

**Regenerative Tourism: Re-invention of Social Order through the
Establishment of a Mobile Network**

By

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FOREWORD

This research was conducted during the fall semester of 2011 and spring semester of 2012, under the teaching supervision of Ted Ngai. The intent of the thesis was to examine the urban metabolism of overpopulated mega-cities, and ultimately devise an architectural solution to mitigate the urban growth. The chosen city was Nairobi, the capital city of Kenya.

Overpopulated mega-cities describe cities that are growing at a rate of 100,000 people or more per year. It is generally an undesirable condition where the number of the population exceeds the city's carrying capacity. This phenomenon can result from many factors, such as increase in births or migration, decrease in mortality rates, depletion of resources etc. The research started out by analyzing the underlying causes of Nairobi's growth.

Once it became clear that Nairobi's population crisis was not going to be solved by identifying and addressing each individual issue, the thesis shifted focus onto a system that could potentially provide the financial means in order to expand the city's carrying capacity: tourism. Since the main form of tourism in Nairobi is safari, eco-tourism became the focal point, which carried the essence of social, economic, ecological and environmental consequences. The goal of this thesis was not to stop the growth from happening, but rather to lessen its impact.

ACKNOWLEDGMENT

First and foremost I would like to offer my sincerest gratitude to my professors at Rensselaer, who have supported me with their patience and knowledge while setting the foundation for me to advance intellectually. I would like to thank Ted Krueger for giving me an amazing opportunity to prove myself, and Andrew Saunders for pushing me hard and believing in my abilities.

I am heartily thankful for my thesis adviser, Ted Ngai, who took me under his wing and trained me to think outside of the box. His critical and innovative ways of thinking, and comprehension of the discipline of architecture inspired me to look at design beyond its boundaries and made me believe that anything is truly possible.

I owe my deepest gratitude to my parents, who have doubtlessly supported me in all my endeavors in the past 26 years. This achievement would not have been possible without their endless encouragement (and waking me up at 6 am after having slept for only an hour). I would also like to thank Wil and Steve, my guardian angels, who have taught me the true meaning of family. Without them, I would not be where I am today and I owe them so much more than just a thank you.

I also owe a big thank you to my friends Jackie and Laura, for listening to my endless rants throughout my studies. My sporadic trips to Atlanta and few nights out in Albany gave me just enough energy to filter through my frustrations and keep marching forward.

Last but not least, I'd like to thank the "Grads". This journey would not have been the same without them. Over the past 3 years, we went from complete strangers, to occasional lunch buddies, to "grad potlucks", to living together and eventually sharing our personal lives with each other. Their competitive edge and immense aptitude made me proud to be a part of such a team, and encouraged me to work harder to keep up.

ABSTRACT

Urban metabolism is the conservation and expansion process of a specific system through the evaluation of energy intake and the waste generated within an environment. The analysis that is derived from this evaluation will demonstrate and suggest methods in which urban sustainability can be approached. Sustainable development is an ever-growing notion that is challenged in Nairobi by rapidly increasing population rates, the illegal construction of infrastructure, and consequently the deterioration of natural resources.

By controlling the urban expansion and implementing a modular, responsive ecotourism network on top of the existing city plan, we can begin to limit and manipulate the transition zone between the built and the natural environment. The scale and application of the network will be a direct response to the energy intake and outtake of specific sites in Nairobi, which in turn will stimulate a more sustainable urban growth model/system.

Through strategic establishment of active nodes based on sensory and experiential parameters that respond to land regeneration rates, the improved ecotourism network can address issues of conservation and localize the tourism job market. Consequently, the goal is not necessarily to increase the number of tourists, but to maximize the tourist experience, while at the same time minimizing its footprint.

1: INTRODUCTION

1.1 Demographics

The chosen site is Kenya's capital and most developed metropolitan city, Nairobi, which was established about a century ago during the construction of the Uganda railway. The railway is the main connecting system between Kampala, the largest city and capital of Uganda, and Mombasa, Kenya's second largest city and major port. The central location of Nairobi between these major cities transformed the region from swampland to a main transportation hub (Figure 1.1). The Uganda Railway and a major international airport have made Kenya very accessible, and because of that, the city has become a central hub for a lot of businesses, international corporations and international conferences. This has caused an increase in its development, and therefore, the city has been growing rapidly over the years.

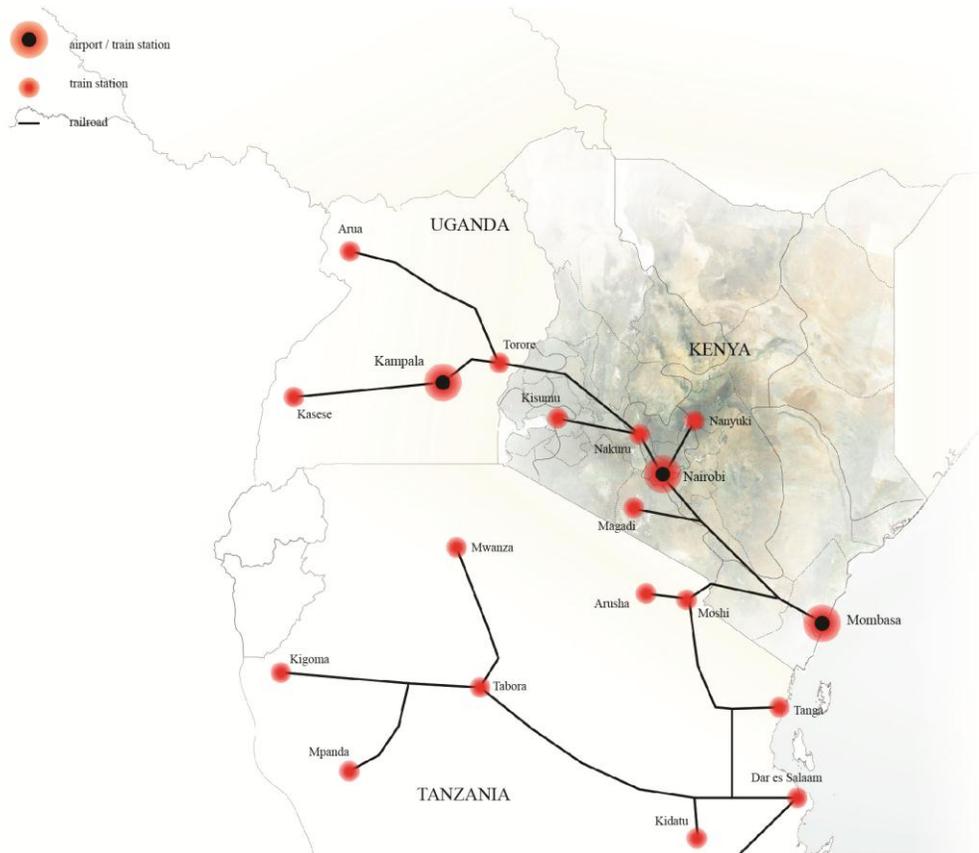


Figure 1.1: The convenient location of Nairobi has introduced a central juncture for transportation and commerce. Due to this accessibility, the city has managed to flourish into the densest city in East Africa.

Since Kenya became independent in 1963, a lot of pressure has been put on open, available lands and the resources it offers due to the dramatic increase of its population. This phenomenon was the reason for an increase in demand for both agricultural land and settlements in the rural and urban sectors. What stands out about Kenya is not only its diversity, but also the stark contrast that exists within various regions and landscapes. Topographically, there's about a 5000 m height difference throughout the country, which ultimately results in many dramatic landscapes. This notion is most evident in central and south-western Kenya, where the land is most developed due to the number of rivers that are accumulated in this region, which has led to uneven supplies of surface water. The water scarcity is directly linked to the population density, poverty rate, major ecosystem types, and the predicted diversity of mammal species (Figure 1.2).

Figure 1.2a shows that due to the network of perennial rivers in central Kenya, most of the population is located in the same region. The nourishment that these streams of water provide is essential for the survival of both the humans and the wildlife. In turn, Figure 1.2b indicates that the poverty rate is also directly related to the source of water. The population living in the outskirts of Kenya, directly on the border of Somalia and Ethiopia, is significantly more impoverished due to water restrictions. Figure 1.2c demonstrates that the majority of Kenya is covered by bush/woodland, yet many of the areas that lack access to direct sources of water are barren and uncultivated. This explains why most mammal species are prone to exist in areas that are able to flourish and provide nutrition, as is indicated in Figure 1.2c.

The contrast within the landscape is also evident within the city of Nairobi. Its landscape ranges from highly developed cityscape consisting of high-rise buildings to untouched infertile land. A great extent of Nairobi is encompassed by a national park (Nairobi National Park), containing a large number of wildlife. The park is separated from the rest of the city by a mere wire fence, making it fairly easy for the locals to co-exist with the wildlife. The urban core of the city, where many of the businesses are located, conforms to a highly gridded and ordered layout. However, as the city moves out towards the edges from the central core, the grid starts to slowly vanish and transform into a mesh of disorder and chaos. This notion is not only due to the accessibility to water (or the lack thereof), but also due to the economic disadvantages

that exist among the local inhabitants of Nairobi. While irrigation is certainly a major issue in Kenya, the capital city suffers from a different problem, which relies heavily on its socio-economic policies.



Figure 1.2a: Population density amplified in central and south-western Kenya.

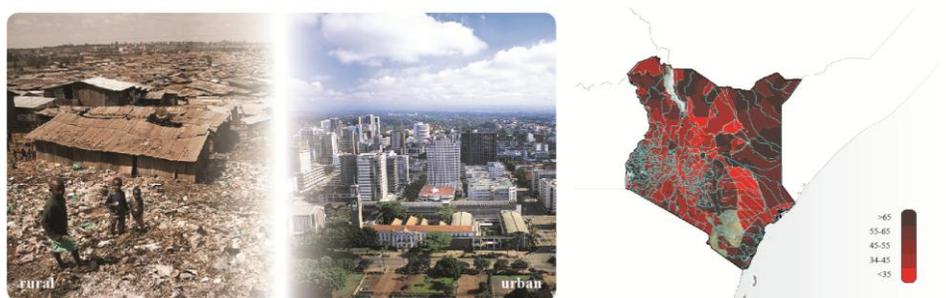


Figure 1.2b: Poverty rate in Kenya is heightened in the arid regions.
(Image credit: Left_ Melisach. Right_ Robert Harding)



Figure 1.2c: Major eco-system types consist of more cultivated land near the water streams.
(Image credit: Left_ Wikimedia Commons image from user Chris 73. Right_ UNEP)



Figure 1.2d: The diversity of mammal species is higher in central Kenya than in the outer, arid regions.
(Image credit: Left_ Filipe Marto. Right_ Wildlife Works)

1.2 Economy & Climate

Nairobi is located within a 100 km radius of the Great Rift Valley (lowland between mountains created by a geologic rift), which is a 6,000 km trench running from northern Syria to central Mozambique. Due to its location right on the equator, Nairobi has a moderate subtropical highland climate. The city is located at 1,795 m above sea level, which causes chilly evenings at times. Besides the weather fluctuations between the wet and dry seasons, there's very little difference between the seasons. The first rain season is between March and May, and the second, which is slightly shorter, is between November and December. Between January and February, the weather is hot and dry, whereas between July and August, it is cold and dry. This weather allows for cultivation of crops such as coffee, rice, fruit, flowers, sugar and tea, which amounts to approximately \$5 billion worth of goods exported (CIA The World Factbook: Africa: Kenya, 2012).

The city houses over 100 major international companies, the Nairobi Securities Exchange, the United Nations Environment Program and UN headquarters in Africa and the Middle East, which have all made Nairobi a financially, politically and socially prominent city. As one of the largest and oldest stock exchanges in Africa, the Nairobi Securities Exchange (NSE) is capable of making millions of trades on a daily basis. All of this has given Nairobi a prominent position as an international social metropolis. One of the drawbacks of this stance is that many of the prominent businesses and income resources are owned by international corporations. This creates a gap between the economy and local communities, since the two are unable to benefit from one another.

