the UN General Assembly adopted the 2030 Development Agenda titled *"Transforming our world: the 2030 Agenda for Sustainable Development"*. This agenda has 92 paragraphs. Paragraph 51 outlines the 17 Sustainable Development Goals and the associated 169 targets and 232 indicators. There are 17 goals in all some which are: No poverty, zero hunger, good health and well-being, quality education, gender equality, etc. Each goal has specific targets to be achieved over the next 15 years. Specifically, Goal 11 is sub-titled **SUSTAINABLE CITIES AND COMMUNITIES DEVELOPMENT**: *"Make cities and human settlements inclusive, safe, resilient, and sustainable."* While Goal 15 is sub-titled **LIFE ON LAND**: *protect, restore and promote sustainable use of terrestrial ecosystem, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.* These goals are of great relevance to the topic under discussion. If building resilient communities and land degradation is appropriately tackled, this will contribute positively to the achievement of goal 11 and 15 in the Sustainable Development Goals (Sustainable Development Goals, 2015).

2.0 LITERATURE REVIEW

2.1 Resilient Cities: Understanding concepts and principles

Globally, all cities are vulnerable to severe impacts from a range of shocks and stresses that can be both natural and human made (UN-Habitat, 2003). Resilience as a term emanates from the Latin word *resi-lire*, which means to "spring back" and was first used in the field of ecology in the 1970s to refer to the ability of a system to maintain stability or recover functionally when exposed to disruption or disturbance. (Haruna, et al., 2018). Resilience refers to the ability of any urban system to maintain continuity through all shocks and stresses while positively adapting and transforming towards sustainability. Therefore, a resilient city is one that assesses, plans and acts to prepare for and respond to all hazards, either sudden or slow-onset, expected or unexpected. By doing so, cities are better able to protect and enhance people's lives, secure development gains, foster and investible environment and drive positive change (UN-Habitat, 2003). The concept of resilience is highly relevant to urban planning because the city represents a complex network of interconnected systems that require constant adaptations to changing conditions.

According to Haruna, et al., (2018), assessing and improving a city's resilience is a complex task, and the need to do so has produced researches that aim to classify urban resilience into sub-indicators or resilient namely, infrastructural resilience, institutional resilience, economic resilience, social resilience. Cutter et al. (2014) and Kotzee and Reyers (2016) as cited by Haruna, et al., (2018), promote a fifth component: "ecological resilience", which assesses the state of ecological buffers, land-use diversity and ecosystem services as crucial indicators for improving the resilience of communities to natural disasters. Further, research conducted by Haruna, et al., (2018), emphasized the link between social and ecological systems in what is termed as "socio-ecological resilience". The term socio-ecological resilience is used to imply the capacity to adapt or transform in the face of changing social-ecological systems, particularly unexpected change (natural disasters), in ways that continue to support human well-being. The use of the words "adapt" and "transform" in reference to socio-ecological resilience of cities are emphasized as important principles of resilient cities. These components are required to possess adaptive and transformative capabilities in order to make them resilient.

2.2 Resilient Cities Report: A Case of Nigerian Cities

Over 50% of Nigerian's already live in cities, 34% below the poverty line and 68% below the empowerment line. By 2050 Nigeria will be home to 295m people, equivalent to half Europe's urban population, and only just falling short of U.S. figures. This momentous shift which will bring nearly 200m new people into cities, create over 20 new middle-tier cities, and ensuring Lagos will rival Beijing, Mexico City and Sao Paolo in size (Green and Resilient Cities, 2015). With cities accounting for est. 75% of greenhouse gas emissions globally, and 53% highly vulnerable to serious and near-term climate change effects, Nigeria's cities will be a vital nexus for mitigation and adaptation initiatives. Not only this, but as the country is yet to build the majority of its urban infrastructure, it has the opportunity to leapfrog developed nations by adopting clean technologies and economic strategies early (Green and Resilient Cities, 2015).

According to Green and Resilient Cities, (2015) Lagos has a climate change policy and is building coastal defenses and drainage channels and moving to greener waste management, to promote emissions reduction, adapt to flood risks and create jobs. While Kano, Kaduna and Abuja are all developing holistic urban resilience strategies. This implies Nigeria is taking an increasingly pro-active and engaged approach to planning for green and resilient cities that will place Nigeria and its urban citizens on a pathway to resilient and inclusive growth.

