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Review Article

An Overview of the Emergence and Challenges of Land Reclamation: Issues and Prospect

Kingsley Eghonghon Ukhurebor,[1] **Uyiosa Osagie Aigbe**,[2] **Robert Birundu Onyancha**,[3] **Juliana Ngozi Ndunagu**,[4] **Otolorin Adelaja Osibote**,[2] **Joseph Onyeka Emegha**,[5] **Vincent Aizebeoje Balogun**,[6] **Heri Septya Kusuma**,[7] **and Handoko Darmokoesoemo**[8]

[1]*Department of Physics, Faculty of Science, Edo State University, Uzairue, Edo State, Nigeria*
[2]*Department of Mathematics and Physics, Faculty of Applied Sciences, Cape Peninsula University of Technology, Cape Town, South Africa*
[3]*Department of Technical and Applied Physics, School of Physics and Earth Sciences Technology, Technical University of Kenya, Nairobi, Kenya*
[4]*Faculty of Sciences, National Open University of Nigeria, Abuja, Nigeria*
[5]*College of Computing and Telecommunications, Novena University Ogume, Kwale, Delta State, Nigeria*
[6]*Department of Mechanical Engineering, Faculty of Engineering, Edo State University, Uzairue, Edo State, Nigeria*
[7]*Department of Chemical Engineering, Faculty of Industrial Technology, Universitas Pembangunan Nasional "Veteran" Yogyakarta, Kota Depok, Indonesia*
[8]*Department of Chemistry, Faculty of Science and Technology, Airlangga University, Surabaya, Indonesia*

Correspondence should be addressed to Robert Birundu Onyancha; 08muma@gmail.com

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The issues of land degradation are directly or indirectly influenced by human and/or natural actions, and it is one of the most challenging issues confronting several regions of the world, especially developing nations. Notwithstanding the importance of land, its degradation consequences, possibly as a result of the various biological, physical, and chemical processes caused by some activities (both natural and man-induced) that diminish viable yield, result in a long-term, enduring devaluation of land. Hence, this present review study is dedicated to some of the most emerging and challenging issues in monitoring, rehabilitation, prevention, and management of land (land reclamation) drawn from existing publications. Also, the description of some of the most extreme procedures of land reclamation in some natural environments with distinct consideration to their positive features is discussed. Some illustrations and instances of the emergence and challenging issues in land reclamation and nature protection, as well as the possibilities and prospects of their resolutions, are discussed and presented.

1. Introduction

Land is one of the most fundamental natural resources for both developed and developing nations. Reportedly, approximately 90.00% of the world's population depends directly or indirectly on land for the implementation and fulfilment of most of the essential needs such as food, energy/fuel, shelter, security, timber, and fibre [1–4]. The land is an everlasting tool for generating wealth, but not without issues, especially with regard to degradation concerns. Hypothetically, the proper monitoring, rehabilitation, prevention, and management of land vis-à-vis soil safety and sustainability play an essential part in agricultural and environmental sustainability (AES). The continuous or incessant use of land, as well as its exploration and exploitation, has led to its dilapidation.

The degradation of land or simply put land degradation (LD) is one of the foremost challenging issues confronting several regions of the world especially developing nations [5, 6]. Asia has the highest hint, followed by Africa, and the European regions have the least impact as a result of distressed and exploited land [6, 7]. However, there are also reports that the LD also takes place in some advanced nations of the world, most of which is as a consequence of man's continuous or incessant exploration and exploitation of land as a major natural resource and owing to the fact that land is a source of other natural resources such as forest resources and petroleum and other mineral resources [8–10].

In a summarized report by policymakers on the thematic evaluation of LD and land reclamation (LR) of the "Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)," circumventing, plummeting, and retreating LD as well as refurbishing degraded land is a critical accomplishment for protecting biodiversity and the entire ecosystem to safeguard humanity [11]. At the moment, LD ensuing from human actions is destabilising the well-being of over three billion people, and it is pushing the Earth in the direction of sixth mass annihilation and costing over 10.00% of the overall Gross Domestic Product (GDP) [11].

Categorically, these environmental problems ensuing from LD are a serious and critical issue confronting several regions of the world, especially the Asian and African regions [12, 13]. According to Sklenicka [14], there is no decisive list of the sources of LD, as it has been reported to be a result of natural and man-made processes and activities. At present, the list of the kinds of LD is subjugated by progressions shimmering the dilapidation of all biological, physical, and chemical physiognomies of the entire ecosystem mechanisms [15]. In the same way, apart from appropriate observation and appraisal, the list of the causes, as well as the methods of identifying the causes of distressed and exploited land (degraded land), is somehow challenging and incomplete [8], which is, in contrast, subjugated by, in addition to natural sources, objects of socioeconomic activities, with the end consequence of the main production services of the entire environment being plummeted [16]. LD entails the deterioration or weakening of land quality or the reduction in land potential productivity attributes [17, 18].

Feasibly, LD may ensue as a result of different biological, physical, and chemical processes caused by some processes that diminish viable yield, resulting in a long-term, enduring devaluation of land. These processes are directly or indirectly influenced by human and/or natural processes and actions [19–22]. These consist of soil erosion, acidification, compaction, salinization, leaching, reduction in cation retaining capacity, nutrient diminution, lessening of the overall biomass carbon, and the declination of biodiversity. The structure of the soil is one of the key issues for all forms of LD procedures and developments; it disturbs the provision of the services of the entire ecosystem mechanisms [23, 24]. Human actions are not only accountable for the LD but also imperative for the enhancement of land via monitoring, restoration, prevention, and management [19], which in this context is termed "LR." Such human actions are shifting cultivation, steep slope farming, deforestation, overgrazing, forest resources [19, 25, 26], and application of computer devices [27, 28], such as the utilization of Artificial Intelligence (AI) and Internet of Things (IoT), in the arrangement, monitoring, control, restoration, prevention, and management, together with other processes involved in LD as well as its reclamation processes [29, 30], the use of chemicals such as pesticides, herbicides, fertilizers [31], and so on.

