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College of social sciences

Department of Geography and Environmental Studies

Causes and Effects of Fire Accident; the Case of Addis Ababa City, Addis Ketema
Fire-Brigade Catchment Area

By

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October, 2019

Causes and Effects of Fire Accident: The Case of Addis Ababa City, Addis Ketema Fire-Brigade Catchment Area.

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October, 2019

I, the undersigned, hereby declare that the Thesis entitled, Causes and Effects of Fire Accident: The Case of Addis Ababa City, Addis Ketema Fire-Brigade Catchment Area, is my original work under the guidance of Dr. Muluneh Woldetsadik and the Thesis contain no material previously published by any other person except where proper citation and acknowledgement has been made. I do further confirm that this Thesis has not been presented or being submitted as part of the requirements of any other academic degree.

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List of Acronyms

AAFEPPRA: Addis Ababa Fire and Emergency Prevention and Rescue Agency

CSA: Ethiopian Central Statistical Authority

EEA: European Environment Agency

ERA: Ethiopian Roads Authority

ESRI: Environmental Systems Research Institute

FAO: Food and Agriculture Organization

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GIS: Geographic Information System

GPS: Global Positioning System

MoARD: Ministry of Agriculture and Rural Development

NGO: Non-Governmental Organization

RS: Remote Sensing

SDG: Sustainable Development Goals

UNEP: United Nations Environmental Programme

UNDP: United Nation Development Program

US: United State

USDA: United States Department of Agriculture

USGS: Untied State of Geological Survey

WWF: World Wide Fund for Nature

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Abstract

Fire accident is serious issues in Addis Ababa, and its impacts have enormous implications on safety, lives, and economy. This study assessed trends and causes, effects and hotspot areas identification of fire accidents in Addis Ababa. For this, primary information was collected from 40 study participants using questionnaires, interviews, and secondary data as well. The trend shows that since 2013/14_2018/19 damages caused because of fire accidents have increased. The main factors for increasing are carelessness, electrical fire factor, poor infrastructure, deforestation, and wild fire. The highest effect of fire accident was very high with injuries and death, psychological impact, socioeconomic impact and cultural impact. Thus, it is recommended that city Fire, and Emergency Prevention and Rescue Agency should put in place strict control and management of emergency response unit, especially in residential areas. This could be done by assigning more fire-bridged officer. Besides, stronger emergency and rescue control mechanisms through first aid skills training; training volunteer service officers on fire safety, providing training of trainers for responsible officer for records and documentation (proper, records, keeping, and documentation), and stronger technical inspection of fire hydrants should be strengthened. Apart from these, implementing fire safety education for children in schools, and in other occasions is vital. Lastly, Addis Ababa roads authority should build and expand proper emergency response roads to minimize the risks of fire accident.

Keywords: Households, Livelihoods, Fire, Accident, Fire Accident

Chapter One

Introduction

The purpose of this chapter is to provide an overview of the research that is present through the body of this work. This chapter provides the background to the study, problem statement and the objectives of the study.

1.1 Background of the study

Fire accident is one of the most common problems not only in developing countries, but also in the developed countries (Fire Protection Association, report 2015). Particularly in Ethiopia, a very large amount of property and lives are unfortunately lost through fire annually. For instance, Addis Ababa lost more than 26 million birr because of fire, and other accidents in the first quarter of the year 2016 and this came as a result of 94 accidents. This has increased a fourfold last year, (Addis Fortune News Paper, 2016). Although it is preventable, fire accidents are a leading cause of morbidity and mortality in the developing world, especially Ethiopia where the slum areas are highest and where it was considered a major barrier to economic development (World Bank economic report, 2018). The economic cost to the nation is great since fire outbreaks tend to exacerbate the poverty level in the country (World Bank economic report, 2018). Emergency response service, especially in the area of fire accident, is therefore, important to save the country from losing, scarce resources (EAA, 2015). Ethiopia is one of the least developed countries in the world with about 30% of its population living under the national poverty line (MoARD, 2010). Fire accidents are a major problem in Ethiopia. Every year it is the leading cause of loss of property and death of lives. It occurs in different season in most parts of Ethiopia with among various causes such as carelessness, kitchen fire (cylinder fire, stove fire, charcoal fire), electric contact fire, shock, candles fire, smoke of cigarette, technical error of electronics material, general negligence (human error), transformer explosion, electrical fire, different factors; including faulty appliances, worn or faulty electrical wiring, improper use of electrical outlets and worn out breaker boxes. Appliances and equipment, electrical issues (electrical equipment), faulty equipment, defective electrics such as loose wires, or faulty equipment that can overheat and cause sparks, overuse of appliances, home heating systems, and children playing with fire, faulty electrics; includes loose wires, plugs that are over

loaded and old equipment, flammable and combustible materials and arson, poor infrastructure, urbanization without proper design and master plan like poor road network and poor housing, or slum, high population density, deforestation and wild fire (AAFEPRRA five years report, 2018). The fire accident patterns and intensity vary greatly due to the large diversity in urbanization, settlement, and population movement within the areas in slum residence (Global Fire Initiative report, 2015). The fire problem varies from region to region because of variations in climate, socioeconomic status, education, demographics and other factors (Global Fire Initiative report, 2015). The fire accident happens through two possible mediums: natural and man-made. The way to solve the fire accident problem is to intervene through these mediums. One of the interventions mechanisms include identifying possible potential hotspot prone areas and origin causes. In establishing fire emergency response database, emergency preparedness planning is important issues that can affect the people live. If planned properly and implemented quickly, it can save thousands or millions of human lives and mitigate some economic losses in affected areas. However, if planned poorly or not implement in a timely manner, the consequence can be dire and could cost human lives (EAA, 2015). An identification of causes, effects and hotspot areas identification use GIS as a tool to map the distribution of fire accident at different spatial scale. Therefore, this study identifying causes effects and hotspot areas identification of fire accident areas. The final output makes it is possible to plan the control measures and response to be implemented by giving priority to high hotspot areas. This situation greatly increases the cost, time, and energy efficiency of the fire accident control and prevention of the study area (Global Fire Initiative report, 2015). The purpose of this study, thus, is to identify the overall trends, causes, and effects of fire accident in case of Addis Ababa city, Ethiopia.

1.2 Statement of the problem

The fire accident loses of life and injury is raising substantially, notably in low-middle income countries, where rates are twice those in high-income countries (WHO, 2013). This is partially attributable to the rapid rate of urbanization (Latif Fauzi, 2007) in many developing countries that have occurred without a parallel investment in fire safety strategies, and land use planning (Bekibele et al. 2007). The pattern of fire accidents varies markedly from region to region depending on settlement, climate and broad utility categories; the fire problem varies from region to region and state to state because of variations in climate, socioeconomic status,

education, demographics and other factors (USFD report, 2013). In Ethiopia fire accidents occur frequently. For example, in 2013/14-2018/19, several accidents were reported. Among this, the annual report of 2013/14-2018/19 is total 1,212 fire accident occurred and damaged 360,184,585.00 birr properties as well as 14 loss of life and 269 injuries (AAFEPRAs five years report, 2018). In study area the five-year report of fire, accident shows the largest magnitude of loss of life and injury, massive property destruction. The annual report of fire, and emergency prevention and rescue agency from 2013/14-2018/19 is total 211 fire accident occurred and massive property destruction and loss that is 159,958,845.00-birr as well as 4 loss of life and 81 injuries in Addis Ketema fire-brigade catchment area (AAFEPRAs, Nov/2018). Accordingly, there is a pressing need to identify fire accident causes, impacts and hotspot areas identification to enhance fire, and emergency prevention and rescue agency decision-making for control and prevention of fire accidents. Therefore, there is a need for optimizing fire accident resources by identifying areas of priority in the Addis Ababa city. This was aimed at providing a better, understanding of the patterns, and trends of fire accidents in the study area. It is also important to find out the contributing factors and impacts associated with fire accidents in the hotspot's areas. In Addis Ababa, fire accident data was collected through the accident report forms, which are completed by the Fire Emergency Rescue and Control Agency. Fire accident in Addis Ababa city varies depending on settlement, seasonal variation and broad utility categories. Large-scale fire accident occurs in Addis Ababa city where settlement is slum, unwise distribution of utility lines and dense population density (AAFEPRAs five years report, 2018). Identifying and describe fire accident causes, impacts and hotspot areas which provides the temporal and spatial pattern and distribution of fire accident could help to control and prevent fire accident. If it is effectively operational, it could assist fire, and emergency prevention and rescue agency decision makers in prioritizing scarce resources to areas most at risk. One approach to identify cause, effect and fire accident hotspot areas based on historical fire accidents cases and risk indicators. To design and implement cost-effective and appropriate interventions, distribution of fire accident, and It's influencing factors are however vital importance. Therefore, this study was initiated to assess causes, effects and occurrences of fire accident hotspot areas, its prompting factors and socioeconomic impacts in Addis Ketema fire-brigade catchment area. In the study area although fire accident is common identification of causes, effect and hotspot areas are not yet done and potentially prone areas are not delineated based on spatial and temporal data. This has created a

problem to target high-risk areas and has substantial increased costs of prevention. This study therefore, applied to identify to cause, effect and hotspot areas based on historical fire accidents which use for fire, and emergency prevention and rescue agency to allocate the resource for high risk area and reduce the loses of life and injury and massive property destruction.

1.3 Objectives of the study

1.3.1 General objective

The main objective of this study is to identify fire accident causes, effects and hotspot areas in temporal and spatial dimensions.

1.3.2 Specific objectives

The objectives of the study are to:

1. To identify the causes of fire accident in the study area.
2. To analyses, the socioeconomic effect of fire accident in the study area.
3. To examine the magnitude and patterns of fire accident in the study area.

1.4 Research questions

The main research questions:

1. What are the leading causes of fire accidents in study area?
2. What are the main socioeconomic effects of fire accidents in study area?
3. What looks fire accident occurrence distribution in study area?

1.5 Significance of the study

Identification of fire accident causes, effects and hotspot areas identification is useful to different stakeholders. The results of this study provide the fire emergency and rescue control agency, municipality of city administration, police and urban planners with the spatial distribution of fire accident and in particular, the location of fire accident causes, effects and hotspot areas in the Addis Ababa city Addis Ketema fire-brigade catchment area. This information can be used as the basis for improving fire safety by allocating resources in high priority areas (Anderson, 2009; Mitra, 2010; Chen et al. 2011). Thus, it will provide the fundamental scientific approach in identifying, managing and preventing fire accident causes, effects and hotspot areas.

Additionally, the research output will be used to support decision-making at the fire-brigade catchment area level for fire accident cause, effect and hotspot area identification hence data is great importance to urban planners and policy-makers. Such data are of value to resource managers that plan and assess fire accident patterns by giving tangible information about the fire accident risk in the fire-brigade catchment area in the last 5 years and enable to foresee the future of that fire-brigade catchment area if things will not be changed.

1.6 Scope of the study

The scope of this study is delimited to time limit, geographical area and issue of concern. Geographically, it is delimited to Addis Ketema fire-brigade branch catchment areas, which include 5-sub city and 31woredas. Among these, 10 woredas from Addis Ketema sub city, 2 woreda from Arada sub city, 4 woreda from Gulele sub city, 7 woreda from Kolfe Keranyo sub city, 8woreda from Lideta sub city which is selected based on largest magnitude, loss of life and injury, massive property destruction (AAFEPPRA five years report, 2018). The annual report of fire, and emergency prevention and rescue agency from 2013/14-2018/19 is total 211 fire accident occurred and massive property destruction and loss that is 159,958,845.00-birr properties as well as 4 loss of life and 81 injuries in Addis Ketema fire-brigade catchment area (AAFEPPRA five years report, 2018). Regarding the area of concern, the focus of the study is identifying the fire accident cause, impacts and hotspot areas identification for the Addis Ababa city, Addis Ketema fire-brigade catchment area. From time perspective, this study is restricted to identify the fire accident cause, impacts and hotspot areas identification of Addis Ababa city, Addis Ketema fire-brigade catchment area using spatial and temporal data from 2013/14-2018/19.

1.7 Limitation of the study

The research only focused on the causes, impacts, hotspot areas identification, and trend analyses of fire accidents in the Addis Ababa city, Addis Ketema fire-brigade catchment area for fire safety (2013/14-2018/19). The major limitations the study might is poor data management system and incomplete emergency fire accident case data in fire, and emergency prevention and rescue agency. These may lead difficult in the study area to make accurate, identify fire accident hotspot areas for the Study area.

Definition of keywords

This section presents definitions of selected keywords that are deemed to be used in the study frequently and which needed clarifications in view of this study.

Fire: a form of a chemical reaction that involves the rapid oxidation of combustible fuel (material) with the subsequent liberation of heat and light (Drake-Hillyard, 2010).

Accident: An unfortunate that happens unexpectedly and unintentionally, typically resulting in damage or injury (Dereje Tesema, 2014).

Fire accident: It is a mishap that could be either man-made or natural. It occurs frequently and can be controlled but may at times result in severe loss of life and property.

Household: the social group which resides in the same place, shares the same meals, and makes joint or coordinated decisions over resource allocation, and income pooling (Dereje Tesema, 2014).

Livelihoods: It is a means of making a living. It encompasses people's capabilities, assets, income and activities required to secure the necessities of life (Muhammad Mehedi Masud, 2015). A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living (Muhammad Mehedi Masud, 2015).

1.8 Organization of the thesis

This paper was organized with five chapters. The first chapter consists of the background of the study, statement of the problem, the objectives, research questions, significance, and scope of the study, limitations and organization of the study.

Chapter two deals with review of related to literature obtained from various published and unpublished reference materials.

Chapter three deal with background of the study area. This chapter includes study area description, methods and methodology of the study area in detail.

Chapter four contains the analysis, results and discussion parts of the study in study area.

Chapter five, this paper, presents a summary of major findings and conclusions in this study, together with recommendations, which can be implemented to reduce the fire accident in study area.

