

Effects of Land Use Changes on Airport and Flight Safety; A Study of Wilson Airport, Kenya

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Abstract:-The aviation sector is one of the most important sectors for any country especially its ability to: promote interconnectedness within countries as well as between countries. However, the sector faces many risks caused by various emergencies and accidents associated with the sector, and much so in the precincts of airports. The impact of these accidents causes monumental social, economic and environmental consequences to victims. The exponential growth of the sector in the country calls for special attention by relevant stakeholders to devise strategies to address disaster preparedness issues. This is especially due to the fact that the country has already experienced a number of aviation disasters and mishaps related to the industry. Consequently, this study sought to assess the effects of land use changes on airport and flight safety at Wilson Airport. This study was carried out at Wilson airport located in Nairobi West. The qualitative design was applied in this study to analyze and describe the effects of land use changes on airport and flight safety in a rapidly growing aviation sector. A total of 216 respondents were targeted by the study (including 150 members of the community, 30 aviation regulators, 30 air operators and 6 service providers) out of which 195 responded (including 132 members of the community, 28 aviation regulators, 29 air operators and 6 service provider) giving a response rate of 90%. Primary data was collected by use of questionnaires, interview guide and Focused Group Discussions while Secondary data were collected from written or published records and maps from the Kenya National Bureau of statistics. Quantitative data was analysed by use of descriptive statistics such as frequencies and percentages while qualitative data was analysed using content analysis. The study found that 42 (74%) of the respondents indicated that land use changes have effect on flight safety. The land use changes included: setting up of major shopping malls near the airport, proximity of Uhuru gardens to the airport, adjacent Nairobi national park, Mitumba slums, upcoming high-rise development and existence of motor garages next to the airport. The results from correlation analysis showed that disaster preparedness is positively related with land use changes with a Pearson's Correlation Coefficient of $r = 0.509$ and that at a level of significance of 0.000 meaning that it is statistically significant as p value is less than 0.05. It was recommended that the government should do an urgent operation on land encroachment as this is perceived to be a disaster in the waiting.

Key Words: *Airport and flight safety, Land use changes*

I. INTRODUCTION

An airport incident can occur anywhere, at any time – day or night, under any weather condition, and varying degrees of magnitude; it can occur instantly or develop slowly; it can last only a few minutes or go on for days (United States Department of Transport, 2009). It can be natural, such as a hurricane or earthquake, or it can be ‘man-made’, such as a hazardous materials spill, civil unrest, terrorism, and major fire or power outage. Moreover, emergencies of the same type can differ widely in severity, depending on degree of warning, duration, and scope of impact (United States Department of Transport, 2009).

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According to Gooch (2007), airport aviation increases the economy of a nation by providing employment globally. For instance in Canada, the airport industry generates \$8 billion dollars and provides 150,000 job opportunities annually. The International Civil Aviation Organization (2006) noted that 2.1 billion passengers travelled by flight globally. This has great influence on global markets. Airport aviation improves global socio-economic development. However, there is growing concern over increasing aviation-related disasters globally. Most of these disasters occur when aviation and related businesses around airports are

increasing thus posing enormous risk and dangers to the immediate precincts as well as to adjoining airports.

Though aviation disasters occur worldwide, there is special concern for aviation disasters in Africa (Kwiatkowski, 2001). The potential for disaster exists everywhere, and there is resultant devastating cost: suffering and loss of life and. Emergencies are perceived as low probability events and preparedness requires time and finances. This often results in planning needs being overlooked. Lack of planning can cost airports and communities a high price including: health and safety problems, social disruption, lawsuits, negative publicity, liability, post-emergency psychological effects. While every contingency cannot be anticipated and prepared for, a strong emergency preparedness programme can limit negative these impacts.

Dannat (2002), observes that air transport has remained one of the most regulated and restrictive industries in international trade. Domestic deregulation and liberalization progress at an uneven pace and liberalization of the international markets has yet to overcome numerous obstacles. Air carriers therefore need to build extensive global networks to realize economies, scope and density and meet consumer demands. The need for expansion and the increase in consumer demand therefore brings the global aviation industry into perspective. In the last two decades, Kenya has witnessed a number of fatal aviation disasters including the Busia (24th January 2003), Marsabit (10th April 2006), Narok (14th June 2008) and Ngong plane (10th June 2012) disasters in which prominent Kenyan political, administration and civil servant leaders have lost their lives (Mutugi and Maingi, 2011: 40). Reports on inquiries into these disasters have pointed to poor aviation environments and non-compliance with international aviation standards and regulations (Mokaya and Nyaga, 2009). Separately, a report by the Aviation Safety Networks (ASN, 2010), provides data of several aviation accidents that have occurred in Kenya between the years 2006 and 2009. The report further observes that it is evident that 50% of the air accidents occurred during take-offs, 28.6% during landing and 21.4% during cruise. Take-offs and landings accounted for 78.6% of the accidents. This is despite the fact that Kenya is a signatory to the International Civil Aviation Convention (ICAC) that sets the standards and regulations to which airports and aerodromes must conform (Mokaya and Nyaga, 2009).

Suda (2000) states that the development of airfields and airports in Kenya requires terrain that is level and free of artificial obstructions in the vicinity. This is similar to other global scenarios. As a result of these factors, airports have tended to develop on large flat sites and affect their social environment and vice versa. Airports originally constructed far from town are becoming embedded in metropolitan areas that grow around them. People live and work much closer to the airport fence than airport and city planners anticipated.

The Kenya Association of Air Operators (KAAO) has constantly warned that airports such as Wilson Airport pose real danger to aviation security and safety due to encroachment onto airport space by residential and commercial buildings, which ultimately renders flight paths invisible to pilots and inhibits smooth take-off and landing. Wilson Airport is currently facing an acute problem of encroachment onto its flight path by exponential real estate developments. Considering it is an airport with approximately 120,000 landings and take-offs annually, as reported by the Kenya Civil Aviation Authority (KCAA, 2007), these encroachments pose a real risk on safety. Despite the increase in threats to aviation safety challenges in Kenya, the KCAA, in response to the national developmental goals envisioned in the Kenya Vision 2030, has put in place measures to ensure Kenyan air operations meet international safety and security requirements to meet the international standards including: infrastructural facilities, communication facilities, and security checks (Hudson, 1997). To achieve this, the Authority needs to augment its capacity to deliver quality regulatory oversight services and ensure its compliance to civil aviation regulations (Kenya Vision 2030 Blueprint, 2009).

