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PREFACE

Climate change is a global phenomenon that significantly disturbs urban life through occurrences such as urban flooding, resulting from extensive rainfall in the cities that are built up and consist mainly of concrete surfaces. The effects of climate change have been exacerbated by the urbanisation process in Africa's major cities and towns. It has dominated contemporary debates in urban planning and development practice. As towns and cities continue to grow and climatic conditions endure change, the urban landscape continues experiencing negative effects of climate stress. The effects of climate change are felt by the natural and built environment, but they are mostly felt by people who inhabit these environments and reap benefits from it. Effects of climate change impact and are costly on service delivery, provision of infrastructure, housing, health and livelihood of the urban citizens. On the other hand, major African cities contribute significantly to climate change due to urban emissions. Built-up areas that include buildings, surfaced roads and concrete driveways prevent precipitation and storm-water to percolate into the ground. Climate change has direct and indirect effects on urban temperatures, rainfall intensity, built infrastructure, energy or power, hydrology and flooding, habitats and biodiversity. Open spaces, parks and places, gardens and streets provide critical services to the urban ecosystem, biodiversity and quality of life for urban citizens.

The deliberate and conscious investment in policy and programmes that deal with climate change has been lagging in urban areas in Africa. The idea of developing urban infrastructure that adapts to climate change has not been fully exploited in African cities and towns. In most populated parts of major cities in Africa, the infrastructure is dilapidated and cannot adapt to climate change. Rapid urbanisation in Africa has reduced the capacities of major cities and towns to provide the required infrastructure and services that adapt to climate change. There has been a mismatch between existing urban infrastructure and population levels in major cities in Africa.

The major cities in Africa that include Nairobi, Harare, Kampala, Lusaka, Johannesburg, Kigali and Lagos, are confronted by urbanisation challenges owing largely to the rapid growth of urban population due to rural-urban migration. Sub-Saharan Africa has a huge annual urban population growth rate that is higher than Northern Africa. Sub-Saharan

Africa is predicted to experience excessive urbanisation in the following three decades. However, most of the urban population in Sub-Saharan Africa lives in slums with no access to safe water and sanitation such as Kibera, Khayelitsha and Kawangware. The urban citizens are left more exposed to the effects of climate change. The consequence of rapid urbanisation is land degradation since shacks and squatter settlements are constructed haphazardly using timber and dagga in an area without basic services. This results in the bare ground that reduces infiltration and accelerates soil erosion due to urban flooding. As people cut down trees for firewood, deforestation occurs, destroying vegetation and increasing the risk of land degradation and climate change. The urban poor are left vulnerable to the effects of climate change, low quality of life and public health challenges.

Most of the urban poor engage in illegal activities including vending which amounts to a third of the Zimbabwean population (100 000 being in Harare), touting, theft and prostitution (estimated to be between 121 000 and 167 000 in South Africa, and about 12 863 in Harare as of 2017) for a livelihood. The urban local authorities are faced with challenges of how to manage these activities in cities and towns to create sustainable communities. There is a challenge to balance rights to the city and proper enforcement of by-laws, especially in parts where poverty is dominant. Every citizen has a right to the city, either to use, inhabit, occupy, enjoy or produce in it. This creates conflicts between different groups as some might see themselves as deserving and not others. It is, therefore, difficult to remove all vendors and touts in the city because the urban poor have a right to exploit it as well. Other civil society organisations argue that the poor must not be infringed on their rights to the city and livelihood. However, this results in citizens being exposed to inadequate resilient urban infrastructure and negative effects of climate change such as floods, hailstorms and cyclones, global warming, heat island and high temperatures. Deliberate efforts in policy and programmes to ameliorate the negative effects of climate change are limited in most major African cities.

Urban local authorities in Africa have limited capacity to address the challenges of climate change because of their magnitude and their impact on the people, for instance, solving city flooding. The urban infrastructure and ecosystems are more exposed to the effects of climate change due to

limited adaptability. The increased hailstorms and cyclones, high temperatures and flooding, result in high volumes of storm-water that existing drainage cannot cope with. This calls for repeated repair and maintenance of urban infrastructure and amenities such as bridges, storm-water drainage, roads and housing. Inadequate data and information on the level of effects of climate change have undermined the scope of the challenge in urban areas in Africa. The current structures are aged and, in some cases, overwhelmed and new technologies are required to address such effects of climate change. Most local authorities struggle to finance service delivery and wage bill for the staff, leaving little for infrastructure development.

However, insufficient funding, technology, equipment and expertise in most cities and towns in Africa limit the capacities of the local authorities to mitigate and adapt to the challenges of climate change and disasters. African cities lack technological advancement in urban infrastructure that easily adapt to climate change. Capacity-building is essential for the creation of sustainable cities in Africa. Local authorities need to significantly invest in adaptive urban infrastructure and engage in mitigatory measures for climate change. Effective measures for climate change have to be implemented at the local level in urban areas. This calls for the creation of relevant institutions and legislation for the implementation of programmes that address the effects of climate change. Budgets and plans of action for the development of infrastructure adaptive to climate change have to be in place. Despite central government and local authorities, other financial resources for climate change policies and programmes can be mobilised from social capital, private players and civil society organisations. This book seeks to explore the impacts of climate change on urban landscapes against the policies, experiences and innovations in African towns and cities.

CHAPTER 1: The Influence of Urbanisation on Climate Change in Major African Cities

Abstract

Urbanisation is one of the key aspects that have led to the fragility of urban landscapes in many parts of the African continent. Over the years, the relationship between people and the environment has been seen as the catalyst to negative environmental changes such as climate change as people have exploited the resources provided by the environment and failed to safeguard them. In developing regions of Africa, most people migrate from rural to urban areas in search of greener pastures. This has caused peri-urban developments, urban sprawl and the growth of settlements on wetlands. Urbanisation has led to major urban problems leading to the destruction of infrastructure through traffic congestion that, in turn, contributes to urban decay and environmental pollution. Urban geographical processes have led to the alteration of seasons, rainfall patterns and the destruction of the ozone layer. This chapter discusses the link between urbanisation and the degradation of environmental quality on the African continent.

INTRODUCTION

Climate change and urbanisation have been one of the two most important issues that have led to policy-making in many regions of the world in the 21st century (Chapman *et al.,* 2017). The rise of the urban form as the dominant geographical context for life on earth and the emergence of climate change as a real and present threat to socio-ecological sustainability on the planet and a potent, if not dominant, force of urban change are components of the earth system that are detrimental to each other (Ziervogel *et al.,* 2014). This relationship has become an important element of policy-making as recent trends are showing that we are living in an era of unprecedented rapid urbanisation, with more than 50% of people in the world living in urban areas and, in particular, Africa, reaching a 50% share of the urban population by 2050 (While and Whitehead, 2013; Allen, 2015; Angelo, 2016; Van Noorloos and Kloosterboer, 2018). The growth of urban centres has led to several urban activities constituting over 80% of anthropogenic carbon dioxide emissions produced globally (While and Whitehead, 2013), with 65% of emissions coming from fossil fuel and industrial processes, 11% from

forestry and other land use. Urbanisation and human activities have become the greatest threats influencing the changing nature of the environment (Nyamadzawo *et al.,* 2015). This can be attributed to the alteration of the natural environment by deforestation for further building and an increase in paved surfaces. In 2021, Zambia cleared about 201 000 hectares of forest land, directly altering the environment (Moyo, 2022). Cities are thus seen to be the main drivers of global outcomes on climate change due to the high carbon footprint in cities which increases the destruction of the ozone layer, as well as due to the high volume of activities carried out in cities that also exacerbate climate change such as industrial activities. This has compromised urban sustainability since there is a gap between the demand of the natural environment and the provisions of land use (Rosenzweig *et al.,* 2018).

The relationship between climate change and urbanisation is thus seen to be a cause-effect relation as urbanisation has impacts on climate change and climate change also alters urban systems. Urban centres drive climate change, and are also amongst the most vulnerable geographical sites to the effects of global warming, whether it is through sea-level rise, changes in temperature, or more extreme and uncertain weather conditions that environmental and social changes codetermine each other, climate change would (Matenga, 2019). Human activities are changing the earth's climate in ways that increase the risk to cities. This conclusion is based on many different types of evidence including the earth's climate history, observations of changes in the recent historical climate record, emerging new patterns of climate extremes and global climate models (USAID, 2018). Cities and their citizens have begun to experience the effects of climate change (Rosenzweig *et al.,* 2015). On the other projections for future climate change as most often defined globally, it is becoming increasingly important to assess how the changing climate will impact cities. Efforts to understand climate change and its impacts and to design and implement adequate adaptation strategies and programmes will inevitably face difficulties related to different dimensions of the socio-ecological system-Earth (Bauer and Scholz, 2010). Anthropogenic climate change resulting from an intolerable accumulation of greenhouse gas emissions in the earth's atmosphere is but the best-known example of these planetary boundaries brought about by urbanisation. Climate change has also brewed centrifugal tendencies in rural areas as urban space perceivably became lucrative for better livelihood options (Kupika *et al.,* 2019). Climate change globally and regionally can influence water

resources, agriculture, environmental health, industry, economy and consequently urbanisation.

In September 2015, the United Nations endorsed the new Sustainable Development Goal (SDG) 11, which is to "Make cities and human settlements inclusive, safe, resilient and sustainable." This new sustainability goal cannot be met without explicitly recognising climate change as a key component (Rosenzweig *et al.,* 2018). Therefore, this chapter aims at assessing the dynamic relationship between climate change and urbanisation to assist policy-making to promote the growth of environmental; friendly and sustainable cities according to the SDG 11. The chapter assesses the degree to which urbanisation has degraded the environmental quality, and secondly, to assess the impact of urban areas and how urbanisation has had an impact on climate change in other neighbouring areas such as the rural areas through deforestation, creation of more buildings and infrastructure, and the growing population into peri-urban areas.

Background Of Urbanisation And Climate Change In Developing Regions

The impact of urbanisation on near-surface temperatures has been investigated since the1980s (Bryceson and MacKinnon, 2012). These studies suggested that a proportion of global warming observed in the last century timescale could be related to local warming induced by urbanisation. Uttara *et al.* (2012) note that the pattern and trend of urban population and number of towns in India from 1901 to 2001, show that the total urban population has increased more than tenfold, from 26 million to 285 million, whereas the total population has increased less than five times, from 238 million to 1027 million in the same period. Rapid urban growth has resulted in the expansion of built-up areas in and around cities, particularly for nations and regions experiencing demographic expansion (Azam and Khan, 2016). This plays a crucial role in the near-surface warming and on temperature (Grimmond, 2007). In India, urbanisation has led to the vast growth of slums which have helped alter the environment and climate negatively.

The urban transition leads to alterations in landscape conditions and important modifications in the urban climate along with several environmental problems, for instance, on water use and quality, on the

generation of air pollution and the production of solid waste and sewage (Paranunzio *et al.,* 2019). China provides the most dramatic example as it has the largest number of urban and rural dwellers in the low-elevation coastal zone and it still has a very strong trend towards increasing population concentration in this zone (Zhou *et al.,* 2004). Increasing trade and market-driven movements, often supported by government incentives, is still attracting people to the coast (Man, 2011). The coastal provinces of China experienced a net in-migration of about 17 million people between 1995 and 2000, creating pressures in the crowded coastal zone (Zenou, 2010). Other East Asian countries have undergone unprecedented urbanisation in the 20th Century. The urbanisation rates of the world average, that is, in terms of the population, have passed 50%. The rapid urbanisation processes have been accompanied by significant changes in climate over urban areas (Chapman *et al.,* 2017). Furthermore, temperate East Asia is remarkably affected by larger-scale climate change and variability, including the East Asian monsoon variability and global warming. Climate mitigation and adaptation considerations are also influencing the spatial planning and development of the suburban landscape in the Czech Republic (While and Whitehead, 2013).

In Africa, it is noted that rural-urban migration has become one of the survival strategies across the continent in times of environmental stress where people migrate to urban areas for employment opportunities (Swinkels *et al.,* 2019). Consequently, if those people fail to access jobs in urban areas, they will look for other survival strategies to sustain their livelihoods such as wetland farming (Frenken *et al.,* 2002). The increasing farming activities in wetlands expose them to environmental threats that affect their nature and biodiversity. Therefore, ecosystem services situated in wetlands are found at the receiving end as a result of the increasing population in urban areas (Nyamadzawo *et al.,* 2015). There is also increased documentation on the inadequacies in drainage and flood protection for urban centres in Africa and Asia and of the trend towards increased numbers of deaths and injuries from flooding (Satterthwaite, 2007). Since urbanisation is likely to increase in the future, it is important to assess the relationship between the effect of urbanisation trends on local and global warming as they are key issues from the climate change perspective (Paranunzio *et al.,* 2019).

THEORETICAL FRAMEWORK

The chapter is based on four important theoretical elements which include the theory of human landscape relationship, that is, the main theme, feeding into other essential themes such as the theory of urbanisation, theory of land and earth fragility and vulnerability and the theory of environmental degradation. These theories form the basis of the study as they help explain the cause-effect relationship between climate change and urbanisation.

THE THEORY OF HUMAN LANDSCAPE RELATIONSHIP

A landscape includes the physical elements of geographically defined landforms such as mountains, hills, water bodies such as rivers, lakes, ponds and the sea, living elements of land cover, including indigenous vegetation, human elements, including different forms of land use, buildings and structures (Hunziker *et al.,* 2007). Therefore, a landscape is spaces and places in which humans exist. The relationship between a human being and his/her environment is where the theory of the human-landscape relationship stems from. Humans are organisms that survive on the earth (Agnew, 2011). They interpret the earth and its resources differently as they are diverse organisms.

Humans fulfil different basic human needs through recreational and aesthetical activities and restoration, on the one hand, regulation of identity and representation of meanings (values, norms, experiences) (Kitchin and Thrift, 2009). Thus, humans have been treated mainly as a cause of disturbances in natural systems, but more and more humans are also recognised as legitimate users of the system, particularly as "receivers" of material goods such as agricultural and forestry products and immaterial goods such as psychological restoration and (visual) information (Hunziker *et al.,* 2007). Therefore, this theory exposes that activities done by humans have an impact on the environment, which then impacts climate change. The fast-growing African cities have people clearing land and creating their own residential areas and the loss of tree coverage has been directly linked to the increase of urban temperatures. The creation of Glaudina in Harare, Zimbabwe, saw a lot of forest land lost to create this residential area, which also has an impact on infiltration and flourishing of a natural ecosystem when it is tainted by humans (Moyo,

2022). The theory highlights that there is a negative relationship between humans and the natural landscape.

THEORY OF URBANISATION

Urbanisation is a process that leads to the growth of cities due to industrialisation and economic development and that also leads to urban-specific changes in specialisation, labour division and human behaviours(Uttara *et al.,* 2012). Urbanisation can be seen through the lenses of population growth or urban expansion. Urban growth occurs because of the economic advantages of cities in terms of scale and density, but reaping these benefits requires investments.

From the public and the private sector and an enabling policy environment:

- **Urbanisation as an engine for economic development and growth.** Recognising that urbanisation is both an unprecedented but also positive transformation for the Eastern and Central African region and that many of the countries in the area are still at the early stages of urbanisation.
- **Urbanisation as a means to foster productive and liveable places:** Harnessing the advantages of cities to generate productive and liveable areas that foster social cohesion, stimulate innovation and employment but at the same time support environmental sustainability.
- **Urbanisation as a potential for upward mobility:** Acknowledging the relationship between urbanisation and increased income and thus the capacity for urbanisation to support poverty reduction and foster greater equality by delivering higher earnings, the better quality of life and thus prosperity to its inhabitants.
- **Urbanisation as positive, rapid and transformative process:** Underlining that managing effective urbanisation requires an integrated, multi-stakeholder approach and stressing the need to plan now for the present and the future.
- **Urbanisation as a foundation for innovation and entrepreneurship**: Affirming that well-structured cities can generate higher productivity and clusters of firms that can foster innovation and entrepreneurship and thus encourage increased employment.

- **Urbanisation as an opportunity to deliver climate-smart cities:** Acknowledging the negative impacts of urbanisation on climate change and thus the current opportunities that exist to support the evolution of climate-smart cities to mitigate these effects(Angelo, 2016; Van Noorloos and Kloosterboer, 2018).

THEORY OF EARTH AND LAND FRAGILITY AND VULNERABILITY

The earth is a planet that consists of five systems: geosphere, biosphere, cryosphere, hydrosphere and atmosphere (Mbereko *et al.,* 2007). These systems interact to produce the environments that we are familiar with, such as rain forests, deserts and water bodies (USAID, 2018). These systems are, however, delicate and if the earth's resources are misused, the land becomes vulnerable to effects such as climate change. Vulnerability to the impacts of climate change is described as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (Mavhura, 2019). Vulnerability is a function of the character, magnitude and rate. Adaptation to climate change in Southern Africa is a function of climate change and variation to which a system is exposed, its sensitivity and adaptive capacity (UNFCCC, 2007). Vulnerability is thus understood as the result of the interactions between socio-economic conditions,(for instance, poverty, income distribution and infrastructure) and their institutional context (quality of governance, rule of law, decentralisation). Vulnerability is considerably influenced by poverty, particularly in developing countries, because the poor are typically more dependent on the direct use of natural resources and have less buff capacity to cope with economic damage caused by natural disasters or incremental degradation (Kaeser, 2016).

THEORY OF ENVIRONMENTAL DEGRADATION

Environmental degradation is a process through which the natural environment is compromised in some way, reducing biological diversity and the general health of the environment (Azam and Khan, 2016). This process can be entirely natural in origin, or it can be accelerated or caused by human activities. Environmental degradation can be described as the disintegration of the earth or deterioration of the environment through the consumption of assets, for example, air, water and soil; the destruction of environments and the eradication of wildlife (Grimmond, 2007). Environmental degradation is caused by various issues such as

urbanisation, population growth, economic growth, intensification of agriculture, increase in energy use and increase in transportation (Akintunde, 2017). The primary cause of environmental degradation is human disturbance.

The degree of the environmental impact varies with the cause, the habitat and the plants and animals that inhabit it. There are several ways in which environmental degradation works. Classically, resources simply become depleted (Hollis, 1990). Air, water and soil are all resources that are susceptible to depletion through overuse, as are natural resources like minerals and oil deposits. Habitat pressures that force animals into a small area can also contribute to resource depletion, as the animals consume a high volume of materials in a small area. Pollution is another cause of environmental degradation (Uttara *et al.,* 2012). When the environment becomes polluted, toxic substances have render it unhealthy. Pollution comes from a variety of sources, including vehicle emissions, agricultural runoff, accidental chemical release from factories and poorly-managed harvesting of natural resources (Azam and Khan, 2016).

LITERATURE REVIEW

Azam and Khan (2016) describe the term 'urbanisation' as a process where a large-scale labour force is going from an agribusiness-based economy to an urban-based industrial economy. This transformation is a trend of economic and social development. According to the World Bank Group(2018), urbanisation has brought unsustainable economic activities such as unregulated wetland agriculture in urban areas, which have resulted in climate change. The relationship between urbanisation and climate change is thus seen to be rooted in human activities and their relationship with the environment (Karsenty *et al.,* 2012; Nyamadzawo, Wuta, Nyamangara and Nyamugafata, 2015; Van Noorloos and Kloosterboer, 2018; Kupika *et al.,* 2019; Matenga, 2019).

Humans have been classified as consumers of the environment and its natural resources. This has brought out a negative relationship, one where the humans reap all the benefits at the expense of the environment and subsequent climate. Trees have been used for furniture and building materials, forests have been cleared to create utilisable land, and wetlands have been encroached upon. The widely encouraged urbanisation has brought with it negative impacts onto the environment such as the

deterioration of biodiversity in urban areas. The bleeding environment has been strained enough to alter the climate of the world and the people now feel those impacts as well.

Human-caused climate change presents significant risks to cities beyond the familiar risks caused by natural variations in climate and seasonal weather patterns. While and Whitehead (2013) state that urbanisation tends to be associated with elevated surface and air temperature, a condition referred to as the urban heat island. Urban centres and cities are often several degrees warmer than surrounding areas due to the presence of heat-absorbing materials, reduced evaporative cooling caused by lack of vegetation and production of waste heat (Bauer and Scholz, 2010).

There has been a growth in the 'urban' setup that has been attributed to urban sprawl, which has seen areas previously unoccupied or designated for urban agriculture being developed to provide housing for people. This has seen the formation of slums and informal settlements such as Kibera and Mathare in Kenya. These slums are characterised by deforestation that has led to compactness of soil, which reduces infiltration and percolation. This exacerbates flooding in the created settlements. There are other extreme events that happen in cities around the world that include heat waves, droughts, heavy downpours and coastal flooding. These are projected to increase in frequency and intensity as urbanisation continues (Chapman *et al.,* 2017).

Peri-urbanisation has also increased as regional areas are adopting urban trends. There has been an increase in development and the extension of city features such as roads, bridges and other buildings. The development of peri-urban areas has been credited to an increase in income and investment in rural areas. This has also increased the concrete surfaces which alter infiltration and cleared forests, leading to climate change as the temperatures in these areas increase. High human traffic volumes cause an increase in activities that produce heat, smoke, dust and other carbon emissions, thereby further straining the environment.

The warming climate, combined with the urban heat island effect, will exacerbate air pollution in cities. The concentration of people, infrastructure, economic activity and ecology within the coastal zone merits specific consideration of hazards exacerbated by a changing climate. Climate change and urbanisation are likely to increase the

vulnerability of biodiversity hotspots, urban species and critical ecosystem services (UNFCCC, 2007). It is supported that climate change is part of a shift to a new era of 'urban ecological security driven by resource shortages, carbon taxes and the physical effects of climate change' (Ren, 2017).

Furthermore, increasing heat waves as a result of air pollution and tall buildings has also exacerbated the increase of the changing climate in urban areas (Hua, 2016). The changing climate in urban areas has exposed wetlands to urban agriculture since they are adaptive to climate change (Rosenzweig *et al.,* 2015). Climate change has the potential to increase flooding risks in cities in three ways, from the sea (higher sea levels and storm surges); from rainfall, for instance, by heavier rainfall or rainfall that is more prolonged than in the past; and from changes that increase river flows, for instance, through the increased glacial melt. The activities that produce heat in cities have led to climatic changes that bring floods. These floods are destroying infrastructure and human life. Cyclones such as Cyclone Idai wiped away about 50% of farm land with maize, yam and bananas was (IFRC, 2020).

Urban areas also present some risk to flooding when rainfall occurs (Satterthwaite, 2007). Buildings, roads, infrastructure and other paved areas prevent rainfall from infiltrating into the soil and so produce run-off (Uttara *et al.,* 2012). Heavy and prolonged rainfall produces very large volumes of surface water in any city which can easily overwhelm drainage systems. In well-governed cities, this is rarely a problem because good provision for storm and surface drainage is easily built into the urban fabric, with complementary measures to protect against flooding, for instance, the use of parks and other areas of open space to accommodate floodwaters safely from unusually serious storms (Satterthwaite 2007; Albino *et al.,* 2015; Sim *et al.,* 2018).

There are high cases of environmental pollution that are a result of urbanisation. There has been so much noise pollution from the hustle and bustle of people in the cities. This is exaggerated by the high volumes of people in the cities. There is also an increase in air pollution resulting from exhausts from vehicles, fumes and smoke from industrial areas and smoke from burning litter that includes plastic and other fossil fuels in residential areas. This negatively affects the air quality in cities, making these areas breeding grounds for pneumoconiosis related diseases.

Another aspect of environmental pollution attributed to urbanisation is land pollution. The growing numbers of people and residential areas have become difficult for the authorities to service properly. People have resorted to throwing away litter anywhere. They have begun dumping their garbage alongside roads and in rivers. This further contaminates the water in the rivers and distorts the size, shape and carrying capacity of the rivers. When the rivers get heavily littered, they become shallow such that they can no longer hold much water, resulting in flooding of nearby areas. The river may even be blocked such that water does not flow freely to water reservoirs.

Figure 1: *A picture showing garbage in a river*

Concerning urban heat islands, higher temperatures occur in urban areas than in outlying rural areas because of diurnal cycles of absorption and later, re-radiation of solar energy and, to a much lesser extent, heat generation from built or paved physical structures (Satterthwaite, 2007). These increase the frequency and severity of heat-stress events in cities

and can affect the health, labour productivity and leisure activities of the urban population. There are also economic effects, such as the additional cost of climate-control within buildings and environmental effects, such as the formation of smog in cities and the degradation of green spaces and increased greenhouse gases if additional demand for cooling is met with electricity generated from fossil fuels (Nyamadzawo *et al.,* 2015). However, 80% of global GDP is generated by cities and thus urbanisation is not only an outcome, but also a driver for economic growth and development. Talk is of developing socio-ecological resilience and adaptive capacity in response to new urban exposures and vulnerabilities (While and Whitehead, 2013).

METHODOLOGY

Research approaches are plans and procedures that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation (Creswell, 2014).The study made use of thematic analysis in highlighting the various changing patterns through themes that are going against the present development control regulations set in the RTCPA of 1996. The study made use of documentary analysis, descriptive statistics and secondary data analysis in the depiction of the recent trends of urbanisation and climate change and in finding the relationship that exists between them. Documentary analysis assists in the enhancement of the reliability of the chapter (de Falco *et al.,* 2019). Documents used include books, journals and websites and newspaper articles. Data obtained were then processed into information and analysed through the use of thematic content analysis. Thematic content analysis is the use of textual material in research, reducing it to more relevant, manageable bits of data. It is also a method of analysing the text of social investigation among the set of empirical methods (Kumar *et al.,* 2020). After summarising literature, it was assembled and structured thematically into important concepts. This brought out themes such as spatial planning, urbanisation and the informal sector that need to be incorporated in development control in Zimbabwe.

RESULTS AND ANALYSIS

There is a cause-effect relationship between climate change and the urban-rural landscape. Climate change has also brewed centrifugal tendencies in rural areas as urban space perceivably became lucrative for better livelihood options. Climate change causes various changes to the earth and its systems and urban systems cause climate changes. This is illustrated in Figure 1.

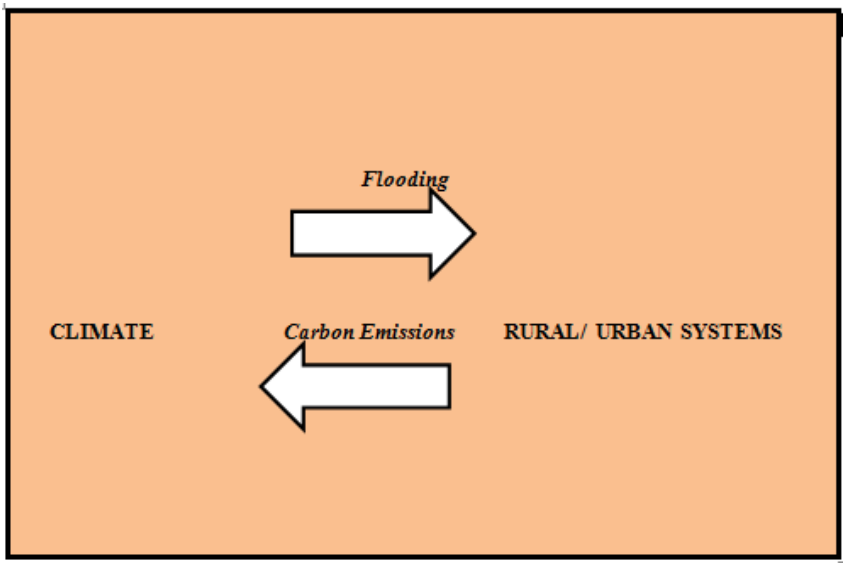

Figure 1: *Cause-effect Relationship between Climate and Rural/Urban Systems (*Adapted from Matenga, 2019).

Figure 1 shows the effects of climate and rural/urban systems on each other. Findings reveal that the relationship between climate and urbanisation is not linear. Climate causes several disasters on the urban/rural landscapes. Climate change causes this prevalence of disorders such as flooding, hail storms, veld fires, earthquakes and cyclones such as Cyclone Idai that occurred in Southern Africa in 2019. However, human interactions with the environment contribute to most of these disasters. The greatest human activity that has altered climate is urbanisation. Urbanisation has brought changes in land use, that is, construction, industrialisation which has resulted in the emission of atmospheric pollutants and the heat island effect. These have led to changes in runoff patterns and momentum fluxes. Changes in cloud condensation, nuclei concentration, changes in cloud amounts, result in rainfall changes in radiation budget, changes in heat and moisture fluxes. The world's poorest and most vulnerable regions between them, the countries of Southern Africa represent roughly one-tenth of the people that Paul Collier refers to as the world's 'bottom billion', the share of the global population that is effectively decoupled from overall global progress(Bauer and Scholz, 2010). That is why the relationship between climate change and urbanisation has had mostly negative impacts on

African urbanisation. The results of the relationship between climate change and urbanisation are illustrated in Table 1.

Table 1: Showing the Relationship between Climate Change and Urbanisation

Urbanisation		Climate Change		Result
Industrialisation	⇨	Low Rainfall	⇨	Hunger
Settlements On Wetlands	⇨	Drought	⇨	Drought
Urban Agriculture	⇨	High Temperatures	⇨	Very Hot Summers
Deforestation	⇨	Ozone Layer Depletion	⇨	Cool and Dry Winters
Stream Bank Cultivation	⇨	Low Rainfall	⇨	High Temperatures
Concrete Jungles	⇨	Global warming	⇨	Urban Heat Islands

Table 1shows the relationship between climate change and urban systems as one element from each of the concepts, causes another element to change. According to Rosenzweig *et al.* (2015):

- Temperatures are rising in cities around the world due to both climate change and the urban heat island effect. Mean annual temperatures have increased at a rate of 0.12 to 0.45°C per decade over the 1961-2010 period.
- Mean annual temperatures in the cities around the world are projected to increase by 0.7 to 1.5°C by the 2020s, 1.3 to 3.0°C by the 2050s and 1.7 to 4.9°C by the 2080s.
- Mean annual precipitation in the cities around the world is projected to change by -7 to +10% by the 2020s, -9 to +15% by the 2050s and -11 to +21% by the 2080s.
- Sea level in the 52 ARC3.2 coastal cities is projected to rise 4 to 19 cm by the 2020s; 15 to 60 cm by the 2050s and 22 to 124 cm by the 2080s.

It can be noted that humans and their activities are a major source of environmental degradation. They pollute the environment through water and air pollution. Water and air pollution are the common causes of environmental degradation. Pollution introduces contaminants into the

environment that can maim or even kill plant and animal life. Humans also degrade the environment through acid rain which occurs when sulphur dioxide from coal plant emissions combines with moisture in the air. A chemical reaction creates acid precipitation. Acid rain can acidify and pollute lakes and streams. It causes similar effects on the soil. If plentiful acid rain falls in a given environment, it can acidify the water or soil to a point where no life can be sustained.

CLIMATE CHANGE, URBANISATION AND WETLANDS

Urban agriculture is a constraint on the usefulness of urban wetlands to mitigate climate change and its negative impacts both on the environment and on humanity. The general proliferation of urban agriculture is fuelled by escalating poverty, high unemployment rate and the availability of open lands in urban areas. Urban agriculture is taking place in wetlands since they are adaptive to climate change. Wetlands play an important role in mitigating climate change. It is noted that the general increase of urban agriculture associated with increasing population has prompted competition in open spaces and wetlands, hence placing residents at loggerheads with city councils that conserve wetlands as a climate change mitigating strategy. Such activities are strictly prohibited by the environmental law, but the implementation of the law is not carried out. Meanwhile, the water provisioning ability of these areas is negatively impacted and the capacity of the dams downstream is reduced due to siltation. According to the *Daily News* (2014, July), Zimbabwe lost over 30 wetlands due to agriculture and urbanisation. The management of wetlands is contested because what is practised by people in wetlands is against environmental laws. Since wetlands are destroyed, the high temperatures in cities cannot be lowered when winds pass over them and so there is no way of lowering temperatures, this increases global warming. Wetlands are supposed to act as absorbers of excess runoff, so without them, the excess runoff floods the streets as some agriculture practices compact the soil and it gets saturated quickly.

CLIMATE CHANGE AND THE URBAN HEAT ISLAND

The surface climate within a city is different from the climate of its surrounding suburbs. This unique local city climate is called urban climate and is generally characterised by higher surface air temperature, weaker mean wind speed and lower relative humidity compared with the suburbs and the countryside (Ren, 2017). Within cities, various neighbourhoods experience different microclimates. Therefore, urban monitoring networks

are needed to address the unique challenges facing various microclimates and the range impacts of extreme climate effects at neighbourhood scales. Cities are characterised by the large diversity of socio-economic groups living nearby. Diversity is often accompanied by stratification based on class, caste, gender, profession, race, ethnicity, age and ability.

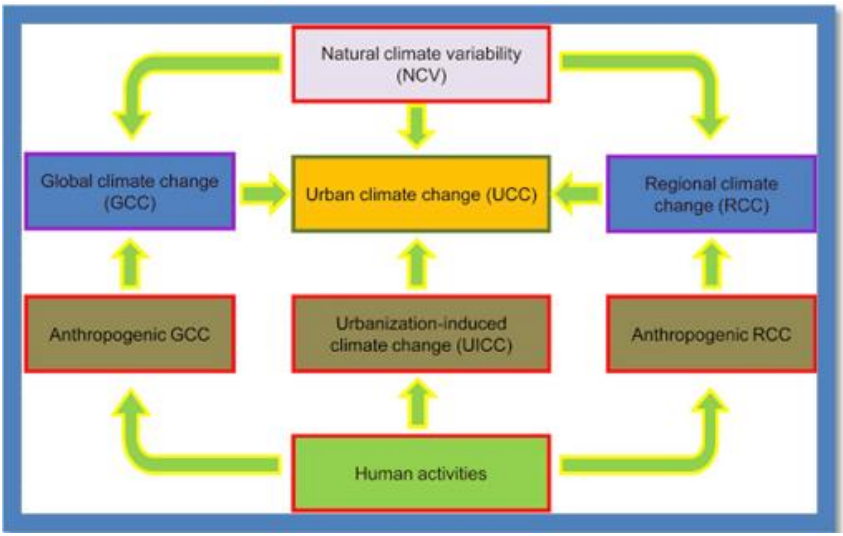

Figure 2: *Urbanisation as the major driver of climate change (* Adopted from Ren, 2017).

Urban surfaces modify the surface hydrologic properties through the increase of impervious surfaces, which reduces rainwater infiltration and evaporation and increases surface runoff. The multi-reflections of sunlight among high-rise buildings are important as well, they significantly increase the absorptivity of heat in the urban canopy. Furthermore, waste heat from winter heating and summer conditioning, along with the air pollution from other human activities within cities, are important. Thus, changes in the energy and water balance in the urban surface will occur, resulting in an increase (decrease) in the absorbed (reflected) solar short-wave radiation during the daytime, a decrease in the emitted ground long-wave radiation into the sky and an increase (decrease) of sensible (latent) heat flux. This, in mid-to-high latitudes, in turn, causes a higher surface air temperature, in particular during the night, a smaller diurnal temperature range (DTR), a smaller near-surface wind speed and a generally lower

(higher) relative humidity in urban areas of humid (arid) regions. For larger, higher-density cities, the temperatures in central "heat islands" can be several degrees higher than in surrounding areas. I n tropical cities, the temperature difference can reach 10 degrees by the end of the night.

Climate Change and Coastal Regions in Sub-Saharan Africa: A Case of Mozambique

Sea level rise affects the massive zones of urbanisation clustered along the world's tidal coastlines and most significantly those cities in places where the land is subsiding. In response to the wide range of risks facing cities and the role that cities play as home to more than half of the world's population, coastal cities such as Beira in Mozambique, have lived with extreme climate events since the onset of urbanisation, but climatic change and rapid urban development are amplifying the challenge of managing risks. For any city, the scale of the risk from these extreme weather events is much influenced by the quality of housing and infrastructure in that city, the extent to which urban planning and land-use management have successfully ensured risk reduction within urban construction and expansion and the level of preparedness among the city's population and key emergency services.

The Southern African region has frequent occurrences of natural disasters and Mozambique tops the list of these countries as the most hit by extreme events across the region with 53 natural disasters in the past 45 years (Brebbia *et al.,* 2004). For small and large coastal settlements, the integrity of coastal ecosystems and in particular protective mangrove and salt marsh systems will also influence risk (Satterthwaite, 2007). In most cities, there is also scope for land-use management and incremental adjustments to increase flood-water management capacity. But in poorly-governed cities, this does not happen. Most residential areas have no drainage systems and rely on natural drainage channels - and it is common for new buildings or infrastructure to obstruct these drainage channels(Satterthwaite, 2007). Floods have very strong impacts on cities and smaller urban centres in many African nations, for instance, the floods in Mozambique in 2000 which included heavy floods in Maputo, the floods in Algiers in 2001 (with around 900 people killed and 45000 affected).Mozambique's long coastline, sprawling river delta and changing weather patterns make it susceptible to multiple hazards as the climate changes.

DISCUSSION

Water resources are diminishing due to large population numbers and wasteful consumption and neglect of conservation. With rapid urbanisation and industrialisation, huge quantities of wastewater enter rivers. Careless use of resources is witnessed mainly in informal settlements. Failure of governance in today's cities has resulted in the growth of informal settlements and slums that constitute unhealthy living and working environments. These have decreased the rate at which evapotranspiration takes place through settling on wetlands, and deforestation. This has altered rainfall patterns in Africa. An adaptation to the impacts of climate change is accomplished through community-based measures to sustain human livelihoods. For instance, the mechanisms developed by rural communities are complex, are used within cultures and depend on the use of indigenous knowledge in the production of subsistence crops (Kupika *et al.,* 2019). People's knowledge of the seasons motivates them to grow subsistence crops with careful consideration of the soil fertility and texture and crop variations which enhance the sustainable production of crops (Green, 2008).The ability of individual households and communities to adapt to climate change depends on their adaptive capacity. 'Adaptive capacity' refers to the potential or ability of a system, region or community to adapt to the effects or impacts of climate (Kupika *et al.,* 2019). This capacity is dynamic and influenced by economic and natural resources, social networks, institutions, governance, human resources and technology (Mugambiwa, 2018).