2.3 Understanding Land Degradation and its Processes

Land degradation, a decline in land quality caused by human activities, has been a major global issue during the 20th century and will remain high on the international agenda in the 21st century. The importance of land degradation among global issues is enhanced because of its impact on world food security and quality of the environment (Eswaran, et al., 2001). The term *land* refers to an ecosystem comprising land, landscape, terrain, vegetation, water, climate while *degradation* or *desertification* refers to irreversible decline in the 'biological potential' of the land. Land degradation refers to the partial or total loss of productivity from both soil and vegetation. It is the result of any process which leads to a reduction in the quantitative and/or qualitative productive capacity of the soil (Ladan, 2004). The Food and Agricultural Organization, FAO, (2004), refers to land degradation as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries. Land degradation is a human induced or natural process which negatively affects the land to function effectively within an ecosystem, by accepting storing and recycling water, energy and nutrients, (WSSD, 2005) as cited by Ladan, (2004). The importance of land degradation among global issues is enhanced because of its impact on world food security and quality of the environment. High population density is not necessarily related to land degradation; it is what a population does to the land that determines the extent of degradation (Eswaran, et al., 2001).

The principal processes of land degradation include erosion by water and wind, chemical degradation (comprising acidification, salinization, leaching etc.) and physical degradation (comprising crusting, compaction, hard-setting etc.). Some lands or landscape units are affected by more than one process, of water and wind erosion, salinization, and crusting or compaction (Eswaran, et al., 2001). The bio-physical processes through which land degradation occurs are presented in Table 1 below

Table 1. Processes of Land Degradation

Processes of Land Degradation	Extent and indicative measurements
Water erosion	<ul style="list-style-type: none"> • Affects 46% of total land area • Estimated losses of soil on agricultural land of 7 t/ha/year (Lesotho); 72 t/ha/year (Kenya); 3-35 t/ha/year (Burkina Faso); 14-221 t/ha/year (Nigeria) (DeGraff, <i>Soil conservation and sustainable land use: an economic approach</i>, 1993)
Wind erosion	<ul style="list-style-type: none"> • Affects 38% of total land area
Decline in soil fertility Nutrient loss	<ul style="list-style-type: none"> • Affects 16% of total land area • Average annual loss of 23 kg/ha (1983-1990) increasing to 48 kg/ha (2000) • 4 million tons nutrient harvested/year against 1 million returned
Deforestation	<ul style="list-style-type: none"> • 3.7 million ha/year (0.7%)
Salinization of irrigated land	<ul style="list-style-type: none"> • Kenya (30% of irrigated areas), Namibia (17%), Nigeria (34%), Sudan (27%), Tanzania (27%)
Water logging of irrigated land	<ul style="list-style-type: none"> • DR Congo (20% of irrigated areas), Mauritania (50%) and Gambia (10%)

Source: Adapted from Assessment of Land Use Pressure, State and Response in Sub-Saharan Africa, 2006

2.4 Causes of Land Degradation

Land degradation occurs in different parts of Nigeria, a country with contrasting environments (Ladan, 2004). The dominant causes of degradation in Nigeria are listed below. Emphasis will be made on those causes induced by human activities.

i. Mining Activities: The mining of some minerals in the country has caused land degradation in those areas where mining activities are being carried out. In the mining of minerals such as limestone and iron ore, open cast method of mining is used. This destroys the top layer of the soil and the soil profile. This method also generates material debris called overburden which is filled on the land that reduces the quality of the land. The tin mining areas of the Jos Plateau has produced landscape features such as mine dumps, pits and ponds. These render the land uncultivable, leaving the land derelict (Ladan, 2004).

ii. Land Pollution: Environmental pollution is rapidly increasing in Nigeria. The major causes of the increase include poor sanitation, inadequate solid waste disposal, effluent discharge, rapid and unplanned urbanization, mining, and increasing use of chemical fertilizers and insecticides. Surface runoffs collect all types of excreta and these are moved into the rivers, dams and sometimes into wells (Babanyara, et al., 2010).