Chapter Two

Review of Related Literature

This section of the thesis reviews literature that are highly important and having a great relation to the focus of the study. Various literatures were reviewed in relation with the research objectives to form the conceptual framework of the study. Moreover, the causes, effects and hotspot areas of fire accidents from different literature analyzed and considering the country's situations in relation to other African countries was presented.

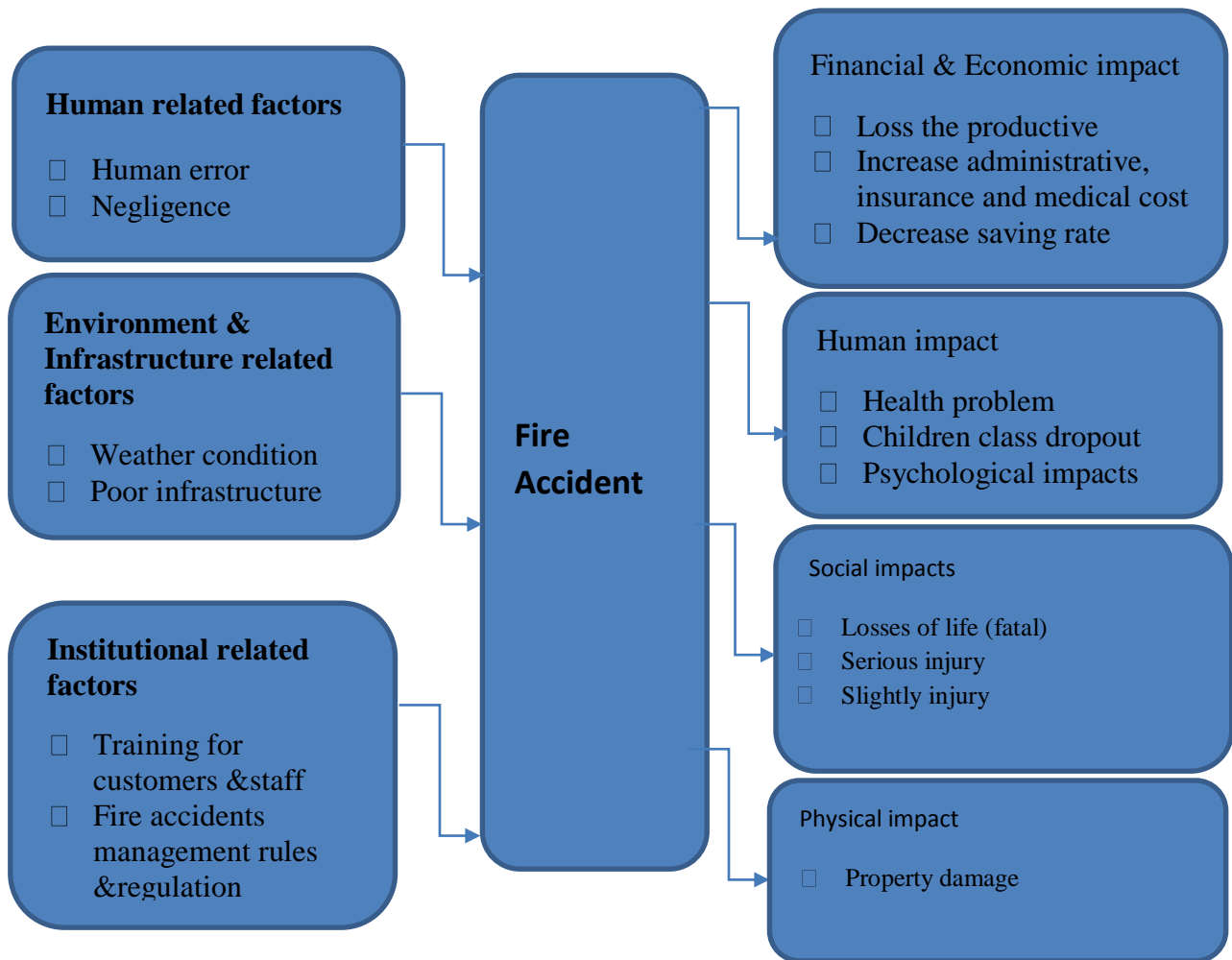
2.1 Concept of fire accident

Fire accidents are a result of complex processes. To enhance the level of fire safety, it is essential to gain a clear insight into the underlying factors (Hermans et al. 2008). To shed light on this phenomenon, relevant literature focusing on fire accidents, including the theoretical frameworks explaining the probable reasons behind the occurrence of fire accident and the cause, effect and identify hotspot area locations were reviewed. Fire is a form of a chemical reaction that involves the rapid oxidation of combustible fuel (material) with the subsequent liberation of heat and light (Drake-Hillyard, 2010). Accident is defined as anything that happens by chance, anything occurring unexpectedly and undersigned (Frachiah Wanjiruwambugu, 2016). Recent fire accident profiles indicate many incidents of fires, which have occasioned great loss of resources and human suffering. It is envisaged that in the future, fire accident may increase regarding frequency, complexity, scope and destructive capacity. Fire disasters may arise from natural causes, negligence, civil disorder, accidents and enemy action (Frachiah Wanjiruwambugu, 2016). Among different types of disasters, fire constitutes a significant threat to life and property in urban and rural areas (Erastus Gatebe, 2016). Globally, fire causes considerable losses that can be alleviated by taking appropriate precautions facilitated by sophisticated systems supported by information technologies (Özkan.U.et al, 2015). To eliminate or reduce the destructive effects of fires, fire risk management is a vital element for those who make the decisions local governments and municipalities concerning fire (FAO, 2015). For this purpose, geographical information systems (GIS) through effective spatial data storage and query can produce the dynamic fire maps (Davis, 2013).

2.2 Conceptual review literature

Based on the identification of applicable variables and conceptual underpinning for this study has been done. Accordingly, a conceptual framework is developed to guide the overall study basing on proper conceptual underpinnings. The conceptual framework for the study is thus shown in the figure below.

Figure 2.1 Conceptual Framework Fire Accidents



Source: Own construction, (2019)

2.3 Magnitude and Trends of Fire Accident

2.3.1 Fire accident at global level

Generally, globally only around 4% of all fires' accident has natural causes such as lightning. In all other cases, humans are responsible for the fire's accident be it directly or indirectly, deliberately or due to carelessness. Often, forests are not able to regenerate from the effects of a fire on their own (Pyne SJ. 2016). Frequently, the burned areas and with it the entire ecosystem with the plants, and animals living within it, are irretrievably lost (FAO, 2015). According to (WWF, 2001) the effects of fires accident on global species diversity are severe; 84% of the surface of all Eco regions that are critical for conserving global species diversity is threatened by changing fire intensities and frequencies (WWF, 2001). The present study summarizes causes and effects of fires accident according to regions and identifies the most relevant "hotspots areas" of the study area (FAO, 2015). Prevent fires- fire prevention should receive the highest priority to reduce firing a risk, and resulting damage. First, the determination of root causes, and an evaluation of immediate and follow-up costs of fires are necessary for each region and require an appropriate statistical data basis. Only on this basis is it possible to develop regionally adapted and cause-specific, effective and efficient strategies for fire accident management. Many countries lack this prerequisite. At the same time, public awareness of fire risk, and appropriate behavior should be strengthened by sensitization and education activities to prevent fires provoked by carelessness (FAO, 2015). Fire, caused by either humans or nature, can pose a hazard to people, properties, and the environment, possibly resulting in psychological damage, physical injuries, death and significant economic losses. For example, there were about 212,500 fires during 2013–2014 in the UK, involving 322 deaths and more than 9700 non-fatal casualties (National Fire Protection Association, 2003). According to the National Fire Protection Association of the US, there were 3240 deaths, 15,925 injuries (Michael J., 2013) and \$11.5 billion economic costs of property damage caused by about 1.24 million (Michael J., 2013) fires accidents in 2013. Urban fire accident is both a physical and a social process (National Fire Protection Association, 2003) in the sense that it occurs within the built environment and affects people and socioeconomic activities in the surrounding neighborhood or communities, usually involving both casualties and economic losses (Fire Department of Ministry of Public Security China, 2013). For instance, in 2015, the massive explosion in Tianjin, China, left more than 170 dead, 700 people injured, thousands homeless, 7 communities involving more than 10,000

households destroyed (Xiaoxiang.Z.et al,2017) and \$1.044 billion direct economic losses, along high levels of environment pollution caused by dangerous chemicals (Fire Department of Ministry of Public Security China, 2013). Given the continuing global trend of urbanization, urban fire safety has been a worldwide concern and presents great challenges to the success of sustainable urban development (Fire Department of Ministry of Public Security China, 2013). Fire and rescue services are therefore, critical to the protection of lives and properties (Corcoran, J., 2007). To improve the efficiency and effectiveness of fire safety management, it is essential to understand well the dynamics of fire incidents, which can offer insights into potential determinants of fire events, enabling better fire risk estimation that can help with future allocation of prevention resources and strategic planning of mitigation programs (Xiaoxiang.Z.et al, 2017). As fires accident occur in geographic space, geographical information system (GIS) based spatial analysis is well suited for the needs of fire and rescue services, which has been widely applied in urban fire analysis due to the increasing in availability of high-resolution data in recent years (Corcoran, J.,2007). For example, spatial distribution of fire events can visualize by desktop mapping in a straightforward way (Corcoran, J., 2007). Also, spatial temporal patterns of fire events can be explored by a range of spatial analytical techniques (Corcoran, J., 2007). For instance, continuous surfaces generated by kernel density estimation (KDE) can show the spatial variations in fire risks (Xiaoxiang.Z.et al, 2017). Further, of more interest is often the relationship between the occurrence urban fires, and the associated driving factors(Xiaoxiang.Z.et al, 2017).For example, it was found that socioeconomic variables such as population density, building conditions and household level generally have more influence on urban fires compared to the physical environment (Xiaoxiang.Z.et al, 2017).Charles.R.J examined the impact of calendar events (e.g., public and school holidays and major sports events) and found that fire incidents would significantly increase during school holidays(Charles.R.J.2013). Fire accident is a serious problem in developing and developed world (UNDP/2013). Fire can have critical consequences for human society due to the damage it causes to buildings and infrastructure (UNDP/2013). In addition, many people lose their lives or become seriously injured because of fires. According to World Health Organization (WHO) statistics, fire-induced burns cause more than 300,000 deaths annually and more than 95 percent of these deaths occur in low and middle-income countries (WHO, 2015). Building fires are a major threat to the safety of building occupants and are mostly caused by people's behavior. In

large residential complexes with many residents, in particular, fires can lead to increase injury or death due to emergency evacuation difficulties (Mohammadreza.S.et al., 2018). This issue has confirmed in various studies. Therefore, the proper and safe design of buildings to protect human life from event of fire is important. Studies show that large fires have occurred in buildings with now or substandard fire alarm systems (WHO, 2015). Surveys conducted also show that at least 75% of fires are preventable (WHO, 2015). Australia experiences the highest fire accident in 2000-2015 report of (Australia Fire Authorities Council, 2015). Fire service organizations in Australia attended an average of 109, 874 incidents each year from 2003-2013. As assessed by firefighters, there was an annual average of \$781.7 million property loss (Australia Fire Authorities Council, 2015). Each year, there was an average of 3,325 fire injury hospital admissions as well as 107 fires related deaths (Australian Bureau of Statistics, 2014). Fires were responsible for 11,600 deaths and 123,000 injuries in the United States during 1974. While serious burns often occur at fires, previous investigations have indicated that inhalation of toxic gases and particulates resulting from burning materials a more frequent cause of death and injury than the burns themselves. This information has usually been gathered by analysis of hospital record or autopsy data on burn victims. To further identify and document the extent and exact nature of the medical consequences of accidental exposure to fires, and to describe the demographic characteristics of the fire victims (Am. J. Public Health, 1977), we have traced the medical course of all persons initially identified by the Baltimore (Maryland) Fire Department as having been injured in fires during a 14 month period (Am. J. Public Health, 1977). In London, 78% of deaths from unintentional fires are relates fires in residential areas (UK fire report, 2013). Fire-related injuries are one of the major causes of death and disability (Mohammadreza Shokouhi, 2018). In recent decades, even in high-income countries, despite the reduction in mortality rates, fire-caused deaths still regarded as a major concern (UK fire report, 2013). Between 2007 and 2010, about 39 % of fires in China occurred in residential areas (China fire report, 2013). Thus, considering the high possibility of death and injury and the financial losses incurred because of fires in residential buildings, more attention should have paid to this issue (China fire report, 2013). Fire accident is a hidden problem in India. It goes largely unseen and under-reported despite the devastation it causes. Officially, police statistics report there were 17,700 deaths by accidental fire in 2015 (China fire report, 2013). These makes fire second only to traffic accidents as the main cause of death by ‘unnatural causes’, and ten times all deaths

caused by natural disasters (NCRB, 2016). According to official statistics, there were 318 deaths and 1,767 people injured by fire in 2017-2018 (UN Habitat, 2016).