This generates several environmental, economic, and socioecological problems such as poverty, inadequate health and nutrition, demographic dynamics through a dip in agricultural productivity, and an upsurge in environmental degradation, as well as altering the climate system [20, 21, 32]. According to Ukhurebor and Azi [33], the alteration in the climate system is possibly influenced by the internal irregularities ensuing from the natural internal progressions within the climate system or external irregularities ensuing from the inconsistencies in natural or anthropogenic exterior effects. Consequently, since the mid-19th century upward, there has been an unprecedented upsurge in temperature measurement records globally [13, 30, 34], and these present vicissitudes in the climate system are one of the confronting issues globally that are also responsible for LD and vice versa.

LR is a bundle of procedures intended for monitoring, regulating, controlling, and managing some of the foremost mechanisms and components of the natural environment for the improvement and enhancement of living organisms and their terrestrial, aquatic, and atmospheric environments [9, 35, 36]. It has to do with the act and procedures of returning explored, distressed, or exploited land to a functioning state. Supposedly, the procedure of LR by most industries, such as the petroleum and mining industries, attests to the fact that explored, distressed, and exploited land is returned to a fruitful and prolific state. Albeit, LR can be seen as a precise technological means to sustain favourable circumstances on land as well as other natural resources that are critical to agricultural as well as environmental, economic, social, and human development. It indicates the fundamental change (enhancement and improvement) of land as a result of some measures [25, 26].

Reclamation of explored, distressed, and exploited land locations resulting from most industrial activities—the petroleum and mining industries, to be precise—essentially begins even earlier as a well is drilled or another structure is erected. Comprehensive LR strategies form part of industrial's application for endorsement for developmental and economic purposes. Once a plan is approved, as part of the land monitoring and management as well as reclamation plan, the soil is detached and deposited for use when the location is restored and reclaimed [10, 37].

According to "the Encyclopaedia of World Problems and Human Potential (EWPHP) of the Union of International Associations (UIA)," the restored and reclaimed lands are often called "reclamation grounds or landfills" [38]. In some locations, such as some regions of the United States, the term "reclamation" could be defined as the act of returning disturbed land to an enhanced, improved, restored, or advanced condition. In Alberta, Canada, for instance, reclamation is defined by the regional authorities as “the process of reconverting and restoring disturbed land to its former or other productive uses.” In Oceania, it is commonly referred to as “land rehabilitation,” while in Africa and some other regions, it is simply termed LR [38]. The processes of LR, such as agroforestry approaches, for example, the application of “Multipurpose Tree Species (MPTs), relay-cropping, terracing and contour cultivation, and strip and alley cropping,” are suitable for accomplishing the desires or requirements of small-scale farmers with truncated resources through the restoration and upsurge of land productivity [19]. Consequently, this approach could potentially improve through comprehensive and scientific efforts that are based on desires or requirements with dynamic involvement of farmers in the planning, arrangement, and implementation processes.

According to Halbac-Cotoara-Zamfir et al. [39], LD is more apparent in locations where situations of environmental susceptibility have previously occurred due to the arid (dry) climate and nonsustainable arrangements of land exploration and exploitation. As a result, semiarid locations and dry locations have been recognized as susceptible land, necessitating consideration from both the scientific domains and policy perceptions. In several locations, such as the Mediterranean regions, LD is predominantly strong, even though there are hardly any described critical or extreme environmental situations. In these circumstances, a comprehensive set of formal (recognized) and informal (casual) responses is required to confront the complex and spatially discriminated territorial progressions in particular. Nevertheless, the right responses have been alleged to vary with time and space, considering the fundamental socioeconomic background and the precise environmental circumstances. Therefore, there is a need to broaden the existing processes of LR to mitigate and manage these challenging issues ensuing from the LD to further enhance AES [16, 25, 26]. Due to the aforementioned, there is a need to develop, explore, and advance innovative processes such as the utilization of some eco-friendly state-of-the-art technologies like nanotechnology (NTech) or bionanotechnology (BNTech) machinery together with the use of AI and IoT for the monitoring and management of the emergence and challenges of LR processes. Such NTech/BNTech, together with AI and IoT, which are presently invoked or put in place in the agricultural and environmental sectors as well as other sectors of human endeavours such as the biomedical sector, are the nanobiosensor mechanisms, which are one of the most emerging and evolving aspects of NTech/BNTech [29, 34, 40–44]. Hence, this present study provides an overview of some of the foremost emerging and challenging issues for monitoring, rehabilitation, prevention, and management of land, which are all embodied in the processes of LR.

2. Land Degradation Issues

According to Barbosa et al. [45], LD denotes a decrease in land prolific rate caused primarily by human overexploration and exploitation of natural resources. Humans characteristically interchange natural vegetation with human-subjugated arrangements. Some of these human-subjugated arrangements are agriculture and forestry events, interchanging of the natural environment with structures, and so on [46, 47]. LD, as adopted from the definition of the Food and Agricultural Organization (FAO), is a prolonged duration of weakening in the functioning of the environment and efficiency. Its effect on the ecosystem via land disturbance is through either human or natural influence. The cruelty of LD experiencing dilapidation is around 20.00% of agricultural land, 30.00% of forestry, and 10.00% of grassland [15].

Land ecologies are vital aspects that enhance human livelihoods and preserve the viable development of society as well as healthy environments. However, the core benefit of the boundless value of land and their dependable value have been mostly taken for granted and underestimated, resulting in severe LD that deteriorates the environmental facilities and hinders reasonable development of several regions [32].

LD is one of the current critical issues confronting most regions globally, and this has borne a series of regular contentious restorations every decade since the period of the Dust Bowl in the mid-West US. The sequential classification of LD is a procedure of destroying the environment (land in particular) and impairment prompted by oblivious farmhands; this was known as the African scourge by Hailey’s African survey in the year 1938 [24]. In all processes of environmental change, the crucial resource that is most depleted in terms of quality with LD is the soil, and a malicious sequence is apparent in several degradation procedures [24].

The assessments of the comprehensive range of LD indicate that the Asian continent is the one most affected, trailed by the African continent, and Europe is the least affected (see Figure 1). According to an estimate by the UN Development Program (UNDP), 42 billion USD and 6 million hectares of fertile land are lost annually due to LD.

