CHAPTER 2: Environment Systems Analysis for Human Settlements Establishment and Management

Abstract

The vulnerability of human settlements to climatic and environmental changes has recently increased. Most cities in developing countries are poorly prepared to counter crises and disasters. Due to poor resilience and preparedness, most people are being displaced from their settlements each time a disaster appears. Weak institutions existing in many cities have continued to resort to post-crisis planning and do not consider the need for futuristic planning that ensures community resilience before a disaster. There seems to be a competitive relationship between human settlements and the natural environment. Where the environment has not been considered of uttermost importance, human activities destroy the vibrancy of nature yet, humans depend on nature for their survival. Thus, the study explores environmental systems analysis as an imperative tool for enhancing human settlements viability. The chapter uses desktop research using literature document review to establish the relationship existing between human settlements and the environment.

INTRODUCTION

Environmental systems analysis has one of the most recommendable approaches to effective and sustainable settlement establishment and management. Before the development of a settlement, environmental analysis should be affront. Moberg (1999) highlights that environment analysis incorporates various tools including 'environmental impact assessment' (EIA), 'strategic environmental assessment' (SEA) and cost-benefit analysis (CBA). These tools facilitate assessing environmental impacts from a certain system, e.g. a project (Noviks, 2015). The vulnerability of human settlements to climatic and environmental changes has recently increased, calling for more assessments to ensure human safety. The UNHABITAT (2010) argues that most cities in developing countries are poorly prepared to counter crises and disasters. Due to poor resilience and preparedness, most people are displaced from their settlements after every disaster. As observed by the UNHABITAT (*ibid.*), weak institutions existing in many cities have continued to resort to post-crisis planning and do not

consider the need for futuristic planning that ensures community resilience before a disaster. Environmental analysis and planning lack prior development and this results in the siting of many informal settlements in disastrous and vulnerable areas due to unsustainable settlement planning. Understanding the concepts of the environment in settlement development helps in land-use planning before disasters occur. The UNHABITAT (*ibid.*) denotes that poor governance in many urban centres with obsolete master plans, worsen the vulnerability of human settlements to environmental hazards.

Human settlements have been established without much focus on the importance of environmental processes. There seems to be a competitive relationship between human settlements and the natural environment. Where the environment has not been considered of uttermost importance, human activities destroy the vibrancy of nature, yet humans depend on nature for their survival. Thus, the chapter explores environmental systems analysis as an imperative tool for enhancing human settlements viability. The study uses a desktop research analysis using literature and policy documents to ascertain the relationship existing between human settlements and the environment.

BACKGROUND AND OVERVIEW

Population increases in urban areas have seen massive expansion beyond city boundaries, consuming natural rural land. Winchester (2005) reveals that urban governments are challenged with balancing the habitability and functionality conditions favourable in many poor regions. Most of the poorly planned informal settlements in cities face imminent climatic and environmental challenges including landslides and flooding. Such settlements have very limited resources to withstand the pressures due to substandard dwelling units and poor infrastructural developments to enhance their resilience (UNHABITAT, 2019). Due to poor resilience and preparedness, most people are being displaced from their settlements at every disaster occurrence. Understanding the concepts of the environment in settlement development provides an alternative to land-use planning before disasters occur. Thus, the urgent need for environmental systems analysis and approach in settlement planning is imperative.

Environmental systems analysis provides better means to manage settlements effectively in a favourable manner for the environment.

Failure to recognise the importance of environmental analyses poses many threats to the environment that affects humans and their settlements. The environment is multifactorial in nature, making it a complex web. Noviks (2015) denotes that the environment is composed of natural (biosphere) and artificial (technogenic sphere) systems existing in the same space, thus creating a complex system. The autonomous and heterogeneous elements with no unitary control make up a complex system. The interactions of such components demand the application of an environmental systems analysis that focuses on communicating, simulating and analysing complex environmental challenges. Environment analysis improves decision making by analysing the environmental impacts of various anthropogenic activities (Moberg, 1999).

The development of settlements should not be focused on the general development of the built environment but on sustainable environmental planning that promotes responsive built environments (Allen, 2003). Human settlement establishment focus should be placed on the physical aspects alone. USAID (2020) defines a settlement as a place for human habitation that ensures people meet their sociocultural, eco-political and environmental needs. All these facets bring in complex challenges that need a comprehensive systems analysis to bring sustainable solutions. While cities are regarded as engines of economic prosperity for nations, it is imperative to note that cities drive climate change and disturbances and are vulnerable to consequences thereof (UNHABITAT, 2019). Some of the settlement challenges result from high urbanisation and frequent natural disasters causing human displacement. When the environmental analysis is carried out efficiently, resilient and well-equipped settlements are developed. Effective settlement management relies on the availability of environmental knowledge acquired by residents through continued learning and capacity building (UNFCCC, 2017).