1.3 Ecology

The soil in and around Nairobi mainly consists of mixtures of lavas coating the bottom of the Mozambique belt with schist and gneiss. Periodically, parts of the crystalline rocks are apparent as the residue is extracted from the Ngong volcano (Woolley, 2001). Over time, the weathering of the volcanic rocks has generated red soils that can be over 15 m thick. The soil's development and condition is varied throughout the area as a result of climate variance, drainage and elevation differences.

The volcanic rocks tend to slope towards the east, causing the drainage to also follow the same direction. Internal drainage is confined to the west, conforming to the slopes of the Great Rift Valley. The various lava flows that have emerged from all directions have created lava plains that create passages between lakebed and stream deposits, with over 300 m of elevation difference. This allows for water to be drained on the eastern end of the hills, where the water accumulates on low ground. The rock formations to the east act as sponges that serve as water containers that supply the wells of the city and surrounding settlements (Figure 1.3). The decomposition of nutrients into the volcanic rocks formulates soluble molecules that release the necessary minerals that provide nourishment to the vegetation during growth (Sheets & Grayson, 1979). The combination of that and the water entrapment make this particular type of soil ideal for plant growth.

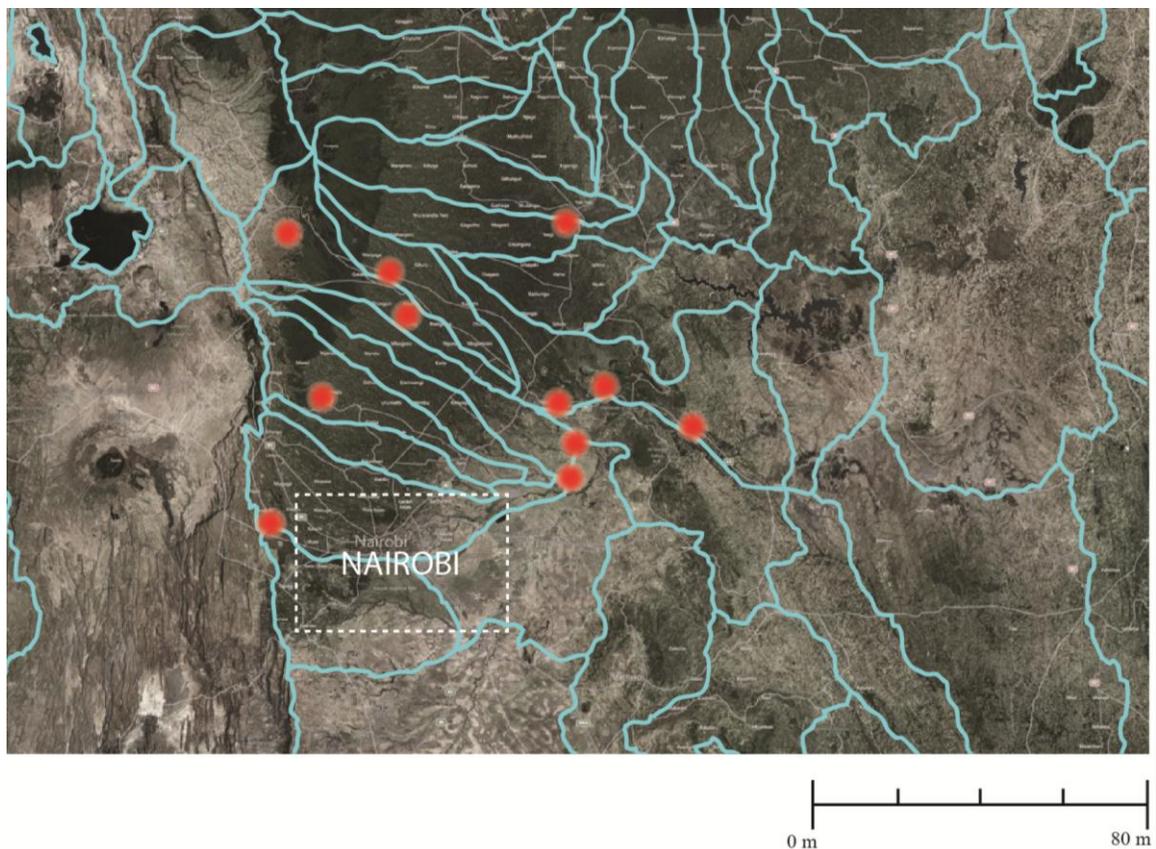


Figure 1.3: Map of Nairobi and surrounding areas. The blue lines demonstrate the water bodies, whereas the red dots indicate the major water basins just north of Nairobi, where most of the settlements receive their main water supply from.

1.4 Current Growth

With a population of 3,138,369 people, Nairobi is the largest city in Kenya and the 12th largest African city. The city is growing at a rate of 3.8% annually, which amounts to over 127,000 people per year (Mitullah, 2003). As one of the world's overpopulated cities, its condition creates conflicts between the human population and its environment. All the economic development caused a mass migration to the city from surrounding villages and towns, in hope of better opportunities, and ultimately, a better life. This is also the reason why Nairobi has a fairly young population. What actually happens when people move to the city is that they end up in a dense region and are unable to find jobs. The city also doesn't have the resources to sustain the growing population, which results in massive pollution as a consequence.

Another consequence is the displacement of the local poor to the boundaries of the city, ultimately resulting in informal settlements. Due to this encroachment, much of the open lands have been occupied by settlers whose only source of livelihood is small-scale farming in order to survive. Nairobi has been growing in a very contained manner, meaning that the center, which was also the most developed region, has remained intact. The city center started growing towards the flat lands, away from the protected lands, and around the main roads and high ways that branched off of the railway (Figure 1.4). This constant growth presents a problem because the city's master plan has not been updated since 1948, so they city is not in the condition to sustain its growing population.

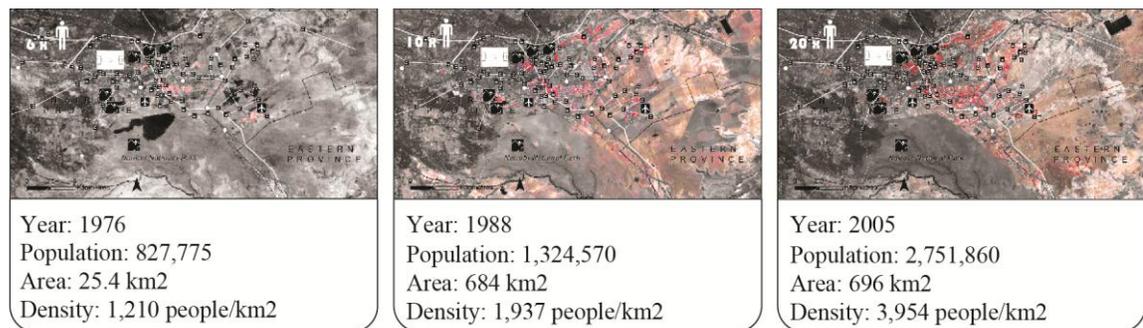


Figure 1.4: Growth of Nairobi starting from its core and radiating out towards the flat lands.

2: EXISTING CONDITIONS

2.1 Land Use

Considering the radial growth pattern of Nairobi, it is no surprise that most of the infrastructure is located in the center. Figure 2.1 shows the density of various parts of the city juxtaposing the poverty levels. As it is indicated, the most centrally located subdivision is also one of the densest areas in the city. Kibera is the largest slum in Nairobi, which happens to be located in that division. With over 170,070 people (Mikel, 2010) Kibera is also one of the densest and poorest parts of the city. Because many of the industries are located in the center of Nairobi, many people relocate to that area in order to find livelihood. Due to the lack of jobs and space, most of them end up as settlers in the slum, which exemplifies the city's inability to take care of a large and growing population.

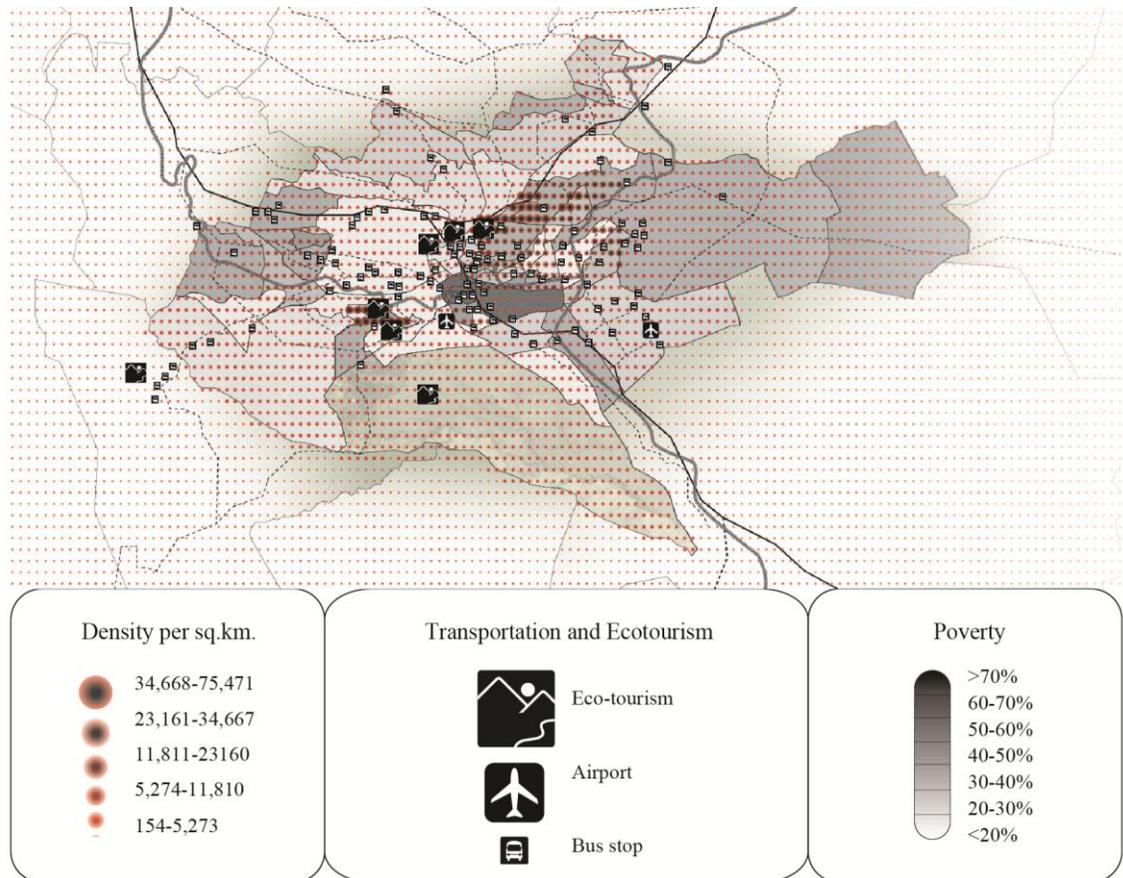


Figure 2.1: Density map of Nairobi indicating population density, poverty levels throughout various regions of the city, and proximity to roads, highways, public transportation and tourist sites.

The extreme high densities in these particular areas of the city influence the delivery of transportation, housing, health services, education, and recreational services. This condition often leaves the slums helpless and creates a large gap between the rich and the poor. The two Google Map images (Figure 2.2) show two different neighborhoods in Nairobi, one being Muthaiga and the other Kibera. Muthaiga is one of the wealthiest areas of Nairobi, and therefore, the properties are much more expensive and not very densely packed. This is much more appealing when compared to Kibera, where there are over 2,000 people per hectare (KENYA: Kibera, The Forgotten City, 2006). The maps show the distinction between the rich and the poor within the urban fabric.

