FACTORS INFLUENCING THE DENSITY OF TREES IN SCHOOL TREE ENCLOSURES WITHIN KAJIADO COUNTY, KENYA

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DECLARATION

I declare that this document and the research it describes are my original work and they have not been presented in any other University for academic work.

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This research is submitted for examination with our approval as University supervisors.

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DEDICATION

This study is dedicated to my dear parents Mr. P**é**p**é** Vuna, Mrs. Annie Vuna and my elder brother Gracy Vuna who contributed a lot to this thesis with their patience, support and encouragement.

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LIST OF ABBREVIATIONS AND ACRONYMS

CGK: County Government of Kajiado

CFM: Community Forest Management

FAO: Food and Agriculture Organisation

FRA: The Global Forest Resource Assessment

KFS: Kenya Forest Service

KMEF: Kenya Ministry of Environment and Forestry

NEMA: National Environment Management Authority

REDD: Reducing Emissions from Deforestation and forest Degradation

ROK: Republic of Kenya

RWH: Rain Water Harvesting

SDG: Sustainable Development Goal

SWC: Soil and Water Conservation

UN: United Nations

UNEP: United Nations Environment Program

UNFCCC: United Nations Framework Convention on Climate Change

UNICEF: United Nations International Children's Emergency Fund

UNSD: United Nations Statistical Division

WCED: World Commission on Environment and Development

WHO: World Health Organisation

WOCAT: World Overview of Conservation Approaches and Technologies

ABSTRACT

Achieving minimum international recommendations regarding tree cover is a challenge in Kenya, particularly in Kajiado County. As the region faces severe land and forest degradation, planting and managing trees inside school compounds can contribute to improving tree density. This study was therefore aimed at assessing the factors that influence the density of trees in school tree enclosures within Kajiado County, precisely Kajiado North, East, West and Central sub-counties. The four specific objectives of this work were to determine the influence of (i) school management; (ii) availability of water; (iii) collective action and (iv) climatic factors on the density of trees in school enclosures within Kajiado County. The target population consisted of 892 primary and secondary (private and public) schools. Twenty three (23) schools with tree enclosures were purposively selected for the study. A random sample size of 324 respondents including students along with teachers was considered as well. A semi-structured questionnaire coupled with observations and measurements were used for data collection in the study area. This study followed the *ex-post facto* design while data collected were analysed through descriptive and inferential statistical methods performed with the Statistical Package for the Social Sciences (SPSS version 26) software, and all ethical and legal practices were respected. This study revealed that the majority of schools had tree densities ranging from 51 to 100 trees per hectare (ha) of school tree enclosure. *Acacia xanthophloea* was the dominant tree species distributed across school enclosures. Moreover, the density of trees was significantly influenced by the school management (β=0.899, $p<$ 0.001); availability of water (β=0.946, $p<$ 0.001); collective action (β= 0.869; $p<$ 0.001) and climatic factors (β=0.907, $p<$0.001). The findings of this study are critical to school community members (teachers, students, and board of management) and other environmental stakeholders such as policymakers, government officials, and donors. The study recommends the setting up of small pieces of land in school compounds to implement tree enclosures as affordable and sustainable ways of improving tree cover in degraded landscapes. The study also suggests the use of Soil and Water Conservation (SWC) techniques such as Rain Water Harvesting (RWH) from rooftops of school buildings along with the digging of pits lined with plastic to collect runoffs as some of the mitigating measures against the low availability of water for tree planting and management in enclosures.

DEFINITION OF TERMS

Enclosure: an area surrounded by fences or walls and used for a specific purpose (The Oxford Compact English Dictionary, 1996).

School management: refers to the process whereby school activities are coordinated to meet the school environmental goals.

Tree: a woody perennial with a single main stem, or in the case of a coppice, with several stems, having a definite crown. This includes bamboos, palms, and other woody plants meeting the later criteria (FRA, 2015).

Tree cover: comprises of tree patches outside the recorded forest area exclusive of forest cover and less than the minimum mappable area (1 ha) (FRA, 2015).

Tree density: The number of trees per unit area (Johnson *et al*., 2009).

Tree enclosure: refers to an enclosure containing trees inside. It is also simply referred to as enclosure or school enclosure in this study.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The potential benefits of trees for both poverty alleviation and the provision of environmental services has been recognised (Tewari, 2008). By planting more trees we compensate for the loss we have caused the planet and bring a lot of benefit to our communities. According to Hamburg *et al.* (2000), tree planting increases tree cover which has been recognised to be necessary as a storage site for carbon dioxide (CO_2) and thus helps in stabilising the global temperatures that have increased since the late 19^{th} century.

The Global Forest Resources Assessment (FRA, 2010) stated in its report that the world's total forest area is estimated to be more than 4 billion hectares which is representative of an average of 0.6 hectares of forest per capita. According to the same report, more than half of the entire forest cover (53 %) on Earth is found in the Russian Federation, the United State of America, Brazil, Canada and China. These countries are the five most forest-rich in the world. Based on FRA (2010) statistics, there are still 64 countries with forest covering less than 10 % of their land area at most. Kenya is one of those countries. Although the global rate of net annual forest loss had slowed by more than 50 % between the periods 1990 to 2000 and 2010 to 2015, decreasing from 7.3 to 3.3 million hectares per year (FRA, 2015), it was nevertheless estimated that the global forest area in 2015 stood at 3 999 million hectares. This figure represents a surface area equal to 30.6 % of the world's land area (FAO, 2016).

The forest sector was considered and addressed by the international community through the 17 Sustainable Development Goals (SDGs) of the 2030 agenda for sustainable development in 2015 (UNSD, 2016). SDG 15 “life on land”, aimed, by 2020, to protect, restore, and promote the sustainable use of terrestrial ecosystems. SDG 15 specifically aimed to (i) manage all types of forests sustainably, (ii) combat desertification, (iii) halt and reverse land degradation, and (iv) substantially increase global afforestation and reforestation efforts (UN, 2016).

Managing forests in a sustainable way in Kenya can contribute to achieving SDG targets as it can lead to the improvement of forest cover in the country. Although a report by the Kenyan Ministry of Environment and Forestry (KMEF) (2018) mentioned that about 7.4 % of the total land area is estimated to be Kenya’s forest cover, which is far from the globally recommended minimum of 10 %; it was however concluded that Kenya’s closed canopy forest cover is currently about 2 % of the total land area. This is still not enough when compared to 9.3 % of the African average as well as the World average of 21.4 % (KMEF, 2018).

Not only has Kenya not reached 10 % forest cover, but the country’s forests have also been depleted at an alarming rate of about 5,000 hectares per annum in recent years (KFS, 2014). This is one of the causes of a reduction of approximately 62 million cubic metres in water availability per year, resulting in an economic loss to the economy of over USD 19 million. The depletion of forests may jeopardise Kenya’s attainment of Vision 2030 and the Government’s Big Four Agenda of affordable and decent housing, food and nutritional security, manufacturing and universal healthcare, if it is not urgently addressed (KFS, 2014).

Recognising the role that the country’s water towers and forests play in providing environmental services that include water quality and quantity, reduction of soil erosion, and creation of micro-climatic conditions that maintain or improve productivity, Kenya's Government has taken the tree-planting drive to Kajiado County as part of a nationwide campaign to increase forest cover to 10 % by the year 2022 (KMEF, 2018). The countrywide campaign consists of each county planting a least a million tree seedlings every year for the next four years to guarantee that the target is met. In order to achieve this goal, educational institutions are one of the means through which more trees can be planted and maintained in Kajiado County as it is among the most affected by deforestation and land degradation. Besides, the Kenyan Ministry of Environment and Natural Resources (2016) underscores the situation by stating in its report that the severe degradation occurring in Kajiado County is mainly due to high soil erosion, drought along with a declining vegetation cover. Grazing, browsing, charcoal burning, extraction of fuel wood and cultivation are other major causes of vegetation reduction (ROK, 2018). These conditions have indeed made the County to be part of the national tree-planting campaign initiated by the government of Kenya to improve tree cover, which will also increase the density of trees in the region.

