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USING GIS TO ASSESS THE RISK OF TERRORISM: A CASE STUDY OF GARISSA COUNTY

Project report submitted in partial fulfillment of Degree in Master of Science in Geographic Information Systems, in the Department of Geospatial and Space Technology of the University of Nairobi

BY

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Declaration

I, Victor Laktabai, hereby declare that this project report is my original work. To the best of my knowledge, the work presented here has not been presented for a project in any other university.

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Date

Dedication

In dedication to my family, the soldiers who have given their life to fighting terrorism and those who lost their lives due to terrorism.

Acknowledgement

I express my gratitude to God for His guidance and providence through my postgraduate journey. His grace has been sufficient to carry me through the challenges of my studies.

My sincere appreciation goes to my family who encouraged me throughout my time of study.

Special thanks go to my supervisor Prof. Faith Karanja for her wise counsel, insightful guidance and patience she selflessly extended while working on this project. To the faculty at the department, thank you for imparting knowledge that has made me a better professional.

Finally, to my classmates, it has been a great pleasure attending class together and helping each acquire, build and sharpen my skills in GIS.

Abstract

Terrorism is one of the biggest security concerns in Kenya. Many lives have been lost and property worth millions destroyed during terror attacks. These terror attacks have been carried out by the Al Qaeda linked group Al Shabaab. The attacks have happened in Nairobi, the coastal counties of Mombasa, Lamu, Kilifi and Kwale. However, majority of the attacks have happened in Mandera, Wajir and Garissa counties representing about 70% of the incidents. Garissa county has been the most affected county with one of the major attacks being the attack on Garissa University that resulted in the death of 149 people.

Counter terrorism and antiterrorism measures have been taken by the government to fight the threat of insurgency. The decisions made on the measures taken to mitigate and prevent terrorist attacks made based on information.

This research project aimed at profiling the county of Garissa into different zones based on the risk of terrorism using secondary data representing different factors of risk. Statistical analysis on the incidents was done on the terrorist incidents that occurred between 2015 and 2019. Hotspot analysis was also performed to highlight areas of high concentration of incidents and identify roads that are prone to Improvised explosive devices incidents. The ArcModel builder was used to build a model that carried out the terrorism risk assessment. The factors that were incorporated into the risk model were previous incidents, road network, proximity to Somalia border and Boni forest and the settlements.

The results of the study were presented in form of graphs and maps. The highest number of incidents by type were improvised explosive device incidents followed by armed clashes representing 35% and 15 % of the incidents respectively. The security forces were the main target of the terrorist incidents. The hotspot areas where terrorism was prevalent was identified to be Liboi on the north eastern side of Garissa and Hulugho in the south eastern part which were areas with a high number of incidents in close proximity. These were the areas of very high risk of terrorism which reduced towards the western side of the county.

It was recommended that the findings of the research be used by the security agencies to make informed decisions in the fight against terrorism. For hotspot analysis it was recommended that the incidents be weighted using either fatalities, injuries or property loss.

The study proposed further research to identify other factors contributing to increased risk of terrorism and a scientific way of weighting the factors contributing to terrorism risk.

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List of abbreviations

ACLED	Armed Conflict Location and Events Data
IED	Improvised explosive device
AIAI	Al-Itihad Al-Islam
IS	Islamic state
ISIL	Islamic State of Iraq and the Levant
GTI	Global Terrorism Index
LAPSSET	Lamu port South Sudan Ethiopia Transport
UNHCR	United Nations High Commission of Refugees
KNBS	Kenya National Bureau of Statistics
START	National Consortium for the Study of Terrorism and Responses to Terrorism
UNOCT	United Nations Office of Counter-Terrorism
NCTC	National Counter Terrorism Centre

CHAPTER 1: INTRODUCTION

1.1 Background

Terrorism is one of the biggest security issues the world over. The impact of terrorism has been loss of life and property which has greatly impacted the economies of the affected countries. To effectively implement counter terrorism and anti-terrorism measures, there is need for information for good decisions to be made (Hu et al., 2019). Different studies have been done with the aim of understanding the formation and ideologies behind terror groups such as Al Shabaab (Harun and Joseph 2018). Other studies have generally looked at the command structure and the nature of operations of Al Shabaab activities (Hassan, 2015)

Armed Conflict Location and Events Data (ACLED) and National Consortium for the Study of Terrorism and Responses to Terrorism (START) are organisations which maintain separate databases that keep track of all terrorist incidents and other ongoing conflicts across the world. This data has been used to carry out statistical and temporal analysis of the activities of terror groups. Other studies have drawn a comparison between activities of different terror groups such as Al Shabaab in Kenya and Boko Haram in Nigeria (Raleigh 2017; Njoku et al., 2018). Garissa county is one of the counties that has suffered from one of the deadliest terrorist attacks on Kenyan soil that was carried out at the Garissa University. This resulted in the death of 147 people where majority were university students (Pate et al, 2015). There have been persistent terrorist attacks in Garissa county targeted at civilians and security forces despite different efforts being made to try and contain the situation. This is driven by the fact that the county shares a porous border with Somalia which is the main operation base of the terrorist group Al Shabaab (Momanyi, 2015). The porous border allows the terrorists to cross from Somalia into Kenya carry out the attack and move back to Somalia quite easily.

This research project aimed at mapping Al Shabaab attacks that had been carried out in Garissa county, map the hotspots of the attacks and developed a model of carrying out terrorism risk ranking. This model was used to profile the county into different zones of risk.

1.2 Problem Statement

Garissa county was rated as one of the safest places in East Africa prior to Kenya Defence forces troops invading Somalia in October 2011 (Elder 2013). Ever since, the security situation has

deteriorated because of increased Al Shabaab attacks. Different efforts have been applied in a bid to improve the security situation.

Majority of researches that have been done have mainly focused on the impact of terrorism on the economy, politics, tourism and social cohesion (Nyongesa 2019; Momanyi 2015; Kirui 2019). In addition, there are researches done to identify the drivers of terrorism in the county (Counter Terrorism Project 2020; Kessels *et al*, 2018; Odhiambo *et al*, 2015). Other studies have focused on analysis of the nature and number of attacks carried out by Al Shabaab and comparing that with other terror groups such as Boko Haram in Nigeria (Raleigh 2017; Njoku *et al.*, 2018).

Although there is existing terrorism incident data, there is a gap when it comes to in-depth statistical and spatial analysis of the terror attacks specific to Garissa county. Further, there is no existing methodology that has been developed to carry out risk assessment for areas affected by terrorism. This study sought to carry out spatial analysis of terrorist activities in Garissa county and in the end profile the county according to different risk levels based on risk model developed.

1.3 Objectives of the study

The overall objective of this study was to use GIS to assess the risk of terrorism in Garissa county

The specific objectives of this study were to: -

1. Identify the factors that contribute to the risk of terrorism
2. Generate a map of terrorism incidents
3. Model the risk of terrorism
4. Profile terrorism risk zones

1.4 Justification for the Study

This research intended to provide information that will be useful in making better decisions on counter terrorism measures. This is achieved by painting a clear picture of the areas affected by terrorism by highlighting the trends of the attacks, mapping the hotspot areas and classifying the county into areas of homogenous risk of terrorism. This information will help those implementing counter terrorism measures like the Kenya Defence Forces, Kenya Police Anti-

terrorism unit, National Counter Terrorism Center and the national crime research to be more focused on the areas most affected by and prone to terrorism.

There are different development projects like roads, water pans etc being carried out in these counties, knowing the level of risk of terrorist attacks to the projects will help inform the measures to be taken for these projects to be successfully implemented.

This research will also be useful for future academic and non-academic research as a reference guide. Modifications can be made on the methodology in order to get better results.

1.5 Scope of work

This research project relied on secondary data collected stored in the ACLED database and other media sources. This data was analysed with the focus being on the attacks perpetrated by Al Shabaab over five years between January 2015 – December 2019. Statistical and spatial analysis was done on the data.

The factors that were used to determine level of risk were location of previous attacks, presence of Al Shabaab militia represented by the Somalia border and the Boni forest and potential targets of terrorist attack which included roads and settlements. These five factors were integrated for purposes of terrorism risk assessment.

Analysis for risk of Improvised Explosive Device (IED) attacks on roads was done to identify dangerous roads.

The results of the analysis were in form of pie charts, line graphs, hotspot maps, risk profile map and a report on the research project.

1.6 Organisation of the report

Chapter 1 of this report covers the introduction by giving the background details of the topic of study, it also states the problem being tackled and outlines the objective of the study. In addition, it gives the justification and scope of the study. Finally, it outlines how the report is organised.

Chapter 2 handles the definition of terrorism and highlights the global, regional and national issues of terrorism. This chapter also gives the main applications of GIS technology in analysis of terrorism and the different methodologies that have been applied in assessing the risk of terrorism. It concluded with identifying the different factors that contribute to the risk of terrorism.

Chapter 3 details the different datasets to used, the analysis applied to the data and the design of a spatial risk model alongside the parameters to used.

Chapter 4 discusses the findings of the study illustrated through maps and graphs.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to Terrorism

There exist hundreds of definitions of terrorism, however, there is yet to be an agreed upon definition and it seems it will be a long while before consensus is arrived at. Terrorism can be defined as a doctrine on a tactic of fear generation, coercive political violence that is implemented in form of violent attacks without respect to legal and moral constraints (Schmid, 2011). The other definition for terrorism is the threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic, religious, or social goal through fear, coercion, or intimidation (IEP, 2019). Acts of terrorism are usually targeted at civilians who are innocent and defenceless.

There are policies that have been developed by international agencies such as United Nations Office of Counter-Terrorism (UNOCT) and national agencies tasked with the mandate to fight terrorism. These policies cover border security, cyber security, foreign terrorist fighters, countering terrorist travel, human rights, prevention of violent extremism, terror financing, victims of terror and counter-terrorism (United Nations General Assembly, 2006). In Kenya, the National Counter Terrorism Centre is the body that leads and coordinates different actors in developing and implementing the national strategy to counter violent extremism (NCTC, 2016).

2.1.1 Global Terrorism

According to (IEP 2019) 71 countries recorded at least one death as a result of terrorism in the year 2018. The report ranks 137 countries in the world as having very low to very high impact of terrorism. The main terrorist groups in the world include Taliban, Islamic State of Iraq and the Levant (ISIL) and Boko Haram. Most of the other smaller terrorist groups are mainly affiliated to these main terrorist groups. Over the last decade, terrorism has been responsible for about 0.05% of global deaths annually (Ritchie *et al*, 2019).

Significant investment has been made in the fight against terror groups by different actors from individual countries to the United Nations. The United States has invested about \$ 175 billion in funding counter terrorism efforts (Zucchi, 2018). This also includes support to other countries in form of training of its security forces on counter terrorism.