CONCEPTUAL FRAMEWORK

Environment systems analysis on human settlements requires the understanding of the primary concepts of ‘environment, environment analysis and human settlement’ that build up the basis for the discussion.

Larsson and Assia (2019) define the environment as a representative of the natural ecosystem, including flora and fauna covering such

elements with their inter-relationship and complexity forming the conditions suitable for humans. An environment is the total of all surroundings of a living organism. This includes natural forces and other living things that provide conditions for growth and development (Shamim, 2016). The study of the environment balances the components of biota and abiotic components (Gallopin, 2008). Humanity depends on the biosphere for support as it involves various ecosystem processes that enhance ecological interactions. Due to population increase, the natural environment has been encountering challenges from human activities that lead to pollution and degradation. Gallopin (*ibid.*) reveals that man's efforts for economic survival have led to the ecosystem and ecological disturbances. Such modifications of the environment speed up climatic changes that affect humanity (Shamim, 2016).

A system is a group of different components that are interconnected and work together as a complex whole. It encompasses a set of controlling principles that influence various actions (*ibid.*). An environmental system thus shows the interrelationship and interconnectivity among different components such as landscape and drainage factors. When the existing relationships are determined, it becomes easier to note the possible impacts that can arise from the interactions (Sydow, 2017). There are various types of environmental systems and these include the cascading systems where elements are connected by flows such as the hydrological and solar systems. The concept of environmental systems is understood from two basic elements of 'behaviour' (how responsive environmental components are to a given disturbance) and 'environmental unity' (the interconnectedness of environmental elements) (Leguizamon, 1975). The existence of various components and their interactions results in a complex web that requires a systems approach and thinking to understand components' interactions and interdependence. As observed by Sydow (2017), understanding systems operations helps to analyse the existing complexity in the interaction of different parts bringing transparency.

The UNHABITAT (2019) defines a human settlement as a town or city where people work and live. Human settlements are as the study of how humans utilise natural resources, their population patterns and growth (*ibid.*). The main thrust of settlement geography is to understand and appreciate human sustenance within a specific

geographical location. Human settlements are clusters of population dwellings of different sizes. Thus, for sustainable habitation and safety, humans erect dwelling structures. Balasubramanian (2015) highlights that settlement planning involves a grouping of people by providing specific territories from hamlets to large metropolitan cities. As settlement size grows, the economic and ecological characteristics of an area changes. Settlements vary in sizes and defining characteristics with sparsely populated and small settlements termed villages whose primary economic activities involve agriculture (UNHABITAT, 2019). Those with fast-paced growth and dense population are urban settlements that depend highly on manufacturing and service industries for their livelihoods (Balasubramanian, 2015).

CLIMATOLOGY AND HUMAN SETTLEMENTS

Climate change impacts including severe floods and droughts, are affecting most settlements located in vulnerable areas. The UNHABITAT (2019) reveals that most settlements are located close to seaports and other vulnerable areas as people are drawn by economic opportunities presented by the regions regardless of their lack of resilience to climate impacts. As observed by McBean and Ajibade (2009), many settlements and urban centres are situated along cyclone paths that cause substantial destruction each time cyclones occur. Climate change impacts are contributing to the loss of life, property and livelihoods in many human settlements. Sea-level rises have been affecting Alaska and some islands such as Tuvalu, and people have been forced to migrate to New Zealand and Australia for safety (*ibid.*). Climate change impacts are among the factors that cause displacements and migration of people from their settlements (UNHABITAT, 2019).

Urban settlements are also affected by the urban heat island effect that makes the areas warmer compared to surrounding rural areas due to the tarmac surface developments in the cities (*ibid.*). This results in a continuous occurrence of heatwaves. Climate sensitive planning is of huge importance in the management and design of settlements. Poorly planned informal settlements and slums experience severe challenges resulting from their physical location, poor economic vibrancy, poverty and institutional marginalisation due to their non-recognition. This results in poor risk-reduction and resilient measures against climate change impacts. All climate change challenges continue to recur, demanding a better approach to managing and developing settlements

in a more resilient manner that promotes human safety and livelihood protection.