Africa's aviation disaster record, and the question marks raised especially by key stakeholders in the aviation industry such as KAA, Association of Air Operators and KCAA concerning compliance to aviation standards and regulations in Kenya, presents researchers and scholars an opportunity to examine these issues in a detailed and systematic way to help reverse the negative aviation record in Kenya and Africa (Oladele, 2005). This study examines the Kenyan aviation disaster risk preparedness context with and recommends means to mitigate disaster occurrence and enhance disaster risk preparedness. It also adds value to aviation studies in the country.

1.1 History of Wilson Airport

The history of Wilson Airport (WAP) dates back to the First World War. Commercial routes were pioneered by Imperial Airways and its successor British Overseas Airways Corporation (BOAC) in the 1920's. In July 1929, Wilson Airways Ltd was formed by Mrs. Florrie Wilson to operate from an airfield in Dagoretti Corner, Nairobi. Later, the airport was relocated to the present site of Wilson Airpor and originally called Nairobi Aerodrome. The construction work was carried out by the Public Works Department. By 1933 two murrum (non-tarmac) runways had been laid. The Imperial Airways then commenced operation of an airmail service to Kisumu in July that the same year (<http://www.kaa.go.ke/airports/wilson>).

In 1962, the GoK renamed the aerodrome 'Wilson Airport' to honour its founder. Today the airport has expanded to become a major domestic airport, a gazetted border control point accommodating short-haul scheduled domestic flights and services, international, and private and charter flights. Wilson Airport is situated

at latitude 0118's and longitude 36 48'49"E, 5km from the Nairobi city centre, and borders Nairobi National Park to the immediate south. It is ICAO Class 2, Category 5, and holds the code HKNW. Currently, Wilson Airport is one of the busiest airports in terms of aircraft movement in East and Central Africa. Domestic flights constitute 90% of the total flights from the airport with international flights accounting for 10%. The airport is a fast and convenient gateway from Nairobi into Kenya's magical interior. Destinations served from the airport include Maasai Mara, Mombasa, Amboseli, Lamu, Diani, Lokichogio, Nanyuki and Kilimanjaro. It is also a modern hub of general aviation in East and Central Africa (<https://www.kaa.go.ke/airports/wilson>).

1.2 Problem statement

Wilson Airport Nairobi is the smallest of the two civil aviation facilities in the city. The airport, which is used mostly by general aviation traffic, caters for both international and domestic traffic. The facility is mainly used by tourism, agriculture and health sectors of the economy. Wilson Airport handles about 120,000 landings and take-offs every year, most of it local and regional traffic. As a result of faster check-in times and fewer flight delays, as compared to Nairobi International Airport, Wilson Airport is commonly used by business executive aircraft for both domestic and International travel. Common domestic destinations from Wilson Airport include Kisumu Airport, Mombasa International Airport and Eldoret International Airport. Despite existence of comprehensive policies on aviation safety in Kenya, critical aviation safety challenges continue to emerge in the existing airports. Over the past decade, Wilson airport has faced different challenges ranging from constrained spaces and aviation related accidents. The airport is constrained by expansion and development space largely due to expansion of aviation businesses as well as developments in its adjoining neighbouring areas. Among the many security and safety concerns raised have been encroachment into airport space with claims that illegal structures and numerous other high-risk business developments within and around the airport have significantly affected flight safety in the airport. All these increasing infrastructural developments pose a threat to aviation activities at the airport.

Different studies have been done in airports in Kenya. Mukaria (2013) did a study on knowledge, awareness and conformity to International Airport emergency preparedness standards: the case of Wilson Airport in Nairobi, Kenya. The study found that dissemination of information among stakeholders was average resulting into low cooperation in the cases of emergency at the Wilson Airport. Obwaya (2010) did a study on disaster risk reduction strategies in preparedness at Jomo Kenyatta International Airport (JKIA) Nairobi Kenya. He found that JKIA plans, facilities and personnel cannot handle a large-scale disaster. No study has been done on the effects on land use changes on airport safety in Kenya. This study therefore examined the effects of land use changes on airport and flight safety in a rapidly growing aviation sector

II. LITERATURE REVIEW

This section presents the theory adopted for the study and the relevant theoretical and empirical literature.

2.1 Systems Theory

Systems theory is associated with Talcott Parsons (1902 – 1979) and is especially drawn from Parsons (1951, 1973). The central argument in this theory is that actors interact in states and come to develop agreements and sustain patterns of interaction leads to relatively stable patterns of interaction among actors in status. Senge *et al.* (1994:90) observe that a system is a perceived whole whose elements hang together because they continually affect each other over time and operate towards a common purpose. If one part of the system is removed, the nature of the system is changed as well. A system can be looked at as having inputs (e.g., resources such as raw materials, money, technologies, and people), process (e.g., planning, organizing, motivating, and controlling), outputs (products or services) and outcomes (e.g., enhanced quality of life or productivity of life or productivity for customers/clients, productivity). Team learning also draws upon the skills of building shared aspirations through improved conversation, dialogue and skillful discussion (Birger and Jeppe, 2005).

The study identified useful tenets in this theory critical to the set objectives. For example the emphasis on the interrelation and teamwork among various members and actors within any given situation or organization is important. While assessing preparedness at Wilson airport, the theory will be useful in guiding analysis of processes of planning for disaster occurrence among existing stakeholders, organizing responses and controlling any situations that might arise in the course of disaster mitigation. Underlying this analysis will be how systems at the airport synergize to either succeed or fail in handling disasters and risks. This study used systems theory to explain the organization of Wilson airport and how its management could compromise disasters management. It focused on how the changes in land use practices and the general organization and management of the airport influences disaster preparedness.

2.2 Land use Changes and Airport Flight Safety

Airports have grown continually since the mid-1960s. This persistent growth has almost always been accompanied by a negative community reaction (Van Praag, 2005). In addition to Federal Aviation Authority's (FAA's) plan to modernize the National Airspace System by 2025, many airports in the United States are seeking to increase their capacity in terms of space. A major concern related to the creation and expansion of airports is incompatible land use in and around noise-sensitive (hospitals and educational institutions) and residential communities. For instance, a study by Kelly (1997) acknowledged that residential populations tended to move towards airports, which ultimately led to complaints by community members and a negative public perception of them. This study sought to find out the reasons why people reside around or near the airports.