On the African continent, situations are worsening with the loss of watersheds and forest resources, as well as sandstorms and a decline in agricultural productivity, which is allied with deficiencies in wealth, instability, and immigration issues. Also, it is anticipated that about 2.6 billion people are distressed by LD and desertification in over a hundred nations, distressing more than 33.03% of the land surface globally. A holistic estimate of distressed and exploited land in dry locations across the various continents of the world as adopted, modified, and revised from the study of Barman et al. [71] is shown in Figure 2.

Reportedly, the African region has some of the most degraded lands globally and is only next to the Asian region in LD magnitude. Even with the reported limited reliable available data on the magnitude of LD in Africa, anyone who has journeyed through this region will observe that LD is prevalent and severe. The occurrence of ravines and sand mounds besmirched forests and lands for grazing is evident, even though the effects of pane erosion and deteriorating fertility of the soil are less perceptible [48].

A significant aspect of the wealth of any nation depends on its capability to manage, preserve, and conserve its land

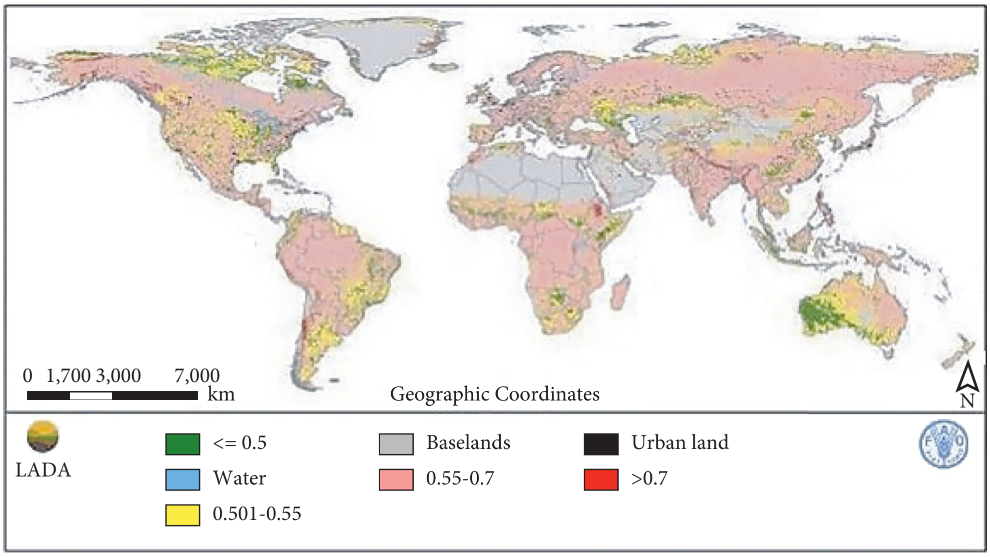

FIGURE 1: Degraded land across the globe [24].

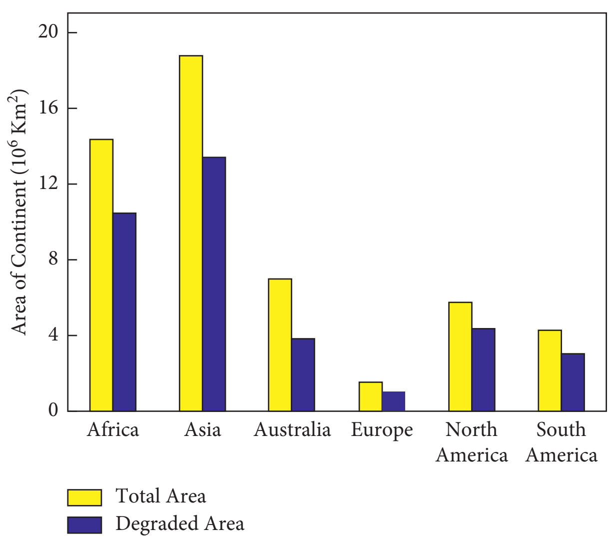

FIGURE 2: A holistic estimate of distressed and exploited land in dry locations.

resources. Obviously, LD results not only in declined agricultural productivity but also in droughts, environmental disparity, and subsequent dilapidation of the quality of life. In most developing parts of the world (Africa to be specific), one of the most noticeable indications of the adverse impact of LD on agricultural productivity vis-à-vis food production is deteriorating and decreasing yields and rising levels of deficiency [48].

Human events in the search for survival (in terms of the quest for food, shelter, fuel, and fibre) have consequently and suggestively modified land mechanisms. However, LD is mostly caused by man. Thus, its pace is overseen largely by the rate at which inhabitants pressure posts. Asymmetrical natural actions, such as droughts, aggravate the circumstances. For example, the 1982–1985 drought in Africa had a dramatic impact on the rate of LD and desertification. Food assistance is provided in such a crisis, and it evidently does nothing to assuage the environmental impairment. Several nations in Africa have already lost a substantial amount of their land to countless forms of LD. Several regions in Africa are said to be losing more than 50 tons of land per hectare annually. This is approximately equal to a loss of around 20 billion tons of nitrogen, about 2 billion tons of phosphorus, and about 41 billion tons of potassium annually [48].

There are also reports of serious erosion in several regions of Africa, such as the Central African Republic, Ethiopia, Ghana, Guinea, Liberia, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, and Zaire. Reportedly, about 319 million hectares of land in Africa are susceptible to desertification threats owing to the movement of sand. According to the FAO/UNEP assessment report on LD in Africa, huge parts of nations in the north of the equator are agonizing over critical desertification complications. Perhaps, in the semiarid regions of the western part of Africa, the desert is moving at an extent of about 5 km annually. However, desertification did not commence with the current drought. Records from archaeology propose that Africa's arid regions have been getting increasingly drier for 5,000 years; this implies that the accident of drought together with the rising pressures placed on the delicate arid and semiarid lands by the increasing numbers of people and livestock is what is new and this is fundamentally what is stepping up LD throughout much of the African regions [15].

Nevertheless, in the wetter regions, there is a better chance that LD can be halted and such land restored. LD induced by human activities can be grouped into those contaminated by soil constituent dislocation (via water and wind erosion) and those by chemical and physical deterioration. Table 1 contains information as adopted from Giuliani et al. [48] on degraded, steady, and enhanced land areas from 2001 to 2015. Figure 3 shows the main drivers and gravities of LD as adopted and modified from the work of Gichuki et al. [48].