2.3.2 African perspective level

South Africa is the world's most unequal country. In 2011, about 1.66 million households resided in informal residential areas from a total population of 51.8 million more recent estimates (Potts, 2012) suggest that somewhere between 18% and 33% of the population to live in, 'backyard dwellings' informal structures erected on formal housing sites (Potts, 2012). The Fire Protection Association of South Africa (FPASA) compiles data on fire from brigades across the country but this is not without its challenges, including incompletely documented or unreported fires (Potts, 2012). Consequently, their data typically underestimates incidence data. In 2016, FPASA recorded 41,873 fire callouts nationally, which translates to about 115 fires per day. Between 2003-2016, the number of fires increased between 1.5-1.7% per annum with the number of fatalities rising between 5-10% per annum (Potts, 2012). The latter refers fatalities recorded by fire services at the site of the fire. Injuries that result to later fatalities are not included in these statistics (Chinamatira, L.,2016). Notably, mortuary data from 2011, demonstrates that 2,243 people died from 'exposure to smoke, fire and flames a total of 8.0% of all accidental injuries (Chinamatira, L.,2016). This figure is 447% higher than the FPASA statistics, highlighting the large number of deaths unrecorded by the fire services(Chinamatira, L., 2016).Fire risk is extremely high within informal settlements(Chinamatira, L., 2016).As many as 10,000 people left homeless in a single fire event (Pluke, 2017). Zimbabwe is among the most fire prone countries in Africa south of the Sahara (Chinamatira, L., Mtetwa, S. & Nyamadzawo.G, 2016). Annually over 1 million hectares of land destroyed by wild land fires during the fire season which runs from July to November (Chinamatira, L., Mtetwa, S. & Nyamadzawo.G, 2016). There are several causes of wild land fires (Chinamatira, L., 2016). Causes of fires include people who ignite fires to clear land for cultivation, smoking out beehives, making charcoal, cooking or trying to keep warm, arson (Chinamatira, L., Mtetwa, S. & Nyamadzawo. G, 2016) and as a way of settling disputes (Chinamatira, L., Mtetwa, S. & Nyamadzawo. G, 2016). Chinamatira argued that recent increase in fire incidences has attributed to newly resettle smallholder farmers (Chinamatira, L.,Mtetwa, S. & Nyamadzawo. G, 2016). In Zimbabwe in 2012, alone, more than 1 million hectares of land destroyed by wild land fires, including property worth more than \$200,000. In 2010, five deaths occurred due to wild-land

fires, while in 2011, twenty-five deaths attributed to wild land fires(Luckson.C.et al. 2016). Fire outbreaks have resulted in a controlled loss of agricultural produce, reduced food availability for both humans and animals, reduced growth rate of vegetation, and loss of equipment (Luckson.C. et al. 2016). Acute impacts such as trauma, loss of shelter and property like the destruction of a home or damage to personal goods, can be a source of grief, stress and people whose lives and property threatened by wild land fires may experience a feeling of helplessness (Luckson.C. et al. 2016). According to Luckson.C.et al. (2016), in most African cultures, poor homeless people often stigmatized, and the loss of livelihoods sources may result complete disintegration of the family unit (Luckson.C.et al. 2016). The result is the resource-poor small-holder farmers ushered deeper into a poverty cycle.

2.3.3 Fire accident in Ethiopian

In Ethiopia, fire accidents occur frequently (NDRMC, 2016). Fire accident, caused by either humans or nature, can pose a hazard to people, properties, and the environment, possibly resulting in psychological damage, physical injuries, death and significant economic losses. For example, there were about 9,755 fires during 2000-2016 in the Ethiopia, involving 853 deaths and more than 5,421 non-fatal casualties (NDRMC, 2016). According to the NDRMC of the Ethiopia, there were 853 deaths, 4523 injuries and above 615 million birr economic costs of property damage caused by about 9,755 fires in 2000-2016 (NDRMC, 2016). Urban fire is both a physical and a social process, in the sense that it occurs within the built environment and affects people and socioeconomic activities in the surrounding neighborhood or communities, usually involving both casualties and economic losses (NDRMC, 2016).

2.3.4 Fire accident in Addis Ababa

In Addis Ababa city administration fire accidents occur frequently. For example, in 2013/14-2018/19, several accidents reported. Among this, the annual report of 2013/14-2018/19 is total 1,212 fire accident occurred and damaged 360,184,585.00-birr properties as well as 14 loss of life and 269 injuries (AAFEPPRA five years report, 2018). In study area, the five-year report of fire accident shows the largest size of loss of life and injury, massive property destruction. The annual report of fire , and emergency prevention and rescue agency from 2013/14-2018/19 is total 211 fire accident occurred and massive property destruction and loss that is 159,958,845.00-

birr as well as 4 loss of life and 81 injuries in Addis Ketema fire-brigade catchment area (AAFEPPRA, Nov/2018).

Table 2.1: Trends of fire accident in Addis Ababa

No.	Year/G.C	Total fire accident	Loss of life and injury	Destruction of property (Birr)
1	2013-14	-	-	-
2	2014-15	61	41	68,090,305
3	2015-16	41	11	22,434,200
4	2016-17	47	8	4,731,800
5	2017-18	45	17	62,340,540
6	2018-19	14	5	2,362,000
	Total	211	86	159,958,845

Source: five-year fire accident report (AAFEPPRA, Nov/2018)

2.4 Cause and impacts of fire accident

2.4.1 Cause fire accident

Fire accident is one of the most destructive man-made disasters of all times. Typical causes of fire accident in urban areas include usage of wood fuel and charcoal and electricity, poverty, ignorance, waste burning, poor city infrastructure for firefighting and accessibility and inefficiencies in prevention fire accident (Gernay et al. 2016). Frequent fire accident is often common in slums with poor infrastructure (Navitas, 2014) and is one of the major concerns for urban planners. Congestion and high density of buildings, and the people increase the potential for fire risk occurrences, heightening the fire risks and rescue efforts (Navitas, 2014).

In Ethiopia, fire accidents are occurring often and one of the primary reasons of these accidents are an unconsciousness of people (AAFEPPRA, Nov/2018). It is clear that people should have

concerned about the causes and damages of fire and be ready to face this catastrophic disaster (AAFEPPRA, Nov/2018).

According to Gernay, main causes of fire include, appliances and equipment, arson, electrical issues (electrical equipment), fireworks, flammable and combustible materials, human error, land use/cover change, urbanization, over population and deforestation (Gernay et al. 2016). Those factors considered the major causes of fire accident. Therefore, activities in the city, such as use of electricity may increase the size of fire accident (Gernay et al. 2016). Since it is impossible to avoid fire accident, there should some management mechanisms to decrease their accident like identifying causes, effects and hotspot areas identification of fire (Gernay et al. 2016).

A report by the UNDP (2008) highlights the reason that causes residential fires in informal settlements as including, but not limited, to improper use electrical appliances, faulty connections, smoking, heating appliances or improper disposal of wood ashes. People's vulnerability could compound by the energy sources used, such as candles and paraffin stoves in informal dwellings.

Fire accident starts from a misuse of appliances and heating equipment (Australia Fire Department, 2013). Some of the most common causes of house fire according to Australia Fire Department (2013);

a. Cooking Equipment

Pots and pans can overheat and cause a fire very easily if the person cooking gets distracted and leaves cooking unattended (Australia Fire Department, 2013). Always stay in the room, or ask someone to watch your food when cooking on hot plates.

b. Heating

Keep portable heaters at least one meter away from anything that could easily catch fire such as furniture, curtains, laundry, clothes and even yourself (Australia Fire Department, 2013). If you have a furnace, get it inspected once a year to make the sure it is working to safety standards.

c. Smoking in bedrooms

Bedrooms are best to keep off-limits for smoking. A cigarette that not put out properly can cause a flame, as but may stay alit for a few hours (Australia Fire Department, 2013). It could burst into flames if it exposed to flammable materials, such as furniture.

d. Electrical equipment

An electrical appliance, such as a toaster can start a fire if it is faulty or has a frayed cord (Gernay et al. 2016). A PowerPoint that is overloaded with double adapter plugs can cause a fire from an overuse of electricity (Gernay et al. 2016). A PowerPoint extension cord can also be a fire hazard if not used appropriately (Gernay et al. 2016). Double-check the appliances and power points in your home (Gernay et al. 2016).

Electricity is one of the basic needs of everyday life (Gernay et al. 2016). Presently most of the slum people have accessed to electricity and other have a rented beside this some families are not able to get electricity, as they are very poor and cannot pay for electricity (Gernay et al. 2016).

e. Candles

Candles look and smell pretty, but if left unattended they can cause a room easily burst into flames (Gernay et al. 2016). Keep candles away from any obviously flammable items such as books and tissue boxes (Gernay et al. 2016). Always blow a candle out before leaving a room (Gernay et al. 2016).

f. Curious children

Kids can cause a fire out of curiosity, to see what would happen if they set fire to an object (Gernay et al. 2016). Keep any matches or lighters out of a reach of children to avoid any curiosity turned disaster (Gernay et al. 2016). Install a smoke alarm in your child's room and practice a home escape plan with your children and family for when there was a fire.

g. Faulty wiring

Homes with inadequate wiring can cause fires from electrical hazards (Gernay et al. 2016). Some signs to see if you have bad wiring; lights dim if you use another appliance; for an appliance to

work, you have to disconnect another; fuses blow or trip the circuit often. Have a licensed electrician come and inspect your house, or contact your property owner if you have any of the above occurrences.

h. Barbeques

Barbeques are great for an outdoor meal, but should always use away from home, tablecloths or any plants and tree branches (Gernay et al. 2016). Keep BBQs regularly maintained and cleaned with soapy water and clean any removable parts (Gernay et al. 2016). Check the gas bottle for any leaks before you use it each time (Gernay et al. 2016).

i. Flammable liquids

If you have any flammable liquids in the home or garage such as petrol, kerosene or methylated spirits, keep them away from heat sources and check the label before storing (Gernay et al. 2016). Be careful when pouring these liquids.

j. Lighting

Lampshades and light fittings can build up heat if they are very close to light globes. Check around the house to make sure. Lamp bases can become a hazard if they are able to knock over easily, and so should remove if they are. Check those down lights insulated from wood paneling or ceiling timbers.

The major causes of fire accidents according Fire Sense Technology (Detech) report (2015) include;

a. Accidents and carelessness

Many people believe that if they are careful, they are much less likely to have a fire (Fire Sense Technology (Detech) report, 2015). While it is true that being careful will make you safer it will not stop fire from happening (Fire Sense Technology (Detech) report, 2015). Most fires are not caused from carelessness. They are caused from everyday living that is almost impossible for us to change.

b. Electrical wiring, electrical outlets and faulty wiring

Whether it is in an electrical outlet or a short in the wall, electrical wiring causes many fires. Older homes are particularly susceptible, as they were not wire for the many, many appliances that we have filled our homes.

c. Appliances

Lamps, toasters and even baby monitors can short out (Fire Sense Technology (Detech) report, 2015). Be particularly careful with older appliances and extension cords (Fire Sense Technology (Detech) report, 2015). Even new appliances can be the source of a home fire. To be safe, appliances should unplug when not in use. Unfortunately, not all appliances can unplug, leaving your home at risk 24 hours a day (Fire Sense Technology (Detech) report, 2015).

d. Heating

Heating is another major cause of residential fire death (Fire Sense Technology (Detech) report, 2015). This is especially true in southeastern states and among wood stove users in the north (Fire Sense Technology (Detech) report, 2015).

e. Unattended Stoves

Another cause of residential fires is cooking, but not due to defective stoves or ovens (Fire Sense Technology (Detech) report, 2015). Often, it is because of unattended pots or the burner left on accidentally and who has not done that at least once or twice (Fire Sense Technology (Detech) report, 2015).

f. Children Playing with Matches

Children and grandchildren playing with matches are a major source of home fires (Fire Sense Technology, 2015). According to Fire Sense Technology (Detech) the Burn Awareness Coalition, burns are the number one cause of accidental deaths in children under two, fire and burn injuries are the second leading cause of accidental deaths in children ages 1-4 (Fire Sense Technology, 2015) and the third leading cause of injury and death for ages 1-18 (Fire Sense Technology, 2015). Matches and lighters in the hands of young children are a significant factor

in fire fatalities (Fire Sense Technology, 2015). Educating parents and grandparents to the seriousness of this issue is paramount (Fire Sense Technology, 2015).

2.4.2 Impact of fire accident

Urban areas increasingly see as places where economic, social, and environmental development can take place through Sustainable Development Goals (SDG) (Koch and Ahmad, 2018) but this threatened by fire hazards and disasters through loss of human life, damage to infrastructure and the associated economic costs in rebuilding(Koch and Ahmad, 2018). Sustainable Development Goals (SDG11) aims to make cities and human settlements inclusive, safe, resilient, and sustainable and to really increase the number of cities and human settlements adopting (UN Habitat, 2016) and implementing integrated policies and plans towards inter alia resilience to disasters by 2020 (UN Habitat, 2016).

A fire can result in extensive damage and destruction of property as well as injuries and death to the occupants of a given premise (Erastus Gatebe, 2016). It can result in serious injury and damage property. The negative effects of fire include hazard to life and property, atmospheric pollution, and water contamination (Erastus Gatebe, 2016). If fire removes protective vegetation, heavy rainfall may lead to an increase in soil erosion (Erastus Gatebe, 2016). In addition, when vegetation is burn, the nitrogen it has is release into the atmosphere, unlike elements such as potassium and phosphorus, which stay in the ash, and are quickly recycled into the soil (Erastus Gatebe, 2016). This loss of nitrogen caused by a fire produces a long-term reduction fertility of soil, which only slowly recovers as nitrogen is fixed from the atmosphere by lightning(Erastus Gatebe, 2016) and by leguminous plants such as clover (Erastus Gatebe, 2016). Even when fires do not injure workers, they can because disrupt activities much and bring most operations to a standstill. Fires can lead to the destruction of property and loss of important records and information hence the need for clear fire safety rules to decrease outbreaks, and the loss that can result from such hazards (Erastus Gatebe, 2016).

During 2010 and 2014, U.S. municipal fire departments responded to an average of 261, 330 fire each, which was intentionally set (Richard Campbell, 2017). These fires included 196,480 outside, or unclassified fires 49,690 structure fires, and 13,160 vehicle fires (Ken Tremblay, 2009). Losses resulting from these fires included 440 civilian deaths, 1,310 civilian injuries, and \$1 billion in the direct property damage (U. S Fire Department, 2015). Despite representing 19%

of all intentional fires, structure fires accounted for 87% of civilian deaths, 84% of civilian injuries, and 86% of direct property damage caused by intentional fires (U. S Fire Department, 2015).