1.2 Statement of the Problem

Achieving the target number of trees to be planted in Kenya is a significant environmental challenge. There is a growing need for planting more trees in order to fight degradation and improve forest tree cover within Kajiado County as it has been severely affected by drought, high soil erosion, declining vegetation cover and clearing of indigenous trees among other things. As many stakeholders have come together with the government of Kenya to address the matter, several programmes such as the Green School programme have started using local school enclosures for tree planting and managing activities. Not only are a lot of environmental benefits reaped from these undertakings such as their contribution to mitigating climate change, cleaning the air and sequestering carbon from the atmosphere, but also they are necessary to increase the density of trees within school enclosures. Furthermore, implementing tree planting campaigns requires the participation of all stakeholders involved in the process to yield desired outcomes while addressing quite a few challenges coming along the way. That is why the effectiveness of tree planting and management activities can be understood through the underlying causes of reduced tree cover within Kajiado County. In this regard, the school management, availability of water, collective action, and climatic factors were identified as factors influencing tree density in school enclosures and will be the focus of this study in Kajiado County, Kenya.

1.3 Research Objectives

1.3.1 General Objective

The general objective of this study was to assess the factors that influence tree density in school tree enclosures within Kajiado County, in Kenya.

1.3.2 Specific Objective

The specific objectives of this study were:

(i) To determine the influence of school management on the density of trees in school enclosures in Kajiado County;

(ii) To Assess the influence of the availability of water on the density of trees within school enclosures in Kajiado County;

(iii) To identify the influence of collective action on the density of trees inside school enclosures in Kajiado County;

(iv) To determine the influence of climatic factors on the density of trees in school enclosures within Kajiado County.

1.4 Research Questions

The research questions that guided this study were:

(i) How does the school management influence the density of trees in school enclosures in Kajaido County?

(ii) To what extent does the availability of water influence the density of trees in school enclosures in Kajiado County?

(iii) How does collective action influence the density of tree inside school enclosures within Kajiado County?

(iv) To what extent do climatic factors influence tree density in school enclosures within Kajiado County?

1.5 Significance of the Study

The aim of this study was to understand the relationship between tree density and factors that affect it in school tree enclosures within Kajiado County. The study brought relevant information regarding the current forest and tree declining while addressing some issues faced by the stakeholders involved in tree planting campaigns carried out in school compounds in Kajiado County. The findings of this study are critical for policymakers, government authorities and the school community in general as they will contribute to the improvement of the number of trees already grown and managed inside enclosures in Kajiado County. This study also provided information useful for halting and reversing land degradation in addition to stopping biodiversity loss as per sustainable development goal 15.

1.6 Scope of the Study

This study was conducted in Private and Public primary and secondary schools owning tree enclosures within Kajiado North, East, West and Central sub-counties in Kenya.

1.7 Limitations of the Study

This study faced two main challenges. First, was the reluctance of the board of management along with other respondents of schools owning tree enclosures as to the real motivation behind it. To overcome that, the respondents were explained the importance and the benefits of this study as per its objectives. The second challenge was due to the fact that the researcher was not familiar with the area of study. This was sorted out through the hiring of two local guides who helped him around.

1.8 Delimitations of the Study

This study was delimited within Kajiado North, East, West and Central Sub-Counties, in Kajiado County, Kenya. Kajiado South was not included since the region is more arid than the others and was considered less likely to have tree enclosures maintained in schools compounds. This study was therefore focused on schools owning enclosures with trees already planted and grown inside.

1.9 Assumptions of the Study

This study was based on the following assumptions. First, Kajiado County is an arid area that has been severely degraded by illegal logging, charcoal production, high soil erosion and climate change; hence tree planting and management activities were being performed to improve tree density. Kajiado South is more arid than the other sub-counties, which makes it less likely to have tree enclosures. The researcher also assumed that all respondents would be honest and straightforward when answering the questionnaire.

1.10 Theoretical Framework

This study was anchored on the sustainability theory, which was conceptualised with the release of the Brundtland Report in 1987 (Stoddart, 2011). Sustainability refers to the ability of a human, natural, or mixed system to withstand or adapt to endogenous or exogenous change indefinitely (Dovers and Handmer, 1992). It encompasses three pillars. Those are the environment that is the natural world made up of forests and dryland ecosystems to name a few, and providing for ecosystem services such as the cleaning of the air and sequestration of carbon to name a few. The social aspect represents the second pillar which is focused on the community (capacity building, participation, and well-being among others). The economic pillar is the last of them (UNSD, 2016).

This theory is relevant to this study in the fact that planting and maintaining trees in school enclosures within Kajiado County is a sustainable way of improving tree cover and density, which is vital for the school community and the environment in general. As benefits arising from tree planting and managing activities have been recognised (Ordonez, Luedeling, Kindt, Lestari, Harja, Jamnadass and Van Noordwijk, 2014), improving tree cover and density can thereby contribute to achieving Sustainable Development Goal (SDG) 15 namely life on land, which supports global afforestation and reforestation programmes (Sentori *et al.*, 2014). Implementing sustainability principles in enclosures is therefore crucial for school communities to adapt to Kajiado County's arid and semi-arid climate already aggravated by climate change as it will strengthen their resilience to environmental changes.

1.11 Conceptual Framework

This section presents the relationship between the dependent and independent variables through graphical depiction. The dependent variable is manipulated by the independent ones. The independent variables are the school management (awareness, participation and commitment of the school board of management to tree planting and management); water availability (amount, quality and seasonality); collective action (school environmental clubs and group activities) and climatic factors (the way climate factors affect tree density through the drying of trees, water availability, and selection of species). The density of trees in school enclosures is the dependent variable; it was measured by the number of trees grown in the school enclosures, size of the enclosure covered with trees, species diversity, and cover.

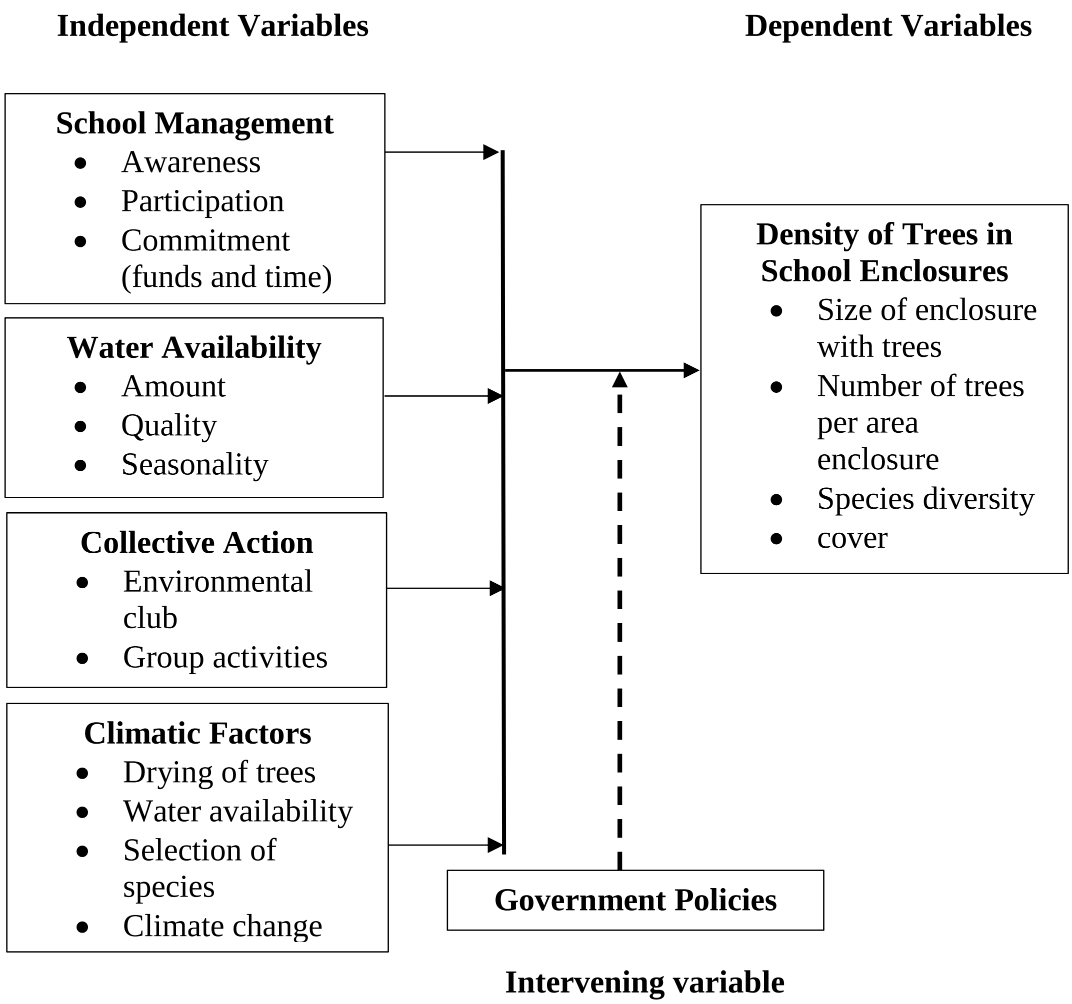

Figure 1.1: Conceptual framework showing the factors affecting tree density in tree enclosures owned by schools in Kajiado County.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section discusses the empirical literature shaping this study and related to the factors affecting tree density in school enclosures. There is an intervening variable of government policies that is addressed as well.