2.1.2 Regional Terrorism

Several African countries have been plagued with terrorism both homegrown and external. Two main terrorist groups that have managed to carry out large scale attacks in Africa are Boko Haram and Al Shabaab. The Boko Haram started in 2002 in Borno state in northern Nigeria as a local Islamic group promoting Sharia law (Kambela 2019). According to (ACLED 2018) Boko Haram carried out about 3416 incidents that have resulted in over 36,000 casualties. The most significant terrorist incident by the Boko Haram was the kidnapping of 276 girls from Chibok village in the year 2014 (Oyewole 2016). The other terrorist group has been Al Shabaab which operates from Somalia. They have carried out attacks in Somalia, Kenya and Uganda.

2.1.3 National Terrorism

Al Shabaab

Al Shabaab is an Al Qaeda affiliated militant group that was formed after the collapse of Al-Itihad Al-Islam (AIAI) in 2008 (Harun and Joseph 2018). AIAI was formed after the fall of Said Barre regime in Somalia in the year 1991. Al Shabaab pledged their allegiance to Al Qaeda in 2012 although in the recent past there is a faction that wanted to be allied to the Islamic State (IS) which ended up leaving Al Shabaab. The Al Shabaab seeks to promote Salafi jihadism where they believe in application of Sharia law in governance. Jihadist believe westerners and anyone associated with them are their enemies, making them their key target.

Al Shabaab operation in Kenya

Although Al Shabaab operates in Somalia, it carries out some of its operations in Kenya. Kenya has been under threat of terrorism since the 1970s, however the first terrorist attack occurred in August 1998 when a bomb exploded at the United States of America embassy in Nairobi. This attack resulted in the death of 224 people and injuring about 5,000 others. This attack was carried out by the Al Qaeda. The other significant attack by the Al Qaeda terrorist group was on Paradise hotel, Kikambala, Mombasa that resulted in 16 people dying and 80 people being injured.

Two kidnapping incidents happened after a long lull of no successful attacks. These separate incidents happened in Lamu where two lady tourists on holiday were captured by the Al Shabaab (Kisiel and Levy 2011). This led to the resolution by the Kenyan government to deploy its army to Somalia to provide a security buffer. The Kenya army today continues to operate in Somalia as part of the Africa union peace keeping mission in Somalia (AMISOM).

Kenya has continued to suffer attacks internally by Al Shabaab despite its army operating in Somalia. The attacks have mainly occurred in Mandera, Wajir, Garissa, Lamu and Nairobi. They continue to target both the government agencies and civilians alike (Hassan 2015). The attacks have resulted in great casualties to both police and civilians. According to the Global Terrorism Index (GTI) Kenya is ranked at position 21 in the most affected countries by terror (November 2019). It further ranks Kenya as medium on the impact of terrorism.

2.2 Classification of terror attacks

A terror incident is defined as an intentional act of violence that causes damage to either life or property and is perpetrated by members of a terror group. The act should have political, religious or social goal (IEP 2019). Each incident will be counted as one if it is carried out in the same spatial location within the same timeframe.

Terror incidents have been classified into different categories based on the purpose of the act, nature of weapon used in the attack and the target of the attack. The Institute of Economics and Peace (IEP) classifies terror attacks as assassination, bombing/explosion, hostage taking, facility attack, ambush or armed assault (IEP 2019). For the bombing/explosion it involves the use of improvised explosive devices (IED) that could be planted on the ground, on a vehicle or a person wearing a suicide vest. In 2018, bombing/explosions constituted 37% of the terrorist incidents recorded (IEP 2019). Bombing is the means used mostly by terrorist groups in Africa.

Armed assaults or armed clash are those incidents that involve an ambush and exchange of fire between two opposing sides. (IEP 2019) stated that of the 2018 global terrorist incidents armed assaults were 24% of the total incidents. In countries where there is active conflict like Yemen, Afghanistan and other Middle Eastern countries, armed assaults are the highest recorded type of incidents.

Assassinations are usually targeted killing of individuals who the terrorist groups consider their enemies. Assassinations accounted for 18% of the incidents in 2018. Assassination is most prevalent in Central America and the Caribbean.

(Yun 2009) defined hostage taking or kidnapping the taking away of a person by force, threat, or deceit, with intent to detain that person against his will. Kidnapping may be done for ransom (economic reasons) or for political or other purposes. Hostage taking constituted 12% of terrorist incidents recorded in 2018 (IEP 2018).

A facility attack is targeted at different public utility facilities which include academic institution, security bases, communication masts and others. This nature of attacks is well

planned and executed after long time of surveillance and intelligence gathering. The number of casualties of facility attacks is usually high. Of all the different types of terrorist incidents they are the least recorded. In the year 2018 they were 9% of the incidents (IEP 2019). These kinds of attacks are mainly targeted in countries or areas with no active conflict. The target is mostly civilian population.

2.3 Impact of terrorist attack

Most of the reports on terrorism measure the impact of a terrorist attack on the basis of the number of fatalities and injuries or the loss of property that result from it. (Njoku et al 2018) measures the impact of terrorism by analysing the number of deaths and injuries resulting from terrorist incidents perpetrated by Boko Haram in Nigeria and Al Shabaab in Kenya over a period of 6 years. IEP in ranking the countries most impacted by terrorism factors in the total deaths and injuries caused by terrorism. This is the direct impact of terrorism.

However, there are other indirect impacts that result from terrorist attacks which could be economic or social which are measured by observing different indices that show growth or decline in the economy or social cohesion. The changes can be measured by comparing these indices before and after a terrorist attack as was done for the United States of America after the 9/11 attack where the consumer confidence index declined from 114 before the attack in August to 85.5 in September (Klein 2007).

2.4 Application of GIS Technology in anti-terrorism and counter terrorism

GIS tools and technologies have been applied at different stages of counter terrorism and anti-terrorism which are monitoring or surveillance, preparedness, response and mitigation. (Deogawanka 2015).

In monitoring and surveillance, the key application of GIS is in spatial analysis of terrorist operations. There are different studies that have been done on the spatial analysis of terrorist activities. (Raleigh *et al*, 2017) used ACLED data to draw a comparison between Boko Haram and Al Shabaab to determine which group is deadliest by looking at the number of attacks and casualties. A similar study was carried out to draw a picture of nature of terrorism in Africa with the case studies being Nigeria and Kenya (Njoku *et al*, 2018). (Medina *et al*, 2011) carried out spatiotemporal analysis of terrorism incidents in Iraq between 2004-2009 with the main objective of identifying any patterns in terrorism after mapping has been done. The analysis was done at

the district scale without looking specifically at where the attacks were happening. The other application of GIS technology in counter terrorism has been modelling of 3D urban space to identify potential sniper locations (VanHorn *et al*, 2010). Different GIS tools such as viewshade was used in identify potential sniper sites. This is one of the efforts that is aimed at mitigating terrorist activities.

2.5 Terrorism risk modelling

The preparedness stage of counterterrorism involves risk assessment where vulnerable locations and people are identified. There are different approaches that have been applied to assess the risk of a terrorist attack. (FEMA 2005) developed a guide on how to mitigate potential terrorist attacks against building by developing a model that does risk assessment using asset value assessment, vulnerability assessment and threat identification and rating as parameters. The model used for risk rating is the product of the three parameters as shown in equation 2.1.

$$\text{Risk} = \text{Vulnerability} \times \text{Threat} \times \text{Asset value} \quad (2.1)$$

Other terrorism risk researchers (Garcia, 2006) (McGill *et al*. 2007) (Pate-Cornell and Guikema. 2002) (Rosoff and von Winterfeldt. 2007) (Willis *et al*. 2003) (von Winterfeldt and O'Sullivan. 2003) have used threat, vulnerability and consequences as the parameters for risk assessment. Similarly, as in the previous model, the product of these attributes is used to get the risk ranking. In this case threat is usually a probability of an attack, vulnerability is the probability of an attacker's success and the consequences are the losses suffered as a result of a successful attack as shown in equation 2.2.

$$\text{Risk} = P(A) \times P(S/A) \times C \quad (2.2)$$

Every risk assessment model needs to take into consideration the following characteristics of terrorist attacks: high level of uncertainty, high level of dynamism, capability of terrorist to choose attack scenarios deliberately, complexity of attacks and terrorists' constant sophistication of the attacks based on lessons learnt (Reznikov *et al* 2018)

(Hu *et al* 2019) developed a risk model that used factor analysis method for qualitative analysis of impact of the attack and K-means clustering analysis to score the level of risk. The results of the two methods were combined to obtain the risk rating.

The risk assessment done previously considered the threat to terrorism on specific targets. There has been no study done that is aimed at analysing the general geographical area to access the

risk. This research aimed at developing a model that can be used to assess the threat of terrorist attacks with reference to the spatial aspects of different factors.

2.6 List of input parameters for the spatial risk model

There are a range of factors that contribute to increased likelihood of a terrorist attack to occur. Several factors will be considered in this project as inputs for the spatial risk model and they are listed below

2.6.1 Presence of Al Shabaab

For the case of Garissa county, the Al Shabaab militants are known to operate from Somalia where they cross the porous border into Kenya, carry out an attack then move back to Somalia (Mutisya 2017). To represent this, the border with Somalia will be considered as an input into the border with Somalia.

Al Shabaab are also known to be hiding inside the Boni forest that is in both Lamu and Garissa counties (Yusuf 2020). They occasionally cross move out carry out attacks in adjacent villages and roads before moving back to their hideouts before crossing to Somalia.

2.6.2 Potential targets

An analysis of previous attacks by the Al Shabaab shows that they mainly target places where there are non-locals who are non-Muslims (Chome 2019). They have targeted teachers in schools, police moving on roads, police stations, communication masts, public transport buses and hospitals (IRIS. 2015).

The datasets that will be used as input are villages with schools, hospitals, communication masts and police stations. Another dataset is the motorable roads used by the police for patrols and public service vehicles.

2.6.3 Previous attacks

The Al Shabaab are known to operate in a limited area for them to easily carry out an attack and escape from the scene. For this reason, many attacks are carried out in near locations. In order to incorporate that into the spatial risk model, incidents that have occurred over a 3-year period (January 2017 to December 2019) will be considered as inputs into the spatial risk model.

2.6.4 Time of attacks

Terrorist groups are known to carry out attacks to commemorate dates that are significant to them like when they successfully carried out a major attack like the Garissa University attack or a date when they appointed a new leader. They are also known to increase the number of attacks during the Ramadhan period as they believe they are fighting a holy war.

CHAPTER 3: MATERIALS AND METHODS

3.1 Area of Study

The area of study is Garissa county in Kenya. It borders Somalia to the East, Lamu and Tana River to the South, Wajir to the North and Isiolo counties to West as shown in figure 3.1. The total area covered by the county is 44,174 Km² (County Government of Garissa, 2018)



Figure 3.1 Area of Study

The population of Garissa county as stated in the provisional 2019 census results was 841,353 (KNBS, 2019). The county is sparsely populated with most of the residents clustered in villages with developed infrastructural facilities. The average population density for the county is 20

persons per Km². Dadaab refugee camp is one of the largest refugee camps in the world with a population of about 217,108 registered refugees and asylum seekers (UNHCR, 2019).