The U.S Fire Department (2015) summarized fire accident impacts as listed below;

a. Socio-economic impact

The impact of fire can result in a controlled quality of life of the affected community. Livelihoods are disrupted, schoolbooks and uniforms may burn in the fires the children may lose schooldays, and that can affect them academically. Parents might be off work due to burn clothes and important documents might be lost in the fire. The family routine might disrupt temporarily as they might force seeking shelter with friends or relatives. Most people in informal settlement save their money in their houses, so their entire savings could be lost in the fire (USDA, 2013). Assets may burn during fires, and that need to replace to the people to have their livelihood back. It is very difficult explicitly draw a line between social and economic impacts due to disasters, as these two are interrelate. Loss of belongings due to fire furniture, finance needed for replacement. Disasters like extensive fires for instance have a bearing on both the social and the economic aspects of the affected community. It is very important to avoid judging the social impact of disasters on the economic impact only (USDA, 2013); though an understanding of negative economic impacts are a good indicator of social impacts (USDA, 2013). Fire outbreaks have resulted in an increased loss of property, reduced food availability for both humans and animals, and reduced growth rate of economy and loss of equipment (USDA, 2013). The overall impact increased food insecurity among households.

b. Cultural impact

Cultural impacts include the temporary loss/alteration of culture by the affected community due to the impact of the disaster (USDA, 2013). Some cultural heritage and treasures may lost during the fires like tangible cultural heritage buildings, monuments, books, works of art, and artifacts and natural heritage including culturally significant landscapes, and biodiversity (USDA, 2013).

c. Health impact

Most informal dwellers know for sure that smoke inhalation from fires can be a health hazard by experience (USDA, 2013). A carbon emission from smog causes chest pains and, in many cases, has caused death (USDA, 2013).

d. Psychosocial impact

During a disaster people suffer stress they are likely to be psychologically affected; signs of anxiety might be depicted long after the disaster has happened, depression and grief as well as behavioral and substance abuse are part of psychological behavior. Psychosocial impacts also include trauma and grief, which cannot be put into monetary value the loss of loved ones, and the attachment families had to their environment earlier than the disaster (USDA, 2013). At the person level, social impacts of fire accidents expressed as changes in attitudes, beliefs, and behaviors. These can result from direct exposure to fire accident events, or they can result from indirect exposure (e.g., via personal contacts or news media) that causes people to reevaluate their ideas or actions. For fire accidents, psychological or behavioral effects can result if an individual suffers direct damage to property or health, but they also can result from exposure to smoke, changes in scenic quality of important view sheds, direct effects experienced by friends or relatives, or memorable images of impacts reported by news media (Mitra, 2010). Such responses may include behavioral changes e.g., increasing efforts to cut fuel hazard on one's own property, or supporting efforts to block a prescribed burning proposal or psychological changes such as an increase in trust or willingness to listen (Mitra, 2010). The intensity and direction of these psychological and behavioral impacts is likely to vary depending upon a number of personal and contextual factors, including the individual's assessment of catastrophic risk and attributions of blame for undesirable events.

e. Socio-demographic impact

People made homeless during fires; in most cases, these are the marginalized group. It could take years to rebuild their homes if not forever, that can force them to live off government grants or from handouts from friends, relatives or even NGOs. The destruction of household dwelling is the most significant socio-demographic impact of a disaster-stricken community as after disaster-affected households to provide with temporary shelters. In most cases, these populations are of

low or no source of income to draw from for recovery, so they are forced to accept temporary housing as their permanent homes.

f. Socio-political impact

During a disaster victims may easily mobilize mainly due to fear or staleness of their mind. Issues of shelter and food supplies can cause major political issues (USDA, 2013).

g. Environmental impacts

Fires cause adverse events with tangible costs to property and human life. Quantification of the immediate and direct costs of fire give a metric for understanding the social and economic impact of fire and for assessing progress in fire prevention and protection (NFPA,2011). In addition to their manifest physical costs, however, fires have a range of less immediate and obvious adverse consequences on the natural environment (NFPA, 2011). The ecological or environmental impacts are difficult to quantify, but there have been efforts to set up environmental costs and losses for significant fire events. Although not all that satisfactory in some respects to date, the evaluation of the impacts on environment is must and improved methods for doing so should have supported by research efforts. This information is particularly essential to underpin changes in land management practice and support the evolution policy, a need emphasized by the public and persistent descriptions of large and damaging fires as environmental disasters (U. S Fire Department, 2015). Fire always affects the environment in which it burns and may alter the ecosystem, which may have both negative and positive impacts on the land (U. S Fire Department, 2015). The negative environmental impact of forest fires caused by release of carbon dioxide and the consumption atmospheric oxygen, the disruption energy flow and the cycling of nutrients upsetting the ecosystem functions and, the pollution of the atmosphere , and water bodies contributing to the impaired health of organisms (WWF, 2001). Furthermore, forest fires affect soils physically, biologically and chemically (WWF, 2001). Because they have such a comprehensive impact on soils, fires may radically change the environment, which much affects an ecosystem's biodiversity (WWF, 2001).

h. Loss of life and injury

The loss of human life caused by a fire accident is not an everyday occurrence, but is rare that it should consider negligible. In addition, financial resources are use firefighting and assets are consuming the fire. Both these must calculate to find losses caused by a fire accident (U.S Fire Department, 2015).

2.5 Fire hazard response and mitigation

For the convenience stakeholders, a broad outline of the plan and its various components put together and mitigation is the action of reducing the severity impact from a fire accident. For fires accident, mitigation actions include cause, impact and hotspot areas identification and disaster assistance the following sections discuss the costs associated with mitigation (National Disaster Management Authority, 2012).

a. Identify the background of the city

City overview—population, density, land use, type of buildings, roads , and accessibility; Infrastructure, health care system, business and industrial locations, schools, educational institutions, and other land use (National Disaster Management Guidelines, 2018). Classify the vulnerable assets, people, housing and critical infrastructure; and Resource and institutions — public and private that can help and support the fire hazard response system (National Disaster Management Guidelines, 2012).

b. Planning process, response and mitigation strategy

Goals, objective and potential actions should clearly spell out in the plan; Identify hazards by collecting historical hazard information (both natural and manmade); Risk and vulnerability assessment — identification of city specific hazards and assessment of risks involved (vulnerability analysis); and Assess own assets and capabilities — (administrative, financial, technical, regulatory, legal) and determine how the ULBs / fire services need to address the requirements.

c. Identification of resource;

Identify role of the government departments, existing institutions, expert agencies, NGOs, etc. (National Disaster Management Guidelines, 2012) along with their capacity assessment; Identify key stakeholders in the community , and surrounding areas (National Disaster Management Guidelines, 2012); Organize resources (National Disaster Management Guidelines, 2012); identify hazard mitigation teams, agencies, community members (National Disaster Management Guidelines, 2012); Decide stages / steps for implementation of plan — key stages, actors, public participation training and capacity building, Public outreach (National Disaster Management Guidelines, 2012) & sensitization plan, involvement and participation of the community and role of ward committee and area Sabhas/ Panchayats , etc (National Disaster Management Guidelines, 2012); Review and incorporation of future developmental plans of the city and other information; Preventive actions — property and natural resource protection techniques and strategies, right equipment and facilities of their own at large colonies and high-rise buildings, like water, fire extinguishers, escape routes, etc.(National Disaster Management Guidelines, 2012), public information and awareness plans and actions required; Potential impact and damages — social, economic , and environmental.

d. Evaluation and monitoring

For making the plan dynamic, integration of the community, continuous evaluation, and monitoring is necessary (National Disaster Management Guidelines, 2012). In towns, interaction with the municipal council and in villages with the PRIs will prove very helpful (National Disaster Management Guidelines, 2012). The plans should discuss with them and suggestions obtained should incorporate from time to time. Surprise mock exercises for fire emergencies will greatly help in evaluating and monitoring of the plan (National Disaster Management Guidelines, 2012).

CHAPTER THREE

BACKGROUND OF THE STUDY AREA AND SURVEY METHOD

3.1 . Description of Study Area

3.1.1 Location area

This study is conducted in Addis Ababa, the capital city of the Federal Democratic Republic of Ethiopia, which is located in the center of the country. It is also a home to the African Union (AU), the Economic Commission for Africa (ECA) and other international organizations. According to CSA, Addis Ababa has a total of 54,000 hectares and population of 4,794,000 and annual growth rate of 4.4 % (UN World Urbanization Prospects, 2019). Addis Ababa is found between 8°50' N to 9°5' N and 38° 38'E to 38° 54'E (CSA, 2013). Addis Ababa city administration extends over 530 square kilometers (km²), the population density is estimated to be near 5,165 individuals per square kilometer available (CSA, 2013). The city has ten sub-cities; Bole, Yeka, Cherkos, Gulele, Kolfe Keranyo, Arada, Lideta, Akaki-Kality, Nefas-Silk Lafto and Addis Ketema (UNEP, 2003). Addis Ababa is home to 25% of the urban population in Ethiopia and is one of the fastest growing cities in Africa (World Bank Group, 2015). The city is a major growth corridor for the country's vision to become a middle income by 2025 (World Bank Group, 2015). The city alone currently contributes approximately 50% towards the national Gross Domestic Product (GDP), highlighting its strategic role within the overall economic development of the country (World Bank, 2015). The city is located in the central highlands of Ethiopia covering an aerial extent of about 530 square kilometers (km²) with an average elevation of 2,500 meters above mean sea level (UNEP, 2003). The altitude range extends from the highest peak at Mount Entoto, which is 3041 meters to 2051-meter mean above sea level at the lower part of Akaki plain (Teferi and Abraham, 2017).

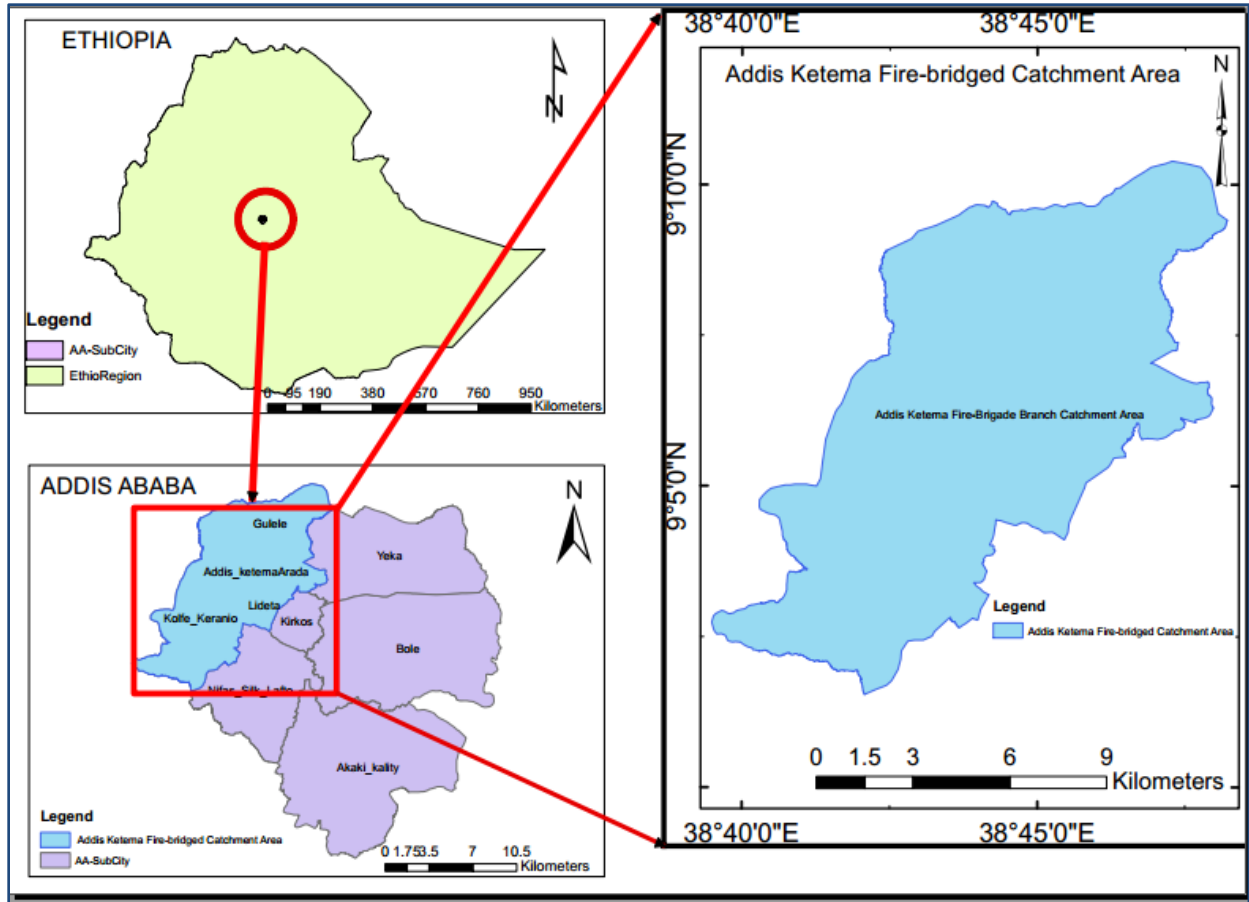


Figure 3.1 Location of Study Area (CSA, 2013)

3.1.2 Climate, topography and settlement pattern

An average maximum temperature for Addis Ababa in the last sixty years was 22.9°C and the average minimum temperature was 10.2°C (Getnet.F.et al.,2018).The average annual rainfall for Addis Ababa was 1184 millimeter (National Meteorology Agency, 2016). The wet season is from June to mid-September (Ermiyas Teferi, 2017). The population density varies from sub city to sub city (Ermiyas Teferi, 2017). The highest density is in Addis Ketema sub city (37,215p/sk.km) to the sparse density in Akaki Kality sub city (1832 p/sk.km) (Ermiyas Teferi, 2017). All the sub cities in the downtown have high population density compared to sub cities found in peripheral areas (Ermiyas Teferi, 2017). Fast rate of urban expansion and built up area are rapidly increasing in Addis Ababa, which were largely attributed to population pressure on the land a rapidly growing infrastructure and poor land use planning (Teferi and Abraham, 2017). An average maximum temperature for Addis Ababa in the last sixty years was 22.9 °C

and the average minimum temperature was 10.2 °C (Getnet.F.et al., 2018). The average annual rainfall for Addis Ababa was 1184 millimeters (National Meteorology Agency, 2016). The wet season is from June to mid-September (Ermias Teferi, 2017). The population density varies from sub city to sub city (Ermias Teferi, 2017). The highest density is in Addis Ketema sub city (37,215p/ sk.km) to the sparse density in Akaki Kality sub city (1832 p/ sk.km) (Ermias Teferi, 2017). All the sub cities in the downtown have high population density compared to sub cities found in peripheral areas (Ermias Teferi, 2017). Fast rate of urban expansion and built-up area is rapidly increasing in Addis Ababa (Woldegerima et al.2016), which were largely attributed to population pressure on the land, a rapidly grown infrastructure, and poor land use planning (Teferi and Abraham, 2017).