Table 1: Information on degraded, steady, and enhanced land areas between 2001 and 2015.

	Area (sq km)	% of overall land area
Overall land area	39,995.90	100.00
Enhanced land area	13,351.30	33.33
Steady land area	20,998.70	52.50
Degraded land area	3,886.80	09.72
Land area without data	1,759.10	04.40

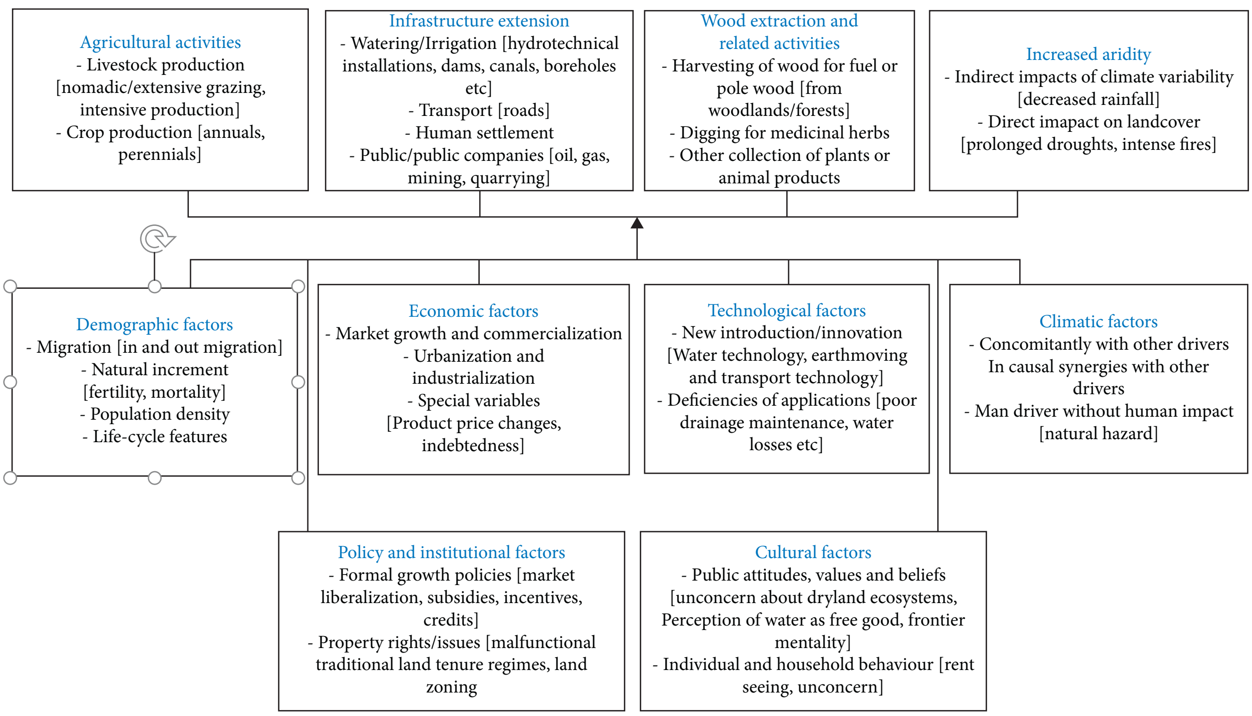

Figure 3: The main drivers and gravities of land degradation.

3. Phases in Land Reclamation Processes

When procedures have stopped, LR trails standard phases that include the following [49–51]:

(i) Ground recontouring, as well as drainage arrangements.

(ii) Substituting topsoil, subsoil, and organic constituents reclaimed before the land disturbance.

(iii) Revegetation and planting.

(iv) Monitoring water and soil quality, as well as vegetation formation.

Like several aspects in the petroleum and mining industries, for over fifty years now, LR procedures have developed tremendously, with industries making efforts to conduct research that would aid in restoring distressed and exploited lands more swiftly and efficiently [18].

In some instances, the aim of the "Agricultural Hydrotechnical Reclamation (AHR)" operation is defined by soils; the tool of AHR operation is regulated by water and related air, thermal, and nutritious regimes along with agrotechnical procedures. The aims and nature of LR are governed by the agrobiological necessities of plants and economic, socioecological, and administrative tendencies that depend on the extent of advancement of socioecological production [19]. The following are some of the most important tasks that are resolved through AHR works [19]:

(i) The upsurge in the capacity of agricultural production by reclaiming, restoring, and altering previously unexploited land, such as marshes and arid locations, into agriculturally utilized locations.

(ii) The upsurge of the capacity of agricultural production by increasing the utilization of the lands accessible for agricultural purposes by cultivating their operative fertility, such as the removal or mitigation of impermanent waterlogging, soil conservation, irrigation, and fundamental enhancement of the savannahs and grasslands.

(iii) Formation of situations for coherent utilization of agricultural devices and other resources of production by employing cultivation and methodological procedures such as consolidation of grounds, levelling, and amputation of stones.

4. Land Reclamation Classification

The requirements for LR vary depending on the circumstances of occupational connection, in wide-ranging geographic terms,

Table 2: Land reclamation classification.