CONCLUSION AND RECOMMENDATIONS

Climate change and urbanisation are two interlinked concepts that are detrimental to the sustainability of the environment. Urbanisation is the contemporary trend in the world and it has had an effect on over policy-making and vast landscapes. Human settlements and their accompanying activities, such as industrialisation, have detrimental impacts on the environment. The emission of greenhouse gases and deforestation have been some of the main causes of the depletion of the ozone layer. This has led to shifts in climatic patterns on the African landscape. There is need to fully grasp the components that make the relationship between climate change and urbanisation as they feed off each other. These concepts are interconnected or interlinked and they determine how each is formed. There is need to incorporate designs for climate change mitigation into

urban planning and thus transition cities to a low carbon development path, develop the capacity and systems needed to mitigate, adapt to and recover from shocks and reducing vulnerabilities through the development and institutionalisation of disaster risk reduction and management framework and to provide new opportunities for green businesses and green jobs.

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CHAPTER 2: African Cities in the Face of Climate Change and Urban Infrastructure Investment

Abstract

It has become obvious that the value of a single "green" building or eco-labelled product is marginal if it is not supported by sustainable urban infrastructure and a culture of sustainability. Developing countries need international assistance to support adaptation in the context of national planning for sustainable development, more capacity-building and transfer of technology and funds. Data collection was done through desktop analysis, secondary data analysis and report analysis. Systematic planning and capacity-building are also needed to reduce the risk of disasters and raise the resilience of communities to increased extreme events such as droughts, floods and tropical cyclones. Funding for adaptation in developing countries must be sufficient and sustained. Least Developed Countries (LDCs) and Small Island Developing States (SIDS), in particular, need special consideration due to their extreme vulnerability.

INTRODUCTION

Africa is under pressure from climate stresses and is highly vulnerable to the impacts of climate change (United Nations Framework Convention on Climate Change, 2007). The purpose of this chapter is to focus on approaches and strategies for enhancing urban infrastructure investment to address challenges posed by climate change in urban areas in Africa. Many areas in Africa are recognised as having climates that are among the most variable in the world on seasonal and decadal time scales. Without the ability to identify and serve these populations, humanitarian aid after disasters and longer-term development programmes may systematically but inadvertently exclude them when creating policies and programmes (Twig, 2019). This will leave out vulnerable groups that are unable to plan for and adapt to change and are exposed to loss of housing, property, life, employment and opportunity for economic and social development.

BACKGROUND AND OVERVIEW

Exposure to sudden or repeated environmental shocks and stressors negatively affects human health outcomes, including mental health (Patz *et al.,* 2005), access to resources such as food and water (McDonald *et al.,* 2011, Cisneros *et al.,* 2014, Porter *et al.,* 2014), livelihood and economic

opportunities (Mearns and Norton, 2010), migration and displacement and may also impede efforts to end harmful social practices such as child marriages and gender-based violence (Raleigh *et al.,* 2010; Svanemyr *et al.,* 2015). Conversely, humans may cause environmental degradation such as deforestation or soil erosion, through the use of environmentally damaging farming practices and poor urban planning. This cycle leads to reliance by vulnerable individuals and communities on environments that may not be able to sustain their needs. Climate change exacerbates many of these interactions (Population Council, 2018).

Harvest failure is a key risk for rural households in Sub-Saharan Africa (SSA) (Sinha and Lipton, 1999). Africa's geography and agro-ecology (prone to drought and intense rain) combine with inefficient agricultural technologies and inadequate agricultural support and result in environmental degradation, unmanaged pests and poor access to inputs, increasing vulnerability. Harvest failure not only affects crop dependent households, but also the wider rural economy (including households dependent on non-farm income sources) and national well-being and stability. It also can have long-term effects as people sell assets as a coping strategy. National budgets are also destabilised as trade (and national income) is reduced and relief has to be imported. The food crisis experienced in Southern Africa in 2001-03 is a case in point. Heavy rains in the late growing season in 2001 triggered a harvest failure of maize, the region's main staple (Wiggins, 2005:3). An immediate impact was felt by crop-dependent households. But harvest failure was not the only cause of this food crisis, for institutional weaknesses, political factors, donor policies and economic inequalities also contributed (Booth *et al.,* 2006: 58). Together they led to a significant increase in prices across the region (for example, a four-fold increase in Malawi), causing acute problems for the poor. It is estimated that in late 2002, the lives and livelihoods of as many as 16 million people in Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe were threatened (Wiggins, 2005:2; Maunder and Wiggins, 2007:4).

LITERATURE REVIEW AND THEORETICAL PERSPECTIVES

Anthropogenic climate change complicates this already complex picture. A changing climate will alter the frequency, intensity, duration, timing and location of slow- and sudden-onset climate-related hazards (IPCC, 2012, 2014a). The impacts of climate change are being felt through increasing drought and heavy rainfall, contributing to flooding, sea-level rise and

abnormally high temperatures (Blunden and Arndt, 2017). These shifts in climate are impacting the ecosystems upon which livelihoods and economies, cultures and societies depend for water, food, energy and waste removal, among other services (Cozzetto *et al.,* 2013). It is important to understand that not all climate-related hazards can be attributed to climate change. Climate attribution science is much stronger at understanding the influence of climate change on hazards (IPCC, 2012; Peterson *et al.,* 2012), but not every occurrence is caused by or unduly exacerbated by climate change.

Human mobility is an age-old phenomenon driven by numerous factors. People move in search of better economic and employment opportunities due to changing policies at home or abroad, to escape conflict and social persecution, or in combination with natural hazards and environmental degradation affecting their livelihoods (Shen, 2013; Lilleor and Van den Broeck, 2011; Piguet, 2010; Ibáñez and Vélez, 2008). A principal cause can rarely be disentangled. Instead, the complex interplay between social, political, economic, cultural and environmental factors that determines an individual's, family's or community's vulnerability and their capacity to uproot or stay that results in population movement. A case study from Vietnam suggests that sudden-onset of events like floods or typhoons increase the likelihood of people migrating internally (either temporarily or permanently), whereas people may seek to adapt to slow-onset events *in situ* (Koubi *et al.,* 2016). By contrast, in Indonesia and Bangladesh, people are temporarily relocating in response to extreme weather events like flooding, but migrating on a longer-term basis when confronted with creeping environmental stress and repeated slow-onset events like prolonged heat and drought during key agricultural seasons (Mueller *et al.,* 2014).

Africa will face increasing water scarcity and stress with a subsequent potential increase of water conflicts as almost all of the 50 river basins in Africa are transboundary (Ashton, 2002; De Wit and Jacek, 2006). Agricultural production relies mainly on rainfall for irrigation and will be severely compromised in many African countries, particularly for subsistence farmers and in SSA. Under climate change, much agricultural land will be lost, with shorter growing seasons and lower yields. National communications report that climate change will cause a general decline in most of the subsistence crops, for instance, sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; millet in Sudan and groundnuts in the

Gambia. Of the total additional people at risk of hunger due to climate change, although a large proportion, Africa may well account for the majority by the 2080s (Fischer *et al.,* 2002).

Climate change is an added stress to threatened habitats, ecosystems and species in Africa and is likely to trigger species migration and lead to habitat reduction. Up to 50% of Africa's total biodiversity is at risk due to reduced habitat and other human-induced pressures (Boko *et al.,* 2007). The latter include land-use conversion due to agricultural expansion and subsequent destruction of habitat, pollution, poaching, civil war, high rates of land-use change, population growth and the introduction of exotic species. For example, the habitat of the great apes, including the western lowland Gorilla identified as critically endangered on the World Conservation Union's (IUCN) red list of threatened species – is likely to decline between 2002 and 2032.

RESEARCH METHODOLOGY

Combining qualitative and quantitative methods can strengthen the credibility (that is, the internal and external validity) and usefulness of findings. While quantitative data can show what is happening, qualitative data can help to explain why something is happening and add a subjective perspective. For this study, desktop review, secondary data analysis and report analysis were used. These include reports, government documents and magazines.

RESULTS AND DISCUSSION

In Uganda, evidence suggests that cash transfers offer high economic returns, especially when coupled with training programmes (Blattman *et al.,* 2014). 'Grand Bargain', agreed at the 2016 World Humanitarian Summit, emphasizes that cash transfers can help empower conflict-affected people and bolster local markets. Cash-for-work components may also be used to (re)construct the necessary infrastructure for people to pursue agricultural livelihood strategies (Twigg, 2019). Indeed, infrastructure in fragile environments has increasingly emerged as a priority among donors, to promote access to markets and establish the preconditions for long-term economic growth (Ali *et al.,* 2015). One impact assessment from the Democratic Republic of Congo (DRC) suggests that improved roads help to increase freedom of movement through better security, reduce transport costs and increase farm-gate prices (Levine and Chastre, 2004). However, the longer-term effects of

cash transfers are not clear. Bypassing the state and its social protection function is not a sustainable policy as it ultimately undermines state legitimacy (Schultze-Kraft *et al.,* 2014).

Financial inclusion, a key resilience capacity, allows for broad-based participation of poor and marginalised groups in these financial intermediation processes (Olga, 2017). Financial inclusion can be defined as access to useful and affordable financial products and services that meet the needs of low-income and vulnerable groups, delivered responsibly and sustainably. Cross-country evidence shows the positive impact of financial inclusion on increasing household resilience to external shocks (Mark, 2017). Digital payments enhance the impacts of risk-sharing (formal and informal insurance) by lowering transaction costs and expanding the social network able to contribute, including across borders. They also increase efficiency and targeting for cash transfer programmes. These efficiency improvements enhance the impacts of financial inclusion on household resilience. For example, following a drought in Kenya, mobile money (M-PESA) users experienced no reduction in consumption compared to a 6-10% reduction in consumption among non-users (Suri *et al.,* 2014). Among women in Niger targeted for cash transfers after a drought, digital payments increased their diet diversity, the amount of food consumed and women's empowerment (Jenny, 2016). In the Philippines, international remittances responded to income shocks related to rainfall, replacing 60% of lost household domestic income.

Another tool for enhancing urban infrastructure investment to address challenges posed by climate change in urban areas in Africa is Geographical Information Systems (GIS). Planners have always been involved in developing communities everyone would want to call home. Originally, this meant designing and maintaining cities and counties through land-use regulation and infrastructure support. Agencies have had to balance the needs of residential neighbourhoods, agricultural areas and business concerns. Now, in addition to that complex challenge, local governments must factor into these decisions, the requirements of a growing list of regional, state and federal agencies and special interest groups. Rapidly changing economic conditions have further complicated the process by threatening the funding needed to carry out these functions. To date, local governments have been right-sized and downsized and have had budgets drastically cut while trying to maintain

service levels. Information technology, especially GIS, has proven crucial in helping local governments cope in this environment.

People have moved throughout history and for many reasons. Some are displaced – forced to move due to conflict and persecution, natural hazards like flooding, or cascading disasters such as drought-influenced famine – and others choose to migrate temporarily or permanently in pursuit of better economic conditions, for family reasons or, at times, when seasonal conditions, like failing rains, make it difficult or impossible to earn a livelihood (Ibáñez and Vélez, 2008; Piguet, 2010; Lilleor and Van den Broeck, 2011; Shen, 2013). In other cases, governments have pursued policies and programmes promoting movement and population relocation from highly hazard-exposed areas, or have forcibly displaced communities through land-grabbing and threats of violence.

Measures addressing climate change adaptation and mitigation, while also adopting an ecosystem-based approach, can be manifold and serve as a useful illustration of how the different sectors can contribute to promoting ecosystem-based approaches. Table provides an overview of ecosystem-based adaptation (EbA) and ecosystem-based mitigation (EbM) measures that can be assigned to the different sectors. As all measures listed contribute to tackling climate change; the climate is not considered as a separate sector.

Table 1: *Measures linked with EbA and EbM, categorised by sector* (Doswald and Osti, 2011)

Sector	Relevant measures linked with EbA) and EbM
Agriculture	• Land-use zoning • Habitat protection for water regulation • Protection of key species (e.g. pollinators) • Conversion/reversion of arable land to grassland or forest • Maintaining genetic diversity • Consistency between crops produced and the local natural environment • Rain-fed water harvesting techniques • Sustainable management techniques for crops and soil • Application of no/low-tillage cultivation, crop rotation, agro-forestry • Soil moisture conservation practices (e.g. incorporating green manure into the soil or providing some degree of surface cover for the soil by mulches or by tillage practices that leave plant residues on the soil surface in water-scarce ecosystems)

Built environment	• Construction of more energy-efficient buildings • Installation of hard defence structures (e.g. sea walls to buffer against coastal flooding) • Reduction of impermeable surfaces • Installation of green roofs and vertical gardens • Use of ecosystem-consistent materials (e.g. barriers for water retention in wetlands constructed with wood and peat from the site instead of concrete)
Urban and regional planning	• Land-use zoning • Increase use of green infrastructure and spaces (e.g. green roofs, urban tree planting, parks/recreational areas, green belts) • Increase blue infrastructure and spaces (lakes and ponds) • Increase soil infiltration in parks, parking lots and green curbs
Energy	• Implementation of renewable energy policies to reduce greenhouse gas (GHG) emissions • Encourage energy-efficient behaviour to reduce public energy demand for fossil fuels • Enhance the use of energy sources restoring biodiversity (e.g. coppicing/wood fuel) • Implement sustainable criteria for biofuels and bio-energy
Fishery	• Sustainable management of fisheries and avoidance of overfishing • Integrated river basin management
Forestry	• Forest conservation, restoration, reforestation • Protection of watershed forests • Sustainable forest management (sequestration of carbon) • Evaluation of the protective characteristics of forests
Health	• Support creation of green spaces in cities to reduce the urban heat island effect • Plant urban trees to improve air quality • Support and marketing of organic food products
Tourism	• Enhance eco-tourism and sustainable nature tourism • Increased green area for recreation
Transport	• Maintain ecological connectivity in constructing grey infrastructure (via e.g. green bridges or tunnels)
Water	• River and floodplain re-naturation/restoration • Restore canals to more natural meandering rivers • Dyke relocation • Habitat restoration, creation or protection • Watershed management • Dune restoration; sand nourishment (coastal zones) • Rain-fed water harvesting techniques • Habitat protection for water regulation
Coastal defence	• Maintenance and restoration of mangrove forests (EU Outermost Regions and Overseas Countries and

	Territories include several small island states in the three oceans – Indian, Pacific and Caribbean) • Implementation and use of Integrated Coastal Zone Management (ICZM) principles and tools (e.g. managing impacts of climate change and safeguarding resilience of coasts/coastal systems; preparing for, preventing and managing natural hazards and technological (human-made) hazards; and integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment
Biodiversity	• Land-use zoning • Protection of key species (e.g. pollinators) • Conversion/reversion of arable land to grassland or forest • Maintaining genetic diversity • Consistency between crops produced and the local natural environment • Sustainable management techniques for crops and soil • Application of no/low-tillage cultivation, crop rotation, agro-forestry • Removal of alien/invasive species
General	• Installation of hard defence structures (e.g. sea walls to buffer against coastal flooding) • Reduction of impermeable surfaces • Use of ecosystem-consistent materials

Glick *et al.* (2011) found that interest in and acceptance of adaptation has increased in both the conservation community and more broadly over the last 10 years. They found a five-fold increase in climate change adaptation literature from 2007 to 2020 and from this, they infer that the conservation and research communities have realised that mitigation alone is no longer sufficient to address the challenges of climate change. However, they did find that literature focused on human systems were most prevalent, with those orientated towards biodiversity and ecosystem conservation being least represented. They also found that from 2007 to 2010,the term 'ecosystem-based adaptation' has gained currency (Colls *et al.,* 2009; Vignola *et al.,* 2009; Watts *et al.,* 2011), although it is still very poorly represented in published literature. While scientists can offer specific information to guide conservation actions, the choice of restoration or management goals is ultimately process-driven as much by societal values, economic constraints and political feasibility as scientific knowledge (Lackey, 2004; Tear *et al.,* 2005; Stein, 2009; Lindenmayer and Hunter, 2010; Glick *et al.,* 2011).

Developing countries are the most vulnerable to climate change impacts because they have few resources to adapt; socially, technologically and financially. Climate change is anticipated to have far-reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN, 2007). Many developing countries' governments have given adaptation action a high, even urgent, priority. Developing countries need international assistance to support adaptation in the context of national planning for sustainable development, more capacity-building and transfer of technology and funds (United Nations Framework Convention on Climate Change, 2007). Systematic planning and capacity-building are also needed to reduce the risk of disasters and raise the resilience of communities to increase extreme events such as droughts, floods and tropical cyclones. Funding for adaptation in developing countries must be sufficient and sustained. LDCs and SIDS in particular need special consideration due to their extreme vulnerability.

Global warming is causing the melting of glaciers in the Himalayas and in the short term, this means increased risk of flooding, erosion, mudslides and GLOF in Nepal, Bangladesh, Pakistan and North India during the wet season (UNFCC, 2007). Since the melting of snow coincides with the summer monsoon season, any intensification of the monsoon and/or increase in melting is likely to contribute to flood disasters in Himalayan catchments. In the longer term, global warming could lead to a rise in the snowline and the disappearance of many glaciers, causing serious impacts on the populations relying on the seven main rivers in Asia fed by melt water from the Himalayas. Throughout Asia, one billion people could face water shortage, leading to drought and land degradation by the 2050s (Christensen *et al.,* 2007; Cruz *et al.,* 2007).

RECOMMENDATIONS AND OPTIONS

Investment must be scaled up and innovative methodological approaches improved. New technologies and innovation can potentially help developing countries tackle a wide range of health, social and economic issues. Multi-stakeholder collaborations (public, private and community) can deliver resilience at scale, especially where it is possible to combine research, innovation and adaptive management of land and resources. As indicated in SDG2, international donors and local governments should 'increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension

services and technology development' to build the resilience of agriculture-based livelihoods.

Addressing deforestation requires an integrated approach to address the energy alternatives to fuel wood and promoting intensification of agriculture for improved productivity to reduce the clearing of forests for farming activities. Policies and legislation that promote community participation in forest and natural resources management must be put in place and implemented with a decentralised system of management that creates incentives and provides adequate capacities for community involvement. Zambia must reduce the deforestation rate to ensure a green economy and sustainable development.

Australia delivers climate finance from entities such as Fidelity and Climate Change Investment Fund and Official Development Assistance in Australia's Green Book, through bilateral programmes, contributions to multilateral funds, and working with countries to support access to and development of climate-friendly technologies, technical support and capacity-building and partnerships with business and other actors (Graham and Serdaru, 2020). Australia will continue to support countries to develop and implement ambitious national mitigation contributions and national adaptation plans, to access funds and attract investment from a range of sources (Boss and Thwaites, 2021).

This submission outlines Australia's efforts to provide and mobilise support for climate change action in developing countries, through:

i. Australia's climate finance pledge to 2020;
ii. Integrating climate change assistance into Australia's development programme;
iii. Contributions to multilateral funds;
iv. Mobilising private finance;
v. Building capacity and enhancing access to climate finance;
vi. Improving tracking and transparency; and
vii. Transformational change in support of Paris Agreement objectives.

Cities have different methods of accessing financing, be it by collecting taxes and fees for service, getting a share of tax income from their national governments, or by being able to issue municipal bonds or get low-interest loans on international money markets. That is where their attitude to

traditional versus high technology or commercial versus non-market solutions becomes significant: are cities able to come up with innovative solutions that do not depend on the most expensive technology and maintenance requirements? The development of the Bus Rapid Transit (BRT) model in Curitiba, instead of a traditional subway system requiring heavy investments, is a prime example.

The EU has a strong commitment to climate change adaptation and mitigation. Firstly and importantly, there is need to reduce GHG emissions (that is, take mitigation action) and take adaptation action to deal with the unavoidable impacts (Mohammed *et al.,* 2020).It recognises that 'strategies focused on managing and conserving water, land and biological resources to maintain and restore healthy, effectively functioning and climate change-resilient ecosystems are one way to deal with the (climate) impact and that is working with nature's capacity to absorb or control impact in urban and rural areas can be a more efficient way of adapting than simply focusing on physical infrastructure. Thus, it provides leverage for the development and implementation of ecosystem-based approaches to climate change adaptation and mitigation, but it contains little specific mention of ecosystem-based actions or evidence of ecosystem-based adaptation and mitigation actions. There is, however, an action point that encourages strategies that increase the resilience to climate change of health, property and the productive functions of land, *inter alia* by improving the management of water resources and ecosystems.

Capacity is still needed to enable developing countries to develop adaptation programmes and strategies. The Nairobi work programme is building capacity to understand and assess impacts, vulnerability and adaptation and to make informed decisions on practical adaptation actions and measures. The NAPAs have proved an important way to prioritise adaptation actions for least developed countries. Initiating a process for extending the positive experience of NAPAs for developing countries that are not least developed countries and that wish to develop national adaptation programmes or strategies, could vitally help adaptation option prioritisation. This would take into account lessons learned from the NAPA preparation process and its successful experience at policy integration and relevant outcomes from the Nairobi work programme. Using local coping strategies can assist community-based

adaptation and can be facilitated by knowledge exchange within different communities facing similar problems, such as via the UNFCCC local coping strategies database. Finding synergies between the Rio Conventions could also help share information and knowledge on assessment processes.

Of the five adaptation principles, maintain and increase ecological resilience, accommodate change and develop knowledge and plan strategically, were evident in both the White Paper and Impact Assessment, while the other two (integrating across all sectors and take practical action now) were only explicitly evident in the Impact Assessment. Examples of acknowledgement of specific actions are given in Box 1.

Box 1: Examples of adaptation actions from the White Paper (WP) and Impact Assessment (IA)

Maintain and increase ecological resilience

- Conserve range and ecological variability of species - measures to maintain diversity in and increase connectivity between nature conservation sites are necessary (IA)
- Maintain existing ecological networks - the impact of climate change must also be factored into the management of Natura 2000 to ensure the diversity of and connectivity between natural areas and to allow for species migration and survival when climate conditions change (WP).

Accommodate change

- Make space for the natural development of rivers - enabling plants and animals to survive and helping wetland-dependent communities to adapt to climate change, while at the same time providing, through wetlands and salt marshes, for natural barriers that allow managing increasing water flow, floods and storms over large areas (IA).
- Develop the capacity of institutions to cope with change – WP mentions guidelines, governance and coordination, an EU action option (p.36) also capacity building (p.40).

Develop knowledge and plan strategically

- Undertake vulnerability assessments of biodiversity: Work is on-going at DG Environment to assess the feasibility and provide options for the design of (set of) vulnerability indicator(s) (WP and IA).
- Identify potential (cross-sectoral) win-win solutions - use the functions and services provided by ecosystems to achieve more cost-effective and sometimes more feasible adaptation solutions (IA).
- Monitor actual impacts of climate change - The proposed system for monitoring and reporting on climate change impacts will help in gathering further knowledge, irrespective of the impacts of climate change (WP and IA).

Integrate across all sectors

- Integrate adaptation and mitigation measures - need to exploit the synergies

between mitigation and adaptation efforts (IA).

- Build and strengthen partnerships -many regions would benefit from assistance for capacity-building and best practice sharing (IA).
- Raise awareness of benefits of the natural environment to society - communication/awareness raising/capacity-building - an EU action option (IA).

Take practical action now

- Conserve existing biodiversity - The maintenance of biodiversity and ecosystems is essential for both ensuring their resilience to climate change impact and allowing the provision of ecosystem-based services (IA).

Source: EU White Paper, Impact Assessment, (2009)

Local coping strategies are an important element of planning for adaptation. Climate change is leading communities to experience climatic extremes more frequently and new climate conditions and extremes. Traditional knowledge can help to provide efficient, appropriate and time-tested ways of advising and enabling adaptation to climate change in communities that are feeling the effects of climate changes. Several examples of local coping strategies are mentioned in the background papers to the workshops.

In Africa, rural farmers have been practising a range of agricultural techniques as coping strategies and tactics to enable sustainable food production and deal with extreme events. These include intercropping and crop diversification; use of home gardens, diversification of herds and incomes, such as the introduction of warming sheep in place of goats in the Bara province in Western Sudan, pruning and fertilizing to double tree densities and prevent soil erosion in semi-arid areas, for example, Senegal, Burkina Faso, Madagascar and Zimbabwe; manipulation of land-use, leading to land-use conversion, for example, a shift from livestock farming to game farming in Southern Africa; water conservation techniques to cope with arid conditions such as the Zaï technique in Burkina Faso. Farmers dig pits in the soil to collect organic material carried by the wind during the dry season. At the start of the rainy season, farmers add organic matter from animals, attracting termite activity resulting in termite tunnels that can collect rain deep enough that it does not evaporate and thus increasing soil fertility. In many locations, tribal and individual movements and migration are also identified as adaptation options.

In Asia, farmers have traditionally observed several practices to adapt to climate variability, for example, intercropping, mixed cropping,

agroforestry, animal husbandry and developing new seed varieties to cope with local climate. Various water use and conservation strategies include terracing, surface water and groundwater irrigation; and diversification in agriculture to deal with drought. Structural and non-structural measures are used to deal with flood and coastal inundation. For example, in the Philippines, after Typhoon Sisang in 1987, which destroyed over 200,000 homes, the Department of Social Welfare and Development decided to instigate a programme of providing typhoon-resistant housing designed to withstand wind speeds of 180 km/h for those living in the most typhoon prone areas. In Bangladesh, the Cyclone Preparedness Programme has been set up over 11 coastal area districts by the Bangladesh Red Crescent Society and is partly funded by the government. Volunteers have been trained to help in cyclone warning, evacuation, rescue, first aid emergency relief and the use of radio communication equipment.

CONCLUSION

Developing countries are suffering from the impacts of climate change and are the most vulnerable to future change. Several developing countries have developed adaptation plans or are in the process of finalising them. These include the National Adaptation Programmes of Action of least developed countries. There is now urgency for developing countries to find ways to implement these plans. Against a backdrop of low human and financial capacity, developing countries lack many of the resources to do this on their own. Multidisciplinary, robust investigations on the links between climate change, migration and displacement are limited. The analysis is constrained by the complexity and interrelatedness of the drivers of human mobility that simultaneously serve as drivers of vulnerability to climate hazards and change. Estimates of migration as a result of climate change must disentangle not only social, political, cultural and economic factors, but also other environmental factors, such as mismanagement of natural resources. Disagreements as to how to link climate change as an environmental stressor with other factors of migration persist. There are multiple challenges with international and internal migration and displacement data, uncertainty about future climate shifts and 'low confidence in quantitative projections of changes in mobility in response to climate change – precisely because of the complex, multi-causal reasons behind human mobility. As such, caution must be exercised and data gaps and challenges identified, to devise policy measures and international agreements that respond to the needs

of people who are displaced or migrate – where climate change might have played some role.

The evaluation provides valuable analysis and insights that can directly inform more effective climate change action through the aid programme. It identifies the key characteristics of investments that effectively achieve climate change outcomes, such as working on longer timeframes and those that are less effective. It underlines the value that whole-of-government partners and technical expertise bring to delivering effective and sustainable climate change action. The evaluation proposes some practical steps for improving the integration of climate change across the aid programme. Office of Development Effectiveness evaluation of climate change effects in the aid programme has identified opportunities for further improvement. The evaluation was requested by the Sustainability and Climate Change Branch at the beginning of 2017 to assist in improving the effectiveness of Australia's climate change investments and to inform the process of integration of climate action throughout the aid programme.

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CHAPTER 3: Urban Ecosystems, Biodiversity and Sustainability in Africa

> *Global warming may dominate headlines today.* Ecosystem *degradation will do so tomorrow (Corporate Ecosystems Services Review, WRI et al., March 2008).*

Abstract

This chapter examines the importance of the relationship between ecosystems and biodiversity in the promotion of resilient and sustainable urban environments. Ecosystems are dynamic interactions between micro-organisms, animals and plants. It is a community of living organisms together with the physical environment they occupy. Biodiversity is concerned with the measure of the variety of life on earth. Thus, biodiversity is a fraction of the ecosystem. For an ecosystem to be functional, there is need for all living organisms to be operating in ecosystem processes. It increases the effectiveness of ecosystem services. Biodiversity is important in regulating carbon capture, soil fertility, water treatment, natural pest control and crop fertilization. In urban landscapes, the nexus between ecosystem and biodiversity assists in the provision of clean air, plants improve the appearance of buildings and they help introduce creative smart city solutions such as green roofs and living walls. Therefore, the chapter clearly articulates the linkages between the functionality of the ecosystem and biodiversity in promoting sustainable urban ecosystems that have a direct impact on human health and security.

INTRODUCTION

The urban ecosystem is an essential component of the world, since most of the population in the world resides in urban areas. The interactions in this ecosystem are affected mostly by human/anthropogenic involvement. With the disturbance by anthropogenic forces, the ecosystem becomes a distorted environment. This is because human leach off from the environment and most of the time do not provide solutions or conservatory ideas to the ecosystem. The involvement of humans in this ecosystem has caused a decline in biodiversity. Human activities tend to be harmful or affect negatively the natural environment such as plant species, animals, birds and micro-organisms. As the world continues to be urban (Heymans *et al.,* 2019), with African cities leading in urbanising,

there arises challenges related to sustainability. The urban ecosystem continues to grow and biodiversity dwindles (UNEP-WCMC, 2016).

The landscape is where people and nature interact most acutely and where ecosystems reside and provide valuable services to people. There are recognised increasing natural losses worsening environments, declining species due to negative human landscape interactions in African urban landscapes (UNEP, 2008). The well-being of society depends, to a large extent, on the benefits derived from the functions and processes that take place within ecosystems (ecosystem services). Therefore, biodiversity plays an important role in the delivery of many of these benefits. However, human activities that derive services from ecosystems may also have adverse impacts on ecosystems and their biodiversity (Balvanera *et al.,* 2016). The significance of declines in biodiversity and the consequences for ecosystem services are increasingly being recognised. For instance, the over-exploitation of fish stocks has led to declines in marine biodiversity via by-catch and fisheries collapse.

Declines in numbers and diversity of wild insect pollinators have been linked to changes in fruit set for many highly valuable crops. In the absence of effective management, the effects of declining biodiversity and ecosystem degradation will be exacerbated by climate change, with consequences, especially for the well-being of future generations.

Biological diversity represents the natural wealth of the Earth and provides the basis for life and prosperity for the whole of mankind. However, biodiversity is currently vanishing at an alarming rate all over the world. A diversity of species and ecosystems is a key indicator of the health and resilience of urban landscapes and their contribution to the quality of life and human health. Thus, the ecosystem services concept highlights the importance of biodiversity for human wellbeing. This has resulted in a shift in philosophy on nature conservation from being species-centred with an emphasis on site protection approaches to an ecosystem-oriented one, focused on an integrated conservation infrastructure. Landscape connectivity, between habitat patches, wetlands, green space, natural elements and different ecosystems, is essential for the conservation of biodiversity and ecological flow.

Losing species can impact a wide variety of ecosystem processes such as primary production and nutrient cycling and promote the loss of other

ecosystem services (Byrnes *et al.,* 2014). These ecosystem services include water management, urban cooling, air quality, food production, storm-water and disease control and recreational, aesthetic, spiritual and psychological benefits. Green spaces in cities can help to alleviate the effects of climate change, including providing flood protection, shading vegetation for urban cooling and biomass for carbon storage. For instance, it is estimated that increasing tree canopy cover in Australian cities by 10% could contribute to reducing surface temperatures from paving, walls and roofs by 15%. Carbon dioxide (CO_2) is considered one of the greenhouse gases (GHGs) that has been associated with global climate change. Since pre-industrial times, global CO_2 has increased by 40% (Dabasso, Taddesse and Hoag, 2014).

Several urban planning strategies for landscape connectivity and biodiversity conservation have been identified and these include green wedges, green infrastructure, ecological networks, patches, corridors, domestic gardens, vacant or derelict land and green roofs and walls. Furthermore, with the aims of enhancing the quality of life, place and environment across different scales and boundaries and improving the ability of the ecosystem in coping with natural disasters or climate change, economic and social crises, resilience is defined as the main goal of green infrastructure planning approach. Also, the main goal of climate adaptation strategies is mandating or facilitating changes in socio-economic systems to reduce the vulnerability of the ecosystem to climate change (Ramyar, 2017).

Studying biodiversity impact on ecosystem functioning in multitrophic systems is important for several reasons:

(1) multiple trophic levels are common in ecosystems and extinction threats appear to be higher for species at higher trophic levels;
(2) changes in consumer richness can have effects on ecosystem functioning that are as large as, or even larger than, comparable changes in primary producers' richness(Thibault and Loreau, 2006).

Therefore, this chapter serves to examine the importance of the relationship between ecosystems and biodiversity in the promotion of resilient and sustainable African urban environments.

CITIES, ECOSYSTEMS AND BIODIVERSITY AT A GLOBAL SCALE

A city, as an ecosystem, does not operate under vacuum conditions. It is a dynamic and wide process. Urbanisation and ecological urban environment are analysed at various global, national, sub-national and local levels (Cepeliauskaite and Stasiskiene, 2020).Scientific research of the 20th and 21st centuries revealed dramatic consequences of human intervention in natural ecosystems regarding the increasing rate of urbanisation and demand for various natural resources in urban territories. According to the UNDP(2017), several cities are struggling with environmental degradation, traffic congestion, lack of urban infrastructure and basic services, such as water supply, sanitation and waste management. Inadequate consumerism, which promotes industrial growth, the pursuit of a better life and its results are not only damaging to the natural ecosystem but also pose a threat to human health/safety and determine climate change (Cepeliauskaite and Stasiskiene, 2020).

Box 1.1: Showing Biodiversity and Ecosystem Changes from the 1990s (UNEP, 2008)

- In the last 300 years, the global forest area has shrunk by approximately 40%. Forests have completely disappeared in 25 countries and another 29 countries have lost more than 90% of their forest cover. The decline continues (FAO, 2001, 2006).
- Since 1900, the world has lost about 50% of its wetlands. While much of this occurred in northern countries during the first 50 years of the 20th century, there has been increasing pressure since the 1950s for the conversion of tropical and sub-tropical wetlands to alternative landuse (Moser *et al.,* 1996).
- Some 30% of coral reefs – which frequently have even higher levels of biodiversity than tropical forests – have been seriously damaged through fishing, pollution, disease and coral bleaching (Wilkinson, 2004).
- In the past two decades, 35% of mangroves have disappeared. Some countries have lost up to 80% through conversion for aquaculture, overexploitation and storms (Millennium Ecosystem Assessment, 2005a).
- The human-caused (anthropogenic) rate of species extinction is estimated to be 1000 times more rapid than the "natural" rate of extinction typical of Earth's long-term history (Millennium Ecosystem Assessment, 2005b).

The effect of trends such as these is that approximately 60% of the Earth's ecosystem services that have been examined have been degraded in the last 50 years, with human impacts being the root cause. At the same time, that global biodiversity loss has accelerated and humanity has become an urbanised species. More than half of all people now live in cities and this proportion is rapidly increasing (Zari, 2018). A second example of the overexploitation of biodiversity is the trade, in most cases illegal, of wild animals and plants for pet, food, ornamental, medicinal and other

purposes. In several cases, the illegally traded animals and plants can be endemic or threatening. It has been suggested that it is urban demand, associated with the generally higher incomes of urban residents (and not local demand), which is driving this wildlife trade in several parts of Asia and possibly around the world(UNU-IAS, 2010). Many of China's growing cities are located in low elevation coastal zones, hence particularly threatened by climate change-related issues, for instance, sea-level rise. Biodiversity enhancing initiatives could help build resilience in vulnerable areas, such as riparian or coastal areas, and mitigate the effects of climate change (UNU-IAS, 2010).More so, in a highly urbanised coastal region of the eastern United States, there is exposure to multiple pressures: urbanisation, invasive species and sea-level rise due to climate change.

Almost all forest patches were adjacent to urban development and a considerable proportion would be inundated in different sea-level rise scenarios. The majority of forests had been invaded by non-native species, most prominently by introduced shrubs and vines, while a great number of tree saplings were native. In addition, the riparian forests of the Danube within the metropolitan region of Vienna in Austria also, were highly susceptible to invasions by alien tree species. Interestingly, urbanisation was positively related to the presence of some, but not all, of the most frequent alien tree species (Kowarik, Fischer and Kendal, 2020). This has led to new or current developments to shift to a more ecological direction in many parts of the world. Many cities around the world are now developing integrated solutions to the major environmental challenges and transforming themselves into more sustainable and self-sufficient communities. There is a set of initiatives and implemented policies that have been carried out through so-called 'green factors'. It started in Berlin in Germany, during the 1990s by the biotope area factor (BAF). Also recently, the green space factor was implemented in urban development in 2001 in Malmö, Sweden and even more recent in 2007, the green factor in Seattle(Dizdaroglu, Yigitcanlar and Dawes, 2009).

CONCEPTUAL FRAMEWORK

Biodiversity: The concept of biodiversity is a contraction of biological diversity and refers to the variability of, and the complex interactions between, living species, genetic material and ecosystems. Biodiversity broadly encompasses the number, abundances, functional variety, spatial distribution and interactions of genotypes, species, populations, communities and ecosystems(Balvanera *et al.,* 2016). The concept became

widely used from the 1980s onwards in response to an increase in interest in biological conservation and began to be embraced by urban planners and designers to improve urban structures as habitats for nature and the protection of ecosystems. The current approach for considering biodiversity in urban planning is to focus on the remnant, biologically dominant patches of habitat such as urban forests and wetlands for rehabilitation and protection. It can be argued, however, that this ignores the potential for urban biodiversity in other urban spaces such as parks, gardens, road edges and vacant lots. Another consequence of this approach is that biodiversity must compete with the many other priorities of urban planners, such as economic development and transportation. A second approach is reflective of the growing interest in the benefits of ecosystem services. The majority of ecosystem structures and functions, on which ecosystem services depend, are influenced by biodiversity.

Ecosystem Services Concept: Ecosystem services are the benefits that humans derive, either directly or indirectly, from the functions of ecosystems (Zari, 2018). The delivery of service arises from the interaction between its supply and the demand from stakeholders who benefit from it. The benefit and value of service reflect how people assign importance to the service, which can be evaluated in terms of market value or from a cultural perspective. For example, primary production (an ecosystem process) is needed to maintain an abundance of the fish population (the service supply), which can be harvested to provide food (delivery) and high nutritional value (benefit). As another example, nutrient cycling (process) is needed for water purification (supply) to provide clean water (delivery) for domestic use (benefit).All terrestrial, freshwater and marine ecosystems provide multiple ecosystem services. However, some ecosystems are particularly important in that they provide services that directly contribute to human health, livelihoods and wellbeing by providing services and goods to fulfil daily needs. Actions taken to protect and restore such ecosystems will have benefits for biodiversity and human wellbeing.