Basically, an airport incompatible land use is any type of land development which jeopardizes the safe operation of aircraft near an airport including: residential buildings, schools and libraries, nursing homes and hospitals, wetlands and open water, landfills and sewerage treatment facilities, generators of light emissions, among others. According to Stephanie (2010), airport compatible land uses are defined as uses that can coexist with a nearby airport without constraining the safe and efficient operation of the airport, or exposing people living and working nearby to unacceptable levels of noise or hazards. Determining the level of compatibility of land uses around an airport is based on the type of use and associated concerns. This study assessed whether there has been a change in land use around Wilson Airport and whether this creates risk regarding the safety of the airport.

According to the FAA guidelines on land use planning, incompatible land use and noise are a growing concern in the United States. Published work related to land use can be traced back to the early 1900s. However, the FAA Guidelines on compatible land use at airports and in surrounding communities were only published recently (FAA, 1998). It has become increasingly apparent that "allowing incompatible real-estate development around an airport signals the first step towards closing the airport" (Esler, 2006). According to the U.S. Department of Transportation, an average of 60 public-use landing facilities were shut down between 1993 and 1998 and, in almost every case, incompatible land use was a major contributor. In the case of Stapleton Airport near Denver, the airport was overwhelmed by noise complaints and eventually forced to discontinue operations due to a successful lawsuit by local citizens.

Guiding compatible land use has been difficult, as most airport development boundaries have pre-existed for years. The additional problem stems from the fact that controlling compatible land use does not preclude minimizing noise for surrounding communities. In fact, much community opposition is based on other grounds rather than on compatible land use jurisdiction. In planning an airport's noise mitigation programme, the economic impact of an airport must be examined. Airports are an economic engine and crucial to a community's ability to expand, attract industry, and improve the quality of life (Arata, 1970), and is directly linked to a public's perception of the airport. If individual citizens do not support their local airport, this will negatively affect the region economically. This study suggests how safety and security at Wilson Airport can be improved.

2.3 Impacts for Settlement around an Airport

Community opposition to growth in airport operations and expansion of airport capacity arises from adverse environmental impacts of aviation including: aircraft noise, air pollution, and exposure to aviation accidents. While stringent noise-reduction policies and advances in technology have made aircrafts quieter, aviation noise remains a concern especially when communities allow incompatible land development (residences, schools, hospitals) near airports, as such developments expose people to aircraft noise (GAO, 2007), which is considered the leading cause of community opposition to airport expansion (GAO, 2008). People are often annoyed by noise and prefer to reduce it or leave a noisy neighbourhood. Noise disrupts sleep, conversation, and leisure activities. A World Health Organization (WHO) report in 1993, entitled Community Noise, found that noise gives rise to certain health problems: insomnia, stress, mental disorders, and heart and blood circulation problems. The more severe adverse health effects have not been demonstrated to occur at noise levels typically found around airports. However, a WHO report indicates there is basis for local citizens to be negatively impacted by aircraft operations and flights. Despite negative community reaction, the aviation industry continues to develop new services to meet the demands of a dynamic economy. Airports create employment opportunities and serve as major industrial compounds that increase local employment. Businesses that rely on the aviation industry are near airports to reduce the cost of goods and supplies transportation. A study by McMillan (2004), suggests that employment opportunities attract people to reside and work near airports. Employees live near their work places to reduce the cost of commuting to work (Nelson, 2004; Lipscomb, 2003), and this in turn leads to the construction of schools, hospitals, shopping centres, churches and other community facilities. Residential developments benefit local jurisdictions by expanding its tax base. This study sought to determine the reasons for residential settlement around Wilson Airport.

Often prime land near airports attracts real estate developers. However, increased population results in increased air traffic and it becomes essential to ensure compatible land use around airports. Airport land use planning and noise management are challenges faced by airports around the world. For example, O'Hare International Airport

began as a four-runway airport in 1945. Although community opposition began as far back as the 1960s when a new runway was to be built, noise-related lawsuits did not start until the 1980s (Metropolitan Planning Council, 1996). Over the past few decades, O'Hare has expanded and grown to become one of the largest and busiest airports in USA. During the earlier years, residential and other incompatible land uses began to develop around the airfield unabated, possibly due to a lack of understanding of potential noise impact (Ming et al., 2007). Because of this unrestricted development, since 1982 O'Hare and the O'Hare's Noise Compatibility Commission (ONCC) have employed the largest land acquisition and home insulation programmes in the country. Due to this initiative, the number of homes affected by O'Hare's noise decreased almost 50 percent between 1979 and 1993. In May 1995, a noise abatement programme consistent with the Part 150 Noise Compatibility Plan was initiated to continue noise impact reduction. Additional measures such as the purchase of a hush house, continual soundproofing, and more stringent land use controls have been employed to ensure that O'Hare manages noise impact and development for mutual benefit (Ming et al., 2007). This study assessed the reasons for residential and other settlements around Wilson Airport despite the dangers.

Many airports have reduced noise for communities by relocating to less populated areas, but this has continued to lead to incompatible land use and noise complaints as communities have grown in size to encroach on airport areas. If we are to achieve the desired balance between airport accessibility and service, and peaceful coexistence with the surrounding communities, we must understand the dynamics and evolution of airport incompatible land use. This study assessed the problems faced by the communities living around Wilson airport and sought their opinions on the way to improve security and safety at the airport.

2.4 Enhancing Land Use compatibility around an Airport

Much can be done by airports to build and improve relationships with surrounding communities. In fact, over the past few decades, the number of people exposed to airport noise has decreased, which, combined with improved airport/community dialogue, can have a very positive impact (Thomas, 2004). Tedrick (1983) recommends that airports should avoid using a "cookie cutter" approach regarding compatible land use and instead focus on their unique airport environment, while maintaining a wide view of the national airspace. Wisconsin, Oregon, California, and Florida, among others, have established guidelines or handbooks for communities to ensure new developments near airports are compatible. The study sought recommendations from respondents on improving the safety and security at Wilson Airport can be improved.