The residents of Garissa county are mainly involved in livestock rearing, agriculture and business. The main economic activity however is livestock rearing where different animals are kept which include cattle, camels, sheep and goats. They are generally pastoralist community moving in search of pasture and water across the county and sometimes to the neighbouring counties of Tana River and Lamu. (County government of Garissa, 2018). Agriculture is mainly practised along the Tana river with a bit of rainfed agriculture in the hinterland.

3.2 Data Sources and Tools

3.2.1 Data Sources

Table 3.1: Data Sources and specifications

Data	Source	Data Specification
Terrorism incident data	ACLED Global terrorism database	Incident data from 2014- 2019
Terrorism risk assessments reports	Online sources	2015-2019
Administrative boundaries	Humanitarian Data Exchange	February 2019
Road network	Humanitarian Data Exchange	February 2019
Boni forest reserve	ICPAC Geoportal	2017

3.2.2 Tools

The hardware used for this study were:

- Laptop computer

- Printer

The software used for this research project were:

- ArcGIS that will be used for spatial analysis and map generation

- Ms Word for the writing and compiling report

- Adobe Illustrator that helps in improving the layout and appearance of the maps and graphs.

3.3 GIS for Terrorism Assessment

The project was executed in three stages as shown in the figure 3.2.

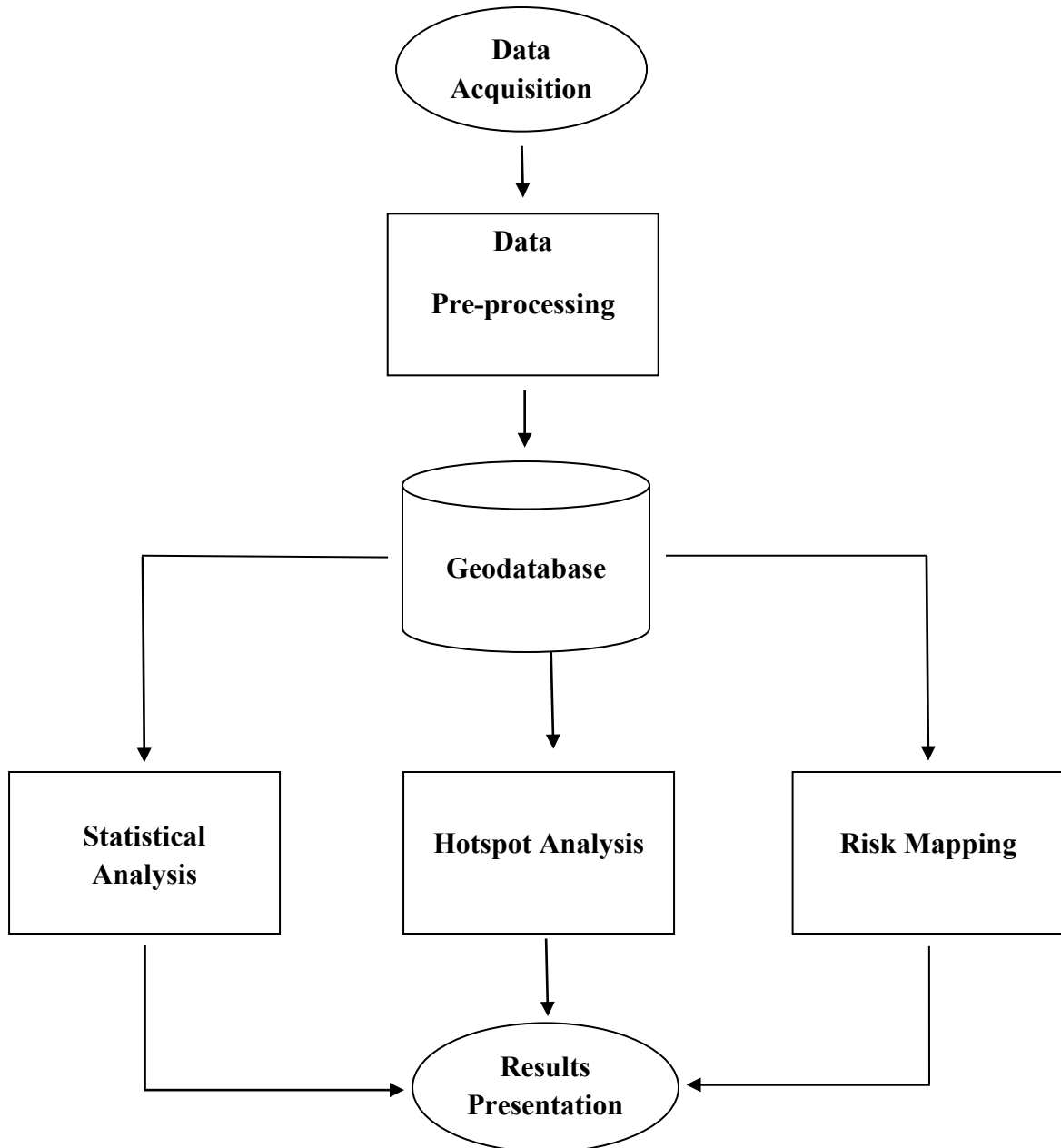


Figure 3.2 Methodology flowchart

The first stage was data pre-processing where the necessary data was acquired and stored in a geodatabase. Data cleaning, filtering and classification was done to ensure the data was ready for analysis stage. The second stage data analysis which was done in three phases i.e. statistical analysis, hotspot analysis and risk mapping. The final stage was the presentation of results in form of graphs and maps.

3.3.1 Data Acquisition

Terrorism incident data for the five-year period. Mention the epochs was downloaded from the online ACLED database. This was be corroborated with data from the global terrorism database and other online articles to ensure any data gaps from the main database was filled.

The road network data, settlement and administrative boundaries data will be downloaded from the humanitarian data exchange portal.

3.3.2 Data Pre-processing

Data filtering and cleaning

Since the data from ACLED contains all forms of conflict incidents, filtering of the data was done in order to extract Al Shabaab perpetrated attacks in Garissa county. The filtering of the data done in excel and the results were exported to the file containing terrorist incidents. This process was done to each file for the respective years; however, the selected data was stored in a single file. A total of 98 Al Shabaab related incidents were reported within the 5-year period between January 2014 to December 2019.

The road network and administrative boundaries datasets were downloaded from the humanitarian data exchange portal. Roads and settlement data were clipped to the area of study.

Data classification

The Al Shabaab perpetrated incidents were classified into seven classes which were IED (Improvised Explosive Device) attacks, grenade attacks, armed clash, attacks on installations/destruction, killings, abductions and ambushes. These classes were added on a new column in the terrorism incidents file.

After the classification of the data, a map showing the distribution of incidents across the county was produced.

Extraction of impact data

New columns of fatalities and injuries were extracted from the incident narrative column.

3.3.3 Statistical Data Analysis

Ms Excel was used to carry out statistical analysis on the terrorism incidents data in the period under study. This was done through querying the data using the filtering tool. The results of the queries were presented in form of graphs. The aim of carrying out the queries was to get the

number of different types of incidents, the number of fatalities as a result of different incidents and the targets or victims of the different types of incidents.

Temporal analysis was also done through querying with the objective of comparing the number of incidents by month for each year.

3.3.4 Hotspot analysis

Incident Hotspot

The “Incidents hot spot” tool was used to statistically identify spatial clusters of high values and low values. This tool calculates the Geis-Ord G_i^* statistic for each incident which compares identifies the statistically significant hotspot. The input point features in this case are the shapefiles containing all the incidents while incident boundary shapefile was the Garissa county boundary. The inputs for the tool are shown in figure 3.3.

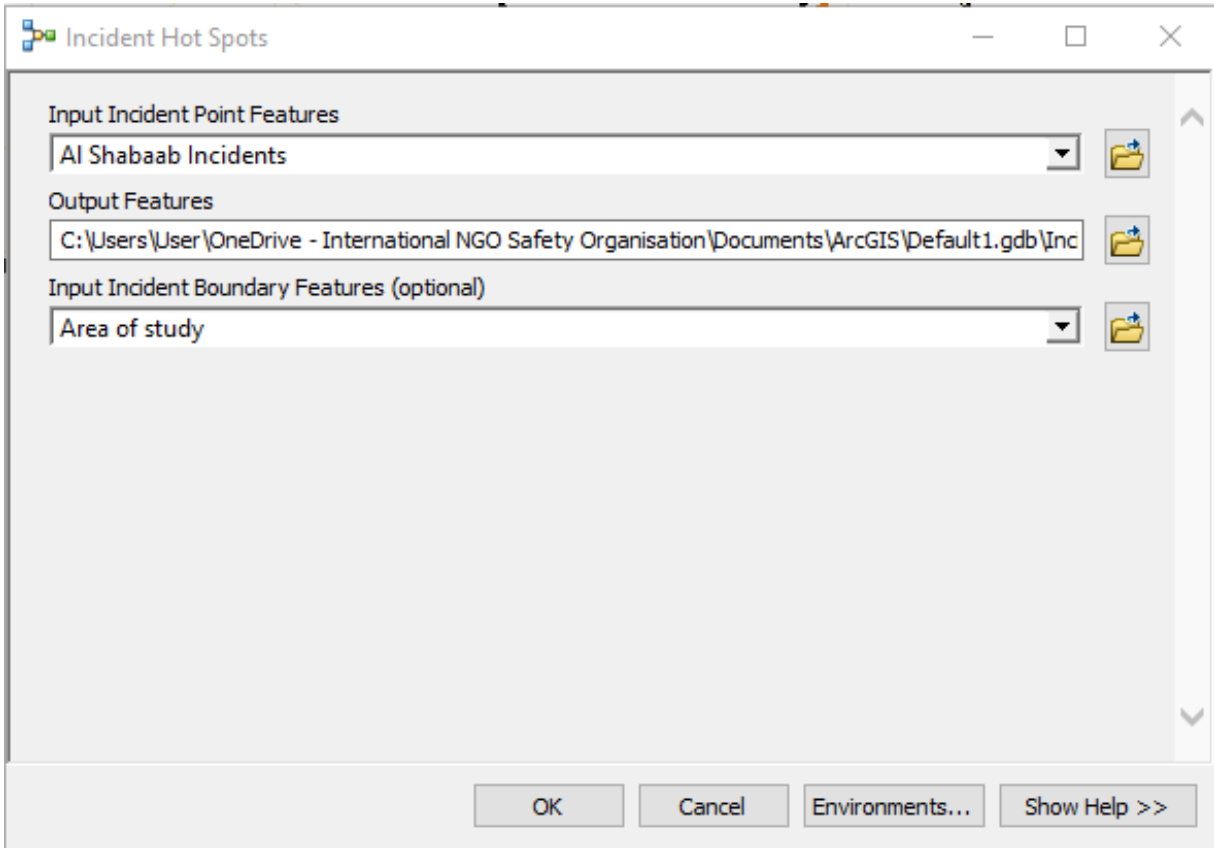


Figure 3.3 Incident hotspot tool

The output of this was a map showing statistically significant hotspots where more incidents occurred.