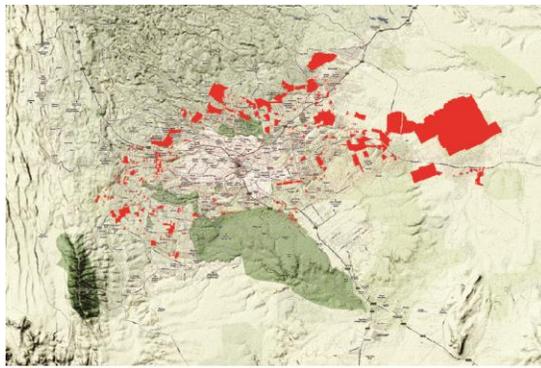


Figure 2.2: Left: Map of Muthaiga (low density). Right: Map of Kibera (high density.)

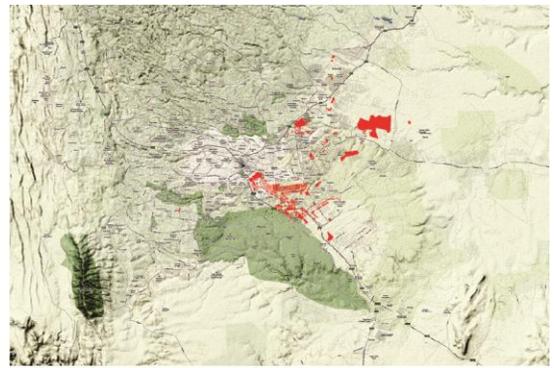
The land-use maps (Figure 2.3) display a fairly scattered urban fabric, and that contrast again starts to emerge within city districts. For example, within the residential sector, the only thing separating the slum with the more upscale, gridded neighborhood is a road. Many of the recreational activities are located near the developed core, which is inevitably also the densest section of the land. As Figure 2.3 demonstrates, the residential sector has spread over the entire city, leaving little to no room for further growth.

2.2 Economic Distribution

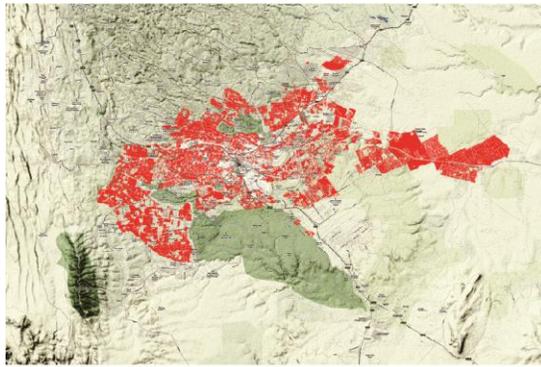
Most of the activity in Nairobi is established within its core. The disparity in economic levels is evident in this region. This creates a dilemma of rich vs. poor, where the poor are not benefiting from the economic sector. This contrast has also been the cause of the displacement of the indigenous and local communities, where they're being pushed to the outskirts and are forced to settle on open lands.



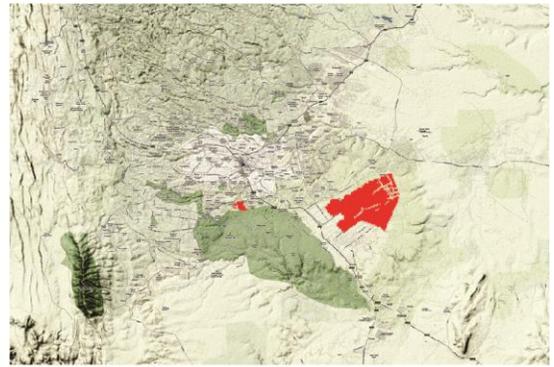
a. Agricultural



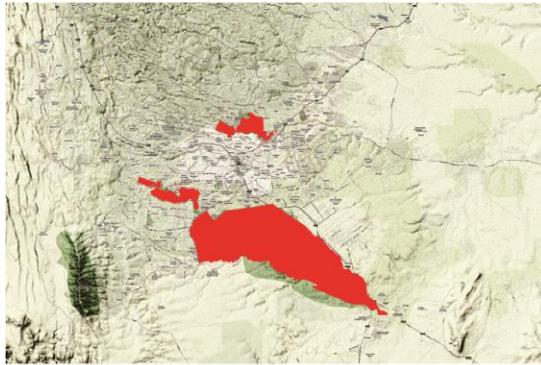
b. Industrial



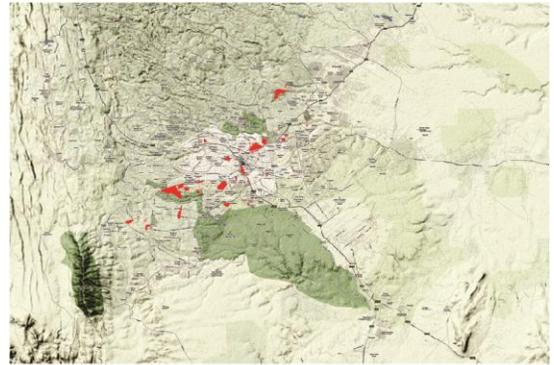
c. Residential



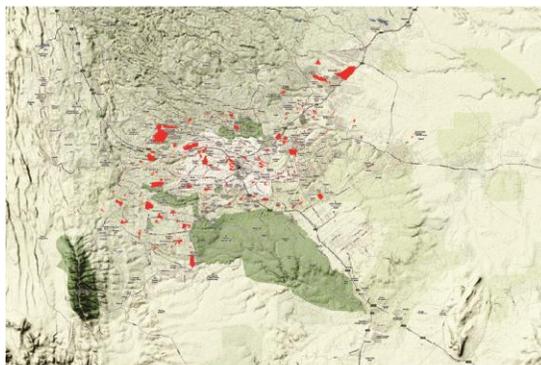
d. Transportation



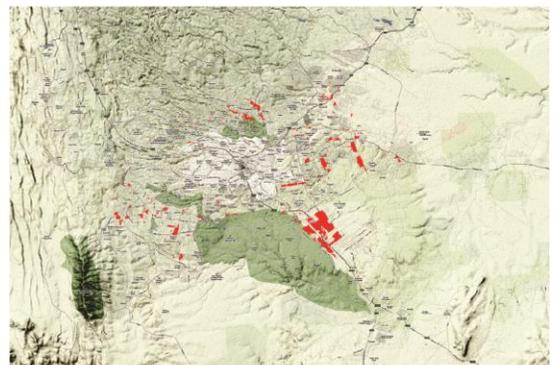
e. Forest



f. Recreational



g. Educational



h. Undeveloped

Figure 2.3: Nairobi land-use maps, with red indicating the occupied land to the corresponding function.

The demands for jobs in Nairobi are higher than ever as the population is steadily increasing. While on average, around 60% of the population of Nairobi is employed, the employment growth is often less than half of the population growth per year. The labor force is expanded by approximately 500,000 employees per year; however the majority fails at securing a position and therefore ends up jobless or working in the informal sector (Odhiambo & Manda, 2003). Figure 2.4 shows the employment distribution in Nairobi. While the majority of the population works in the informal sector, only about 2.2% of the people are officially employed by the service sector, which includes tourism. The economic sector is mainly driven by the service industry, where 63% of the annual revenue is generated from tourism (Kenya Travel & Tourism). Other major sectors are agriculture, transportation and communications, manufacturing and trade.



Figure 2.4: Employment distribution diagram in Nairobi, Kenya. The largest sector is the Informal Sector, whereas the Trade sector only employs about 2% of the population even though tourism is a major economic driver.

2.3 Forms of Tourism

Nairobi's major airport is Jomo Kenyatta International Airport. As the largest airport of East and Central Africa, it handles millions of passengers on a yearly basis. This airport is also considered the main transportation hub for visiting Africa's safari lands, serving not only Kenya, but also other cities in East and Central Africa. Located within 20 km from downtown Nairobi, it serves passengers ranging from Europe to Asia. Plans for the expansion of the airport will allow for direct flights from other far destinations, such as the United States, therefore accommodating a growing number of visitors and air traffic.

Kenya has a total of 55 national parks and reserves, totaling to 580,367 km² of protected land (Parks and Reserves). Land-based tourism is a major economic activity in Africa, drawing millions of visitors to different sites across the region every year and generating millions of dollars in foreign exchange earnings. Tourism not only generates revenue to support conservation and management of natural environments but it also creates many jobs. Approximately 180,000 people in Kenya are employed by the tourism industry (Betsy & Meagan); however only about 15% of the tourism money reaches Kenya. With over 1,810,700 visitors to Parks yearly, the tourism earnings total to about \$73 million (Okulo, 2011).

Nairobi is located within a 100 km radius of some of the nation's most popular national parks. Tourism in Nairobi mainly consists of wildlife and safari. The city itself offers the big 5, which are elephants, black rhinos, buffalos, lions and leopards. Of course the main draw is the interaction between humans and wildlife. Within city boundaries, there are numerous tourist attractions within walking distance from the city core (Figure 2.5). It is also within a 10 min driving radius of forests, parks and national reserves. Nairobi National Park, the largest park within the city limits, was the first official National Park in Kenya, established in 1946. The park offers more than 400 species of animals and covers an area of 117 km².

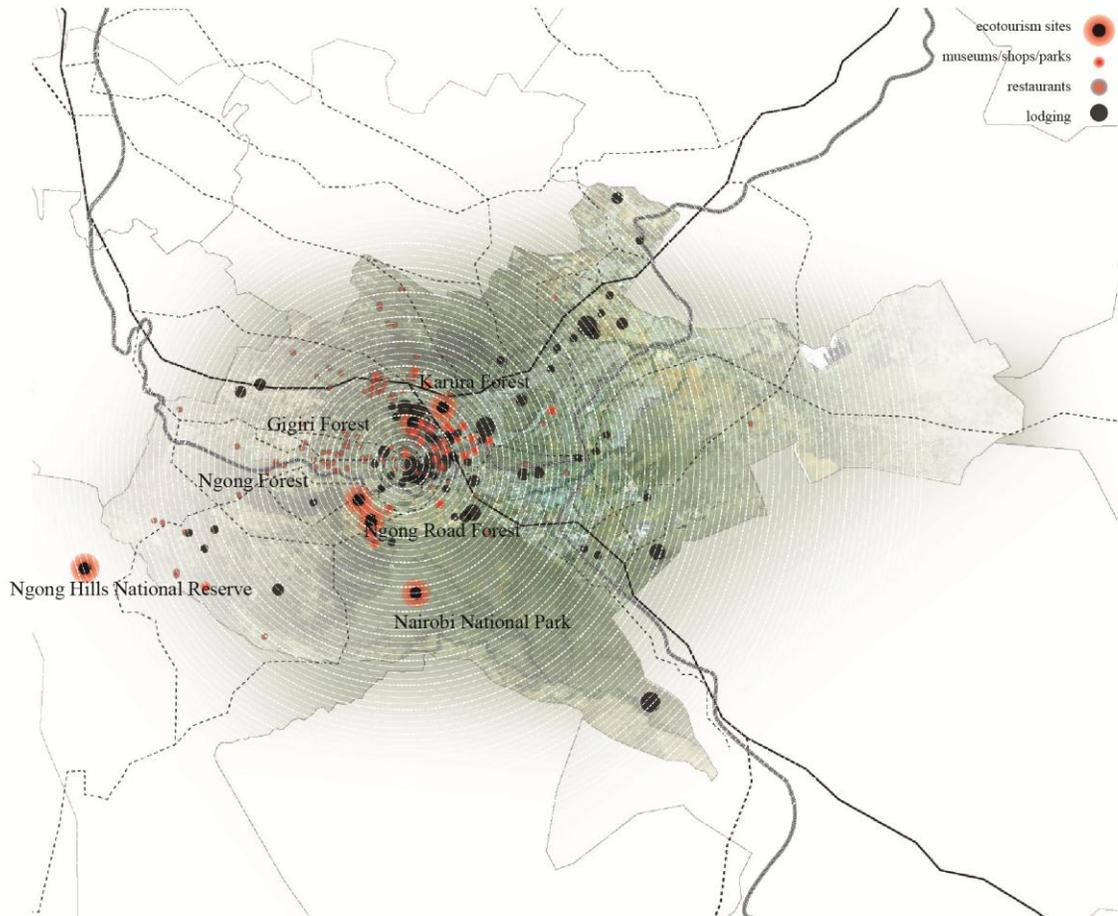


Figure 2.5: Map of Nairobi indicating the major points of attraction, hotels and restaurants. Each loop symbolizes a 1/4 mile distance (400 meters), which is generally considered a comfortable walking distance.