According to FAA, proactive approaches exist for local governmental authorities to prevent or discourage incompatible land uses near airports including using the following: overlaying or conventional zoning and control of planned unit developments with certain density of clear zone requirements; enforcing subdivision regulations requiring open space, restricting development in stipulated zones, building code restrictions or conditions to ensure sound-proofing; and agreeing with land owners on navigation easements granting over-flight rights, even if such an agreement carries a price tag. Such proactive measures will release the local government authorities from claims against any nuisance, damage or other suits arising from inappropriate land use near airports; real property notice requirements pursuant to state law, which alert the buyer to the location of the airport, and possible nuisances or damages which might follow; airport runway and clear zone requirement above what any regulatory agency, such as the FAA, might otherwise mandate; and buy-out by the local government of real property in certain identification zones, either by agreement, or by condemnation under police powers. However, some airports have expressed the desire that the federal government play a much stronger role in ensuring land use compatibility. The compatible land use guide entitled *Land Use Compatibility and Airports* (1998) was developed for airport managers, local land use planners and public officials, with the purpose of providing information on FAA programmes, and promoting an understanding of land use compatibility around airports. When local land use planners and airport planners evaluate new development around the airport, the FAA guidelines stipulate that: (1) the local land use plans are incorporated into the airport master plan; and (2) a comprehensive review is carried out before future land use. According to compatible FAA land use guidelines, several regulations related to planning have been enacted over the years and are summarized below:

Federal Airport Act, 1946 – Established a federal airport grants-in-aid system known as the Federal Aid to Airports Programme (FAAP). It was replaced by the Airport and Airway Development Act (AADA) in 1970. It obligated the airport owner to operate, maintain, and comply with several standards and assurances.

Aviation Safety and Noise Abatement (ASNA) Act, 1979 – Assists airport owners to prepare and carry out noise compatibility programmes. Federal Aviation Regulations Part 150 Airport Noise Compatibility Planning Programme, 1981 – Funds airport noise compatibility planning programmes and provides financial assistance to airport owners to assess noise impacts, and identify and apply noise-reduction measures.

Airport Noise and Capacity Act, 1990 – Enacted in recognition of the need to establish a uniform policy at national level to reduce aviation noise and preclude the proliferation of local noise and access restrictions. The

Act called for a phased elimination of the operation of civil, subsonic Stage 2 turbojet airplanes over 75,000 pounds, to or from airports in the contiguous United States by December 31, 1999.

Many articles exist that provide a survey of federal noise legislation, and their effectiveness. Wesler (1981), Hartman (1986) and Foster (1977), all give an account of these regulations and provide a review of how they are executed in the aviation industry. The Land Use Compatibility Guide includes a list of preventive measures against additional and future noise in sensitive land areas. The Guide also calls land use controls according to the following: (i) zoning changes, residential density – planned development, large-lot and multi-family zoning; (ii) noise overlay zoning – special regulations for high-noise areas; (iii) transfer of development rights – zoning framework to authorize private sale of development rights to discourage development in high-noise areas; (iv) environmental protection zoning to support airport land use compatibility; (v) subdivision regulation changes which require dedication of noise or navigation easements (vi) building code changes which – require sound insulation materials in new construction; (vii) dedicated noise or navigation easement which require development permits; (viii) fair disclosure regulations which require a seller to notify a buyer of aircraft noise; (ix) comprehensive planning – policies supporting land use compatibility; (x) can involve specific land use plans and policies to guide re-zoning, variances, conditional uses, and public projects; and (xi) capital improvement programming regarding public investments which support airport land use compatibility.

Apart from preventive measures, the guidelines also suggest remedial measures for noise issues in incompatible land use areas. A summary of the suggested remedial measures are as follows: (i) guaranteed purchase (Fee Simple) – outright purchase of property with the intent of removing incompatible use by demolition of structure; (ii) development rights purchase – purchase of rights to develop property; (iii) land banking – acquisition of vacant land for long-term airport facility needs; (iv) redevelopment – acquisition and redevelopment of property; (v) purchase assurance – airport acts as buyer of last resort, sound-insulates house, sells property, and retains easement; (vi) noise or navigation easement purchase – purchase of easement only; (vii) sales assistance – airport sound-insulates house, guarantees that the property owner will receive the appraised value (or some increment thereof, regardless of final sales value that is negotiated with a buyer), retains easement; and (viii) sound attenuation – the airport provides sound insulation for homes and other noise-sensitive institutions while retaining an easement. This is the most prominent and expensive noise mitigation effort employed by airports.

The costs of land use controls around airports to prevent incompatible developments are concentrated in one stakeholder – the local government, which also imposes land use controls. In particular, local jurisdictions incur costs when placing restrictions on residential development near airports, and these costs fall into three categories: (1) welfare losses, (2) planning and enforcement costs, and (3) fiscal losses. Disallowing residential developments near airports results in welfare losses, because it reduces the supply of land available for residential development in the entire city or county, making land scarcer and indirectly limiting choices elsewhere in the city or county (Dings et al., 2003). There are staffing and related costs involved in formulating and enforcing land use plans and controls. Finally, local governments suffer from fiscal losses from a reduced property tax base if alternative land uses do not generate net fiscal revenues commensurate with residential development. While fiscal losses do not necessarily translate into economic welfare losses to society as a whole, local government officials and planners must consider them.

In contrast, benefits outweigh the costs to stakeholders, of preventing incompatible land use development. Airport sponsors and users who suffer the consequences of operational restrictions, development constraints, and safety hazards, people living near airports who are exposed to negative environmental effects; and the local and regional jurisdictions that fail to realize the full economic impact of unconstrained air service, also benefit from such prevention. This study therefore sought to find out the measures taken by airport management and other stakeholders in ensuring the safety of Wilson airport.

III. METHODOLOGY

This study was carried out at Wilson airport located in Nairobi West. The airport is strategically located only about 5 kilometers from Nairobi city centre. The descriptive design was applied in this study to analyze and describe the effects of land use changes on airport and flight safety in a rapidly growing aviation sector. A total of 216 respondents were sampled for the study including 30 aviation regulators, 30 air operators, 6 service providers, and 150 members of the community.