Road hotspot mapping

The other form of analysis done was to determine dangerous areas on the road based on the IED incidents recorded. The tool used in this case was “Count by Loc” tool under the incident analysis toolbox in ArcGIS. The input dataset required is point feature which was the IED incident shapefile while the linear data used were the motorable roads in the county. The area of interest used for this was the Garissa county shapefile defined boundaries of the area where analysis was done.

The search radius for analysis was set at 50 meters which defined the buffer distance from the road from which incidents considered for analysis should fall. The inputs were entered into the tool as shown in figure 3.4

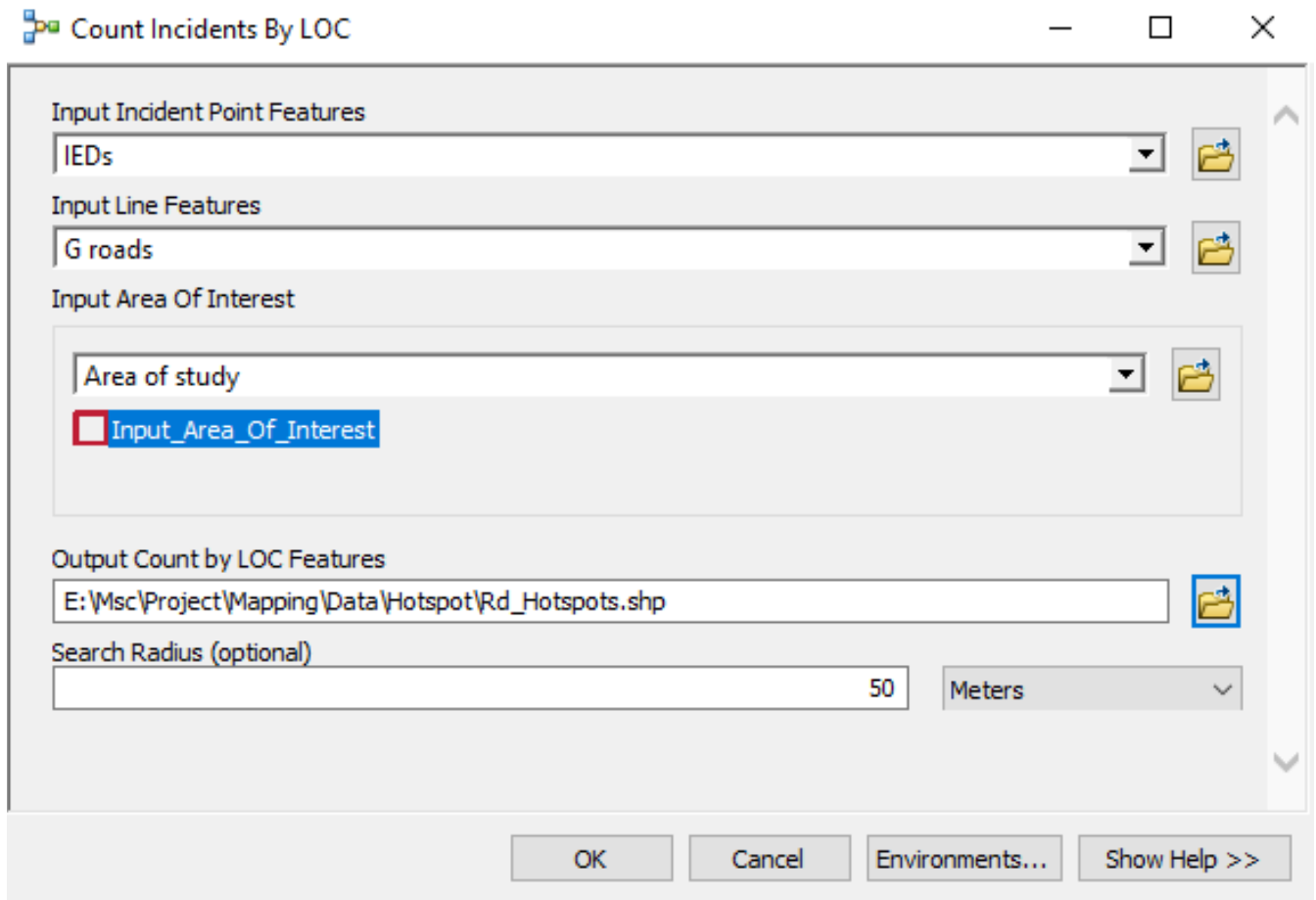


Figure 3.4 Count incidents by Loc tool

3.3.5 Terrorism Risk Mapping

Desktop Research

Desktop research was done in order to identify the factors that contribute to the risk of terrorism. The first step was to identify and compile all existing literature that has covered terrorism risk assessment.

The next stage was to identify the spatial related factors that contribute to increased risk of terrorism.

The final stage was to compile a report of a list of the factors to be considered during assessment of risk. The graphical representation of the model is shown in figure 3.5

Risk Modelling

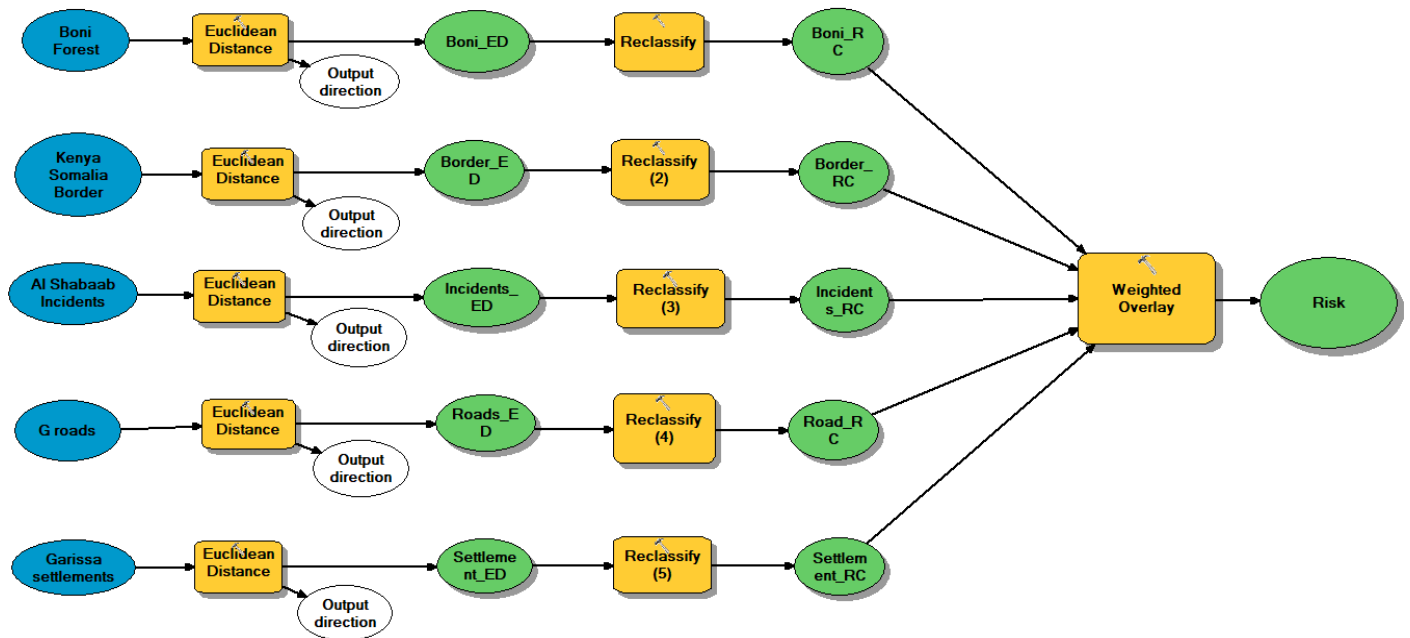


Figure 3.5 Risk assessment model

The ArcModel builder was used to construct a model that was used to carry out risk assessment. The different datasets representing the factors contributing to increased risk previously identified during the desk research were used as the inputs for the model.

Deriving datasets

The primary tool that was used in deriving proximity distance datasets was the Euclidean distance tool shown in figure 3.6. Distance increases from the reference point which is the location given by the input data. This was done for point, line and polygon vector input datasets

representing the different factors. For every input the same default cell size 0.011602478024 was used.

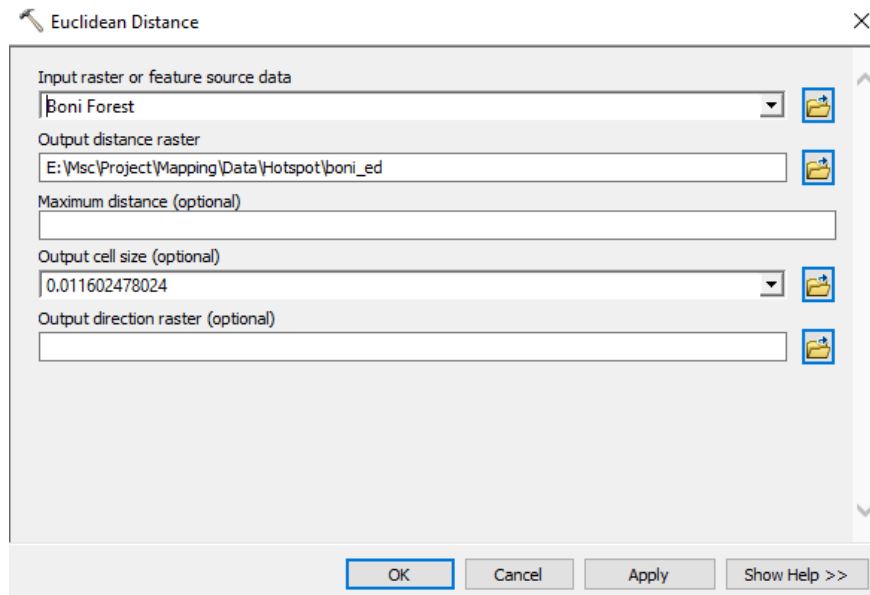


Figure 3.6 Euclidean distance tool

Reclassifying derived datasets

The reclassify tool from the reclass toolset was applied to reclassify each of the derived datasets to a common scale running from 1 to 9. The field used for the reclassification was “value” with the equal interval method being applied to generate 9 classes as shown in figure 3.7. The output rasters from these operations were then be combined to form different zones of risk for Garissa county.

