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Exploratory Review of Urban Expansion, Coastal Vegetation Environments (CVEs) and the Paradox of Sustainability

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ABSTRACT Vegetation forms a fundamental proportion of resources used to determine the potential of the land on which they are sustained, unfortunately, urbanization has altered ecological systems and coastal vegetation environments all over the world, and the conservation of the endangered resource is still a serious challenge. Further, urbanization around the coastal vegetation environments is expanding at unprecedented rate, and this has resulted into more people relocating to these areas. For example, urban expansion reduces coastal vegetation, soil moisture and quality, and invariably results in poverty. From the foregoing, there is need for constant monitoring of endangered coastal ecosystems. Therefore, this paper appraises the impact, relevance perspectives threats, and challenges of coastal vegetation resources on account of urban expansion. Also, major advances and key issues relating to coastal vegetation management, as well as recommendations are discussed so as to help move the field forward.

INTRODUCTION

Coastal vegetation is core in ecosystem functioning and biodiversity enhancement (Brockerhoff 2017). These ecological systems rank amongst the most significant worldwide, providing several ecosystem goods and services which are central to the welfare of mankind (Adekola and Mitchell 2011), and these include the protection of the coastal ecosystem , improvement of water quality, biodiversity support, fishery nurseries, etc. Further, CVEs provide ecosystem services which relate to local climate mitigation, regulation and adaptation, food security (such as habitat provision, food supply and nurseries for seedlings and fisheries), occupational security, and an array of social/traditional benefits, scientific knowledge, ecotourism, recreation, as well as the preservation/development of spiritual and cultural values. Inspite of all these merits derived from coastal vegetation environments, ecosystem degradation and biodiversity loss, which greatly undermines the life's foundations is the abysmal phenomenon is experienced in CVEs (UNDP 2012). A great challenge to humanity, most especially the world's poor is the loss of biodiversity and ecosystems. It is stated in literature that over 1.1 billion humans live on less than US$ 1 daily (UNSDSN 2013; FAO 2017), and they hinge directly on coastal vegetation environments for their feeding, energy needs, shelter and medical requirements, as well as ecosystem goods and services so as to sustain their livelihood (Rego 2018). Consequently, at present, over fifty percent of the world's population (that is over 3 billion inhabitants) reside around 100 km radius of a coast, which is less than 20 percent of all landmass (UNEP 2016). Also, it is assessed that over 450 million people live around the coastal zones in Sub-Saharan Africa (Sale et al. 2014). It is also epitomized in literature that pressure resulting from anthropogenic factors in and around coastal vegetation environments (CVEs) has greatly sustained threat to vegetation, wildlife as well as economically important micro-organic resources in most developing societies, South Africa inclusive (Food and Agriculture Organization 2011; Amosu 2012). It is also elucidated in literature that the coastal environment, is the harbinger of biodiversity, as well as economic activities and leisure (Amosu 2012). For instance in South Africa, the native CVEs play germane roles regarding the stabili-

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zation of landscape against wind erosion, in addition to providing wildlife habitation. Further, CVEs play a critical role in the global sequestration of carbon that would otherwise remain as atmospheric CO_2 and exacerbate climate change (Laffoley 2009; Ñellemann 2009). These ecosystems sequester carbon, and this has culminated in improved research efforts in carbon sequestration and carbon dynamics over time (Mcleod 2011). Hence, it is imperative to restore and protect these endangered and highly fragile ecosystems, on account of the innumerable benefits accruing from the all-important, but highly threatened environment (Olatoye 2019).

All over the world, it is found that rapid urbanization is a consequence of population growth. Haub (2011) opined that the human population all over the world has rapidly increased to about 7 billion people by the year 2012, and this is further projected that by year 2024, human population will not be less than 8 billion, and over 9 billion by the year 2043, with over half of these population figures living around coastal environments. As part of this development, coastal cities in the developing economies have undergone rapid urban expansion (Azadi 2011) and this has consequently culminated in tremendous burden on land use/land cover (LULC) from both unintended and unrestrained alterations (Kumar 2016). Additionally, undue pressure on ecological systems have resulted in urban sprawl in most metropolitan areas, (Laprise 2016) contributing to environmental change on the global scene (Wu 2014). Significant land use and land cover changes thus occurs in coastal cities, with population rise projected to more than 32 percent between 2015 and 2030 (Merkens 2016). These coastal cities perform important logistic, production and governance roles within the communities and regions they are found (Wei and Ye 2014). It is also projected that coastal cities have great impact on the future economic advancement of countries and larger geographic areas of the world (Roberts 2014).