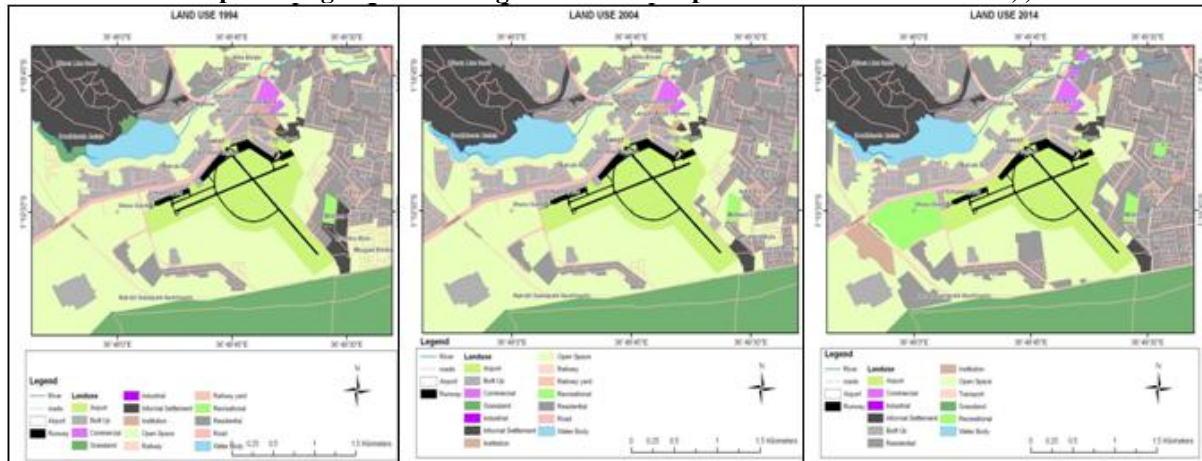
This population has been targeted due to its significant role in either determining issues of preparedness for disaster and risk or being potential causes of disasters and risks at Wilson airport. This study collected primary and secondary data. Primary data was collected by use of questionnaires, interview guide and Focused Group Discussions while Secondary data were collected from written or published records and maps from the Kenya National Bureau of statistics. Qualitative data was analysed by use of descriptive statistics such as frequencies and percentages while qualitative data was analysed using content analysis.

4.0 Findings of the Study

4.1 Effect of land use changes on airport and flight safety

This section presents findings on the effect of land use changes on the airport safety.

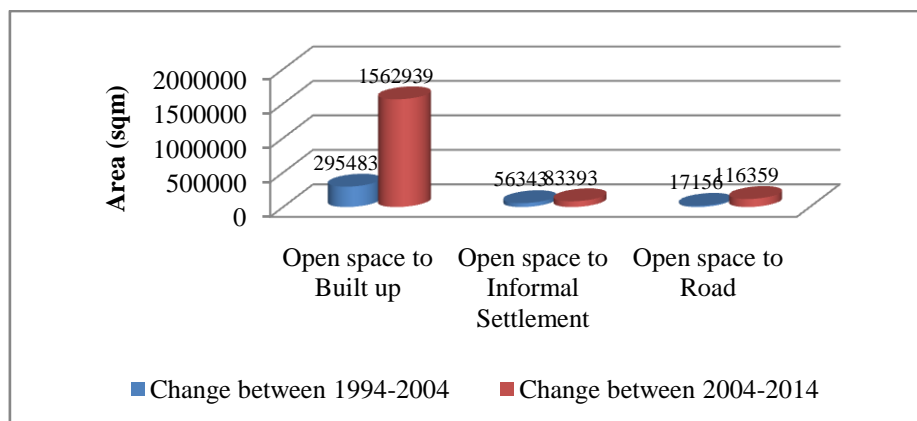
Map showing land use changes at Wilson Airport between 1994 and 2014, ,



Source: QuickBird (2014)

Figure 1: Map showing land use changes at Wilson Airport between 1994 and 2014

By 1994, there were few buildings constructed around Wilson airport as shown in the Maps above. There was more open space around the airport. In 2004, some residential buildings had been developed along the Eastern boundary of Wilson Airport, which reduced the open space around the airport. Such construction continued into 2014. Regarding land use changes between 1994 and 2014 therefore, there was increased construction around Wilson Airport. From the maps above, by 2014, construction, including commercial premises, had increased around the Wilson Airport and ultimately reduced the open space areas around the airport. There was also the emergence of Uhuru Gardens as a recreational facility, neighbouring Wilson Airport. This study analyzed land use changes around Wilson Airport between 1994 and 2014 and the findings were as presented in Figure 2 below.



Source: Author (2014)

Figure 2: Land use change between 2004 and 2014 around Wilson Airport

Analysis of the land use changes around Wilson Airport between 1994 and 2014 shows that the built-up areas covered 295,483m² between 1994 to 2004, and 1,562,939m² between 2004 and 2014. This signifies an increase of 529%, and indicates a high level of construction around the airport in the past decade.

The area of informal settlement covered an area of 56,343m² between 1994 and 2004 which reflected an effort to clear the informal settlements like *Mitumba* slums, and between 2004 and 2014 informal settlements covered an totalling 83,393 m² signifying an increase of 32.4% in informal settlements.

The analysis further revealed that there was road construction covering an area of 17156 m² between 1994 and 2004, and 116359 m² of road construction between 2004 and 2014 signifying an increase of 678% in road construction around Wilson airport.

4.2 Effect of land use changes on flight safety

Aviation regulators and air operators were asked to indicate whether the land use changes had affected flight safety at Wilson Airport. The study found that 42 (74%) of the respondents indicated that land use changes did affect flight safety, while 15 (26%) of the respondents indicated that it did not. In an interview with the service providers on the land use problems facing Wilson Airport highlighted the following issues about its location: its close proximity to the Central Business District; predominantly residential areas close to it; its proximity to major infrastructure such as Lang'ata Road and recently constructed Southern By-Pass; and its proximity to key natural parks and other features such as the Nairobi National Park, Uhuru Gardens, and Nairobi Dam, which are wildlife habitats that serve as natural structural edges that constrain growth. According to Esler (2006), in recent years it became increasingly apparent that, allowing incompatible real estate development around an airport signals a sure step towards the closing of the airport. In the case of Stapleton Airport near Denver, the airport was overwhelmed by noise complaints and eventually forced to discontinue operations due to a lawsuit by local citizens (Esler, 2006). Thus, the encroachment of businesses and residential buildings around Wilson can be considered as a major threat to the airport's continued existence. According to the *National Airports System Plan Report* (2010), the Nairobi National Park and Uhuru Gardens are adjacent to the airport and directly constrain its growth.

In an interview with the airport manager, he mentioned that Lang'ata Road is a major threat to the security and safety of Wilson Airport. He explained that people converge by Lang'ata Road to watch take offs and landing by planes through the airport fence.

In an interview with service providers on the land use practices posing a threat to Wilson Airport, the following were mentioned: increase of shopping malls around the airport, proximity of Uhuru Gardens to the airport, adjacent Nairobi National Park, *mitumba* slums increase, upcoming high-rise buildings increase, and existence of motor garages next to the airport. Plates 1, 2, and 3 below present the situation.