iii. Overgrazing: Overgrazing is the dominant cause in most of the dry land countries, not only in developing countries (e.g. Libya, Tunisia, Iran, Iraq, Syria), and across virtually the whole of the Sahel belt of Africa. It is also the major cause in many parts of Central Asia, Argentina, and in dry

lands of developed countries including Australia and Western United States (Assessment of Land Use Pressure, State and Response in Sub-Saharan Africa, 2006). In Nigeria there is the traditional method of tree range grazing of livestock which has led to uncontrolled grazing and browsing of natural vegetation. This is informed by the general inadequacy of feed and water supply, coupled with inadequate funds to cattle owners to rear animals in a confined area. The livestock especially goats are very destructive to the vegetation cover especially grassland areas that provide cover the land. The overgrazing of lands causes land degradation. Excessive trampling when conditions are dry reduces the size of the soil aggregates and plant litter to a point where they are subjected to wind deflation processes. Trampling, by puddling the soil surface, accelerates soil deterioration and erosion as infiltration capacity is reduced. Thus overgrazing especially in the northern Nigeria where livestock farming is practiced causes land degradation. This is by allowing farm animals to eat all the vegetation cover until the soil is exposed and the plants cannot regenerate themselves quickly. The system of allowing animals to roam about is a danger to afforestation efforts in desert prone states like Katsina, Zamfara, Sokoto, Kebbi as the seedlings planted outside find it difficult to survive trampling and browsing by the animals (Suleiman, 2004 cited in Ladan, 2004).

iv. Deforestation: Deforestation is a process whereby trees are felled for several purposes, but without replanting to replace the one felled. The continuous removal or destruction of significant areas of forest cover results in a highly degraded environment with attendant reduction in biodiversity. It also causes soil erosion and in marginal lands, can lead to desertification (Babanyara, et al., 2010). Deforestation causes land degradation. This is so because forest protects the underlying soil from the direct effect of rainfall, runoff is generally reduced, tree roots bind the soil, and the litter layer protects the ground from rain splash. In this way, with the removal of forest, the rate of soil loss increases and mass movement increases in magnitude and frequency. The rate of soil erosion whether by water or wind increases greatly when the ground is left bare (Ladan, 2004). Additionally, uncontrolled and indiscriminate fire by farmers and hunters has also consumed much of Nigeria's forest cover. With the increasing global demand for tropical hardwoods, many hardwood species are being recklessly exploited from large areas of natural forests and sold in both local and international markets leading to an uncontrolled decimation of our forest resources (Babanyara, et al., 2010).

v. Bush Burning: The regular burning of rangelands by pastoralists to generate pasture for their livestock is a common practice in northern Nigeria. The fires as well as farming and hunting related bush burning also result in controlled loss of vegetation. The result is increased soil erosion and decline in soil fertility (Nwonkonwo, 2003 cited in Ladan, 2004). This has contributed to land degradation in the north. Thus, with bush burning, serious erosion can occur if heavy downpour occurs and if the ashes are blown away, loss of nutrients results. In the southern part of Nigeria, forest areas and bushes are set on fire for the prime reason of clearing plots of land for shifting cultivation. Areas of the country's forests are being destroyed by fires and on steep slopes serious erosion may follow such fires. This has caused land degradation in those areas (Ladan, 2004).

vi. Poverty: Poverty and environmental degradation in general forms a vicious cycle. Poverty leads to production, consumption and living styles that degrade the land and depletes its resources. Many people in the country are poor who depend heavily on the land to make a living. Due to poverty, they overuse the land. Poor people generally, in sub-Saharan Africa have no choice but to opt for immediate benefit from the land, very often at the expense of long term sustainability and they be quite aware of it (Tulu, 2002 cited in Ladan, 2004). Poverty induces land degradation which in turn reinforces poverty leading to further land degradation and so on

vii. Excavation and Construction activities: Excavation of laterite, sand, kaolin, gravel, clay etc. for building purposes are common in many parts of Nigeria. Most of the materials excavated will never be replaced leaving the areas with hollows and even gullies. This has led to the creation of ‘badlands’ in some areas and in other areas these hollows created are filled with rain water creating artificial ponds thus causing the degradation of the land. For construction purposes, the land and its vegetal cover are tampered with. The land is dug, the soil removed, hollow or trenches created. This has serious consequences on the land as it renders it unfit for any productive use (Ladan, 2004).

