

# 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<sub>2</sub>) is considered one of the greenhouse gases (GHGs) that has been associated with global climate change. Since pre-industrial times, global CO<sub>2</sub> 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)**

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- 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).
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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**

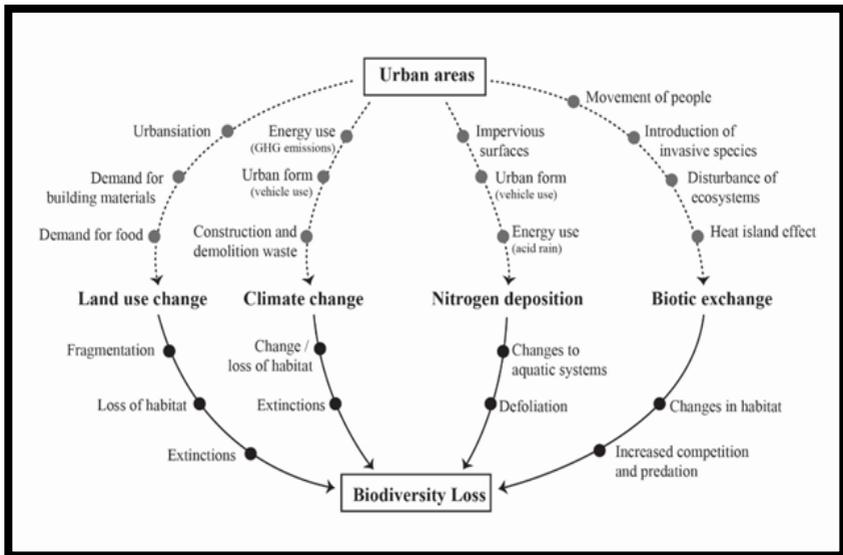
Africa is immensely rich in biodiversity. Its living organisms comprise around a quarter of global biodiversity and it supports the earth's largest intact assemblages of large mammals, roaming freely in many countries. Africa's biomes extend from mangroves to deserts, from the Mediterranean to tropical 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)

<i>The Impact of Cities on Biodiversity</i>	<b>The Impact of Biodiversity on People in Cities</b>
<i>Land-use and land cover change, including urbanisation,18-20</i>	a. Human physical health,27,28 and
<i>ii. Climate change,21,22</i>	b. Human psychological health,29,30
<i>iii. Nitrogen deposition and acid rain,23 and</i>	c. Societal and cultural health,14,31
<i>iv. The introduction of invasive species to ecosystems (biotic exchange),5,24</i>	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 of 1% 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.

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**Box2: Impact of Fisheries Subsidies in Senegal.**

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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

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**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 taxa 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