Natural assets are found across Africa. Provisioning services from forest ecosystems, notably timber and fuelwood from trees, medicinal plants and animals, wild foods and bushmeat from wildlife species, are the critical sources of maintaining food, medicine and livelihoods for many African people, particularly poor forest dwellers (UNEP-WCMC, 2016). Human survival is dependent on biodiversity, that is, the diverse range of

organisms inhabiting the planet. This is because they affect ecosystem processes and functions and, therefore, ecosystem services (Zari, 2018).

The Ramsar Concept of "Wise Use": The pioneering 'Wise Use Guidelines' emphasized the importance for contracting parties to:

- adopt national wetland policies, involving a review of their existing legislation and institutional arrangements to deal with wetland matters (either as separate policy instruments or as part of national environmental action plans, national biodiversity strategies, or other national strategic planning);
- develop programmes of wetland inventory, monitoring, research, training, education and public awareness; and
- take action at wetland sites, involving the development of integrated management plans covering every aspect of the wetlands and their relationships with their catchments.

The Wise Use Guidelines also emphasized the benefits and values of wetlands for sediment and erosion control; flood control; maintenance of water quality and abatement of pollution; maintenance of surface and underground water supply; support for fisheries, grazing and agriculture; outdoor recreation and education for human society; and climatic stability.

The Concept of Urban Ecology: The most popular definition for urban ecology in natural sciences implies the study of the interactions between biotic and a biotic in the urban environment, using similar approaches and techniques as in the natural environment, an emerging interdisciplinary field that aims to understand how humans and ecological processes can coexist in human-dominated systems and help societies with their efforts to become more sustainable (Cilliers and Siebert, 2012). This is where the idea of eco-cities (ecological cities) was adopted from. The idea of building an 'eco city' harks back to the mid-1970s when the Urban Ecology group was set up with the aim of (re)constructing cities in balance with nature.

LITERATURE REVIEW

Cities are complicated complex systems and the human factor, its dominance and impact, have led to various changes in the concept of the ecosystem in terms of climate, soil, water circulation, species composition, dynamics of population, energy and material flows and formed a unique urban ecosystem phenomenon (Cepeliauskaite and Stasiskiene, 2020; Kowarik, Fischer and Kendal, 2020; Acuto, 2020). According to UNEP-WCMC (2016), over three million hectares of natural habitat are converted

for other uses each year in Africa. Many studies have found out that the major causes of deforestation and forest degradation come from subsistence and commercial agriculture, timber extraction, urbanisation and the rise of biofuel plantations (Bryan *et al.,* 2011; Nyamadzawo *et al.,*2015; Azam and Khan, 2016; Balvanera *et al.,* 2016; Zari, 2018). Cities are responsible for 80% of the GHG emissions causing climate change (Thomas, 2017). The design of urban areas with increased impermeable surfaces and reduced vegetation also contributes to urban heat island effects, exacerbating heat waves that adversely impact public health (Heymans *et al.,* 2019). Dizdaroglu, Yigitcanlar and Dawes (2009) have argued that as a result of development pressure on green fields, urban green areas are reduced, scattered and polluted. The development of transportation networks caused negative impacts such as energy consumption, emission of air pollutants, traffic congestion and noise.

The well-being of every human population in the world is fundamentally and directly dependent on ecosystem services, as land-use changes and how they depend on different levels of biodiversity (Balvanera*et al.,* 2016). A few empirical studies suggest that diversity may increase the provision of several ecosystem processes simultaneously, the so-called 'multifunctionality' of ecosystems and that effects of diversity on multifunctionality may not saturate at the low levels typical of single functions (Byrnes *et al.,* 2014). In the system of human ecology, it can be argued that abiotic (atmosphere, temperature, water, minerals and waste), biotic (materials, food, energy and waste), cultural (law, economics, technology, politics, ideology, values and lifestyle) and human factors interact with each other in the city area (Cepeliauskaite and Stasiskiene, 2020; Zari, 2018). The latter system highlights the ability of humans to dispose and transform natural resources that are dependent on legal regulation, consumption and production processes, technological development, values and ideology. consumers may modify the relationship between diversity and primary production as multitrophic diversity increases, average ecosystem properties could increase, decrease, stay the same or follow more complex non-linear patterns (Schwarz *et al.,* 2017). Humans may also transform and adapt natural resources into urban ecosystems which include blue and green spaces, such as parks, cemeteries, yards, gardens, forests, swamps, rivers, lakes and ponds. Therefore, in the context of urban planning, the urban ecosystem is represented as a synthesis of green and built infrastructure (Cepeliauskaite and Stasiskiene, 2020).

It is, therefore, undeniable that humanity receives countless benefits from the natural environment in the form of goods and services such as food, wood, clean water, energy, protection from floods and soil erosion. Today's global consumption and production patterns are underpinned by ecosystems around the world. Many different types of policies can affect the resilience of natural and human-modified ecosystems. There is need to increase biodiversity in urban landscapes. According to Balvanera *et al,* (2016), there are three main ways in which increased biodiversity may result in increased ecosystem service provision and explain how the decreasing biodiversity could lead to a decrease in ecosystem services. First, complementary differences between species, combined with spatial heterogeneity, could lead to the whole community providing services at rates greater than the sum provided by its component species. This is currently referred to as the complementarity effect. If different species respond differently to environmental changes, theory predicts that community variability should decline with increasing species richness. Thus, biodiversity can also provide an 'insurance' or a buffer against environmental fluctuations, leading to the more predictable aggregate community or ecosystem properties (The´bault and Loreau, 2006; UNEP, 2008; Dabasso, Taddesse and Hoag, 2014; Kupika *et al.,* 2019).

There is need for urban areas to build ecosystem resilience. Ecosystem resilience means the capacity of ecosystems to absorb and adapt to disturbances while preserving their ecological functions and without moving to a new state governed by different processes and controls (UNEP-WCMC, 2016).Africa has a long experience with ecosystem-based conservation and restoration, including afforestation, rangeland regeneration, catchment rehabilitation and community-based natural resource management. One of these conservation methods includes local ecological knowledge (LEK) which refers to knowledge, practices and beliefs shared among local resource users regarding ecological interaction within an ecosystem (Kupika *et al.,* 2019).

METHODOLOGY

Research approaches are plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation (Creswell, 2014). The study made use of documentary analysis, descriptive statistics and secondary data analysis.

Documentary analysis assists in the enhancement of the reliability of the chapter(de Falco, Angelidou and Addie, 2019). Documents used include books, journals, websites and newspaper articles. Secondary data sources such as United Nations reports on climate change, ecosystem and biodiversity, journal articles and books were also used. Data obtained were then processed into information and analysed through the use of thematic content analysis. Thematic content analysis is the use of textual material in research, reducing it to more relevant, manageable bits of data. It is also a method of analysing the text of social investigation among the set of empirical methods (Kumar *et al.,* 2020). After summarising literature, it was assembled and structured thematically into important concepts. This assisted the chapter in bringing out themes such as spatial planning, urbanisation and climate change that need to be understood to implement efficient and sustainable policies.

RESULTS AND ANALYSIS

Africa is immensely rich in biodiversity. Its living organisms comprise around a quarter of global biodiversity and it supports the earth's largest intact assemblages of large mammals, roaming freely in many countries. Africa's biomes extend from mangroves to deserts, from the Mediterranean to tropical forests, from temperate to sub-tropical and montane grasslands and savannahs and even to ice-capped mountains. There are many examples of success and innovation in the conservation of Africa's biodiversity, yet Africa is also experiencing unprecedented rates of population growth, urbanisation and agricultural development, that create immense challenges in reconciling human well-being with environmental and economic prosperity(UNEP-WCMC, 2016).

It has been recorded that in 2014, 6419 animal and 3148 plant species in Africa were recorded as threatened with extinction on the IUCN Red List. Of all freshwater species in Africa, 21% are recorded as threatened and 45% of freshwater fish and 58% of freshwater plant species are over-harvested. African birds show a decline over the past 25 years, meaning that African birds are increasingly at risk of extinction (Birdlife International unpublished data). Trends for other groups are also likely to be negative. African vertebrate species where data are available is calculated to have declined by around 39% since 1970. Declines are more rapid in Western and Central Africa than in Eastern or Southern Africa. Population trends in smaller species are generally unknown (UNEP-WCMC, 2016).

Table 1.1: *The Relationship between People, Cities, Biodiversity and Ecosystems* (Adopted from Zari, 2018)

The Impact of Cities on Biodiversity	The Impact of Biodiversity on People in Cities
Land-use and land cover change, including urbanisation,18-20	a. Human physical health,27,28 and
ii. Climate change,21,22	b. Human psychological health,29,30
iii. Nitrogen deposition and acid rain,23 and	c. Societal and cultural health,14,31
iv. The introduction of invasive species to ecosystems (biotic exchange).5,24	d. Economic health and stability.

Africa is mostly dependent on agriculture as a primary source of food. There is no sign that the pressure for conversion from natural ecosystems towards arable land will abate. Demand for food is set to increase as populations grow and their consumption shifts towards meat. Supply cannot keep pace as yields are growing only slowly (UNEP, 2008). The growing population and demand for land in urban landscapes in Africa is worsening the threat to biodiversity loss.

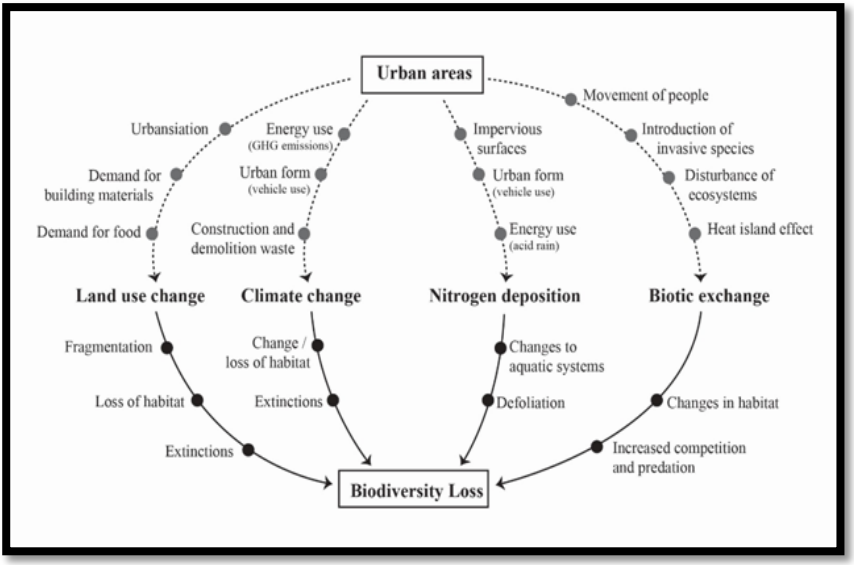

Figure 1*: Built Environment Drivers of Biodiversity Loss* (Zari, 2018)

Ecosystem services are highly dependent upon the health and diversity of species and ecosystems. Biodiversity requires a high degree of

connectivity between natural spaces and different ecosystems for ecological flow and to conserve habitat. Multifunctional, multi-scale and multi-object green infrastructure provide the ability to deliver multiple, connected ecosystem services into the built environment, both spatially and temporally. It can include integrated networks of green and blue spaces and hybrid structures of artificial and natural elements such as green walls. Cities are socio-ecological systems and unpredictable, hence the sustainability of the system is dependent on its resilience capacity. This needs to be inclusive of all human and non-human inhabitants of cities to encourage virtuous cycles or feedback loops that produce or enhance ecosystem services and other positive social and ecological outcomes. Thus, biodiversity and ecological connectivity are important to resilience capacity.

Biodiversity, Climate Change and Water Conservation in African Urban Landscapes

There is growing pressure on water resources, that is, both the supply of water and its quality. Many parts of the world live with water stress and Africa is amongst the most threatened. Many cities in countries such as Zimbabwe, Ghana are now depending mostly on community taps or boreholes due to higher demand and low supply of high-quality water. Urban sprawl and peri-urban development in African cities have also put on more pressure on natural resources. How a city interacts with its hinterlands shows clearly how biodiversity and ecosystems can be unbalanced by urban demands. These findings are in line with those of the UNEP-WCMC(2016), who state that many habitats are subject to tremendous pressure from resource use and development and expanding human populations. Mangroves, moist and seasonally dry forests and wetlands have all declined significantly over the past 20 years, with the declines typically being in the range of1% loss per annum.

Biodiversity loss has led to more frequent and intense climate extremes such as droughts and floods and increased variability in soil moisture and surface water. Drying up of rivers and poor water quality in surface and groundwater systems have been studied to have a causal relationship as the impacts on water resources act in conjunction with other factors to affect ecosystem health and socioeconomic well-being of human communities (Gambe and Dube, 2015). For instance in Kenya, climate change interacts with anthropogenic activities along rivers to contribute to

the reduction of river water volume over time and weakening of critical ecosystems like forest watersheds (Kupika *et al.,* 2019).

Water quality is often determined by levels of chemical (e.g., nitrates), microbiological (e.g., faecal bacteria), or physical (e.g., soil particles) pollutants. The amount of pollutants that is acceptable varies among different types of uses (e.g., irrigation vs. drinking water) and among contexts (e.g., different countries). The avoidance, removal and storage of these pollutants are key ecosystem services. The chemical, microbiological and physical quality of water at the point of human use can depend on many factors. For example, chemical pollutants can be regulated by river organisms through the processing of nutrients or toxic substances during metabolic breakdown. Transiting chemical pollutants are exported through the food web and can find their way either downstream or to the top of the food chain. Microbiological quality is often linked to catchment management (Wilkes *et al.,* 2013). River physical quality, for example, temperature or flow, is often dependent on the character of riparian vegetation.

Unsustainable harvesting of fish and inappropriate fishing methods, and wetland drainage for agriculture, are putting increasing pressure on African freshwater systems. Water pollution from excess nutrients, domestic and industrial organic loads, pesticides and heavy metals and the impacts of invasive species. These pressures are resulting in biodiversity degradation in freshwater ecosystems, especially in East Africa's Lake Victoria, the Mediterranean and Atlantic coasts of Morocco and many major African rivers (Darwall *et al.,* 2011). Furthermore, according to UNEP and UN-Habitat(2005),while not strictly migratory, the Lesser Flamingo moves frequently between the soda lakes of Kenya and Tanzania. The flamingos are a key tourist attraction for the town of Nakuru in Kenya's Rift Valley. Urban encroachment on Lake Nakuru, however, has affected water levels in the lake and the release of untreated industrial waste and sewage is damaging the lake's ecosystem. These developments are threatening the flamingo population and leading to fears for the economic and environmental sustainability of the town.

BIODIVERSITY AND CREATIVE SMART CITY SOLUTIONS IN AFRICAN URBAN LANDSCAPES

Incorporation of biodiversity into cities through ecosystem services provision Ecosystems services analysis (ESA) is a means by which the

concept of ecosystem services is specifically applied to urban areas. ESA was developed to quantitatively measure past and current ecosystem services provision on a given site (predominantly cities) to compare these figures and determine site-specific design or policy goals that are based on the healthy ecological functioning of the site. The impetus behind developing ESA was that one way to reduce or to reverse the negative ecological impact of the built environment, may be to create or re-design cities so that they provide, integrate with, or support, ecosystem services and, therefore, reduce pressure on both local and distant ecosystems and biodiversity pressure.

Smart city solutions have been implemented in different parts of the African continent to conserve the environment. These solutions have been linked to produce environmental social and cultural benefits. In Africa, there is evidence that ecosystem and diversity provide a broad spectrum of non-tangible and non-market benefits to human well-being (i.e., psychological health, social relationships and cohesion). These may also be termed cultural services. It follows that cultural services should be analysed considering the range of services (recreational activities and tourism, aesthetic values, spiritual values, local identity, etc.) and the range of values given to each service by individuals. These values are also at the very core of any decision relating to managing, provisioning or regulating services. Differences in vegetation colour, often related to leaf nitrogen content, can be associated with the aesthetic value of landscapes. At the species level, functional traits of vegetation are significant for the supply of specific cultural services, such as recreation and aesthetics.

BIO-MIMICRY ARCHITECTURE: A CASE OF EASTGATE SHOPPING MALL HARARE, ZIMBABWE

The Eastgate Shopping Mall in Harare, Zimbabwe, typifies the best of green architecture and ecologically sensitive adaptation. The country's largest office and shopping complex is an architectural marvel in its use of bio-mimicry principles. The mid-rise building, designed by architect Mick Pearce in collaboration with Arup engineers, has no conventional air-conditioning or heating, yet stays regulated year round with dramatically less energy consumption using design methods inspired by indigenous Zimbabwean masonry and the self-cooling mounds of African termites.

Figure 2: *Eastgate Shopping Mall, Harare* (Pearce, 2017)

The Eastgate Shopping Mall, largely made of concrete, has a ventilation system that operates similarly. Outside air drawn in is either warmed or cooled by the building mass, depending on which is hotter, the building concrete or the air. It is then vented into the building's floors and offices before exiting via chimneys at the top. The complex also consists of two buildings side by side that are separated by an open space that is covered by glass and open to the local breezes.

Africa has been making considerable efforts to build ecosystem resilience as a contribution to climate change mitigation and adaptation. In many cases, these efforts build from the traditional practices of African peoples who have developed land and water management strategies that facilitate conservation outcomes. Several African countries are taking actions related to restoration. For example, Algeria, Benin, Chad, Morocco, Niger, the Seychelles and Sudan, have restoration projects, including reforestation, underway. Burundi and Côte D'Ivoire have commenced the process of determining the carbon sequestration capacity of forest ecosystems by integrating REDD+ and Cameroon uses protected areas as a tool for ecosystem restoration. Communities from different parts of the world use local knowledge about ecosystems to recognise and respond to the impacts of climate change and variability. African rural communities have been documented as constructing climate change realities based on

their experiences of the impacts and effects (Kupika *et al.,* 2019), while African urban communities are utilising green projects such as green roofs, walkways and biomimicry buildings as part of their urban ecological designs.

Box2: Impact of Fisheries Subsidies in Senegal.

Government subsidies at national level also have consequences on African fisheries. In Senegal, some 600000 people (about seventeen percent of the working population) depend on fisheries for their livelihoods. Senegal's rich fish resources are being depleted due to overfishing carried out mainly by local fishermen. This overfishing is driven by government subsidies that have been in place since the 1980s, including no taxes on outboard motors and fishing gear; a fuel subsidy for artisanal fleets; micro-credit for small-scale fisheries; and export subsidies. These subsidies have been a decisive factor in modernising small-scale fishing equipment, facilitating the use of more powerful engines and opening up new fishing areas, ultimately leading to overfishing. Although increased fish production supported by fisheries subsidies can greatly contribute to the national economy through increased exportation, subsidies that provide incentives for overfishing should be addressed with a broader perspective that considers the role of biodiversity and ecosystem services in the long-term poverty alleviation. Although these impacts are significant locally, they are overshadowed by the impacts of subsidised fleets from distant countries fishing in offshore waters

Source: UNEP (2008).

BIODIVERSITY PLANS AND POLICIES IN AFRICA: A CASE OF SOUTH AFRICA

South Africa initiated a process to develop a National Biodiversity Strategy and Action Plan in May 2003. The Department of Environmental Affairs and Tourism (DEAT).

The new millennium saw the coming of age of various research initiatives to establish a systematic conservation plan for the Cape Floristic region as one of the global biodiversity hotspots. The City of Cape Town is unique in terms of its high biodiversity, including a large diversity of endemic and endangered vegetation types and species and should, therefore, be conserved (Cilliers and Siebert, 2012). It was noted that changes in biodiversity will likely lead to trade-offs in ecosystem service provision. For example, converting diverse grassland to cropland tends to provide high levels of crop production but low levels of many other ecosystem services. There is now considerable evidence that different ecosystem processes depend on different sets of plant species (Isbell *et al.,* 2011). Furthermore, more diverse plant communities can provide higher levels of multifunctionality and higher levels of multiple ecosystem services (Balvanera*et al.,* 2016). The presence of inedible species and a trade-off

between plant competitive ability also strongly affects the relationships between diversity and ecosystem processes. There is the initiation of smart ecological urban designs with the inclusion of plants and animals that assist in promoting the provision of ecosystem services that help in providing good air and water quality and carbon sequestration in urban areas.

Most efforts in African cities are centred mainly on rural lands than urban lands. Urban landscape solutions to keep the resilience of ecosystems and biodiversity are still being conducted at a small scale. Despite all the efforts made by African countries to protect biodiversity and ecosystem services in their urban landscapes, there is room to do more and adapt other strategies to promote spatula-human relations or human interactions with the environment. Thus, consideration needs to be given to a more harmonious human-environment relationship that reframes humans as intrinsically part of and fundamentally dependent on the natural world. There is evidence that such a new ecological paradigm is emerging, based on a synthesis of older philosophies and evidence-based findings from new research in ecology, physics, social sciences, sustainability and resilience. This paradigm is based on a whole-systems perspective of socio-ecological systems that emphasizes interconnection, interdependence, adaptability, co-creation and co-evolution and the reciprocal relationship between humans and nature. The role of cities in harbouring high levels of biological diversity and important components of biodiversity, such as endangered species, is increasingly evidenced in developed countries.

DISCUSSION

Designed urban green spaces offer many opportunities as shared habitats for people, plants and animals. One important opportunity is the introduction of biodiversity-sensitive management techniques to manage particular land-uses. Cemeteries in Chicago, United States, are home to a considerable number of cavity-nesting birds. They reveal how landscape-level features explain patterns in the species richness of these bird species. Creating more biodiversity-friendly cemeteries include promoting sufficient snag availability, sympathetic mowing regimes and planting designs such as clusters of trees and shrubs to promote particular species. Novel management techniques could help overcome some pressures on native grasslands, such as using trees to create habitat complexity and refugia for some native species in grasslands where natural disturbance by

fire has been suppressed. Biodiversity sensitive planning is also an important pathway to achieving conservation with sustainable development. While habitat fragmentation is an ubiquitous challenge in urban regions, for example, a set-aside railway bridge in Basel, Switzerland, small-scale measures can make useful contribution to addressing this challenge. It is revealed that abandoned elements of the transportation infrastructure can help connect urban habitats for a range of animal tax a and should thus be integrated into urban biotope network schemes. The habitat functions of forests emerging on vacant urban land in Berlin, Germany, for plants and invertebrates, is argued to be a solution that should be used to integrate these informal ecosystems into the urban green infrastructure. Cities provide opportunities for new approaches to supporting biodiversity that would not be feasible in most rural landscapes. Green roofs and constructed wetlands are important decentralised eco-technologies for the adaptation of cities to climate change.

CONCLUSION

Urbanisation is a defining feature of the modern human-dominated geological age. However, the prevailing model of urban development profoundly alters the natural environment, reduces biodiversity and threatens human well-being. Incorporating connectivity for urban biodiversity and ecosystem functions into the planning of urban spatial form requires a better understanding of the functions and services of biodiversity for human wellbeing. There is much evidence that many scientists and agencies or organisations use green infrastructure to address the ecosystem consequences of environmental pressure. Cities must become key players in global efforts to conserve and restore biodiversity. At the same time, if the goal of urban design is to create or retrofit cities so that they support the wellbeing of people, the support and regeneration of urban biodiversity must be integrated into design decision making and interventions. This may help to reframe the essential human-nature relationship and may be of use to designers or policy-makers working to create highly sustainable or even potentially regenerative urban areas. To progress this agenda, urban design concepts and methods that enable cities to produce ecosystem services in greater volume are needed. The ecosystem services analysis concept is one such method.

The intersection of biodiversity, urban environments and people is a fascinating and important field of research. It is also a promising arena for

urban policies aiming at reconciling urbanisation processes with biodiversity in urban regions—for the sake of both urban residents and urban nature. Many are not always conscious of the links between the surrounding environment and well-being, hence may not always take the true value of ecosystems into account in the decision-making processes. Considering the true value of ESA in policies and decision-making could help better management of resources in a way that would benefit humans economically, environmentally and socially.

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CHAPTER 4: Understanding the Cityscape: Towards a Systematic Design that Embraces Climate Change and Ecology

Abstract

Rapid urbanisation has caused several changes around urban and rural landscapes in developed and developing regions. These changes have seen the alteration of climate and the environment. This chapter highlights and argues on the significance of designing and managing public urban spaces and city features with the consideration of the current trends in climatic and ecological systems. Growing populations in urban areas mean that on landscapes, there's an increase in deforestation, the environment is changing and so are the atmospheric conditions surrounding urban areas. There is need to consider implementing designs that embrace components such as vegetation in the city centre. The chapter highlights that there is need to promote urban resilience through urban design. Therefore, the chapter bases on the concepts of environmental design and urban ecological design. These concepts help examine the different strategies that can be implemented through urban design that are socially, ecologically and aesthetically engaging with the sustainability of the built environment in the face of climate change.

INTRODUCTION

The world's climate is changing and it will continue to change throughout the 21st century and beyond (Rosenzweig *et al.,* 2015). Rising temperatures, new precipitation patterns and other changes are affecting many aspects of human society and the natural world (Chapman *et al.,* 2017). Cities around the world are facing an ever-increasing variety of challenges that seem to make more sustainable urban futures elusive. In the last 50 years, the valuation and preservation of nature have been the core issues for ecological development and sustainability (Khajurira *et al.,* 2008). Many of these challenges are being driven by and exacerbated by increases in urban populations and climate change. Anthropogenic greenhouse gases (GHGs) are responsible for the current climate change. Living organisms are intimately connected to their physical surroundings (Nyamadzawo *et al.,* 2015). Even small changes in the temperature of the air, the moisture in the soil, or the salinity of the water, can have significant effects. Each species is affected by such changes individually,

but those individual impacts can quickly reverberate through the intricate web of life that makes up an ecosystem. Urban areas are responsible for more than 70% of the emissions, with over half of the world population living in urban areas (While and Whitehead, 2013). It is crucial to develop more sustainable urban areas that will significantly reduce the carbon footprint of cities while at the same time taking into account the rising temperatures and the vulnerability of the urban spaces (Skutsch and Ba, 2010). Considering climate change and ecological changes occurring in the atmosphere helps to create sustainable infrastructure, mobility and housing. Almost all of the impacts of climate change have direct or indirect consequences for urban ecosystems, biodiversity and the critical ecosystem services they provide for human health and wellbeing in cities (Chirisa *et al.,* 2016). These impacts are occurring in urban ecosystems and their constituent living organisms.

Urban planning and urban design have a critical role to play in the global response to climate change (Ren, 2017). Adaptation strategies and actions that simultaneously reduce GHGs emissions and build resilience to climate risks should be prioritised at all urban metropolitan regions, cities, districts/neighbourhoods, blocks and buildings. This needs to be done in ways that are responsive to and appropriate for local conditions (Rosenzweig *et al.,* 2015). Many adaptations and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link mitigation and adaptation with other societal objectives. Therefore, urban design is a discipline that integrates many other disciplines in adapting to ecological and climatological changes through the use of environmentally friendly urban designs (Tompson, 2017). Thus, the task of anticipating climate change has prompted growing interest in the science (and politics) of urban climatology and its intersection with issues of urban form and design (While and Whitehead, 2013).

There is need to use urban design as an adaptation/ mitigation strategy to various ecological and climatological changes because cities are recognised as the priority source of pollution (Bauer and Scholz, 2010). Most energy consumption is connected to cities, which have to make the greatest efforts to manage sustainable resources under the social, environmental and economic aspects and to improve the quality of life of their citizens (Gujiba *et al.,* 2012). Heat-waves in cities generate serious

inconveniences for the most vulnerable citizens, especially the elderly and children (NASA, 2020). Climate impact requires the use of innovative solutions and the rethinking of urban management and planning. New urban and territorial structures, low-energy consumption buildings and infrastructures, green areas and the adoption of advanced technologies mitigate global emissions and local pollution, promote adaptation to climate change, reduce the energy costs of families and businesses and improve the climate of cities (Ziervogel*et al.,* 2014).

BACKGROUND OF ECO-FRIENDLY URBAN DESIGNING

In Europe, urbanisation processes are progressing rapidly, causing soil sealing and the reduction of its functions and quality (Van Noorloos and Kloosterboer, 2018, Paranunzio *et al.,* 2019). One of the major consequences of urbanisation, in terms of the impact on human health and environmental quality, is the "urban heat island" (UHI) effect (the phenomenon whereby cities appear to be warmer than the surrounding rural area) (Azam and Khan, 2016; Chapman *et al.,* 2017). It is estimated that climate change will greatly aggravate the extent of the UHI, particularly in hot regions characterised by periods of summer dryness such as the Mediterranean Basin. The UHI effect has caused various changes in climate and climatic regions, for instance, in the Arctic, shrubs are slowly infiltrating the territory where once there was only ice, snow and lichens (Chirisa *et al.,* 2016; Matenga, 2019). Although these unassuming, stunted plants may not seem like much of a threat, their expansion driven by warming temperatures across the Arctic is causing a cascade of ecological impacts through the region's food chain. This has led many regions around the world to implement urban designs that are environmental friendly (Khajurira *et al.,* 2008).

In the 1960s and 1970s, in the context of an increasing focus on environmental issues, scholars and practitioners began to give greater recognition to an ecological approach to urban planning and design (Skiyi *et al.,* 2016). The growth of interest in this area has been particularly noticeable in the past 30 years, with a range of theoretical concepts being put forward, including ecosystem services, landscape urbanism, urban ecology, landscape ecology, biophonic design, resilience planning and regenerative design (UNFCCC, 2007; Kupika *et al.,* 2019; Matenga, 2019).A range of tools, frameworks and assessment systems have also been developed to support the application of ecological principles into building design, landscape architecture and urban planning. Globally, over

the last 15 years, a very significant effort has been made to transform our thinking and, therefore, our language about nature and economic relationships, in particular; for example, the need to recognise the socio-economic value of ecological services (Harrison *et al.,* 2014; Kupika *et al.,* 2019)

The first example of eco-architecture is believed to have been built during the energy crises in the 1970s in Minnesota. What has been regarded as "Ouroboros architecture" was constructed by environmentally friendly principles, minimising the harm on the environment through the emission of its components (Terranova and Tromble, 2016). In 1990, the United Kingdom established the first green architecture environmental assessment method. The United States took the helm in energy and environmental design, building a rating system in 1998 (Azhara *et al.,* 2011). China, with its rapid urban sprawl, began to set up an eco-architecture assessment system after 2006, whereby ecological building sites were to meet the standards of harmlessness in design, construction, use and demolition. China has made eco-city development, eco-restoration and eco-civilisation its legislative priority and its national strategy. By realising the importance of "lucid water and lush mountain" (Wang *et al.,* 2019), China committed to protect natural forest reserves, restore its forest ecosystems and increase the forest coverage rate from 8% in the late 20th century to 22.6% recently.

CONCEPTUAL FRAMEWORK

This chapter is based on concepts of urban design and the environment and its components. These theories are used in this chapter with the intention of bringing out the importance of ecology and climate in spatial planning and urban design. These concepts include urban design, environmental design and ecological civilisation concepts.

THE URBAN DESIGN CONCEPT

Urban design describes the physical features that define the character or image of a street, neighbourhood, community, or the city as a whole. Urban design is the visual and sensory relationship between people and the built and natural environment (Davoudi, 2008). The built environment includes buildings and streets and the natural environment includes features such as shorelines, canyons, mesas and parks, as they shape and are incorporated into the urban framework. Citywide urban design

recommendations are necessary to ensure that the built environment continues to contribute to the qualities that distinguish the City of San Diego as a unique living environment (Gurran *et al.,* 2015). The urban design element addresses urban form and design through policies aimed at respecting the natural environment, preserving open space systems. Urban design can help lower GHG emissions that are causing global climate change. Providing for the needs of pedestrians, bicyclists and mass transit users will help reduce fossil fuel use by personal vehicles. Current design practices often make it difficult to leave the car at home (Salizzoni *et al.,* 2020).

CONCEPT OF ECOLOGICAL CIVILISATION

Ecology is the study of the relationships between living organisms, including humans and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them. The World Bank (2018) defines eco-cities as:

> "cities that enhance the well-being of citizens and society through integrated urban planning and management that harness the benefits of ecological systems and protect and nurture the natural assets for future generations (Mtambanengwe, 2005).

Ecological civilisation differs from sustainable development in the emphasis placed on political and cultural factors and on defining new relationships between people and nature that would permit living well and within the eco-environmental bounds of planet Earth. However, some people term ecological civilisation as sustainable development (Brandl and Zielinska, 2020). As a form of human civilisation, ecological civilisation is based on natural respect and protection takes the harmonious symbiosis among human-human, human-nature, human-society as its purpose, establishing sustainable production and consumption patterns as its content and focusing on guiding people to get on the sustainable and harmonious development path. Ecological civilisation emphasizes human consciousness and self-discipline, stresses interdependence, mutual reinforcement and coexistence between human and natural environment. Ecological civilisation construction is systematic engineering, It needs respective correlative departments to integrate resources, coordinate work such as developing plans, propagandistic education, policy measures and systematic security (Elagroudy *et al.,* 2016).

URBAN ECOLOGICAL DESIGN CONCEPT

Eco-architecture design has been the theory, science and style of building designs and its themes may run through the whole construction process, guiding project feasibility demonstrations, environmental impact assessments, construction, building operation management, building materials recycling and beyond (Sekar *et al.,* 2019). Human ecology attempts to apply biological processes/concepts to the social world and maintains that the city and city life are the product of competition in the natural environment. Urban ecological design is a practice that is socially, ecologically and aesthetically engaging with aims to improve ecological functioning, preserve and generate resources for man use and foster more resilient approaches to design and management of the built environment (Mustapha, 2016). It also presents an interdisciplinary method of transforming urban spaces that considers the issue of ecology and the built environment. It inspires the use of ecosystems in urban design. The role of ecosystems is vital to the sustainability of growing and expanding urban spaces across the globe (Mustapha, 2016).

ENVIRONMENTAL DESIGN CONCEPT

Designing with nature is an approach linking design and ecology, focusing on living with nature, caring for nature and aiming for a sustainable society (Azam and Khan, 2016). This links the urban design and ecology, which focuses on living with nature, caring for nature and aiming for a sustainable society. It is also the process of addressing surrounding environmental parameters when devising plans, programmes, buildings policies or products. The environmental design creates visual solutions to the environment and human activities (Grimmond, 2007). It is used in designing several architectural infrastructures, such as walkways and playgrounds. Environmental design is critical for urban planning as it is an approach that assists in reducing GHGs in the atmosphere as the built environment contributes 50% of all man-made GHGs. Environmental designing includes considerations on the orientation of buildings, type of building materials, use of solar systems, that is, the use of less energy in architecture.

THE CONCEPT OF URBANISM

Urbanism is the patterns of behaviour, relationships and modes of thinking that characterises urban dwellers (Gilderbloom, 2018). The UNDP has projected that developing nations will urbanise faster than the developed world in the 20st century. The year 2007 was announced as a remarkable

point in human history when more than 50% of the world population lived in urban regions. Urbanisation occurs in three broad stages. First, there is an early period when improvements in agriculture lead to population growth and more densely populated settlements. Next comes a period of industrialisation (Bryceson and MacKinnon, 2012).

New jobs associated with industrialisation draw even more people from rural areas, often causing public-health crises as the cities become overcrowded and the infrastructure fails to keep pace with the population. Finally, specialisation of urban space occurs (Gurran *et al.,* 2015). This line of thinking by urban dwellers has contributed significantly to climate and ecological changes occurring in the earth and its atmosphere currently. Urban growth has been associated with polluted rivers, dirty air, contaminated lands and lost ecosystems. Since the early 1980s, a growing group of planners, architects and developers has been rebelling against "conventional" suburban development as it has been practised in the United States since the end of World War II. Instead, they have offered an alternative vision of suburban neighbourhoods and, indeed, an alternative vision of metropolitan areas as a whole. Therefore, new urbanism lies in a set of "neo-traditional planning" principles meant to restore both the physical design and social values. This includes eco-friendly urban planning and urban design (Gilderbloom, 2018).

LITERATURE REVIEW

Urban ecosystems and biodiversity have an important and expanding role in helping cities adapt to the changing climate. Harnessing urban biodiversity and ecosystems as adaptation and mitigation solutions will help achieve more resilient, sustainable and liveable outcomes (Ministry of Environment, Water and Climate Republic of Zimbabwe, 2013; Gurran *et al.,* 2015). Conserving, restoring and expanding urban ecosystems under mounting climatic and non-climatic urban development pressures will require improved urban and regional planning, policy, governance and multi-sectoral cooperation (Skiyi *et al.,* 2016). Despite not having received nearly as much attention as climate change, the reduction of flora and fauna, or the loss of biodiversity, is another major ecological threat that could potentially have comparably significant impacts (Nyamadzawo *et al.,* 2014). Humankind occupies an ever-increasing extent of planetary space and this has resulted in the harmful invasion of all other forms of eco-systemic life on Earth. In and of itself, this increases global risks (African Development Bank, 2011).

Urban planning is a concept that encompasses the entire set of prospective activities aiming at regulating the development of urban territorial systems (i.e. the regulation of land-use, infrastructure planning) (Wekwete 1989; Chirisa, 2014; Chigudu, 2020). Urban and regional planning can also be described as the capacity to manipulate shape and place. Urban planning can include urban renewal, by adapting urban planning methods to the existing cities suffering from decline (Salizzoni *et al.,* 2020). In the late 20th century, the term "sustainable development" has represented an ideal outcome in the sum of all planning goals, including climate change adaptation. The issue of urbanism has been the major factor in pushing urban planning that conforms to environmental standards (Gilderbloom, 2018). This has been because urbanism interferes widely both with the natural environment and the artificial or human-made environments, through complex theoretical and operational relationships, sometimes difficult to define and quantify. The imbalance between human activities and the environment has increased persistently (Zhou *et al.,* 2004; Uttara *et al.,* 2012; Ren, 2017). This has led to the planning system metamorphosing to keep up with changing circumstances such as the vendors' struggles by organising and mobilising them to revive the indispensable informal economy in Zimbabwe (informal economic sector reconstruction) (Gumbo and Geyer, 2011). Therefore, there is need for urban planning and design to also incorporate long-range strategies for climate change that reach across physical scales, jurisdictions and electoral timeframes (Ren, 2017). These activities need to deliver a higher quality of life for urban citizens as the key performance outcome.