2.5 Concept of Landscaping

Landscaping is an expression of the lifestyle and value of the residents which reflects their personality and their attitudes towards the environment. The search for a qualitative, well landscaped environment, proper use of land and its resources are crucial issues for residential development (Ajayi, et al., 2016). The environment which people live and how it is organized have profound consequences both for the society and individual. Therefore the need to focus on damage occurring to the natural environmental not only to the present and past landscapes, but to the future landscapes as well.

The design material are basically divided into two major categories based on the application and the way they appear. *Soft landscape*: refers to the living or natural materials used in landscaping (Ayeni, 2012; A Handbook of Landscape, 2013; Adegbe, et al., 2013; Adekunle, et al., 2016) these include trees, groundcover, hedges, shrubs and flowers. They are collectively known as vegetation (Ayeni, 2012). Generally, soft landscape serves the functions of screening and maintaining privacy, which breaks the monotony of view; provides habitat for animals-which is important for biodiversity, visual enhancement, erosion control, noise pollution, demarcations, shading, wind breakers as well as air purification (Ayeni, 2012). and the *hard landscape*: refers to inanimate elements that relate with accessibility, of course change the natural surface to paved surfaces such as kerbs, stones, steps, ramps, walls, bricks, concrete, metal, bollards, tiles, walkways, asphalt, paving, planters, sculptures (Olanrewaju, 2011; Ayeni, 2012; A Handbook of Landscape, 2013; Adekunle, et al., 2016). Hard landscape materials can be transformed into landscape features that can attract the eye, add mass and weight to the composition, create themes and add pleasure to the landscape. Not only does it reduce maintenance costs, it in addition helps divide and define spaces in the landscape, orchestrate the way the landscape is viewed and enhance its beauty (Ayeni, 2012).

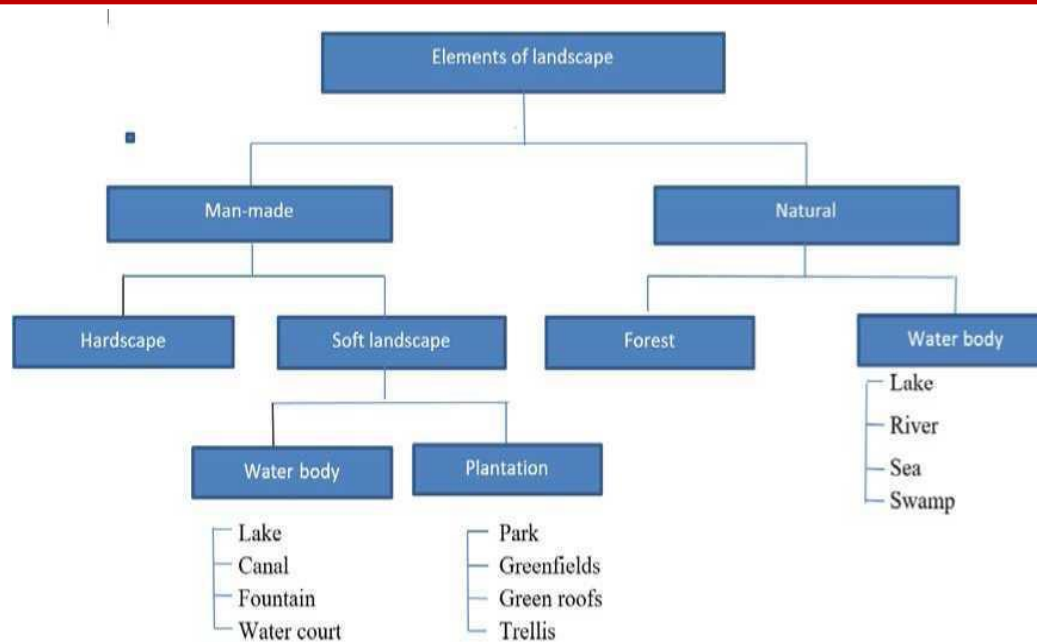


Figure 2: Elements of Landscape
Source: Adapted from Ale, et al., 2019.