2.2 Tree Density Concept

The density of species is the number of individuals per unit area (Kronenfeld and Wang, 2007). It is an essential regulator of forest growth and competition (Liang *et al.*, 2019; Rubio-Cuadrado, 2018). Tree density simply refers to the number of trees per unit area (Johnson *et al.*, 2009), which is a metric of the abundance of trees in a given area and can be used to indirectly measure the intensity of competition that influences tree growth, mortality and dieback (Bottero *et al*., 2016). It can be expressed in hectares for example. Tree population density can be calculated from sizes and numbers of all trees present within an area, and compared to an upper biological maximum tree population density to estimate relative tree population density, which enables comparisons between diverse sites, species, and stand ages (Jack and Long, 1996). According to Adams *et al*. (2009), plant population density is crucial as it can govern patterns of resource availability and competition in order to determine growth, rates of recruitment and mortality. Plant characteristics such as density, crown, height and diameter at breast height can indicate ecological functions of plants, growth status and affect the ecological process of a population, community, or even an ecosystem (Vidal *et al*., 2008; Wadt *et al*., 2005). Tree density can be used as an indirect measure of intensity of competition in forest ecosystems and influences forests growth and mortality around the world (Hille *et al*., 2002). The role of the density of tree population on forest growth in response to periodic drought has been quantified by some studies (Sohn *et al*., 2016; Hille *et al*., 2002; Hartel *et al*., 2013). Jakobsson and Lindborg (2015) revealed in a recent study that the density of trees could promote a broad and species-rich plant community in consistently managed pastures without negatively affecting grassland specialist species. Hartel *et al*. (2013) focused on shrub density and argued that it had a positive linear effect on both species richness and abundance.

Sohn *et al.* (2016) arguing on decreasing population density, concluded that reduced tree population densities could enhance the resilience and resistance of forest growth to drought. Moreover, Naito *et al*. (2008) claimed that the amount of pollen available for outcrossing could be limited by a reduced population density which could reduce production of seeds, while a decrease in population density in several species could be compensated by a change in the behaviour of pollinators allowing for higher dispersal distance of pollen following Carneiro *et al*. (2011) findings. Additionally, the density of trees can also be decreased through logging. Studies addressing the impact of logging have been subjected to contradictory results with most of them demonstrating, for instance, that logging has a limited impact on the genetic diversity and reproductive biology of timber species after only one event of logging (Carneiro *et al*., 2011; Sohn *et al.*, 2016). Based on De Lacerda *et al.* (2013;) and Wernsdörfer *et al*. (2011) studies, the demography and genetic diversity of harvested tree species can be negatively affected by multiple cycles of logging.

2.3 Role and Significance of Enclosures

2.3.1 The Concept of Enclosure

Enclosures are areas surrounded by fences or walls. Benkhe (1986) defines enclosures and exclosures as spaces closed off from grazing for a specified period of time in order to enable vegetation to regenerate. They are conventional approaches used for the rehabilitation of rangelands with poor conditions (Verdoodt *et al*., 2010).

In recent years, confusion and misunderstanding have occurred from the interchangeable use of enclosure and exclosure as terms (Aerts *et al*., 2009). Exclosures are fenced or manually protected areas that are established for the purpose of fighting grazing and at times, the natural or planted regeneration of vegetation (Benkhe, 1986). For instance, exclosures have been used as a method for rehabilitating degraded land in Ethiopia (Nyssen *et al*., 2015). They refer, in the Ethiopian context, to degraded lands that have been excluded from human and livestock intrusion in order for them to be rehabilitated (Winberg, 2010). Based on studies by Verdoodt *et al*. (2010), Angassa and Oba (2010), enclosures in many ways can be considered as effective measures to preventing livestock from grazing protected areas during wet seasons, when neighbouring open rangelands are often grazed by them. They are specific land units that are protected from activities of a particular class of animals using appropriate barriers such as fencing to control the influence of those animals (Young, 1958) and are primarily established to rehabilitate degraded landscapes according to Benkhe’s (1986) definitions. Aerts *et al*. (2009) consider that exclosures are mainly concentrated on the exclusion of livestock, while enclosures ensure that livestock (or crops at times) is kept inside a given area. The term “enclosure” will be used throughout this study.

2.3.2 Environmental and Conservation Role of Enclosures

Setting up of enclosures has increased in recent decades (Beyene, 2009). They have emerged as one of the strategies to rehabilitate and restore degraded environments (Kibret, 2008). Enclosure is a widespread practice used by pastoralists in communal rangelands in East Africa (Angassa and Oba, 2010). It has begun to dominate individual user and access rights with its increase in scale, frequency, and permanence (Nyberg *et al.*, 2015). Tefera (2005) and Descheemaeker *et al*. (2006) argue that enclosure areas improve soil quality, essentially through organic matter accumulation. They involve the protection and resting of severely degraded lands to restore their productive capacity (WOCAT, 2013). Enclosures not only prevent loss of soil but also ensures that it is not deposited in lakes, river bottoms, and dams by significantly reducing sediment loads coming from eroded upstream crops and rangelands if vegetation coverage is the land use (FAO, 2001).

Mureithi *et al.* (2015) and Verdoodt *et al.* (2010) discussing on the impact of enclosure management stated that the use of enclosures encompasses a wide choice of management techniques such as the physical fencing of reduced parcels of land for private or communal purposes as well as the implicit social contracts concerning the use of larger areas of communal land (Barrow, 2016). Enclosure is a well-known management tool for environmental rehabilitation (Aerts *et al.*, 2002). It constitutes in some areas, a traditional periodic land management tool used for subdividing communally owned grazing land into open parcels for grazing in different seasons (Angassa and Oba, 2010; Abate, 2016), while in other areas, enclosures can be used to address food insecurity, socio-economic crisis of endemic poverty and for rehabilitating degraded rangelands (Nyssen *et al*., 2015). For example, enclosures have been used in Mu Us desert in China as most suitable measures for their simple implementation, low cost and quick effects in restoring degraded grassland despite the application of a wide range of practices including ploughing, reseeding, fertilising, establishing artificial grasslands, controlling grazing intensity, and balanced management of the grassland (Batoyun *et al*, 2016). This shows that using enclosures for restoration of lands that are degraded is a cheap method as natural processes lead to recovery of vegetation without any human intervention and financial investment (Mengistu, 2005). Closing off an area of land from grazing can help natural vegetation to recover. This can increase plant cover and production of grasses, herbs and trees biomass (Angassa, 2016; Yayneshet *et al.*, 2009) while generally improving plant biodiversity natural regeneration (Hailu, 2016; Angassa, 2014). The cover, proportion and abundance of annual and perennial grasses increase as well (Verdoodt *et al*., 2010; Hailu, 2016). Moreover, Descheemaeker *et al*. (2006) also state that area enclosures were essential measures to combat land degradation and increase biomass production. Nyssen *et al*. (2007) reveal that sheet and rill erosion rates decreased while spring discharge, vegetation cover and crop production improved in area enclosures. The gradual restoration of an ecological environment using enclosures can allow for the gradual recovery of the vegetation community (Li *et al*., 2017; Deng *et al*., 2014).