Map showing Uchumi Hyper and Uhuru Gardens

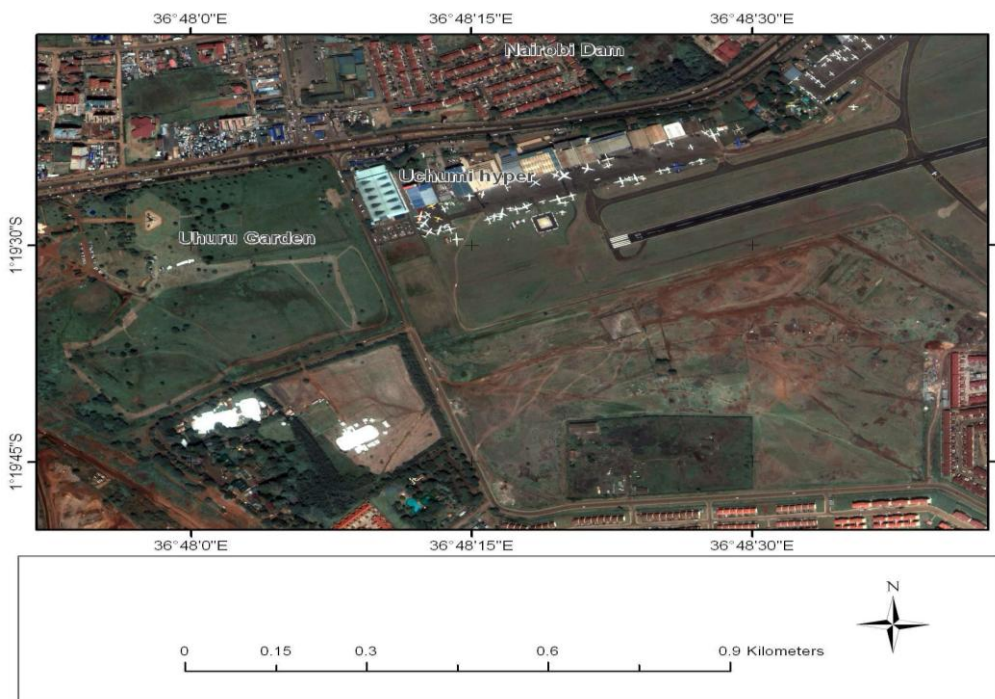


Figure 3 Map showing Uchumi Hyper and Uhuru Gardens in relation to Wilson Airport
Source: KAA (2013)

The map above shows the emergence of shopping malls around the airport.



Plate 1: New town houses on the flight path, south of Wilson Airport
Source: KAA (2013)

Plate 1 shows the development of new town houses along the Wilson Airport flight path, which presents disaster risk in the form of failed take-offs, as well as health risks such as noise and damage from air crashes.



Plate 2: Mitumba slums along the Wilson Airport flight path, Source: KAA (2013)

Plate 2 shows *Mitumba* slums which are located along the Wilson Airport flight path. In cases of aborted takeoff, access to the airport may be hampered and emergency operations hampered. The slum acts as attraction sites for birds which feeds on their garbage heaps and pose a threat to aircrafts taking off.



Plate 3: Uhuru Gardens next to Wilson Airport, Source: KAA (2013)

Plate 3 shows Uhuru Gardens which is next to the airport. There are functions normally held in the garden including weddings, which pose a threat to the airport. In an interview with one of the captains at Wilson

Airport; the garden was mentioned as a major threat to the safety of the airport, due to the functions and picnics normally held there which attract birds, and ultimately interferes with the taking off or landing of planes.

There are many food sources that usually attract birds, especially gulls, pigeons, and starlings. A bird which finds food attracts others quickly (Kuyk, 1981). If the attracted bird species is hazardous prey, controlling the population is a possible solution. Food attractants are often the result of human activities.

Examples of food attractants are open water, trash bins and storage areas (especially when improperly handled), worms on runways during rain, and fishing vessels (e.g. on an island at sea). Other examples are fish or meat industries, landfills, sewer treatment plants, lagoons, birds being fed in parks, grain storage, and agricultural activities. Awareness of such food sources at and around the airport is very important. Proper cleaning up, handling of trash, supplemental bird controls measures, and adjustment of land use are all vital methods to prevent attraction of birds (Godsey, 1997).

“Marabou Stork is the most dangerous bird to aircraft safety at Wilson Airport. At least five pilots have perished because of such bird strikes. The bird is very heavy, as such, it may see the aircraft but because of its weight it cannot move out of the way quickly and often collides with the plane. Whenever these birds hit the wind screen of the aircraft, it smashes because of the bird’s weight” (Testimony of a 50-

Plate 4 below is evidence of frequent hitting of planes by birds during takeoff or landing.



Plate 4: Dead bird that was hit by a plane at Wilson Airport

Source: KAA (2014)

According to Devine (2009), bird strikes are a notable airport hazard.



Plate 5: A Windscreen of an aircraft that was hit by a bird

Source: <http://www.birdstrikenews.com>. Accessed April 2014

Plate 5 depicts what usually happens when Marabou Stork hit airplanes during takeoff and landing. The cases of birds hitting windscreens of aircrafts have been experienced at Wilson airport and often dead birds are later picked up along the flight path.

Police used to be used to scare the birds away, but the police would sometimes shoot into the planes in their effort to shoot the birds. Currently, the airport authority has recruited some bird scouts to scare the birds away. The scouts have adopted better methods including recording the sound of the predators such as eagles and using these sounds to chase the birds away.

4.3.3 Airport Land Loss

By 2004, there was a clear change in land use around the airport. Many structures had developed signifying an increase in activity around the airport.