Figure 2 above shows the classification of landscape elements grouped into man made and includes hardscape, soft cape, water bodies and plantation and natural that is the forest, rocks, ground form and water body (Ale, et al., 2019).

2.6 Consequences of Land Degradation in Nigeria

Land degradation is a human induced or natural process which negatively affects the land to function effectively within an ecosystem, by accepting storing and recycling water, energy and nutrients (WSSD, 2005 cited in Ladan, 2004). Regionally, the effects of land degradation such as cases of overgrazing, desertification, gully erosion, bush burning, deforestation, mining activities and many other dysfunctional environmental phenomenon (See Plate v, vi, & vii) have become routine occurrences in Nigeria. Research been conducted in Nigeria, reveals the worst affected areas of gully erosion are the steep slopes of the eastern scarp lands of the Jos Plateau (See Plates i, ii, ix & x) and parts of Sokoto State (Ladan, 2004), occurring in very densely populated areas where over-cultivation and overgrazing have exposed and impoverished the soil. Overgrazing of lands in Katsina, Zamfara, Sokoto, Kebbi states, and tin mining activities on the Jos Plateau (See Plate iv). Routine floods in the South Western Nigeria such as Ifako, Lekki & Osborne Estates in Lagos State; Isheri Estate in Oyo State; and Patani L.G.A of Delta State (TVC News at 10.00pm on 17th, 18th, & 21st October, 2019), and in Jos, Plateau State (See Plate iii), deep gully erosion in Anambra State with enormous soil loss and severe threat to agricultural production, homes and other civil structures (Babanyara, et al., 2010).



Plate i: A deep gully located at Tudun Wada, Jos.
Source: Author's field work, 2018.



Plate ii: The reality of erosion menace in Jos.
Source: Author's field work, 2018.



Plate iii: Floods at Federal College of Forestry, Jos.
Source: Author's field work, 2019.



Plate iv: Tin mining activities at Little Rayfield, Jos.
Source: Author's field work, 2019.



Plate v: Serious land degradation in Tudun Wada after depletion of the phosphate Cover through mining
Source: Author's field work, 2019



Plate vi: View of degraded buffer area along Bauchi Expressway, Jos converted into dumping site by residents.
Source: Author's field work, 2019



Plate vii: Indiscriminate dumping of municipal Solid waste at filin stukwa, residential area of Jos.
Source: Author's field work, 2019



Plate viii: A view of refuse burning on an open space of an Institutional facility in Jos..

Source: Author's field work, 2019



Plate ix: Minor water way on site

Plate x: Drainage channel within the gully eroded site

Source: Author's field work, 2018.

3.0 METHODOLOGY

3.1 Source of Data

The study employed the use of two data sources which were primary and secondary data. The primary data used were visual survey, case study and the use of digital camera to capture images of interest to the study, while the secondary data used include, published materials such as books, academic and professional journals, published information, article, dissertations and geographical maps of Nigeria, Plateau State.

3.2 Research Locale

The study area is Jos a town that its background and growth dates back to the early 19th century and also its commercial and cosmopolitan ascendancy is as a result of the mining activities in Tin and Columbite in its general area (Orewere, et al., 2019). The town is also a terminal for railway line. At the outskirts, is an international airport, the Yakubu Gowon International Airport at Haipang. Through all these periods there have been steady and continuous increase in human population, businesses, buildings and other paraphernalia of urbanization including cars busses, trucks and articulated vehicle as major means of transportation within the city (Orewere, et al., 2019).

Jos plateau, is located in the central part of the country (see Figure 3) between latitude $8^{\circ} 30'$ and $10^{\circ} 30'$ N and longitude $8^{\circ} 20'$ and $9^{\circ} 30'E$, with a surface area of about $9,400\text{km}^2$. It has an average elevation of about 1,250 metres above sea level and stands at a height of about 600 metres above the surrounding plains (Archives of Library and Documentation Unit FCF, Jos, 2018).