Various definitions have been provided for the definition of urbanization in literature. From the foregoing, an urban space (such as a metropolitan area, city or town) has been diversely defined by city administrators and the academia in terms of population density, total population size, and built-up surface areas or structures (Wu 2014). Further, the preponderance of built-up infrastructures, high population density, wide-ranging impervious surfaces, air pollution, altered conditions of climate and hydrology, as well as altered ecological system function and services permeate urban environments. Nevertheless, it is impracticable to epitomize all the core features and components of urban areas into one definition. Basically, the two most important factors that satisfactorily defines urban areas are extensive built-up areas and high human population. Fundamentally, these two factors directly or indirectly define the key ecological and environmental characteristics of urban systems (Wu 2014). Urban coastal vegetation helps to regulate temperature, also providing natural filter and noise absorbing functions. CVEs also improves the aesthetic and physical quality of natural resources as well as micro-climatic conditions (Patarkalashvili 2017). CVEs also promote improved value of life of urban dwellers on account of the delivery of several ecosystem goods and services, thereby enhancing physical, mental and social health, as well as improving the urban environment in general (Nesbitt 2017). Despite these innumerable merits of CVEs, little has been done to protect this fragile ecosystem, hence, the need for constant monitoring of land use and land cover changes in CVEs (Peng 2017). Thus, in order to fulfil the goals of a smart coastal city, the preponderance of illegal, unintended and arbitrary urban development to the detriment of natural coastal vegetation must be checked and the strategic development frameworks have to be strictly implemented by all stakeholders.

On account of population pressure around coastal cities, it is therefore imperative to conserve and safeguard coastal vegetation across the world, as well as ensuring that ecosystem services and biodiversity function at optimum levels (Maskell et al. 2013; Sandifer et al. 2015). Despite the declining state of the world's vegetation over the years, Barbier (2015) elucidates that millions of poor people live on coastal vegetation resources (CVEs), as well as sustaining the livelihood of over 2,500 native cultures. Additionally, FAO (2016) projected that over 2 billion people, (Not less than 40% of the population of developing countries), depend on fuel-

wood for domestic purposes. To this end, it is therefore imperative to provide substitute energy sources, as well as the need to monitor and conserve CVEs so as to ensure ecosystem functioning and provisioning sustainability (Sandifer 2015). This will also ensure that the negative effects of urbanization are mitigated, in addition to reducing the harmful effects of climate change (Keenan 2015; Ibrahim et al. 2016). Besides the conservation of biodiversity, other numerous environmental functions and services are derivable from CVEs (Elmqvist et al. 2015), these include reduced soil erosion, flood and desertification control, sequestration of carbon, water supply (Adhikari 2016) and beautification of CVEs (FAO 2016). This paper therefore makes a clarion call for continued research to be undertaken, in addition to consistent monitoring and conserving our fragile CVEs, with the aim of achieving optimum functioning and service delivery of CVEs (Martinez-Harms 2015).

Aim of Study

This study aims at reviewing the challenges of urban expansion, conservation of coastal vegetation environments and the paradox of sustainability.

Urban Sustainability

This concept, as defined by Huang (2015) is the notion that urban centres can be structured without undue dependence on neighboring areas and can be self-sufficient with their utilization of renewable sources of energy. The aim of this is to create the minimum possible ecological footprint which results in the generation of the lowest quantity of pollution possible by ensuring efficient land usage, use of compost materials, conversion of waste to useful sources of energy, and to greatly reduce the challenges of climate change and global warming. As indicated in the Brundtland Report (2010), sustainable urban development ensures the synchronization and enhancement of resource utilization, institutional transformation, technological development and properly channeled and well-managed investments, so as to meet both current and future requirements of man. It is also estimated by Siemens (2018) that no less than fifty percent of the world's human population are urban dwellers, a population that will escalate to 70 percent by the year 2050. This will consequently impact both the urban inhabitants and the environment (Kotsoni et al. 2017).