Environmental urban design has led to the growth of eco-cities around the globe (Davoudi, 2008; Skiyi *et al.,* 2016; Tompson, 2017). An eco-city is an ecologically healthy, sustainable, energy-efficient, low-carbon, smart energy city and an ecosystem whose structure and function are self-sustaining and resilient. Eco-architecture, also known as "green architecture", "sustainable architecture", or "green building", not only skilfully utilises natural resources, but also brings a new concept of living, which is an important concept of Design with Nature (Elagroudy *et al.,* 2016; Mustapha, 2016; Gilderbloom, 2018). Eco-architecture has attracted

widespread attention in China. Sustainable development and energy conservation will become important . Eco-cities contain environmentally friendly designs that utilise new materials in building infrastructure. For instance, the properties of materials used in building envelopes and insulation values, play an essential role in the thermal response and environmental impact of buildings (Chirisa *et al.,* 2016). Primarily, two effects must be considered. Firstly, the envelope characteristics directly affect the heating and cooling loads generated to ensure indoor comfort and, secondly, the envelopes constitute an essential element in an urban site, transforming the microclimate, which in turn has a substantial impact on building energy demand and outdoor and indoor comfort (Yigitcanlar and Dur, 2010; UN, 2016; Ferrer, 2017).

It is sensible to explore envelope characteristics in a mitigation strategy for climate change and to exploit their direct and indirect effects on indoor comfort (NASA, 2020). Protecting, upgrading and increasing urban and peri-urban forests and street trees through the enhancement of the green infrastructures (GIs) is, therefore, fundamental for the sustainable development of urban areas that represent "demand areas for Ecosystem Services", the goods and services provided to man by nature (Gilderbloom, 2018). The management of climate change risk through adaptation, in particular through the reduction of vulnerability and exposure through development, planning and practices that include "low-regret" measures, i.e. those that produce benefits even in the absence of climate change and with which the adaptation costs are relatively low compared to the benefits of the action is vital to the protection of the environment (Ziervogel et a*l.,* 2014). Lastly, the maintenance of urban green spaces is one of the approaches suggested by SDGs 11 (Sustainable Cities and Communities) of the UN Agenda to 2030.

METHODOLOGY

Research approaches are plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis and interpretation(Creswell, 2014). The study made use of case study analysis, documentary analysis and secondary data analysis in the depiction of recent trends of urbanisation and climate change and in finding the relationship that exists between them. The case study analysis approach allows for an in-depth appreciation of a particular phenomenon

under study. Therefore, through the review of different strategies in urban design that are climatologically and ecologically friendly, the chapter was able to highlight the importance of environmental design. Documentary analysis assists in the enhancement of the reliability of the chapter(de Falco *et al.,* 2019). Documents used include books, journals and websites and newspaper articles. Data obtained were then processed into information and analysed through the use of thematic content analysis. Thematic content analysis is the use of textual material in research reducing it to more relevant, manageable bits of data, It is also a method of analysing the text of social investigation among the set of empirical methods (Kumar *et al.,* 2020). After summarising literature, it was assembled and structured thematically into important concepts.

RESULT AND DISCUSSION

Urban design, through environmental conservation lenses, has led to the development of various eco-cities around the world. Urban waste heat and GHG emissions from infrastructure, including buildings, transportation and industry, can be reduced through improvements in the efficiency of urban systems. Urban designers have influenced environmental designs at micro and macro levels, that is, designing layouts and designing single buildings.

CLIMATE CHANGE AND THE URBAN HEAT ISLAND

Urbanisation reduces green space, increases impervious surfaces and alters albedo and geometry compared to rural surfaces. Human-caused climate change presents significant risks to cities beyond the familiar risks caused by natural variations in climate and seasonal weather patterns. Urbanisation tends to be associated with elevated surface and air temperatures, a condition referred to as the urban heat island (UHI). Urban centres and cities are often several degrees warmer than surrounding areas due to the presence of heat-absorbing materials, reduced evaporative cooling caused by lack of vegetation and production of waste heat. This shows that traditional approaches to urban designing have failed to adapt to climatological and ecological changes occurring in the atmosphere. The heat emitted from insulated buildings has been a contributing factor to changes in climate, thus causing extreme events in many cities such as heatwaves, droughts, heavy downpours and coastal flooding which are projected to increase in frequency and intensity(Chapman *et al.,* 2017).

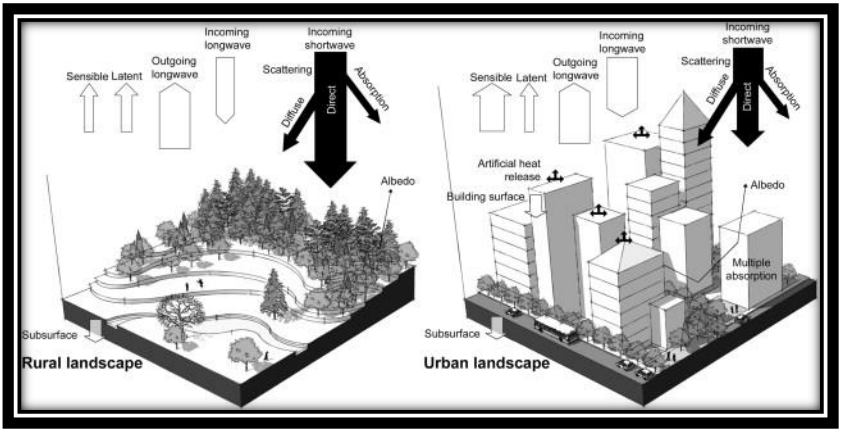

Figure 1: *The Amount of Heat Released for Rural Versus Urban Areas (*Ren, 2015).

The warming climate, combined with the UHI effect, will exacerbate air pollution in cities. The concentration of people, infrastructure, economic activity and ecology within the coastal zone, merits specific consideration of hazards worsened by a changing climate. Climate change and urbanisation are likely to increase the vulnerability of biodiversity hotspots, urban species and critical ecosystem services (UNFCCC, 2007). Urban Heat Islands are thus vital in the move towards eco-friendly urban design. There is a need to reduce heat in cities and urban centres to adapt/mitigate changing high temperatures in various localities. This can be done through the use of open spaces and green buildings.

OPEN SPACES

Open spaces are green spaces that are incorporated in urban planning and layout designing that allow an area to 'breathe'. An pen space is any open piece of land that is undeveloped and is accessible to the public. In Zimbabwe, the layout designing manual recommends strategic placement of open spaces in neighbourhoods and central business districts (CBD). This has been adopted from various policies and frameworks such as the Public Space Framework by and for local governments of 2016 presented by representatives from Bogota and eThekwini (UCLG, 2016). Open spaces can be in the form of parks, playgrounds, wetlands, public seating areas, schoolyards, vacant lots, cemeteries, community gardens or woodlands.

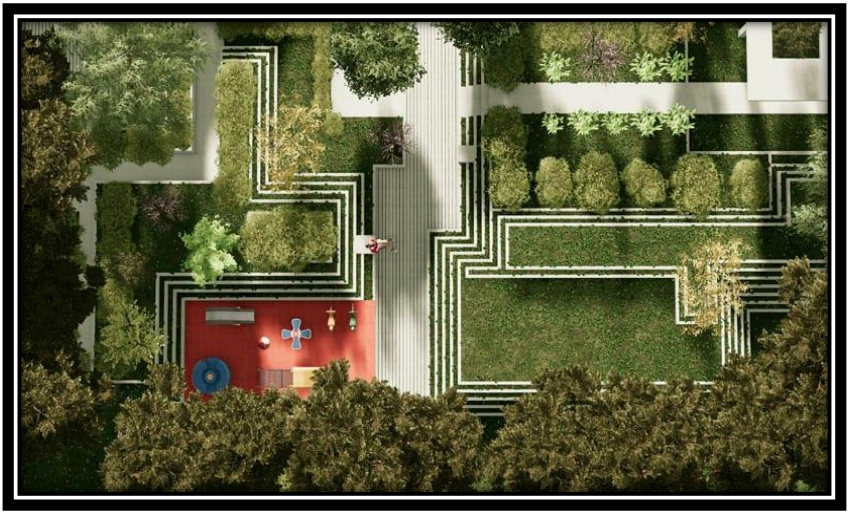

Figure 2: *Open Space in the Form of a Park* (Doucette and Park, 2018*).*

Open spaces allow for recreational areas for residents and help enhance the aesthetic beauty of surrounding neighbourhoods. Proximity to parks and public spaces in residential areas increases property values. Public open spaces are usually characterised as green spaces as they contain vegetation and trees. They are an essential part of environmental design, and these are dated from the formation of cities, i.e. from the garden city movements. They assist in capturing precipitation, allow for infiltration of water, thereby reducing storm water drainage costs, and also protect and preserve underground water. Therefore, including open spaces in urban design helps to adapt to ecological and climatological changes that are occurring in today's cities.

GREEN INFRASTRUCTURE

Buildings are important components of the built environment, influenced both by the long- and short-term changes of climate. Building energy demand will change in response to future climate change, with cooling and heating demand going in opposite directions. Net increases or decreases depend largely on a region's cooling or heating demand dominance. It is thus key to understand how local climate change affects building energy demand, distinguishing between heating and cooling. Modifying the form and layout of buildings and urban districts can provide

cooling and ventilation that reduce energy use and allow citizens to cope with higher temperatures and more intense runoff (Rosenzweig *et al.,* 2015).

The green building concept is part of the current movement towards more sustainable societies Green development establishes and reinforces connections and applies ecological thinking by creating places for people to live and work. Green development is more than individual buildings or their components, It seeks to minimise entire life cycle impacts by employing resource-efficient and environmentally and community-sensitive land-use by fitting the site, thus using resources efficiently through the provision of an adaptable healthy indoor environment. It is generally accepted that green building refers to both a structure and the use of processes that are environmentally conscious and resource-efficient throughout a building's life-cycle, from setting up, siting to design and construction.

Figure 3: *Al Shaheed Park, Kuwait Zinco Green Roof Systems* (ZinCo Project Report, 2019)

Green roofs in urban design have been used in various regions as a means to incorporate climatological and ecological changes. Green roofs can be modular with drainage layers, filter cloths and plants. They involve the development of contained green spaces on top of human-made structures.

Therefore, green roofs are complete systems that enhance green roof systems that go beyond the meaning of contemporary architecture and give a new value to the role of buildings in urban planning. They are designed not only to bring back the natural element in the urban environment, but also to provide solutions for important issues such as UHIs and stormwater management.

URBAN GREEN WAYS

Green ways are a general term of showing linear consistency, linking open and green spaces and providing development into the urban texture. There are bicycle passages, wildlife routes, improved watersides or a river far from a city developed along a bay.

Figure 4: *Urban Green Ways in Urban Centres* (Salici, 2013).

Greenways are linear open spaces such as canals and scenic roads that are set along riversides, hillsides or valleys, converted to recreational use along the railways. In Europe, greenways are described as avenues for protecting environmental values and the network of routes that are allocated for the motor less vehicles only (on horseback, bicycling, etc.),to increase the health of environmental life, considering an integrated management approach. The main concept is to keep the corridor "green"

with the natural vegetation and to connect the interesting points along the river and similar systems to a "way" or line. Greenways are formed directly and indirectly for people's benefits and uses. For example, a greenway can provide recreational walks, observing wildlife, recognition and evaluation of the environment, river fishing and riverside protection. There are six types of greenways that can be used in urban design and these are riversides greenways, recreational greenways, natural corridors that are of ecological importance, greenways that are visual and historical in value, greenways that aim to control urban development and greenways systems and networks.

Role of Green Infrastructure in Ecological and Climate Change Adaptation in Zimbabwe

The Green Building Council of Zimbabwe (GBCZ) was launched on the 30th of September 2016 in Harare to spearhead the green building concept in Zimbabwe. This council is still in its infancy. The GBCZ advocates for integrated building designs and a multi-disciplinary approach to design, catering for the Planet, People, Productivity (3 Ps) which, in essence, refers to sustainable green building practices by educating industry players on the best materials to use. This policy was implemented due to the realisation of the importance of urban design in ecological and climate mitigation and adaptation. In Zimbabwe, most materials used in the construction industry in the past have not been environmentally friendly. Central to cost-effective green building and site design is a factor of interrelationships and correlated cost and performance trade costs associated with changing space configurations and greater design flexibility (UN-HABITAT, 2010).

A green building is one whose construction and a lifetime of operation assures the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources (GBCSA, 2016). Green buildings use environmentally responsible and resource-efficient materials, depending on their quality, availability, access to water in buildings, design, construction, operation. Green infrastructure helps in protecting water sources, reducing pollution, increasing riverside habitat and biodiversity, reducing flood harms, providing recreational opportunity, supplying environmental education, alleviating noise, enhancing micro-climatic effects of both cooling and decreasing pollution and reducing riverside erosion.

CASE STUDIES

ENVIRONMENTAL URBAN DESIGN STRATEGIES: A CASE OF SAN DIEGO

San Diego's distinctive character results from its unparalleled natural setting, including beaches, bays, hills, canyons and mesas that allow the evolution of geographically distinct neighbourhoods. There are several urban design principles relating to the existing city form and achieving a compact and environmentally sensitive pattern of development envisioned in the City of Villages strategy. These principles are identified below to provide a framework for the goals of the Urban Design Element in San Diego.

Box1: Urban Design Strategies of San Diego

STRATEGIES

- Contribute to the qualities that distinguish San Diego as a unique living environment;
- Build upon existing communities;
- Direct growth into commercial areas where a high level of activity already exists;
- Preserve stable residential neighbourhoods.

CORE VALUES RELATED TO URBAN FORM

- The natural environment;
- The city's extraordinary setting, defined by its open spaces, natural habitat and unique topography;
- A compact, efficient and environmentally sensitive pattern of development;
- The physical, social and cultural diversity of the City and its neighbourhoods.

GOALS OF URBAN DESIGN

- A built environment that respects San Diego's natural environment and climate.
- Improved quality of life through safe and secure neighbourhoods and public places.
- A pattern and scale of development that provides visual diversity, choice of lifestyle, opportunities for social interaction and that respects desirable community character and context.
- A city with distinctive districts, communities, neighbourhoods and village centres where people gather and interact.
- Maintenance of historic resources that serve as landmarks and contribute to the city's identity.
- Utilisation of landscape as an important aesthetic and unifying element throughout the city.

Source: Adapted from City of San Diego General Plan (2008).

San Diego's topography and year-round climate are ideal for outdoor pedestrian activity of all kinds. Therefore, the urban design element addresses urban form and design through policies aimed at respecting the natural environment, preserving open space systems. Increasingly important are changes in density and intensity occur over time, as San Diego evolves. The urban design principles established in this element are intended to help achieve an identity for the city as a whole, while encompassing its physical, social and cultural diversity. A higher overall quality of urban design is another fundamental goal. The urban design applies at multiple levels from citywide to community, to the neighbourhood and, ultimately, to individual projects. Urban design is a process to foster quality in the built and natural environment as the city changes.

SPONGE CITIES: A CASE OF CHINA

A "sponge city" is a city that is designed to passively absorb, clean and use rainfall in an ecologically friendly way that reduces dangerous and polluted runoff. Associated techniques include permeable roads, rooftop gardens, rainwater harvesting, rain, gardens, green space and blue space such as ponds and lakes. A sponge City is one whose infrastructure passively absorbs, filtrates and preserves rainfall in an ecologically friendly way that reduces soil and water erosion and polluted runoff. In this design, promoted are the development and restoration of city wetland parks, forest parks and rain gardens, which opened new and natural possibilities for city ecosystems based on historical and natural topography. China has made eco-city development, eco-restoration and eco-civilisation its legislative priority and its national strategy. By realising the importance of "lucid water and lush mountain" (Wang *et al.,* 2019), China committed to protect natural forest reserves, restore its forest ecosystems and increase the forest coverage rate from 8% in the late 20th century to 22.6% recently. The country has been advocating the use of "Sponge City Design" in more than 100 cities.

Figure 5: *Sponge City Concepts in Yanweizhou Park in Jinhua, eastern China* (Li *et al.* (2017)

Like many places around the world, Chinese cities are considering ways to combat flooding in the face of climate change. Increased urban development has made flooding worse and turned some neighbourhoods into vulnerable waterfront locations. The Chinese government is now pursuing an idea that could alleviate the problem: sponge cities. Launched in 2015, the Sponge City Initiative invests in projects that aim to soak up flood water. The projects are being built in30 cities, including Shanghai, Wuhan and Xiamen. By 2020, China hopes that 80% of its urban areas will absorb and re-use at least 70% of rainwater. To date, the cities have received more than$12 billion for sponge projects, according to *China Daily (2021).*The central government funds around 15% to 20%of the costs, with the remainder funded by local governments and private developers. Lingang, a planned city in Shanghai's Pudong District, hopes to become China's largest sponge city project.

In early 2016, Shanghai announced the construction of4.3 million square feet of rooftop gardens throughout the entire city. In April, utility company Suezstarted installing a new 7-square-mile drainage system in Chongqing. The system's embedded sensors will allow local officials to monitor their sewer and storm water networks to mitigate the risk of flooding, according to the company. Many of the projects incorporate green space, like wetlands and bio swales, which naturally help absorb water. The efforts seek to reduce the amount of rainwater runoff. Though the Yanweizhou

Park in Jinhua, eastern China, opened in 2014 (before the initiative began), it serves as a model for the type of flood-resilient, green infrastructure the country wants to continue building. Featuring a series of winding pedestrian paths, it is designed to exist with floodwater during heavy rainfall.

CONCLUSION AND RECOMMENDATIONS

Urban design that embraces changes occurring climatologically and ecologically is viable in the face of rapid urbanisation. It can be seen that traditional methods of construction around the world are being eliminated in favour of eco-friendly designs such as green roofs and sponge cities. It is vital for countries, especially in the developing world, to be more involved in eco-friendly technologies and buildings to adapt to and mitigate the impacts of climate change. Selecting construction materials and reflective coatings can improve building performance by managing heat exchange on the surface. There is need for policy-makers in urban development and design to help increase the vegetative cover in a city as it can simultaneously lower outdoor temperatures, building cooling demand, runoff and pollution, while sequestering carbon. Municipalities are also called to respond to climate problems with new governance tools to distribute the risk of impacts, which aims to involve citizens to a greater extent in the project proposals for interventions and measures.

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CHAPTER 5: Property Values, Urban Heatwave and Flooding in African Cities

Abstract

A variety of factors causes the shifting of the Open Property Market *values. However, the contemporary environmental problems of climate change have posed a greater threat to urban property values in Africa. The recently increased frequency of extreme flooding and extreme heat poses a threat to the real estate market as it increases utility costs and operational costs of buildings to withstand the long droughts or flooding. These extreme weather conditions require buildings to adopt a higher level of resiliency in terms of building materials and utilities on site. Therefore, the chapter seeks to elaborate on the various socio-economic and physical impacts that climate change has on property values in the real estate management sector. Data was obtained using documentary analysis and secondary data sources such as United Nations reports on climate change and journal articles and books on climate change and real estate. African countries face a higher risk of facing greater impacts of climate change on properties due to most countries having financial and capacity constraints. Therefore, there is need for stakeholders in the real estate market to fully understand climatological changes that affect property values in the African context so to help plan for sustainable and resilient strategies.*

INTRODUCTION

Every place grows in space, density, facilities and complexity over time. Cities across the world have their own unique spatial and demographic history and development. Contemporary trends have been highlighting that the population in urban centres across the globe is increasing at a high rate and it is projected that by 2050, two-thirds of the world's population will live in cities. In Africa, urban population is projected to triple by 2050, increasing by 0.8 billion (UN DESA Population Division, 2010). African countries are experiencing some of the world's highest urbanisation rates (UN-habitat, 2009). Population growth and urban development have caused a series of changes to the environment, including climate (Marquette, 1997). Climate change is the greatest price society is paying for decades of environmental neglect (Thomas, 2017).

Urban areas have been seen to be the most affected by climate change and global warming. This is because cities are densely populated and, with the high population, there is an increase in paved surfaces that absorb heat, tall buildings that trap heat because of obstruction of wind and other heat-generating activities carried out in urban areas. The generation of heat in cities and the emission of greenhouse gases (GHGs)destroy the ozone layer. These issues are attributed to global warming. The impact of global warming is most visible in the rising threat of climate-related natural disasters such as prolonged periods of heat waves and heavy rains. Due to extended periods of heat and heavy rains, many cities have experienced the occurrence of natural disasters such as cyclones, veld fires, floods and hurricanes (Chapman *et al.,* 2017). Since the surge of intense floods, storms, droughts and heatwaves have an ominous link to climate change, it is predicted that global climate change is almost certain to increase the frequency and intensity of heatwaves (global warming) and flooding across the globe. Hazards of nature have always been with mankind, but growing incidences of floods, storms and droughts all across the world are putting the spotlight on the need for action (Thomas, 2017).

In urban areas, the impacts of heatwaves are aggravated by the concrete surfaces that absorb heat and the availability of tall buildings that trap heat, not negating the heat producing activities such as industrial activities and burning of fossil fuels, and so, the vulnerability of ecosystems and urban communities increases(Depietri *et al.,* 2012). Over the last 50 years, there has been an increase in frequency of extreme flooding and extreme heat in heatwave events, as a result of human activity (You and Wang, 2017). Floods affecting urban areas can be either generated locally or in other locations in the watershed and basin. Urban areas often generate impacts on watershed-wide ecosystems through land-use changes and infrastructure development, which affects watercourses. Hazards hitting densely populated areas are more likely to turn into disasters by the sheer number of people exposed, therefore cities are being hit the hardest (Thomas, 2017).

Urban areas are vulnerable to hydro-meteorological hazards and the impacts of these disasters have been witnessed through changes in food supplies, freshwater resources and an increase in extreme weather events (e.g., heatwaves and droughts). These consequences of climate change in urban areas are expected to lead to several consequences on human health in terms of; heat stress, cardio-respiratory and infectious diseases

(Nilsson and Kjellstrom, 2010). The risk of flooding has always been present for buildings close to rivers or coasts. The severity and frequency of natural disasters are rising and this has, in recent years, exacted a shocking toll on human and economic losses. Therefore, it can be seen that buildings are also suffering the same fate as humans. Damage to real estate properties from disasters incurs costs for repair and maintenance (Smith *et al.,* 2017).

The occurrence of natural disasters has affected the urban property market across the globe and mostly in developing countries (Boustan *et al.,* 2020). Fear of natural disasters has influenced decisions to either invest or not invest in urban property. This has impacted greatly on urban property values in Africa (Wisner *et al.,* 2014). For instance, the fear of natural disasters factors into criteria for choosing where to live. In an efficient housing/property market, the price of property located inside the floodplain ought to be lower than the price of equivalent property outside. This price discount is interpreted as a measure of the benefits of a reduction in flood risk. Numerous authors have investigated the effect of location in a 500-year or 100-year floodplain on property prices for both inland and coastal locations (Montz, 1992; Eves, 2002; Depietri *et al.,* 2012; Desmet *et al.,* 2021). The results are, however, inconsistent and sometimes point to the presence of a price premium rather than the expected discount (Desmet *et al.,* 2021). It can be seen that flooding has influenced the pricing of property on the open market. This is because damage to real estate properties from disasters incurs costs for repair and maintenance. Increasing numbers of people have begun to consider the history and future likelihood of disasters in a neighbourhood when purchasing properties and the real estate prices in disaster-prone areas have been, accordingly, volatile (Jung and Yoon, 2018).

BACKGROUND OF THE EFFECTS OF FLOODING AND HEATWAVES ON A GLOBAL AND REGIONAL LEVEL

The impact of urbanisation on near-surface temperatures has been investigated since the 1980s. Studies suggested that a proportion of global warming observed in the last century timescale could be related to local warming induced by urbanisation (Paranunzio *et al.,* 2019). In Europe, heatwaves have been the most prominent hazard with regards to human fatalities in the last 10 years when more than 70000 deaths were reported during the summer and 15000 deaths in France alone (Depietri *et al.,* 2012). A large precipitation scarcity during the spring of 2003 contributed

to a rapid loss of soil moisture (Dosio, 2017). As a result, the summer of 2003 was the hottest since 1500 AD in Europe and it seems that heatwaves will become more intense, longer-lasting and/or more frequent in future warmer climates. Severe flooding throughout England in the autumn of 1998 and 2000, was due to an increase in the extent of flood liable residential areas throughout England and an increase in the actual levels of flood damage in all previously recognised flood-prone residential areas (Ismail *et al.,* 2014). Flooding has led to damage to property, including roads and houses (Eves, 2002). Furthermore, a prolonged U.S. heatwave during the summer of 1980, during which researchers estimate that between 1500 and 10000 people perished. The 2006 deadly heatwave in California, in which at least 140 and as many as 466 people died, has faded quickly from public consciousness. The numbers of those who die from excess heat annually are significant. More people die of heat-related deaths annually in the U.S, on average than from any other natural disaster (Depietri *et al.,* 2012).

More so, the first half of the 2010s was characterised by deadly climate-related disasters. Among them were the great floods in Thailand in 2011, Typhoon Haiyan in the Philippines in 2013. Notably, hydro-meteorological (floods, storms, heatwaves) and climatological (droughts, wildfires) disasters are increasing and not geophysical ones (earthquakes, volcanic eruptions) (Thomas, 2017). In 2014, 17.5 million people were displaced by climate-related disasters, 10 times more than the 1.7 million displaced by geophysical hazards(Thomas, 2017). In South Korea, the amounts of property damage caused by natural disasters have nearly tripled in the years since 2000, such as Typhoon Rusa in 2002 and Typhoon Maemi in 2003 (approximately 1,7 billion US dollars per year) as compared to those during the 1990s (approximately 618 million US dollars per year); 15 times that of the 1960s when there was a flood in Jeollabuk-do Namwon-eup and Gyeongsangbuk-do Yeongju-gun, and the Suncheon flood of 1962 (approx. 114 million US dollars per year) (Jung and Yoon, 2018). The Korean government projects that the equivalent cumulative damage will cost about 2.5 trillion US dollars by 2100 (Jung and Yoon, 2018). Disasters that caught international attention included the floods in Pakistan in 2010 that killed almost two thousand people and affected 20 million (Lucas, 2020). The floods submerged a fifth of the country in this once-in-a-thousand-years phenomenon.

In Africa, Ibadan, the capital of Oyo State in Nigeria, suffers regular and severe flooding when the rivers that run through the city overflow their channels into surrounding floodplains. The upper catchments of the Ona and Ogunpa rivers, in particular, are found in densely populated areas which are highly impervious, leading to high runoff when it rains (*ibid.*).

Heavy rains and cyclones Connie and Eline in February and March 2000 in Mozambique led to the worst flooding in 50 years and brought widespread devastation to the capital city, Maputo, and the city of Matola. Mozambique, along with Madagascar, was found to be particularly vulnerable in a study of the combined impacts of sea-level rise and cyclonic storm surges (Serdeczny *et al.,* 2017).This has led to a series of cyclones occurring from the year 2000, such as Cyclone Eloise in 2021, Cyclone Idai 2019, Cyclone Kenneth 2019, Cyclone Gwambe 2021, Cyclone Eline 2000, Cyclone Favio 2007. These cyclones have affected most parts of Mozambique, some parts of Malawi, Eswatini and Zimbabwe. Upwards of one million people were directly affected (Salami *et al.,* 2017). Africa is also warming up faster than the global average (Mbokodo *et al.,* 2020). Heatwaves in Africa come in series, especially in very dry summers. Every year there are incidents of heatwaves, especially in sub-Saharan Africa. The period 2014-2019 was one of the six warmest years in the continent since 1800. Southern Africa recorded land surface temperature between 1-2 degrees Celsius. Lack of data on heatwaves in Africa has seen EM-DAT list only two heatwaves in Saharan Africa since 1900 (Mbokodo *et al.,* 2020). These led to seven recorded premature deaths. However, with the changing climate, heatwaves are becoming more recognised as a big threat to sustainability in Africa.

THEORETICAL FRAMEWORK

The chapter is based on four theoretical concepts that seek to give a deeper understanding of real estate markets and natural disasters. These theories help to showcase the relationship between property market forces and natural disasters.

URBANISATION AND URBANISM THEORY

Urbanisation and urbanism form the central trope around which urban social theory tries to discuss the growth and development of cities (Gilderbloom, 2018). First, urbanisation was taken as an index of economic development and social change, not only for its part in the dissolution of feudalism in the medieval West, but also as a measure of

modernisation in the Third World today (Paranunzio *et al.,* 2019). The second concern in urban studies has related broadly to culture. This has been interpreted not simply in terms of the culture of its inhabitants, but more generally, the urban as a social space is also associated with a state of mind. Urbanisation refers to a general increase in population and the amount of industrialisation of a settlement. It includes an increase in the number and extent of cities (Uttara *et al.,* 2012). It symbolises the movement of people from rural to urban areas. Urbanisation happens because of the increase in the extent and density of urban areas. Although it is impossible to restrict urbanisation, it has to be ensured that urbanisation proceeds on the right path, causing minimum impact on the environment (*ibid,*).

REAL ESTATE VALUATION THEORY

Valuation theory has similar links in the evolution of economic theory as does urban land theory, but there is little, if any, cross-fertilization of economic thinking between the real estate economist and the urban land economist (Lawson, 2008). The profession of real estate valuers arises because each real estate asset is different from all other properties. Real estate assets are heterogeneous, that is, their characteristics vary. Therefore, the real estate valuation theory seeks to emphasize that valuation is a prediction of human behaviour under uncertainty, that is price, property components and market characteristics determine the buying and selling of property (Kummerow, 2008). Thus, the real estate valuation theory is a part of the economic theory (*ibid.*).

The market value of the real estate (developed or undeveloped) is determined by a large number of value-influencing factors. Next to the common conditions of the real estate market at the valuation date (also includes the economic situation), three quality components need to be considered. These are the location, usability (legal situation determined by regulations and laws) and property conditions (actual characteristics) (Jung and Yoon, 2018). The land economist von Thünen in his *The Isolated State* (1826), saw the initial concept of 13 spatial economics and the linking with the theory of rent. From this concept, von Thünen developed the quintessence of the marginal productivity theory of distribution with distance as a central concept by which it could be argued, was an early concept of marginal utility (Housing Bubble, Politics and Trouble, 2016). This concept is a huge component of the real estate

valuation theory. The recognition for a valuation theory emerged and argued that valuers should not attempt to develop a theory of valuation, but instead adopt price theory as a proxy for valuation theory.

PRICE THEORY

The price theory and its relation to flooding and heatwaves predict that buyers will attempt to discount property prices for flood risk if they are aware. Valuation experts and mortgage lenders need to know about the value of the property at risk to advise their clients and protect their investments (Ryan and Pearce, 1977). Literature research on national and international studies have shown that a flood event and flood risk in general influence the market value of real estate. But there exists a large spread when it comes to discount rates (Ryan and Pearce, 1977; Kropp,n.d). In practice valuation, experts use individual loadings or discounts based on their own experiences to consider the fact of flooding. Using specific numbers derived from comprehensive fundamental analysis would be a better alternative(Kropp,n.d).

DISASTER THEORY

Disaster theory stipulates the elements that define an event as catastrophic, as the term "disaster" is highly subjective (Etkin, 2016). The word disaster is a combination of the prefix "dis", which means bad or ill-favoured and suffix "aster" which means star. Its literal meaning, therefore, has an astrological context where calamity results from unfavourable position of a planet or star. This meaning is interesting not only for historical reasons, but also because of the fatalistic philosophy that underlies it (*ibid.*). Though there are some common threads about how we understand disaster, there is also vast disagreement on the specific meaning of the word and even of the importance of trying to define it (Modh, 2010). Traditional definitions typically revolve around four key ingredients: agent description, physical damage, social disruption and negative evaluation.

Disasters may be natural or the result of accidental or deliberate human action (Thomas, 2017). Examples include earthquakes, floods, pandemics and, notably, terrorist attacks and other events that officials and experts designated disasters. The disaster theories have been classified into four,

which are acts of God, acts of nature, joint effects of nature and society, and social construction. The act of God theory emphasizes on natural occurrences caused by a higher power, such as the flood during the time of Noah, as divination was employed for the retribution of sin. This theory was also used in the evasion of responsibility by people in power, such as in February 1972, when a makeshift coal company experienced a dam failure in Buffalo Creek, West Virginia and claimed 125 people (Gee, nd; Steinberg, 2006). The act of nature theory was used to express that things just happen, in an attempt to remove the theological aspect as the disasters happening were claiming more and more lives, and also because the leaders needed people to work and not stop and think upon their sins after a disaster had occurred (Chaudhary and Piracha, 2021). However, this study uses the theory of the intersection between society and nature, as a way of explaining the disasters happening all over the world. This theory establishes that there is a relationship or a link that is there in the occurrence of disasters, between nature and society (Oliver-Smith, 1999). It is a sort of causal relationship, where humans are causing stress to the environment and it is the environment's way of retribution that is causing disasters. These come back to affect people as the value of real estate property is affected by the occurrence of said disasters, such as flooding, earthquakes and heat waves.

Definition of Key Terms

Heatwaves: At present, there is no globally accepted definition of the conditions that constitute a heatwave. Debates abound on the parameters that should be included in measuring heatwaves (Shafiei Shiva *et al.,* 2019). Government agencies and the American Red Cross generally define heatwaves as extended periods, typically 48 to 78 hours or longer, with excessive heat and humidity. A heat index is used to determine excessive heat, taking into account both temperature and humidity. Excessive heat appears to differ regionally so that a precise definition of a heatwave includes sustained maximum temperatures over average temperatures in a particular area. Even more sophisticated analyses go beyond measuring temperature and humidity, incorporating types of air masses that surround particular geographic areas to predict the mortality effects of heatwaves (*ibid.*).

Floods: As a hazard, the European Union Floods Directive defines a flood as a temporary covering by water of land not normally covered by water. Floods are the result of meteorological and hydrological factors, but anthropogenic modifications can also play a role in defining the magnitude of the event. Therefore, floods in urban areas are the result of natural and manmade factors (Jung and Yoon, 2018; Lucas, 2020).

Urban Property: For this study, urban property means buildings that are located in areas designated as urban under urban local councils. These buildings are categorised into different types according to the various uses to which they are being put and for which they are designed. These uses include residential, commercial, industrial and recreational buildings (Dabara *et al.,* 2014).

LITERATURE REVIEW

The general cause of climate change is the imbalance between the energy that Earth receives from Sun and the energy reflected to space (Zhou *et al.,* 2004; While and Whitehead, 2013). The rise of greenhouse gases emissions in the atmosphere induced by nature or humans has changed climate system balance (Nyamadzawo *et al.,* 2015). This change leads to two significant changes in climate that are considered the main reason behind other changes in Earth ecological situation. The first one is temperature rise that includes warmer seasonal temperatures and then increase in annual mean temperatures and warm days and decline in cold days. The second is changes in precipitation that includes reduction in the long-term snowfall and precipitation levels in hot tropical climate and increase in precipitation levels in humid climate zones (UNFCCC, 2007; UNDP, 2017;Moran *et al.,* 2018).

Urban climatic zones have been created through urban development that has modified land surface, leading to the creation of distinct urban climates (Zhou *et al.,* 2004; Sturiale and Scuderi, 2019). Urbanisation has quickly transformed ecosystems into infrastructures and buildings that increase thermal storage capacity (Stagrum *et al.,* 2020; Schoch-Spana *et al.,* n.d). Built-up and impervious surfaces are stronger absorbers and the radiation is then slowly re-emitted as long-wave radiation that is responsible for warming up the boundary layer of the atmosphere within the urban canopy layer producing what is called the Urban Heat Island (UHI) effect (Depietri *et al.,* 2012; Shafiei Shiva *et al.,* 2019; Mbokodo *et al.,* 2020). Urban residents are exposed to higher heat stress risk than rural

residents due to the UHI; defined as urban areas being warmer than surrounding rural areas(Chapman *et al.,* 2017). Most of the research suggested that natural disasters negatively affected market values of housing and land (Jung and Yoon, 2018). Urban areas always present some risk of flooding when it rains. Buildings, roads, infrastructure and other paved areas prevent rain from infiltrating into the soil and so produce more runoff (Lucas, 2020). Heavy and/or prolonged rainfall produces very large volumes of surface water in any city, which can easily overwhelm drainage systems (Satterthwaite, 2007; Depietri *et al.,* 2012; Ismail *et al.,* 2014; Jung and Yoon, 2018; Lucas, 2020). In well-governed cities, this is rarely a problem because good provision for storm and surface drainage is easily built into the urban fabric, with complementary measures to protect against flooding, for instance, the use of parks and other areas of open space to accommodate floodwaters safely from unusually serious storms(Satterthwaite, 2007). Heatwaves are the most notable cause of weather related human hospitalisation and mortality in the United States and the world and are generally considered a period of extremely hot weather (Shafiei Shiva *et al.,* 2019).

Floods and heatwaves in urban areas have also affected the real estate market across the globe (Dabara *et al.,* 2014). Real estate connotes land and other immoveable objects attached to the land. Real property also refers to the interests, benefits and inherent right in the ownership of the physical land (Kummerow, 2008; Lawson, 2008; Dabara *et al.,* 2014; Jung and Yoon, 2018). A real estate development project is distinguished by the unique characteristics of its location (Beltrán *et al.,* 2018). A combination of the conditions and features of the land and surroundings, the legal status of the landed property, availability or otherwise of basic infrastructures and characteristics of the neighbourhood, accessibility and the local property market characteristics influences its development opportunities (Dabara *et al.,* 2014). Real estate development processes are characterised by their long duration. Because of the cyclical character of the real estate market, it is hard to predict construction costs, rental or sales revenues (*ibid.*). Flooding, location in a floodplain area or the risk of recurrent flood events affect the value of the real estate (Svetlana *et al.,* 2015). On the other side, the positive effect of waterfront location has to be considered (Kropp n.d).