2.4 Pros & Cons of Eco-Tourism

Kenya has been recognized as one of the top 10 eco-tourism destinations in the world. While eco-tourism has been promoted as low-impact travel, over the years, it has presented more challenges than benefits. The current eco-tourism industry has become a mass market, where the offering of predefined packages is the norm. As a consequence, there is a lack of understanding and exploration of other landscapes, settlements and communities that have a lot to offer.

Eco-tourism really started booming in the past 30 years, however at the same time, we are now realizing that even the most miniscule impact has negative effects on the environment. A common modern definition eco-tourism is the practice of low-impact, educational, ecologically and culturally sensitive travel that benefits local communities and host countries (Kamauro, 1996). Many of the ecotourism projects are

not meeting these standards. Even if some of the guidelines are being executed, the local communities are still facing other negative impacts.

The establishment of eco-tourism industries requires the construction of facilities and infrastructure, which in turn could lead to the exploitation of non-renewable energy sources (such as the illegal extraction of medicinal plants, timber, firewood, wood carving, thatching and construction materials, causing land depletion and degradation), unmanageable waste disposal and deforestation. The various ways of waste disposal, such as the disposal of fertilizers and pesticides from agricultural activities outside of protected areas, and industrial and domestic discharge can infiltrate into wetlands, streams and rivers, causing both illnesses and land degradation.

Ideally, the notion of eco-tourism hints at a profitable venture due to the fact that it is less destructive to the environment, while at the same time benefits the communities economically. The industry is understood as a sustainable means of providing entertainment to adventure seeking public. Eco-tourism is advertised as a mass-market. The aim of the abundant travel agencies is to make maximum profit by getting as many people to the protected areas as possible. However, according to Okello, we have now reached a point where “national parks are increasingly being insularised into unviable conservation units whose former wildlife range is being taken over by increasing human population (Okello, 2005)”.

Due to the increase in the number of tourists, the various industries are prompted to establish more parks and reserves, which cause the displacement of the indigenous people. This issue has created a lot of animosity and resentment of the local communities towards the tourism industry. While it is important to view eco-tourism as a commercial enterprise, it is just as important to take into account the involvement and livelihoods of the local communities. The current eco-tourism industry offered in Nairobi fails to take these factors into account. There is a lack of communication between the tourism industry, which generates large revenue, and the locals, who are directly affected by the actions of the tourism sector.

3: SITE, CONTEXT & EXISTING PROBLEMS

3.1 Site Analysis

Nairobi is located close to the south-eastern border of Kenya. The central highland areas surrounding the city contain the highest population densities. Similarly, areas located near Lake Victoria also have high densities, due to their close proximity to water. Kenya's topography ranges from low coastal plains on the eastern border at 0 m., to over 5,000 m at its highest point, which is Mount Kenya (CIA The World Factbook: Africa: Kenya, 2012). The total annual rainfall also varies drastically from northern and eastern Kenya, which is arid and dry, to western and central Kenya. This difference in climate offers diverse ecosystems throughout the country. Kenya offers the following ecosystems (refer to Figure 1.2c for a map): bush-and woodlands, savannah and grasslands (70%); cropland or agro ecosystems and natural vegetation mosaic (20%); sparse or barren vegetation, snow or ice (6%); wetlands and water bodies (2%); urban ecosystems (0.2%); and densely forested areas (1.7%) (World Resources Institute, 2007).

Mount Kenya is located to the east of the Rift Valley. Being the highest mountain in Kenya, it is covered by evergreen forests at high altitudes towards the southwest, while tropical woodlands and grasslands spread across the southeast. Most of Kenya's densely packed forests are located in high rainfall zones such as mountain ranges. Nairobi is ideally located in close proximity to many of such zones, since it is in the range of the Great Rift Valley. The majority of the country consists of semi-arid, bush-covered plains (FOA Forestry Department, 2010). Areas that are designated as forests are regulated by the government and are often labeled as "National Parks / Reserves". Construction in these areas, as well as extraction from these government regulated forests, are illegal.

The majority of Kenya's wildlife and livestock resides in the grassland, savanna, shrub-land, and woodland ecosystems. Since the wildlife's habitat is not restricted to protected areas, they migrate across the entire land, resulting in various and uncontrolled densities. Many of these species tend to congregate near National Parks due to their lush grounds. The forests and rangelands are home to the majority of Kenya's biodiversity.

Due to its rich biodiversity, freshwater systems (see Chapter 1.3) and vast forests, Nairobi has the potential for a bright future. If these systems are managed sustainably, the opportunities that the city provides, such as agriculture, cultural diversity, and a large tourism industry, can begin to flourish and benefit not only the residents of Nairobi, but also its ecology and biodiversity.

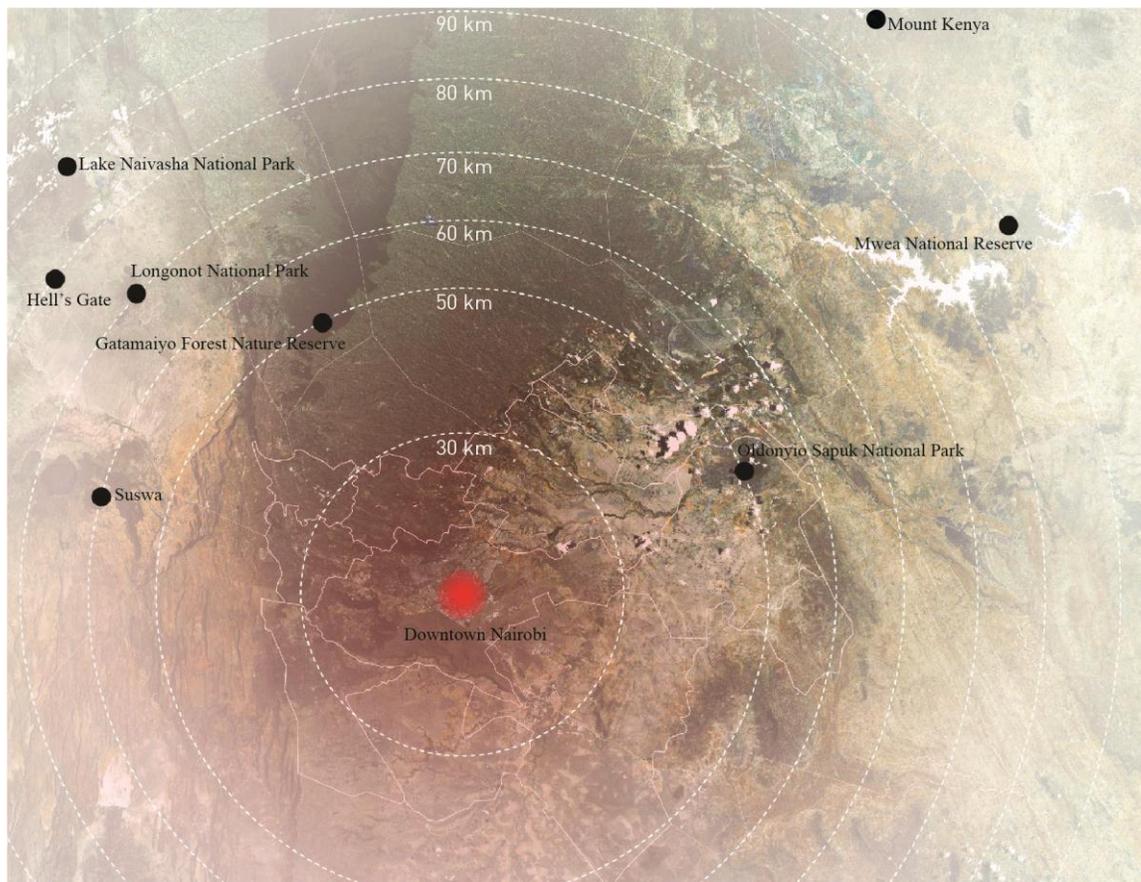


Figure 3.1: Map of Nairobi and surrounding context. The bullet points indicate the major National Parks within a 100 km radius of downtown Nairobi.

3.2 History of Eco-Tourism

Eco-tourism is defined as tourism that is highly involved with ecology and the social consciousness of the visitors. In many instances, it is associated with adventures in the wild, learning about local cultures, and sometimes even personal growth. Its main focus is to adapt to a new way of living that benefits the planet. It wasn't until the eighties that eco-tourism generated a general concern among the population, which led to a growth of consciousness towards the environment.

As the timeline in Figure 3.2 shows, the birth of eco-tourism originated as a bourgeoisie activity associated with big game hunting in Africa. Conservationist Mervyn Cowie, born in Nairobi, grew concerned about the fast depletion of the animals and began a campaign in order to establish a national park system in Kenya. In 1946, Nairobi National Park was opened officially as Kenya's first national park (Morell, 1996). Within the next thirty years, many more followed.

While Nairobi National Park was designated as protected land, hunting was still legal in Africa. This prompted the national park system to create recreational "hunting zones" in order to control how and what was being hunted. This was not an easy task, since the wildlife was not restricted to a specific area. In the 1970's, conservationist were alarmed to see the numbers of animals dwindling. This phenomenon led to another series of campaigning that called for a redefinition of the term "eco-tourism". The interest was no longer just the establishment of government protected land, but to also change the rules and regulations of that land.

Coincidentally, it was also in Kenya, where the new definition for the term "eco-tourism" began to emerge. Biologist David Western was one of the first to attempt to promote a link between tourism and community conservation. After a decade of research, his work was recognized in 1978 (Who Owns Wildlife?, 2009). Hunting finally became illegal and topics such as ecology and environment became more widely known and studied.

Now that the history of eco-tourism has gone through many changes and we have become aware of the consequences, we are taking preventative measures in order to conserve natural resources to prevent tourism from inflicting harm on the environment. Since the 1980's, the green movement has gradually warned us all about the repercussions of our actions, and consequently, many of our designs and activities now incorporate sustainability as the main focus. More and more people find the exploration of natural environments more enticing than mass tourism.

Eco-tourism has not only helped with the conservation of our planet, but it has also refined the lifestyles of the locals in areas of eco-tourism. The promotion of environmentally friendly tourism has attracted people who are cautious of their surroundings and are willing to learn not only about nature, but also about the local

communities that reside in the area. Therefore, this industry has also been able to provide financial support to the indigenous people. Even though eco-tourism has made a positive impact in the tourism industry, its methods and approaches are not quite ideal. Section 3.3 – 3.5 discuss the risks of the current system of eco-tourism.