Merits of Coastal Vegetation

The regulation of urban climate and conservation of biodiversity are key ecological provisions of coastal vegetation environments (Haq 2011). It is also observed in literature that in comparison to rural areas, cities experience varying intensities of precipitation and temperature on account of urbanization (Tan et al. 2010; Wu 2014) resulting in urban heat islands due to the high energy use, as well as heat absorbing surfaces in coastal environments (Stone et al. 2010; Stewart and Oke 2012; Zhou et al. 2013). Therefore, sustained coastal vegetation conservation practices and monitoring can help to salvage the situation (Malavasi 2016). Seinfield (2012) opined that chemical, biological and particulate materials are known to be key pollutants in CVEs, and these exist in either solid, liquid or gaseous states. Further, urban environments have being at the receiving end of air and noise pollution from vehicles and industries (Haq 2011) and these are very harmful to the existence of man and environment (Rojas-Rueda et al. 2011; Dewan et al. 2012). From the foregoing, the harmful tendencies of air pollution can be reduced by conserving ecosystems in coastal urban areas (Niemela 2010). It has also been revealed through research that air pollution can be filtered for more than 70 percent in CVEs (Hausmann 2016). Noise pollution on the other hand, is a common phenomenon in urban areas, and this can create health problems for urban dwellers (Gomez-Baggethun 2013). For example, the overall cost implication of noise in European Union have been estimated to be between 0.5 percent - 2 percent of Gross Domestic Product. Consequently, it is advised that coastal vegetation spaces in urban ecological systems should be conserved, so as to achieve environmentally viable economies (Huang 2009). Another major merit of coastal vegetation is that they are centres for conservation and quality control for flora, fauna, water and soil quality (Sandilyan and Kathiresan 2012). Also, CVEs perform a key role of connecting urban and rural areas with the

natural biosphere (Benedict and McMahon 2012). Therefore, in order to ensure sustainability and self-sufficiency of urban landscapes, a functional network of CVEs should be priority to urban planners and ecologists (Lennon 2014). It has also been observed in literature that energy costs of cooling buildings in built-up areas can be achieved with the establishment of CVEs. This is due to the fact that CVEs improve aeration, act as shelterbelts, and ensure evapotranspiration (Almusaed and Almssad 2012). CVEs also provide cooling effects and help to lower air temperatures. Also, Weber and Shah (2011) elucidates that an increase in vegetal cover by about 10 percent is prerequisite to the reduced energy requirements for cooling and heating.

The viewpoint that human populations all over the world are generally attracted to coastal city areas with robust greenery cannot be overemphasized. For example, the vegetation of the Amazon Basins was a key factor that enticed foreign investors who greatly assisted in the rapid economic emancipation of the area (Dieleman and Hemming 2009). It is also believed, as stated by Gomez-Baggethun (2013) that biodiverse resources in CVEs increase financial earnings and property values of between 5 percent and 15 percent. On account of the high preponderance of residences, industries, academic and military infrastructure that parades the coastal cities, they have become centres of rapid socioeconomic development on the African continent (Adelekan 2010). Also, findings by Jorgensen and Gobster (2010) show that in the United Kingdom, over 80 percent of her population live in urban centres, and thus CVEs within urban areas offer sustainable outdoor recreational services as well as providing emotional warmth (Jorgensen and Gobster 2010).

Haq (2011) revealed in his study that stress levels are less in CVEs as compared to the urban areas. In the same vein, patients in hospitals that are adjacent to CVEs have 10 percent faster rate of recuperation, as likened to patients who stay in rooms that are adjacent to building walls. Based on this premise therefore, ecologists, environmentalists and health managers recommend the establishment of protected green areas in coastal urban centres, so as to promote the physical and mental wellbeing of urban dwellers (Pataki et al. 2017; Kothencz et al. 2017). Certainly, improved air quality, which culminates into healthier respiratory systems is achieved in CVEs (Ghorani-Azam et al. 2016). It is therefore opined that there should be greater levels of connection between human populations and natural environments, so as to enhance work productivity, human health and recreation.