The combination of global rising temperatures and the UHI the effect can, especially in big cities, cause severe problems with overheating. This

might influence the price of purchasing or managing a building as there would be a need for cooling materials such as air conditioning to make the building liveable (Montz, 1992). Disasters are, therefore, threat to property values (Eves, 2002; Ismail *et al.,* 2014). For instance, over-flooding can result in significant damage to property, hence a decline in value (Svetlana *et al.,* 2015; Lucas, 2020; Desmet *et al.,* 2021). Generally speaking, minor flooding causes little damage to property. However, if the water rises above the floor level, it can cause much damage to houses and reduce the property price in the flooded area (Beltrán *et al.,* 2018). In general, the longer the duration of the flood, the greater the cost needed for repair works on the damaged property, resulting in a further decline in the property value.

Besides, properties that frequently experience flooding tend to be perceived as having a higher risk (Salami *et al.,* 2017). As a result, the residential property market significantly declines in value due to the flood occurrence. (Ismail *et al.,* 2014). Most commonly surface water flooding in times of heavy rain, river and coastal flooding will result in the flooded property (Serdeczny *et al.,* 2017). In addition, due to the increase in global temperatures average sea level will rise. That will especially endanger regions situated some centimetres above sea level. Even if damned adequate increased groundwater can also destroy property and cause high costs (Beltrán *et al.,* 2018).

Areas with large coastal settlements, for example in South and East Asia, might experience dramatic disasters. Moreover, properties trade infrequently, perhaps once every 5-10 years for the average house (Kummerow, 2008). The amount of sales evidence varies widely in particular cases, but generally there are few sales of properties similar enough to be considered "comparable" and none of identical properties (Kummerow, 2008).

There are several causes of flooding. Flooding itself, location in a floodplain area (justified by a legal designation of the flood area, for example, through flood risk maps) or the risk of recurrent flood events can affect the value of real estate substantially (Desmet *et al.,* 2021). On the other hand, the positive effect of waterfront location has to be considered and taken into account in the calculation. Increasing numbers of people have begun to look in the history and future likelihood of disasters in a neighbourhood when purchasing properties and the real estate prices in

disaster-prone areas have been volatile accordingly (Stagrum *et al.,* 2020). In the U.S., for example, the rate of appreciation of housing prices in safer areas was roughly 15% higher than that in areas with higher risks of natural disasters over the 10 years from 2005 to 2015. Evaluation of adaptation measures for buildings is, therefore, of high importance. To assist future research and to find conclusions from previous studies, it is necessary to map the extent of scientific publications on climate adaptation (*ibid.*).

METHODOLOGY

Research approaches are plans and procedures that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation (Creswell, 2014). The study made use of documentary analysis, descriptive statistics and secondary data analysis. Documentary analysis assists in the enhancement of the reliability of the chapter (de Falco *et al.,* 2019). Documents used include books, journals and websites and newspaper articles. Secondary data sources, such as United Nations reports on climate change and journal articles and books on climate change and the real estate employed. Data obtained were then processed into information and analysed through the use of thematic content analysis. Thematic content analysis is the use of textual material in research, reducing it to more relevant, manageable bits of data. It is also a method of analysing the text of social investigation among the set of empirical methods (Kumar *et al.,* 2020). After summarising literature, it was assembled and structured thematically into important concepts. This assisted the chapter in bringing out themes such as spatial planning, urbanisation and climate change that need to be understood to implement efficient and sustainable policies.

RESULTS AND ANALYSIS

Niang *et al.* (2014) state that Africa, as a whole, is one of the most vulnerable continents due to its high exposure and low adaptive capacity. Therefore, there is need to fully plan, forecast, anticipate and prepare for natural disasters that are to come to minimise costs. Real estate is important in Africa as it is still a developing sector. Real estate assets are heterogeneous, that is, their characteristics vary. Researchers and practitioners have found that hundreds of factors might affect prices in various situations. This chapter seeks to understand flooding and heatwaves as some of the various situations that may cause price variations on the real estate market.

Floods and storms displace most people. In 2014, 17,5 million people were displaced by climate-related disasters, 10 times more than the 1,7 million displaced by geophysical hazards across the globe. Global temperatures have been steadily rising and 2015 was the hottest year since records began in 1880. Attention to climate-related disasters, arguably the most tangible manifestation of global warming, could help mobilise broader climate action. It could also be instrumental in transitioning to a path of low-carbon and green growth. The impact of heatwaves is often greater in cities, where dense urbanisation often replaces vegetated and natural soil surfaces with hardscape, thereby decreasing natural cooling by evapotranspiration (Shafiei Shiva *et al.,* 2019). In Africa, main contributors to the heatwave and flood risk are poverty because poorer people are more exposed and vulnerable to flood risk and are more severely affected when floods occur; and poorly managed urbanisation, especially the expansion of settlements into coastal and river (Lucas, 2020).

The Variance of Heatwaves in Different Parts of the African Continent

Heatwaves and heat-related health effects are only beginning to attract attention in Africa. High ambient temperatures are associated with increased mortality in Ghana, Burkina Faso and Kenya with associations varying by age, gender and cause of death. Children are, particularly, at risk. Heat-related health effects also may be of concern in the west and southern Africa. Low ambient temperatures are associated with mortality in Kenya and Tanzania. Heatwaves occur slowly and without significant spectacle. Unlike other natural disasters like hurricanes, tornados and earthquakes, heatwaves may not even be viewed as disasters or catastrophes by many. They differ in important respects from natural disasters like hurricanes or earthquakes. A much dire consequence of excess heat is a rapid rise in mortality rates, particularly among the vulnerable populations. The elderly, the poor, the socially isolated and the mentally and physically ill, are at the highest risk of dying of heatstroke and other heat-related illness. There are high expectations that heatwaves and warm spells will increase, suggesting an increased persistence of hot days (90th percentile) toward the end of the century. It is very likely that the mean annual temperature has increased over the past century over most of the African continent, except areas of the interior of the continent,

where the data coverage has been determined to be insufficient to conclude temperature trends (Niang *et al.,* 2014).

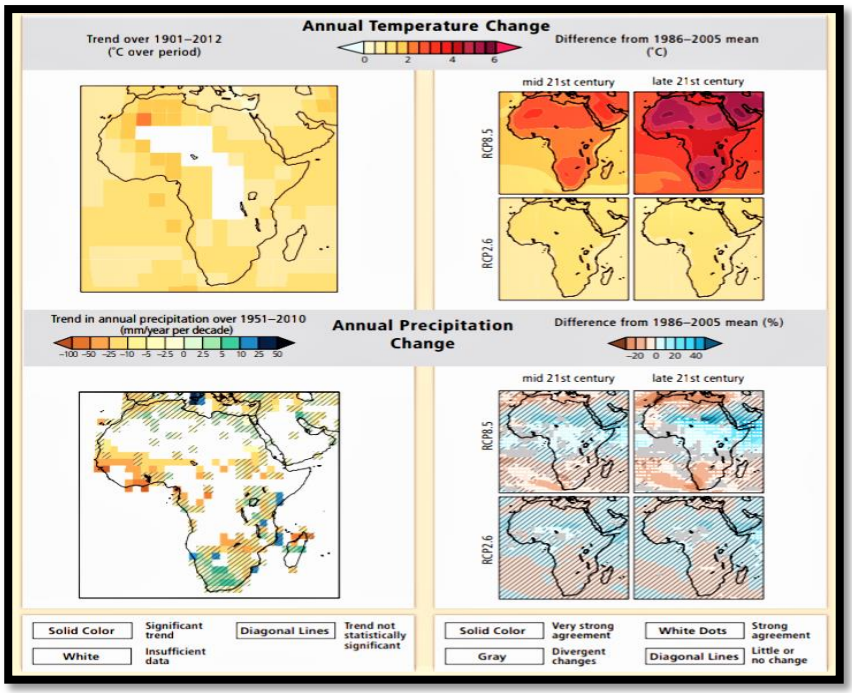

Figure 1: *Observed and Projected Changes in Annual Average Temperature and Precipitation (*Niang *et al.,* 2014).

Mean land surface warming in Southern Africa is likely to exceed the global mean land surface temperature increase in all seasons. Towards the end of the 21st century, the projected warming of between 3.4°C and 4.2°C above the 1981-2000 average under the A2 scenario, far exceeds natural climate variability. High warming rates are projected over the semi-arid south-western parts of the sub-region covering north-western South Africa, Botswana and Namibia. Observed and simulated variations in past and projected future annual average temperature over five African regions, indicate the projected temperature rise is very likely to exceed the 1986-2005 baseline by between 3°C and 6°C across these regions by the end of the 21st century under RCP8.5 *(ibid.).* Extreme precipitation changes over eastern Africa such as heavy rainfall and droughts have been experienced more frequently during the last 30 to 60 years.

Continued warming in the Indian Pacific warm pool has been shown to contribute to more frequent East African droughts over the past 30 years during the spring and summer seasons (Williams and Funk, 2011). Most of these indices are based on the maximum or minimum daily temperature. Such additional endogenous heat sources contribute to a phenomenon known as the UHI effect, which further exacerbates local heating and magnifies the frequency and intensity of heatwaves in cities.

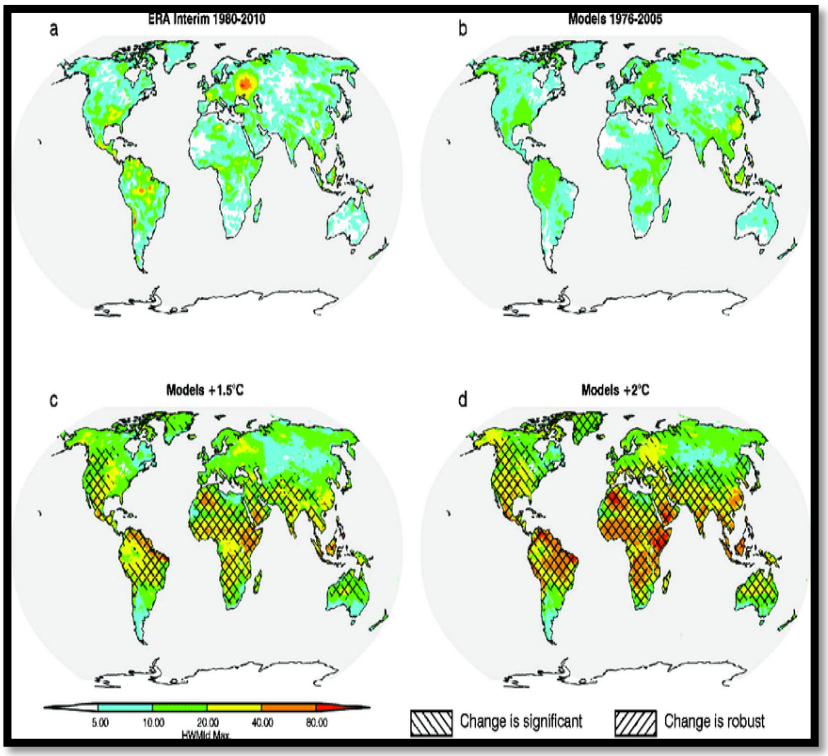

Figure 2: *Present and Future Distribution of Heatwaves (*Adapted from Dosio *et al.*, 2020).
(a) Maximum heatwave magnitude (HWMId) observed during 1980-2010. (b) Modelled maximum HWMId in the reference period (1976-2005). (c) and (d) Projected maximum magnitude in a 1.5 • C and 2 • C worlds, respectively. Modelled results are shown as the median of the seven model runs. Regions, where the change is statistically significant and robust, are highlighted.

HEAT-RELATED EFFECTS ON PROPERTY VALUES IN AFRICA

Heatwaves cause little or no property damage. Prolonged extreme heatwaves in urban areas are closely related to air pollution. The UHI effect and the worsening air quality that occurs during heatwave episodes, increase the average temperatures. This is a threat to African cities as this increases heat stress on humans and property. Heat stress exacerbates the need for cooling mechanisms for buildings, leading to an increase in operational costs for real estate assets. For instance, there will be need to increase air conditioning in shopping malls. Therefore, it can be noted that heat stress or increasing temperatures have an indirect causal effect on real estate markets as consumer preferences shift. These increased operational costs in Africa are a liability as many countries are underdeveloped and suffer from extreme poverty. Anything that endangers the economy will be a big setback. Therefore, there is need for a new urban design that allows the natural cooling of buildings in the future development of African cities.

THE VARIANCE OF FLOODS IN DIFFERENT PARTS OF THE AFRICAN CONTINENT

Floods are frequent and widespread in Africa, particularly in sub-Saharan Africa. It is postulated that an average of 500 000 people are affected annually by floods in West Africa. The sub-Saharan region has experienced 654 floods which have affected 38 million people in the last 33 years (Tiepolo, 2014). In Nigeria, the flood disasters that occurred in 2012 affected 32 of the country's 36 states, with 24 states severely affected and an estimated total of 7.7 million people being affected. In East Africa, floods affect countries such as Burundi, Kenya, Tanzania, Uganda and Rwanda.

Flood risks in African cities have been exacerbated largely as a result of anthropogenic influence which immensely contributed to the flood disaster risk. Urban settlements in African cities are commonly affected by pluvial, flush, fluvial and coastal flooding (Salami *et al.,* 2017). In the last five years, multiple countries in Africa have experienced heavier and wider rainfall which has led to cyclones and flooding. In southern Africa, one of the countries affected by flooding is Mozambique and some parts of Zimbabwe. Mozambique has been affected by cyclones such as Cyclone Eloise in 2021, Cyclones Idai and Cyclone Kenneth in 2019, Cyclone Gwambe in 2021 and Cyclone Favio in 2007. From May 2020, multiple

countries in east and central Africa have also faced more rainfall than usual. African countries that have faced the most severe flood conditions include Kenya, Somalia, South Sudan and the Democratic Republic of Congo (DRC).

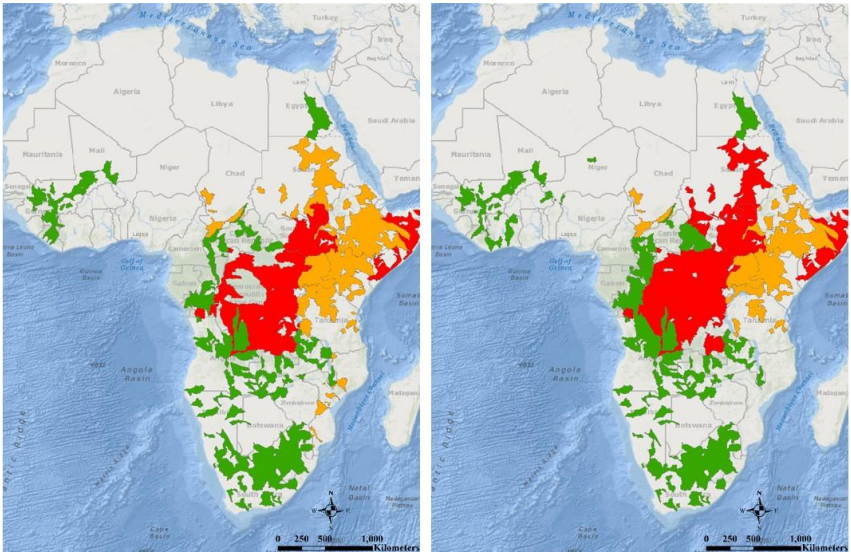

Figure 3: *2020 East Africa Floods* (NASA, 2021).

KEY

Red: Water shades in Africa experiencing a flood

Orange: Warning

Green: advisory conditions

EFFECTS OF FLOODS ON PROPERTY VALUES

The impact of floods on property has been analysed from various perspectives such as residential property value. However, the findings are mixed. The impact of these floods on the value of residential properties varies, depending on the frequency, depth and duration of the flood. According to Bin and Kruse (2006), flood reduces the value of residential property. However, Babcock and Mitchell (1980) found otherwise. They demonstrated little significant impact of the flood on residential property values. Meanwhile, Tobin and Montz (1990) found a positive relationship between flood and house value, where there was a small increase in price

for houses sold in the flooded area. The following are impacts of flooding on urban property in Africa.

Locational attributes: Flooding in Africa has caused a reduction in property value in many regions in Africa. This has influenced underdevelopment in many cities. For instance, in Mozambique, Costa De Sol is an area in Maputo that experiences rapid occurrences of flooding. It is expensive to build but sell at a lower price as people do not want to settle in flood-prone areas. Therefore, floods have affected property values in flood plain areas in Africa, leading to uneven and underdevelopment.

Loss of trust in property investments: Changes in the values of real estate could have unpredictable consequences. Investment in real estate is a major source for saving for retirement. Flooding and the destruction of property can make pension plans unreachable. The massive flood impacts on property result in high repairs, renovation and maintenance costs of property. Therefore, the damage and destruction of a residential property due to a flood affects the house value. The damage negatively affects a buyer's decision to buy a property in a flood-prone area, hence reducing the property market price. For instance, in Zimbabwe, reconstruction of roads and other properties in Chipinge since Cyclone Idai in 2019 is still underway. This has led to some investors losing confidence in the area and, therefore, there is now a reluctance to invest in Chipinge. Thus, most investments are coming in with donor funds rather than investments for economic progress and sustainability.

Reduction of the remaining operating life: The building of structures in periodically flooded areas is more affected by negative ascendancies. Chances of building defects are higher. That is why the total operating life period is lower compared to objects that did not experience a flood event. Impairment hardly depends on the period of being underwater and the altitude of the water level related to the building. At the same time, a shorter total operating life period results in a modified shorter remaining operating life period. This needs to be taken into account in the valuation process and will lead to a lower market value.

Reduction of the amount of the rent: The basis for the calculations in the discount cash flow method is the achievable rent. In case of a flood, the absolute use of space on the property (land outside and inside the house) is limited for an unknown period. In general, limitations in the use refer to

the ground floor for the period of flooding and the necessary reconstruction time. The rent is to be reduced or put aside completely depending on the level of devastation. The business buildings will be affected more than the residential buildings because the ground floor, as it is the one most affected by floods, is usually the sales floor with the highest sustainable rent. Another "adjusting screw" in the discount cash flow method can be the property yield. Flood risk could be included by increasing the rate.

Increase of management costs: Management costs include expenses for maintenance and repair, operating, vacancy and collection loss and administrative work. All four factors increase in the event of a flood. The number of loadings depends again on the type of the object (business or residential), interval and water level of the flood.

Consideration of actual costs for 100%insurance cover*:* There is some evidence that the increase in flood risk and flooding is affecting the insurability of residential properties. In general, insurance cover is usually required for mortgage lending. The availability, terms and conditions attached to the insurance contract and the level of premiums are influenced by the flood risk. Premiums are also high. Under the assumption of a 100% insurance cover, the market value reduced by the costs for this insurance type (capitalised for a specific period) would theoretically neutralise the threat, but the essential question would be on the occurrence of the next flood.

Consideration of actual costs for restoring the original condition of the property: In case of an instant flood event, the market value is reduced by the costs that are necessary to restore the conditions without flood. An important part of this overall reduction is the costs for restoring the original condition of the property (other costs, for example, for psychological harm caused by a flood event are even harder to monetise). There is a positive connection between the duration of a flood and house damage. In general, the longer the flood, the greater the cost needed for repair works on the damaged property, resulting in a higher decline in property value. This indicates that the value of the residential property that faces a flood risk tends to decline. This is because prolonged flooding is associated with more residential damage, increasing property restoration costs. Long periods of flooding attract high repair costs in renovating damaged property (Ismail *et al.,* 2014).

All these impacts are not applicable to all cases where heatwaves and floods occur. First, when a weather event occurs in a low-risk area, property values temporarily decrease, but soon go up to original levels, because the probability of recurrence of the event is low. Second, in disaster-prone areas, occasional weather events do not stir the real estate market, since market prices reflect the risk, or because government guarantees compensation for the consequent loss through a mandatory catastrophe insurance system. Third, when weather events occur in areas with no previous experience of natural disasters, property prices remain at low levels for longer, because potential home-buyers feel that the area is no longer a disaster-free zone. Fourth, market prices decrease temporarily and then go up even higher than before when local conditions are improved.

DISCUSSION

African cities and towns represent highly vulnerable locations to the impacts of climate change and climate variability. High levels of vulnerability and low adaptive capacity result from structural factors, particularly local governments with poor capacities and resources. Weak local governments in developing countries such as Zimbabwe, create and exacerbate problems such as the lack of appropriate regulatory structures and mandates; poor or no planning (in slum and informal settlements such as Kibera and Ibada); lack of or poor data; lack of disaster risk reduction strategies; poor servicing and infrastructure (particularly waste management and drainage); uncontrolled settlement of high-risk areas such as flood plains, wetlands and coastlines (seen through the development of settlements on wetlands all over Zimbabwe); ecosystem degradation; competing for development priorities and timelines; and a lack of coordination among government agencies.

Rapid rates of urbanisation put a burden on the economies of African urban areas, due to the massive investments needed to create job opportunities and provide infrastructure and services. Basic infrastructure services are not keeping up with urban growth, resulting in a decline in the coverage of many services (Banerjee *et al.,* 2007). Squatter and poor areas typically lack provisions to reduce flood risks or to manage floods when they happen (Douglas *et al.,* 2008). Due to Africa's vulnerability to the effects of climate change, there is need for efficient adaptation measures against floods and heatwaves. Effective preventive flood protection does not only mean technical flood protection, but also water retention in the

area. Only through specific and binding legal regulations, can it be ensured that in a case of a flood catastrophe, the consequences are as limited as possible (Kropp,n.d).

Adaptation needs governance that unites environmental and natural resource management approaches. Known as adaptive governance, it shares some or all of the following principles: polycentric and multi-layered institutions, participation and collaboration, self-organisation and networks and learning and innovation (Ramyar, 2017). Natural hazards are inherent in the world, but their severity and impacts can be minimised with disaster mitigation. Climate change mitigation is now understood to be within the bounds of responsibility and human capacity. The call to action is spurred by the understanding that the severity of climate-related hazards is induced by human activity.

CONCLUSION AND RECOMMENDATIONS

Urban areas continue to attract people because of the many economic advantages they provide. It is, therefore, critical for urban areas to provide safe livelihoods for their populations. Climate change means that natural disasters will be more common in the future and financial losses will increase. Valuation of endangered real estate has to consider the aspects of flooding and heatwaves on property values to sustain economic sustainability and prosperity.

Adaptation of infrastructure (transportation, buildings, food storage, coastal zones) against natural hazards is possible and can be achieved at low cost and additional implementation of soft measures such as building codes and zone planning. Examples of adaptation actions for road and transportation infrastructure include submersible roads in Madagascar and building dikes to avoid flooding in Djibouti. Infrastructural climate change impact assessments and enhanced construction and infrastructural standards such as raising foundations of buildings, strengthening roads and increasing stormwater drainage capacity are steps to safeguard buildings in vulnerable locations or with inadequate construction. Mainstreaming adaptation into infrastructure development can be achieved at a low cost, as has been shown for flood-prone roads in Mozambique. Integrating climate change considerations into infrastructure at the design stage is preferable from a cost and feasibility perspective than trying to retrofit infrastructure. Softer measures, such as building codes and zone planning are being implemented and are needed

to complement and/or provide strategic guidance for hard infrastructural climate-proofing, for example, the adoption of cyclone-resistant standards for public buildings in Madagascar. Research in South Africa has recognised that the best option for adaptation in the coastal zone is not to combat coastal erosion in the long term, but rather to allow the progression of the natural processes.

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CHAPTER 6: Urban Vulnerability: Experiences and Ways the Urban Poor are Coping with Risks of Climate Change

Abstract

Cities are centres of innovation and prosperity yet they disproportionality bear the impacts of 21st-century challenges such as climate change, inadequate infrastructure, population growth and social and economic inequity. The poor are more likely to rely on child labour and to engage in risky coping strategies, including illegal and criminal activities such as prostitution and smuggling. Accessing public health and education services may pose a financial burden on refugees that exceeds the burden experienced by other urban poor. In many cases, financial shocks come in the form of school fees and hospital bills that exceed their monthly income and may indebt them to their community or employers. The methodology used in this study includes desktop review, secondary data sources, reports and magazines. Planned anticipatory adaptation has the potential to reduce vulnerability and realises opportunities associated with climate change, regardless of autonomous adaptation. Implementation of adaptation policies, programmes and measures usually will have immediate and future benefits. Adaptation measures are likely to be implemented only if they are consistent with or integrated with decisions or programmes that address non-climatic stresses. The costs of adaptation are often marginal to other management or development costs. Adaptation to climate variability from physical, economic and social perspectives at the community level can be scaled up to the local government level through a pro-poor approach in land-use planning and the development of buildings and infrastructure that take climate change risks into account.

INTRODUCTION

Climate change has brought about numerous challenges to the people. These challenges are however, felt mostly by the urban dwellers. This is because most of the changes are being felt in the cities due to the swelling population in cities and increased urbanisation. This has made urban areas vulnerable to the risks of climate change phenomena. In most urban areas, there are increasing cases of heavy rains accompanied by flooding, as well as heat waves that causing these areas to be too hot. The frequent heat

waves breed highly charged thunderstorms that disrupt daily activities in urban areas. The urban poor are the most vulnerable because of their lack of capacity to handle and adapt to climatic changes.

Climate change will lead to increased frequency, intensity and duration of extreme weather events such as heavy rainfall, warm spells and heat, drought, intense storm surges and associated sea-level rise (IPCC, 2007, 2012; Hunt and Watkiss, 2011; Romero-Lankao and Dodman, 2011; Rosenzweig *et al.,* 2011). Adaptation to climate change depends centrally on what is done in urban centres, which now house more than half the world's population and concentrate most of its assets and economic activities (World Bank, 2008; UN DESA Population Division, 2012).

The purpose of this study is to understand the nuances and manifestation of urban vulnerability in Africa regarding ways in which the poor are coping with risks induced by climate change. The term "vulnerability" is also applied to sectors including food processing, tourism, water, energy and mobility infrastructure and their cross-linkages, for instance, the dependency of perishable commodities on efficient transport (Satterthwaite *et al.,* 2014). These groups are often the least resilient and have the least capacity to cope in the short term and adapt over the long term. They are vulnerable because they are poor, live in high-risk areas and have limited social capital and access to resources and institutions—all things that make it harder for them to recover after damaging climate events.

The Population Council is prioritising research to strengthen the evidence on resilience among those who are vulnerable to environmental stressors (Population Council, 2018). The research is designed to fill gaps and generate the evidence decision-makers need to develop and implement effective programmes and policies that can build the resilience and adaptive capacities of those most vulnerable to environmental shocks and stressors. The serious impacts of extreme weather on many urban centres each year demonstrate some of the risks and vulnerabilities to be addressed (UNISDR, 2009; IFRC, 2010).

METHODOLOGY

The study used desktop review, secondary data sources, reports and magazines in coming up with the data. This was in a bid to obtain data on vulnerable groups and their adaptive strategies. Trend tracing through

document analysis was employed. Reviews of policies and frameworks on adaptation to climate change were done.

BACKGROUND AND OVERVIEW

In situations of conflict and unstable governance, a sudden climate-related hazard, or successive occurrences of multiple climate hazards, might aggravate tensions and displace people for longer periods or contribute to decisions to migrate internally to urban areas (Moench and Dixit, 2007; Hunter, 2001). In some instances, people are displaced for months or years post-hazard due to underlying vulnerability and inadequate responses (Crawford *et al.,* 2015). Examples include the 2016 floods in Louisiana in the United States of America, when some households were displaced for months due to damaged homes and assets and shortcomings in government relief systems (Domonoske, 2016), or the 2008 Kosi floods in Nepal and Bihar, India, where many of the displaced were still living on embankments up to a year after the flood due to slow relief and recovery responses (Ghimire and Chautari, 2010).

In 2008, more than half the world's population was living in urban centres and the proportion continues to grow (UN DESA Population Division, 2012). Three-quarters of the world's urban population and most of its largest cities are now in low- and middle-income nations. The gross domestic product (GDP) of most nations is generated in urban centres and most new investments have concentrated there (World Bank, 2008; Satterthwaite *et al.,* 2010). In terms of the population, economic activities, assets and climate risk, they increasingly concentrate on, adapting urban areas to climate change require serious attention Satterthwaite *et al.,* 2014). Most urbanisation is underpinned by economic logic. All wealthy nations are predominantly urbanised and rapid urbanisation in low- and middle-income nations is usually associated with rapid economic growth (World Bank, 2008; Satterthwaite *et al.,* 2010). Most of the world's largest cities are in their largest economies (World Bank, 2008; Satterthwaite *et al.,* 2010).

LITERATURE REVIEW AND THEORETICAL PERSPECTIVES

For each of the direct and indirect impacts of climate change, there are groups of urban dwellers that face higher risks (illness, injury, mortality, damage to or loss of homes and assets, disruption to incomes) (Hardoy and Pandiella, 2009; Mitlin and Satterthwaite, 2013). Age may be a factor (for instance infants and elderly people are more sensitive to particular

hazards such as heat stress) or health status (those with particular diseases, injuries, or disabilities may be more sensitive to these impacts). It may also be that they live in buildings or locations facing greater risks—for instance, on coasts or by rivers with increased flood risks—or that they lack coping capacities. Women may face higher risks in their work and constraints on adaptation if they face discrimination in access to labour markets, resources, finance, services and influence (Satterthwaite *et al.,* 2014).

In urban centres, where virtually all buildings meet health and safety standards, where land-use planning prevents developments on sites at risk and where there is universal provision for infrastructure and basic services, the exposure differentials between high- and low-income groups to climate-related risk are quite low. Having low income and few assets in such urban centres does not necessarily imply greater vulnerability to climate change (Mitlin and Satterthwaite, 2013). Typically, the larger the deficit in infrastructure and service provision, the larger the differentials in exposure to most climate change impacts between income groups (Satterthwaite, 2014). Low-income groups in low- and middle-income nations are often disproportionately vulnerable because of poor quality and insecure housing; inadequate infrastructure; and lack of provision for health care, emergency services and disaster risk reduction (UNISDR, 2009; IFRC, 2010; UN-HABITAT, 2011a; IPCC, 2012; Mitlin and Satterthwaite, 2013). Most deaths from disasters are concentrated in low- and middle-income countries—including more than 95% of deaths from natural disasters between 1970 and 2008 (IPCC, 2012).

The urbanisation-climate change connection has important implications for ecological sustainability (Satterthwaite *et al.,* 2014). Climate change can accelerate ecological pressures in cities and interact with existing urban environmental, economic and political stresses (Wilbanks and Kates, 2010; Leichenko, 2011). This is especially important in a world where transgressions of key planetary boundaries such as climate change and biodiversity may take humanity out of the globe's "safe operating" space (Rockström *et al.,* 2009:1) into an unsafe and unpredictable future. A study by Trusilova *et al.* (2008) analyses the urbanisation-induced disturbances of the carbon cycle in Europe through land-use change, local climate modification and atmospheric pollution. This study shows that urban effects spread far beyond the city's boundaries and trigger complex feedback/responses in the biosphere (*ibid.*). Urbanisation changes land-

use cover, generally reduces the amount of ecologically intact land and causes fragmentation of the remaining land, which reduces habitat value for species and increases the likelihood of further ecological degradation (Satterthwaite *et al.,* 2014).

RESULTS AND DISCUSSION

The level of funding needed for sound urban adaptation could exceed the capacities of local and national governments and international agencies (Parry *et al.,* 2009; Brugmann, 2012). Much of the investment will have to come from individuals and households, communities and firms through their decisions to address adaptation and resilience (Agrawala and Fankhauser, 2008; Fankhauser and Soare, 2013). This might suggest a role for governments, especially local governments. Whether these small-scale decisions by households, communities and firms do contribute to adaptation depends, in large part, on what local governments do, encourage, support and prevent—and their contribution to providing required infrastructure and services. An important part of this is the provision by local governments of appropriate regulatory frameworks and the application of building standards, to ensure that the choices made by individuals, households and firms support adaptation and prevent maladaptation (Satterthwaite *et al.,* 2014). For instance, land-use planning and management have important roles in ensuring sufficient land for housing that avoids dangerous sites and protects key ecological services and systems (UN-HABITAT, 2011a).

Recent analyses of disaster impacts show that a high proportion of the world's population most affected by extreme weather events is concentrated in urban centres (UNISDR, 2009, 2011; IFRC, 2010).About one in seven people in the world live in poor quality, overcrowded accommodation in urban areas with inadequate provision (or none) for basic infrastructure and services, mostly in informal settlements (UN-HABITAT, 2003a; Mitlin and Satterthwaite, 2013). Much of the health risk and vulnerability to climate change is concentrated in these settlements (Mitlin and Satterthwaite, 2013). Their low-income households may need particular assistance because of greater exposure to hazards, lower adaptive capacity, more limited access to infrastructure or insurance and fewer possibilities to relocate to safer accommodation, compared to wealthier residents (Satterthwaite *et al.,* 2014).

Adaptation in a particular area or settlement may have clear benefits for the inhabitants, but can also have knock-on effects on the wellbeing of inhabitants in other areas. Diverting a river course or building an embankment to protect new development, may prevent flooding in one location, but cause or increase flooding somewhere else (Revi, 2005, for Mumbai; Alam and Rabbani, 2007, for Dhaka). Assessments of vulnerability to climate change draw on assessments in other contexts—including the vulnerability of low-income groups to stresses and shocks (Chambers, 1989; Pryer, 2003) and disasters (Cannon, 1994; Manyena, 2006). This includes people's inability to avoid the hazard (exposure), anticipate it and take measures to avoid it or limit its impact; cope with it; and recover from it (Hardoy and Pandiella, 2009).

Mainstreaming adaptation into urban planning and land-use management and legal and regulatory frameworks is key to successful adaptation (Lowe *et al.,* 2009; Kehew *et al.,* 2013). It can help planners rethink traditional approaches to land-use and infrastructure design based on past trends and move toward more forward-looking risk-based design for a range of future climate conditions (Kithiia, 2010; Solecki *et al.,* 2011; Kennedy and Corfee-Morlot, 2013) and reducing administrative cost by building resilience through existing policy channels (Urwin and Jordan, 2008; Benzie *et al.,* 2011; Blanco *et al.,* 2011). Mainstreaming through local government policies and planning ensures that investments and actions by businesses and households contribute to adaptation (Kazmierczak and Carter, 2010; Sussman *et al.,* 2010; Brown, 2011; Mees and Driessen, 2011). But this must avoid overloading complex and inadequate planning systems with unrealistic new requirements (Roberts, 2008; Kithiia, 2010); particularly in many low and middle-income countries, these systems are stressed by lack of information, institutional constraints and resource limitations.

RECOMMENDATIONS AND OPTIONS

All successful urban centres have had to adapt to environmental conditions and available resources, although local resource constraints have often been overcome by drawing on resources and using sinks. This includes importing goods that are resource-intensive and whose fabrication involves large greenhouse gas (GHG) emissions. The growth of the urban population over the last century has also caused a very large anthropogenic transformation of terrestrial biomes. Urban centres cover only a small proportion of the world's land surface, only 0.51% of the total

land area. Only in Western Europe do they cover more than 1%. However, their physical and ecological footprints are much larger. The net ecological impact of urban centres includes the decline in the share of wild and semi-natural areas from about 70% to less than 50% of land area, largely to accommodate crop and pastoral land to support human consumption. It has led not only to a decrease in biodiversity, but to fragmentation in much of the remaining natural areas and a threat to the ecological services that support both rural and urban areas. Future projections suggest that, if current trends continue, the urban land cover will increase by 1.2 million km^2 by 2030, nearly tripling global urban land area between 2000 and 2030. This would mean a considerable loss of habitats in key biodiversity hotspots, destroying the green infrastructure that is key in helping areas adapt to climate change impacts and increasing the exposure of population and assets to higher risk levels.

Many of the challenges and opportunities for urban adaptation relate to the central features of city life—the concentration of people, buildings, economic activities and social and cultural institutions. Agglomeration economies are usually discussed with the advantages for enterprises locating in a particular city. But the concentrations of people, enterprises and institutions in urban areas also provide potential agglomeration economies in lower unit costs for piped water, sewers, drains and a range of services and in the greater capacity for people, communities and institutions to respond collectively. Agglomeration is essential in cities as it encourages the growth of economic outputs. However, it can come with a lot of vulnerable people who become the urban poor. The Outline Development Plan for the Guangdon Greater Bay Area in Hong Kong-Macau has been an initiative to try and combat climate change issues in the city with agglomeration of economies (Yu, 2021). The plan is successful in wealthier areas because they have the means to construct housing on allocated land. However, the urban poor find it difficult sometimes to maintain green spaces because they need cheaper land to settle on and so they end up utilising the open spaces, which have been termed to be the right way of combating some climatic issues (Wang *et al.,* 2022).

The advantages that come with these concentrations of people and activities are also accompanied by particular challenges, for instance, the management of storm and surface runoff and measures to reduce heat

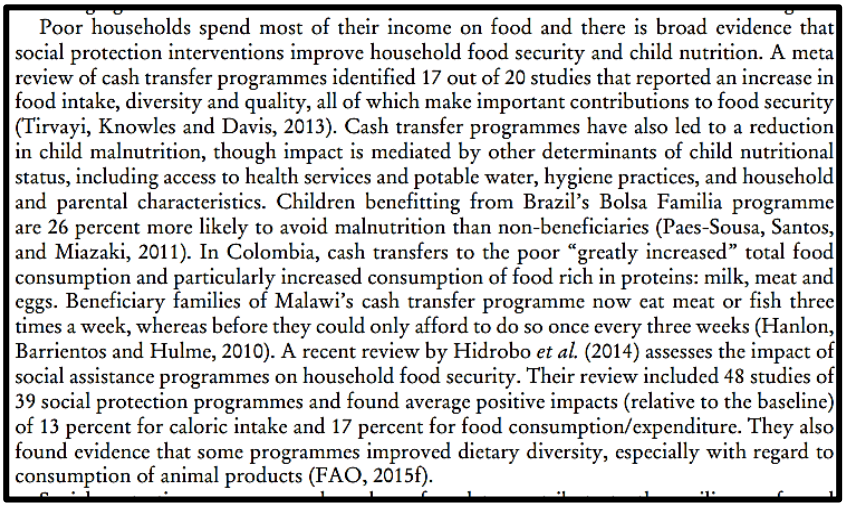
islands. Large cities concentrate demand and the need for ecological services and natural resources (water, food and biomass), energy and electricity and many city enterprises rely on lifeline infrastructure and supply chains that can be disrupted by climate change.