Categories	Subcategories	Form
Hydrotechnical	Drainage	Reclamation/drying-out of swamplands, marshlands, or wetlands
	Flood monitoring and management	Flood and waterlogging monitoring and management/eradication of wet spots (sluggishness of swift water on the surface)
	Irrigation	Humidifying irrigation/fertigation (fertilizer irrigation)/sterilizing irrigation/ unfreezing irrigation/soil-cleaning irrigation
	Drainage and humidifying	Control and management of water-air regime of drained lands/irrigation of drained swamplands, marshlands, and wetlands
	Irrigating or watering	Irrigating of arid areas/irrigating of low-water areas/irrigating under the situations in tropical locations
Agrotechnical	Control and management of drainage	Creating depressions in-ground/mole plowing/narrow conventional plowing/ soil adornment/wrinkling/soil slotting/ridging/bed-forming
Land	Accumulation/conservation of soil	Nonmould board releasing/deep plowing/decompaction of the soil/sheet erosion, subsurface erosion, ravine erosion, and soil blowing monitoring and management
	Reconstruction of the soil	Development of topsoil/granulometric enhancement of the soil via the addition of sand and clay/thickening of humus-accrued prospect
	Cultivation and technical	Levelling of the surface/land clearance and management
	Reclaiming and landscaping	Reclamation of open-cast mines such as rock dump pits, peat mines/ash-disposal locations/demolitions instigated by natural catastrophes such as hurricanes, floods, storms, and dust
Vegetative	Phytoreconstructive	Development of woodland belts/complete afforestation/phytoncide or resort planting
	Conservation of landscape	Protection of water/control and management of wind, snow, bank, landslide, and landslip
Climatic	Thermal	Control and management of frosts, frost-killing and damping-out/basin, and thermal/agrothermal
	Distribution of moisture	Enhancement of precipitation/control and management of snow-melting
	Weakening of wind	Local arrangements/antihurricane measures, especially in Hurricane formation areas
Agrochemical	Salt enriching, acid monitoring, and stabilizing the soil	The use of mineral fertilizers/monitoring and management of nutrient distribution/the use of lime, especially on acidic soils/acid monitoring, especially on solonetzic soda soils, solonchak soils, and other soils with high alkalinity/the use of gypsum, especially on alkali and solonetzic soils/soil conditioning and stabilization against soil puncture/soil silicatization
	Sanitary and disinfecting	The use of arboricides and pesticides

depending on which mechanisms of the natural environment are targeted for recovery, restoration, and renovation procedures. These procedures could be of diverse categories, subcategories, and/or forms (classification). Sequentially, depending on the means of carrying out the reclamation process, each category or form could be divided into successions of various subcategories and/or subforms. As reported by Golchenko et al. [52], the LR classification according to the influence on natural ingredients is tabulated in Table 2, which indicates the categories, subcategories, and forms in the classification LR as adopted, modified, and revised by Golchenko et al. [52].

5. Measures of Land Reclamation

Potentially, human activities are essential for the improvement and enhancement of explored, distressed, and exploited land by monitoring, prevention, adaptation, restoration, rehabilitation, and acclimatization [3, 7, 9, 18, 19, 32]. All these are personified in terms of LR. However, for adequate measures of LR to be effective and proficient, there is a need to possibly identify the kinds, likely causes, and complete extent of the degradation [53, 54]. Earlier, the various phases in LR processes and LR classification have been briefly discussed in the preceding sections.

Among the various LR procedures, drainage and irrigation are the most important ones. Potentially, LR contributes to the conservation, preservation, improvement, enhancement, and development of soil fertility, plant growth capacity, the upsurge of AES, the extenuation of climatic influences, and the variations in production capacity [1, 8, 26]. Supposedly, even as the measure of LR increases, nevertheless, at the present stage, one of the utmost emphases is on enhancing its effectiveness and efficiency [54].

Some of the utmost LR objectives are as follows:

(i) Enhancement and development of land under adverse water management situations are demonstrated in either surplus moisture or its deficiency to the extent that is considered adequate for effective use of the location for economic tenacities.

(ii) Enhancement and development of the land that is under adversative physical and chemical physiognomies of soil, such as heavy clay, saline, and thick soils, with advanced acidity, and so on.

(iii) Enhancement and development of the land, which is responsible for the loss of physical influences such as wind and water erosion, resulting in the development of landslides, the formation of ravines, the scattering of soil, and so on.

Depending on a tangible purpose, diverse categories of reclaiming land procedures are employed. The reclamation procedure concerned with the removal of excessive moisture from any affected location is commonly known as drainage reclamation. It is employed, in addition to agricultural and industrial processes, public effectiveness, and the construction of infrastructures such as buildings and roads [32, 54]. It is also employed in the extraction of peat when carrying out remedial measures on swamp locations (such as swamplands, marshlands, or wetlands), as well as other land development and advancement activities. However, the LR process envisioned for the elimination of water deficiency in the soil/land for agricultural purposes is often referred to as irrigation [37].

Soil aeration improved by LR procedures with adversative physical physiognomies is intended for the improvement and enhancement of soil aeration, in addition to increasing its permeability and porosity [37]. Hence, appropriate plant rotation practices are introduced and reinvigorated; the application of sand to muddy or murky soil and mole drainage are done with the intention of contributing water and air to the layers of deep soil [6, 18].

The LR procedures with adversative chemical physiognomies entail the removal of injurious salts via leaching, the dropping of soil acidity by applying lime, increasing soil nutritional-supplying capacity through fertilizer distribution, and the introduction of appropriate plant rotation techniques with an advanced ratio of pasture [55, 56].

The LR procedures liable to wind and water erosion mostly comprise the procedures intended for the reduction of the amount and dropping of the rate of running down surface water, increasing the resistivity of the soil to dispersion and erosion [36, 57]. These procedures are based on applying an inclusive set of agrotechnical, reafforesting, and hydrotechnical measures [32].

Under present circumstances, in the majority of the aspects subject to LR dealings, generally not a single but numerous of the above-mentioned LR categories are carried out depending on some combinations of economic and natural situations. For instance, forest belts are cultivated, plant rotation is introduced on irrigated locations, fertilizers are used, and leaching of saline land locations and so on is employed concurrently with irrigation of the region. All of this, particularly the widespread scale of reclamation formation, makes LR one of the hydrological regimes and major anthropogenic factors in the overall and specific transformation of nature.

The following are some of the main procedures that are recognized in planning the complete extent of distressed and exploited land:

(i) Professional or expert assessments.
(ii) Biophysical models.
(iii) Enhanced Vegetation Index.
(iv) Field-based and remote sensing procedures.

Distressed and exploited land can be reclaimed, controlled, or managed by the following measures:

(i) Afforestation.
(ii) Application of eco-friendly energy source.
(iii) Application of eco forest system.
(iv) The institution of green business.
(v) Application of appropriate overgrazing measures.
(vi) Application of appropriate irrigation system.
(vii) Application of appropriate waste management system.
(viii) Utilization of conventional techniques and cutting-edge technologies.
(ix) Application of appropriate organic agricultural practices (such as climate-smart agriculture (CSA)).
(x) Application of appropriate industrial process.
(xi) Enactment of appropriate policy frameworks.