The poor location of human settlements exposes inhabitants to disastrous challenges. Urban centres face contesting issues of trying to protect the sensitive environment, solving housing shortages and ensuring human safety. In the end, decisions that favour the majority vote of housing provision gains popularity regardless of the possible dangers. Such is the case that faced Bolivia. As observed by the UNHCR (2015), Bolivia La Paz has an estimated population of 1.6 million and has 70% of the houses built in sensitive areas that experience recurrent flooding. It is important to note that the decision to relocate people is difficult and costly but unavoidable when the consequences are fatal. As such, environmental analyses need to be carried out before settlement establishment. The UNHCR (*ibid.*) reveals that the municipality of Bolivia La Paz developed a monitoring tool to ascertain unsafe settlements and evacuate the families to temporary but safe shelters. The timely evacuation saved the lives of the people as a landslide hit the high-risk areas and destroyed at least 5 000 houses. Natural hazards are a danger to settlement sustainability and an important issue to consider in planning to ensure human safety.

HYDROLOGY AND HUMAN SETTLEMENTS

Salas *et al*. (2014) explain that hydrology encompasses water movement, storage and occurrence in an earth system. With human interactions with the hydrological processes, the quality and quantity of water have been affected. The general process of water circulation has been heavily influenced by human activities (Salas *et al*., 2014). Gumindoga *et al*. (2014) argue that the continued rise in rural-urban migration in most developing countries has seen changes in the hydrological processes as urbanisation has influenced water resource management and planning. Some of the settlements are located very close to the ocean affecting the sustainability of their houses (UNHABITAT, 2019). Various measures can be put in place to counter drainage challenges. The UNHABITAT (*ibid.*) suggests the creation of containment basins, seepage drainage systems and runoff structures that comply with better adaptation principles. Climate change effects may worsen challenges experienced by the affected areas as they have impacts upon the hydrologic cycle.

Adual, Jewitt and Toucher (2017) recommend the need for carrying out impact assessments on the potential influence of land-use changes on the hydrological processes. Land-use changes and the development of hard tarmac surfaces have a huge contribution to hydrologic changes. After impact assessments, the Bonsa catchment in Ghana (1482 km^2) revealed that precipitation levels were affected by heavy human activities that modified hydrological activities. Deforestation is one of the major contributors to hydrological changes that affect stream flows (*ibid.*). Saint Louis is a city in Senegal with about 250 000 population size. As observed by the UNHABITAT (2019), it is situated in a wetland as it is an island surrounded by water. The city is vulnerable due to its location on the borders of the Senegal River estuary and faces massive erosions from the Atlantic Ocean (*ibid*.).

GEOLOGICAL AND GEOMORPHOLOGICAL ANALYSIS FOR HUMAN SETTLEMENTS

Price *et al*. (2011) regard humans as geological and geomorphological agents that affect landscape evolution from settlement, urbanisation and industrialisation. From the past, humans have modified the landscape, at first digging up rocks for sculpture instead of using loose materials. In the location of settlements, various factors are considered, including the geology of an area, economic and environmental factors. Various geological and geomorphological factors affect human settlements. Ballabh, Pillay and Hariram (2018) reveal that the Alakhanda River mountain watershed close to the Lesser Himalayas in India contains various geomorphic landforms and landscapes that affect construction activities in nearby settlements. The Himalayan areas often incur mass wasting and flash floods that affect settlement location.

Hajissani *et al*. (2011) allude that the increasing populations have resulted in high demand for settlement location and this requires the provision of infrastructural services such as water and sewerage tunnels. However, where geological factors do not allow, settlements are affected as there may be difficulties in controlling underground movements. Most human settlements are located in alluvium areas and this is the case with the Shiraz Subway tunnels in India (Ballabh, Pillay and Hariram, 2018). Geological factors are important to consider providing essential services such as water supplies. This often requires the drilling of boreholes and where the underground surface does not allow it, it becomes difficult. Also, some geological conditions allow for

the provision of building materials that enhance settlement development through building construction. As observed by Margottini and Spizzichino (2014), rock weathering tends to provide the much-needed sand and clay that is moulded into bricks for housing construction**.**

Earthquake occurrences are some of the geologically motivated hazards that affect many settlements, especially in earthquake-prone areas. Nepal and Haiti's settlements are situated in high-risk areas. The UNHCR (2015) reveals that an earthquake shook the central part of Nepal and affected the Pokhara and Kathmandu cities resulting in 8 786 deaths and 2.8 million people were left homeless. For Haiti, a high impact earthquake led to more than 200 000 deaths and a displacement of 1.5 million people. The devastating impacts of these disastrous earthquakes are worsened by poor planning and location of settlements that lead to high vulnerability (*ibid.*). Whenever natural hazards occur, the most affected areas are those informal settlements and slums and this poses serious expenses of relocating people to safer places, rather than provision of before disasters.