3.1.3 Population and socio-economic characteristics

The society social, economic status and demographic characteristics are influential in the magnitude and pattern of fire accident. Demographic characteristics and socioeconomic status helped to know the purpose of why fire accident increase;

3.1.3.1. Population

Addis Ababa has a total population of in the near future is expect to grow to exceed 6.5 million residents. The annual growth the rate of the city has estimated in recent years to 3.8%. In earlier years, growth has been as much as 8%. The city is a thriving urban area in Ethiopia, and the jobs available in Addis Ababa, availability of clean drinking water and plumbing, and many shops and businesses make sure that growth will continue to steady in this capital city well into the future (World Population Review, 2019).

3.1.3.2.Economy and income

The economic activity in Addis Ababa is diverse (Massreshaw, 2017). According to official statistics from the federal government, some 119,197 people in the city are engage in trade and commerce (Massreshaw, 2017); 113,977 in manufacturing and industry (Massreshaw, 2017); 80,391 private producers of a different variety; 71,186 in civil administration; 50,538 in transport and communication (Massreshaw, 2017); 42,514 in education, health and social services; 32,685 in hotel and catering services; and 16,602 in agriculture (Massreshaw, 2017). In addition to the

residents of rural parts of Addis Ababa, the city dwellers also take part in animal husbandry and market Gardening (Massreshaw, 2017). The irrigated land is 677 hectares or 6.77 square kilometer (km²), on which about 129,880 quintals of vegetables are cultivated. Based on the (CSA in 2007), there were 652,000 households with average household size of the level of income is low and average household monthly income is about 725 Ethiopian Birrs. Nearly 50% of the population is below poverty line with income less than 400 birrs per household per month, and 23% are in absolute poverty with less than 260 Ethiopian birr per month (Miheretu, 2005). The income levels are divided into three classes, high-income levels (>2500 birr), medium (between 500 to 2500 birr) and low-income groups (<500 birr) per month (Miheretu, 2005). It can observe that the central area has higher population and the income levels at these areas are medium to low. These areas correspond to the old city. Mainly central sub-cities, Arada, Cherkos, Lideta and Addis Ketema were characterizes by slum settlement.

3.1.3.3. Transport infrastructure

Transport infrastructures include road length, road width, public transport hubs and even road furniture and these factors affect accessibility of transport system. Roads should have sufficient width, suitability graded and located, and adequately constructed to accommodate the traffic, afford adequate light and air, help public transport, provide access for fire protection, and refuse protection vehicle and road maintenance equipment. These roads should co-ordinate to compose a convenient system properly related to the proposal shown on the development plan. The arrangement road should such as to avoid undue hardship to adjoin property ownership /occupiers/ and no property shall render inaccessible from an existing public road or from a proposed road in a subdivision. Fire accident, and it impacts is increase by the network structure and condition. Network structure determines how direct the route between two points is and type of the road determines how fast the vehicles can travel (ERA, 2001).

3.1.3.4. Addis Ababa fire-brigade station

Addis Ababa city established for the first fire emergency elimination time in 1926 E. C which was known as “fire emergency elimination ” and later it changes to fire , and emergency prevention and rescue agency; the agency would aspire to make Addis Ababa one of the African models cities regarding security by protecting the inhabitants ' life & material from emergency

accidents and creating the sense of security insurance in themselves by the year 2012 E.C. Preventing emergencies that would expect to happen in the city by participating the stakeholders & inhabitants (Agency report, Nov/2018). Ensuring the inhabitants ' security by providing life rescue support & immediately controlling the accident unfortunately when it occurred (Agency report, Nov/2018). The fire and emergency prevention and rescue agency have nine fire-brigade catchment area stations. They are Addis Ketema, Akaki Kality, Arada, Bole, Central or Piassa, Cherkos, Gulele, Kolfe Keranyo, Nifas SilkLafto (Agency report, Nov/2018).

3.2 Research methodology and methods

3.2.1 Research methodology

This study was intend to find the causes, impacts and hotspot areas identification of fire accident in Addis Ababa city fire and emergency prevention and rescue agency. In order to fulfill the objective necessary methods and techniques has adopted to procure the necessary data (Soumyajit Halder, 2016). Most of the information in this study has collected through primary survey and extensive field survey. The methodology of the present work may categorize in three stages;

A. Pre-field method: Collection of necessary secondary information and data from archives of various newspaper reports, Addis Ababa city administration municipality fire and emergency prevention and rescue agency.

B. Field method: Primary data have collected through field survey and discussion with victims with the help of questionnaire schedule and through detailed observation.

C. Post field method: Data collected from the field was analyze and computed in the form of tables. Then different types of diagrams with the help of different statistical techniques interpret it.

3.2.2 Study design

This study uses a cross-sectional survey method as study design to collect both qualitative and quantitative data form primary and secondary sources. A cross-sectional survey method was

employ to assess causes, impacts and hotspot areas fire accident in Addis Ababa city fire , and emergency prevention and rescue agency.

3.2.2.1 Data source and type

This study employed both primary and secondary sources to generate appropriate data (Raimo Streefkerk, 2018). Primary data was collected from fire accident victim households, city administration of the municipality and other primary sources. On the other hand, secondary data was collected from relevant documents such as books, articles, statistical reports (Abinet Ergando, 2011). In addition, important documents from other stakeholders were used as sources of secondary data.

3.2.2.2 Data collection instruments

A different data collection instruments such as open-ended and close-ended type survey questionnaires were used to generate primary data.

A. Questionnaire

A questionnaire is a systematic compilation of questions that are submitted to a sampling of population from which information is desired (Kothari, 2004). The survey questionnaires used for this study comprises a set of questions for fire accident victim households. The survey mainly aimed at gathering information on the causes, impacts of economic, social, and other related issues. It has also covered socio-demographic background variables such as age, sex, literacy status, educational status and marital status. The survey questionnaire has used both close-ended and open-ended questions (Kothari, 2004).

3.2.3 Sampling design

The sampling designs that match with the selected research approaches and objectives of this particular study are a non-probability sampling method. Non-probability sampling was employed to select respondents for both qualitative and quantitative data collection (Kothari, 2004).

3.2.3.1 Sampling techniques

The researcher used non-probability sampling technique that is totally based on judgment. Fire accident victim household respondents were selected through a mix of purposive and snow ball sampling. Purposive sampling, a non-probability sampling technique, is best suited when it is difficult to determine the probability of any given element that would be selected in sample (Kothari, 2004). A non-probability sample was selected based on characteristics of a population and the objective of the study (Kothari, 2004). It used by researchers because it is extremely timing and cost effective when compared to other sampling methods. Snowball sampling is also a non-probability sampling technique, used to locate additional respondents by the referrals (Kothari, 2004). Having this technique, 40 individuals were selected as sample to collect the causes and socioeconomic impacts of fire accident. The study area, Addis Ketema fire-brigade catchment area is including 5 sub-cities and 31 woredas. Among these, 10 woredas from Addis Ketema sub city, 2 woredas from Arada sub city, 4 woredas from Gulele sub city, and 7 woredas from Kolfe Keranyo sub city and 8 woredas from Lideta sub city.

3.2.3.2 Sample size determination

The actual sample size was determined using the following formula developed by using Cochran's formula (Cochran, 1977). This formula was used to calculate the sample size as shown below:

$$n = \frac{(Z)^2 * p * q * N}{(e)^2 * (N - 1) + (Z)^2 * p * q} \dots \dots \dots (1)$$

Where n is the sample size, N is the population size, and e is the level of precision.

n= the desired sample size

N= 55 victim households selected based with loss of life, severe injury and property damage out of 211 total accident which include the slight injury and property damage.

Z= standard normal deviation (1.96 for 95% confidence level)

P= the estimated proportion of an attribute that is present in the population, 0.5 (proportion of population to be included in sample i.e., 50%)

$q = 1 - p$ i.e. $(1 - 0.5 = 0.5)$

$e =$ the margin of error (expected error is 8% i.e. 0.08)

$$\text{Thus; } n = \frac{(1.96)^2 * 0.5 * 0.5 * 55}{(0.08)^2 * (55 - 1) + (1.96)^2 * 0.5 * 0.5}$$

$$= n = \frac{52.822}{1.306}$$

$$= n = 40.44$$

$$\approx n = 40 \text{ sample size}$$

3.2.3.3 . Data type and source

The use of multiple data sources and theory or triangulation, ensures the validity and reliability of findings Creswell. W, 2003. The study used both types of data; primary and secondary and incorporates both quantitative and qualitative data. These were discussed in detail below.

Primary Source

To identify the magnitude of fire accident, and its economic impacts on victim households, primary data would be collected from victim households, and concerned bodies. To get ample information about the fire's safety problems of the Addis Ababa, fire brigade, and other officials would also be consulted.

Secondary Source

Secondary data would be obtained from the fire, and emergency prevention and rescue agency in City Administration. Moreover, different books, journals of WHO and World Bank reports would also be included. Furthermore, to get a general picture of fire safety problems, online data sources would be utilized as necessary. In addition, important documents from other stakeholders would be used as sources of secondary data. The data was expected to consist of information such as the location and the time of accidents, the gender and age of the primarily responsible party and the cause and severity of accidents, and estimate cost of losses of life and property.

3.2.4 Methods of data collection

The main data gathering instruments that were employed in this study are semi-structured questionnaire as well as document reviews. These tools were expected to facilitate and enhance the data collection process and thus would employ as and when needed. The proposed tools were discussed as follows.

3.2.4.1 Questionnaire

The survey questionnaires that would use for this study would comprise a set of questions for fire accident victim households. The survey mainly aims at gathering information on the causes, socioeconomic impacts of fire accidents on victim households.

3.2.4.2 Key informative interview

The key informant interview would hold with different key individuals, including those experts and officials from fire rescue and control agency and victim households. The interview guiding questions would also develop with intention of getting richer information than what is usually available from surveys. Here, unstructured questions would use to give freedom for respondents to express their ideas by their words without restrictions. Thus, three interviews would conduct with different individuals at different administrative and experts' levels. Accordingly, this would include higher officials, mid-level and field level experts and victim households would interview.

3.2.5 Methods of Data Analysis

The study used both qualitative and quantitative methods of data analysis to meet its objectives. Primary and secondary data was collected from questionnaires and analyzed qualitatively and quantitatively.

3.2.5.1 Quantitative data analysis

For the quantitative type of data, the study would employ descriptive and inferential statistical methods. The descriptive analysis would information to analyze the data, like percentage, and frequency distribution would use to describe the socioeconomic characteristics of the sample households.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

In this section, the results of descriptive analyses; the analysis was made by examining the personal characteristics of victim households and causes of fire accident; investigate socioeconomic impacts of fire accident in the victim households.

4.1 Assessment and magnitude of fire accident in the study area

The incident of fire accidents varies with time as attributed by the variation in poor infrastructure, carelessness, electrical fire, environmental/weather condition, level of awareness of households. The frequencies of incidences of fire accidents in Addis Ababa city also exhibit such fluctuations in this decade due to either of these reasons. The trends of fire accidents were presented by the type of accidents (Table 4.1).

Table 4.1: Trends of fire accident in Addis Ababa

No.	Year/G.C	Total fire accident	Loss of life and injury	Destruction of property (Birr)
1	2013-14	-	-	-
2	2014-15	61	41	68,090,305
3	2015-16	41	11	22,434,200
4	2016-17	47	8	4,731,800
5	2017-18	45	17	62,340,540
6	2018-19	14	5	2,362,000
	Total	211	86	159,958,845

Source: five-year fire accident report (AAFEPR, Nov/2018)

As shown in Table 4.1 above, more than 241 fire accidents occurrences have been recorded in Addis Ababa city from 20013/14 to 2018/19. Whereas as, throughout the country about 211 fire

accidents occurrences have been recorded from 20013 to 14 to 2018/19. This means the occurrence of fire accidents in Addis Ababa city, in the last five years from 20013 to 14 to 2018/19 cover 87% of the fire accidents that occurred in the Addis Ketema fire bridge catchment area. The fire accidents incidence of the city has shown an increasing trend in the last five years (AAFEPR, Nov/2018).

In study area the five-year report of fire, accident shows the largest magnitude of loss of life and injury, massive property destruction. The annual report of Addis Ababa City Administration Fire , and Emergency Prevention and Rescue Agency from 2013 to 14_2018/19 is total 211 fire accident occurred and massive property destruction and losses of life and injury in Addis Ababa city (AAFEPR, Nov/2018). According to the data from the survey, the total victims by road traffic accidents were 211 in 2018/19. The mean value of victims has showed an increasing trend.

4.2 Major causes of fire accident in Addis Ababa

In this section, individual experiences of each of the study participants (victim households) injured in fire accidents were documented. Several causes result in fire accidents across in the world. According to AAFEPR, the major causes of fire accidents in Addis Ababa were the results of blunders of human error, carelessness, poor infrastructure, electrical fire, deforestation and wild fire.

The main causative factors for the occurrence of fire accident in Addis Ababa city were identified based on the existing realities and knowledge of the study area. Fire accident that normally occurs in the country including Addis Ababa city is through the year in different season and specifically in holiday.

In this study, an attempt has been made to compute the fire accident cause, impact, and hot spot area analysis of the Addis Ababa city, Addis Ketema fire-brigade catchment area from 2013/14-2018/19.

4.2.1 Cause of fire accident

In this section the individual experiences of each of the individual victim households injured in fire accidents was documented. Details of each fire accident and its causes are presented rank 1st, 2nd, 3rd, 4th, and 5th.