When considering ecosystem services, Mekuria (2011) indicates that enclosures are service regulators through below and aboveground carbon sequestration while contributing to the provision of ecosystem services through the generation of animal feed and human food (Haile, 2012). Additionally, the main contributions of enclosures are seen through improvement of food security, reduction of vulnerability, enhancement of well-being and provision of forest products including trees that can increase incomes to the livelihoods of the poor in rural areas (Kibret, 2008; Girma, 2006). Enclosures also, through functions such as the prevention of physical soil loss, protection and increase of topsoil depth, maintenance and increase of soil water holding capacity, prevention of loss of soil nutrient content and increase of soil organic matter can improve hydrology, soil quality and productivity inside forested land in several ways (Descheemaeker *et al*., 2006). Kindeya (2004) and Kibret (2008) add that the establishment of area enclosures can reduce the risks of flooding and drought in vulnerable ecosystems, improve land use planning of the watershed and help to enhance sustainable utilisation of agricultural land down streams. Enclosures encourage the resilience of ecosystems (Wu, 2009) by excluding livestock and improving livelihood of environmental conditions (Gao, 2009). Flintan *et al*. (2011) and Fekadu (2009) consider controversial the effectiveness of enclosures in restoring specific herbaceous and woody vegetation attributes arguing that enclosures are rangeland privatization strategies that threaten their long-term sustainability. Tache (2011), Angassa and Oba (2010), state that many authors have considered enclosures as means of recovering good quality grazing resources as they can increase plant biomass (Batoyun, 2016; Zhu, 2016) and improve plant diversity and soil physicochemical properties (Zeng, 2017; Li, 2017; Deng, 2014).

2.3.3 Socio-Economic Contributions of Enclosures

Socio-economic needs of local people are fundamental for enclosures to carry on their environmental and conservation role. Most traditional pastoral communities implement enclosure management systems as they set aside portions of their grazing land for different uses over time. According to Descheemaeker *et al.* (2006), a positive attitude towards enclosures can be obtained from sustainable and socially fair harvesting systems of wood resources as well as a rotational grazing system. In Tanzania and Ethiopia for instance, decisions regarding size of enclosures, when or where to enclose along with whose livestock, and when to get access to the enclosures, was managed by traditional institutions (Napier and Desta, 2011; Selemani *et al*., 2013). More recently, increase of land pressure, population and commoditisation of agriculture has led to increased use of enclosures as a land management tool (Woodhouse, 2003; Nyberg *et al*., 2015). In addition, Karmebäck *et al.* (2015) and Wairore *et al.* (2015) consider that enclosures can facilitate diversification of agriculture.

Furthermore, they recognise evolving enclosure systems as one that can bring about, in society, elite capture which means that rich and well-connected people in local societies are first to claim land. This has led to the evolution of conflicts between pastoralists, crop farmers and agro-pastoralists (Beyene, 2010).

2.4 Role and Importance of Forests and Trees

Forests and trees play a vital role for many people across the world as they contribute to their livelihoods, conserve biodiversity, and provide for clean water and air (FAO, 2018). Forests do not only improve the overall environmental quality, but ecosystem services such as recreation and landscape enhancement are also some of the benefits that are provided by forests (Bottalico *et al.*, 2015).

According to FAO (2016), more than three-quarters of the world's terrestrial biodiversity is found in forests. Forests are the main areas of interest when it comes to biodiversity conservation (FAO, 2016). Forests with mixed-species may lead to more productive, more resilient and healthier forest ecosystems (Ordonez *et al*., 2014). A diverse forest can bring a lot of benefits to the environment and the people that depend on it for their living. The role of forests in bringing global social, economic and ecological benefits is increasingly being recognised (FAO, 2016). Reed *et al.* (2017), arguing on the importance of forests said that an in-depth understanding of forest-based contributions to supporting food production remains limited. Based on studies by Misbahuzzaman and Smith-Hall (2015), fodder, fuelwood, wild food, construction materials, primary health care, to name a few, are some of the resources whereby forests contribute to the livelihoods of millions of traditional ethnic people around the world. Forests are not only essential for many people across the globe but also help support a healthier and more productive environment.

Locatelli *et al.* (2015) focused on the climate-regulating functions of forest and stated that the role of forests in rainfall and temperature control at local and regional scale should be recognised. Carbon storage, timber and non-timber forest products provision are other functions of forest that should be considered (Locatelli *et al.*, 2015). Trees and forests are contributors to rainfall intensification through the biological particles they release into the atmosphere (Sheil, 2014). Following Heiblum *et al.* (2014) findings, a larger forest cover can attract more clouds, hence increase rainfall in the region the forest occurs. Forests can increase low-level cloud cover and raise reflectivity (Heiblum *et al.*, 2014).

In urban settings as well as in rural areas, tree cover is useful to the environment as it can reduce temperatures. For instance, in tropical areas, forests have been recognised by local inhabitants for cooling local temperatures (Meijaard *et al.*, 2013), while, in urban settings with more substantial vegetation and tree cover, lower temperatures are observed more than in areas blanketed by solid surfaces (Bounoua *et al.*, 2015). Bounoua *et al*. (2015), also add that planting trees in urban areas can increase greenspaces and have an impact on the micro-climate. Planning and preserving greenspaces in and around cities can buffer micro-climate temperature extremes. The role of trees in the rehabilitation of degraded lands must be taken into account. For instance, *Acacia Xanthophloea* commonly called fever tree, was used in Kenya for its rehabilitation characteristics of degraded lands. This was supported by Kahuthia-Gathu *et al.* (2018) saying that fever trees were used to rehabilitate quarries in Athi River, Kenya. They continue and add that the tree species are also associated with curbing soil erosion and can increase and preserve plant biodiversity while contributing to nature restoration. Besides, fever trees are sought for providing timber, shade and shelter, nesting for birds, fixing nitrogen in the soil, ornamental purposes, natural fencing, charcoal production, and apiculture products (Okello *et al*., 2001). Trees improve recharge of groundwater and hold the soil together minimising water erosion as intermediate tree densities on degraded lands may, in fact, maximise groundwater recharge (Ilstedt *et al*., 2016). Bargués *et al*. (2014) found that tree roots and enhanced levels of soil organic matter from litter inputs improve soil structure, enhance aggregate stability, and promote faunal activity. The study also states that soil conservation through tree planting can lead to higher macro-porosity, thereby creating preferred pathways for infiltrating water to move rapidly (Bargués *et al*., 2014).

In recent decades, forests have experienced significant changes globally (Li *et al*., 2016) because of human activities such as agriculture (Kim *et al*., 2015) and the combined effects of natural factors like fire and drought (Allen *et al*., 2015) that has led to deforestation. Ntungwe and Nforngwa (2017) argue that illegal logging activities are significantly responsible for such a rise in deforestation. Steffen *et al*. (2015) consider that deforestation and anthropogenic land-use transformations have severe implications for climate, the survival of species, ecosystems and sustainability of livelihoods. This situation is raising concerns over the long-term impact of deforestation on natural earth system functions. Forest stock losses, especially in the tropics, are an essential part of greenhouse gas emissions due to long-term land-use change (Settele *et al.,* 2014). Deforestation can consequently impact rainfall for reasons beyond its impact on perceptible water (Kim *et al*., 2015).

Declée *et al*. (2014), when carrying research on drivers of deforestation in the Congo Basin, estimated that small scale deforestation is connected with growing slash-and-burn practices in agricultural activities. The study also pointed out that activities such as artisanal timber logging, artisanal charcoal production, and firewood harvesting were connected with deforestation as well (Declée *et al*., 2014). Following Yurike *et al*. (2015) findings on drivers of deforestation and forest degradations, forest lands are cleared and grabbed by the people because they do not understand the benefits of environmental services brought by them. Even though people are aware of the legal status of forests as state forests, they do not consider land titles as sufficient proof of land ownership (Yurike *et al*., 2015). Lawrence and Vandecar (2015) state that deforestation caused reductions in precipitations that have repercussions for regional livelihoods and economies. Additionally, Tan-Soo *et al.* (2014) say that forest and tree removal could increase the likelihood of floods. Integrating forests into the landscape of heavily deforested regions represents a practical and possibly cost-effective solution for flood mitigation (Jongman *et al.*, 2015).