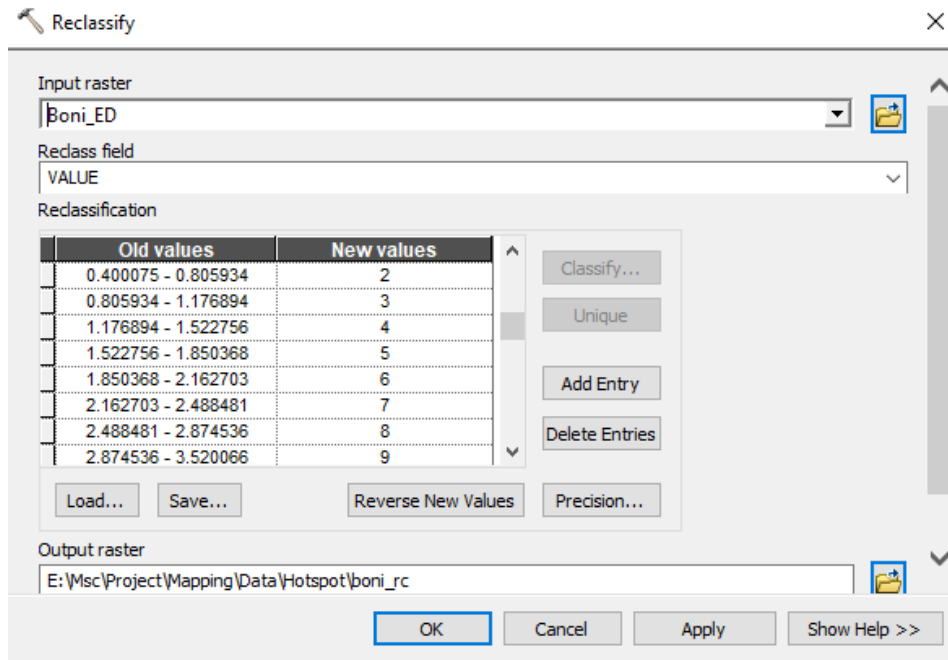


Figure 3.7 Reclassify tool

Weighting derived datasets

There was no reference literature that could be used in the assigning of weights. For this reason, the reclassified datasets were assigned an equal weight of 20% was assigned to each raster dataset that was overlaid.

Combining derived datasets

The reclassified datasets were integrated using the Weighted Overlay tool of the Overlay toolset. The value field was used for the weighting, with the risk values being assigned to the respective layers. The result was an output raster created contiguous zones of risk. Places that had equal risk of terror attacks were placed in the same zone. The input parameters are as shown in figure 3.8.

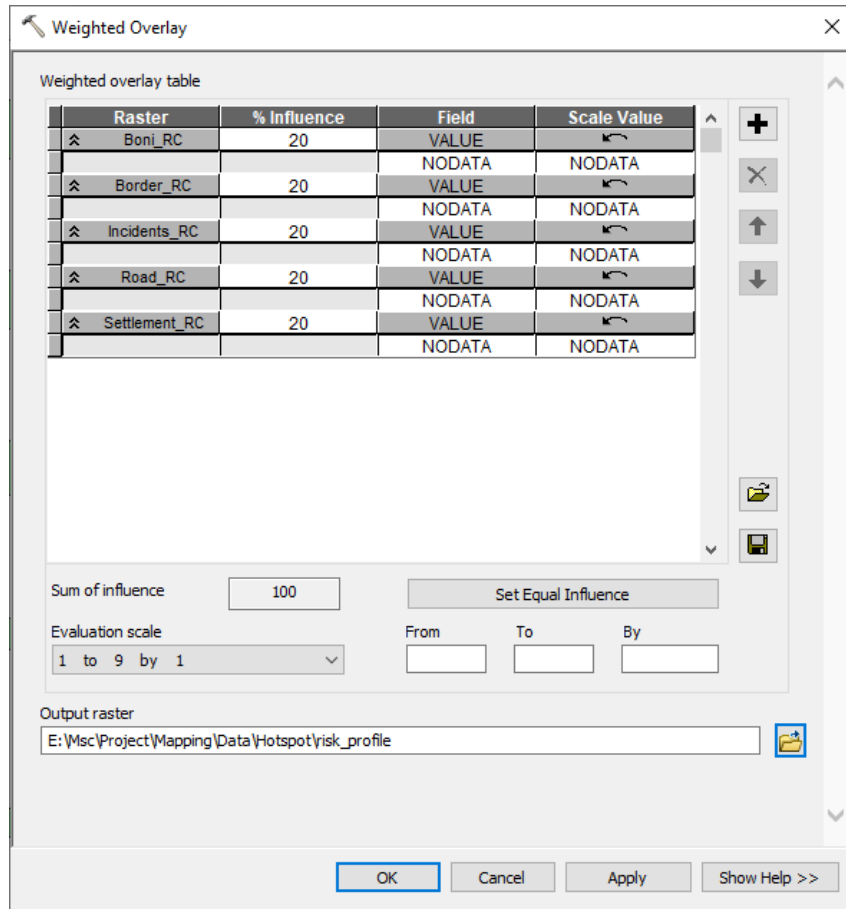


Figure 3.8 Weighted overlay tool

3.3.6 Results Validation

The previous five-year incidents were used to check on the accuracy of the final risk model. This was done by checking the number of incidents in each zone where it is expected the areas of higher risk to have a higher number of incidents while the areas of low risk to have few or no incidents.

CHAPTER 4: RESULTS AND DISCUSSIONS

This chapter presents the results of the research study. The factors contributing to increased risk that were identified are listed. Graphs are used to present the results of statistical analysis of the incidents. Different maps show where the incidents occurred, the dangerous areas and the different risk zones. Discussions of the results is the final section of this chapter.

4.1 Factors contributing to terrorism risk

After carrying out desktop research five factors were identified to contribute to increased risk of terrorism. These were location of previous incidents, targets represented by location of settlements and the motorable roads. The last two factors representing presence of Al Shabaab were the Kenya Somalia border and the Boni forest reserve. The spatial aspects of these factors were used to model for the risk of terrorism.

4.2 Incident Analysis Results

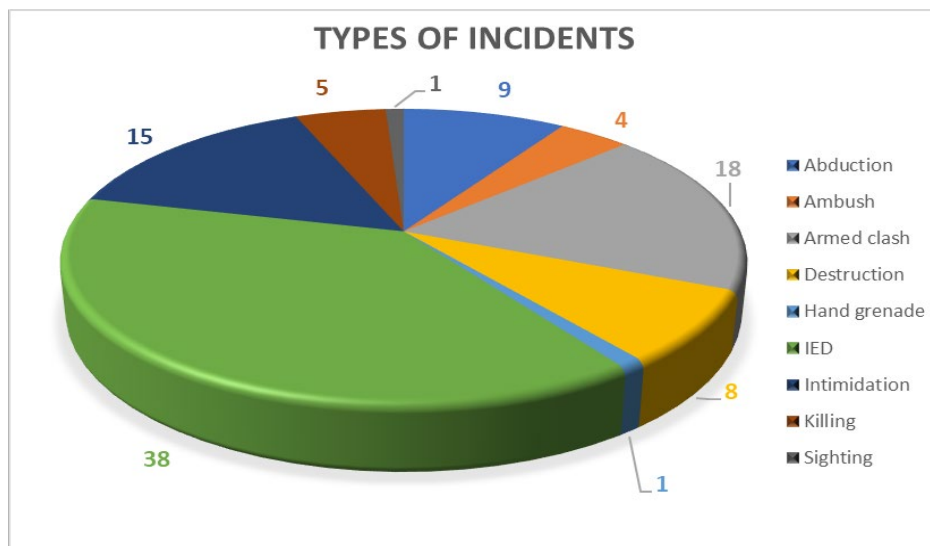


Figure 4.1 Types of incidents

Over the five-year period the total number of incidents recorded was 100. These incidents were classified into nine classes and the percentage of the total incidents in each class are illustrated in figure 4.1. IED, armed clash and intimidation were the types of incidents with over 10 incidents with each having 38, 18 and 15 incidents respectively. For type of incidents with less than 10 incidents each there was abduction with 9 followed by destruction of property with 8, killings with 5 and 4 ambushes. For hand grenade attack and sighting each had only one incident.

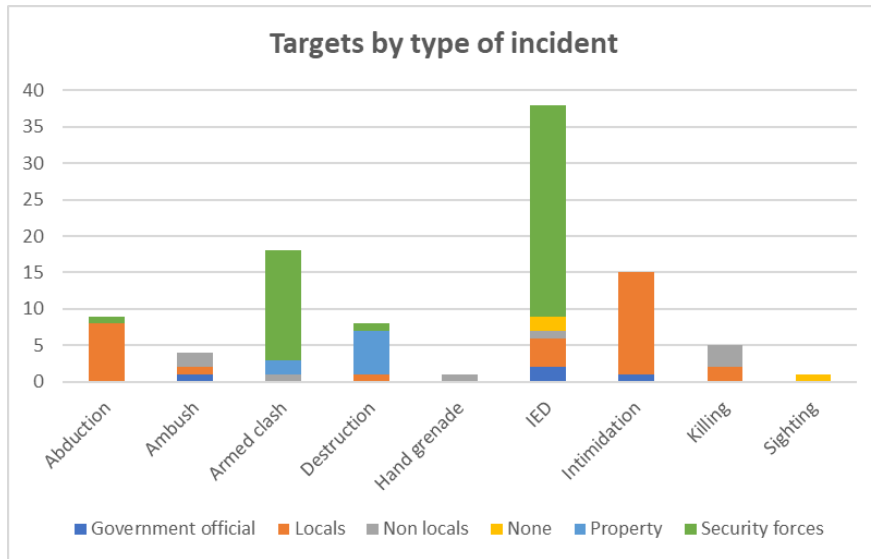


Figure 4.2 Targets by type of incidents

For every type of incidents there were victims who suffered from them except for sighting which was not violent in nature hence no target or victims of the incident. As shown in figure 4.2 the security forces were the victims of most of the incidents and were mainly targeted with IEDs and armed clash. The locals were either abducted or intimidated by the Al Shabaab when they invaded the villages rounding them up the villagers in the mosques. The non-locals who are not the natives of Garissa county or the north eastern part of Kenya were mainly victims of killings or ambushes and in a few incidents of IED and armed clash. Government officials were also victims of ambushes and IED mostly when in transit to carry out their duties. Other government officials were also threatened and intimidated in one of the incidents.