Several causes result fire accidents across in the world. According to Chen B., the major causes of fire accidents in Ethiopia and its cities include carelessness, electrical fire, poor infrastructure, deforestation and wild fire (Chen B., 2005).

In addition to this, the common and frequently observed causes of fire accidents in Addis Ababa are also similar to the aforementioned reasons. Seemingly, with some additional variables of causes of fire accidents, Table 4.1. As shown below describes the current main reasons of fire accidents occurrences in Addis Ababa

Table 4.2 Causes of fire accident in Addis Ababa

No.	Cause of fire accident	Rank	Respondent	Percent
1	Poor infrastructure	3	10	25
	Urbanization without proper design and master plan poor road network, poor housing or slum			
	High population density			
2	Carelessness	1	15	37.5
	Kitchen fire (cylinder fire, stove fire, charcoal fire)			
	Electric contact fire, shock			
	Candles fire			
	Smoke of cigarette			
	Technical error of electronics material			

	General negligence (human error)			
	Transformer explosion			
3	Electrical fire	2	13	32.5
	Different factors; including faulty appliances, worn or faulty electrical wiring, improper use of electrical outlets and worn out breaker boxes. Appliances and equipment, electrical issues (electrical equipment), faulty equipment.			
	Defective electrics such as loose wires, or faulty equipment that can overheat and cause sparks			
	Overuse of appliances, home heating systems, and children playing with fire.			
	Faulty electrics; includes loose wires, plugs that are over loaded and old equipment			
	Flammable and combustible materials			
	Arson			
4	Deforestation and wild fire	4	2	5
	Total		40	100

Source: Own Survey (2019)

The respondents were asked to identify the causes of fire accident. According to Table 4.2 about 37.5% of the respondents confirmed that carelessness, kitchen fire (cylinder fire, stove fire, charcoal fire), electric contact fire, shock, candles fire, smoke of cigarette, technical error of electronics material, general negligence (human error), transformer explosion are main causes for the fire accident followed by 32.5% for electrical fire, different factors; including faulty appliances, worn or faulty electrical wiring, improper use of electrical outlets and worn out breaker boxes. Appliances and equipment, electrical issues (electrical equipment), faulty

equipment, defective electrics such as loose wires, or faulty equipment that can overheat and cause sparks, overuse of appliances, home heating systems, and children playing with fire, faulty electrics; includes loose wires, plugs that are over loaded and old equipment , flammable and combustible materials and arson, 25% for poor infrastructure; urbanization without proper design and master plan (poor road network, poor housing , or slum) and high population density, 5% for deforestation and wild fire.

In study area was mentioned as the main cause of fire accidents were carelessness, electrical fire, poor infrastructure, deforestation and wild fire. Findings showed that respondents answered the questionnaire 100% were experiencing the fire accident problem. These results imply that fire accident is still a problem that needs to be solved in a controlled manner. The causes of fire accidents broadly categorized as carelessness, electrical fire, poor infrastructure, deforestation and wild fire, and their risk factors were examined. The results revealed that out of the 210 fire accidents recorded in the study area from 2013/14-18/19, carelessness was the leading cause, accounting for 37.5%, whereas electrical fire was responsible for 32.5%, poor infrastructure factors resulted in 25% and deforestation and wild fire factors accounted for 5%. These statistics indicate that main factors for fire accident are carelessness, electrical fire and poor infrastructure in study area.

In addition to this, information collected from some fire-brigade officers (key informants in this study) have added that, carelessness, electrical fire and poor infrastructure and lesser awareness of the society about fire accidents are the major causes of fire accidents occurrences in the city.

4.2.2 Impacts of fire accident

This section was focused on the overall socioeconomic impacts of fire accidents for victim households. Information was first provided on the questionnaires in each of the fire accidents victim households' respondent documented in the study area. The main overall impacts of fire accidents were then identified and discussed followed in the Table 4.3.

Fire accidents have multifaceted impacts over the economy of a nation. In addition to social, impacts of fire accidents, Addis Ababa City is also suffering huge economic loss from fire

accidents. Some impacts of fire accidents have direct economic impact when it was manifested over a property and have indirect influence when it is exhibited on victim households.

The social, economic, and political impacts of the fire accidents are widespread all over the world. The loss of lives, damage to property and the sorrow it leaves in human mind are profound though the degree varies from nation to nation, developing nations being the hardest hit. Fire accidents were found to be among the tops leading causes of deaths, and injuries of various levels. Some major impacts of fire accidents identified and discussed followed in the Table 4.3.

Table 4.3 Impacts of fire accident in Addis Ababa

No.	Fire accident impact	Rank	Respondent	Percent
1	Injuries and death	2	10	25
2	Psychological impact	3	3	7.5
	Suffer stress; trauma and grief			
	Signs of anxiety might be depicted long after the disaster has happened, depression and grief as well as behavioral and substance abuse			
3	Socio-economic impact	1	25	62.5
	Children class dropout (school books and uniforms)			
	Burnt clothes and important documents			
	Damage and destruction of property			
	Unemployment, loss of shelter/ accommodation, loss of livelihood, forced to burden communities used to live with			
4	Cultural impact	4	2	5
	Loses of cultural heritage			
	Total		40	100

Source: Own Survey, 2019

The respondents were asked to identify the impacts of fire accident in the city. According to Table 4. 3, indicates that out of the respondents who stated that all is the main consequence of fire accident, 62.5% of the respondents are confirm socioeconomic impact is the main impacts of fire accident followed by 25% for injuries and death, 7.5% for psychological impact and 5% for cultural impact.

The impacts of fire accidents broadly categorized as injuries and death, psychological impact, socioeconomic impact and cultural impact, and their risk factors were examined. The results revealed that out of the 210 fire accidents recorded in the study area from 2013/14-18/19, socioeconomic is the leading impacts, accounting for 62.5%, whereas injuries and death impact was responsible for 25%, psychological impacts resulted in 7.5% and cultural impact accounted for 5% fire accident in the study area. Based on this information the main impact of fire accident in the study area is socioeconomic impact that accounts 62.5% of the total.

4.2.3 Time of response for fire accident

Response time is the most common performance measures are used by the fire service because it is understood by citizens, easy to compute, and useful in the evaluation of results. Rapid response is also an aspect of service quality that citizens care. There have been a few attempts to measure the incremental value of a minute faster response time for fires and 939 calls, but there is no definitive study of the incremental benefit. Faster is better, but it is unclear how much better regarding money (birr) or lives saved. Table 4.4 time of response for fire accidents vary within the occurrence of accidents in the city.

Table 4.4 Distributions of respondents by time of fire accidents response

No.	Time (minute)	Rate	Rank	Respondent	Percent
1	≤ 10 min	Very good	4	2	5
2	10-20 min	Good	3	10	25
3	20-30 min	Poor	2	11	27.5
4	≥ 30 min	Worse	1	17	42.5

	Total			40	100
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Source: Own Survey, 2019

The respondents were asked to identify the response time for incident take place. According to Table 4.4, about 42.5% of the 40 respondents confirmed, that the fire brigade members arrived mean after 30 minutes of happening incident in the study area and followed by 27.5% of the respondents confirmed that the fire-brigade members arrived between 20-30 minute of happening incident in the study area. From these statistics, the late coming of members of fire brigade increases the damage to property.

4.2.4 Seasonal variation of fire accident

The occurrence of fire accidents varies within the seasonal variation of a year. Table 4. 4, specifies the variation of occurrences of fire accidents in Addis Ababa city, regarding the seasonal variation of year.

Table 4.5 Distributions of respondents by Seasonal variation of fire accidents response

Season	Rank	Respondent	Percent
Winter [Dec, Jan, Feb]	2	13	32.5
Summer [Jun, July, Aug]	4	4	10
Autumn [September, October, November]	3	6	15
Spring [March, April, May]	1	17	42.5
Total		40	100

Source: Own Survey, 2019

The respondents were asked to identify the season most of the time fire accident takes place in the area. According to Table 4.5, about 42.5% of the 17 respondents confirmed that spring was the peak season of fire accident in the study area followed by 32.5% of the 13 respondents

confirmed that winter, 15% of the 6 respondents confirmed autumn and 10% of the 4 respondents confirmed summer. The 75% of the 40 respondents confirmed, fire accident occurred during the dry season, from December to May and the peak periods were spring followed by winter. There is a need for fire data recording, and this data should be in integrated manner (FAO, 2013). In addition, in spring and winter there are many public holidays and are the hottest seasons of the study area.

4.2.5 Factors for hinder to arrive fire-brigade to control fire accident

The hindrance factor of fire-brigade unit to arrive incident takes place to control fire accidents in the city. Table 4.6, specifies the variation of occurrences of fire accidents in Addis Ababa City, regarding the seasonal variation of year.

Table 4.6 Distributions of respondents by factors that hindered early arrival fire accidents response

Factors	Rank	Respondent	Percent
Traffic congestion	2	11	27.5
Unplanned residents' site	3	8	20
Long station distance (dispatch office)	4	4	10
Lack of using technology to know exact place of fire emergency site	5	2	5
Poor infrastructure	1	15	37.5
Total		40	100

Source: Own Survey, 2019

The respondents were asked to identify the factors that hindered early arrival of fire brigade to control fire accident in the study area. According to Table 4.6, about 37.5% of the respondents confirmed that poor infrastructure was the main factors hindered early arrival of fire-brigade to control fire accident followed by 27.5% traffic congestion, 20% unplanned residents' site, 10% long station distance (dispatch office) and 5% lack of using technology to know exact place of

fire emergency site. Based on table poor infrastructure and traffic congestion that is the highest majority that takes 65% of the 40 respondents confirmed that, the main hindering factor of fire brigade to arrive late in the study area.

4.2.6 Respondents source of knowledge and experience

Table 4.7 Distributions of respondents about source of knowledge and experience about fire emergency safety rules

Who is your source of knowledge and experience about fire emergency safety rules?	Rank	Respondent	Percent
Community	1	11	27.5
Parents	2	10	25
Schools	5	4	10
Fire-brigade	3	9	22.5
Media	4	6	15
Total		40	100

Source: Own Survey, 2019

The respondents were asked to identify the source of knowledge and experience about fire emergency safety rules. According to Table 4.7, about 27.5% of the respondents confirmed that main source of knowledge and experience about fire emergency safety rules be community like police, NGO, red cross and hospital followed by 25% parents, 22.5% fire-bridged, 15% media and 10% schools. From this tabular statistic the fire-brigade could not work on society awareness creation of 52.5% of the 40 respondents confirmed that, couldn't have source knowledge and experience of the society/respondent about fire emergency and safety rules. The lead the fire accidents effects on society is severe in case of property destruction, loss of life and injury.

4.2.7 Level of fire accident in Addis Ababa

Table 4.8 Distributions of respondent about level of fire accidents in Addis Ababa

How do you perceive the level of fire accidents in Addis Ababa city?	Respondent	Percent
A big problem	31	77.5
A moderate problem	9	22.5
Not a problem	-	-
Total	40	100

Source: Own Survey, 2019

The respondents were asked to identify the level of fire accidents of the city, according to Table 4.8, 77.5% of the 40 respondents confirmed, that the level of fire accidents of the city is a big problem followed by 22.5% a moderate problem the level of fire accidents of the city. This indicates that the fire accident in study area is crucial problem.

4.3 Socio-economic activities of the region prone to fire accident

A fire accident in the study area was identified by the report (AAFRCA, 2018). The five woredas of Addis Ketema sub city with the highest fire occurrences were noted as woreda 8, woreda 10, woreda 4, woreda 7 and woreda 9 respectively. In mentioned above woredas 67% massive property damage loses of life and injury of recorded, that is hundred fire accidents occurred out total 150 fire accidents in study area. This suggests that fire is definitely a persistent issue with almost the same regions identified with the most fire incidents in both assessments.

The step taken in compiling this fire accident hotspot for study area is a sound strategic one and should be something that was repeated in most countries that are working to understand and account for fires accident in their landscapes. In the preparation of the fire accident hotspot area map there has been a series of aspects that have been identified, which can provide a set of ongoing analyses to further refine and contribute to enhance the insights and understanding of fire accident in the study area.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This chapter of the study presents concluding remarks and recommendations basing on the findings in the previous chapter. The study examined the cause, impacts, and hotspot area identification of fire accident. Concomitantly, the following concluding remarks and recommendations give more emphasis over these, and were presented as follows;

5.1 . Conclusions

The study has assessed the causes, effects and hotspot areas identification of fire accident of victim households in Addis Ababa city administration. It has also focused on other vital issues related to fire to accident such as magnitude and patterns of fire accident in the study area. Based on the data collected from primary and secondary sources, three research objectives have been addressed through quantitative and qualitative data analysis approach.

As far as fire accidents concerned, it is not implausible to say that Addis Ababa is suffering from it greatly. The results in the trend analysis show that since 2013/14_2018/19, the damages caused have almost doubled 159,958,845-birr total damages, and there is a dire need for interventions to revert this trend. The total damage caused by fire accident was computed with damages that occurred in the form of death, serious injuries, slight injuries and property damages. Although different initiatives have been taken, the trend shows there be yet much to be done considering the highly increasing trend in accidents in the city. One of the institutions established by the city administration is fire, and emergency prevention and rescue agency that is responsible for the overall fire and emergency rescue management and devises mechanisms to lessen the aforementioned mounting trend of accidents in the city.

Fire accidents in Addis Ababa is often results of factors more specifically, carelessness, poor infrastructure, electrical fire, faulty electrics, deforestation and wild fire is the main factors. In these regards, this study also made assessment over the causes and effects of fire accidents in Addis Ababa basing on documented evidence from victim households. Nearly 1 in 4 accidents are the results of carelessness related factor such as Kitchen fire (cylinder fire, stove fire, charcoal fire, Electric contact fire, shock, Candles fire, Smoke of cigarette, Technical error of electronics material and Transformer explosion. This is followed by electrical related factors

which were causes for one in five accidents as a result of causes such as Different factors; including faulty appliances, worn(faulty electrical wiring, improper use of electrical outlets and worn out breaker boxes). Appliances and equipment, electrical issues (electrical equipment), faulty equipment, defective electrics, faulty electrics and flammable and combustible materials. Evidence support that fire accidents are highly related to factors such as carelessness; electrical related factors; poor infrastructure and deforestation and wildfire.