Kenya requires 4.5 million ha of tree cover to achieve 10 % of forest cover threshold recommended by international institutions (KFS, 2014). It is estimated that the country's actual forest cover stands at about 7.4% of the total land area available in the country. This highlights the fact that a lot of efforts are yet to be made to achieve global targets associated with the matter (KMEF, 2018). Doing so will not only improve forest cover in Kenya, but also contribute to the rehabilitation of Kajiado County's most degraded areas.

2.5 Trees in School Compounds

The universal importance of tree planting undertakings as both practical means to conserving the environment and as effective awareness-raising activities is recognised by UNEP (2011). There have been numerous reviews of studies considering green space benefits for childhood health and well-being (Chawla *et al.*, 2014; James *et al.*, 2015; Dadvand *et al*., 2015). Lekies *et al*. (2015) argue that high levels of students' interest have been linked to learning in relatively green classrooms, school gardens and natural contexts. Additionally, proximity to green spaces such as parks has been associated with increased physical activity (James *et al.,* 2015). Dadvand *et al*. (2015) state that green spaces' ability to moderate air pollution from traffic could positively impact on cognitive development of children in schools. According to the Convention of Rights of the Child (1989), a clean environment protected from pollutants such as dust is necessary for students and pupils in schools. Environmental degradation is killing children (UNEP, 2011) through negative environmental indications like dust polluting the air and contributing largely to the occurrence of diseases (UNICEF, 2002).

Tree planting in schools needs to be common practice as learners get protection from dust and other pollutants. Tree planting and management should be used to provide children with a safe environment where learners concentrate on the learning process (Dadvand *et al*., 2015). Tree nurseries can be used in that regard. They are indeed useful tools for improving tree density in school compounds as they contribute to the environment by providing oxygen, conserving water, improving climate, preserving soil, improving air quality and supporting wildlife through tree planting and nurturing (McPherson, 2006). UNEP (2011) recognised the use of tree nurseries as a universal way of practically conserve the environment in addition to their effectiveness in bringing further awareness to numerous projects involving community participation around the world. Tree nurseries' usefulness for addressing the global diminishing forest cover has been acknowledged by many studies as well (McPherson, 2006; Prober *et al*., 2015). A sustainable supply of planting material is crucial for any plant-based ecological restoration project (Broadhurst *et al*., 2016) to succeed. Seed should be sourced in the future from areas currently experiencing climatic conditions considering that global climate change is increasingly being recognised (Prober *et al*., 2015). Such behaviour towards seedlings can help strengthen their resilience.

2.6 Effect of School Management on Tree Density in School Enclosures

Management guarantees the sustainability of standards set for obtaining raw materials, producing processes, and dispensing of finished products within an organisation (Drucker, 2008). School management is the process by which different school activities are coordinated to meet the objectives of the school. It is the system that allows schools to organise and manage their resources and includes three main branches according to (Galiani and Perez-Truglia, 2014): the school market (whether the school is public or private, and the regulation of competition in the schooling system), the school administration (whether the system is centralised or there is school-based management of power, knowledge, and budget) and the school organisation (curriculum, tracking of students, incentives, class-size and contracts to teachers to name a few). Wango (2009), adds that the school management through its internal management structure ensures that the necessary planning, implementation accompanied with a thorough monitoring and evaluation process is undertaken to realise the school goals. Moreover, the school management is the responsibility of stakeholders (Black and Walsh, 2009). Their role is to make sure that the finances, human resources, curriculum, and the physical facilities are well managed in a school (ROK, 2015). For example, stakeholders in Kenya comprise of student leaders, teaching and support staff, parent association, the school administration, the Board of Management, and the Ministry of Education (ROK, 1999). Onyango (2003) stresses the fact that the board of management bears the responsibility of promoting school community relations. He adds and emphasises on head teachers' responsibilities saying that they must deal with all activities revolving around organising and accounting for students as well as providing specialised services.

Students can perform activities such as sports, entertainment, cleaning, dishing meals, washing clubs, and welfare support among others. Delegating responsibilities by including the participation of students can demonstrate that their roles are valuable and that they are capable of solving problems that contribute to the promotion of a positive school management climate (Blum, 2005). For example, In the USA, students can participate in environmental protection projects through organisations such as the Raising Student Voice and Participation (NASSP, 2013). Furthermore, schools through their education systems have been widely recognised for improving the possibilities of achieving sustainable lifestyles and societies (Arlemalm-Hagser, 2013) as education appears to be an excellent vehicle for raising environmental awareness and sharpening environmental skills (Agarwal and Nangia, 2005).

2.6.1 Schools in Kajiado County

According to the County Government of Kajiado (2018), knowledge is provided in the county through pre-primary education, primary education, secondary education, technical and vocational training centres, tertiary education, adult and continuing education as well as non-formal education. The county has 446 public and 325 private schools making a total of 711 primary schools. The total population of pupils is estimated at 154,677 with a pupil-teacher ratio of 43:1. The net enrolment rate is 77 % with Kajiado North holding the highest record. On the other hand, secondary schools form a total number of 121 (70 public and 51 private schools) with a net enrolment rate of 54 % despite a significant drop out rate of 15 %. The rural areas are taking the lead with an average dropout rate of 30 %. There is a lack of mobile education programs in the county, and community distance distribution to the nearest public secondary school remains high especially in remote areas across the county.

2.7 Effect of the Availability of Water on Tree Density in School Enclosures

Water is generally considered as the most indispensable natural resource (Vorsmarty *et al*., 2000). It is a vital substance for the survival of all lives (Thliza *et al.*, 2015) and is ultimately necessary for most life driven process (Aroh *et al*., 2013). Water is essential for drinking, industrial and domestic use (Isikwue and Chikezie, 2014), as it can be found in liquid, solid and gas form simplifying biological activities under all environmental conditions (Thliza *et al.*, 2015). Water covers 71% of the Earth's surface with 97% of it found in oceans (USGS, 2016b). Mcintyre (2012) estimates that 98% of the water on planet earth is salty, and 2% only is fresh. He continues and argues that about 70% of freshwater remains frozen as ice and snow, 30% is found in the form of groundwater, 0.5% is surface water including rivers, lakes, swamps, and so forth, while 0.05% originates from the atmosphere. According to GRACE (2016) freshwater supply is mostly found in mountain runoffs and snowmelt providing more than 50% of the planet's freshwater. In rural areas, water is mostly obtained from piped borne sources, rivers, boreholes and wells (Kuta *et al*., 2014). Manhokwe *et al*. (2013) argue that water is fetched mostly from either ground or surface water sources in rural set-ups. As for the quality and safety of the majority of these water sources, Muhammad *et al*. (2017) indicate that it is unknown as seasons and location influence them.

Water availability was one of the key factors addressed by the United Nations in the 2030 Agenda for Sustainable Development in 2015 (UN, 2015). In recent decades over this century, significant increases in water withdrawals were observed (Wada *et al*.,2013) and have led to severe water scarcity in several regions throughout the world (Schewe *et al.*,2014) with freshwater access being limited in some countries and even continents (Berger and Finkbeiner, 2010). Shivoga *et al*. (2007) consider that water scarcity and shortage are global concerns with about 35% of the world population currently unable to meet their daily water demands which are estimated to be about 2000 m^3 per year per capita. There are about 1.2 billion people across the globe who do not have access to safe and affordable water for their domestic needs (WHO, 2003), with an estimated 768 million people remaining without access to potable water (Muhammed *et al*., 2017). Although water supply and accessibility aim to ensure environmental sustainability (Oludairo and Aiyedun, 2015), the World Bank (2016) estimates that the number of people living in regions with absolute water scarcity will increase from 1.6 to 2.8 billion people by 2050. Water availability is also affected by overpopulation. This can be seen in the fact that aquifers are being utilised 3.5 times faster than they can be recharged naturally (Gleeson, *et al*., 2012). Additionally, population increase, urbanisation and climate change are likely to aggravate further the world water situation in the next century (Essumang *et al*., 2011; Manhokwe *et al*., 2013).