LR is created with the goal of increasing soil productivity and maintaining viable agrobusiness, as well as ensuring definite agricultural production based on the maintenance and improvement of soil fertility, in addition to the creation of the required environments for the drawing of unexploited and truncated-yield land into agricultural creation, the establishment of a coherent pattern of land, forest conservation and management, reproduction, and resource management [53].

6. Sustainable Development Goals (SDGs) for Land Management

The sustainable use of land vis-à-vis soil protection plays a crucial part in AES, the climate, and the protection of lives. Notwithstanding, the LD has turned out to be a global problem, occurring in almost all regions (in both developed and underdeveloped nations) and agroecologies. For the past several years, there has been an intense accelerated rate of environmental adulteration and dilapidation of physical resources.

In all this, there have been continuous efforts from relevant stakeholders to develop and preserve the environment, for example, the 1972 exceptional global landmark event titled "The Human Environmental Conference." Continuing in this direction towards AES, the UN established 17 SDGs, of which one of the major targets was to protect, restore, and promote maintainable use of vegetation and wildlife, combat desertification, halt LD, and control the mutilation of biodiversity [24, 59].

In most developing nations, LD has become a critical issue, and this has led to augmented concern about AES and is having long-lasting consequences on the populace.

The natural environment (land in particular) is a fundamental element for improving humans' livelihoods and the preservation of social group development. But the core services of exceptional quality land and their core values are mostly taken for granted and underrated, resulting in severe LD, declining biological services, and a deterrent to the development of the environment. It is a concerted progression that encompasses several recurrent mechanisms, such as climate change, land use, and human-subjugated land management, playing a critical role [16, 32].

Generally, LD is a consequence of multidimensional interassociation among socioeconomic and biophysical concerns that influence several people and their land, predominantly in the undeveloped and humid regions. It encompasses the dilapidation of both vegetation and soil, with the dilapidation of the soil describing the unwanted modifications in the biological, chemical, and physical possessions of soil, while the dilapidation of the vegetation entails a weakening in the number of species and the configuration of the vegetation [58].

Circumventing, plummeting, reversing LD, and reestablishing degraded land are crucial for protecting biodiversity and the ecosystem mechanisms that are dynamic for humanity. To stop and mitigate the existing tendencies in LD, there is an instantaneous necessity to improve national capacities to commence measurable evaluations and charting of their degraded lands as desired by the SDGs, specifically, the SDG indicator 15.3.1, "proportion of land that is degraded over the total land area." Also, Earth Observations (EO) could play a vital role both in producing this indicator and in supplementing or enhancing national official data sources. Earth to monitor LD in accordance with SDG 15.3.1 depends on default datasets of coarse spatial resolution. As a result, methodologies to assist with intermediate to high-resolution satellite EO data (such as Landsat or Sentinels) are required. Reportedly, the main drivers of LD in most developed nations are the high consumption standard of living, while those of most developing and evolving nations are rising consumption [48, 59]. This, combined with population growth, is driving an unmanageable number of natural resources, agricultural growth, and mineral extraction, as well as urbanization, all of which typically lead to a higher degree of LD. Consequently, appropriate action to circumvent, reduce, and mitigate LD will enhance AES as well as water safety. This action could contribute considerably to the adaptation and extenuation of climate change, the loss of biodiversity, and decreased migration and conflict; eventually, this is crucial in meeting most of the SDGs as stated in "the Agenda 2030 for Sustainable Development" [26, 58, 60].

In mitigating and reversing the present tendencies in LD, there is an instantaneous necessity to improve national capacities to assume quantifiable evaluations and consistent mapping of their degraded lands as required by the SDGs, specifically, the SDG indicator 15.3.1, as well as by the implementation of "the Land Degradation Neutrality (LDN)" targets with the support of the "United Nations Convention to Combat Desertification (UNCCD)" [48, 59, 62].

7. A Scientific Case Study of Land Reclamation Procedure

A scientific case study of the LR procedure presented in this study is the work of Xueyi et al. [37]. This study aims at a primary deliberation on the evaluation content, procedures involved in the evaluation, and indicators of evaluating LR benefits in mining locations. The study utilized what is called the "fuzzy comprehensive evaluation (FCE) technique" in assessing the LR. Subsequently, the authors compiled a model of the LR-inducing features. An index of evaluation of LR usefulness in the mining locations was created by employing the LR monitoring statistics for the polar (northern) part of the mining location over the last ten (10) years. Also, an expert grading technique and a traditional assessment model were utilized to evaluate the all-inclusive benefits of LR at a mining location within the studied area (Hanjiawan coal mine at Shendong mining location in the eastern region of the People's Republic of China). LR evidently enhanced the land category within the mining area and reduced the quantity of degraded land, including decreased and engaged land. Furthermore, LR enhanced the accessibility of land locations like construction and agricultural land. This proposed model attained a total of about a 63% rise in the LR part. Besides, this technique can be employed for specific assessment of wide-ranging benefits after LR, and the evaluation consequences will offer a reference source for maintainable advancement and development of the mining locations. The wide-ranging advantage in the evaluation of LR in the Shendong mining location was based on the structure of the evaluation model. Hence, the complete assessment analysis of LR in the mining location as adopted, modified, and revised by Xueyi et al. [37] is summarized as follows:

(i) The first point has to do with the suitability evaluation of land in a mining location.

(ii) The second point has to do with the analysis of the LR impact factor, selection of the evaluation factors, quantification of the evaluation factor and calculation of its weight value, and examination of the matrix consistency.

(iii) The third point has to do with the definition of the structure of a hierarchy.

(iv) The fourth point has to do with the classification of the evaluation grade.