Regarding effects, it was found that an increase in socioeconomic impact because of fire accidents are associated with higher impacts on victims households and similar findings were noted. Concerning injuries and death, and property damage findings indicate that all household who reported property damage (such as house, vehicles, etc.) were found to have high impacts on their livelihoods status. Psychological impacts on households were found to be high and associated with high impacts on livelihoods. It was also found that the higher the impacts on income and savings, the higher the impacts on livelihoods of households.

Besides, cause and effects in the city Addis Ketema fire bridge catchment area is a very high hotspot areas, which were deemed to have resulted in the different livelihoods impacts status among the studies participants, was assessed.

5.2 . Recommendations

Fire accident, serious issues in the country, and causes, impact and hotspot area identification have enormous implications for growth and safety in the study area. Although the recommendations address the issues raised in the report, and victims, they also focus areas where future research would be instrumental in providing greater knowledge that could potentially instigate long-term safety, rule, and regulation and standards improvements within the fire accidents.

Accordingly, based on the research findings the following recommendations were forwarded to help minimize the impacts of fire accidents on victim's households and ensure overall safety.

- The City Fire, and Emergency Prevention and Rescue Agency should put in place strict control and management of emergency response, especially in residential areas. This could be done by assigning more fire brigade officer. This could also help place stricter controls over fire accident of carelessness,
- Stronger emergency and rescue control mechanisms, which contribute towards lessening, sever impacts of accidents. This perhaps could be corroborated by first aid skills training to lessen the chance of injuries leading to death;
- Volunteer service officers should also be trained on fire safety and should be ready and be able to assist with issues related to fire to accident.
- Technical inspection of fire hydrants should be strengthened. This is very crucial as most of the inspections are being done in private and public institutions that need strong inspections.
- Implementing fire safety education to improve source knowledge and experience of the society/ community about fire emergency and safety rules; for children is also very important in schools, and in other occasions;
- Training of trainers for responsible officer for records and documentation (proper, records, keeping, and documentation), training government officials on fire record keeping to all levels, top-down exchange of information, there should be designing uniform data template and reports form to complete for fire events, develop a follow-up mechanism and compilation of data, practice integrated fire management institutional wise, other agencies and institutions, capacity building on proper

management of fire incidence and information, management, fire data compiling and analysis for region and strengthen the agency.

- The agency should also encourage civil society organizations and other interested stakeholders to get involved in providing promotion of fire accident related issues through information sharing to the public (either audio-visually or through posters and banners).
- The Addis Ababa Roads Authority should build and expand proper emergency response roads to minimize the risks and destruction of property and impacts on livelihoods of the society and the economy in general.

Reference

1. Abinet Ergando, 2011: The Role of Remittance and Return Migrants on Urban Growth and Rural Urban Linkage: The Case of Hosanna
2. Addis Ababa fire and emergency prevention and rescue agency 5years report, Nov/2018.
3. Addis Ababa city Fire and Emergency Prevention and Rescue Agency: <http://www.addisababa.gov.et/>
4. Addis Fortune News Paper, Addis Ababa, published on Nov 15, 2016; Vol 17, No 863.
5. Anderson, T.K., (2009). Kernel Density Estimation and K-means clustering to Profile Fire Accident Hotspots. *Accident Analysis and Prevention*, 41, pp. 359–364.
6. Am. J. Public Health 67:1077-1080, 1977: Fire Victims: Medical Outcomes and Demographic Characteristics
7. Australian Bureau of Statistics, (2014). Annual Fire Report
8. Arnold, J.E.M. 1998. Forestry and sustainable rural livelihoods. In D. Carney, ed. *Sustainable rural livelihoods: what contribution can we make?* London, UK, Department for International Development.
9. Australia Fire Department, (2013), Annual Fire Report
10. Australia Fire Authorities Council, (2015). Annual Fire Report
11. Bekibele, C.O., Fawole, O.I., Bamgboye, A.E., Adekunle, L.V., Ajav, R and Baiyeroju, A.M., (2007). Risk Factors for Road Traffic Accidents among Drivers of Public Institutions in Ibadan, Nigeria, *African Journal of Health Sciences*, 14(3-4). pp. 137-142.
12. Central Statics Agency. (2007). Household income, consumption and expenditure (HICE) survey 2004/2005, Volume I, Analytical Report Statically Bulletin 394. Addis Ababa.
13. Central Statics Agency. (2011). Ethiopia Demographic and Health Survey, preliminary report.
14. Central Statics Agency. (2013). Population projection of Ethiopia for all regions at Woreda level from 2014 - 2017. https://www.academia.edu/30252151/Federal_Democratic_Republic_of_Ethiopia_Central_Statistical_Agency_Population_Projection_of_Ethiopia_for_All_Regions_At_Wereda_Level_from_2014_2017. Accessed Mar 2017.
15. Charles R Jennings, 2013: Social and economic characteristics as determinants of residential fire risk in urban neighborhoods: A review of the literature Luckson Chinamatira, Spikelele

- Mtetwa & George Nyamadzawo, 2016: Causes of wildland fires, associated socio-economic impacts and challenges with policing, in Chakari resettlement area, Kadoma, Zimbabwe
16. Chen, Y., Liu, C., Wu, H and Un, W., (2011). Identification of Black Spot on Fire Accidents and its Spatial Association Analysis Based on Geographic Information System. Seventh International Conference on Natural Computation, 143-150.
 17. Chen B., 2005. High rise building fire safety analyzing, safety healthy 2, p. 30-31.
 18. Chinamatira, L., Mtetwa, S. & Nyamadzawo, G. Causes of wildland fires, associated socio-economic impacts and challenges with policing, in Chakari resettlement area, Kadoma, Zimbabwe. *Fire Sci Rev* 5, 1 (2016). <https://doi.org/10.1186/s40038-016-0010-5>
 19. Cochran, W. (1977). *Sampling Techniques* (3rd ed.). New York: John Wiley & Sons.
 20. Corcoran J, Higgs G, Brunson C, Ware A, Norman P (2007). The use of spatial analytical techniques to explore patterns of fire incidence: A South Wales case study, *Computers, Environ. Urban Syst.* 31: 623-647.
 21. Corcoran, J. /2007; the use of spatial analytical techniques to explore patterns of fire incidence.
 22. Creswell.W. (2003). *Research design: Qualitative, quantitative, and mixed methods approach*. Sage Publications Limited, United States. Second edition, Thousand Oaks: Sage.
 23. Davis, B. E., 2013. *GIS: A Visual Approach*. 2nd ed. Canada: Onward Press.
 24. Delhi Fire Service (DFS) (2017) Annual Statistics.
 25. Department for Communities and Local Government, *Fire Statistics Great Britain April 2013 to March 2014*.
 26. Dereje Tesema, 2014: The first part deals with livelihood assets
 27. DiGuseppi, C., Roberts, I., Wade, A., Sculpher, M., Edwards, P., Godward, C. ... & Slater, S. (2002). Incidence of fires and related injuries after giving out free smoke alarms: cluster randomised controlled trial. *Bmj*, 325(7371), 995.
 28. Drake-Hillyard, (2010). Lost Horse Fire at Joshua tree Consumes 450 Acres.
 29. Dube OP (2013) Challenges of wild land fire management in Botswana: Towards a community inclusive fire management approach. *Weather and Climate Extremes* 1:26–4
 30. EEA (2015), *Analysis of fire impacts: Fatalities and economic losses*.
 31. Ellis, F. (2007). Household strategies and rural livelihood diversification. *The Journal of Development Studies*, 35(1):1-38

32. Ethiopian Road Authority. (2001). "Urban Transport Study and Preparation of Pilot Project for Addis Ababa", Final Report, Volume I and II, Consulting Engineering Services (India) Private Limited and SABA Engineering Private Limited Company.
33. Erastus Gatebe, 2016: Assessment Of Fire Safety Preparedness At Jomo Kenyatta International
34. Ermias Teferi, 2017: Urban Heat Island Effect of Addis Ababa City: Implications of Urban Green Spaces for Climate Change Adaptation
35. FAO; 2015: Global Forest Resources Assessment 2015. Desk reference.
36. Fire Department of Ministry of Public Security China Fire Services; report/2013;
37. Fires and fire losses classified 1974. Fire Journal, September, 1975.
38. Fire Protection Association of South Africa (FPASA), (2018) South Africa fire loss statistics 2016', Fire Protection, June, pp. 13–28.
39. Fire Protection Association, report 2015.
40. Fire Sense Technology (Detech), (2015), major causes of fires accidents report.
41. Frachiah Wanjiruwambugu, 2016 ; Assessment of Fire Safety Preparedness at Jomo Kenyatta International Airport Nairobi, Kenya, 2016.
42. Getnet Feyissa, 2018: GIS based quantification and mapping of climate change vulnerability hotspots in Addis Ababa
43. Gernay, T., Selamet, S., Tondini, N. & Khorasani, N.E., 2016, 'Urban infrastructure resilience to fire disaster: An overview', *Procedia Engineering* 161, 1801–1805. <https://doi.org/10.1016/j.proeng.2016.08.78>
44. Gitau, (2006). Fire disaster management a case of Nairobi central business district, Nairobi: Masola Publishers.
45. Global Fire Initiative report/ 2015 <http://nature.org/fire>
46. Hermans, F., Bossche, Van den and Wets, G., (2008). Combining Fire Safety Information in a Performance Index. *Accident Analysis and Prevention*, 40(4), pp. 1337-44.
47. Jing Xin, 2013: Fire risk analysis of residential buildings based on scenario clusters and its application in fire risk management
48. J.M. Watts, J.R. Hall, Introduction to Fire Risk Analysis, SFPE Handbook for Fire Protection Engineering, third ed., NFPA, Quincy, MA, 2002.
49. Ken Tremblay, 2009, "Firewatch," NFPA Journal, November/December.

50. Koch, F. and Ahmad, S. (2018) 'How to Measure Progress towards an Inclusive, Safe, Resilient and Sustainable City? Reflections on Applying the Indicators of Sustainable Development Goal 11 in Germany and India', in, pp. 77–90. doi: 10.1007/978-3-319-59324-1_5.
51. Kothari, C. (2004). *Research Methodology: Methods and Techniques*, 2nd ed., Jaipuri: New Age International Pvt. Ltd., approaches (2nd ed.). California: Sage publications, Inc
52. Latif Fauzi, 2007: *Urbanization, Their Problems and Their Remedies*: <https://www.civilserviceindia.com/subject/General-Studies/notes/urbanization-their-problems-and-their-remedies.html>
53. Luckson.C, 2016. Causes of wildland fires, associated socio-economic impacts and challenges with policing, in Chakari resettlement area, Kadoma, Zimbabwe
54. Machilis GE (2002) *Burning questions: A social science research plan for federal wildland fire management*. University of Idaho, Moscow
55. Massreshaw Assnakew Abebe, 2017: *Segregation of Solid Waste at Household Level in Addis Ababa City*
56. Michael J. Karter, 2013: *Fire Loss in the United States During 2013*
57. Mihretu Tesfaye (2005). *Housing Strategies in Inner City Areas. The Case of Low-Income housing in Inner City Addis Ababa, Ethiopia.*
58. Mitra, S., (2010). *Enhancing Fire Accidents Safety: A GIS based Methodology to Identify Potential Areas of Improvements*, San Luis Obispo, California Polytechnical State University.
59. Ministry of Agriculture and Rural Development (MoARD) (2010), "Ethiopia`s Agricultural Sector Policy and Investment Framework (PIF) 2010-2020," Draft Final Report: Addis Ababa, Ethiopia.
60. Mohammadreza Shokouhi, 2018: *Preventive measures for fire-related injuries and their risk factors in residential buildings: a systematic review*
61. Mossink J. & De Greef M. (2002). *Inventory of Socioeconomic Costs of fire Accidents*. European Agency for Safety and Health at Work.
62. Muhammad Mehedi Masud, 2015: *Livelihood Assets and Vulnerability Context of Marine Park Community Development in Malaysia*

63. National Disaster Management Authority, Government of India, 2012; National Disaster Management Guidelines—Scaling, Type of Equipment and Training of Fire Services.
64. National Disaster Risk Management Commission (NDRMC), Early Warning and Response Analysis - April 2016
65. National Disaster Management Guidelines - Disaster Management Guidelines, 2012
66. National Fire Protection Association, Fire Loss in the United States during 2003;
67. NCRB, N. C. R. B. (2016) Accidental Deaths and Suicides in India 2015. New Delhi.
68. National Meteorology Agency, 2016, weather condition in Ethiopian,
69. Navitas, P., 2014, 'Improving resilience against urban fire hazards through environmental design in dense urban areas in Surabaya, Indonesia', *Procedia – Social and Behavioral Sciences* 135, 178–183. <https://doi.org/10.1016/j.sbspro.2014.07.344>
70. Nyamadzawo G, Gwenzi W, Kanda A, Kundhlande A, Masona C (2013) Understanding the causes, social and environmental impacts, and management of wildland fires in tropical Zimbabwe. *Fire Science Reviews* 2:9–13
71. Özkan Uğurlu, Umut Yildirim, Ercan Yukseyildiz (2015) Investigation of oil tanker accidents by using GIS
72. Pharaoh, R. (2009) 'Fire Risk in Informal Settlements in Cape Town, South Africa', in Pelling, M. and Wisner, B. (eds) *Disaster Risk Reduction - Cases from Urban Africa*. Taylor & Francis, pp. 105–125.
73. Phiri M, Zingwena S, Mahamba SM (2011) Community-based fire management; experiences from the FAO funded project in the provinces of Manicaland and Matabeleland North, Zimbabwe. In: FAO, *Integrated fire approach: From global monitoring to natural fire management*, Fire management working paper FM/27/E. FAO, Rome, pp 51–60. doi:10.1071/WF03015
74. Pluke, M. (2017) 'Case study - Imizamo Yethu fire disaster 11 March 2017', in *Western Cape Disaster Management Risk Symposium*. City of Cape Town.
75. Potts, 2012, *Fire risk reduction on the margins of an urbanizing world*.
76. Pyne SJ. 2016. *Fire in the mind: changing understandings of fire in Western civilization*. *Phil. Trans. R.*