ECOLOGY AND HUMAN SETTLEMENTS

Environmental management is of huge importance to the protection of socio-economic and ecological functions in human settlements (Allen, 2003). Balasubramanian (2015) denotes that it is imperative for a specific approach that balances human-ecological processes in lightight of global warming and vulnerability. The planning of human settlements needs to be highly comprehensive, placing the needs of the human population at the front. Kustysheva (2017) emphasises the need to create favourable living conditions for people when planning settlements as this protects the proper functioning of ecological systems. It is imperative to appreciate that there is more to be considered in the planning of settlements than the basic industrial factors. Kustysheva (*ibid.*) highlights the need to encompass air quality and natural landscapes that enhance the protection of natural resources sustainably.

As observed by Shamim (2016), ecology is the study of human-nature interactions in an environment. Man is the steward of the natural environment with the intelligence to manage natural resources. Various methods are used in the management of the natural environment through policy development that enhances the maintenance of

ecological balance. The study of ecology promotes the sustainable management of natural resources to ensure a balance and not overexploitation (Preisendorfer and Diekmann, 2021). Curitiba in Brazil is one of the most common examples of cities that have witnessed a successful implementation of a local development plan that encompassed environmental, ecological and socio-cultural factors comprehensively (Winchester, 2005). The development plan for Curitiba emerged from a more visionary plan that produced the desired population density for specific and available land resources.

ROLE OF ENVIRONMENTAL PLANNING IN SETTLEMENTS ESTABLISHMENT AND MANAGEMENT

Environmental elements directly influence the way urban settlements operate and impact the level of safety for the population. This makes environmental planning an integral part of the effective management of human settlements. Kustysheva (2017) denotes that settlement planning and management should target the improvement of the ecological environment. Most cities experiencing climate disasters are often vulnerable due to initial consideration of environmental issues (*ibid.*). It is imperative to develop adaptive climate-resilient initiatives. The UNFCC (2017) recommends bringing nature to the cities as an essential means to enhance the urban environment. Environmental planning promotes the revitalisation and maintenance of nature sustainably within urban areas. The existence of vibrant environmental planning boards serves to create environmental policies that enhance the protection of the natural environment (Sadeghi and Khakzanf, 2016). It is the mandate of environmental planning to preserve the natural environment with the help of communities, either in rural or urban centres.

The continuous growth of urban settlements is an inevitable process that requires well planned and conscious environmental consideration. Although urbanisation brings various benefits such as better access to health and educational facilities, many disadvantages that affect the environment are inclusive, especially where there is a lack of proper planning. Sadeghi and Khakzanf (*ibid.*) denote the lack of ecologically sensitive areas in urban centres as natural landscapes and vegetation are destroyed to accommodate human settlements. Environmental problems seem to be solved better by bringing back the lost environmental look of the city. Vibrant and sustainable settlements require efficient environmental strategies that protect the settlements

from future environmental and climatic hazards (Lekwot *et al*., 2014). Environmental planning helps to solve environmental problems. However, the effectiveness of this demands the active participation of all communities from various settlements, as many of the challenges are human-induced.

As observed by Lekwot *et al*. (*ibid.*), environmental planning is a process that allows for participation and stakeholder interaction in finding solutions to environmental problems. This is a very interactive bottom-up approach making communities fully aware of the possible environmental impacts that may arise from mismanagement. There are contentions between humans and the natural environment as human economic activities fight against the thriving of the natural environment (Kustysheva, 2017). The scramble for economic prosperity leads to environmental degradation that is exacerbated by massive increases in human populations that see more expansion in human settlements. Environmental planning thus seems to be a solution to environmental protection. Lekwot *et al*. (2014) reveal that environmental planning is the modern way of organising ideas on effectively mobilising resources, taking action and tackling environmental and development issues. The process is flexible, interactive and dynamic, encompassing all environmental challenges. This makes it very imperative to adopt environmental planning in physical planning and development. Settlement planning should not be deemed necessary in the absence of environmental planning *(ibid.*).

- ***ENVIRONMENTAL IMPACT ASSESSMENT***

Environmental impact assessment (EIA) is one of the procedures taken before development takes place to ascertain damage or promotion to the natural ecosystem. The process, to be well effective, is done to ensure damage is avoided before any costs of development are incurred. As observed by Calgunner (1999), EIAs become an inventory procedure to ascertain whether the chosen location for a certain development is sustainable. EIAs ensure enhanced quality of life in a developed area and complements land use management sustainably. However, despite the relevance of EIAs to environmental protection, many developments have taken place without paying any attention to the sensitivity of the area, due to corruption in urban development and management. A lot of governments consider monetary profits more than the protection of the environment. As

observed by Lawrence (1992), EIA is a mandatory procedure to be taken before the development of any settlement.