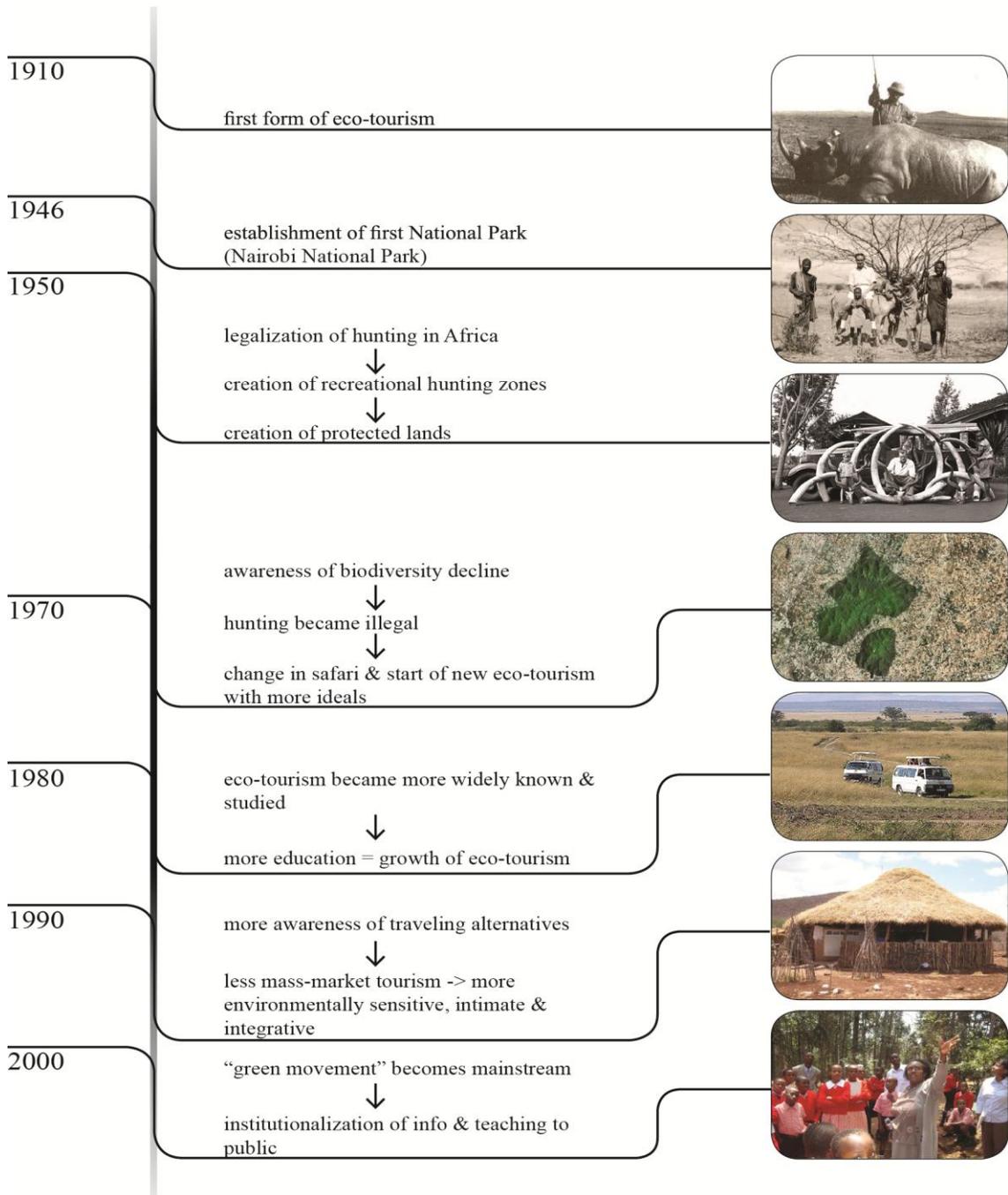


Figure 3.2: Timeline of Eco-Tourism as a market since the early 1900s.

3.3 Ecological Threats

It is a widely known fact that biological diversity is severely threatened in Kenya, and its protection requires extensive intervention and efficiency. Since the biodiversity crisis directly corresponds to social and political development, it calls the foundation of human organization into question. The protection of biological diversity is a goal that is shared by both the indigenous people and conservation organizations. However, difficulties arise when these two forces have to cooperate, and because of that, the ambition to protect land and preserve biological diversity has been met with complications that have put a halt on the protection of nature. What has resulted from this fiasco are protected lands that are impossible to manage, which has led the indigenous people to poaching and trespassing in order to make ends meet. As a consequence, the locals are confined to live in poverty.

For example, one of the biggest safari attractions is the wildebeest migration, where wildebeests migrate from Tanzania to Kenya on a yearly basis (Figure 3.3). The number and size of wildebeest populations just south of Nairobi National Park declined sharply between the 1970s and the 1990s. Historically, these plains provided migration corridors and rainy season grazing grounds for vast herds of wildebeest, but land-use changes and fencing of private lands for domestic livestock ranching now threaten seasonal wildlife movements. Biodiversity is declining due to threats that are either directly or indirectly related to tourism, such as human-wildlife conflicts, human encroachment, over-exploitation of natural resources, pollutants and tourism impacts such as off road driving, harassment of wildlife, and destructions of wildlife habitat for construction of facilities.

Human encroachment by agricultural communities has increased drastically in the past forty years. This has led to the decrease of wildlife in semi-arid rangelands, where most of the wildlife resides. Over time, many problems have emerged that have created conflicts between the human population and the wildlife, whose natural habitat has been tainted. The increase of human settlements near the boundaries of protected areas can cause the livestock to illegally graze within those protected boundaries. As a consequence, fences are put up to keep the animals out, which means that the livestock will be displaced out of their natural habitat. This conflict leads to crop raiding,

transmission of diseases among wildlife and livestock, human injury or death due to wildlife conflicts, and destruction of properties.

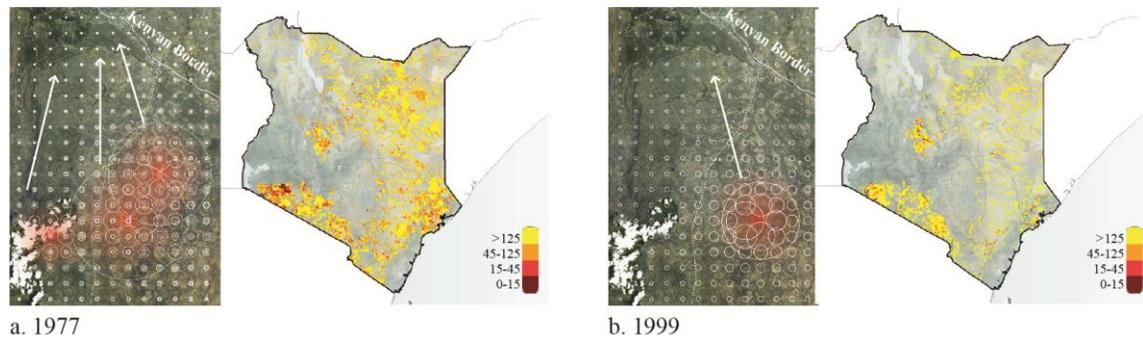


Figure 3.3: Wildebeest population trends indicate a steep decline from 29,000 wildebeests in 1977 to 1,500 in 1999. This data is in correspondence with the wildlife density maps, demonstrating the vast deterioration of wildlife existence in Kenya.

3.4 Environmental Threats

Due to the dramatic increase of the population in Kenya, there has been a lot of pressure put on the land and its resources. This phenomenon has led to the encroachment of humans in lands that were previously inhabited by wildlife. As a consequence, “this has precipitated multiple problems such as environmental degradation, human-wildlife conflicts, competition for water and forage resources and a serious general hatred and negative attitude towards wildlife, tourism and conservation areas” (Okello & Kiringe, 2004, p. 56).

Another environmental issue is the density and distribution of humans onto protected lands. This not only causes conflicts with the wildlife, but can also lead to the depletion of resources, such as firewood or timber. Consequently, the extraction of natural materials will eventually lead to land degradation and deforestation. This exploitation of natural resources can also lead to water and air pollution that can harm not only the wildlife, but the humans themselves as well.

There are also threats that are caused directly by tourists, such as off road driving. This causes severe erosion that ultimately changes the topology and kills a lot of the vegetation. Other human threats, such as harassing the wildlife for viewing, and hotel discharge are a major problem in Nairobi. Due to the sheer volume of people, the city is unable to deal with the waste, resulting in many dumpsites that often flow into water

streams. The polluted waters kill most fish and many plants, but also contaminate the soil, and therefore also the food that the soil produces.

One major problem that further enables environmental threats is the lack of research that is generally conducted on such issues, causing many of the threats to go unnoticed. In order to gain a better understanding of the conservation efforts needed to protect the land, thorough analysis needs to be done to evaluate the different types of threats that would potentially harm the environment.

3.5 Social Risks

The establishment of protected lands has often been the cause of the displacement of the indigenous people from their natural grounds. The need to build new infrastructure or organize development strategies for conservations sites has created difficulties for many communities (Cernea, 2004). Figure 3.4 highlights some of the risks involved with the displacement of local communities due to the establishment of conservation sites, and several solutions in order to alleviate those risks.

The development of tourism, specifically eco-tourism in the case of Nairobi, is a policy that aims to achieve a sustainable society. It is a strategy, rather than an end goal, that offers alternative developmental opportunities to the local communities. In Kenya, the tourism industry is identified as a major source of income. However, as Chapter 2.2 noted, many of the occupations offered are low paying positions that ultimately force the locals to find other means of income. By excluding the locals from these businesses that are dominating the socio-economic system, the tourism industry is merely expanding the gap between the rich and the poor (Akama & Kieti, 2007). Therefore, in order for a conservation community to function effectively, it needs to be able to cooperate with the locals at various levels so that both parties are benefiting from one another.

Socio-economic development in Kenya could potentially be improved upon through the promotion of sustainable tourism. However, the establishment of such an industry has caused more social harm in local communities than good. In his book, *Conservation Refugees: The Hundred-Year Conflict between Global Conservation and Native People*, Mark Dowie discusses the conflicts that have developed between the indigenous people and conservation organizations. Dowie explains: “Indigenous peoples

and conservation organizations should be natural allies in the struggle to conserve both a healthy natural world and healthy human societies. Regrettably, the goals of conserving biodiversity and protecting and securing indigenous cultures and livelihoods have sometimes been perceived as contradictory rather than mutually reinforcing” (Dowie, 2011).

The simplest solution would be to contrive a community-based tourism that would involve the local communities in the economic development, rather than neglect them. Community-based tourism often fails due to lack of support from the initial processes, including lack of skills and knowledge, poor management and leadership, and lack of investment (Manyara & Jones, 2007). In order to prevent these failures from happening, the social needs of local communities need to be adequately addressed from the initial phases of organization.

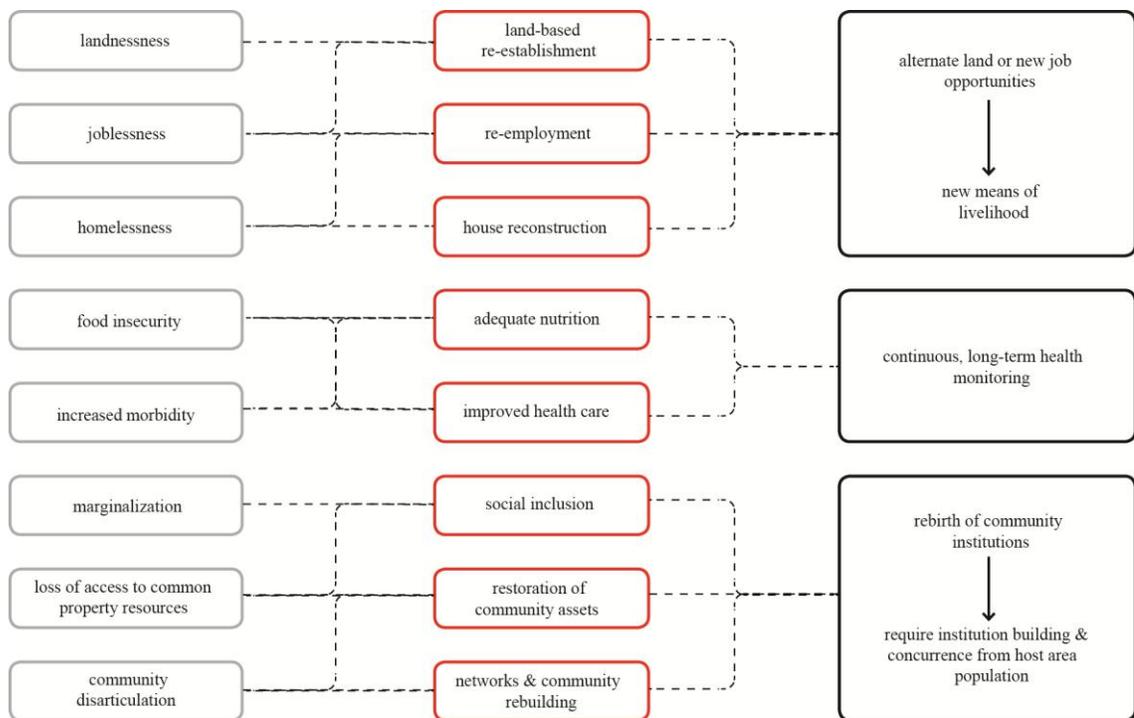


Figure 3.4: Displacement risk diagram, with the gray column indicating the risks involved with the displacement of local communities as a result of the establishment of conservation strategies. The red column lists the solutions to those risks, while the black column provides methods of action.