Theoretical Framework for this Study

Various theories exist in relation to coastal vegetation management and conservation in literature. These include Urban Green sustainability (UGS) Theory, Environmental Impact Assessment Theory, the Ecosystem Adaptive Theory, and the Urban Floristic Change Theory. For this study, the Urban Green Sustainability (UGS) Theory is adopted .The theory refers to the linkage of natural and semi-natural areas, as well as vegetation environments in rural and urban, terrestrial and coastal climes (Naumann 2011; Konau 2016). It is an all-encompassing theory which incorporates natural phenomena, such as costal vegetation reserves, green estates, forest reserves, hedgerows, revamped and intact wetlands as well as man-made phenomena, such as cycle paths and eco-ducts (Naumann 2011; Konau 2016). The aim of UGS is to promote healthy, buoyant, resilient and diverse ecological systems for the purpose of ensuring biodiversity conservation and ecosystem services enhancement (Naumann 2011). Ecosystem services are germane to ensuring the sustainability of both man and environment (Sandifer et al. 2015). In addition, European Union (2010), Naumann (2011) postulated that UGS also categorizes multi-functional zones and integrates ecological system renewal measures into land-use policies and plans so as to ensure integrated and cohesive spatial development. Consequently, the UGS Theory will help to buttress the significance of urban CVE conservation and management. Hence, UGS as serves as a guide in the conservation and management of urban CVEs, as well as providing a holistic conceptualization of plant ecology (Vogt et al. 2013). From the foregoing, examples of research efforts on the management of CVEs is presented in the Table 1.

Table 1: Literature on coastal vegetation management

Authors	*Topic*	*Source of publication*
Rapinel 2014	Mapping and Identifying natural coastal vegetation using Worldview-2 satellite imagery	Journal of Environmental Management (Elsevier)
Giri 2014	Distribution and dynamics of mangrove forests of South Asia	Journal of Environmental Management, 148: 101-111.
Rapinel 2015	Mapping of combinations of marshland vegetation with the Use of bi-Seasonal Landsat-8 Imagery	Journal of the Society of Wetland Scientists (Springer)
Schael 2015	Ephemeral wetlands of the Nelson Mandela Bay Metropolitan area: classification, biodiversity and management implications.	South Africa water Research Commission
Hague 2016	Use of Remote Sensing to Map and Monitor Coastal Dune Vegetation Change at Southampton, Ontario, Canada.	Graduate Program in Sustainability Science and Society Brock University Ontario, Canada
Jana 2016	Seasonal change monitoring and mapping of coastal vegetation types along Midnapur-Balasore Coast, Bay of Bengal using multi-temporal Landsat data	Model. Earth Syst. Environ. Journal (Springer)
Mbolambi 2016	Remote Sensing Assessment of Degradation of Coastal Vegetation in False Bay, South Africa	Dissertation submitted to the University of Stellenbosch

MATERIAL AND METHODS

This study reviewed relevant literature (ranging from 2009 to 2019) on related, cognate and broader issues pertaining to urban expansion, coastal vegetation environments and ecosystems conservation, which were sourced from research articles, books as well as journal publications, and these databases helped in providing vivid and meticulous information which were very useful in the course of this study. Additionally, the theoretical framework (which is the Urban Green Sustainability Theory) underpins the conceptualization of the crux of this study.

Threat to CVEs from Urban Expansion

All over the world, urban expansion poses as constant threat to CVEs (Cetin 2016). For instance, UNDP (2010) explained that sporadic human population growth all over the world wields undue pressure, thereby hampering habitat health, composition and diversity, as humans gradually exhaust vegetal resources so as to meet their own needs, urbanization inclusive. Urbanization is a resultant effect of uncontrolled population with inadequate resources, and this has compelled South Africa to embrace sustainable industrial activities and subsequently providing for their country's ever-increasing demands (Kalumba et al. 2017). Also, resources in CVEs are being depleted every second for the purpose of constructing roads, rail, houses, cities, public infrastructure and dams (Su et al. 2011; Adinkrah-Appiah et al. 2015). Other urban expansion activities include draining wetlands, mining of fossil fuels, deforestation (Wiens et al. 2009), thereby resulting in the introduction of exotic and invasive flora species, as well as overgrazing of savannas (FAO 2016). All of these anthropogenic actions make the biosphere more comfortable for man at the detriment of species biodiversity in general (Adinkrah-Appiah et al. 2015), which destroys the habitat and nutrition sources for numerous flora and fauna species (Baker et al. 2012; Goudie 2018), which are essential to human survival (Goudie 2013).