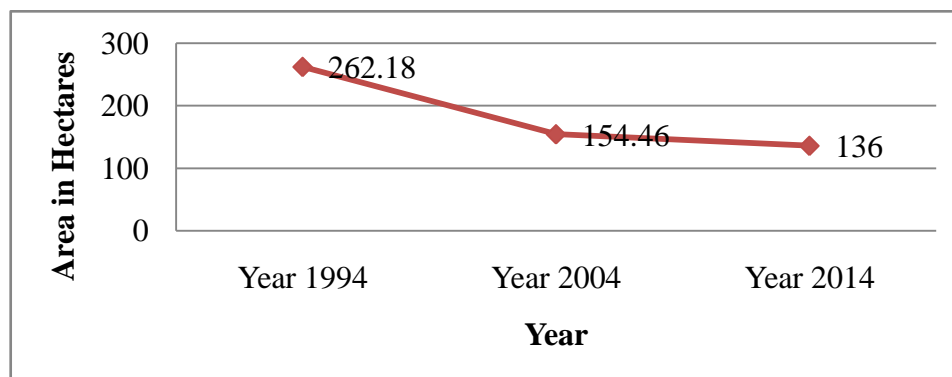


Source: QuickBird (2014)

Figure 4 : Maps showing Wilson Airport Land Loss between 1994 and 2014

The maps show that by 1994, Wilson Airport had an area of 262.18 hectares. A confidential document on The Registration of Titles Act showed the area of Wilson Airport to be 163.67 hectares by 1996. By 2004, the airport had an area of 154.46 hectares showing a loss of 107.72 hectares (41.09%). By 2014, the airport had an area of 136 hectares signifying additional loss of 18.46 hectares as a result of changed land use.

The map shows that there was change in the boundaries of Wilson Airport between 1994 and 2014 and that over 20 years the Wilson Airport had lost an area of 126.18 hectares signifying a loss of 48.13%. The change in the boundary demarcated by the development of different structures and land use activities around the airport is evidence of a loss of Wilson airport land. Figure 5 shows a graphical presentation of land loss around the Wilson Airport between 1994 and 2014.



Author (2014)

Figure 5 Land Losses between 1994 and 2014

4.3.4 The extent to which land use changes are a threat to airport safety and security

Regarding the effect of land use changes on airport safety and security, 42 (73.7%) of the study respondents indicated that the construction of tall buildings on the approach and take off path of planes is to a very large extent a threat to aircraft safety. Additionally, 40 (70.2%) aviation regulators and air operators indicated that the

encroachment of non-aviation activities around the Wilson Airport is a threat to a very large extent to its security and safety, while 36 (63.2%) respondents indicated that the location of dumping sites around the airport, which attracts birds, is a threat to a very large extent to plane visibility and airport safety. The results are as presented in Table 1 below.

Table 1: Extent to which land use changes are a threat to airport safety

Statement	Very large extent		Large extent		Neutral		Small extent		No extent at all		Total (%)	
	F	%	F	%	F	%	F	%	F	%	F	%
The construction of tall buildings on the approach and takeoff path is a threat to aircraft safety	36	63.2	17	29.8	4	7	0	0	0	0	57	100
The location of dumping sites around the airport, which attracts birds, is a threat to visibility and airport safety	42	73.7	10	17.5	5	8.8	0	0	0	0	57	100
The encroachment of non-aviation activities around the Wilson Airport threatens security and safety	40	70.2	15	26.3	2	3.5	0	0	0	0	57	100

Source: Author (2014)

In an interview with the service providers on how land use changes have affected airport security and safety the following were mentioned: there has been encroachment of tall buildings around the airport which threatens visibility during landing and taking off by planes; activities around the airport and development of slums pose a risk of insecurity to the airport. Defining airport compatibility land uses, Stephanie *et al.* (2010), refers to them as uses that can take place near an airport without constraining the safe and efficient operation of the airport or exposing people living and working nearby to unacceptable levels of noise or hazards. From the findings of the study, it can be said that one of the major challenges facing the safety of Wilson Airport is the increase and encroachment of incompatible land uses around the airport.

There are new and upcoming developments on the southern edge of the airport that include a 5-star housing estate and the high-rise Kenya Police Quarters, which obstruct aviation activities using Runway 07-25. There are also proposed residential developments on the parcels bordering the southern edge of the Wilson Airport boundary. Their location is not compatible with airport operations due to noise and safety matters. The runway was actually 40 metres from the residential buildings. At the end of the runway there is a distance of 60m to the airport fence. According to the recommendation by Airports Council International (ACI) *Policy and Recommendation Practices Handbook* (2009), where it is not possible to comply with the ICAO recommendation of 240 metres, for space and other development reasons, alternative solutions may include providing an arrestor bed, or other mitigating measures. The defined area is graded, cleared of obstacles, and prepared, in order to reduce the risk of damage to aircraft that undershoot, overshoot, or veer off the runway (FAA, 2004). The trapezoidal area beyond the runway end serves to protect people and property on the ground from aviation accidents.

Safety standards play an important role in the interaction between aircraft performance, operational regulations, and infrastructure design. Operational regulations such as the Procedures for Air Navigation Services and Operations (PANS-OPS) require sufficient runway length for each take-off and landing. Although these regulations are well established, regulators sometimes issue additional rules governing the operation of aircraft to increase the safety margin. For example, the FAA published a Safety Alert for Operators (SAFO) in August 2006 in response to the landing overrun at Chicago Midway Airport eight months earlier (FAA, 2006). The document recommends jet operators to consider landing performance based on conditions at the time of arrival, in addition to assessment at dispatch. Airport operators are required to designate a portion of the airport where security measures are applied to protect areas used for landing, takeoff, or surface maneuvering of airplanes. As defined, the Analysis of Alternatives (AOA) encompasses the (1) runway, (2) taxiway, (3) ramp, (4) parking, (5) tarmac, and (6) undeveloped areas within the airport perimeter. Plate 8 and 9 show the effects of construction along the flight path at Wilson Airport.



Plate 6: Construction going on 5 metres from Wilson Airport along Runway 07
Source: Author (2014)

Plate 6 shows a construction going on adjacent to the fence of Wilson Airport and effect of land use changes on airport safety. This poses a security threat based on the fact that there is no space left between the airport fence and the construction outside the airport.



Plate 7: An aircraft crashed on a house at Ngei Estate near Wilson Airport, Source: Daily Nation, 21 December, 1999.