In recent years, literature has emerged discussing resilience to climate change for urban centres and what contributes to it. Addressing resilience for cities is more than identifying and acting on specific climate change impacts. It looks at the performance of each city's complex and interconnected infrastructure and institutional systems, including interdependence between multiple sectors, levels and risks in a dynamic physical, economic, institutional and socio-political environment. When resilience is considered for cities, certain systemic characteristics are highlighted, for instance, flexibility, redundancy, responsiveness, capacity to learn and safe failure.

An important aspect of resilience is the functioning of institutions to make this possible and the necessary knowledge base. The emerging literature on the resilience of cities to climate change also highlights the need to focus on resource availability and seeps beyond the urban boundaries. It may also require coordinated actions by institutions in other jurisdictions or higher levels of government, for example, watershed management upstream of a city to reduce flood risks. There are also the slow onset impacts that pose particular challenges and that may also be outside the jurisdiction of urban governments, for example, the impact of drought on agriculture, which can raise food prices and reduce rural incomes and demand for urban services.

Climate change impacts can have far-reaching influences on food security and safety, but these will crucially depend on the future policy environment for the poor. Agriculture has managed to keep up with rising demands worldwide, despite rapid population growth, the reduction in agricultural workers that accompanies urbanisation and dietary shifts that are more carbon and often land intensive. But food security may be eroded by competing pressures for water or bio-fuels. In addition, there may be tensions between managing land-use to reduce flood risk and food and energy policies. Adapting urban food systems represents a major challenge and will necessitate radical changes in food production, storage and processing (and in reducing waste), transport/the supply chain and access. With the aid of early warning systems, the nation can be alerted of

dry spells and prepare for irrigation schemes in order to provide food security to the people, especially the vulnerable groups. Some use social protection interventions in countries such as Colombia, Brazil and Malawi, as a way to provide food security to vulnerable groups (Akurugu, Damba and Mohammed, 2022).



Poor households spend most of their income on food and there is broad evidence that social protection interventions improve household food security and child nutrition. A meta review of cash transfer programmes identified 17 out of 20 studies that reported an increase in food intake, diversity and quality, all of which make important contributions to food security (Tirvayi, Knowles and Davis, 2013). Cash transfer programmes have also led to a reduction in child malnutrition, though impact is mediated by other determinants of child nutritional status, including access to health services and potable water, hygiene practices, and household and parental characteristics. Children benefitting from Brazil's Bolsa Familia programme are 26 percent more likely to avoid malnutrition than non-beneficiaries (Paes-Sousa, Santos, and Miazaki, 2011). In Colombia, cash transfers to the poor "greatly increased" total food consumption and particularly increased consumption of food rich in proteins: milk, meat and eggs. Beneficiary families of Malawi's cash transfer programme now eat meat or fish three times a week, whereas before they could only afford to do so once every three weeks (Hanlon, Barrientos and Hulme, 2010). A recent review by Hidrobo *et al.* (2014) assesses the impact of social assistance programmes on household food security. Their review included 48 studies of 39 social protection programmes and found average positive impacts (relative to the baseline) of 13 percent for caloric intake and 17 percent for food consumption/expenditure. They also found evidence that some programmes improved dietary diversity, especially with regard to consumption of animal products (FAO, 2015f).

Figure 2: *Social Protection Intervention to Improve Food Security* (FAO, 2015)

Urban centres that are seriously impacted by extreme weather face serious challenges in ensuring that those affected have access to adequate and safe food and water supplies. Flooding, drought, or other extreme events, often lead to food price shocks in cities and spoiling or destroying food supplies for many households. After the 2004 floods in Bangladesh, Dhaka's rice prices increased by 30% and vegetable prices more than doubled, with urban slum dwellers and the rural landless poor the worst affected. When facing increased food prices, the urban poor adopt a range of strategies such as reduced consumption, fewer meals, purchasing less nutritious foods, or increasing income-earning work hours, particularly for women and children. But these erode nutrition and health status, especially of the most vulnerable and fail to strengthen resilience, particularly in the context of more frequent disasters.

Adaptive local responses include support for urban and peri-urban agriculture, green roofs, local markets and enhanced safety nets supplies. Food price increases may be moderated by improving the efficiency of urban markets, promoting farmers' markets and investing in infrastructure and production technologies. Food security may be enhanced by support for urban agriculture and street food vendors and access to cheaper food or measures such as cash transfers (for example, Brazil's Bolsa Familia Programme) or, for older groups, pensions. Initially rural in focus, cash transfer programmes have expanded in urban areas, in some places reaching much of the low-income population.

Passive cooling can be used in both new-build and retrofitted structures to reduce solar and internal heat gains, while enhancing natural ventilation or improving insulation. Passive designs, using super-insulation, ventilation and other measures to ensure energy is not required for most of the year, as in the Beddington Zero Energy Development (BedZED) in London or Germany's Passive Haus standard have set precedents for mitigating household emissions but they can simultaneously contribute to adaptation. Thermal mass can be used for cooling, because it introduces a time-delay between changes in the outside temperature and the building's thermal response necessary to deal with high daytime temperatures. Structures in southern Europe use solar shading, ventilation and thermal mass to promote enhanced cooling. Simulations for London (under UKCIP02 Medium-High emissions scenarios) suggest that passive designs are an eminently viable option for the UK, at least over the next 50 years or so. There are several obstacles though: opening windows may be hampered by security concerns or noise pollution. Modern windows may not ventilate well and site restrictions and cost can impede the use of passive cooling in refurbishing existing buildings.

Policies and incentives need to be aligned to work coherently across multiple levels of government to define and deliver effective urban adaptation. This often involves institutions at different levels with different scopes of authority. Water authorities, for instance, may operate at the water-basin level, representing both national and local interests, while operating independently of urban authorities. Failing to ensure consistent alignment and integration in risk management can lock in outcomes that raise the vulnerability of urban populations, infrastructure and natural systems even where pro-active adaptation policies exist. Local

government capacity is important and the institutions that facilitate coordination across multiple, nested, poly-centric authorities with potential to mainstream adaptation measures and tailor national goals and policies to local circumstances and preferences are also vital as they facilitate the process from the government to the people in their local areas. Horizontal coordination and networking across actors and institutions in different municipalities and metropolitan areas can accelerate learning and action.

CONCLUSION

To fully understand and address the needs of vulnerable communities, the local government is building on its existing research, deep global research expertise and proven approaches in reaching and working with vulnerable populations to examine how humans interact with their environments and explore how to test and develop successful strategies for building resilience. In reviewing adaptation needs and options for urban areas, the documentation reviewed for this study points to two key conclusions. The first is how much the adaptive capacity of any city depends on the quality of provision and coverage of infrastructure and services; the capacities for investments and land-use management; and the degree to which buildings and infrastructure meet health and safety standards. This capacity provides a foundation for city resilience on which adaptation can be built. There is little of this foundation in most urban centres in low-income and many middle-income nations.

The second conclusion is the importance of the city and municipal governments acting now to incorporate climate change adaptation into their development plans and policies and infrastructure investments. This includes mobilising new resources, adjusting building and land-use regulations and continuously developing the local capacity to respond. This is not to diminish the key roles of other actors. But it will be up to the city and municipal government to provide the scaffolding and regulatory framework within which other stakeholders contribute and collaborate. Thus, adaptation in urban areas depends on the competence and capacity of local governments and a locally rooted process of learning about changing risks and opportunities, identifying and evaluating options, making decisions and revising strategies in collaboration with a range of actors.

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CHAPTER 7: Policies and Programmes for Urban Resilience in Africa

Abstract

In the context of global environmental change, much hope is placed in the ability of resilience thinking to help address environment-related risks. The term 'resilience' is widely used in policy, practice and academic discourse. It is applied in different contexts, including engineering, ecology, organisational and management studies, psychology, risk management and disaster reduction. Literature suggests that there is a complex interplay between environmental risks, built infrastructure, governments and institutions and sociocultural factors that can either promote or undermine resilience. The methodology used in this study includes desktop review, reports and magazines, government documents and statistical reports. Little attention in Africa has been given to building resilience and adaptive capacity in development programming. It is important to note that building resilience is critical to ensure equitable and sustainable trajectories out of poverty. Evidence suggests that the frequency and intensity of environmental hazards such as floods, cyclones and droughts, may be increasing, leading to high volatility in many parts of the world. The impact of these events falls unequally on the most vulnerable individuals, households and communities. To date, there is little subnational and local area data available to measure the exposure and risk of individuals, households and communities to environmental shocks and stressors. Where data exist, they are often not disaggregated by critical measures of vulnerability, including sex, age, poverty status or social capital. Programmes and policies are being slowly developed, but are often not rigorously evaluated or evidence-based. A long-term vision and 'durable solutions' approach for the reintegration of displaced people and the sustainable management of an enabling environment are fundamental to fostering resilience. This requires integrated policies and strategies to address national and local development priorities that are climate-smart, environmentally friendly and gender-sensitive and that address the drivers of displacement.

INTRODUCTION

The agenda for resilience is recognised in both developed and developing countries following Sustainable Development Goals (SDGs). Anticipation

strategies work against known problems, while resilient strategies are better against unknown problems (Normandin *et al.,* 2007). In this context, urban planning is a central component of global ambitions to deliver climate change adaptation and disaster risk reduction and emerging urban policy agendas have galvanised around the notion of resilience (Moglia *et al.,* 2018; Pelling *et al.,* 2018; Elmqvist *et al.,* 2014). Resilience is recognised as central to achieving the SDGs, the Sendai Framework for Disaster Risk Reduction (DRR) 2015-2030 and the Paris Climate Agreement (Twigg *et al.,* 2019). Resilience is defined as a set of capacities that enable a person, household, or community to withstand and recover from adversity or turbulent change (National Biodefense Science Board (NBSB) 2014;Meyers and Hardee (2017). The main focus of this chapter is to map policies and programmes that can enhance urban resilience in Africa. Attention to building resilience and adaptive capacity in development programming is critical to ensure equitable and sustainable trajectories out of poverty.

It has been conceptualised in various ways, ranging from traditional ideas around resistance to shocks and the ability to maintain or bounce back to the status quo to more progressive ideas linked to adaptive management and the creation of new capacities to deal with unforeseen changes (de Bruijne *et al.,* 2010; Manyena *et al.,* 2011). In the fields of development, DRR and adaptation, resilience programming has been strongly influenced by systems thinking regarding the interactions between human societies and the environment (Walker and Salt, 2006). Small- and medium-sized cities and towns in sub-Saharan Africa are growing fast and accumulating risks. Local governments seek to build the resilience of their cities in conditions of complex interdependent urban systems and gaps in data and information. Technical and financial capacity issues often lead to them resorting to external expertise, which shifts the decision-making power away from the citizenry and elected leaders. To capacitate cities to lead their resilience-building processes, new decision-support tools are required that can operate on data that are good enough and can enhance inclusive decision-making processes and local ownership (Urban Africa Risk Knowledge, 2019).

METHODOLOGY

Mixed-methods behavioural and social science research was used in this study. This study also employed innovative demographic methods, longitudinal panel surveys, qualitative studies and implementation science

to assess vulnerability and resilience in households and communities and to develop and test programme solutions. The study aim was to measure and understand how household and community responses evolve over time and whether negative effects are compounded by multiple intersecting shocks.

BACKGROUND AND OVERVIEW

In 2010, a third of the world's extreme poor lived in fragile states (Goldstein *et al.,* 2015). Eight years later, the proportion increased to one half and was projected to reach two-thirds by 2030. Illegitimate governance, weak institutions, conflict and violent extremism have also led to unprecedented levels of humanitarian need in recent years, including four famines or near famines in 2017. The ultimate goal must be to address the underlying causes of conflict and fragility. However, there is an urgent need for understanding what makes households and communities more resilient in the face of these types of shocks as a complement to conflict mitigation and management efforts.

If adaptation is about shaping the future through judgements on what to enhance, retain and discard, then resilience helps set the frame of reference to legitimise these decisions. Resilience narratives frame policy discussions, bound the aims of climate change adaptation and disaster risk management and give legitimacy to specific forms of knowledge – and to those who hold and produce this knowledge (Owens *et al.,* 2006; Goldstein *et al.,* 2015). These narratives are constructed by dominant actors and countered by subordinate actors to shape the possibility for urban futures and are associated with clear practical and material implications (Sandercock, 2003; Friend and Moench, 2015).

Others focus on the general features of resilient systems, trying to integrate resilience, disaster management and climate change adaptation at policy and programme levels (Bahadur *et al.,* 2010). Resilience theory and programming also need to take social power relationships into account, as the benefits of resilience may not be distributed equally within and between communities (Cannon and MüllerMahn, 2010; Levine *et al.,* 2012). In Thailand, institutional structures have also been put in place. The National Disaster Management Committee (NDMC), an inter-ministerial committee, was established in 1999 to develop policies and coordinate DRD activities throughout the country. A National Disaster Management Office (NDMO), under the Ministry of Labour and Social

Welfare, was established in 2000 to serve as the secretariat of NDMC (Levine *et al.,* 2012).

LITERATURE REVIEW AND THEORETICAL PERSPECTIVES

Resilience has now become a buzzword and is being used by actors and organisations from both science and policy backgrounds operating at different scales and with different purposes and meanings (Brown, 2014; Meerow *et al.,* 2016). In this respect, while becoming a hegemonic framing at the policy level, resilience acts apparently as a boundary object (Brand and Jax, 2007) in urban politics, able to bring together actors and organisations with otherwise different agendas and interests.

A coherent approach is required to address these environmental threats in a manner that is consistent with the development and social priorities of different countries. It is particularly important in light of the global nature of many of the challenges described above. In some cases, such as climate change, countries cannot individually reverse adverse trends (OECD, 2001). In others, such as biodiversity and water shortages, consequences of continued degradation spill over national borders. Globalisation of economic activity and changes in countries' relative economic weights have also shifted policy priorities from the local and national levels to the regional and global ones (*ibid.*). As a result, national policies in many areas have become less effective on their own, prompting calls for new multilateral responses. International co-operation, however, requires shared priorities for action and criteria for sharing its costs. It is difficult to reach an agreement on these priorities when large disparities exist in economic conditions among countries.

The concept of resilience has broad policy and scholarly appeal and has contributed to the modern understanding and management of complex socio-ecological systems such as cities (Berkes, 2003; Seeliger, 2013). However, this concept is also fast becoming a cliché. Different political actors from non-governmental organisations to policy-makers employ resilience to promote different agendas, ranging from the provision of protective infrastructure and enforcement of land-use regulations to changing livelihood sources and resettlement of vulnerable communities (Anguelovski *et al.,* 2016). In urban planning, climate change and disaster studies, resilience refers to the capacity of a socio-ecological system to withstand and recover from threats (Berkes, 2003). This includes the

degree to which a system is capable of stability, persistence, adaptability and transformability (Seeliger, 2013; Walker *et al.,* 2004). Adaptability is a characteristic that allows a system to cope, survive, learn and self-organise in response to threats (Berkes, 2003). Transformation, on the other hand, involves creating a fundamentally new system when ecological, economic, social and political conditions make the existing system untenable (Walker *et al.,* 2004).

The most common policy applications of resilience are efforts targeted at improving stability and persistence and, to some extent, adaptability (Berkes, 2003). Examples of transformation are limited, perhaps because it represents an irreversible regime change (Pelling, 2010). Transformation destroys old coping mechanisms and structural barriers to deep ecological, economic and social reforms, while creating new sets of demands, accompanied by a radical shift in behaviours, politics, culture, economic processes, worldviews, institutional arrangements and development patterns (Bahadur, 2014; Pelling, 2010). Favourable transformation can enhance resilience but undesirable transformation may lead to loss of resilience (Bahadur, 2014). Crises provide a window of opportunity for transformation (Pelling, 2010, Seeliger, 2013). However, contemporary resilience planning at such periods has not been transformative. At best, they tend to "build back better" (e.g. construction of higher levees in flood zones) and this is often done within existing institutional and socio-political parameters (Taylor, 2014). In other words, resilience planning and actions are directed at accommodating risks and their root causes, rather than the root causes themselves (Pelling, 2010).

Conventional thinking and planning for resilience have been criticised for failing to adequately take into account the multiple stressors that shape urban societies. These societies are not only vulnerable to environmental and climatic risks, but have become increasingly vulnerable to the outcomes of economic restructuring under neoliberal and entrepreneurial principles, changing property markets and global capital pressures (Datta, 2015). These global metabolic assemblages and the political economy in which they operate, played a key role in creating the present environmental crisis that resilience thinking is mobilised in response to (Swyngedouw, 2015). Davoudi (2012) states that resilience, as a concept, also fails to take into account the power relations, politics and social

conflicts, among actors, involved in adaptation but, instead, reinforces existing inequalities brought about by neoliberal governance (Swyngedouw, 2015). The fact these issues are under-theorised within conventional thinking, makes the uncritical promotion of resilience as a goal in urban planning and adaptation problematic.

This literature notes that cities' resilience challenges are multi sectorial, multifaceted and contextually specific (Bicknell, Dodman and Satterthwaite, 2012; Cutter, Burton and Emrich, 2010; Sherrieb, Norris and Galea, 2010). Consequently, urban resilience interventions need to involve social and economic strategies as much as physical ones (Jha, Miner and Stanton-Geddes, 2013; Tanner *et al.,* 2009). However, the literature's findings diverge between studies that find that effective resilience-building interventions should be varied and tailored to specific city contexts and those suggesting more prescriptive processes, solutions and implementation.

Past evidence also supports these strategies. The literature suggests that resilience planning and plans are needed in cities (Berke and Smith, 2009). Literature also cites notable barriers to successful implementation, including the lack of funding, institutional constraints and difficulties in anticipating long-term physical and social needs such as climate change scenarios (Biesbroek and Lesnikowski, 2018; Bulkeley, 2013). Some evidence indicates that resilience activities should include a focus on institutional change in government operations as well, such as de-siloing efforts between emergency management and community development entities (Aylett, 2015; Martín *et al.,* 2016). However, past attempts to transform city government or public operations and planning through staffing, intensive technical assistance, or funding, are few and far between and have provided few documented outcomes or impacts.

RESULTS AND DISCUSSION

The goal of resilience-building is transformation. The transformation has been described as 'an approach to holistically and fundamentally build, reshape and enhance people's capacity to adapt to, anticipate and absorb shocks and stresses' (Bahadur *et al.,* 2015:12). It is a deliberate, strategic

process, usually involving innovation, empowerment and fundamental changes to how people's capacity to adapt to, anticipate and absorb shocks can be built, reshaped and enhanced (Bahadur *et al.,* 2015).

Findings suggest programming to strengthen community resilience should centre on community networks and social capital and should support community-driven responses (Community and Regional Resistance Institute (CARRI), 2013). With the skyrocketing number of urban dwellers, cities will struggle to provide water due to hydrologic changes and increased need; modelling found that by 2050, one billion people will reside in cities with perennial water shortages (not accounting for access issues or quality of water) (Population Council, 2018). In the first global survey of large cities' water sources, researchers found that previous analyses overestimated global water stress because they did not account for infrastructure. However, despite significant infrastructure, one in four cities remains water stressed due to geographical and financial limitations (McDonald *et al.,* 2014).

Evidence about city networks affirms their increasing importance for sharing resilience lessons (Alger, 2011). It is argued that cities must be brought together in a network that encourages global environmental governance (Bulkeley, 2005; Gustavsson, Elander and Lundmark, 2009). Though there is strong political and ideological support for these networks (Giest and Howlett, 2013; Hakelberg, 2014; Lidskog and Elander, 2010; Toly, 2008), efforts often fall short of expectations as the ability to deliver results depends on many factors that are often not considered by all network members (Fadeeva, 2005). Beyond city outcomes, network use also leads to outcomes relating to the management and structure of the network itself. Bouteligeir (2013) notes that city-to-city networks often face complex power dynamics and unequal involvement is unavoidable. Successful curation of the network is, therefore needed, especially in a network's early formation.

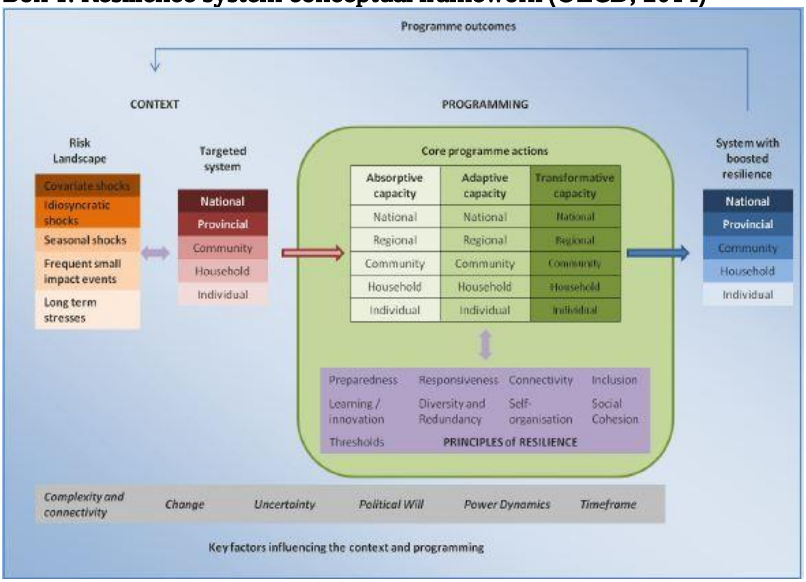
In this context, recent research has called for more attention to be dedicated to urban knowledge systems (Jon, 2018; Muñoz-Erickson *et al.,* 2017). Several scientific tools and technical devices, such as maps and

Geographic Information Systems (GIS), are routinely used in urban planning and support the development of resilience strategies (Pelling, 2011; Godschalk,2003). Practices such as community vulnerability and risk assessment and resilience action plans pervade and also delineate how resilience is constructed (Kitchin *et al.,* 2012; Porter, 1996). Science is not a monolithic block and different epistemologies and forms of knowledge exist (Knorr Cetina, 2007). With regards to resilience, much knowledge comes from natural science disciplines, with social science often limited to vulnerability assessments (Donovan and Oppenheimer, 2015).

Quantitative tools are generally granted more authority than other forms of knowledge(Kovacic, 2018).Yet, rather than more physical science knowledge, it has been argued that it is more social scientific knowledge that is needed to understand, for example, barriers to climate change adaptation (Hackman *et al.,* 2014; Lorenzoni and Whitmarsh, 2014). At the same time, several authors have questioned the dichotomy between lay and expert knowledge (Wynne, 1992) and emphasized the value of local knowledge, such as in the case of climate change adaptation (Naess, 2013). Box 1 shows the conceptual framework for a resilience system. To integrate resilience into programming, it is critical to understand the key concepts underpinning resilience systems analysis. The analysis process, summarised in Box 1:

- starts with an understanding of the risk landscape in a particular context.
- looks at how those risks will affect society's systems.
- gathers information about how those systems are set up to cope with those risks and whether this makes them resilient.
- determines what needs to be done to boost resilience; to help the different parts of the system to either absorb those shocks, adapt so that they are less exposed to those shocks, or transform so that the shock will no longer affect them.
- the result is a resilient system, which will then change the overall context and risk landscape.

Box 1: Resilience system conceptual framework (OECD, 2014)



Boosting resilience is an iterative process: resilience programming targets specific societal systems and the risk landscape affecting them. The outcomes of programming will, in turn, affect the context.

Attempts have also been made to identify common features of resilience at the community level (Twigg, 2009; Arup International Development, 2012). A recent review identified nine core elements of community resilience: local knowledge, community networks and relationships, communication, health, governance and leadership, resources, economic investment, preparedness and mental outlook (Patel *et al.,* 2017). Although many different matrices have been developed, there is no consensus on how to measure resilience in the field. It is generally agreed that resilience is highly contextual, requiring multi-sectoral approaches adapted to local circumstances (Winderl, 2014; Levine, 2014). Without the ability to identify and serve these populations, humanitarian aid after disasters and longer-term development programmes may inadvertently systematically exclude them when creating policies and programmes (Population Council, 2018). This will leave out vulnerable groups that are

unable to plan for and adapt to change and are exposed to loss of housing, property, life, employment and opportunity for economic and social development.

Increasingly, resilience is being understood in terms of building different types of capacity within communities and social-ecological systems. Many agencies use the approach of the Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) programme, which identifies three types of capacity: adaptive, anticipatory and absorptive (often referred to as the '3As') (Twigg *et al.,* 2019:3; Bahadur *et al.,* 2015). Adaptive capacity is the ability of social systems to adapt to multiple, long-term and future climate change risks and to learn and adjust after a disaster. Anticipatory capacity is the ability of social systems to anticipate and reduce the impact of climate variability and extremes through preparedness and planning (Bahadur *et al.,* 2015). Absorptive capacity is the ability of social systems to face and manage adverse conditions or emergencies. The 3As approach is widely used by operational agencies to plan and evaluate resilience programmes. Linked to this is transformation, the series of deliberate attempts to engineer the changes required to build capacities and achieve the desired goal – for example, to alter institutional policies or power relations – often involving innovative technologies and processes (*ibid.*). Table 1 provides some examples of the three types of capacities, for different categories of capital within the livelihood system.

Table 1: Some examples of the three types of capacities, for different categories of capital within the livelihood system

	Absorptive capacity	**Adaptive capacity**	**Transformative capacity**
Financial capital Human capital	- Support access to markets to increase the sale of agricultural/livestock products - Setting up and linking savings groups, pooling of community goods, mutual solidarity banks. - Integration of displaced children into new schools in host communities	- Better access to micro-credit and revolving funds, to encourage risk-taking for new incoming generating activities - Introduction of e-banking mechanisms - Increase understanding of the rights of the child (including education) - Establish formal health insurance schemes	- Open a formal insurance market - Social protection systems. - Simplify and explain the tax law to limit corruption - Provide free education - Decentral ise the healthcare system

	- Use of traditional medicine - Social support groups to help families pay for health care		
Natural capital Physical capital	- Sale or slaughter of livestock - Moving to a more secure area -Vaccination - Reforestation - Setting and securing national park boundaries -Strengthen committees in charge of infrastructure maintenance -Ensure community participation in planning processes for community infrastructure	- Diversification of livestock holdings Animal vaccination -Support to the REDD+ process - Introduce new technologies: efficient combustion fireplaces, recycling and improved management of waste, alternative energy sources -Promote civic education in schools, including a component on energy, environmental protection and climate change	- Reform of Land tenure Law: assuring proper planning and synergies with different land-users - Advocate for greater decentralisation of national budgets and systems
Political capital Social capital	- Better transparency and accountability in community decision-making -Support and strengthen local initiatives for community meetings and for land conflict resolution - Use of mediation and peace committees -Community networks for the protection of children, youth patrols to prevent theft and rape	- Support community organisations to participate in local power structures, including greater inclusion of women and different ethnic groups -Educate voters, strengthen democratic culture and increase dialogue between political parties - Training of peace committees and another group -Promotion of shared community spaces and natural resources -Strengthen the role of women in community governance	- Advocate improving election transparency -Educate citizens about democratic principles -Advocate for the respect and the reform of land-related Legislation - Support the restoration of formal justice systems and promote trust in these mechanisms -Reinforce women in leadership positions -Remove the stigmatisation of those suffering from rape and other critical protection incidents

Aid and development agencies face significant challenges in building resilience in unstable and violent contexts, especially in protracted crises (Levine and Mosel, 2014). Conflict reduction and DRR initiatives are usually carried out separately and there has been little progress in adopting more integrated approaches (Peters, 2017). A 2016 report by the Organisation for Economic Cooperation and Development (OECD) observed that, 'in reality, policy-makers and practitioners know relatively little about how to reduce fragility and increase resilience' (OECD, 2016: 13).

However, superficial value-neutrality does not mean that value conflicts are resolved, rather, conflicts overvalues maybe suppressed and hidden (Simon and Randalls, 2016; Welsh, 2014). If so, this may only delay and deepen tensions and potentially undermine the long-term functioning of integrated planning approaches that are thought essential for sustainable urban development (McEwen *et al.,* 2017; Mitra *et al.,* 2017; Bull-Kamanga *et al.,* 2003). The meaning and practice of resilience are shaped by competing and unequally powerful actors in the city and beyond (Leitner *et al.,* 2018; Wilson, 2012). Where diversity is not acknowledged, debates over resilience will undermine the potential for more integrated policy and democratic decision-making. Consensus will be built on false foundations and may undermine trust between urban actors (Solecki *et al.,* 2017). On the other hand, if urban resilience is negotiated and even contested, through a process, it can help to surface these tensions and better situate and ground the focus of resilience goals and activities (Harris *et al.,* 2017; Friend and Moench, 2013).

RECOMMENDATIONS AND POLICY OPTIONS

The World Food Programme (WFP)'s 2016–20-Zimbabwe strategy ('Building resilience for zero hunger') also addresses long term recovery and resilience-building to address the underlying causes of food insecurity and nutrition, while maintaining humanitarian assistance capacity. Specifically, resilience can help build the capacity of states and societies to deal with increased risk, recover their core functions quickly after a shock and deliver long-term solutions. The European Union(EU) aims at a dynamic, multi-dimensional approach to resilience at all levels to address the risk nexus, that is, vulnerability to multiple interrelated risks, including environmental and economic shocks, disasters, conflicts and global threats to health – and enhance the resilience of the most vulnerable people, particularly in countries facing protracted or recurrent crises. This

requires operationalizing the humanitarian-development nexus by strengthening the links between relief, rehabilitation and development. According to Urban Africa, Risk Knowledge (2019) for resilience to take place the following recommendations were made:

- Build a common understanding and awareness about the city's resilience and promote urban resilience planning using 'good enough' data in a participatory manner, based on the knowledge and perceptions of municipal staff and local communities.
- Leverage local knowledge of urban risk through inclusive consultations, participatory risk mapping and focus group discussions and build local ownership of the city resilience planning process to define priority actions in the short-, medium- and longer-term, within a 10-year vision and with minimum interventions from externals.
- Develop local capacity and engagement to facilitate the implementation of identified priorities with clear responsibilities assigned to different stakeholders.
- Use the resulting city Resilience Framework for Action (RFA), which allows local stakeholders to self-organise and can be used for leveraging funds from sub-national or national authorities or external partners.

Although some aspects of resilience in fragile and insecure contexts have been researched, for example, issues linked to climate resilience or informal coping mechanisms, there is need to better understand the relationships between insecurity and fragility and resilience, based on empirical evidence from programmes. Private sector organisations can play an important role in such contexts by creating jobs and economic opportunities and as programme partners, implementers and intermediaries in contexts where state institutions lack the authority or capacity to play this role effectively.

Resilience-building and livelihood approaches in fragile and volatile environments need adaptive management and flexible programming. International donors and policy frameworks should acknowledge that experimental learning and a readiness to pilot new ideas and learn from failure can be key success factors, but this takes time. Sustainable and predictable funding should be allocated to conflict prevention and peace-

building in fragile contexts, with different and adaptable approaches, to contribute to building resilience and enhancing livelihoods.

Interventions enhancing community resilience should be tailored to the specific characteristics of the local context. Interventions aiming to move from a short-term humanitarian perspective to a longer-term development one should invest in background analysis to understand how local resources (socio-economic, institutional and environmental) define local vulnerabilities, but also how they can be key to building resilience strategies. International donors and policy frameworks should promote dynamic and multidimensional approaches to resilience. Building resilience to multiple and interrelated risks requires multifaceted solutions integrating humanitarian assistance and development, covering different sectors with interventions that are both nutrition-sensitive and climate-smart at global, regional, national and local levels.

Governments also need to "lead by example" in promoting sustainable development. Governments should, therefore, focus their internal policy design and implementation processes on more effectively integrating the three dimensions of sustainable development (economic, environmental and social); improving their capacity to support sustainable development; and developing transparent and productive mechanisms for interacting with civil society. They should improve the capacity for policy integration at all levels of government by:

- ensuring that key economic, environmental and social considerations are integrated into sectoral policy analysis, design and implementation before decisions are taken, using tools such as environmental, social and regulatory impact assessments and cost-benefit analysis.
- ensuring that the best scientific advice on sustainability issues is coordinated at the highest possible level within government and communicated promptly to decision-makers.
- co-operating internationally to develop common approaches for making economic, environmental and social policies mutually supportive.
- assessing the coherence of their international engagements, to improve international policy-making processes.

- identifying sustainable development policy targets and timetables and conducting regular reviews of progress (including through peer review).
- developing the capacity within government to use information and communication technology to coordinate effectively across government.

CONCLUSION

Resilience is enhanced by improving the anticipatory, absorptive and adaptive capacities of households and communities to moderate the impact of shocks and adjust responses to changing internal and/or external drivers. This helps to build transformative capacities for systemic change. Addressing climate change is a particularly urgent challenge, requiring strong international cooperation and leadership from OECD countries to act rapidly to achieve the mitigation levels envisaged under the Kyoto Protocol. OECD countries need to better align their domestic policies with climate change objectives. They also need to introduce market-based measures, such as emission trading systems, carbon taxes and subsidy reforms and to combine these policies with focused programmes for technology development and diffusion that include low carbon emissions energy sources. They need to develop long-term mitigation policies and strengthen their partnerships with developing countries, to stabilise concentrations at levels that avoid dangerous interference with the climate system.

This study reveals the complexities and 'messiness' of resilience planning and adaptation in the context of an emerging future city in an African megacity. It shows that resilience planning and climate change adaptation are not necessarily mutually inclusive, as some actions may lead to maladaptation where attention is not paid to issues of power relations, capital accumulation, discursive politics, knowledge contestations and marginalisation of the poor and vulnerable. Theoretically, this study brings into closer dialogue UPE scholarship and the resilience and risk debate in the context of future cities. The study revealed how 'future city planning' as a political project, perpetuates enclosure and commodification practices to increase the resilience of capitalist investors, the economic elite and the transnational class. Furthermore, knowledge generated from this endeavour, adds new impetus to the scrutiny of the constructive and destructive processes associated with certain State-sponsored public-private adaptations.

Despite the planners' win-win rhetoric, the EAC may turn out to be a zero-sum project that will increase social inequity and create an unsustainable adaptation trajectory. The project emerged against the backdrop of socio-spatial inequality and an exclusionary planning process that supports a growth-based and market-led vision of adaptation but does not invite a transformation of the current socio-political or socio-economic order. This type of adaptation planning undermines participation and does little to foster accountability and egalitarian management of coastal threats and future risks. A paradigm shift driven by new modes of environmental politics, transformative discourses, new planning systems and inclusive ideologies is, therefore, warranted.

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CHAPTER 8: Sustainable Urban Management for African Cities

Abstract

There are facts in development and academic literature that reveal that Africa is urbanising faster than any other region of the world. The region is, however, characterised by unplanned urbanisation that reflects through urban problems such as informal settlements, urban poverty, urban sprawl, incapacity institutions and urban sprawl. Specifically, the chapter seeks to proffer a scholarly persuasion and thinking that suggests that effective and sustainable urban management is key in addressing urban dynamics in Africa. Key players such as the state, community, voluntary and the private sectors, are critical towards improving urban affairs. This chapter is based on an extensive literature review that highlights the gaps in effective urban management in Africa. Specifically, the chapter draws from experiences in Cairo (Egypt), Johannesburg (South Africa), Nairobi (Kenya), Dakar (Senegal), Rabat (Morocco), Accra (Ghana), Harare, (Zimbabwe) and Kigali (Rwanda). The roles of different players are interrogated concerning the contribution towards sustainable urban development. Urban management in Africa is constrained by poor fiscal decentralisation efforts, out-dated urban planning and management instruments, disconnected urban investments and incapacitated institutions. Effective and sustainable urban management needs the presence of effective, coordinated and capacitated institutions that addresses both national, sub-national and local urban issues. This is achieved through sound policies, plans and regulations that guide urban growth and development. Having urban plans and national goal frameworks that converge with the ultimate outcomes is important and this calls for capacitated institutions at all levels.

INTRODUCTION

Africa is urbanising at a faster rate than most continents due to growth in technological use and globalisation. There are challenges and opportunities that go with urbanisation. If properly managed, such an increase in the absolute number of urban inhabitants in Africa could propel social and economic growth, part of a phenomenon called the "demographic dividend" (UN-Habitat, 2009). However, given the current development pace in the region, most countries might not be able to

harness this urban dividend. Some of the opportunities include investments in infrastructure, industrial and commercial structures. However, to realise these opportunities, deliberate urban management approaches are needed (Andersen, Jenkins and Nielsen, 2015). These have been lacking in many African countries, resulting in cities in the region being characterised as being simply crowded but not economically dense.

The investments in infrastructure, industrial and commercial structures have not kept pace with the concentration of people, nor have investments in affordable formal housing; congestion and its costs overwhelm the benefits of urban concentration. There are costs associated with this and the costs include high costs of living, low investment and many other social and economic challenges (Josse, 2020). The region is characterised by unplanned urbanisation that reflects through urban problems such as informal settlements, urban poverty, traffic congestion and water stress (UN-Habitat, 2009). Specifically, the chapter seeks to proffer a scholarly persuasion and thinking that suggests that effective and sustainable urban management is key in addressing urban dynamics in Africa.

Urban management is defined as the process of taking responsibility for actions to achieve improved urban human settlements (Mattingly, 1995). This responsibility is assumed by three tiers of government: central government, the provincial government and local government. These functions are drawn mainly from various pieces of legislation that include constitutions of respective countries and town planning laws (Josse, 2020). There are several professions involved in urban management and these include town planners, engineers, realtors, architects and economists. These professionals are employed in state and non-state organisations and directly or indirectly perform functions that are related to urban management. Besides these professionals, there are policy-makers, elected representatives and politicians involved in urban management through establishing governing laws, policies, vision and ideologies at international, national and local levels (Bolay, 2015). In addition, there are also non-state agencies that support the functions of urban management. In summary, the key players in urban management include the state, community, voluntary and the private sectors, which are critical towards improving urban affairs.

It is widely acknowledged that without appropriate planning and management of urban areas, there are risks that these urban areas will become increasingly chaotic, inefficient and unsustainable (*ibid.*). In many countries in Africa, urban management tools such as legislation, date back to the colonial era. These legislations are ill-equipped to deal with contemporary urban problems. A shortage of urban planning and management professionals trained to respond to urban complexity with progressive pro-poor approaches, exacerbates urban dysfunction (Africa Research Institute, 2013). The absence of a well-functioning urban management system results in the creation of dysfunctional settlements. The urban management system needs to be well-resourced for it to perform all the duties and responsibilities for a functional urban system (Lall, Henderson and Vernables, 2017). The urban management system comprises the institutions such as central and local governments, urban policies and plans, legislations and human resources. All these components of the system are critical in improving urban land development processes and land-uses. In the absence of a well-resourced and functioning planning system, development fosters deal-making among the influential and financially better-off – rather than compliance with accepted and transparent planning processes (Africa Research Institute, 2013).