Global warming and Climatic changes, particularly in the arid and semi-arid areas increase the rate of evaporation in surface water sources (Bada *et al*., 2017). Hobbs (2011) adds that water as a limiting factor can strongly affect selection on seed while Larios *et al*. (2018) establish that the dynamics of selection on seeds is influenced by the availability of water which is mediated by the amount of precipitations varying from years to years. A deficit in water can intensify forest vulnerability to stressors while regional vegetation die-offs may trigger changes in forest ecosystems distribution (Choat *et al*., 2012; Rigling *et al*., 2013), potentially causing prevalent changes in services provided by ecosystems and carbon stores (Anderegg *et al*., 2013). Water deficits combined with altered water availability patterns can cause drought stress that may be exacerbated by the competition for soil moisture, hence influence the global vulnerability of forest ecosystems (Zhang *et al*., 2015). Reduction in availability of water within fine-textured soils during drought strongly influences seedling survival (Valdecantos *et al*. 2006).

To improve water supply, water conservation practices can be used in enclosures. This can be done through Rainwater Harvesting (RWH) which is the collection of water from a catchment area on which rain falls and a conveyance system to a subsequent storage facility for later use (Lopes, 2017). In recent years, new technology advancements have prompted many countries to implement RWH practices to address the increase in water demand pressures associated with changes in the environment, climate, and society (Amos *et al*., 2016). RWH implementation is associated with significant water conservation benefits (GhaffarianHoseini *et al*., 2016). Also, it is one of the measures for reducing the impact of climate change on water supply and should be considered a relevant component for its increase in both urban and rural settings (Lopez, 2017). Based on the findings of Carmona and Velasco (1988), the survival rate of planted trees can be improved through the application of micro-catchment water-harvesting systems which increase the amount of rainwater available for the trees.

Almazroui (2017) argues that RWH has been used for the provision of water for domestic and agricultural uses in arid and semi-arid areas as it can be a source of free water that requires minimal maintenance and storage costs while bringing water to the place of need (Efe, 2006; Opare, 2012). It is a fundamental part of communities situated in remote areas where piped water and reliance on wells is no longer an option (Opare, 2012) For example, in arid and semi-arid Indian rural regions, rooftop and ground RWH is considered an ancient technique still in use to provide water supply for domestic use (Agarwal and Narain, 1997).

Aladenola and Adeboye (2010) support the fact that rooftop rainwater harvesting systems represent one of the solutions to mitigating the lack of access to safe domestic water supply. The collection of rainwater can be done through the use of storage tanks which are mostly set either above or below the ground (Srinivas, 2007). RWH systems also need gutters to transport rainwater from the roof to the storage tank (WaterAid, 2011). Mwami (1995) considers the lack of proper maintenance and unsuitable design of a rainwater catchment system to be the main factors hindering their performance. Srinivas (2007) states that there are various types of storage tank such as reinforced concrete and stainless steel, but it is mostly plastic tanks which are more efficient and popular in developed countries. However, some precautions should be taken in implementing rainwater harvesting storage systems as they can provide excellent habitats for mosquito breeding (EnHealth, 2010) and are identified as potential breeding sites for vector dengue virus if not properly maintained (Waller, 1989). Improved water supply through the use of well-maintained storage tanks can contribute to increasing the density of trees in trees enclosures.

In Kenya, yearly fresh water available per capita stands at 650 m^3, and the capita endowment is fast decreasing because of high rates of deforestation, recurrent droughts, increased human population and climate change (Okello *et al*., 2014). Most water resources in the country are found in the highland areas, mainly Mounts Aberdares, Elgon, Kenya, Cherangani Hills and the Mau Complex. However, these key water catchment areas have recently experienced extensive and severe environmental degradations which compromise their water resource production and potential (Luwesi *et al*., 2012).

2.7.1 Water availability in Kajiado County

Kajiado County entirely depends on groundwater reserves due to limited numbers of permanent rivers and reliable rainfall regimes (CGK, 2013). Major rivers in the county include; Olkejuado, Athi, Ewaso Ngiro and Noolturesh (CGK, 2013). Shallow wells and boreholes continue to be the most prevalent methods of accessing water in the region. Water supplied to the area is far short of the estimated demand. The County Government of Kajiado (2018) states that the region is characterised by an arid and semi-arid climate which exacerbate water shortages.

Acute clean and safe water shortage for drinking and other activities is still an issue. Only 67.2 % of the whole population has access to safe water, with 36.8 % of households accessing piped and portable water. The county comprises of 1150 public boreholes that are commonly managed by local communities. There are no reliable sources of water even though the main ones are dams and water pans (38%), boreholes and shallow wells (34%), traditional river wells (7%) among others (21%). Several water suppliers and five Water Resource Associations (WRA) managed by local communities deal with the distribution of water across the county. The situation has proven that water is not sufficiently available and may be an underlying cause of inadequate forest and tree cover in the area.

2.8 Influence of Collective Action on Tree Density in School Enclosures

Collective action is an action taken by a group of people that aim at improving their status by achieving common goals. It involves a group of people with some shared interest whose realisation depends upon coordinated actions of their own (Meinzen-Dick *et al*. 2004). Collective action activities can be carried out through community forest management (CFM) which aims to maintain ecological sustainability by preserving biodiversity and reducing deforestation while improving the livelihoods of local communities (Bowler *et al*., 2012). Although CFM has failed in some places (Bowler *et al*., 2012), it has produced as per Pagdee *et al*. (2006) suggestions, successful outcomes by improving forest cover, increasing plantation zones, reducing community poverty while providing for equity of benefit sharing in several countries.

In schools, communities have been used for carrying out environmental activities through school clubs or environmental clubs. According to Ndaruga (2004), environmental issues can be addressed by school clubs through use of tree planting, dramas, music festivals, lectures, posters, advocacy, audio-visuals, films, simulations, and others. Students can be involved in environmental activities through clubs (Mamvibela, 2002). These activities consist of planting trees, commemorating important environmental days, cleaning up the environment form pollutants, participating in environmental recycling projects, raising funds through concerts and sponsored walks to name a few. By planting trees, students contribute to increasing tree density in their school. According to NEMA (2000) in Uganda, tree planting is used as a practical collective method for education and management of activities that can improve tree density in light of the decreasing forest cover observed across the country. Morgenstern and Pizer (2007) add that the role of environmental clubs as essential tools for environmental policy is crucial. Environmental clubs can also be used for bringing awareness which is crucial for actions to be taken (Kaur and Kaur, 2013) by the school community for the improvement of their tree enclosures.

2.9 Effect of Climate on Trees Density

Climate is the composite of all many varied, day-to-day weather conditions in a region over a considerable time. The characteristics of climate often become decisive elements for the presence of plants (Steffen, 2008; Sáenz-Romero *et al.;* 2010). Climate variables such as temperature, sunshine duration, seasons and length of the growth period among others can affect the growth of plants (Kożuchowski and Tegirmendžić, 2005).

Climate change, on the other hand, is a change of climate which is directly or indirectly attributed to human activities that modify the composition of the global atmosphere (UNFCCC, 1992). Conde *et al.* (2011) along with Sáenz-Romero *et al*. (2010) state that recent research suggests a change in the global climate system with changes in environmental conditions over short periods of time that are threatening the survival of species and ecosystems. Such findings portray the fragility of both natural and human systems to climate change (Bernstein *et al*., 2008). Changes in climate impact on natural and human systems across continents and oceans.

Discussing on the impact of climate change on forest ecosystems, Choat *et al*. (2012) said that forest dynamics are already negatively affected by climate and likely to be more impacted by the increase in frequency and intensity of severe droughts. In some regions, anthropogenic climate change is already affecting the delivery of ecosystem services provided by forests which include but are not limited to the provision of wood fibres, regulation of water resources, and creation of environments conducive to recreation and well-being (Seidl *et al.*, 2014). Seidl *et al.,* 2014 continue and add that anthropogenic climate change disturbs forest biomes by altering environmental conditions and increasing the frequency and extent of turbulences to forests production. Following Kelley *et al*. (2015) studies, climate change can exacerbate water shortages and threaten food security, triggering mass migrations and increasing social and political conflict. This can lead to additional stress on forests. Climate change is predicted to create substantial shifts in tree species distribution and forest structure

(Gustafson *et al*., 2010). Following Brienen *et al*. (2015) studies, climate change can cause a combination of warming and altered rainfall patterns that can lead to feedback effects on remaining vegetation, reduced biomass accumulation, drought, die-off and fires.