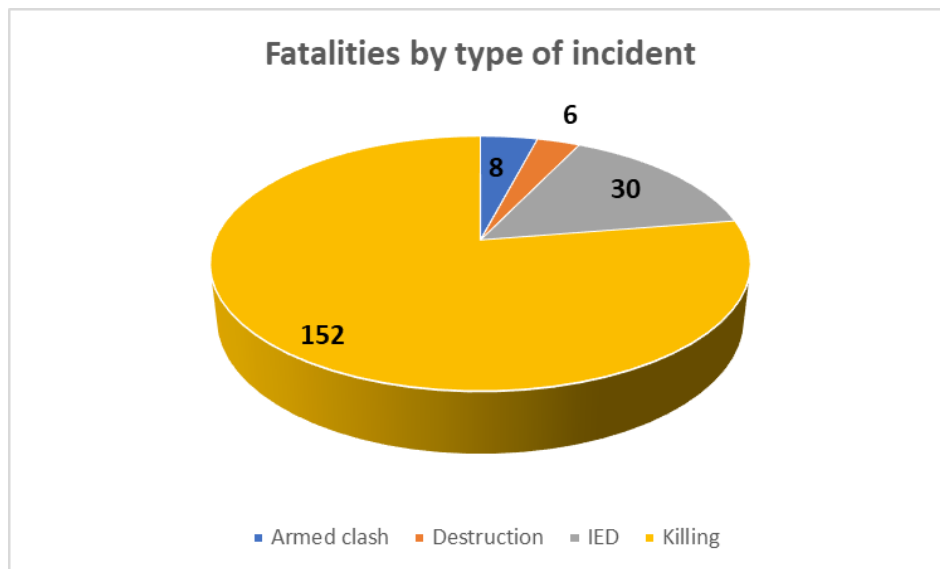


Figure 4.3 Fatalities by type of incident

A total of 196 lives were lost as a result of terrorism over the 5 years. The fatalities were broken down into the respective type of incident that resulted in fatalities and this was presented in figure 4.3. Only four types of incidents resulted in fatalities. Although 5 incidents of killing were recorded, they represented the highest number of fatalities with 152 fatalities. The incident with the highest number of fatalities was the attack on Garissa University attack that resulted in the death of 149 people. IED incident resulted in the death of 30 people. Destruction and armed clash incidents led to the death of 6 and 8 people respectively. For the other types of incidents, no fatalities were recorded.

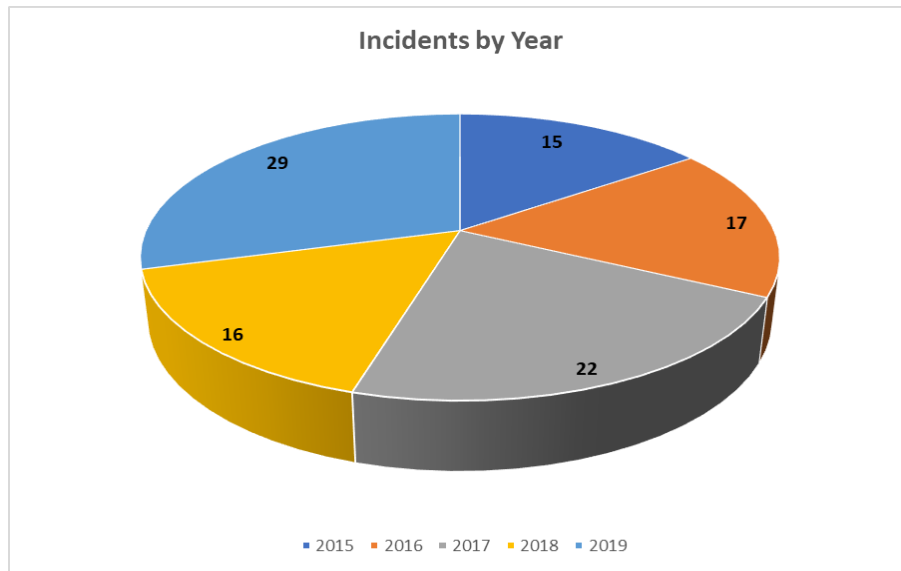


Figure 4.4 Incidents by year

The incidents recorded for every year during the five-year period of study are as shown in figure 4.4. The year 2019 had the highest number of incidents followed by 2017. The year that recorded the least number of incidents was 2015 with a total of 15. The average number of incidents per year was 19 incidents.

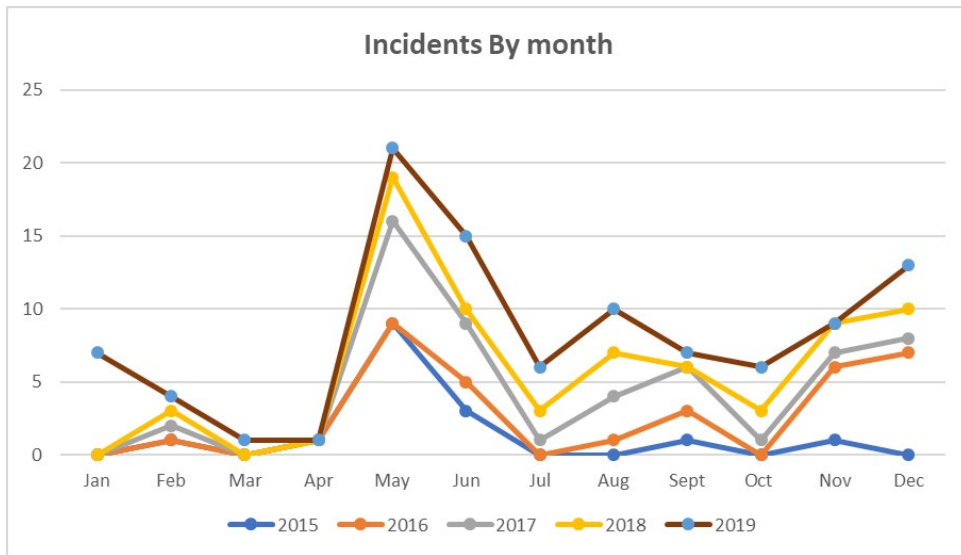


Figure 4.5 Incidents by month

The incidents over the 5 years varied between 29 and 15 incidents with the year 2019 having the highest number of incidents while 2015 the least number of incidents as shown in figure 4.4. On all the years the highest number of incidents was recorded in the month of May as shown in figure 4.5. The Ramadhan period is usually between the month of April – May or May -June. The terrorist groups believe that there is a great reward if the attack is carried out during the Holy month which could explain the reason for incidents peaking in the month of May.

From figure 4.5 whenever there was a surge of incidents in a specific month it was followed with a decline afterwards before another surge. This could be because the terrorist group retreat to restrategy before attacking again.

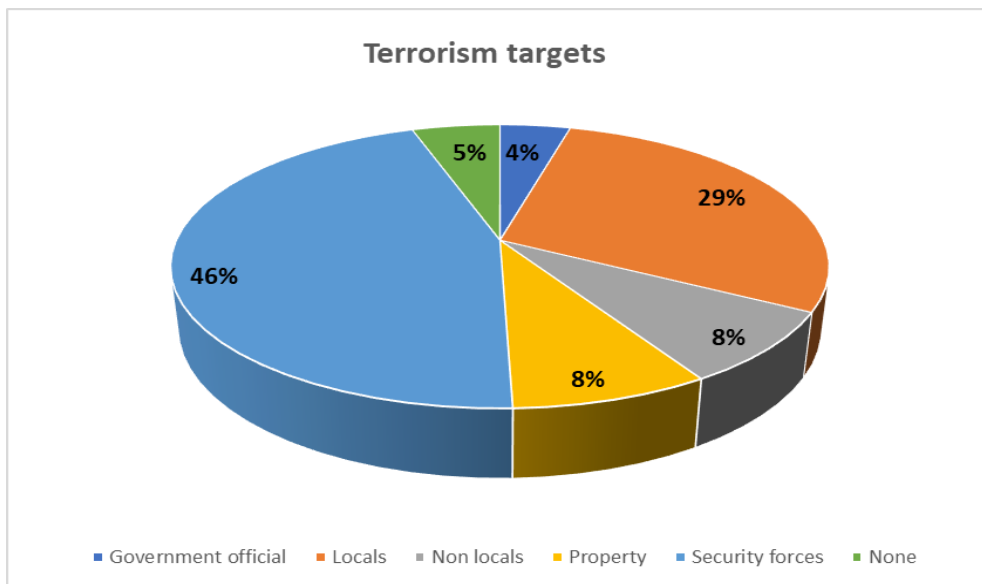


Figure 4.6 Terrorism incidents target graph

The victims of the terror attacks were categorized into 6 classes which constitute the target of the attacks. Figure 4.6 gives the percentages for the specific group of victims or targets of the terror incidents. Security forces represented by both the police and the army involved in maintaining law and order and implementing security operations in the county are the most targeted by terror attacks representing 46% of the incidents. 29% of all the incidents were targeted at locals who are the native residents of Garissa county. Non-locals composed of civil servants, students and construction workers made up were the target of 8% of the attacks. Similarly, 8% of the incidents were targeted at physical property mainly communication masts in the county. Government officials for example the local area chiefs were targeted by 4% of the attacks. 5% of the incidents didn't have specific victims as they were failed attacks or sighting of the incidents.

4.3 Terrorism incidents map

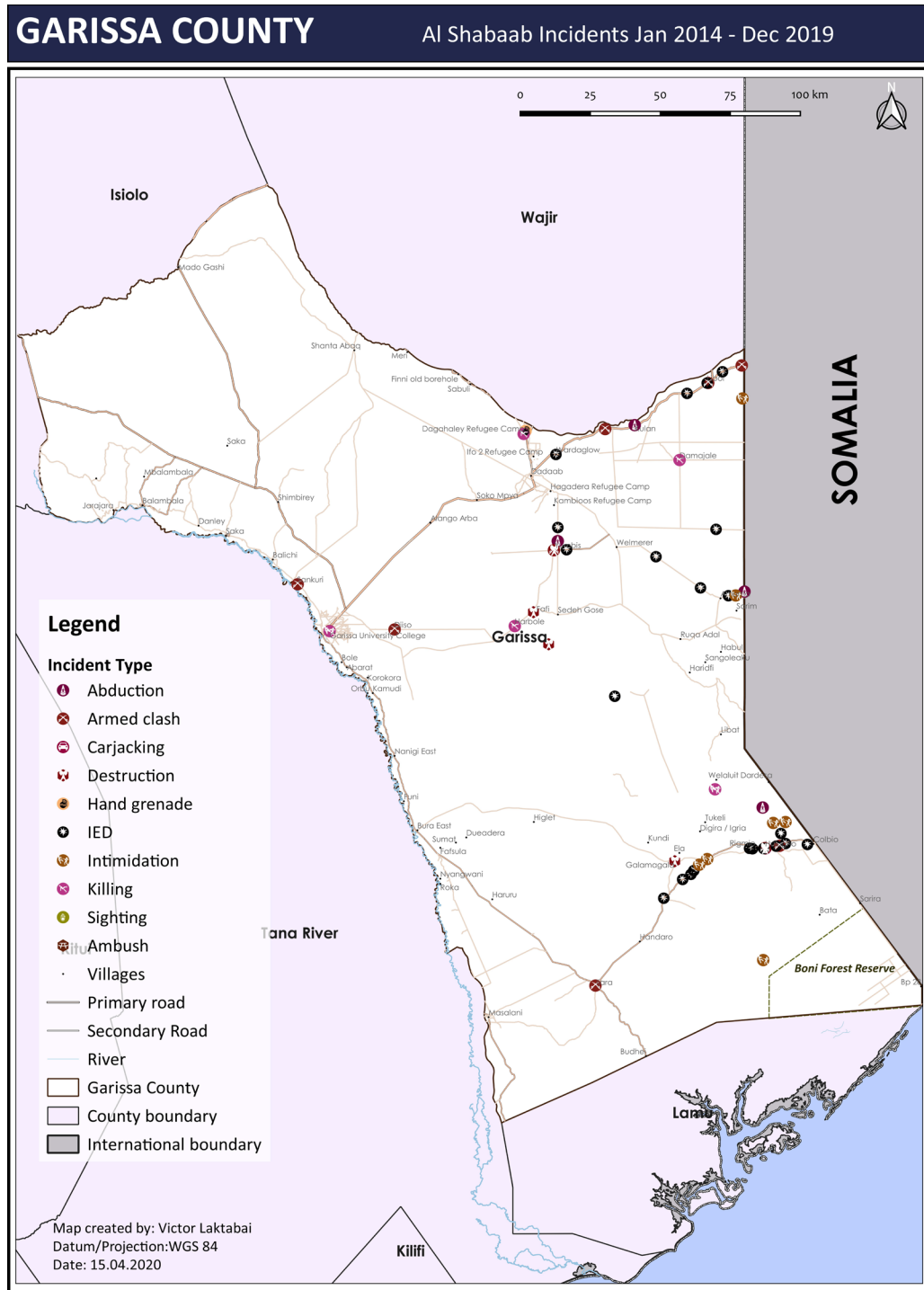


Figure 4.7 Terrorism incidents map

From figure 4.6 majority of the incidents happened on the eastern side of Garissa county close to Somalia border and near Boni forest. The attacks were carried out mainly in villages or along the main roads. Areas away from the villages and roads didn't have any incidents.

