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

Abstract

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

INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

THEORETICAL FRAMEWORK

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

URBANISATION AND URBANISM THEORY

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

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

REAL ESTATE VALUATION THEORY

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

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

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

PRICE THEORY

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

DISASTER THEORY

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

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

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

Definition of Key Terms

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

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

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

LITERATURE REVIEW

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

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

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

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

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

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

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

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

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

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

METHODOLOGY

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

RESULTS AND ANALYSIS

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

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

The Variance of Heatwaves in Different Parts of the African Continent

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

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

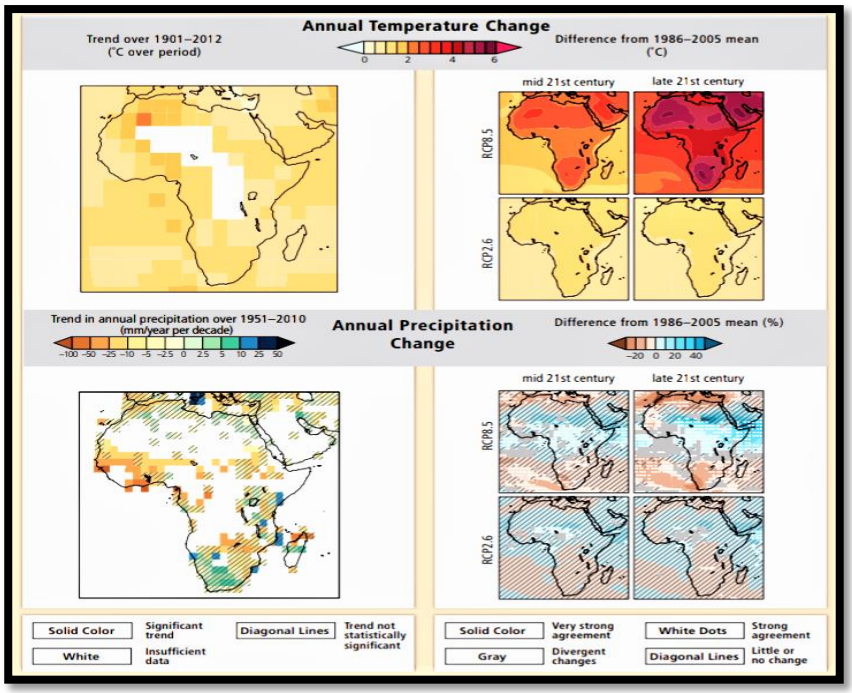

Figure 1: *Observed and Projected Changes in Annual Average Temperature and Precipitation (*Niang *et al.,* 2014).

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

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

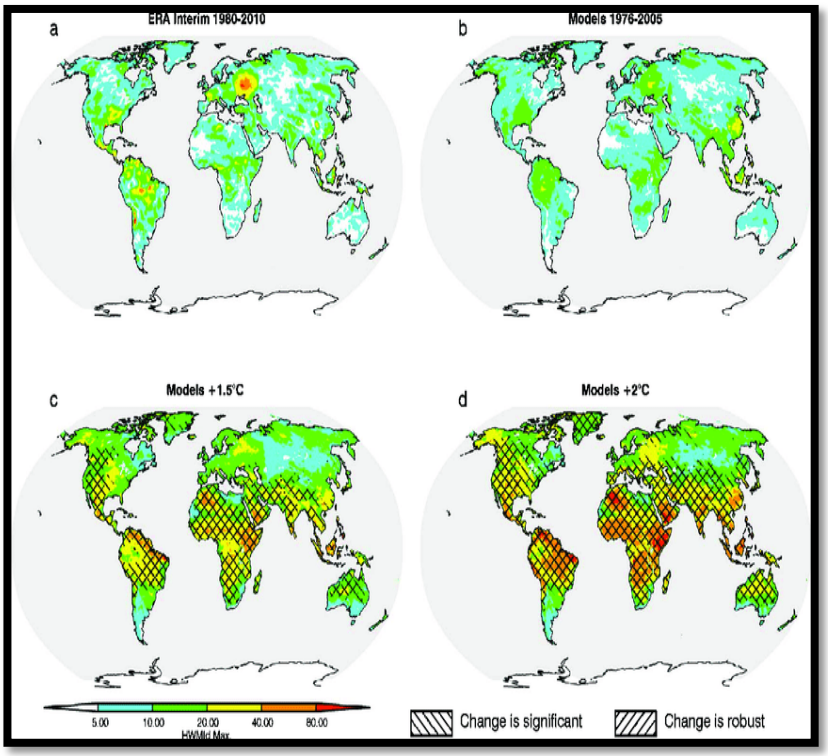

Figure 2: *Present and Future Distribution of Heatwaves (*Adapted from Dosio *et al.*, 2020).
(a) Maximum heatwave magnitude (HWMId) observed during 1980-2010. (b) Modelled maximum HWMId in the reference period (1976-2005). (c) and (d) Projected maximum magnitude in a 1.5 • C and 2 • C worlds, respectively.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

HEAT-RELATED EFFECTS ON PROPERTY VALUES IN AFRICA

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

THE VARIANCE OF FLOODS IN DIFFERENT PARTS OF THE AFRICAN CONTINENT

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

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

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

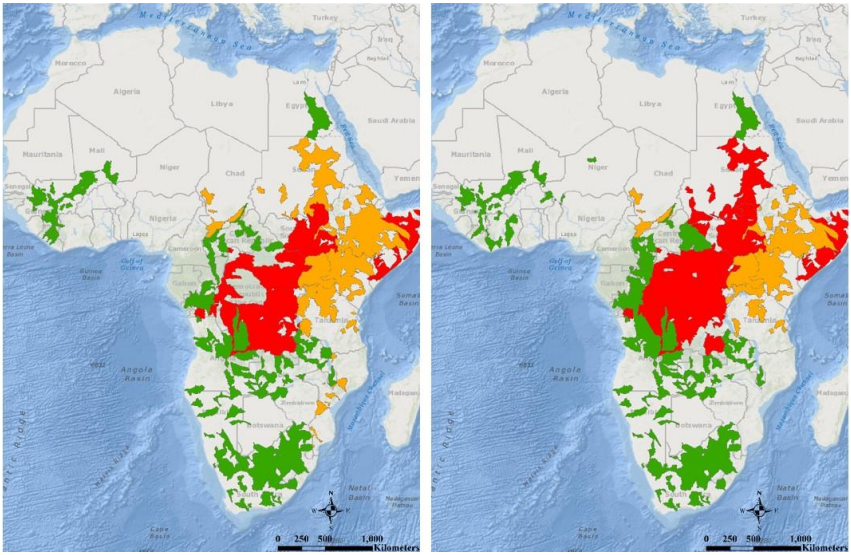

Figure 3: *2020 East Africa Floods* (NASA, 2021).

KEY

Red: Water shades in Africa experiencing a flood

Orange: Warning

Green: advisory conditions

EFFECTS OF FLOODS ON PROPERTY VALUES

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

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

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

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

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

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

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

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

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

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

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

DISCUSSION

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

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

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

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

CONCLUSION AND RECOMMENDATIONS

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

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