- ***STRATEGIC IMPACT ASSESSMENT***

Strategic impact assessment (SIA) is another important pillar in environmental planning. As highlighted by Shepherd and Ortolano (1996), SIA analyses the impacts of environmental policies, programmes and plans to promote sustainable environmental planning and management. Through SIA, it is easier to blend in environmental plans and physical development plans as it weaves principles of sustainability into urban plans effectively. SIA is of uttermost importance to sustainable planning. As observed by Culguner (1999), SIA can be effectively blended into physical plans leading to considerations in settlement development. It also acts as a better way of implementing environmental plans, providing better institutional development and cooperation.

In the face of massive population growth and increasing urban challenges, environmental and settlement planning is inevitable towards the achievement of sustainable development. As climate change is taking its toll, resilient measures are needed for the urban environment. The UNHABITAT (2016) highlights that effective settlement and environmental planning contribute to solving water scarcity, biodiversity losses and the changes in the nitrogen cycle and such should be considered as planning issues. The safety of human populations is important and achieving that comes from well-planned environments. Climate change disasters require stricter planning and environmental considerations due to the uncertainties they pose on human habitations and the natural environment.

DISCUSSION

Population increases globally are said to be the contributing factor to environmental damage as human activities are harming the environment (Larsson and Assia, 2019). The nature of environmental challenges change over time and this is directly related to population activities. Most cities in developing countries are poorly prepared to counter crises and disaster. Due to poor resilience and preparedness, most people are being displaced from their settlements each time a disaster appears. As observed by the UNHABITAT (2010), weak institutions existing in many cities continue resorting to post-crisis planning and do not consider the need for futuristic planning that

ensures community resilience before the occurrence of a disaster. Environmental analysis and planning lack prior development and these result in many informal settlements being situated in disastrous and vulnerable areas due to unsustainable settlement planning (Noviks, 2015). Understanding the concepts of the environment in settlement development provides a briefing to land-use planning before disaster occurrence. The UNHABITAT (2010) denotes that poor governance in many urban centres with obsolete master plans, worsens the vulnerability of human settlements to environmental hazards.

The UNHABITAT (2019) recommends the need to carryout vulnerability assessments in human settlements that helps cities to monitor environmental management. The UNHCR (2015) reveals that there has been an increase in the rate of population displacement over the years with an estimated 1.6 million people displaced between the years 2000 and 2014 and 65.3 million as of 2015. Considering the increasing natural and environmental disasters occurring without resilient settlement development and management, more displacements are expected. This requires immediate action, including the appreciation of the importance of carrying out environmental assessments before and after settlement development. It is imperative to understand that shelter is a human right and that it is more than building walls and roofs. It is needless to say that many development officials consider this 'physical' structure with uttermost importance, rather than equalising it with the social and economic aspects.

Environment analysis provides various tools for site assessment including EIAs and SEAs (Moberg, 1999). When carried out efficiently, this helps to make informed decisions regarding the sustainability of the settlement location. However, due to the corrupt vices and bypassing of safety protocols regarding settlement establishment, a big number of development professionals consider only the economic value of development projects and less the potential hazards threatening the location. As observed by Noviks (2015), the huge costs incurred when carrying out environment analysis and the time-consuming nature of the processes, make many decision-makers bypass the evaluation stages and carry on with settlement development.

CONCLUSION AND FUTURE DIRECTION

Settlement planning and management require the need to verify plans in the field. Effective resource management is of importance to improve the vibrancy of human settlements. This includes the preservation of flora and fauna species, ecological corridors and wetlands. All planning should centre on improving human needs and should be people-centred. For recovering settlements, it is imperative to ensure recovery plans are formulated under the local context to ensure site-specific solutions. It is imperative to have a comprehensive understanding of the 'environment' in all its facets. The concept of 'environment' is multifaceted in that it is complex and the emanating challenges resulting from the interactions make it even difficult to solve except when the 'environment systems approach' is incorporated. Due to the increasing environmental hazards being worsened by climate change, improperly planned settlements become more vulnerable and this places even human lives in danger. Sustainable settlement planning places the safety of people at the front and as such should consider precautionary safety measures.

RECOMMENDATIONS

- Making environment analysis a mandatory procedure before the establishment of any settlement to improve decision-making.
- Ensure a high level of preparedness for all settlements, the presence of early warning and evacuation systems.
- Climate change adaptation strategies should be incorporated to improve housing conditions and environmental restoration.
- Improve capacity building in the management and preservation of the natural environment to enhance climate adaptation.