4.4 Incident hotspot map

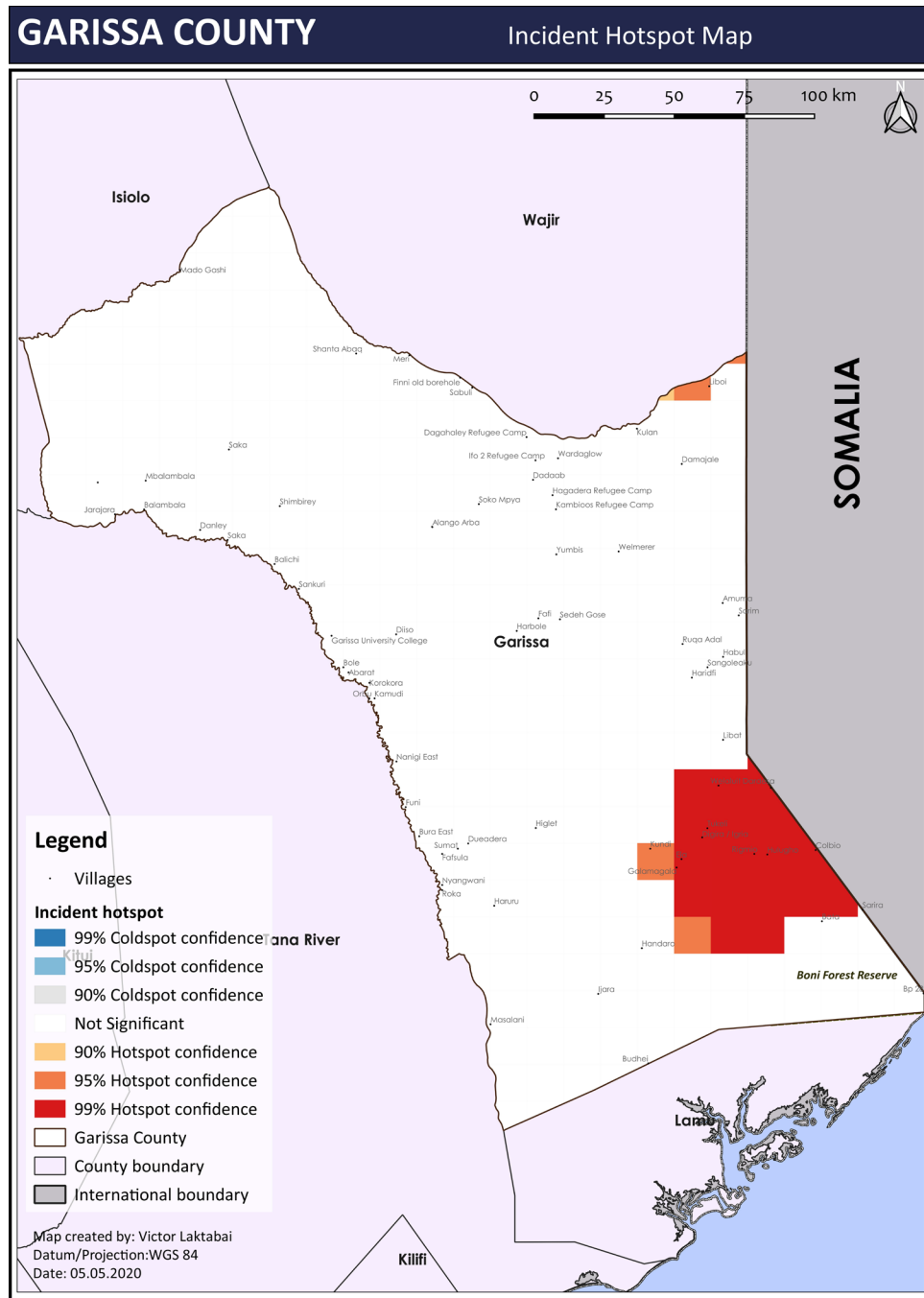


Figure 4.8 Incident hotspot map

The hotspot areas were identified by computing the Getis-Ord G_i^* statistic whose results are given by the hotspot confidence levels. The incident hotspot in Garissa county was identified to be the area around Hulugho in the south eastern part of the county and are shown in figure 4.8. The other area with high concentration of incidents was the area around Liboi near the Somalia border.

4.5 Road hotspot map

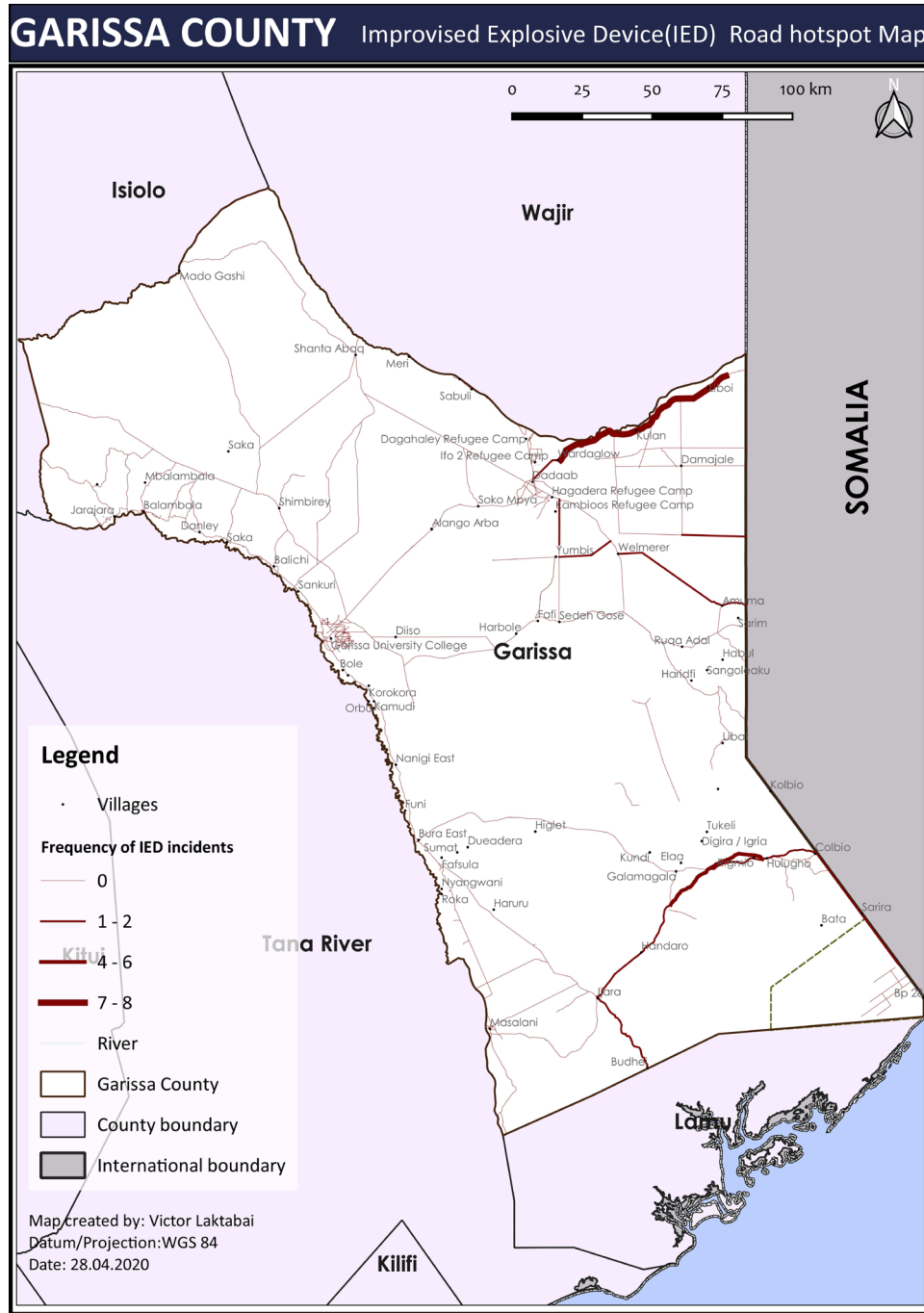


Figure 4.9 IED road hotspot map

The roads that were affected by IED within the county are shown in figure 4.9. These roads are Yumbis – Hagadera, Dadaab- Liboi, Welmermer – Amuma and Ijara – Colbio road. Ijara – Colbio road is one that had the most incidents of IED recorded on it. All these roads lead to the Somalia border.