4: ARCHITECTURAL PROPOSAL

4.1 Redefining Boundaries

The new eco-tourism network proposes to redefine the boundaries by constructing new and improved transport infrastructures. Even though most tourists visit Nairobi primarily for the safari experience, most are unaware of what else the area has to offer, such as cultural values spread out across several settlements. The population of Nairobi can be distributed across the other regions by revitalizing the existing settlements. This procedure will not only provide better opportunities to the locals, but also link the towns to one another by opening up the network of transportation routes.

The reinforcement of new tourism “hubs” outside the capital (Figure 4.1) will create wealth and promote sustainable development versus uncontrolled growth. The scheme will provide an integrated environmental plan that provides for an ecological balance while at the same time supporting new technologies and energy initiatives throughout the regions. By improving the quality of life for both the residents and the visitors, the new network will strengthen the identity of the existing towns and communities.

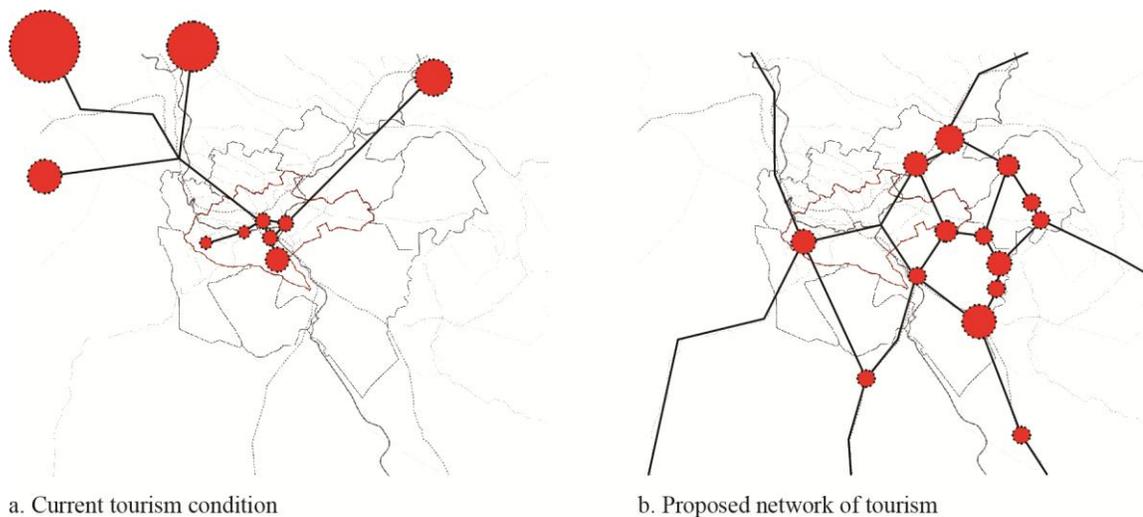


Figure 4.1: The current network for Tourism in Nairobi consists of a small centralized cluster of nodes that connect to the surrounding safari sites. The proposed network contains a distributed network of nodes which includes many of the surrounding settlements outside of the city boundaries.

The new network proposes to integrate community, economy and environment. Currently, these sectors are functioning separately, without benefiting from one another.

The new network will create a synthesis amongst the three sectors in order to create more efficient settlements. For this proposal to be able to function properly, threats to biodiversity and their implications need to be addressed early on to lessen the negative impact.

4.2 Self-Sustainable Eco-Tourism

By introducing a new waste economy system, the process of land regeneration can potentially be accelerated, and eventually optimized. The system operates within the restoration strategy, providing jobs and livelihoods for communities. The proposal involves localized renewable energy production, which can be developed by using re-processed waste products. This recycling process makes use of existing transportation paths, but also proposes the rehabilitation of new transportation infrastructure. Infrastructure changes as vegetation grows and biological diversification increases, thus transforming the types of activities that take place in a particular area. This waste economy system ultimately creates a regenerative loop that enables self-sustainability of nature and community.

This new system is also a means of providing new jobs to the communities. Existing transportation routes, such as train lines and roads, are utilized for the transportation of materials, waste, and people. Over time, new transportation lines will be added to the communities to allow for more communication and connection between various settlements. As the landscape is regenerating itself, the infrastructure will simultaneously change also and become reinvigorated. With it, many of the activities that take place in these communities will also change and transform according to the diversification provided (Figure 4.2).

The following diagram maps out an integrated social network of community amenities, leisure activities and events that take place over the course of a 100 year plan. These strategies are all interconnected through the environment, economy and community, while corresponding to development strategies that integrate the regeneration of vegetation and the rejuvenation of settlements. The system relies on the recursion of the generated revenues, which cycle through the community through funding and the development of amenities.

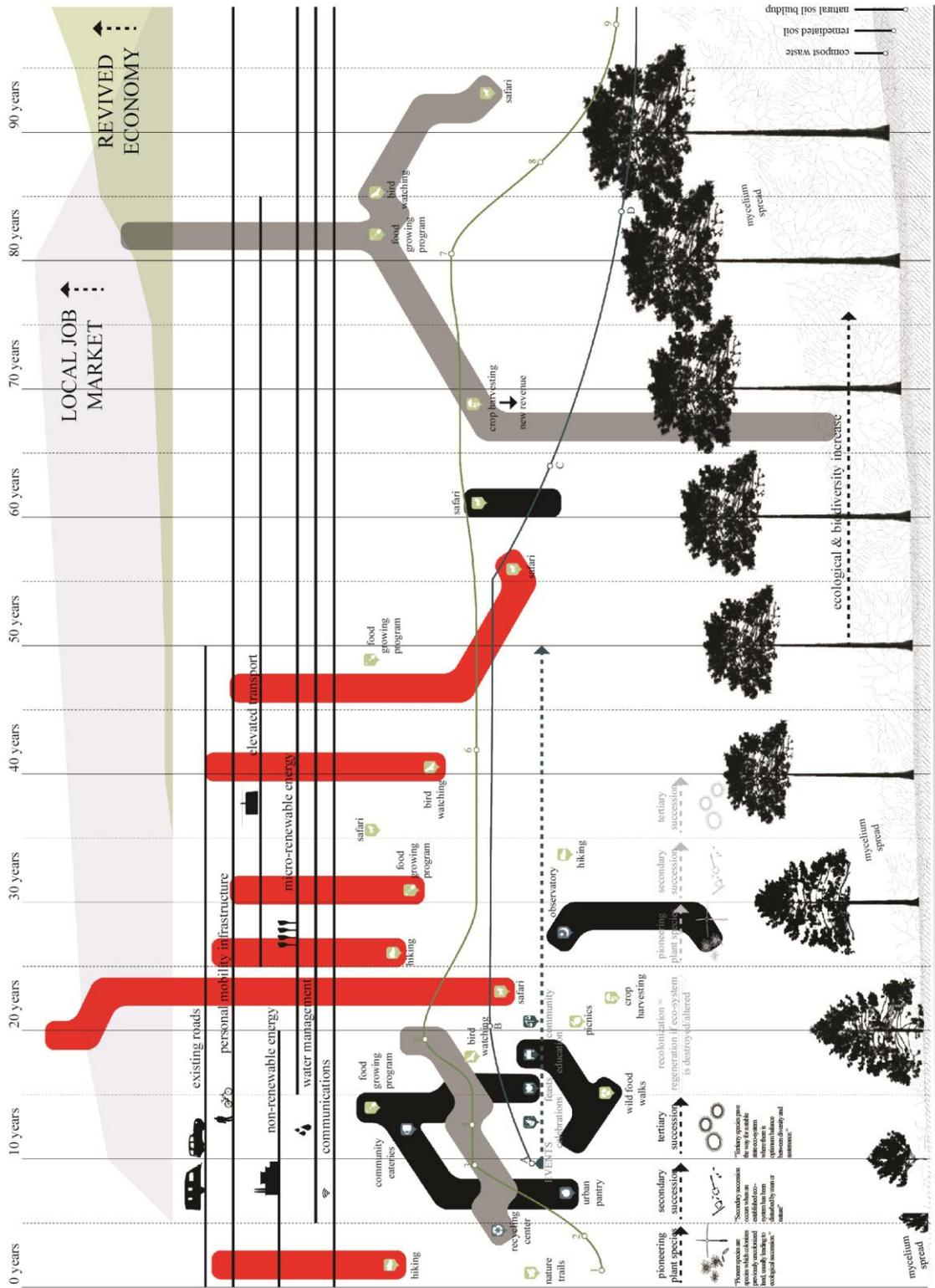


Figure 4.2: Communal, economical, and environmental development chart showing the physical and economic progression of Nairobi and surrounding communities over the next 100 years.

4.3 Environmental Development

As Figure 4.2 indicated, the development of the new eco-tourism network is a lengthy process that requires the integration of environment, economy and community. Even though this new system utilizes most of the existing infrastructure and frameworks, it also proposes the expansion of these fundamental organizations. For example, the existing railway will initially get used as a means of transportation of materials and people. Once some revenue has been generated, improved railways can be placed in order to better connect Nairobi to the surrounding settlements. As profits keep expanding, various types of more sustainable public transportation can be introduced to the system. In this case, the placement of an elevated cable car system can provide an alternative way of connecting points of interest.

The new developmental plan provides a new social structure that requires constant care and maintenance that will be assigned to the locals as a way of integrating the community. The introduction of a new waste economy system will teach the locals the value of recycling and even promote the use biodegradable materials that can eventually be composted and used as an agent for plant growth.

Eventually, the revenue generated from this new system will help clean up the arteries between the settlements around Nairobi, and create a larger network of communication among the locals. The decentralization process of Nairobi's densely packed core is advocating the development and growth of the settlements surrounding it. While Nairobi is lacking the resources to efficiently accommodate its large population, by introducing a new, organized development system that promotes sustainable growth and community integration, we are countering the unmanageable growth issue by tackling the environmental consequences before they even arise.

5: AUTONOMOUS VEHICLE

5.1 Land Regeneration

Nairobi is currently housing about a quarter of Kenya's urban population, amounting to over three million people. Due to its large population and lack of resources to accommodate the ever-growing population, Nairobi has developed a waste management problem. (Aquah, 2007). While the waste is accumulating at over 2,000 tons per day, the city does not have the capacity to dispose of it. This causes a serious issue, because the generated waste is continuously added on to the various dumpsites scattered around the city without any supervision, consequently polluting both the land and the water and causing illnesses.

Another major issue with recycling in Nairobi has to do with the fact that many of the materials that are discarded are not separated, but are rather aggregates of various products. This causes the output of materials to be inferior to the previous life-cycle. In order to prevent this from happening, scientific methods must be used throughout the recycling process, such as the production and use of biodegradable bottles and cans. These new products can be turned into compost that eventually benefits the land rather than harm it (Figure 5.1).

In order for this new system to operate correctly, new research must be conducted on material properties, processing, and decomposition rates. Therefore, the workers in the industry must gain both scientific and biological knowledge of the various processes affecting the land regeneration. For land regeneration to be successful, it is important to take the existing biodiversity into account. The new strategy proposes to accommodate wildlife habitat and habits in order to avoid scaring off the animals or encroaching onto their territories. Instead of having the animals be the objects on display, perhaps the humans in turn can be viewed by the animals in a non-threatening matter. By reversing the roles, we start questioning the relationship between humans and wildlife, which can ultimately spark an investigation into animal lifestyles and needs.