According to Population Action International (2011), urbanization is a major challenge resulting in population pressure affecting advanced economies such as Norway, Germany and Britain. Further, in the USA, there is a positive relationship between degradation of CVEs and proliferation of cultivated land (Atapattu

and Kodituwakku 2009). Also, Chakravarty et al. (2011); Pendleton et al. (2012) postulated that all over the world, more than half a hectare of coastal vegetation is lost to other land use types as every second counts. One of the impending jeopardies of decreasing habitat loss is that species will go extinct on earth and fragile ecosystems, such as the CVEs will be the worst hit (Sandifer et al. 2015). Urbanization leads to increased demand and consumption of resources in CVEs, in addition to escalating the demand for food and energy, which inevitably increases the degradation our fragile CVEs (UN World Economic & Social Survey 2013; Kalu et al. 2014). It is evident from literature that degradation of CVEs will negatively affect both deprived and advanced economies. It should also be noted that the degradation of CVEs exacerbates poverty, decreases labor efficiency and output, thereby worsening current socio-economic challenges all over the world (Ahmad 2014). It is unfortunate that it is the deprived nations will that will be most affected, since they depend greatly upon nature for their means of livelihood and survival (Rands et al. 2010).

OBSERVATIONS AND DISCUSSION

The State of Urbanization and Sustainability of Coastal Vegetation Environments (CVEs)

CVEs are fragile ecological systems which necessitates continuous conservation and monitoring in order to ensure sustainability, because CVEs don't only sustain high biodiversity and productivity (Lefcheck et al. 2015), they are also storehouses of nutrients and sediments, thereby preventing soil erosion and ensuring soil stabilization (Scott et al. 2014). Further, Andersson and D'Souza (2014) stated that CVEs provide nutrition benefits and means of livelihood for the human populations that live around them. All over the world, loss of coastal vegetal cover is triggered by both anthropogenic and/or naturally occurring factors, urbanization inclusive (Rosenzweig 2014). In order to meet the demands from increasing populations in urban societies therefore, a paradoxical phenomenon exemplifying the need for urban development and the necessity for conservation of CVEs thereby arises, and as a result, more urban spaces are required in this regard. Consequently, this has led to the encroachment on CVEs, so as to meet up with the rising demands of urbanization. Urban expansion has been found to jeopardize these natural CVEs (Neumann et al. 2015), by causing vegetation loss, coastal degradation, erosion, climate change and global warming, just to mention a few (Barbier 2015), These factors have a colossal impact on CVEs and their surrounding communities thereby resulting in air and environmental pollution (FAO 2012; Kotsoni et al. 2017). From the foregoing, this research paper seeks to bring to the awareness of stakeholders on the uncontrolled threat to CVEs resulting from uncontrolled urban expansion, and hence there is need to asses, monitor and protect our threatened, fragile and endangered coastal vegetation resources from extinction (Pimm et al. 2015; Sexton et al. 2016).

The Quest for Sustainability Regarding Coastal Vegetation Conservation and Urban Development

Several literature on the management of CVEs advocate for a paradigm that is hinged on sustainability (Porter et al. 2013). Also, the relevance of ecological system services to human well-being has been over-emphasized in several studies on urban coastal ecology (Wortley et al. 2013; Standish et al. 2014; Albert et al. 2014). Further, ecologists have made clarion calls pertaining to the sustainability, conservation and protection of CVEs on one hand, and urban development on the other (Gaston 2013; Ramalho et al. 2014). While urbanization is viewed by geographers and urban managers from the perspectives of landscape development, environmentalists and ecologists on the other hand underscore the need to conserve CVEs in a changing urbanized setting (Standish et al. 2014, by providing a common platform (in this case, the landscape) intended for conservationists, geographers, planners, scientists, and engineers to function together so as to ensure an optimum society where man and nature can both flourish over time.