3.3 Reconnaissance Survey

A reconnaissance survey was carried out at different times of the year, subsequently, various surveys were carried out from which the following has been deduced after comparing and complementing primary data taken from site with other secondary data.



Figure 3: Map of Nigeria (top) showing Jos and Map of Plateau State (down) showing Greater Jos (study area).

Source: Adapted from Orewere, et al., 2019.

4.0 RESPONSES OF LANDSCAPING TO LAND DEGRADATION CHALLENGES AND BUILDING RESILIENT CITIES

Landscaping seeks to enhance the architectural composition and ecological qualities of degraded environments, it creates opportunities for building socio-ecological resilient cities that are capable of adapting to the changing global climate. Through the use of the soft and hard landscape elements the city of Jos and its immediate environment can be made resilient.

4.1 Soft Landscaping

Nikolaenke as cited by Omokhua, et al., 2002, asserts that plants are the lungs of the earth. By definition, soft landscape refers to animate elements, also known as organic elements and includes trees, groundcover, hedges, shrubs and flowers. Generally, soft landscape serves the functions of screening and maintaining privacy, which breaks the monotony of view; provides habitat for animals-which is important for biodiversity (Ayeni, 2012). Plant materials are described as soft landscape materials (Ale, et al., 2019). Plants play a vital role in a community's scenic beauty, the character of the local landscape and the overall quality of the environment. The benefits of curbing land degradation through the use of soft scape elements include:

i. Prevention of Soil Erosion

Soil Erosion is the process whereby the surface of the land is attacked, eaten, sculptured into valleys, hills, and cliffs are completely washed into the sea, river or ocean. It may be gradual or rapid depending on the velocity of the eroding force and the texture of the soil (Etukudo, 2000). Trees and shrubs could serve as shield to cover the bare soil while holding the soil together and their roots serving as barriers against run-offs. The characteristic features of plants in land reclamation and erosion control is that their strong spreading roots help to hold the soil particles together (Adams, et al., 2002). Most of the incidences of soil erosion in urban centres can be minimized if appropriate and well planned tree planting is combined with other developmental activities.

Trees recommended for quick vegetal cover of erosion sites include *Terminalia catappa* has strong spreading roots that can hold the soil together. *Anacadium occidentale*, *Pinus caribaea*, *Eucalytus citriodora*, *Acioa barteri*, *Oxytenanthera abyssinica*, *Bambus vulgaris*, *Dacryodes edulis* (Etukudo, 2000). Planting of drought resistant trees such as *Azadirachta indica* and *Acacia spp* in the Northern part of the country could be effectively used to checkmate the deleterious effects of wind storm common in Kano, Borno and Sokoto States.

ii. Green Manure and Soil Reclamation

Green Manure crops and nitrogen fixing trees, are recommended for fragile farming ecosystem in the tropics. Green manure crops improve fertility, moisture availability, nutrient retention and general tilt when incorporated into soils (Etukudo, 2000). Exotic species certified good as efficient green manure crops include *Leucaena leucocephala*, *Gliricidia sepium* The local trees and shrubs species include *Gmelina arborea*, *Albizia lebbek*, *Calliandra calothyrsus*, *Flemingia congesta*, *Cassia spp*, *Prosopis juliflora*, *Acacia auriculiformis*, *A Senegal*, *A mearnsii* amongst others (Etukudo, 2000).

iii. Water Quality

Plants help anchor soil and reduce storm water runoff, saving the high costs of drainage ditches, storm sewers, and other "engineered solutions" to storm water management. A Street lined with 32' tall trees can reduce runoff by almost 327 gallons, allowing cities to install smaller and less expensive water management systems. Reducing runoff also decreases topsoil erosion and the amount of silt and other pollutants washed into streams, rivers and lakes (A Handbook of Landscape, 2013).