4.6 Risk profile map

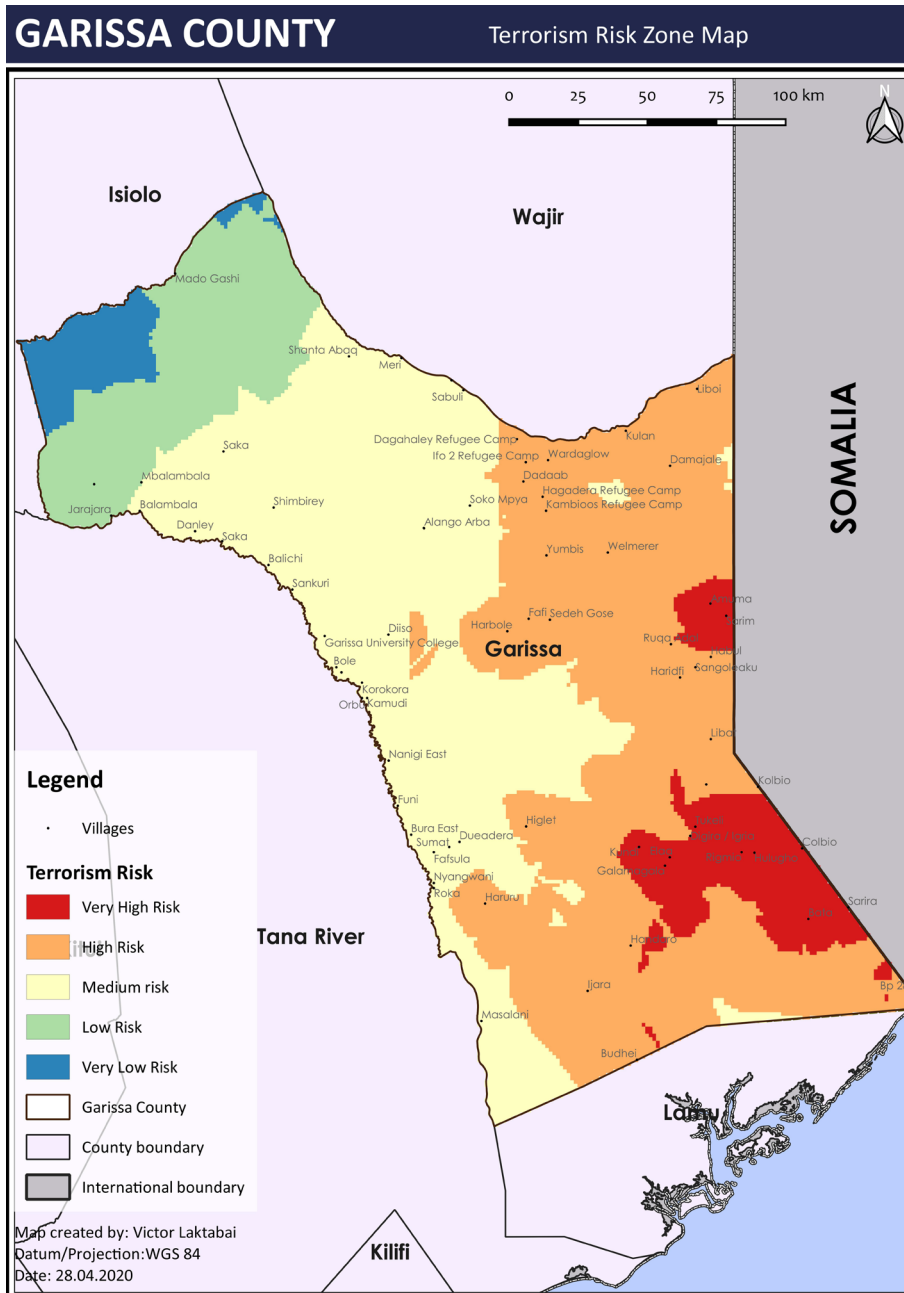


Figure 4.10 Risk profile map

Garissa County was profiled into 5 risk zones as shown in figure 4.9. The very high-risk zones were two areas the first around the Hulugho and the second very high risk zone was around Amuma. The borderland area adjacent to the Somalia border was either very high risk or high-risk area. Medium risk zone coincides with the central part of the county including Garissa town. The low and very low risk areas are on the western side of the county.

4.7 Validation of results

To check for the accuracy of the results of risk assessment, the number of incidents in each zone were calculated and are presented in the figure 4.11.

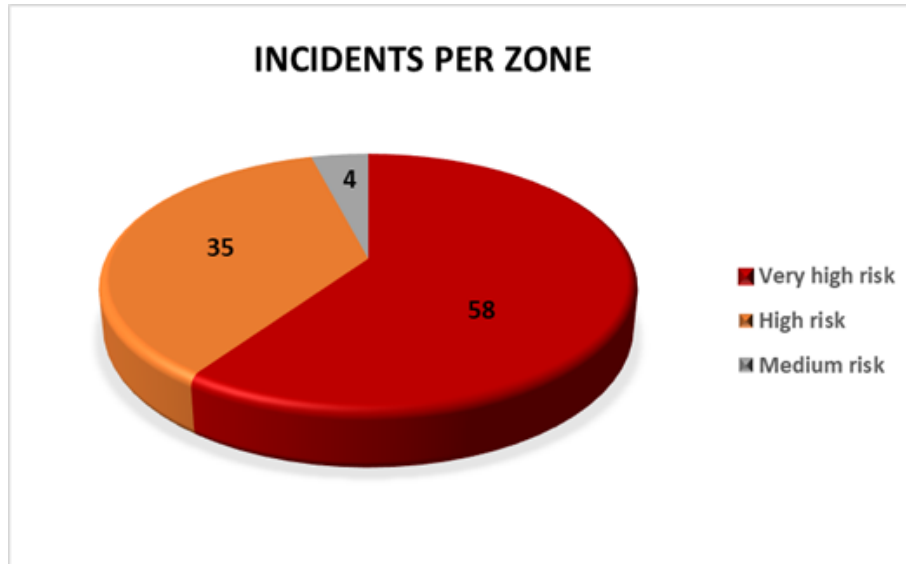


Figure 4.11 Number of incidents per risk zone

There were 58 incidents recorded in the very high-risk areas and 35 incidents in the high-risk areas. There were only 4 incidents in the middle risk of terrorism zones. However, there were no incidents recorded in the low and very low risk areas.

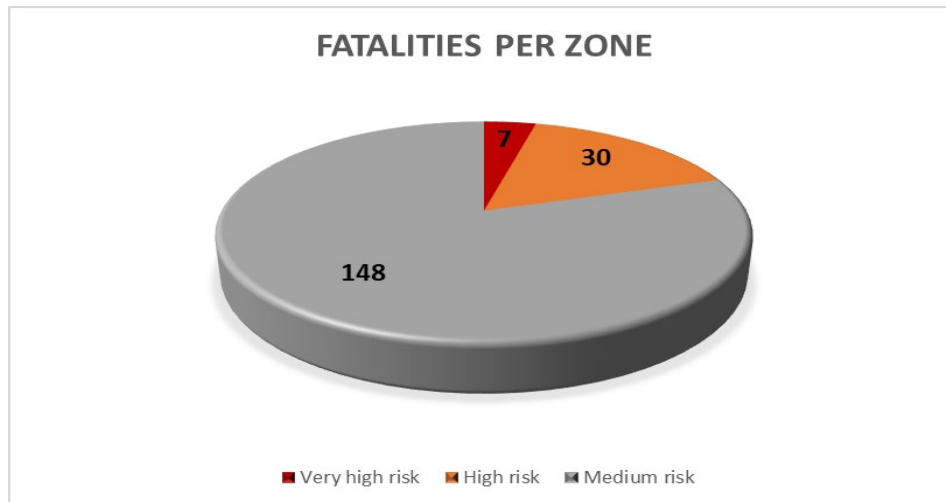


Figure 4.12 Number of fatalites per risk zone

The other method of validating results was to identify the number of fatalities for each zone. The highest number of fatalities were in the medium risk zone with 148 fatalities from one incident.

The high risk zone has 30 fatalities while the very high risk zone had 7 as shown in figure 4.12. There were no fatalities in the low and very low risk areas.

4.8 Discussions of the results

The map of incidents shows that the Al Shabaab mainly targeted the villages and roads close to the Somalia border. This is because it is easy for them to cross from Somalia execute their attacks before crossing back into their hide outs. The nature of population in Garissa is clustered in villages hence most of the attacks will happen in the villages.

The hotspot areas are close to the Somalia border and along the two main roads to Somalia near Liboi in the north eastern part and Hulugho in the south eastern part. These two areas are the most developed areas compared to other border settlements in terms of development. These makes them easy targets for the Al Shabaab.

The security forces are vulnerable when patrolling or moving in different roads hence making ambushes and improvised explosive devices the most preferred methods of attack by the Al Shabaab. This is because it's difficult to detect a buried improvised explosive device and it also causes most damage to property and results injuries and death. The roads in the areas identified as hotspots are also the roads with the highest frequency of improvised explosive devices attacks.

The risk model developed classified county of Garissa into five distinct zones of risk of terrorism based on the confluence of the five factors identified previously. The spatial aspect of the factors was of key interest in the model. The areas of very high and high-risk are those most prone to frequent terrorist attacks. The medium-risk areas are those with a relatively low frequency of attack while the low and very low risk areas where the possibility of a terrorist attack being carried out is the exception rather than the norm. This indicates that in areas where the different factors intersect, Al Shabaab finds it easy to carry out attacks.

The incidents were recorded only in the very high-risk, high-risk and medium-risk zones. There was no incident recorded in the low and very low-risk areas. This shows that the model was relatively accurate in profiling the county into the different zones of risk of terrorism.

The number of fatalities were highest in the medium risk zone and areas as one moved to the very high risk zone. This shows the incidents in the medium risk even though fewer were more fatal compared those in the very high risk zone. The terrorist groups always maximize the impact the incidents executed in areas of lower risk since they require intense planning and resources too.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study explored terrorism in Garissa county which has been one of the most affected counties in Kenya because of its proximity to Somalia and Boni forest which are the main hideouts of the Al Shabaab terror group. Spatial and statistical analysis techniques were applied to develop a methodology that in the end was used to build an evidence-based narrative of the nature of attacks and more importantly spatially profile the county into different zones based on the risk of terrorism.

Five factors with spatial aspects were identified to be contributing to increased terrorism risks. Based on their location and the relative proximity to each other the risk of terrorism increased.

The mapping of the terrorist incidents has shown that attacks are mainly carried out in villages and along motorable roads.

Hotspot analysis highlighted the roads headed to Somalia and the villages along the Somalia border were found to be the most prone to terrorist attacks. The type of incident with the highest frequency were IED incidents targeted at security forces in the main patrol routes.

The risk model developed incorporated different spatial analysis tools that the five factors was subjected to and in the end produced a risk profile map.

The terrorism risk profile map has illustrated that the areas of high risk of terrorism are the areas bordering Somalia and the risk reduces as you move further away.

5.2 Recommendations

As demonstrated in this study, terrorism has its spatial aspect where GIS analytical methods should be adopted as a means of giving more information required to make decisions in counter terrorism measures.

Hotspot analysis can be refined by having incidents included in determining the hotspots by having different weights assigned to the incidents. The weights could be determined according to the impact measured by either injuries or fatalities.

The security agencies should have explosive ordinance disposal teams scan the roads with high frequency of improvised explosive devices for before patrols are made.

The security agencies working on counter terrorism should focus on the areas of medium to very high-risk areas in order to effectively deal with the terrorists as this are their areas of operation.

5.3 Areas for further research

Further research could be conducted to identify other factors that contribute to increased risk of terrorism and have not been included in the model.

The model can be improved upon by researching on a scientific method of determining the allocation of weights. This will greatly improve the accuracy of the model and better risk map.

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