CONCLUSION

This paper focused on the review of relevant literature pertaining to urban expansion and

conservation of coastal vegetation environments, and conforms to the reviewed literature by scholars that have been quoted in this research, which also guided the author in the course of this present study. The aim of this research is to offer an understanding of the impacts of urbanization to the coastal environment, so as to enhance the management and conservation of the rare and endemic species of vegetation, as well as conserve the fragile ecosystem around the coastline. The literature used in this paper emphasized the germaness of CVEs, as well as the need to conserve the greatly endangered resources, which were organized thematically using themes gleaned from the Urban Green Sustainability (UGS) theory and the broader aspects of this study.

Urban expansion is the consequence of socioeconomic development, and it is manifested through the physical development of urban environments. The rapid growth in global urbanization results in multifaceted landscape changes, which further culminates in the altering of environmental systems, as well as CVEs structure and functioning. Also, significant environmental challenges such as climate change and global warming which is witnessed all over the world today is as a result of increased energy consumption levels in urban areas. From the foregoing, the environmental pollutants that are released on account of exacerbated deforestation levels, energy consumption and environmental degradation in urban areas pose negative implications on human health and well-being. Also, increases in built-up areas significantly alter urban soil microbial and hydrological activities, and consequentially raising budgets devoted to land surface radiation. The uncontrolled incursion of urban expansion into CVEs thereby reduces the efficiency, functioning and output of ecosystem biodiversity. It is therefore imperative to control urban expansion in its totality, and ensure that sustainable urban development policies are entrenched in constitutions at local, regional and national scales. Finally, the evolution taking place in the CVEs and urban societies at large continues unabated. Our future cities will depict our decisions, values and interests, and ultimately, as our actions on the ecosystem will consequentially determine the fate of the human, flora and fauna species. Therefore, urban expansion has to embrace the sustainability of ecological systems in scientific practice and as its ultimate goal.

RECOMMENDATIONS

This study proffers specific recommendations on how to ensure sustainability regarding urban expansion vis-à-vis conservation of CVEs, hence, the following recommendations are made:

Policy makers should ensure that Environmental Impact Assessment (EIA) reports are carried out as part of the necessary conditions for awarding contracts for spatial development most especially around coastal ecosystems. Further, it is germane to invest in the preservation of healthy ecosystems, therefore, preserving and/or restoring ecological systems in coastal ecosystems is sine-qua-non to decrease risks of environmental degradation. Further, adaptation options, which are ecosystem-friendly, could be utilized in the reduction of the negative effects of climate change on vegetal resources, so as to achieve optimum delivery of ecosystem services and intensify the resilience of coastal ecosystems to the adverse effects of climate change.

Furthermore, the improvement of conservation strategies and communal ventures aimed at proffering innovative solutions to environmental challenges in CVEs should be greatly considered. From the foregoing, it is imperative for stakeholders such as environmentalists, ecologists, policy makers, urban planners, city managers and coastal community dwellers to ensure optimal protection, restoration and reclamation of vegetal lands as well as the protection of vulnerable and endangered species. It is also imperative to state that the organizations driving conservation issues in CVEs should be fully funded with adequate infrastructure, human and material resources, grants as well as conducive working environment to expedite their ecosystem conservation roles. Hence, there is need for conservation units to fully operationalize their roles as a separate entity, as divergent from being a microcosm of another planning establishment. Furthermore, the need to enhance promulgation and expedition of programmes that conform to green infrastructure strategies is essential because of the fact that green spaces are

known to greatly improve human health and wellbeing. Also, there should be holistic management of all aspects of coastal vegetation management through firm articulation and effective implementation of coastal management laws, which are geared towards sustainably planned and controlled urban development. Also, the use of satellite monitoring is proffered so as to have current updates on CVEs. Finally, there must be strict prohibition regarding the influence of anthropogenic factors such as deforestation and selective logging in CVEs. Finally, it is recommended that afforestation and reforestation projects should be greatly encouraged in degraded and/or deforested areas.

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