The LR technique as reported by Xueyi et al. [37] is as follows:

7.1. Terraced (Attached) LR. Habitually, the gradient of the extra land produced by coal mining subsiding is comparatively trivial, at roughly 2.00°C. When the ground could be cultivated via land smoothing/levelling or roughness/unevenness, it could be restored along the contour (delineation) line when the gradient of the surface is between 2.00 and 6.00°C. Similarly, it is attached and inclined a little inward. When land is utilized, it could be placed between forestry and agriculture [62]. Also, contour cultivation could be employed for soil (land) and water (aquatic) conservation; such LR is terraced reclamation. For mining locations situated in hilly regions or in the middle of coal seams, the mutilation of cultivated land is characterized by unevenness or even step-like landforms. Additionally, terraced reclamation is appropriate for subsidence basins situated in mountainous and rocky locations or for bulky surface gradients after mining subsidence in small and medium-sized water table mining locations.

7.2. Artificial (Nonnatural/Man-Made) Afforestation. After mining, the LR machinery for establishing forests could swiftly form green vegetation on the land, shield the soil from land/soil erosion, increase the fertility of the land, and advance the regional environmental settings. The utilization of afforestation machinery for LR in most mining locations could characteristically attain improved results. According to Peng et al. [63], the basis (key) of this reclamation technique is the choice of the types of trees (species). In several nations, tree type (species) selection has been the focus of reclamation research studies, as reported by some scholars from America who comprehensively considered this aspect and accumulated rich creation experience and scientific research consequences [64]. The designated plants ought to have bioecological features such as resistance to contamination, a quick growth rate, and decent soil (land) and water (aquatic) conservation.

7.3. Multiple (Manifold) Procedures Combined. Typically, LR is executed via engineering reclamation to eradicate accrued droughts, water, and floods. Biological reclamation procedures are employed for the enhancement of the quality of the soil and monitoring, regulating, or controlling the environmental contamination resulting from mining, while environmental recovery or reclamation procedures are employed for the improvement of the reclamation of the local ecological environment of the land, not only aiding the land to be recovered or cultivated but also apprehending the wide-ranging benefits of the mining locations [65].

According to Xueyi et al. [37], FCE is the grouping of analytic hierarchy procedures and fuzzy calculation. However, the analytic hierarchy procedure efficiently resolves multiobjective as well as multilevel decision-making difficulties in huge arrangements and has the features of reasonable (high) logic, simplicity, and flexibility. The LR venture in the mining location comprises several influences and encompasses difficult links [37]. During LR, there could be several procedures to select from. One could sort out numerous representative procedures, employ an analytic hierarchy procedure for the selection analysis, acquire a superlative reclamation result with as few reclamation procedures as possible, and also acquire decent or friendly environmental, social, and economic benefits and usefulness [37].

8. Application of Geospatial Technology for Land Management

Several approaches can be utilized for studying LD as well as the reclamation processes of land. Some of these modern approaches are geospatial technology, such as remote sensing (RS) procedures and field or ground measurements using geographic information systems (GIS) [65, 67]. RS is highly useful in measuring huge areas of land within a short time with little effort and is cost-effective when compared to field or ground measurements. Hence, satellite information is one of the best tools for the detection of most of the impact of LD for multiple periods [65, 67].

According to some reports, the combination of satellite data and GIS could be used to identify deteriorated lands [66, 68]; thus, the extraction of variations in land utilization and land protection, as well as their environmental consequences, is required for the achievement of sustainable advancements in cities. Also, as reported by Shareef et al. [67], the application of geospatial technology together with fuzzy analytical hierarchy process (FAHP) approaches in LD as well as the reclamation processes of land has presently been explored.

Satellite-derived remotely sensed Earth Observations (EO) can also provide a consistent means of monitoring changes in land cover and biomass action over long periods [48, 69]. Reportedly, this has been extensively employed for monitoring the dynamics of desertification [70], forest dilapidation [71], or variations in land cover [72].

Nevertheless, several regions, specifically those in the developing regions, have some problems in accessing and/or generating the required information for monitoring LD from EO data [48]. The UNCCD in the year 2015 introduced an "LDN target-setting pilot project" with fourteen nations to assess the efficacy of the global datasets (GDS) on the land cover together with the land productivity dynamics resulting from remotely sensed EO data. Supposedly, some nations were able to utilize the global datasets together with their national data to set their targets [1]. Even though the designated GDS has been beneficial in moderating coarse spatial resolution (such as 250.00 m to 1.00 km), it is a problem for effectively evaluating LD, mostly in regions with mountains, small island regions, and extremely uneven landscapes [48]. Consequently, it is essential to develop procedures for generating improved spatial resolution indicators (such as 10 m to 30 m) for assessing LD.

9. Possibility of Utilizing Nanotechnology in Land Reclamation Processes

As previously stated in the introduction section, innovative processes such as the utilization of nanotechnological machinery for the monitoring and management of the emergence and challenges of LR such as nanobiosensor mechanisms are essential and need to be explored, developed, and advanced. NTech is an evolving aspect of the scientific domain that deals with nanomaterials (NMs) [20, 27, 40, 53, 72, 73, 75].

According to the definition of the US Environmental Protection Agency, NTech is a new-fangled discipline of science that has to do with the understanding, monitoring, control, and management of materials at sizes (dimensions) within 1.00 to 100.00 nm, with exceptional physical possessions that make innovative applications conceivable [34, 42, 76]. This description of NTech, according to Mukhopadhyay (2014), is to some extent inflexible with respect to size (magnitude) dimensions. However, more prominence has been placed on the problem-resolving competence and ability of these NM. Some other efforts in defining NM from the angle of the agricultural and environmental sectors comprise particulates ranging from 10 to 1,000 nm in size (magnitude) dimensions that are concurrently colloidal particulates.

Other efforts to define NM from the agricultural and environmental sectors include particulates ranging in size (magnitude) dimensions from 10 to 1,000 nm that are also colloidal particulates [34]. Presently, NTech can be described as the aspect of science in designing and producing machinery in which all particles and chemical/organic bonds are precisely quantified [42]. It is not a group of specific procedures, machinery, or products, but a group of competencies that are put in place when our technology originates near the boundaries set by Modern Physics [77].

The increasing and evolving applications of NTech in agricultural and environmental sectors need a continuous enactment to completely depend on the problem-solving capability of this NM which is unlikely to observe very strictly to the higher extent of 100 nm, owing to the fact that NTech for AES will in no doubt address the large-scale inherent limitations and complications in agricultural and environmental processes (such as very low input use effectiveness), which could entail NM with flexible magnitudes (dimensions), which however execute tasks proficiently in the agricultural and environmental settings [77, 80].