iv. Humidity Control

Humidity is a measure of the amount of water vapor in the air (Ahrens, 2007). As long as heat present, the heat energy will be absorbed by moisture and released to the air in exchange for

the use of heat energy. Plants in general increase the humidity of the site. They can therefore increase the thermal comfort during hot, dry seasons, although the plants have to be watered regularly. The plants take water from the soil, and when this water evaporates from the leaves it increases the relative humidity while lowering the air temperature. Pools and ponds behave in a similar manner. Water evaporating from the surface increases relative humidity while reducing air temperature (Adedeji, et al., 2010).

iv. Abatement for Air Pollution

Particles of air pollutants are absorbed by leaf surfaces or they may be deposited on the leaves as they fall on the soil, they are absorbed. Kecher's study as cited by Mbah, (2001) indicated that quantified pollution remediation by plants and showed that 85% of lead from vehicles can be removed by a shelter belt of trees. Landscaping plants mask fumes and disagreeable odour by replacing them with more pleasing scents or absorbing them. Air flow modification caused by these plants affect transport and diffusion of water pollutants and energy. Trees particularly and other plants through their growth processes act as a sink for atmospheric carbon dioxide, the predominant greenhouse gas.

Furthermore, Mbah's study as cited in Orewere, et al., (2019) assert increased trees in the landscape will potentially slow the accumulation of atmospheric CO₂. In addition, the production of CO₂ by fossil powered generating plants will be reduced and energy conserved. Some plants such as *Eucalyptus saligna*, *Brunfelsia hopeana*, *Nerium oleander* etc produce sweet scent capable of neutralizing the polluted air thereby making the air fresh for human consumption.

v. Live Fences

Live fences are common features in the rural landscape (Etukudo, 2000). The construction is non-technical and the materials are available free. Where a gap exists in the fence, it can be easily mended at no cost. Live fences are popular in demarcating farmlands, boundaries between school premises and adjoining lands etc. Prunings from the fences provide fodder and mulch for farmland.

Plant species such as *Duranta rupens*, *Dodonea viscosa*, *Hibiscus spp.*, *Thevetia peruviana*, *Rosa sinensi* are used in constructing fences in our surroundings. While Popular woody species such as *Lonchocarpus cyanescens*, *P. santalinoides*, *Millefia thonningii*, *Jatropha species*, *Dracaena mann* *Thevetia peruviana*, *Moringa oleifera*, *Calotropis procera* serve for boundary demarcation in both urban and rural landscapes in Nigeria. They demarcate boundaries between church lands, school lands and farm lands (Omokhua, et al., 2002). Some live fences are also used as ornamentals thus *Newbouldia laevis*, *Baphia nitida*, *Markhamia tomentosa*, *Ipomoea carnea* at appropriate times produce their flowers and beautify the fences (Etukudo, 2000).

vi. Less Drainage Infrastructure

Trees absorb the first 30% of most precipitation through their leaf system, allowing evaporation back into the atmosphere. This moisture never hits the ground. Another percentage (up to 30%) of precipitation is absorbed back into the ground and taken in and held onto by the root structure, then absorbed and then transpired back to the air. Some of this water also naturally percolates into the ground water and aquifer. Storm water run-off and flooding potential to urban properties is therefore reduced (Burden, 2006).

vii. Reduced harm from Tailpipe Emissions

Automobile and trucks exhaust is a major public health concern and contains significant pollutants, including carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NO₂), and particulate matter (PM). Tailpipe emissions are adding to asthma, ozone and other health impacts. Impacts are reduced significantly from proximity to trees (Burden, 2006).

4.2 Hard Landscaping

Hard landscape is a landscape design term for inorganic structures, including stones, fences, deck, path and anything made of concrete which helps to create a visual balance between artistic composition of plants and non-living elements (Stone Landscaping, 2008). Landscape design involves integrating these elements systematically within the environment to give it aesthetically pleasing visual effects (Stone Landscaping, 2008). The hard scape elements that can effectively be used in curbing land degradation include:

i. Retaining Walls and Fences

Retaining walls are often used to create boundaries between hardscapes and earth landscaping features, or landscapes. (See Plate ix & x). Walls can be used to deflect the wind, it is often used to create privacy and comfort and it can also be used to channel the wind. Walls are usually solid, while fences are made from stakes, rails, wire, netting, and etcetera. Fences thus allow some wind to flow through them, even when they have climbers (Olanrewaju, 2011).