Bonan (2008) argued that the increase in temperature has significant impacts on natural systems as it provides longer growing seasons for the trees. Several authors agree that the increase in global temperature affects biodiversity at different scales and ways, geographically shifting plant and animal communities and altering the ecological niche of organisms and the ecosystem functions (Desai *et al*., 2008, Zhu *et al*., 2011). Prolonged severe droughts may, in fact, greatly influence tree physiological responses, leading to irreversible alterations in the xylem hydraulic system, loss of hydraulic conductivity and depletion of stored carbohydrates (Rigling *et al*., 2013; Rowland *et al*., 2015). According to Gates (1990), instability in climate patterns will most likely affect forest process as it has been portrayed by Northward displacement of forests in North America and Europe in the Holocene period. Based on Levesque *et al.* (2014) findings, forests that develop in arid and semi-arid locations and at their dry limits are for the most part vulnerable to climate change.

Havens *et al.* (2015) arguing on the impact of climate change on seed sourcing strategies said that it would increasingly affect the way seeds are obtained. Other studies recommend, in this regard, the sourcing of seeds from diversified sources in order to prevent the potential impacts of climate change (Sgro *et al*., 2011; Breed *et al*., 2013; Prober *et al*., 2015). Thomas *et al*. (2014) carry on and add that the minimum conditions for forest resource materials (FRM) to be selected are (i) their ability to achieve restoration goals, (ii) adaptation to survive and thrive under the conditions of degraded lands and (iii) sufficient genetic diversity that can warrant their potential to adapt to changing conditions in the future. For example, acacia tree species such as *Acacia Xanthophloea,* are known for their adaptive abilities to environmental changes (Ludwig *et al*., 2004) and for their capacities to resist to drought stress (Oba *et al*., 2001) to name a few. Genetic origin and quality of FRM are critical in dealing with climate change (Bozzano *et al*., 2014; Havens *et al*., 2015). Gregorio *et al*. (2016) argue that inadequate attention to considerations such as the ability of FRM to resist stressors like drought and other effects of climate change can fail restoration processes. For that reason, overcoming drought at the seedling stage is the main challenge in dryland restoration when out-planting methods are used (Oliet *et al*. 2002). Climate can also affect the growth of trees through soil moisture. Observations have been made on highly positive relationships existing between soil moisture and seedling survival (Padilla and Pugnaire, 2007).

Forest ecosystems are shaped by climate; thus, changes in climatic factors are likely to strongly affect them by influencing tree physiology, growth, mortality, and reproduction with repercussions on species selection. Climatic factors must be considered in projects seeking to improve forest and tree densities such as those using school enclosures.

2.9.1 Climate of Kajiado County

According to the County Government of Kajiado (2013), the county has a primarily semi-arid climate characterised by prolonged periods of abnormal low rainfall and shortage of water. On average, the temperature stands at 18.9°C, and 500 mm of rainfall is received annually in the area where most of it falls in April. The month of August is usually extremely dry. Rainfall patterns are bi-modal and not uniformly distributed throughout the county where they vary from 300 mm at a minimum in the Amboseli basin to a maximum of 1250 mm in the Ngong Hills and the slopes of Mt. Kilimanjaro. Long rains fall between March and May. Short ones occur in the period between October and December (CGK, 2018).

Climate change has affected the county in many ways through drought, famine, flash floods, and winds. Environmental pollution and degradation are other issues faced by the region. For example, local farmers and pastoral communities were hit in 2009 by a drought that led to a crop failure of more than 90 % with livestock losses estimated at 70 % (CGK, 2018).

2.10 Government Policies on Forest and tree Conservation

Policies consist of guidelines developed for achieving specific objectives in government bureaucracies and private-oriented concerns. Policies are justified at times to ensure equity or protection of the public welfare (Frederick *et al*., 2007). In this regard, governments play a critical role in policy implementation.

States have promoted strategies for sustainable forest management (Banerjee *et al*., 2009) and made efforts to avoid deforestation (Meyfroidt *et al.,* 2008). Governments in developing countries, through activities such as REDD (Reducing Emissions from Deforestation and Forest Degradation), have enhanced conservation and forest carbon stocks helping to compensate and mitigate emissions for forest projects under the global climate regime (Cerbu *et al*., 2010). For example, South Korea achieved forest recovery in the 1970s through the implementation of reforestation policies (Bae *et al*., 2012) and programmes such as the National Greening Program which contributed to successful reforestation in the country for two decades (Park and Youn, 2013). On the other hand, regulations that are poorly designed can cause market failure, discourage investment and limit the development of innovative and sustainable environmental solutions (Pastakia, 2002). According to Quesenberry (2001), failure in implementing forest conservation policies is due to the favouring of economic outcomes over environmental sustainability.

Moreover, government policies can influence the distribution of urban vegetation by regulating the removal of trees from private properties and directing planting in public open spaces and streetscapes (Conway and Urbani, 2007). The implementation of policies such as watering restrictions may also reduce tree cover and inequality in vegetation diversity (Harman *et al*., 2008). Based on Landry and Chakraborty (2009) findings, programs and policies focused on increasing tree cover in disadvantaged areas may be successful alone if income is the main driver of tree cover. Wolf (2003), on the other hand, said that public education campaigns explaining the benefits of trees could increase the acceptability of urban trees in cities where education level rather than income is driving tree cover. Such campaigns can be significant contributors to the success of tree planting programmes. For example, new national policies and many regional programmes implemented by local governments with support from private companies, in China, encouraged farmers to plant trees (Yin and Yin, 2010).

In Kenya, the government has launched and funded many environmental programmes such as The Green Schools Programme (KFS, 2014), which is an initiative by the Ministry of Environment and Forestry jointly with KFS that seeks to involve all public schools in the country to set aside land for tree planting in their compounds using government funds in association with technical support from KFS. The main objectives of the programme are to assist in greening the country and to inculcate a tree growing culture among children. In the programme, pupils are encouraged to manage trees to maturity and sell those to KFS and other commercial tree buyers. A budget of more than Kshs. 37 million was made available in order to build the capacity of the schools, implement tree nursery infrastructures, encourage water harvesting, promote woodlots establishment, and woodlots protection. Enforcing environmental protection and conservation policies is therefore crucial for improving tree cover and density in Kajiado County. Table 2.1 displays some policies and programs related to this study.

Table 2.1 Selected Policies Connected to this Study

Policy	Linkage
International	
Convention on Biological Diversity 1993	Conservation of biodiversity (trees, forests to name a few), sustainable use of biodiversity resources.
United Nations Convention to Combat Desertification 1994 (UNCCD)	Land productivity improvement, land restoration, mitigation of drought effects, and combat desertification in arid and semi-arid lands.
The Paris Agreement 2015	Mitigation of climate change.
The Sustainable Development Goals (SDGs) 2015	Sustainability of life on land, support for afforestation and reforestation.
National	
National Forest Policy 2014	Monitoring of national forests
Kenya Vision 2030	Improve quality of life in a clean and secure environment.
National Policy for the Northern Kenya and other Arid Lands 2012	Sustainable development of arid lands.
Kajiado County Integrated Development Plan 2018-2022	Fight degradation, climate change mitigation, halt illegal logging and charcoal production.