Plate 7 shows plane crash on one of the adjacent residential houses along the flight path at Wilson Airport. On the east of the Wilson Airport, there are middle-income residential areas of South C, West Madaraka, and Nairobi West, and apartment blocks that all increase the risk of accidents by low-flying aircraft using runway 07–25. Carton City, an informal settlement is also located in this area; the settlement's proximity to the airport poses a safety and security threat to airport operations. Without an adequate solid waste management strategy, indiscriminately strewn litter attracts birds, which increases the threat of bird strikes to aircraft. There is also the risk of spontaneous fires from settlements and adjacent open-air motor garages that do not observe high safety standards in their work. Such fires could spread fast due to the combustible construction material used and the congested nature of the settlements encumbers rescue operations. Moi Educational Centre is a school also located close to the airport, which increases noise levels at the airport. Figure 6 below shows the incompatible developments around the Wilson Airport

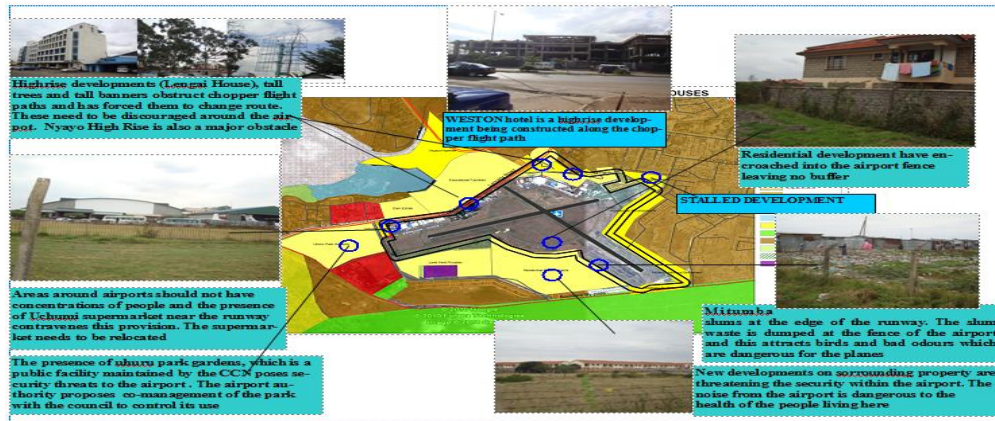


Figure 6: Land use around Wilson Airport
Source: National Airports System Plan Report (2010)



Plate 8: Phenom Estate found to the south of Wilson Airport
Source: Author (2014)

Plate 8 shows the development of residential houses to the south of Wilson Airport, which poses a threat to security and safety during takeoff and landing of planes. In an FGD with the members of the community on the reason behind their occupancy of the residential houses around the airport, they gave the following responses: the rents are affordable, people had already settled in the area and they just joined them, and they work in the areas around the airport. In support of these findings, studies have proven that airports create employment opportunities, thereby making areas around airports major industrial compounds that increase the rate of employment. Businesses that rely upon the aviation industry are established in the vicinity of airports to reduce the cost of transporting goods and supplies. A study by McMillan (2004), suggests that employment opportunities attract people towards airports. A large number of people want to live as close as possible to their place of employment, to minimize time commuting to work. This leads to more residents near the airport and, in turn, the construction of schools, hospitals, shopping centres, churches and other community facilities. In an interview with a captain on the danger of having a national park close to the airport, he explained that, the park in itself is a saviour in case of mechanical problems during takeoff.

"The busiest runway - 'runway 07' - is in the direction of South B and South C estates, which are very heavily built up areas. We have had slight disasters on that runway. This makes the National Park the only escape route in case of danger. What currently helps is that pilots prefer to use runway 14 which empties into the National Park. Every year we have at least 3 to 4 airplanes that take off from runway 14 and end up landing in the National Park. (Interview: A 45-year old captain from Wilson Airport)"

The captain mentioned that the major threats are dogs which get in to the airport area through the fence from *mitumba* slums. Additionally, during the rainy season there are pools of water which attract birds to the airport area. Garbage heaps also from the *mitumba* slums attracts birds as do garbage bins at supermarkets near the airport. According to MacKinnon (1997), sewage lagoons or treatment plants and on-base landfills should be situated as far from the runway as possible so that birds on food flights do not cross the runways. A small working surface, overnight waste dumping and immediate covering, combined with exclusion and repellent techniques are advisable to reduce this risk. High trees around landfills, the presence of dogs, and continual harassment of birds at landfills have proven effective methods of discouraging gulls from feeding on airport areas. Plate9 below shows the Nairobi National Park which pilots prefer in cases of emergency during takeoff.



Plate 9: Aircraft accident in Nairobi National Park adjacent to Wilson Airport

Source: KAA

Plate 9 exhibits what happens in cases of emergency when pilots prefer to land in the Nairobi National Park when they experience technical hitches during takeoff. The existence of the park however poses a challenge to accessibility especially to emergency responses after an air crash.

4.3 Summary of Findings

On the effect of land use changes on flight safety at Wilson Airport, the study found that 42 (74%) respondents indicated that land use changes has an effect on flight safety; and 15 (26%) indicated that land use changes does not have an effect on flight safety. Land use changes included: setting up of major shopping malls near the airport (Uchumi Supermarket on the west of the airport; T-mall on the North east of the airport); Uhuru Gardens on the west of the airport; Nairobi National Park on the south side; *mitumba* slums on the eastside; upcoming high-rise developments on the South side (Phenom Estate, Five Star Estate), and motor garages on the east of the airport. The findings revealed that Wilson airport had lost an area of 126.18 hectares (48.13%) to activities and developments around the airport.

The study further found that 42 (73.7%) respondents indicated that the construction of tall buildings on the approach and take off path of the airport is a threat to aircraft safety to a very large extent. It was also found that 70.2% of aviation regulators and air operators indicated that the encroachment of non-aviation activities around Wilson Airport is a threat to its security and safety to a very large extent; while 63.2% respondents indicated that the location of dumping sites around the airport which attract birds is a threat to visibility and airport safety to a very large extent. The reasons for the occupancy of residential houses near the airport included their affordability and the fact that people had already settled in the area thus prompting others to join them. Land use change is a major determinant of disaster risk preparedness at Wilson Airport. The results from correlation analysis showed that disaster preparedness is positively related with land use changes with a Pearson's Correlation Coefficient of $r = 0.509$ and that at a level of significance of 0.000 meaning that it is statistically significant as p value is less than 0.05.

IV. CONCLUSIONS

From the findings of the study, it can be concluded that land use changes is a major threat to safety and security at Wilson Airport. This is evidenced by setting up of major shopping malls near the airport, proximity of Uhuru Gardens to the airport, adjacent Nairobi National Park, *mitumba* slums, upcoming high-rise developments, and existence of motor garages next/near to the airport.

V. RECOMMENDATIONS

The study recommends that the government should do an urgent operation on land encroachment as this is perceived to be a disaster on the waiting. This will help in clearing the surrounding areas especially along the flight path, approach and take off routes

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