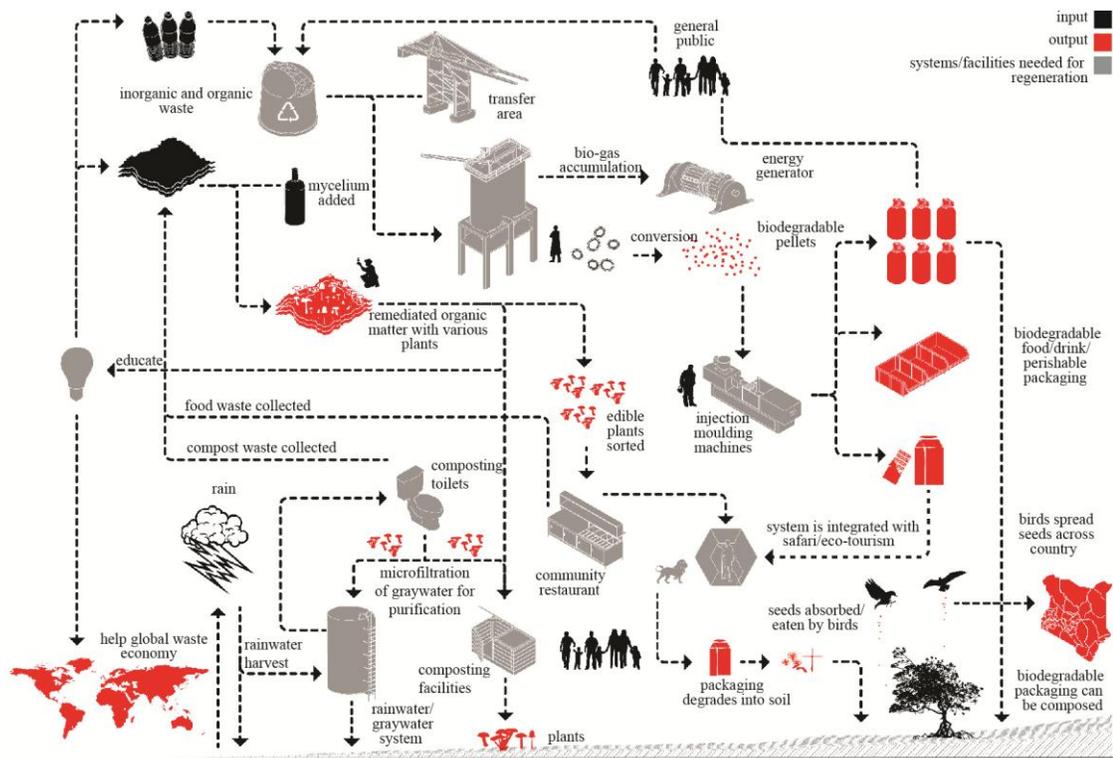


Figure 5.1: The new waste economy system, allowing for local goods to be utilized by the service industry, and transformed into compost in order to speed up the land regeneration process.

5.2 Mobility

The new eco-tourism industry will counter the current trend of the “tourist experience”. In the current model, tourists usually lodge in static hotel rooms and spend a great deal of their trip traveling back and forth to specific, designated sites assigned for visitors. In this scenario, the guests are limited to the lodging options provided to them. Furthermore, they are also confined to the tourist attractions that may or may not be a part of their vacation package.

Today’s traveler wants to experience more than just that. The new model proposes a dynamic system of vehicles that move and spread throughout the landscape. These vehicles will serve as hotel suites to the guests, but can also navigate through the national parks without damaging the landscape. Rather than imposing on the wildlife, the “mobile hotel rooms” become part of the landscape and “live” as a species amongst the other organisms.

Dubbed as the Kinetic Ambulating Metabolic Proctors, aka KAMPs, the pods utilize four sets of legs, mimicking the movement of animals, such as the lion. The mechanism is based on Theo Janssen's Strandbeests (Jansen). The legs of his Strandbeests are based on 11 elements that are each proportioned according to the 11 "holy numbers".

In the middle of each beach animal is a kind of spine, more specifically a crankshaft. The remarkable thing about this spine is that it can rotate. In the model, my hand turns the crank of the crankshaft. This rotation is converted by 11 small rods into a walking movement drawn by a small toe at the end of the leg. Whenever the toe is on this base, it touches the ground and carries the animal. It describes a horizontal line; or rather the entire animal does, since the toe is carrying the animal. The same holds for a wheel; the axle also describes a horizontal straight line. The beach animal doesn't lurch. When the toe reaches the end of the base (at right), the leg is lifted whereupon it rapidly describes the other two sides of the triangle. During that time the animal is supported by the other legs which at this stage are on the ground. [The above curve is the ideal walking curve; a flat base with rounded corners] The curve this produces is dependent on the ratio between the lengths of the 11 small rods. Another ratio gives an entirely different curve, a figure 8 for example. These, then, are the holy numbers: a = 38, b = 41.5, c = 39.3, d = 40.1, e = 55.8, f = 39.4, g = 36.7, h = 65.7, i = 49, j = 50, k = 61.9, l=7.8, m=15 . It is thanks to these numbers that the animals walk the way they do. (Jansen)

These legs are not only able to mimic the movement of any specific animal (if the ratios are adjusted), but they also touch the ground very lightly. Due to the triangulation of the members, the surface area needed for the "toe" to touch the ground is at a minimum (Figure 5.2).

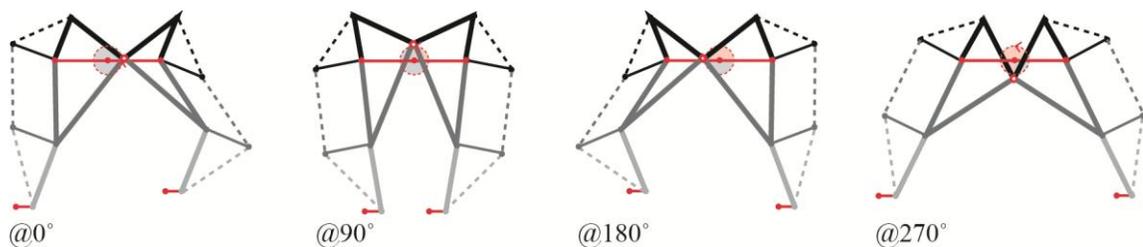


Figure 5.2: Theo Jansen's Strandbeest's leg mechanism. While the legs are moving, the central axis remains intact, helping the robot maintain equilibrium.

5.3 Zero Footprint

The innovative design of the KAMPs moves towards a vision of global carbon footprint reduction, by making the least ecological impact possible. Regarding sustainability as the highest priority, the KAMP's design, behavior and materiality recognizes the environmental constraints and opportunities as sustainability features. The design of the legs allows the pod to lightly tread the landscape, while at the same time aerating the soil, allowing for the vegetation to regenerate itself faster. Due to its mobile nature, it causes minor damage to the ground, and leaves practically no trace behind.

At times, the KAMP can also be lifted in the air using a cable car system (Figure 5.3). This system requires a number of strategically placed towers that span between environmentally sensitive areas of the protected land. This includes areas that require special protection in order to protect endangered flora and fauna.



Figure 5.3: Preliminary design proposal for the KAMP utilizing the cable car system in environmentally sensitive areas.

The KAMP will also be highly energy sufficient by utilizing passive energy sources, such as solar and hydro-electric power. Because Nairobi is located close to the equator, there is little variation between the timing of sunrise and sunset. Therefore, the energy intake from the solar panels will remain fairly constant throughout the year. During the rainy season (between March to May, as well as November and December), the main energy source could be hydro-electric power, which would use a micro turbine installed in each KAMP (Micro Hydro Power, Micro Hydro Generator, Small Hydro, Mini Hydro). The benefit of such a system is the elimination of fossil fuels, and hence the use of unnatural and harmful energy sources.

The various passive energy sources should provide enough power for heating water, a small fridge and light fixtures. However, due to the energy being limited, luxury items such as hairdryers will not be allowed, effectively reinforcing the overall concept of the KAMP, which is meant to bring you closer to nature.

5.4 Concealment

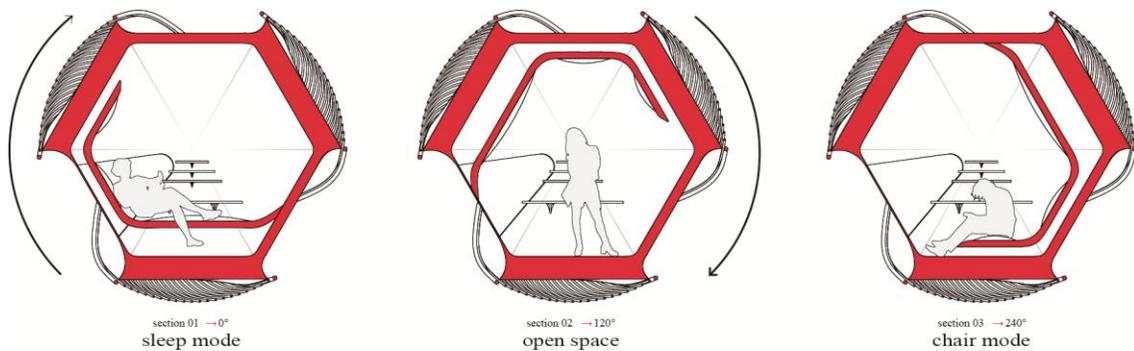
In nature, an organism's chances of survival are increased by taking advantage of every opportunity. Some organisms have in fact developed specific characteristics that help them adapt to their environment by blending in. This simple notion has supported the survival and evolution of many species, by providing them the ability to hide themselves from predators and prey. The KAMP uses the same concept through the use of natural materials in order to blend into the natural environment.

A primary material used will be bamboo. There are around 150,000 hectares of bamboo forests in Kenya (Kigomo), and it is largely used as a construction material. The bamboo will be harvested and processed by the locals, providing an opportunity for livelihood. Furthermore, the natural material will act as camouflage in the wilderness, and therefore will not intimidate the wildlife. The KAMP's materiality aims to expose the opportunities provided through the use of organic fibers and composite materials. Each material used will be native to the specific settlement that is producing the KAMP. Bamboo is just one example of many natural materials available in Kenya, and each settlement can contribute their own expertise to the design of the KAMP. Ultimately, this vehicle can look drastically different depending on where it was produced.

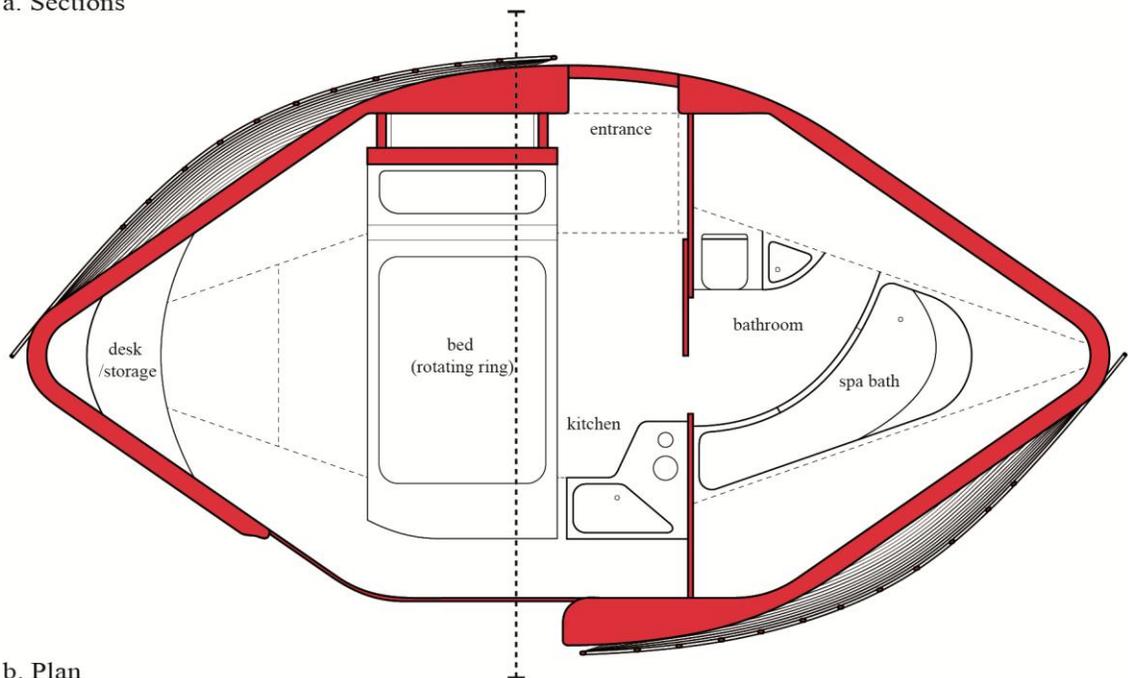
6: REGENERATIVE NETWORK & CONCLUSIONS

6.1 Conditions of Final Design

The design of the Kinetic Ambulating Metabolic Proctors is intended to give the visitor a first class cabin experience rather than a standard hotel room. The interior palette is reduced to the basic furnishings, enclosed with elegant curves and large windows that wrap around the entire frame. In order to conserve space, three programs are combined into one through a rotating ring. This will in turn also decrease the demands for heating and cooling, making the spatial layout more efficient. The rotating ring combines a bed, lounge and seating area all in one (Figure 6.1).



a. Sections



b. Plan

Figure 6.1: Sections of the KAMP demonstrate the various programmatic capabilities depending on the rotation angle of the central ring. The plan demonstrates the efficient spatial layout of the 2-person unit.