77. Schifiliti, R. (2009). Notification appliances. In A. Cote (Ed.), Fire protection handbook (19th ed.), (Vol. 2. Section 9. pp. 35-42). Quincy, MA: National Fire Protection Association.
78. Scoones, I. (2009). Livelihoods perspectives and rural development. *Journal of Peasant Studies*.
79. Soumyajit Halder, 2016: Fire Accident in Kolkata Slums: A Case Study of Basanti Colony and Tangra Slum-Causes, Consequences and Possible Ways to Mitigation Sanat Kumar Purkait
80. Sustainable Forest Management in a Changing Climate FAO- Finland Forestry Programme – Tanzania, 2013
81. StatsSA (2018) South Africa - Key Statistics.
82. Sustainable Forest Management in a Changing Climate FAO- Finland Forestry Programme – Tanzania; Dares Salaam, 2013.
83. Teferi,E., and H. Abraha. 2017. Urban Heat Island effect of Addis Ababa City: Implications of urban green spaces for climate change adaptation. *Climate Change Adaptation in Africa, Climate Change Management*. https://doi.org/10.1007/978-3-319-49520-0_33
84. The Herald (2011), Veld fires destroy 5,000 hectares.
85. The International Federation of Red Cross, annual report, 2017
86. Richard Campbell, (2017): NFPA's "Intentional Fires"
87. Raimo Streefkerk., 2018: Primary and secondary sources
88. UK fire department report, (2013). Annual fire report
89. UNDP , (2008), Human Development Report 2007/08
90. UNDP, (2013). Human Development Report 2013
91. UNEP. (2003). Scientific report on the ground water vulnerability mapping the art water supply aquifers, Addis Ababa, Ethiopia.
92. UN Habitat, (2015) Sustainable Development Goal 11. Available at: <https://sustainabledevelopment.un.org/sdg11>.
93. UN Habitat, (2016) HABITAT III New Urban Agenda.
94. UN World Urbanization Prospects, (2019).link: <https://population.un.org/wup/>
95. U.S Fire Department (USFD) fire report, 2013.
96. U.S Fire Department, 2015, Annual fire report

97. USDA (2013) Wildfire, Wildlands, and People: Understanding and Preparing for Wildfire in the Wildland-Urban Interface. United States Department of Agriculture (USDA), Washington DC
98. WHO, (2013). Global Status Report on Road Safety.
99. WHO, (2015). Global Status Report on Road Safety.
100. Woldegerima, T., K. Yeshitela, and S. Lindley. 2016. Characterizing the urban environment through urban morphology types (UMTs) mapping and land surface cover analysis: The case of Addis Ababa, Ethiopia. *Urban Ecosystem*.19 (2): 245–263. <https://doi.org/10.1007/s11252-016-0590-9>.
101. World Bank. 2015. Enhancing urban resilience Addis Ababa, Ethiopia.
102. World Bank. 2018. Ethiopia: New World Bank Report Shows Mixed Outlook as Growth Leads to Overall Poverty Reduction.
103. World Population Review, (2019); <https://worldpopulationreview.com/world-cities/addis-ababa-population/>.
104. World Wide Fund (WWF) (2001); DGIS-WWF Ethiopia Project: Forest Conservation in High Priority Areas, February, Addis Ababa
105. Xiaoxiang Zhang, (2018): Exploring Spatiotemporal Dynamics of Urban Fires: A Case of Nanjing, China
106. Addis Ababa city Fire and Emergency Prevention and Rescue Agency: <http://www.addisababa.gov.et/>

Appendices

Appendix A

Addis Ketema fire-brigade branch catchment area include in the study area

No.	Sub city	Woreda														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Addis Ketema	1	2	3	4	5	6	7	8	9	10	-	-	-	-	15
2	Arada	-	2	-	-	-	-	7	-	-	-	-	-	-	-	-
3	Gulele	-	-	-	-	-	-	-	8	9	10	-	-	-	-	15
4	Lideta	1	2	3	4	5	6	-	8	9	-	-	-	-	-	-
5	Kolfe Keranyo	1	-	-	4	-	-	-	-	-	10	11	12	13	14	-

Source: five-year fire accident report from 2013/14-2018/19

Appendix B

Addis Ketema fire-brigade branch catchment area five-year report 2013/14-2018/19

No.	Year	Total fire accident	Loss of life and injury	Destruction of property (Birr)
1	2013-14	-	-	-
2	2014-15	61	41	68,090,305
3	2015-16	41	11	22,434,200
4	2016-17	47	8	4,731,800
5	2017-18	45	17	62,340,540
6	2018-19	14	5	2,362,000
	Total	211	86	159,958,845

Source: five-year fire accident report (AAFEPR, Nov/2018).

Appendix C

Addis Ababa city fire-brigade branch service area five-year report 2013/14-2018/19

No	Name branch	Total	Injury	Death	Destruction of property (Birr)
1	Arada	210	24	2	24,614,697
2	Addis Ketema	211	81	4	159,958,845
3	Gulele	36	-	-	3,969,000
4	Cherkos	210	37	3	20,823,453
5	Akaki Kality	128	16	-	16,779,600
6	Bole	210	80	3	66,373,590
7	Kolfe Keranyo	96	22	1	56,465,600
8	Nifas Silk Lafto	111	9	1	11,199,800
	Total	1,212	269	14	360,184,585

Source: five-year fire accident report from 2013/14- 2018/19

Appendix D

Questionnaire to be responded by selected individual in the study area

Introduction

This questionnaire is prepared by a student of the Addis Ababa University, graduate program. The aim of the questionnaire is to examine the existing condition of fire accident in Addis Ababa city administration. Your cooperation in filling the questionnaire is honestly appreciated. The data collected will remain confidential, so your name and address are not needed.

1. General information about respondents

1.1 Date (day/month/year) _____/_____/2019

1.2 Sub city: _____

1.3 Woreda: _____

1.4 Village: _____

1.5 Sex _____; A. Male B. Female

1.6 Age _____;

1.7 Marital Status ____; A. Single B. Married C. Divorced D. Widowed/Widower

1.8 Family size _____;

1.9 Education ____; A. Illiterate B. Primary (1 - 8) C. Secondary (9 - 12) D. Tertiary (12+)

1.10 Job _____;

2. What was the cause of fire accident you face or observed? [rank 1st, 2nd, 3rd, 4th and 5th]

No.	Cause of fire accident	Rank
1	Poor infrastructure	
	Urbanization without proper design and master plan [poor road network, poor housing or slum]	
	High population density	
2	Carelessness	
	Kitchen fire (cylinder fire, stove fire, charcoal fire)	

	Electric contact fire, shock	
	Candles fire	
	Smoke of cigarette	
	Technical error of electronics material	
	General negligence (human error)	
	Transformer explosion	
3	Electrical fire	
	Different factors; including faulty appliances, worn or faulty electrical wiring, improper use of electrical outlets and worn out breaker boxes. Appliances and equipment, electrical issues (electrical equipment), faulty equipment.	
	Defective electrics such as loose wires, or faulty equipment that can overheat and cause sparks	
	Overuse of appliances, home heating systems, and children playing with fire.	
	Faulty electrics; includes loose wires, plugs that are over loaded and old equipment	
	Flammable and combustible materials	
	Arson	
4	Deforestation and wild fire	
5	Others	

3. What impacts of fire accident you face or observed? [rank 1st, 2nd, 3rd, 4th and 5th]

No.	Fire accident impacts	Rank
1	Injuries and death	
2	Psychological impact	
	Suffer stress; trauma and grief	
	Signs of anxiety might be depicted long after the disaster has	

	happened, depression and grief as well as behavioral and substance abuse	
3	Socio-economic impact	
	Children class dropout (school books and uniforms)	
	Burnt clothes and important documents	
	Damage and destruction of property	
	Unemployment, loss of shelter/ accommodation, loss of livelihood, forced to burden communities used to live with	
4	Cultural impact	
	Loses of cultural heritage	
5	Others (loss of social links (capital)	

4. When the fire accident takes place/happened [rank 1st, 2nd, 3rd, 4th and 5th]

No.	Season	Rank
1	Winter [Dec, Jan, Feb]	
2	Summer [Jun, July, Aug]	
3	Autumn [September, October, November]	
4	Spring [March, April, May]	

5. What time the fire brigades arrive at fire emergency place. [rank 1st, 2nd, 3rd, 4th and 5th]

No.	Time (minute)	Rate	Rank
1	≤ 10 min	Very good	
2	10-20 min	Good	

3	20-30 min	Poor	
4	≥ 30 min	Worse	

6. What are the factors for hinderances to arrive fire-brigade to control fire accident? [rank 1st, 2nd, 3rd, 4th and 5th]

No.	Factors	Rank
1	Traffic congestion	
2	Unplanned residents' site	
3	Long station distance (dispatch office)	
4	Lack of using technology to know exact place of fire emergency site	
5	Poor infrastructure	
6	Others (poor communication)	

7. Who is your source of knowledge and experience about fire emergency safety rules? [rank 1st, 2nd, 3rd, 4th and 5th]

No.	Source of knowledge and experience	Rank
1	Community	
2	Parents	
3	Schools	
4	Fire-brigade	
5	Media	

8. How do you perceive the level of fire accidents in your area and general the Addis Ababa city?
- a. A big problem
 - b. A moderate problem
 - c. Not a problem

9. Would you describe some cause of fire accidents in the study area?

10. Would you describe some impacts of fire accidents in the study area?

11. Suggest some possible solutions to prevent and reduce fire accidents in the study area.

Thanks for your cooperation!!

Appendix E

Ground control points (GCP) of fire accident existing point is collected by using GPS, which were generated during field survey.

Unit: meter

No.	Coordinate	
	X	Y
1	471754	996312
2	470676	996953
3	471748	997991
4	470609	997097
5	470737	996950
6	470354	996636
7	472199	996792
8	472228	996844
9	469308	999094
10	470678	998122
11	469775	999680
12	469298	998970
13	470546	998349
14	470035	998897
15	470822	999908
16	470789	998443
17	470392	999904
18	469616	997820
19	469186	998041
20	469651	998645
21	469517	998731
22	470123	997502
23	471118	998101

24	470794	998700
25	468905	999796
26	468852	999731
27	469800	998661
28	471153	998267
29	469598	998242
30	470480	998841
31	470906	998563
32	468669	998647
33	471379	998561
34	470567	998121
35	469517	999625
36	471099	998198
37	471170	998538
38	469889	998664
39	470762	998183
40	469275	998046
41	470875	998625
42	469649	998586
43	469532	998590
44	470818	998313
45	467614	1000343
46	467731	1000518
47	464748	994934
48	467651	999396
49	465577	998163
50	467160	1001126
51	468656	1002440
52	469497	1001047
53	468940	1001695

54	470158	1000442
55	468923	1001843
56	470482	1002159
57	469663	1000873
58	469039	1001138
59	469226	1002002
60	470170	1001208
61	470763	1000570
62	471154	997418
63	470010	998659
64	470795	998429
65	470628	997602
66	470794	998417
67	469795	999250
68	470503	998348
69	470020	997951
70	470655	999957
71	470641	997898
72	469627	998052
73	471101	998789
74	469339	999762
75	470544	998362
76	471109	998103
77	470264	998557
78	469310	999121
79	470221	997998
80	471150	999014
81	471315	998458
82	470809	998306
83	470520	998465

84	471157	998703
85	471085	998010
86	470296	999497
87	470403	998666
88	470578	997960
89	468644	999256
90	471099	997799
91	469275	999207
92	470099	997857
93	469571	998719
94	471498	998809
95	467514	1000052
96	468309	1000936
97	467676	999971
98	467169	998391
99	468263	1001027
100	467115	1001059
101	469574	1001993
102	469165	1001403
103	471764	997556
104	471662	996739
105	470368	997201
106	470554	997079
107	470620	997279
108	468845	997660
109	471337	997961
110	470155	998688
111	468501	999543
112	470250	999015
113	471674	998021

114	470409	999402
115	470013	998713
116	469677	998026
117	470780	998042
118	471705	998715
119	470735	997841
120	470330	999913
121	470938	999677
122	469835	998515
123	470817	998198
124	468858	999255
125	470465	998565
126	470444	998721
127	469349	997586
128	469172	998155
129	471638	998059
130	469490	998577
131	471653	997990
132	471084	997639
133	471124	998786
134	468690	999841
135	468745	998988
136	468606	1000459
137	474590	998921
138	470636	999945
139	470271	999480
140	469233	999326
141	470646	997877
142	470088	997824
143	466891	998250

144	467710	999289
145	466357	1001786
146	466746	999271
147	466756	997614
148	467882	998646
149	469575	1001648
150	471489	997757
151	469795	996147
152	471633	997669
153	470762	997109
154	468827	997565
155	470572	998018
156	469408	997791
157	468660	999211
158	470002	998234
159	469728	997834
160	470687	998839
161	469966	997750
162	469942	997707
163	469856	997722
164	469899	997760
165	469935	997648
166	469074	999590
167	469259	999183
168	470739	998566
169	470252	998653
170	470128	997906
171	470584	999116
172	470837	998585
173	470095	998543

174	469253	997880
175	470442	998802
176	470429	998343
177	470391	998336
178	469403	998208
179	469975	998537
180	469716	997921
181	470767	998421
182	471528	998580
183	469153	998823
184	469916	999170
185	469765	997820
186	470158	998066
187	470530	998032
188	470220	997995
189	469507	998223
190	468423	999524
191	470585	997820
192	465477	992255
193	468479	998883
194	467365	998795
195	470539	998041
196	471576	997730
197	469851	999985
198	469998	998718
199	469344	998942
200	470623	996860
201	469913	996461
202	469632	997253
203	470738	999383

204	470269	998252
205	470981	997624
206	471106	997596
207	470281	996154
208	468598	999107