LITERATURE REVIEW

Urban areas are the locale for complex networks of activities essential to basic human functions of living and working (Lall, Henderson and Vernables, 2017). There has been a growing complexity in urban problems and the responses to these problems. Initially, urban management functions were more state-led when professions such as town planning, engineering and architecture emerged (UN-Habitat, 2009). The growing complexity of governing in a globalising and multi-level context has initiated a change of focus where more actors, other than the state are merging. In developing countries, the concept of governance has been promoted along with decentralisation and democratisation (Berrisford, Cirolia and Palmer, 2018). Changes in economic and governmental systems, like civil society and the nature and scale of environmental challenges, have all had major impacts on processes of urbanisation and urban growth and socio-spatial dynamics in urban settlements (UN-Habitat, 2009).

Governance is a broad concept covering all aspects of the way a country is governed, including its economic policies and regulatory framework and adherence to the rule of law, acceptance of pluralism and participatory models of leadership selection (*ibid.*). Governance is defined as:

> "the provision of the political, social and economic public goods and services that every citizen has the right to expect from their state and that a state has the responsibility to deliver to its citizens" (Mo Ibrahim Foundation, 2019: 17).

Good governance (Figure 1), in terms of transparency and accountability in its operations and decision-making, has been offered as an objective for better urban management. Governance performance is thus indicative of a country's and urban areas' readiness to provide social protection services to its citizens. In Southern Africa, Botswana and South Africa are the top-scoring countries in terms of overall governance (Mo Ibrahim Foundation, 2019) but have been on a concerning downward path since 2015.Angola and Swaziland are at the bottom of the ranking, though they are on a steady path of improvement since 2010.

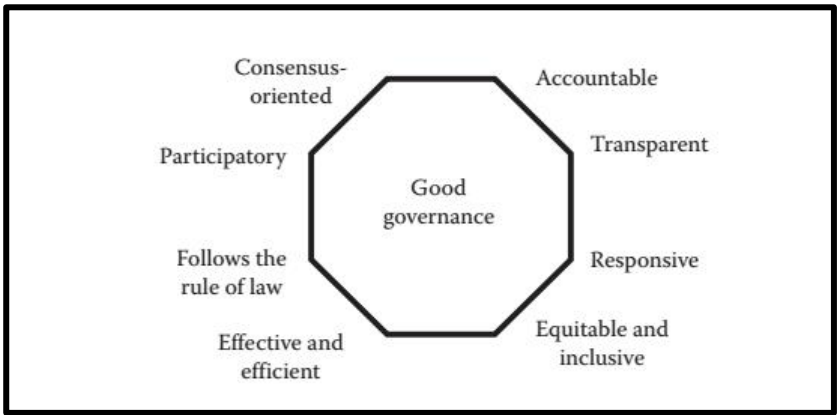

Figure 1: *Principles of good governance (*Picard, 2013:16)

African cities are expensive to investors, particularly regional and international investment, due to high transaction costs associated with inefficient urban form, e.g. urban sprawl and underdeveloped transport networks (Lall, Henderson and Vernables, 2017). Therefore, steering African urbanisation along more sustainable paths is not only a challenge for Africa, but also requires international cooperation to ensure that resource utilisation is well managed and that African cities develop

sustainable and inclusive economies, societies and environments (Picard, 2013).

Most nation-states in sub-Saharan Africa remain economically fragile and politically weak in terms of democratic accountability and executive capacity, reflected in the continued emphasis on state-based land-use planning practice (DFID, 2015). Traditional forms of governance and resource control are becoming increasingly superseded and fused into so-called 'informal' systems of urban management that are characterised by informal land developments and informal activities access and use (Africa Research Institute, 2013). This is particularly the case in and around the rapidly growing peri-urban areas, where different kinds of 'informal' systems dominate (Andersen, Jenkins and Nielsen, 2015).

Africa's cities are growing fast. This is despite the region being one of the poorest regions in the world. Africa is undergoing a critical demographic transformation. Most of the expected population growth in Africa will be absorbed in urban areas (Picard, 2013). Half a billion people live in Africa's cities and another 800 million are projected to join them by 2050 as the continent shifts to an urban majority (Bolay, 2015). How these cities develop, grow and provide liveable homes for their swelling populations is the key to Africa's future success or despair (Lall, Henderson and Vernables, 2017). Urban management is critical in an urbanising region to enhance the provision of jobs, water, electricity, sanitation and transport. The scale of urban growth being experienced in Africa overwhelms the capacity of governments to provide basic services such as education, health services, housing, potable water, electricity and waste disposal. As such, most urban dwellers in African cities live in overcrowded informal settlements (Africa Research Institute, 2013). Without these services, there are fears that the cities will become places of conflict and insecurity (Berrisford, Cirolia and Palmer, 2018). The creation of jobs and the provision of housing, electricity, water and security is not keeping pace with the volume of people streaming in from the countryside.

Management objectives are critical in guiding urban management approaches and the sustainability of the managed urban areas. These objectives are derived mainly from national policies and visions. In most instances, the local experiences are a reflection of the national state of management of affairs (UN-Habitat and IHS, 2018). Some of the international guiding urban management objectives include the Paris

Agreement on Climate Change, the Sendai Framework, the New Urban Agenda and the Agenda 2030 (Josse, 2020). These are, however, localised with varying degrees in African cities (Berrisford, Cirolia and Palmer, 2018).

Urban management in the 21st century calls for creative and innovative urban managers as the societal problems keep evolving (Andersen, Jenkins and Nielsen, 2015). New urban problems are emerging resulting from climate change, diseases, conflicts and increased urban poverty levels and these may require new urban management skills (Berrisford, Cirolia and Palmer, 2018). In addition, production and consumption patterns keep changing and these need to be well managed to meet urban dynamics (Lall, Henderson and Vernables, 2017).

Having up-to-date data is important in guiding decision-making in urban areas. Without access to simple data such as the number of residents or the state of existing buildings, success in public policy-making can only be hit-and-miss (Josse, 2020). This information is essential for detecting people's needs, preventing risks and assessing costs. It could be said that Africa's cities are operating blindly, such as the lack of basic data (DFID, 2015). The lamentable deficiency of good data to assist urban development in Africa needs to be overcome. As noted by Lall, Henderson and Venables (2017), across Africa, opaque and inadequate land databases and information systems distort land prices and availability. Technocratic functions, although they may, in certain circumstances, achieve positive results, are often ineffective, hindered by a lack of political will, technical expertise and adequate data. Data are important in influencing the decision. For instance, problem and solution modelling the dynamic environment are more critical than ever. Without reliable data, urban managers are often accused of producing plans that do not reflect the realities of cities (UN-Habitat, 2009). The other challenge is, however, having data but not accessible to different users due to lack of coordination at the institutional level. Often, useful information may be held by international agencies and research departments but is not accessible to professional urban managers. In administrations that tend to be highly compartmentalised, existing data are rarely digitised and shared between different municipal departments (Bolay, 2015).

Fiscal decentralisation looks at the share or percentage of the government's total expenditure carried out by subnational/local

governments. This is whereby the government gives some of the financial responsibilities to the local government. This has the desired effect of encouraging local participation in issues to do with a local community, because local governments are considered to be closer to the people and, therefore, allows participation to take place. In South Africa, the Constitution of 1996 divides revenue between the national government, the nine provincial governments and the 284 local governments (Ahmad and Tanzi, 2002). Fiscal decentralisation allows local governments to make decisions best suited for their community at a quicker rate than wait for advice from other local governments who may have different problems to them, or same problems but requiring different solutions (Haniff, Wallace and Gago-de-Santos, 2020). Financial decentralisation has also been known to improve the cases of collection and expenditure of domestic tax and non-tax sources of government revenue, and improve on accountability of the government to the local people as seen in the case of Brazil and Indonesia (Yilmaz and Zahir, 2022).

Cities have a broad spread of tax instruments available to them such as levies, business taxes, and fees for exploitation of natural resources and land taxes. The challenges of inaccurate data impact the financial performance of urban local governments, for instance, through the administration of property taxes and development levies. Many governments have been advocating varying fiscal levels of decentralisation that impact the ability of urban managers to meet urban development objectives through increased revenue sources and increased autonomy on financial management. Cities may have good visions and policies but financing these programmes determines the extent of success. Financial sources in local governments are a critical issue that needs to be looked into. If taxation systems remain inadequate in most African cities, it is because political leaders are unable to enact far-reaching fiscal reforms. Fiscal reform is counter-productive in terms of the political calculations that govern the thinking of local leaders and external lenders. Improving the system is an extremely long and involved process and only the drawbacks are ever pointed out, with short-term advantages hard to discern.

Various institutions in urban areas are incapacitated because of various issues. These institutions are facing challenges in performing their tasks and ensuring their success. Urban planning institutions do not have enough money and ideas to combat or adapt to various issues (Asongu

and Le Roux, 2019). There is financial incapacitation that limits the execution of plans. Plan implementation becomes difficult in the absence of financial resources needed to pay workers and for the tools and equipment needed (Akabuiro, 2022). In countries like Zimbabwe, there may be power outages that limit execution. This answers to the statement that low income and poverty are the major challenges hindering development in Africa. There is also the risk of lack of technical support. Legislation may also b e a factor in implementation of best laid plans, as legislature guides the task at hand and without guidance, there are a lot of delays (Fagbadebo, 2019).

METHODOLOGY

This study is based on a systematic review of policy and development literature that is related to urban management and sustainable development. A case study approach has been adopted to elucidate the existing urban management challenges in selected urban areas in Africa, drawing opportunities and lessons for sustainable urban management. Specific cities of focus are Cairo, Johannesburg, Nairobi, Dakar, Rabat, Accra, Harare and Kigali. However, some experiences will be drawn from other African countries as well. Key sources include national policies, visions and programmes, urban policies and plans and academic sources that address issues of urban management. Thematic analysis was used in data analysis.

RESULTS AND DISCUSSION

African countries have adopted key international and regional policies and frameworks that are related to sustainable urban management. The adoption of these policies is a true reflection, at least on paper, of the commitment of African countries towards sustainable urban management (UN-Habitat, 2009). This is considered because development happens at local spheres and the international and regional policies influence national development plans and strategies which then influence local actions. Sustainable urban management at the local level borrows directly from national and regional standpoints. It is consistent with global and regional policy frameworks such as the New Urban Agenda, the Sustainable Development Goals and the Africa Agenda 2063 (Bolay, 2015). The New Urban Agenda stresses harnessing the advantages of urbanisation. These advantages are realised through taping from the role of cities in economic

growth. Cities are viewed as vehicles for inclusive and sustainable economic growth. It leverages urbanisation for structural transformation, higher productivity and inclusive growth, economic diversification, value-added activities and resource efficiency while supporting the sustainable transition of informal to formal economies (Josse, 2020). The sustainable development goals emphasize balancing development between economic, social and environmental goals (UN-Habitat and IHS, 2018). In addition, the SDGs emphasize inclusive cities that accommodate and meet the various needs of diverse societal groups. The African Union's Agenda 2063 undisputedly acknowledges that urban centres substantially contribute to African GDP, generate employment, reduce poverty and can be considered a major driving force in the continent's transformation (Josse, 2020).

Urbanisation is strongest in Africa compared to the rest of other regions in the world (Berrisford, Cirolia and Palmer, 2018). However, this urbanisation is occurring in cities that have low levels of public investments, weak quality of local administration, and lack of social safety nets for citizens and large dependence on external donors (Bolay, 2015). The annual rate of urban growth has been gradually decreasing in Africa over the past decades. This is evidenced by a change from 4.16% in the 1980s to 3.29% in the years 2000-2010 (UN-Habitat and IHS, 2018). However, urbanisation remains high in the region and it is estimated that by 2050, there should be about 1.2 billion citizens, representing 58% of the continent's population (Bolay, 2015). This spatial and demographic expansion and its effects in terms of poverty and urban insecurity should be the foundation of urban management in Africa (Andersen, Jenkins and Nielsen, 2015). Countries like Rwanda have formulated urbanisation policies that are instrumental in guiding urban management.

Rapid urbanisation in Africa is simply not matched by the job creation required to secure livelihoods and public intervention is not keeping pace with the demand for shelter and land (Lall, Henderson and Vernables, 2017). Most urban master plans do not take into account the informality of urban life, either social, economic, property, or land-use (Bolay, 2015). These dimensions of the life of the poor must be reinstated in urban management. This process begins in training curricula of future

professionals (engineers, architects, urban planners, realtors, etc.) as in their practice, once they are at the command posts (Mattingly, 1995).

Table 1: *Percentage FDI received by African regions from global regions (2003-2016)* (UN-Habitat and HIS, 2018)

Central Africa	Eastern Africa	Northern Africa	Southern Africa	West Africa
15	20	4	12	22

Foreign direct investment (FDI) in cities reflects the level at which cities are competing to attract investment. This investment is a key determinant of the sustainability of cities especially in the era of globalisation and urbanisation (Berrisford, Cirolia and Palmer, 2018). As people continue migrating from rural to urban areas in Africa, they need sustainable economic opportunities (UN-Habitat, 2009). Cairo holds first place in Africa in terms of volume of FDI attracted, followed in by Johannesburg, Tangiers, Lagos, Casablanca, Algiers, Cape Town, Nairobi, Abidjan and Dakar, in that order (UN-Habitat and HIS, 2018). Cairo is at the top in terms of FDI because it is a vibrant city with well-developed infrastructure and road networks, availability of skilled workers, a conducive foreign investment environment and ease of doing business which makes it a desirable location for investment (*ibid.*)). The FDI in selected Africa countries is presented in Table 2.

Table 2: *The 2016 FDI rank of African cities* (UN-Habitat and HIS, 2018)

Cities	**African Rank**	**Country**	**Region**	**Total (USD millions)**
Cairo	1	Egypt	Northern Africa	13716
Johannesburg	2	South Africa	Southern Africa	13211
Nairobi	8	Kenya	Eastern Africa	5978
Dakar	10	Senegal	Western Africa	4775
Rabat	11	Morocco	Northern Africa	4737
Accra	13	Ghana	Western Africa	4066
Harare	41	Zimbabwe	Southern Africa	415
Kigali	27	Rwanda	Eastern Africa	2302

Despite Cairo and Johannesburg doing well in attracting FDI, at the global level, no African city is found within the top10 FDI recipient cities of the world (*ibid.*). The key lesson for urban management drawn in countries with high FDI is that business and industrial clusters are catalysts for

industrial growth in Africa because they help firms overcome growth constraints and also enable governments to address multiple constraints holistically (Lall, Henderson and Vernables, 2017). Planning and managing these land-uses is important in sustaining cities and fighting the current urban challenges such as poverty, unemployment and informality in cities such as Harare and Nairobi (Josse, 2020). Clusters promote knowledge sharing between firms, common infrastructure and services, pools of labour and raw materials and providing a larger market (UN-Habitat and HIS, 2018). The cities of focus in this study (Cairo, Johannesburg, Nairobi, Dakar, Rabat, Accra, Harare and Kigali) have, in common, discontinuous territorial development, dispersed in the periphery and with low land occupancy, whose influence extends continuously further in the suburbs and farmland, thereby causing shifts (Andersen, Jenkins and Nielsen, 2015).

There are similarities in the institutions and actors involved in urban management across African cities. What differs, however, are the levels at which these actors are involved in urban management functions. Across all urban areas of focus in this study, one of the most fundamental and critical challenges faced is the crippling weakness of institutions of urban development planning and management (*ibid.*). Coordination is limited amongst public institutions and this creates bureaucracy in the operation and management of development objectives. In many instances, central government policies are formulated and implemented (at sector ministry), yet the implementation of these policies will cut across sectors (Africa Research Institute, 2013). Even at the local level, there are still coordinating gaps between local governments and related institutions such as those responsible for regulating the environment. Since the 1970s and 1980s, urban management process began to involve, admit of and be affected by a wider variety of participating actors, including from the government (central, state/regional and local levels), community and neighbourhood associations and other civil society stakeholders and interest groups (UN-Habitat, 2009).

Major actors involved in urban management in Africa are urban planners, engineers, surveyors, realtors and architects who are technocrats performing technical urban management services (Mattingly, 1995). These technocrats are employed in public institutions (central and local government) and private institutions. There are also financial players such as banks and building societies which are critical in financing urban

development and management. Civil society is emerging as a key player in urban management through social accountability strategies that demand feedback on services being provided and also collaborating with service providers (UN-Habitat, 2009). The sectors are instrumental in making sure that urban policies are formulated and implemented in response to the current and future urban problems (DFID, 2015). Yet, experiences in African countries show that there is a disconnection between a plan on paper and plans at the implementation phase (Andersen, Jenkins and Nielsen, 2015). These gaps expose the weak coordination of actors involved in urban management.

Decentralisation and devolution have resulted in increased responsibility for local governments in African countries. Despite the tendency of national governments to resist relinquishing responsibilities and the pervasive anti-urban bias, both the functions local authorities are meant to perform and the overall area and numbers of people they are meant to serve, have grown rapidly (DFID, 2015).

One of the forms of decentralisation, fiscal decentralisation has, however, been lacking and this has resulted in many operational challenges. Constrained fiscal decentralisation, on the other, has limited the resources available to African urban authorities to fulfil these expanding functions and to address urban growth. Resources to invest in capital development (i.e. long-term infrastructure investments) have been particularly lacking (Africa Research Institute, 2013). Due to the diversity of African cities, trends in income and expenditure are difficult to determine. Experiences in Harare, Accra, Dakar and Nairobi indicate that local governments often focus on operational expenses (such as salaries) and have little surplus to invest in the capital; significant revenue flows are captured by national state-owned entities (such as utility companies) and are thus not reflected on local government balance sheets; direct lending to local governments for infrastructure is minimal; and local revenue collection (for example, property tax collection) tends to be inefficient and not maximised (Berrisford, Cirolia and Palmer, 2015). Local authorities are, therefore, limited in terms of pioneering their development objectives and managing these development options.

In many cases, plans were created for many cities of Africa, but with no convincing results (Bolay, 2015). One of the key explanations for this failure lies in the lack of available basic data about cities and their

inhabitants. The data exist but are not managed or exploited. Data in urban management are needed for policy ad plan preparation. For instance, data on population projections, land and property use registers and tax systems based are needed for the operation and financing of urban systems and the provision of services (Africa Research Institute, 2013). These data are required across all departments at the local government level. Digital investments in data management have been minimal in Cairo, Nairobi, Dakar, Rabat, Accra, Harare and Kigali. Johannesburg has made significant strides in data management through collaborations between the city, private institutions and universities (Josse, 2020).

Land registers, with accurate and up-to-date management of land-use, are essential for proper planning as they make it possible to identify all the plots that together make up the city. But land-use is not controlled in Africa: structured neighbourhoods sit alongside informal ones, flood-risk zones are built on and so on (Lall, Henderson and Vernables, 2017). This creates challenges, especially in the advent of emergencies such as COVID-19 and climate change (Josse, 2020). Without information, it is impossible to build a land registry system and without a land registry, it is impossible to collect the taxes needed to finance shared services.

Sustainable urban management at the local government level stems from global and regional frameworks such as the SDGs, the New Urban Agenda and the Africa Vision 2063 (Bolay, 2015; Josse, 2020). These policies influence national and local policies. For instance, the SDGs were adopted by all eight countries of focus in this study. Local governments have made deliberate efforts to localise the SDGs. One of the urban challenges in the 21st century is urbanisation and its management in urban areas. Current urban problems in cities like Harare, Kigali, Nairobi and Johannesburg are a result of uncontrolled urbanisation. Urban managers need to find sustainable ways of positively managing urbanisation to attract FDI and enhance industrial development (UN-Habitat, 2009).

CONCLUSIONS AND RECOMMENDATION

Major urban challenges of the 21st century include the rapid growth of many cities and the decline of others, the expansion of the informal sector and the role of cities in causing or mitigating climate change. With these challenges, the effectiveness of urban managers for dealing with the unprecedented challenges facing 21st-century cities and for enhancing sustainable management is called for. Better management of human

settlements in less developed countries has become a priority if the aspirations of citizens, governments and the concerned international community are to be realised. Recognition of this need has been prompted by a growing awareness that cities, towns and villages have functions to perform which are as important as those of rural areas. Sustainable urban management is a product of many factors that include capacitated institutions, effective decentralisation efforts, coordinated institutions and actors and deliberate efforts to manage urbanisations. The management of cities determines, to some extent, the levels at which the cities will attract FDI. Balancing between social, economic and environmental objectives is critical in making sure that cities function holistically. Experiences from this study indicate low economic investments in urban areas and this is partly because of weak urban management strategies. African governments need to connect FDI attraction to sustainable urbanisation by underpinning it with robust national urban policies, urban planning and financial and legal systems. It is recommended that institutions and actors involved in urban management should be capacitated and well-coordinated to address current urban problems.

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CHAPTER 9: Best Practices and Building Local Capacity to Address Hazards of Climate Change in African Cities and Towns

Abstract

This chapter looks at the various efforts used to address climate change in Zimbabwean urban areas. This is against the background that climate change risks are increasing as exemplified by the occurrence of hazards such as floods, urban heat islands, sea level rises, heat waves and cyclones. Due to their densities, urban areas are exposed to various climate change risks and disasters and deliberate planning efforts are needed to respond to the hazards. The question raised in this chapter is: What are the key strategies adopted in response to climate risks and disasters in selected urban areas in Africa? The case study approach draws from experiences in urban areas in Southern Africa, West Africa and East Africa. An extensive desk review is used to understand and examine the best practices being implemented by different stakeholders, including public agencies, the private sector, community-based organisations (CBOs), non-governmental organisations (NGOs), civil society organisations (CSOs) and the general public. Emerging from this review is that deliberate response strategies are being implemented by different stakeholders but in an uncoordinated manner. The public sector is often financially constrained but also does not adequately prioritise post-disaster recovery. Other existing sectors such as CBOs, NGOs, CSOs have responses that are more reactive than proactive and this, again, does not reduce the likelihood of future risks from turning into disasters. The existing policies are not specific as to what roles stakeholders play.

INTRODUCTION

Africa is amongst continents that are experiencing urban growth together with increased climate change risks and disasters as a result of hazards such as floods, cyclones, droughts and sea level rises (African Union, 2019). The increasing frequency and intensity of climate-related hazards in Africa will impact the livelihoods, settlements, health and infrastructure in urban centres. Overall, this will negatively impact the socio-economic development of urban areas and the progress towards meeting the sustainable development goals. Despite noting this, the IPCC's Urban

Chapter of the Fifth Assessment Report noted that literature detailing climate change risks and the best response practices remains low and this applies to Africa's urban areas (Fraser *et al.,* 2017).

Risks and disasters in Africa's urban spaces are rooted in deep inequalities, limited adaptive capacities, state fragility, uncontrolled urbanisation and environmental deterioration. Consequently, climate change poses a major threat to sustainable development at the micro and macro levels (Brown *et al.,* 2012; African Union, 2019). While many countries in Africa have made significant development, achievements evidenced by a 4.5%annual growth over the last decades, are significantly threatened by increasing water, weather and climate risks (African Union, 2019). The interaction between climate change risks and deliberate response strategies is critical in fostering development agendas in urban areas in Africa.

As Busayo and Kalumba (2020:1) put it,

> "the urban populace and planning stakeholders are grappling with the challenges of seeking ways to integrate adaptation measures into human livelihoods and planning systems".

African cities are not passive bystanders to climate change risks and disasters, but are active in certain areas that will be detailed in the results section. For instance, there are local authorities that have mainstreamed climate change policies in their development agendas. There are development partners also active in climate change risk reduction in urban areas, for instance, various UN agencies (Fraser *et al.,* 2017).

National governments are also visible through guiding national policies, influencing decentralisation and devolution policies to increase control over resources at sub-national and local levels. African governments such as Mozambique, Senegal and Uganda are investing resources to reduce the risk of natural hazards (UNISDR, 2012). These practices form different spheres depicting that deliberate efforts are being taken to combat the impacts of climate-related risks in urban areas in Africa. This brings in issues that include actors, actions, capacities and ambitions and involved in deliberate practices in response to climate change. The urban context varies in Africa and this influences the practices being implemented (Busayo and Kalumba, 2020). As such, the study looks at best practices at

the sub-regional level, bearing in mind the differences in climate-related disaster contexts.

GLOBAL AND REGIONAL INSTRUMENTS FOR CLIMATE DISASTER REDUCTION

Africa has a long history of regional political commitment to disaster risk reduction – often acting as a pioneer in recognising the importance of preventive action (UNISDR, 2012). This is shown by several regional policies such as the Africa Agenda 2063 that focuses on developing Africa as a whole. Its main goals are to improve the standard of living, quality of life and well-being of citizens, and living in countries with transformed economies. This can only be achieved with focus on building the capacity for local people and the national and local government (Mhangara *et al.,* 2019). The commitment to global instruments, such as the Hyogo Framework for Action of 2005 to 2015, is also vital in the fight against hazard impacts on people. The Hyogo framework focuses on reduction of disaster risk and prioritises the issue of reducing the impacts of disasters on people. This is seen through the framework's principles of knowing the risk and taking action to combat impact of disaster, being prepared for the risks and being ready to take action when it strikes (Wanner, 2020).

The Sustainable Development Goals of 2015 are also another global instrument utilised in climate change reduction. The goals include goal 13 that seeks to combat climate change and address its impacts. This influences individual countries and continents to work together and reduce the causes and impacts of climate change as it brings about various challenges to the people (Fuso Nerini *et al.,* 2019). The Sendai Framework (2015-2030) seeks to reduce global mortality resultant from disasters, the number of people affected, economic loss and damage to infrastructure. It also seeks to increase availability of access to multiple early warning systems against disasters, in order to ensure people are prepared and take action when disaster strikes. (African Union, 2019; World Bank Group, 2021). These regional instruments seek to, among other things, improve the resilience of settlements to climate change disasters through deliberate planning, resource prioritisation, the establishment of key institutions and inclusion of the locals in the planning and management of sustainable settlements (Busayo and Kalumba, 2020). Africa is committed to the principles highlighted in these global commitments. While these global commitments are not action plans, it is imperative to note that they play a key role in guiding the development of national and local action plans (World Bank Group, 2021).

There are technical and resource constraints in translating these instruments into national and local action policies (Heinrichs, Krellenberg and Fragkias, 2013). African states have to redouble their efforts in mobilising domestic resources to achieve resilience targets. Recent studies point to the need for additional efforts to build the technical capacity of African states to improve practices towards reducing the risks from climate change and disasters (Joshua, Jalloh and Hachigonta, 2014; Godfrey and Tunhuma, 2020; Busayo and Kalumba, 2020). At the regional level, Africa's development is guided by the 50-year Pan African Agenda, the Agenda 2063. This Agenda was adopted in 2003 and is an important ligament that coordinates the implementation of practices for resilience building in the wake of climate-related disasters and risks (African Union, 2019).

LITERATURE REVIEW

Urban areas are being considered as central elements in responding to climate change. This is because urban areas are concentrated places as a result of people and their homes, industries, wasters and physical assets (Godfrey and Tunhuma, 2020). Urban area events that have potential for disasters will likely impact urban areas because of the concentrated densities and concentrated hazards. The urbanisation rates are increasing and current statistics point out that more than half of the world's population (55%) are residing in urban areas (Busayo and Kalumba, 2020). Globally, urban areas consume approximately 75% of the planet's resources despite occupying a small percentage of the planet's space (World Bank Group, 2021). These consumed resources are significant in the emission of greenhouse gases (GHGs) that are key climate change causes.

Confronting climate change will, therefore, depend on the changed habits of urban inhabitants through deliberate policies and actions. Cities are confronted with existing vulnerabilities that can be made even worse by climate change (Heinrichs, Krellenberg and Fragkias, 2013). The existing vulnerabilities, particularly in developing countries, include the following: urban poverty, inequalities, housing deficit, informal activities, deterioration of infrastructure, lack of access to key resources and social exclusion (Godfrey and Tunhuma, 2020). These existing vulnerabilities, coupled with climate hazards, increase the likelihood of climate disasters.
Hazards can be categorised into primary hazards and secondary hazards. Primary hazards may include flooding and secondary hazards will include the contamination of water sources as a result of flooding (Heinrichs,

Krellenberg and Fragkias, 2013). A hazard is defined as the "physical process or event (hydro-meteorological or oceanographic variables or phenomena) that can harm human health, livelihoods, or natural resources" (World Bank Group, 2021: 1). A hazard may not necessarily turn into a disaster. Deliberate efforts can be put in place to contain hazards to such an extent that they do not turn into disasters and this is most important in the era of increasing climate events (Busayo and Kalumba, 2020). A disaster is defined as an event that harms humans and disrupts the operations of society (UNDRR, 2020).

Hazards are considered disasters if they occur and affect humans. Humans are at risk of both hazards and disasters. A risk is defined as "the potential for consequences where something of human value (including humans themselves) is at stake and where the outcome is uncertain" (World Bank Group, 2021:1). Climate risk is a result of exposure to a hazard, sensitivity to impact and adaptive capacity. Climate change leads to disaster by altering the frequency and intensity of hazard events, affecting vulnerability to hazards and changing exposure patterns (UNDRR, 2020). Figure 1 presents the connections between climate change causes, effects and outcomes.

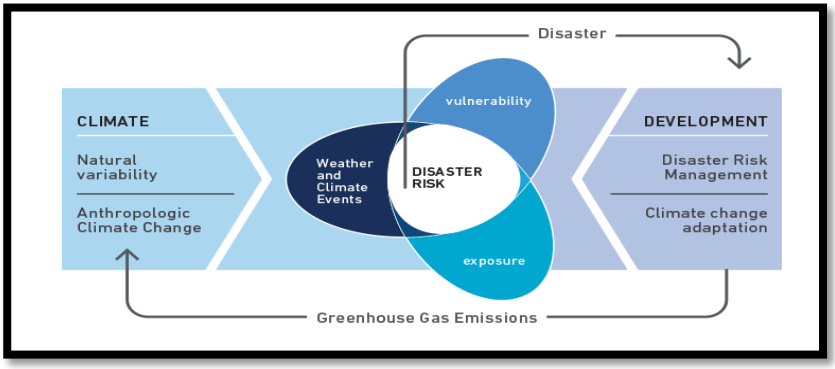

Figure 1: *Climate change causes, impacts and outcomes (*Extracted from UNDRR, 2020:2).

Adequate urban planning and governance are, therefore, needed to enhance the safety of urban areas even in cases of inevitable disaster occurrences (Busayo and Kalumba, 2020). Urban governance

encompasses a wide range of frameworks that include urban policies, laws, administrative structures, decentralisation, room for other actors and the people in urban areas themselves (Heinrichs, Krellenberg and Fragkias, 2013). Collectively, the role of various stakeholders in urban governance is important in fighting against climate-induced disasters in urban areas (Godfrey and Tunhuma, 2020). It is important to mainstream climate change considerations into various urban sectors such as housing, transport, energy, land-use and environment.

Across all regions, local actors are actively involved in climate change mitigation and adaptation practices (Busayo and Kalumba, 2020). Local governments are visible through urban development planning and management projects from their resources and support from development partners (Godfrey and Tunhuma, 2020). In particular, local governments are visible through their participation in environmental policies and practical actions, either alone or in collaboration with ministries responsible for environments (Heinrichs, Krellenberg and Fragkias, 2013). In the global north, in particular, cities launched concrete local policy initiatives to reduce consumption of environmental resources like energy. In the 2000s, issues of climate change risks were being addressed embedded in the sustainability concepts. International development partners, such as UN agencies, have been instrumental in funding climate adaptation and mitigation projects in many countries and urban areas across the globe (Godfrey and Tunhuma, 2020). The private sector,as well the general public, have also been active through household and individual responses (Heinrichs, Krellenberg and Fragkias, 2013). Capacities at the local level and the level of inclusion of climate change into development agendas, determine the level of implementation and success stories of the strategies used.

Due to the occurrence of natural and human-induced disasters, building resilience in Africa has gained momentum on the continent (Heinrichs, Krellenberg and Fragkias, 2013). This resonates with global resilience-building initiatives in many countries as a result of climate change and many other livelihoods and human life-threatening risks such as terrorism, civil wars, emerging diseases and viruses (Godfrey and Tunhuma, 2020). However, building resilience in African cities is a burdensome task because of financial incapacitation that most of the developing countries are facing. The plans are adopted from global initiatives but crippled at implementation due to uncoordinated efforts of various stakeholders in

the countries that may have different agendas. There is the risk of alternatives that plagues African cities as there are few cases of providing alternatives, for instance, where did all the people who had businesses around Mbudzi Roundabout, Harare in Zimbabwe, go? Some people had legitimate businesses, but because there was a greater need for traffic movement, these people were displaced and their benefits altered.

THE DISASTER PROBLEMATIC IN AFRICA

While African countries have experienced large scale disasters, such as the 2011 drought in the Horn of Africa, most disaster impacts are related to smaller, recurrent events with potentially high localised impacts. In 2011, a drought hit Somalia, Djibouti, Ethiopia, Kenya and Uganda as a result of two consecutive seasons of rain interrupted by the strong La Nina over the Pacific. This had a great impact on the people of the mentioned countries such that there were recorded deaths of up to 260 000 people and 9.5 million others affected by the drought. This drought created food and water challenges where animals died of hunger and thirst; especially in some other areas that already received little rainfall.

The Global Assessment Report (GAR)(2011) demonstrates that this is the case in other regions as well. However, available data from countries like Mozambique, which monitor disaster losses due to drought systematically, point towards a higher percentage of losses because of extensive risk in Africa (Godfrey and Tunhuma, 2020). Another important factor behind the levels of vulnerability are the dynamics behind rapid urbanisation in African cities (*ibid.*). In 2013, the Gaza Province of Mozambique was greatly affected by floods that in a day, five were left dead and 30 000 needed to be evacuated to drier land. Chowke and Guija were also affected, with the floods reaching Kruger National Park where tourists were to be evacuated also. There was great destruction of infrastructure such as dwelling units, roads and bridges. With property destroyed, there was also the issue of food, because most of agriculture crops were flooded by the waters. This also posed a threat to the health of the people because flood water is dirty and contaminated, and is the source of various water and vector-borne diseases.

While growing urban populations in Latin America and Asia are partially driven by industrialisation processes, studies show that this economic basis for urbanisation is weaker in Africa. This is one of the possible elements that consequentially lead to insufficient levels of urban planning

and government investments in infrastructure. The high proportion of informal settlements in African cities is one of the factors behind the high impacts of recurrent floods in Nairobi slums, for example (UN-Habitat, 2010). A direct implication of this is the need to address the underlying risk drivers of urban poverty, rapid urbanisation, inequality and environmental degradation in Africa, maybe more than anywhere else, by ensuring basic development, urban planning and infrastructure are in place. Investment in basic infrastructure in urban areas is a critical factor for reducing disaster risk (UNISDR, 2012:2). The problems in Africa's cities point towards the need for specialised practices that respond to climate change and the current urban development problems (Godfrey and Tunhuma, 2020). The strategies will have to address the existing vulnerabilities in Africa's urban areas.

RESEARCH METHODOLOGY

The study focus is Africa and the study will specifically look at practices in sub-regions that are North Africa, Southern Africa, West Africa and East Africa. The study adopts a case study approach of the mentioned areas through document review and analysis as well as from documents from the UN. Best practices, in connection with climate change and resilience building, were reviewed and summaries of sub-regions drawn.

RESULTS AND DISCUSSION

AFRICA URBAN LANDSCAPE

The African urban landscape is generally composed of cities, municipalities, town councils and local boards. At the regional level, the United Cities and Local Governments of Africa (UCLGA) is the united voice and representative of local government in Africa (Godfrey and Tunhuma, 2020). The degrees of autonomy of local governments in Africa vary from one country to the other. For instance, in countries like South Africa, Tanzania and Uganda, local authorities enjoy greater autonomy and their functions are less conferred by the central government through ministries responsible for local government (UN-Habitat, 2010). In countries like Zimbabwe, local authorities enjoy less autonomy as they perform functions conferred to them by ministries responsible for local government (Chirisa, Mavhima and Nyevera, 2020). Most of the urban landscapes in Africa were developed during the colonial era and the development was influenced mainly by the goals and objectives of the colonial masters. Most African countries still have planning legislation

based on British or European planning laws from the 1930s or 1940s. Many local authorities still use the master and local plans that are largely reflective of colonial urban planning and management approaches (UN-Habitat, 2010). However, the colonial planning approaches had but also control of urbanisation processes and the urbanising population, albeit with racial segregation (*ibid.*).

Though Africa is the least urbanised, it is urbanising faster than any other continent (Chirisa, Mavhima and Nyevera, 2020). Africa's urbanisation is manifest in the growth of its megacities and that of its smaller towns and cities (UN-Habitat, 2010). The local authorities are responsible for the provision and management of local public services. One of the raised issues is that local authorities in Africa are constrained in the provision of enough services for the ever-increasing African urban population (African Union, 2019). The increase in Africa's urban population causes additional strain on existing infrastructure and services (UN-Habitat, 2010). Many local authorities have struggled to meet the increased demands for urban services and infrastructures and this is reflected by the influx of slums, informal settlements and the outbreak of medieval diseases such as cholera and typhoid (Chirisa, Mavhima and Nyevera, 2020).

SOUTHERN AFRICA

All governments in Southern Africa have developed national climate change frameworks and these frameworks guide the development of sectoral and local climate policies and action plans (Heinrichs, Krellenberg and Fragkias, 2013). The national frameworks seek adaptation policies and at the same time promote climate change-resilient, low-carbon economies and societies (Joshua, Jalloh and Hachigonta, 2014). In addition, the National Adaptation Programmes of Action (NAPAs) has been developed as a strategy for operationalizing climate change adaptation at the national level. The involvement of urban local authorities in national climate change practices is minimal in most countries in southern Africa (Busayo and Kalumba, 2020).