Each end of the KAMP contains other essential programmatic needs, such as a bathroom, spa bath, kitchen, work space and storage. This allows for a concentrated water filtration and storage unit to be positioned at one end of the unit. Furthermore, the large windows give the guests views from all angles within the module, yet obstruct views into the private areas, such as the bathroom. The openings aim to bring the visitor closer to nature, as if they are truly one with the wildlife rather than mere spectators (Figure 6.2).



Figure 6.2: Rendering of an interior view of the KAMP, looking into the landscape from the bed.

The shell consists of a bamboo louver system that is harvested, constructed and assembled by the locals, which also rotates around the ring to provide shade. The louvers also serve as a rain collection system that transfers rainwater to the water storage unit placed inside the shell. These louvers cover the protective frame of the KAMP, which is also constructed out of locally produced materials, and therefore differs from one area to another. This shell contains an array of photovoltaic cells that wrap around the exterior, which generate power. Lastly, the overall form of the KAMP is created by the manipulation of 3-point curves, which generate an aerodynamic shape that withstands high-powered winds and allows for faster speeds (Figure 6.3).



Figure 6.3: Diagram of resource conserving systems. The unit utilizes solar power to generate power, and contains a water collection system, which harvests rainwater and puts it to beneficial use.

6.2 Redefined Site Conditions

Nairobi is located within a 60 km radius from fourteen surrounding settlements (Figure 6.4). Even though these communities are considered urban sites, they are economically detached from Nairobi. This separation is often a cause of financial distress, because most of these settlements go by unnoticed since they are not advertised as “tourist towns”. The aspiration of the proposal is to physically integrate these communities with the economic system.

The introduction of a new eco-tourism sector aims to decentralize downtown Nairobi by distributing wealth across surrounding communities. By providing a common industry in which all indigenous people can partake, we are providing a network that will stimulate a dialogue between various settlements. Each settlement will be considered a primary node within a larger network, and in turn, each KAMP is then a secondary node emerging from the primary nodes. The network will only be able to work efficiently if there is free passage between both primary and secondary nodes. This means that in order for the network to function properly, the new eco-tourism system needs to clean up the cities’ arteries (Figure 6.5).

The construction of new or improved roads and rails is essential for linking existing settlements to one another. The creation of new transportation infrastructure will reinforce the creation of new hubs of eco-tourism outside the capital. If each community plays an integral role in the new eco-tourism industry, the creation of wealth will in turn strengthen their identities. The green and improved corridors connecting the settlements to downtown Nairobi will essentially redefine the city’s boundaries.

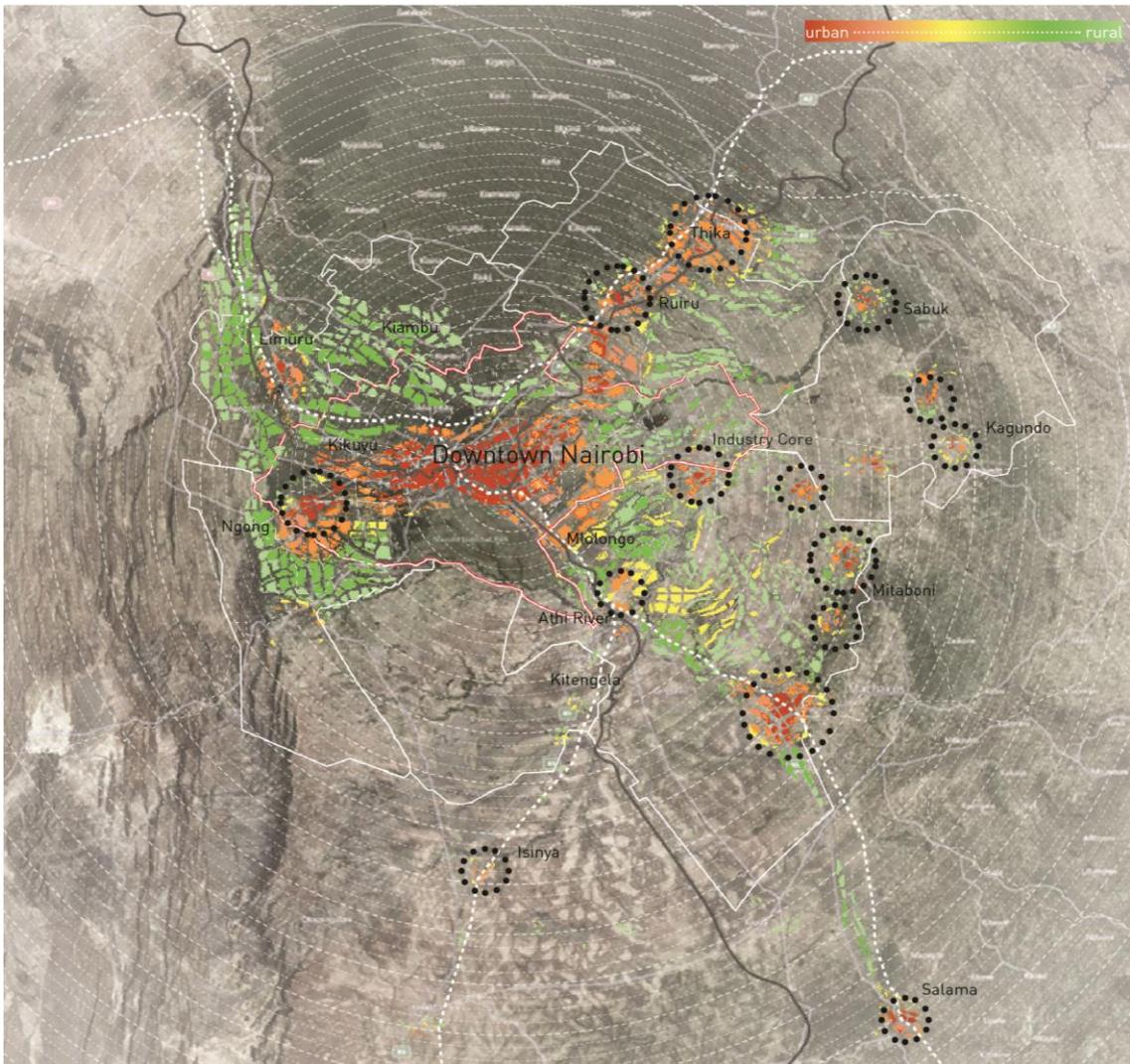


Figure 6.4: Map of Nairobi with surround urban settlements that have the potential to accommodate a growing population, and therefore will act as primary nodes.



Figure 6.5: The image on the left shows the current state of Kibera, the largest slum in Nairobi. The rendering on the right is a vision of what Kibera after regeneration. (Image credit: Louis Rezac)

6.3 Environmental Impacts

The new eco-tourism network will affect the city of Nairobi on all scales. From the small scale of the KAMP, acting as a secondary node, up to the metro scale of the hubs, which are the primary nodes that are meant to generate and maintain the KAMPs, the concept is meant to re-establish a new identity for the city and contribute to future planning ideas. This way, opportunities will be offered in more cities rather than just Nairobi. Therefore, the population growth will not be as concentrated and will spread out across a larger region, making it easier to manage.

The substantial growth of the population has been the cause of many environmental changes, such as waste generation, food and water consumption, and land use patterns. Currently, these factors are making a huge impact on Nairobi because they are condensed in one area that doesn't have the financial means to regulate it. Once the elements are distributed and organized, the management will be more feasible. This will give Nairobi the opportunity to "re-green" itself, meaning that if the population is no longer densely packed in one area, more space will be opened up and dedicated to nature (Figure 6.6).

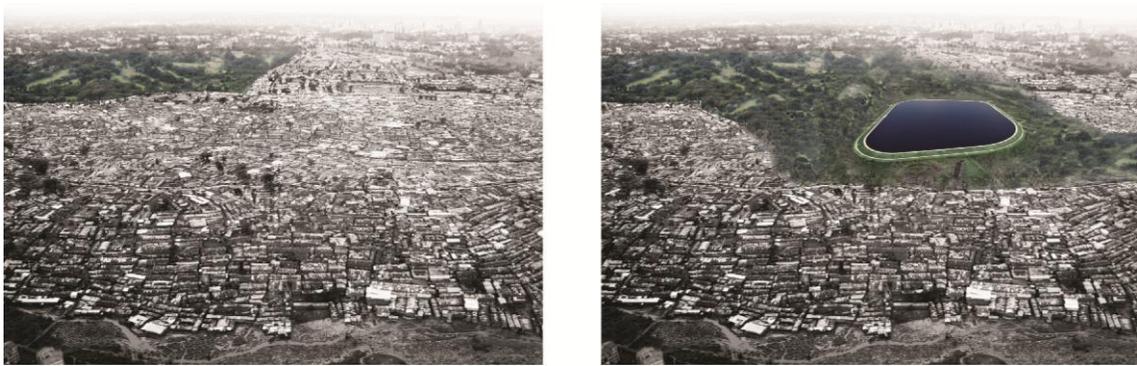


Figure 6.6: The image on the left is an aerial view of the slum Kibera. By implementing the new eco-tourism network, the city will have the opportunity to regenerate itself and dedicate more space to nature. The image on the right is a rendering showing the possible transformation of Kibera. (Image credit: Ben White, ICT4Entrepreneurship)

The design of the KAMP specifically will also have an environmental impact. While offering a luxurious retreat, it also fits into the environment well. Its compact shell is the scale of an average African elephant; therefore its presence is not overpowering or threatening. Furthermore, with its serene presence and delicate movements, the KAMP embodies the quintessence of an organism (Figure 6.7).



Figure 6.7: Renderings of a 2-person KAMP treading across the safari and becoming one with the wildlife. The size of the KAMP is slightly larger than the average African elephant, making it not too dominating.

6.4 Conclusions

The conditions that overpopulation has presented have raised concerns for decades across the planet. Both scientists and economists have predicted that humans will eventually outgrow their available resources if precautionary measures are not taken immediately. This thesis was an indirect response to the issue of population growth through architectural innovations that can be applied on a multitude of scales.

By analyzing an industry that is already considered successful and generating wealth for the city, I was able to attack the problem from a different perspective. Rather than focusing on the issues at hand, such as pollution, disease, water scarcity, and food deprivation, the thesis sought to devise a solution that could integrate all those factors as part of the design.

The design of the KAMP is the architectural solution that approaches the issue of overpopulation in its own way. Many of the city's problems are addressed through the design of a single unit. Since the KAMP is able to deal with these issues one by one, the city and its surrounding sites have the opportunity to recalibrate their carrying capacity since these units are now carrying much of the load.

The concept breezed across various scales, from the material scale of the individual units, to the local scale of the hubs, to the urban scale of the various settlements. While the breadth of the research was unfortunately not extensive enough to address every scale in detail, the cohesion of the new eco-tourism network seems to imply that such a system could in fact be implemented provided that enough initial funding is available.

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