The utilization of these NTech processes using nanobiosensors has been considered by some scientists/researchers as one of the dynamic aspects in the purifying, monitoring, and management of LR processes that have produced some beneficial results in dealing with some of the emergence and challenging issues of LR, especially as they relate to environmental sustainability and safety, by offering resolutions to the environmental adulteration drives in LR processes, which has been described as one of the universal leading complications confronting the whole ecosystem. The prospect of the application of NTech in agricultural and environmental sectors for the purpose of AES is exceptional. It is a relatively new aspect of research, which is approximately less than two decades old. However, as conventional agricultural processes become increasingly insufficient, particularly in light of the emergence and challenges of LR, and as desires outnumber the carrying capacities of the global ecosystem, we have a slim chance of exploring NTech in all agricultural domains. It is well known that the implementation of innovative technology is critical to the accretion of national affluence [40, 73, 78].

10. Conclusion and Future Prospect of Land Reclamation Processes

The appropriate use and exploitation of land vis-à-vis soil safety and sustainability play a fundamental role in AES as well as climate change mitigation and other critical progressions of the ecosystem in general. However, the continuous and incessant use and exploration of land as well as its exploitation have led to its dilapidation (degradation). The dilapidation of land (or, in this context, LD) is a major challenging issue confronting not just the regions of Africa but most regions of the world. Consequently, appropriate actions are needed for the enhancement of LR via the monitoring, rehabilitation, prevention, and management of land (all of which are embodied in the processes of LR). Hence, this study precisely examined some of the most pressing and challenging issues of LR that give the impression of imminent connections between nature protection, the natural environment, and LR procedures.

The following are therefore the pointwise conclusion drawn from this review study and possible suggestions for future outlooks:

(i) LR for any location plays a significant role in the socioeconomic and socioecological development and advancement of such an area.

(ii) It provides significant socioeconomic and socioecological benefits and is critical in preserving and sustaining agricultural productivity as well as the healthy development of industrial innovativeness.

(iii) Additionally, LR plays a dynamic role in the improvement of the environment and agronomy as well as the ecological landscape.

(iv) LR procedures for any distressed or exploited land can be managed, such as afforestation, the application of eco-friendly fuel sources, the use of appropriate agricultural practices (such as CSA), appropriate waste management systems, and appropriate management and utilization of industrial processes.

(v) Suggestively, by executing and applying appropriate LR procedures, industrial benefits will increase, and the consequences ensuing from most industrial activities, especially as it relates to LD, will drastically reduce. Its reclamation procedures will be easily and significantly attained at a very high growth rate of about 56.0%.

(vi) Undoubtedly, LR offers virtuous environmental, social, as well as economic benefits and usefulness. It is exceedingly critical to safe and sustainable agricultural processes via LR procedures, as well as the maintainable and healthy advancement of industrial creativity.

(vii) Also, LR plays a dynamic part in the improvement and development of a comfortable environment for inhabitants and the environmental landscape. It also contributes to the economic advancement and development of industrial locations such as mining locations.

(viii) Innovative processes such as the utilization of NTech or/and BNTech machinery together with the use of AI and IoT for the monitoring and management of the emergence and challenges in LR processes such as nanobiosensor mechanisms are therefore essential and need to be explored, developed, and advanced. NTech or/and BNTech promise innovation in improving our current appalling nutritional efficiency through nanoformulation of manures and fertilizers and breaking nutritional quality barriers through BNTech (nanobiosensors mechanisms in particular), observation and management of disease and pests, understanding the machinery of host-parasite relations at the molecular level, growth of novel-generation pesticides and nonviolent carriers, protection, and packaging of evolving our understanding of the hypothetical fundamentals of agricultural and environmental systems, combined with the application of forward-thinking concepts, models, and/or theories such as chaos and string theory, may open up new avenues.

(ix) Material science, as well as its fabrication and machinery, necessitates systematic understanding of material science, as well as knowledge of agricultural and environmental systems. The precision of this encounter could possibly attract vivid minds to work in the agricultural sector since the emergence and challenges of LR, as well as other environmentally challenging issues, are mitigated. It could still take a couple of years for NTech/BNTech in the agricultural and environmental domains to move to a more advanced level, especially since it has to evade the drawbacks experienced with bionanotechnology (nanobiosensor mechanisms). For this to materialise, continuous funding and consideration by researchers and policy developers, together with practical prospects, would be critical for this promising and emerging field to blossom.

(x) The application of geospatial technology together with fuzzy AHP approaches in LD as well as the reclamation processes of land is also an area that requires advancement, such as RS procedures and fields measurements.

(xi) Conclusively, it is recommended that imminent research studies on LR procedures should place more prominence on developing eco-friendly (less harmful), more operative, cost-effective, and increasingly ecological techniques such as the ones involving NTech/BNTech, especially the nanobiosensor mechanisms together with the use of AI and IoT as well as RS, GIS, FCE, and FAHP approaches.

(xii) The government and relevant stakeholders, as well as researchers, should put in place evidence-based and action-oriented policy frameworks for the management and mitigation of the dilapidation of land.

(xiii) Correspondingly, incessant prospects for imminent studies and the establishment of the theoretical route as well as the systematic foundation for the application of eco-friendly techniques and measures in LR procedures should be reinvigorated.

Abbreviations

AES: Agricultural and environmental sustainability
AI: Artificial Intelligence
BNTech: Bionanotechnology
EO: Earth Observations
FAHP: Fuzzy analytical hierarchy process
FCE: Fuzzy comprehensive evaluation
GDS: Global datasets
IoT: Internet of Things
LD: Land degradation
LR: Land reclamation
NM: Nanomaterial
NTech: Nanotechnology
RS: Remote sensing
GIS: Geographic information systems
SDGs: Sustainable Development Goals.

Data Availability

Completely, data produced or investigated during this work are available in this submitted paper.

Disclosure

Kingsley Eghonghon Ukhurebor is the submitting author of this article.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors' Contributions

All authors contributed significantly to this review study.

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