Plate xi: Cut stone retaining walls at the Jos Zoological Garden **Plate xii:** Use of wall and Fence to deflect wind impact

Source: Author's field work, 2019

ii. Steps and Paving

The choice of the surface finishing, material and construction of steps and paving can play a significant role in the reduction of ground temperature (See Plate xi). The use of asphalt in parking lots without any form of shade is a primary source of discomfort (Olanrewaju, 2011).



Plate xiii: Use of cut stones for steps **Plate xv:** Sidewalk ways as hardscape element at JUTH
Source: Author's field work, 2019.

iii. Stones

A Stone is any type of rock that has been selected or processed by cutting, shaping, or sizing for use in building construction or for decorative purposes. (Dictionary of Architecture and Construction, 2006). Stones and boulders can be arranged to direct airflow and to provide shade and for aesthetic.



Plate xv: Use of stones for retaining walls
Source: Author's field work, 2019.

iv. Slopes and Barriers

The use of slopes and barriers to direct airflow can be very effective on sites with significant variations in the topography (Adedeji, et al., 2010).



Plate xvi: Use of stones for sloppy terrain
Source: Author's field work, 2019.

5.0 RECOMMENDATIONS

Land degradation remains a serious global threat but the science concerning it contains both myths and facts. Understanding the unique nature of a landscape terrain and its characteristics, environmental factors such as gully formation, flooding, etc. necessitates the following recommendations.

1. Introduction of environmentally friendly agricultural practices such as agro-forestry, mixed agriculture and land management techniques such as land husbandry, whereby degraded lands are protected from further degradation and then nurtured back to productive use.
2. Mulching practices can also be encouraged to increase the fertility of the soil. Grasses, dry leaves and leguminous plants from previous crops help build up nutrients lost in soils again. Land covered in this way offers better resistance to invasive species, is less susceptible to run-off and is better protected against wind erosion.
3. All the unused land should be converted to farm lands since it will prevent people from engaging in indiscriminate tree cutting and soil excavation, which tempers with the land fertility and ecosystem stabilization. Also, strong laws should be put in place to prevent those who live on harvesting trees for fuel wood as a lazy profession to stop.
4. Effective landscape planning and implementation is very vital in achieving goal 11 and 15 in the Sustainable Development Goals. This can be achieved through-
 - i. Improving vegetation cover “surface cover” with trees, shrubs should be used in mitigating erosion where grazing is likely to occur and restricting stock access and Planting erosion resistant grass such as carpet grasses (*Axonopus spp.*), vetiver grass with deep roots, Bermuda grass (*Cynadon dactylon*), Zoysia grass (*Zoysia tenuifolia*)
 - ii. Land reclamation measure such as construction of retaining walls, fencing, and construction of deep and wide drainage systems to channel volumes of water to safe discharge points should be given priority.

5. Design a lifeline resilient system of roads, utilities, infrastructure and other support facilities that functions in the face of environmental degradation, other shocks and extreme conditions.
6. Government initiatives and trends should be developed for effective green infrastructure planning and management, professionals and other stakeholders should be encouraged to collaborate with the government to win the current war against abuse of both the built and the natural environment. With this appropriately utilized, land degradation challenges in Nigeria can be sufficiently tackled.

6.0 CONCLUSION

Land is the foundation for all life-sustaining processes on the planet such as agriculture, raw materials, shelter and basic infrastructure. Restoration of the degraded sites would best be based on vegetal and soil restoration which can best be achieved through the adoption of agroforestry system of agriculture at the degraded sites. Because of all these, it becomes of absolute importance to take care of land and prevent its degradation. Furthermore, Governments at all levels should collaborate to find a lasting solution to the phenomenal by adopting recommendations contained in this study as well as integrating other ones not mentioned here but would complement the efforts of an holistic tackling of the menace.

Finally, adopting the principles of socio-ecological resilience will produce social, ecological and economic benefits to help lessen the vulnerability of unexpected change (natural disasters), in ways that continue to support human well-being. This will be a step in the right direction in achieving Goals 11 and 15 of the SDGs in Jos, Nigeria.

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