In South Africa, frameworks, such as the International Council for Local Environmental Initiatives (ICLEI) and United Cities and Local Governments (UCLG) are key in mainstreaming climate change policies and platforms in the sector (*ibid.*). Two cities, eThekwini (Durban) and Cape Town, for instance, have established adaptation policies and plans that currently guide adaptation actions (Mapfumo, Jalloh and Hachigonta,

2014). Except for South Africa, development policies in most Southern African countries have paid little attention to urbanisation and climate change impacts on the urban sector. In most countries, such as Malawi and Zimbabwe, national initiatives take place largely outside urban local government (Godfrey and Tunhuma, 2020). As a result, urban local authorities are less active in key climate change debates (Mapfumo, Jalloh and Hachigonta, 2014). Many initiatives in the region have also been led and/or financed by international agencies, institutions and NGOs working with regional partners.

Southern Africa's responses to climate change are guided mostly by a sectoral approach reflected in different ministries within a country (Busayo and Kalumba, 2020). The urban areas draw their practices from sector policies and their policies at the local government level. At the national level, there are programmes that governments initiate with support from development partners, for instance, the programmes like the following: Integrated Water Resources Management (Zambia, Namibia, Malawi and Zimbabwe); Improving Community Resilience and Adaptive Capacity (Mozambique, Zambia); and Multi-City Challenge Africa (Zimbabwe) (Africa Development Bank, 2012; UNDP, 2020). The projects were implemented by development partners such as UNDP, African Development Bank and World Bank in conjunction with respective local governments and national governments (Heinrichs, Krellenberg and Fragkias, 2013).

In summary, the projects seek to strengthen the resilience of urban settlements through sufficient water resources, reduced disasters related to flooding; and mainstreaming climate change in central budgets and planning, sectoral investments and the private sector (Africa Development Bank, 2012; Godfrey and Tunhuma, 2020). Several other development partners are implementing projects, particularly in the water, sanitation and health(WASH) sector and this is important in response to climate change impacts that may disrupt the water supply (Godfrey and Tunhuma, 2020). These programmes are important as they address issues of capacity gaps existing in most local authorities in Southern Africa (Rhodes, Jalloh and Diouf, 2014). While local governments provide the administrative functions of the programmes, the development organisations are responsible for funding and any other technical support for programme implementations, such partnerships are very important in localising climate change global and regional policies and instruments (Busayo and

Kalumba, 2020). The Multi-City Challenge Africa, for instance, is funded by the UNDP in partnership with Mutare, a local authority in Zimbabwe. The programme required researchers and individuals to submit proposals for improving informal settlements' resilience to floods. The UNDP will select the best proposals and offer financial support for the implementation of the selected proposals.

Most of the research on climate change in Southern Africa have focused on rural areas, despite the economic importance and associated vulnerabilities of urban areas (Heinrichs, Krellenberg and Fragkias, 2013). In urban areas, adaptation to climate change is weak because of weak institutional coordination, limited support to local government practises and the use of old and un-updated urban planning and management tools that have not captured issues of climate change (Mapfumo, Jalloh and Hachigonta, 2014). The initiatives by international, multilateral and bilateral organisations in championing operational climate change programmes are, therefore, at the heart of climate change response programmes in most parts of Southern Africa.

WEST AFRICA

Most West African countries have climate change policies. However, the countries do not have specific policies that address climate change risk and disaster reduction in urban areas and adaptation policies in general (Busayo and Kalumba, 2020). What is existing in the countries in the sub-region is climate change policies, climate change frameworks and NAPAs as in many other countries across the African continent. Countries such as Ghana, Nigeria and Senegal have dedicated climate change adaptation plans, strategies and frameworks (Heinrichs, Krellenberg and Fragkias, 2013). These plans, strategies and frameworks influence the development and implementation of urban policies and plans towards climate change mitigation and adaptation. In urban areas, climate risks and disasters are somehow addressed in the climate change or environmental plans of action at the level of provinces or states, for instance, in Lagos, Bayelsa and Ondo States in Nigeria (Busayo and Kalumba, 2020). Ghana has made significant strides in mainstreaming climate change policies into urban planning policies (Godfrey and Tunhuma, 2020). This is evidenced by the country, through the National Climate Change Policy Framework, which later developed into the Ghana National Climate Change Policy 2012, addressed issues to do with improved city planning and a more modern

public transport system based on high occupancy buses running in dedicated lanes.

West African urban areas are home to approximately 40% of the population in the sub-region. However, the majority of urban dwellers in Western Africa reside in settlements located in coastal areas and are, therefore, exposed to flooding, coastal erosion, high tides and sea-level rise and many cities in the region have low adaptive capacities to water stress (Rhodes, Jalloh and Diouf, 2014). To reduce the effects of climate change on freshwater sources, some strategies have been adopted across cities and these include the following: construction of infrastructure to collect, supply and store water; protection of aquifers and reservoir sites; improvement and stabilisation of watershed management and capacity building to understand surface water cycles (Godfrey and Tunhuma, 2020). The key players in these strategies are local authorities, CBOs, government ministries and the general public. In coastal cities, there are weak response strategies (Busayo and Kalumba, 2020). For instance, during flooding in the Alajo community in Accra, community members responded through individual and uncoordinated responses that included temporarily moving away from the area to stay with friends and family; creating raised walls of stones and keep valuables at the top of the wall; and putting property on top of wardrobes and in the small spaces between ceilings and roofs (Heinrichs, Krellenberg and Fragkias, 2013). These local and individual responses expose the incapacity of state and local governments to devise sustainable climate change response strategies.

Like in Southern Africa, the international, multilateral and bilateral organisations, in partnership with local governments and respective central governments, are instrumental in the implementation of climate change mitigation and adaptation measures that reduce the risks and hazards of climate change (Godfrey and Tunhuma, 2020). The dominant organisations in the sub-region include the UNDP, th World Bank, the Global Environment Facility (GEF), the World Food Programme and the United Nations Environment Programme (UNEP) (Busayo and Kalumba, 2020). Many initiatives in the region have also been led and/or financed by international agencies, institutions and NGOs working with regional partners. Despite all the initiatives cited for West Africa, the sub-region still faces operational constraints that stem from dysfunctional institutional structures, lack of technical and institutional capacities in some local

governments and the existence of local competing needs such as security challenges in the sub-region (Rhodes, Jalloh and Diouf, 2014).

EAST AFRICA

Consistency with other countries in sub-regions in Africa, countries in East Africa have developed their NAPAs and demonstrated commitment towards the Initial National Communications (INC) (*ibid.*). These international commitments, together with national climate change documents, focus on the following climate change issues: agriculture and food security, water resources, forests, disaster response, livelihoods, health, energy and coastal zones (Joshua, Jalloh and Hachigonta, 2014). In addition to that, some countries such as Tanzania, Uganda and Kenya have set up task forces that are geared towards the formulation of climate change adaptation policies (Mubaya, Jalloh and Mogaka, 2014).

Like in Southern and Western Africa, international organisations and development partners are instrumental in enhancing the implementation of direct climate change mitigation programmes (Godfrey and Tunhuma, 2020). For instance, in 2011, the UN-Habitat and the UNEP had a programme on enhancing energy efficiency in urban areas. The Water and Sanitation Initiative is a collaborative effort between UN-Habitat, Kenya, Tanzania, Uganda and the East African Community (EAC) (Heinrichs, Krellenberg and Fragkias, 2013). The locals have also their local and household ways of addressing the risks and hazards of climate change. For instance, when confronted with floods, residents in the slums of Nairobi and Kampala employ the following practices such as constructing water barriers at doorsteps, placing children in higher and safer places for periods, constructing temporary structures such as dykes and trenches around the house, using bags of sand to stop water from filtering into the house and gigging trenches around houses before and during floods (Busayo and Kalumba, 2020). These local practices are key in ensuring the safety of citizens, bearing in mind that these are responses that are directly linked with the immediate effects of disasters. However, these approaches are mostly short-term in nature and long-term approaches are needed to complement them and sustainably address the underlying problems (Rhodes, Jalloh and Diouf, 2014). However, the overall picture of local and best practices in addressing climate change through city-level codes and standards is limited. There are also urban food security systems that have developed in many urban areas in East Africa (Godfrey and Tunhuma, 2020). Food production in the urban areas of the region has

grown, not only for subsistence, but also as a major form of income for the urban poor, especially women.

State and local governments should take the lead and formulate policies that address unsustainable use of resources, shortage of technical competence, unsustainable growth, uncontrolled environmental degradation and bad governance (Busayo and Kalumba, 2020). Emerging from the existing literature is a dichotomy between governing institutions and networks of local capacities. Leveraging on the initiatives by development partners in localising climate change, adaptation and mitigation measures will go a long way in creating climate change resilient settlements (Mubaya, Jalloh and Mogaka, 2014). The actors involved in research and policy-making on climate change adaptation in urban areas include international, multilateral and bilateral organisations, the different tiers of government, grassroots groups and local communities, private enterprises and institutions, non-governmental and civil society organisations, networks and individuals (Heinrichs, Krellenberg and Fragkias, 2013).

CONCLUSION AND POLICY OPTIONS

The chapter presented practices that are currently being implemented in Southern Africa, West Africa and East Africa in response to climate change risks and disasters. It emerged from the study that through there are weal connections between local authority practices and national climate change policies, there are international, multilateral and bilateral organisations that are actively participating in reducing the disasters and hazards as a result of climate change. Opportunities for the development of sustainable adaptation strategies exist through collaboration with various actors and partners. The study recommends that state and local governments take a leading role in the development of communities. The state and local movements are, therefore, needed to give a platform for all other actors and stakeholders.

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CHAPTER 10: The Future of Innovations and Adaptive Urban Infrastructure to Climate Change

Abstract

This chapter explores the innovations and adaptive urban infrastructure to climate change showing the increasing present-day challenges from climate change and urbanisation. Half of the earth's population lives in urban areas, and projections suggest that this share will increase up to 66% by the mid-21st century. This urban expansion will heavily draw on natural resources including open space and will have severe effects on ecosystems and the services they provide. Cities are the first to experience impacts from climate change. Rising temperatures, heatwaves, extreme precipitation events, flooding and droughts are causing economic losses, social insecurity and affecting health and human well-being. This chapter is based on a desktop study where a literature review was gathered from Google Scholar in the form of articles, magazines, secondary government reports and newspapers. The methodology used in this study included thematic content and textual analysis of different materials. The study is against the backdrop that traditionally, urban planners and practitioners in land and resource management have relied on conventional engineering solutions to adapt to climate change, but this may not always be cost-effective, sufficient or sustainable. Nature-based solutions can address societal challenges from climate change and urbanisation in a sustainable way. By using ecosystem services, nature-based solutions are innovative solutions that use natural elements to achieve environmental and societal goals. They offer significant potential to provide energy and resource-efficient responses to climate change and to enhance the natural capital. Nature-based solutions provide additional multiple benefits to city residents such as improvements in health and wellbeing and improvements of the local green economy. Understanding and anticipating these changes will help cities prepare for a more sustainable future.

INTRODUCTION

The chapter argues that making cities more resilient to climate-related disasters and managing long-term climate risks in ways that protect people and encourage prosperity includes improving a city's ability to reduce greenhouse gas (GHG) emissions. This chapter demonstrates the

importance of taking a systemic approach to combine knowledge from different fields such as urban planning, nature conservation, urban engineering, governance or social justice and public health to address complex issues sustainably. To date, an increasing number of nature-based solutions (NBS) projects have been implemented. The international climate science research community has concluded that human activities are changing the earth's climate in ways that increase the risk to cities. This conclusion is based on different types of evidence including the earth's climate history, observations of changes in the recent historical climate record, emerging new patterns of climate extremes, and global climate models. Cities and their citizens have begun to experience the effects of climate change.

Innovation is key to coping with climate change impacts. At a local level, communities are responding to climate stresses in innovative ways. Replicating successful solutions in other parts of a country or region can save valuable time and money. By setting up pilot projects and carefully monitoring their results, insights and best practices can be fed into policy processes, helping to scale up successful approaches (White *et al.,* 2005). Africa will be one of the continents hardest hit by the effects of climate change. Increased drought, desertification, variability in rainfall and other consequences resulting from environmental changes, undermine the continent's ability to adapt. Many African countries are marked by grinding poverty and possess unsupportable infrastructures and weak governance mechanisms that contribute to political instability. In September 2015, the United Nations endorsed the new Sustainable Development Goal 11, which is to "make cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, 2015). This new sustainability goal cannot be met without explicitly recognising climate change as a key component. Likewise, effective responses to climate change cannot proceed without understanding the larger context of sustainability. As cities mitigate the causes of climate change and adapt to new climate conditions, profound changes will be required in urban energy, transportation, water use, land-use, ecosystems, growth patterns, consumption, and lifestyles. New systems for urban sustainability that encompass more cooperative and integrated urban-rural, peri-urban, and metropolitan regional linkages will need to emerge.

Importantly, research from the natural and social sciences is combined and results are interlinked with urban governance and local participation.

This volume demonstrates the importance of taking a systemic approach to combine knowledge from different fields, such as urban planning, nature conservation, urban engineering, governance or social justice and public health to address complex issues sustainably. This integrated view to sustainable urban development is also emphasized in the 2030 Agenda for Sustainable Development, the New Urban Agenda adopted at the United Nations HABITAT III conference and supported by the European Commission's research and innovation policy on nature-based solutions (United Nations, 2015). By understanding the value of nature-based solutions to climate change adaptation for society and by developing the policies, research and practice to implement them, there can be contributions to enhancing the preparedness of cities and their communities to meet environmental and societal challenges.

BACKGROUND AND OVERVIEW

Recently, Hurricane Sandy, the most destructive and second-costliest for the US after 2005's Katrina, affected millions of people, including many in the Caribbean. It caused more than US$50 billion in economic loss and over US$5 billion in damage to New York's urban infrastructure (Wakefield, 2020). In the Philippines, Typhoon Haiyan (2013) affected about 25 million people, and two years after, Typhoon Koppu affected one million people with damages of US$160 million. These facts represent only a fraction of what climate change, associated sea-level rise, and extreme climatic events can do. Observed data also reveal that since the early 20th century, the global mean sea-level increase has ranged between 1.3 and 1.7 mm per year. However, from 1993, the rate has risen to between 2.8 and 3.6 mm, varying regionally. For example, in the tropical western Pacific, this rate is four times higher (i.e., 12 mm/year) than the global average (Nurse *et al.,* 2014). In addition to the direct impacts on humans and infrastructure, climatic impacts, and rising sea levels and temperature significantly damage natural resources and ecosystems, particularly in coastal areas which might otherwise have natural and long-term resilience to cope with such events. Mangroves in many coastal areas, for instance, increase resilience naturally, reducing the impacts of sea-level rise, particularly wave energy, beach erosion and storm surges. However, climate change impacts along with anthropogenic interventions, have caused mangrove deforestation at a rate of 1% to 2% annually (Alongi, 2015).

Climate change presents one of the greatest challenges to society today. Effects on nature and people are first experienced in cities (White *et al.,* 2005). Cities form microcosms with extreme temperature gradients and about half of the human population globally lives in urban areas (United Nations, Department of Economic and Social Affairs 2014). Climate change has a significant impact on biodiversity and ecosystem functioning through threatening current habitat conditions due to heat and water stress (European Environment Agency, 2012). Climatic stress leads to a decrease in the distribution of typical native species and facilitates the establishment of alien invasive species (Knapp *et al.,* 2010). The influences of climate change on society include health-related effects and socio-economic impacts induced by increased numbers of heatwaves, droughts and flooding events (European Environment Agency, 2016). In addition to climate change, urbanisation and the accompanying increases in the number and size of cities, are impacting ecosystems as urbanisation is driving a significant conversion of rural to urban landscapes (Seto *et al.,* 2011).

Several interlinked pressures, such as loss and degradation of natural areas, soil sealing and the densification of built-up areas, pose additional significant challenges to ecosystem functionality and human well-being in cities around the world. These processes may lead to biodiversity loss (Goddard *et al.,* 2010) and a reduction of functions and services that urban ecosystems provide (Haase *et al.,* 2014). However, urban green and blue spaces have the potential to counteract these pressures by providing habitats for a range of species (Niemela 1999; Goddard *et al.,* 2010) and several environmental and cultural benefits while contributing to climate change adaptation and mitigation (Kabisch *et al.,* 2015; Kabisch *et al.,* 2016a).

Scholars (Carina and Keskitalo, 2008; Douglas *et al.,* 2008; Barnett *et al.,* 2005) tend to agree that climate change will potentially increase the frequency and intensity of extreme events. Its impact on cities will be more adverse because most of the developments taking place rarely take into consideration the impacts of potential changes to the climate (Houghton, 2004). Climate change impact is expected to vary between places and among individuals owing to their differing levels of vulnerability. The impact will, therefore, be potentially higher where settlements are located in low-lying coastal areas, flood plains and hill slopes (Adger *et al.,* 2003). The extent to which impacts will occur will

also depend on the level of development in different places (UNFCCC, 2008:10). Agrawal *et al.*(2008:33) have shown that institutional and social factors are important determinants of the level of climate change impacts. They argue that the way institutions shape climate change impacts can be explained in terms of how individuals are differentially affected by the same climatic event. The work uses the examples of particular cases to explain these differences, by focusing principally on the differential access of individuals and households to resources, information and decision-making processes. Similar sentiments have been voiced by Adger *et al.* (2003:181) and Hardoy and Romero Lankao (2011), who have explained it in terms of the differences in the entitlement of individuals and groups to call upon collective resources.

THEORIES INFORMING THE STUDY

This chapter builds on Friedmann's transactive planning model to construct a theoretical framework that combines the experiential knowledge from Community Based Adaptation (CBA) and Ecological Based Adaptation (EbA), the expert knowledge from landscape ecological urbanism and the participatory methods of urban planning to address climate change adaptation in vulnerable coastal communities. The proposed approach deploys the design charrette, a participatory tool, to operationalize this framework in Africa and Zimbabwe areas vulnerable to climate change. In exploring these multi-disciplinary theoretical and empirical links amongst EbA, CBA, landscape ecological urbanism and urban planning, this study builds on Steiner's (2014) recommendation for the development of an integrated approach to address climate change adaptation through design. In particular, this study addresses Steiner's (2014:308) question: "how can concepts such as resilience and green infrastructure be advanced to design settlements to mitigate extreme weather events?"

LITERATURE REVIEW

Concerning urban green and blue spaces, NBS can foster and simplify implementation actions in urban landscapes by taking into account the services provided by nature (Secretariat of the Convention on Biological Diversity, 2009). The concept of NBS evolved over the last years and was shaped by several actors (IUCN and the EU Commission). The concept of NBS is particularly embedded in wider discussions on climate change adaptation, ecosystem services and green infrastructure (Kabisch *et al.,* 2016a). Examples of NBS include the provision of urban green such as

parks and street trees that may ameliorate high temperatures in cities (Gill *et al.,* 2007; Bowler *et al.,* 2010) or regulate air and water flows. Allocation of natural habitat space in floodplains may buffer impacts of flood events. Furthermore, architectural solutions for buildings such as green roofs and wall installations for temperature reduction and related energy savings through reduced cooling loads (Castleton *et al.,* 2010), can contribute to NBS. Importantly, by integrating NBS in urban landscapes, multiple benefits related to climate change adaptation and mitigation are increasingly recognised as influential determinants of human health and well-being (Barton and Grant, 2006; Hartig *et al.,* 2014). They relate to the provision and improved availability of urban green spaces and may result in better mental and physical health (Keniger *et al.,* 2013). In addition, NBS may present more efficient and cost-effective solutions than traditional technical approaches (European Commission, 2015). In policy and practice, NBS complement concepts like green infrastructure or ecosystem-based mitigation and adaptation.

Increasing urban densities is seen as a way towards sustainable urban development. Across Europe, there is presently a trend for densification as a planning approach for sustainable development to foster efficient use of resources, efficient transport systems and a vibrant urban life (Haaland and van den Bosch, 2015). Development often takes place in areas that are often viewed as underutilised land (such as green space) or through redevelopment on previous industrial estates (van der Waals, 2000). However, this approach has also been challenged for its threat to urban green spaces (Haaland and van den Bosch, 2015) as with urban brownfields, they potentially have an important role in offering climate change adaptation solutions. The creation, re-establishment, improvement and upkeep of existing vegetation systems and the development of an integrated urban green infrastructure network could provide a valuable asset in which to incorporate the establishment of new NBS to deal with local effects on climate change. The dual inner urban development could be seen as a constructive way forward (BfN, 2008). The approach combines densification of existing built-up areas with a mixture of conservation actions, thereby boosting the presence, quality and usability of green spaces and enhancing other green infrastructure such as street trees, green walls and roofs (*ibid.*).

The distribution of climate-related health burdens is described as almost inverse to the global distribution of GHGs emissions (Patz *et al.,* 2007).

Africa is likely to be affected the most and is where the observed adverse consequences of climate change are most apparent (Collier *et al.,* 2008; Campbell-Lendrum *et al.,* 2003; McMichael *et al.,* 2008). Predictions are that the loss of healthy life years due to global environmental change (including climate change) is 500 times greater in Africa than in Europe and, yet, health is widely recognised globally as a fundamental human right (McMichael *et al.,* 2008). A vital step towards achieving health for all, even in Africa, requires nations to ensure the provision of access to universal health coverage (Garrett *et al.,* 2009). In addition, the World Health Organisation's (WHO) Commission on Social Determinants of Health has emphasized that actions to promote health must go well beyond health care and must focus on people's daily living conditions, including the conditions in which they are born, grow, live, work and age, and on the structural drivers of those conditions such as inequities in access to power, money and other resources (WHO, 2008).

Climate change has significant negative impacts on the social determinants of health. These conditions are intertwined and play a major, albeit indirect, role in creating and perpetuating health inequities within and between nations. In sub-Saharan Africa, rain-fed agriculture provides food for roughly 90%of the population and provides livelihoods for 74% of the poorest people. Therefore, major reductions in the amount of rainfall or changes in its patterns would lead to population ill health. The threats to health by climate change operate through direct consequences from extreme weather and through indirect pathways such as changing patterns of disease and morbidity, water and sanitation, food security, global economic crisis, population pressure, migration and urbanisation (Costello, Abbas and Allen *et al.,* 2007). The spread or resurgence of malaria to the highlands of East Africa is widely cited as an example of a vector-borne disease spreading to new geographical areas as a consequence of climate change (Wanding, Opondo and Olago *et al.,* 2008).

With the current process of climate change, Europe is expected to face major challenges to adapt to and mitigate the consequences of severe weather conditions (Kreibich *et al.,* 2014). The year 2016 saw new temperature records for each month, with July 2016 being the hottest month since the temperature started to be recorded according to NASA measurements (NOAA, 2016). An increase in temperature can cause discomfort, economical loss, migration and increased mortality rates on a

global level (Haines *et al.,* 2006). In addition, there are predicted increases in extreme weather events (e.g. heat and cold waves, floods, droughts, wildfires and windstorms) with several parts of Europe to be exposed to multiple climate hazards (Forzieri *et al.,* 2016). Next to a changing climate, both in Europe and globally, there is an on-going urbanisation process. In the year 2007, half of the world's population lived in urban areas and it is predicted that by 2050, 66% of the world's population will live in urban areas (UN, 2014). The urban climate often differs from the surrounding rural countryside as it is generally polluted, warmer and rainier and less windy (Givoni, 1991). This suggests that the effect of climate change with the predicted increase in temperature and more extreme weather events will be experienced to a greater extent in urban areas compared to the surrounding landscape. The changing climate might also exaggerate the negative effects of urbanisation experienced, such as increased urban temperatures and flooding (Semadeni-Davies *et al.,* 2008). This occurrence of floods risks infrastructure in urban areas as the floods may lead to destruction of housing and service infrastructure. There is also contamination of water sources (Musacchio *et al.,* 2021),especially in urban areas that experience water shortages such as Chitungwiza, Budiriro and Epworth (Kudumba, 2022), which can cause cholera, typhoid and other water borne diseases.

RESEARCH METHODOLOGY

This chapter is based on a desktop study where a literature review was gathered from different scholarly articles in the form of journal articles, books and secondary government reports. Thematic and textual analysis of different tools was used in this study. Climatic existing experiences, case study and documents were used as archival methods. The information used was taken from different parts of the world because climate concepts, debates and ideas are more based on both developed countries and developing countries.

RESULTS AND DISCUSSION

In Africa, he most unsettling aspect of climate change from the perspective of many scholars (Corfee-Morlot *et al.,* 2011; Ranger *et al.,* 2011; Romero-Lankao and Dodman, 2011; Satterthwaite *et al.,* 2009) relates to the potentially catastrophic impacts it will have on the human and socio-ecological systems of cities. Earlier empirical studies of climate change (IPCC, 2001; Tol *et al.,* 2000; Mintzer, 1992) have focused more on its causes which have been largely attributed to human activities.

According to the IPCC (2007), the warming of the global climate is now overwhelmingly beyond dispute (despite the doubts expressed by a body of climate change sceptics) and several long-term changes in the world's climate are currently witnessed in many parts of the world. The environmental impact of global warming will be manifested in the form of various types of severe weather events (Romero Lankao, 2008; Simon and Fragkias, 2008). Impacts will be reinforced more by the local contextual conditions of places (characteristics of topography and location, quality of urban planning, urban services and infrastructure) than by the average global change (Hein *et al.,* 2008; Simon and Fragkias, 2008). Several of the recent climatic disasters involving severe disruptions to urban systems exemplify the extent to which the impacts of climate change will bear on humankind (Moser *et al.,* 2010; Bulkeley and Betsil, 2003).

Technology can help Africa cope with climate change. Above all other concerns, climate change is becoming the defining challenge of the 21st-century generation, especially in Africa. Predictions suggest that African nations, which are least responsible for climate change, are those most vulnerable to its effects. The most important climate change impacts for cities have been identified in many studies (Huq *et al.,* 2007; Parry, 2007; Wilby, 2007) as sea-level rise, flooding, problems of water availability and resources, human health problems, shortage of energy and damage to city infrastructure and the ecosystem. While these may not be the only climate change impacts for cities, this review will focus only on this limited range, since they have tended to receive wider acceptance. Limiting the review to these impacts only will facilitate a better understanding of what response actions cities in developing countries ought to prioritise, given the scarcity of municipal resources.

In Africa, CBA is an approach based on human rights and represents a new field in development and climate change studies. CBA refers to "a community-led process, based on communities' priorities, needs, knowledge, and capacities", whose objective is to "empower people to plan for and cope with the impacts of climate change" (Reid *et al.*, 2009:13). CBA involves governance, power structures, changes, and uncertainty, while simultaneously considering issues of poverty, vulnerability, and the inequitable distribution of and access to resources. Two key factors dominate CBA; which comprise a community, and where this community is (Reid and Schipper, 2014). Community refers to anyone

or any group of individuals affected by the impacts of climate change hence, is working with or without external interventions to cope with these impacts. As for the place, its scope determines the scale of a community and the extent of this community's vulnerability. CBA also identifies the adaptation priorities by relying on community-based and bottom-up tools. For example, the community-based vulnerability assessment (CBVA), developed by Smit and Wandel (2006), deploys the tools of CBA to identify and document the conditions and risks of communities and any challenges related to adaptation approaches.

The Secretariat of the Convention on Biological Diversity (2009) defines EbA as "the sustainable use of biodiversity and ecosystem services into an overall adaptation strategy that can be cost-effective and generate social, economic and cultural co-benefits and contribute to the conservation of biodiversity". EbA research and practice typically include: i) coastal defence through coastal vegetation maintenance and/or restoration; ii) sustainable management of wetland floodplains; iii) natural conservation and restoration of vegetation and forests; and/or iv) healthy and diverse agroforestry systems (Munroe *et al.*, 2011). EbA ensures participatory decision-making and flexible management at multiple geographical scales and combines the best available science and local experiential knowledge of CBA (Andrade *et al.*, 2011). Perhaps that is why over 60% of EbA projects employ CBA initiatives (Doswald, *et al.*, 2014). Like CBA, EbA is a relatively new concept, spearheaded by environmental and biological conservation experts who embrace multidisciplinary, participatory and culturally appropriate approaches (Andrade, *et al.*, 2011). Furthermore, EbA and CBA seem to be complementary: while EbA underscores reversibility and biodegradability simultaneously with increasing the resilience of ecosystems and humans, CBA identifies people and communities at risk and empowers them to take part in decision-making (Girot, Ehrhart and Oglethorpe, 2012). Thus, EbA projects rely on local communities and ecosystems and rank long-term, low-cost, and no-regret adaptation interventions.

CLIMATE CHANGE IN AFRICA AND ZIMBABWE

Climate change is a reality in Africa. There are prolonged and intensified droughts in eastern Africa, unprecedented floods in western Africa, depletion of rain forests in equatorial Africa, and an increase in ocean

acidity around Africa's southern coast. Vastly altered weather patterns and climate extremes threaten agricultural production and food security, health, water and energy security which, in turn, undermine Africa's ability to grow and develop. Climate and environmentally related disasters which threaten human security can induce forced migration and produce competition among communities and nations for water and basic needs resources, with potentially negative consequences for political stability and conflict resolution. As climate change becomes increasingly acknowledged as a key driver of global, regional and local-scale impacts that exacerbate the vulnerability of human systems, the question of how to conduct 'climate compatible development' within urban systems has become more pressing. This is because the planet is currently mid-way through the second global wave of urbanisation, which is proceeding on a scale and at a historically unprecedented rate. Moreover, this second wave of urbanisation is largely taking place within the slums and informal settlements of developing-world cities in Africa and Asia where multiple pressures combine with climate change impacts to exacerbate pre-existing vulnerabilities and inequalities.

In Zimbabwe, climate change impacts cannot be neatly separated from other pressures that have a bearing on the viability of poor urban African household budgets. Planning and undertaking climate compatible development in African cities must accommodate this reality, accounting for a broader set of interconnected vulnerabilities and development priorities. At the heart of this challenge lies the question of how to balance and find synergies between immediate development priorities and building the longer-term climate resilience and sustainability of African cities. This challenge is particularly pronounced in the context of slums and informal settlements within African cities where there are high levels of contingency, fluidity and immediacy. In this regard, the African Centre for Cities (ACC) and the Climate and Development Knowledge Network (CDKN) are primarily concerned with how to support and facilitate development in African cities that address the realities and particular challenges associated with informality and inequality, while integrating climate change and long-term sustainability considerations.

EFFECTS OF CLIMATE CHANGE IN AFRICA

Although for the large part, developed countries are culpable for climate change and have contributed most to total global emissions, it is poorer countries that will suffer catastrophic impacts in the long term. Small

island developing states (SIDS) such as Cape Verde, Seychelles and Mauritius, and African mega deltas such as the Nile Delta in Egypt, Niger Delta, the Kalahari and Okavango Deltas in Botswana, are particularly vulnerable (Black, 2001). Current projections of sea-level rise and increased tropical cyclone intensity, may make many of these small island states in Africa uninhabitable. The effects of climate change include an increased frequency of extreme weather events, rising sea levels, changes in precipitation patterns and droughts, increasing water shortages, the spread of tropical and vector-borne diseases and increased frequency and intensity of storms. Recurrent droughts are becoming commonplace in several parts of Africa with the impacts on the population increasing exponentially. Droughts have largely occurred in the Sahel and some parts of southern Africa. During the Sahelian drought of the early 1970s, about 300000 people and millions of animals died. Flooding, on the other hand, has also caused havoc, particularly in southern and eastern Africa. Floods in Mozambique in 2000 resulted in two million people being displaced with 350000 jobs lost, impacting the livelihoods of up to 1.5 million people (Nkomo *et al.*, 2006).

The effects of climate change will be felt most acutely by the vulnerable segments of the population (Centre for International Earth Science Information Network, 2009). The impact of climate change on livelihoods is manifested directly and indirectly, including loss of natural resources and changes in the viability of economic processes due to changes in global markets. Future climate change is expected to have considerable impacts on natural resource systems and changes in the natural environment, sustenance and livelihoods. These, in turn, can lead to instability and conflict often followed by displacements of people and changes in migration patterns. For example, the on-going conflict in Dafur relates to scarcity induced conflicts. Therefore, as hazards and disruptions associated with climate change grow in this century, so too may the likelihood of related population displacements (Hugo, 1996). Mass movements of people are projected to occur, especially from developing countries that cannot cope with recurrent droughts and associated food shortages and climate change-related migrations. Such population movements are likely to pose serious international security challenges in coming decades (Mitchel and Tanner, 2006). In sub-Saharan Africa, instances of climate-related conflicts have been noted. As most climate models predict a decline in precipitation in several dry-lands in sub-

Saharan Africa with consequent declines in biodiversity, there might be an increase in these scarcity-induced conflicts (Nkomo *et al.*, 2006).

CONCLUSION AND RECOMMENDATIONS

Climate change is a global problem facing all nations. To realise cross-border and local solutions, all countries need to join in managing the effects of climate change on health. This daunting challenge requires a multidisciplinary approach that involves all sectors of government, NGOs, civil society, the private sector, media, various academic disciplines and innovative forms of international cooperation. African nations, their communities and all partners, cannot afford to be passive participants in the struggle against climate change. They should be creatively and meaningfully engaged with full participation over the long haul. Partners should play an active role in monitoring, discussing, advocating and assisting with the process of adaptation and mitigation. Each country should show leadership by putting in place appropriate public health systems to deal with adverse health outcomes, developing its capacity to monitor emerging health and health-related problems, improving the evidence base for policy-makers, planners and practitioners, implementing programmes and undertaking regular evaluations to assess and guide interventions. The scale of current and projected environmental changes necessitates a crucial role for central governments in Africa. However, benefits can be maximised and risks minimised if vulnerable populations are meaningfully involved in planning, implementation, monitoring and evaluation and coordinated responses to environmental change.

Urban planning and design are often cited as the key determinants to improving the resilience (coping ability) of built environments to reduce the increasing impacts of climate change. However, urban planning and design literature has hardly addressed climate change adaptation, particularly at the neighbourhood and district scales. From the perspective of environmental change, over decades, the primary focus of planning research has been on achieving sustainability, a branch that advocates for several strategies to reduce greenhouse gas emissions and facilitate climate change mitigation. The unavailability of climatic information in terms of precision, format and scale has created challenges for planning scholars wishing to advance climate change adaptation.

In particular, the information on climate change impacts on cities representing, as it does, complex interactions between human and natural systems is not sufficient. As a result, current adaptation planning includes only normative strategies from a hypothetical point of assessing risks and proving expert-driven adaptation actions. The process of developing such actions often overlooks two aspects: i) highlighting the theoretical and methodological links used in both planning and adaptation literature; and ii) assessing and prioritising the climatic problems and their solutions by incorporating local experiential knowledge.

Vegetation can, indeed, play an important role in moving the urban climate closer to a pre-development state. Urban green infrastructure (UGI) and NBS are fundamental concepts in this work with an emphasis on the role that nature can play in providing multiple services to the urban population. UGI is a concept that stems from planning, hence the focus is on the strategic role for integrating green spaces and their associated ecosystem services within urban planning at multiple scales. NBS are broad in its definition and scope, with a broad view on 'nature', and an emphasis on participatory processes in creation and management.

The issues have mostly focused on the way human activities are fast changing the composition and behaviour of the atmosphere and the extent of disruption which this may cause. Cities are singled out to play a very important role in dealing with climate change since, in addition to being the major source of GHGs, they have frequently been the major centres of the impact of the most severe climatic events. Coastal cities are specifically required to take urgent action because, even if all GHG emissions were to cease today, temperature and sea levels would continue to rise globally owing to the quantity of GHGs released into the earth's atmospheric system. Climate change impacts are predicted to be particularly adverse for many cities in the developing world, where millions of people will be severely affected in the course of this century. Urban planning is primarily called upon to play an important role in adapting cities to climate change impacts, and in mitigating GHG emissions. The role of urban planning is to be particularly critical in dealing with climate change since most municipal governments making urban planning decisions also have a great deal of influence over emission sources and the range of adaptation activities that take place.

Recent studies in African countries have examined ways in which populations have attempted to cope with recurrent droughts. Agriculture in these countries is heavily dependent on rainfall (as opposed to irrigation in more developed countries), rural populations there are particularly exposed to fluctuations in precipitation. The evidence is that drought occurs with sufficient frequency that some groups have adopted a range of adaptive strategies to cope with climatic risks, including particular temporary migration patterns. In western Sudan, for example, such migration strategies have included sending an older male member to Khartoum to seek wage labour when drought conditions occur. Similarly, the migration patterns of young people in northern Ethiopia appear to respond directly to patterns of drought. In dry rural areas, once drought becomes particularly severe and other adaptation options are exhausted, entire families and communities will move to places where relief is expected to be available. The international community in December 2009, at the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC), agreed on a way forward to cut back on GHG emissions.

There is need to increase people's resilience to the impacts of climate change so that fewer people are forced to migrate. The breakdown of natural-resource-dependent livelihoods is likely to remain the premier driver of long-term migration during the next two to three decades. Climate change will exacerbate the situation unless vulnerable populations, particularly the poorest in Africa, are assisted in building climate-resilient livelihoods. This will require substantial investment in:

1. Adaptation measures, including water-wise irrigation systems, low/no-till agricultural practices, income diversification and disaster risk management.
2. Initiatives to help small farmers and other vulnerable groups to protect and promote agricultural production: simple, inexpensive actions such as setting up an effective system of meteorological alerts, improving agricultural extension services to increase yields and the establishment of independent networks of information exchange between and among communities across the region.
3. The empowerment of women and other marginalised social groups to overcome the additional barriers they face to adaptation.
4. Inclusive, transparent and accountable adaptation planning with the effective participation of especially vulnerable populations across the continent.

Regarding implications of climate change for infrastructure and urban system risk management strategies in the global, regional and local context, the study found out that:

- Risks of disruptive impacts of climate change for infrastructures and urban systems can be substantially reduced by developing and implementing appropriate adaptation strategies.
- Many of the elements of such strategies can be identified based on existing knowledge.
- In most cases, climate-resilient pathways for infrastructure and urban systems will require greater flexibility than has been the general practice, along with selective redundancy where particular interdependencies threaten cascading system failures in the event of disruptions.
- Revising engineering standards for buildings and other infrastructures to accommodate projected climate change is a promising strategy.
- In some cases, especially if climate change is substantial, climate-resilient pathways will require transformational changes, beyond incremental changes.

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