2.11 Research Gap

A lot of programmes have been launched and supported by the government of Kenya as well as many stakeholders involved in activities aiming to increase forest cover in the country. The current land area covered with forest in Kenya is estimated to be 7.4 % of the country's total land even though 10% is the minimum international requirements for a country to be environmentally stable (FRA, 2010). Efforts are being made to increase tree cover through tree-planting campaigns using schools in Kenya. Kajiado County's schools are also part of the efforts. Many studies have been carried out on forest cover and tree density (Bottero *et al*., 2016; Adams *et al*., 2009; Bottalico *et al.*, 2015; Ordonez *et al*., 2014). The role of enclosures in restoring degraded lands has been addressed by many scholars as well (Nyssen *et al*., 2015; WOCAT, 2013; Angassa, 2016). Furthermore, several studies (Arlemalm-Hagser, 2013; Zhang *et al.*, 2015; Ndaruga, 2004; Levesque *et al.*, 2014) have demonstrated that factors such as school management, availability of water, collective action and climate can affect trees in many ways. Despite that, there is a contextual and conceptual gap emerging as those studies did not specifically address the effect of the aforementioned factors on the density of trees nor were they carried out in school compounds within Kajiado County. That is why this study, unlike others, was focused on the factors influencing the density of trees inside school tree enclosures in one of the driest areas of Kenya, namely Kajiado County. The study also contributed to providing information useful for achieving global tree cover targets.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the research design of the study, research sites and their rationale, the target population, the sampling size and procedure, the data collection procedure, the instrument of the research, This chapter also provides information about data analysis, presentation of findings, ethical and legal considerations.

3.2 Research Design

This study used the *ex-post facto* research design. It is a design that, in the context of social science, seeks to reveal possible relationships by observing an existing condition or state of affairs and searching back in time for plausible contributing factors (Kerlinger and Rint, 1986). Following Cohen, Marion, and Morison (2000) findings, an *ex-post facto* research design searches in retrospect for factors that brought about differences between groups that are already different from the beginning. This design can transform in this regard a non-experimental design into a pseudo-experimental study.

3.3 Research Site

This study was carried out in Kajiado County, Kenya. The area is situated between longitudes 36^{o} 5' and 37^{o} 5' East and between latitudes 1^{o} 0' and 3^{o} 0' South (Amwata, 2013). Most of the region lies in the arid and semi-arid zone (Beckure *et al.*, 1999) set in the southern part of Kenya. There are 5 sub-counties (Kajiado North, Kajiado East, Kajiado West, Kajiado Central, and Kajiado South) and 25 wards in the county. Kajiado North represents the smallest sub-county and Kajiado West the largest in terms of Km^2. The urban population is estimated at 395,051 inhabitants, representing 35% of the total population (CGK, 2018).

The county is characterized by infertile soil, unreliable rainfalls, and high temperatures (Amwata, 2013) reaching about 34^o C at their highest and 10^o C at their lowest (ROK, 2018). Kajiado has two distinctive rainy seasons: a long one (March to May) and a short one (October to December). Rainfalls are not equally distributed across the region as they are becoming highly variable and unpredictable especially in recent decades (ROK, 2009). The mean annual rainfall ranges from as low as 300 mm to as high as 1250 mm. Temperatures vary both with altitude and season. The coolest period ranges between July and August, while the hottest months are observed from November to April. Canopy cover ranges from less than 1% on heavily settled areas to about 30 % on steep hills (ROK, 2018).

The research sites were made up of twenty-three (23) primary and secondary schools (private and public) owning tree enclosures within Kajiado North, East, West, and Central Sub-Counties. A map of the study area depicting the location of surveyed schools was drawn using their Global Positioning System (GPS) coordinates. Besides, a base map of Kenya downloaded from the internet website https://www.diva-gis.org, was also required in that regard. The latter combined with the schools' GPS coordinates were then processed in the Geographic Information System (GIS) software ArcGIS version 10.7 to create the map shown in Figure 3.1.

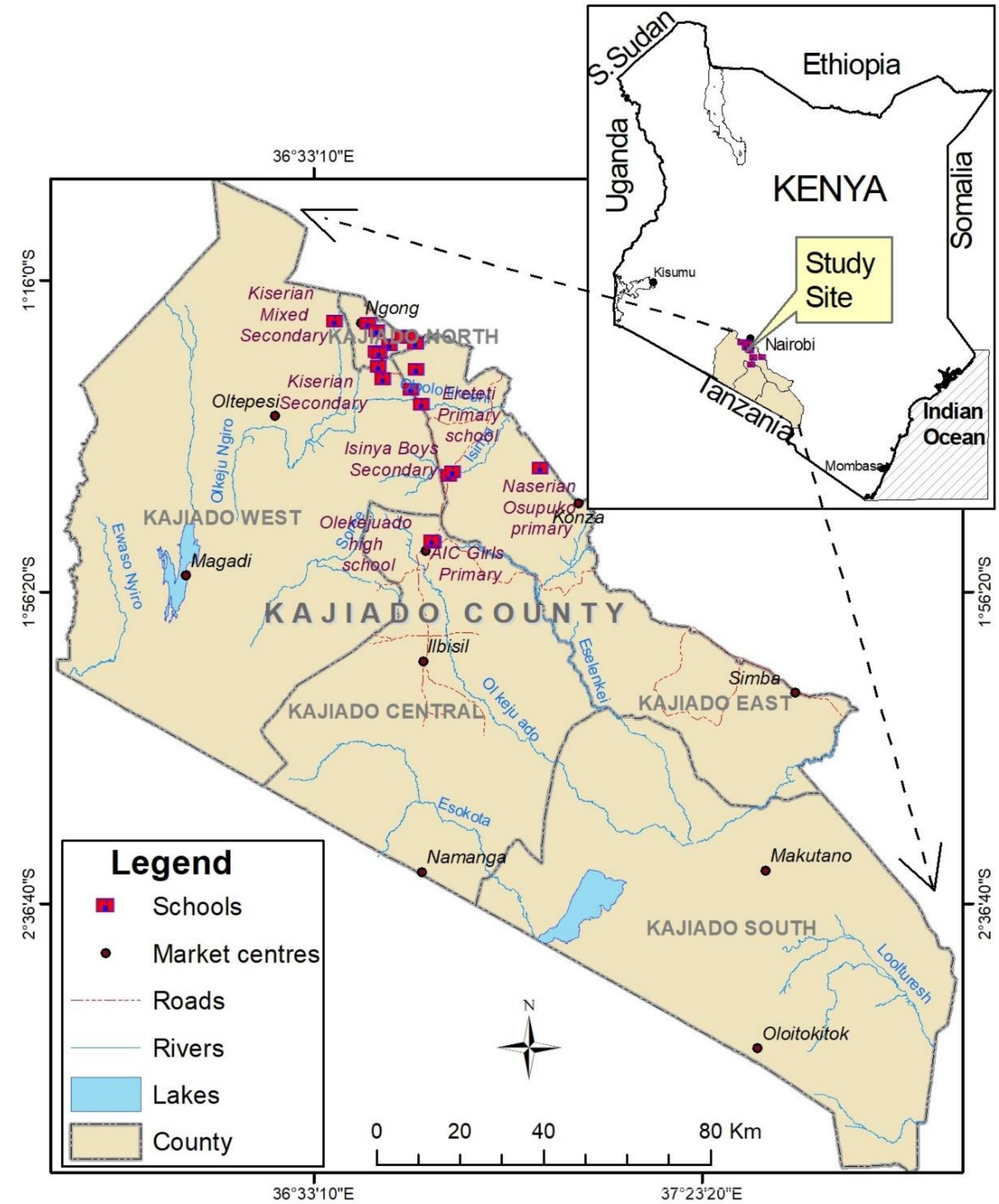

Figure 3.1: Location of the study schools in Kajiado County, Kenya

3.4 Target Population

The target population was made up of 892 primary and secondary schools distributed across Kajiado County. There were 446 public schools along with 325 private ones adding up to a total of 711 primary schools. Secondary schools were composed of 70 public schools in addition to 51 private ones making 121 schools (CGK, 2018).

Obwatho (2014) states that the target population is the whole group a researcher is concerned about, it is the target group of the study.

Table 3.1: Target Population

Scholl Category	Public	Private	Target Population	Percent
Primary school	446	325	771	86.4
Secondary school	70	51	121	13.6
Total	**516**	**376**	**892**	**100**

Source: County Government of Kajiado (2018).

3.5. Study Sample

3.5.1 Study Sample Size

The study population was determined prior to computing the sample size of this study. In order to do that, twenty three (23) schools with tree enclosures were purposively identified and selected within Kajiado County. Besides, 30 teachers along with 60 students per surveyed school were also included in the process of determining the study population. Teachers and students were considered for participating in the school environmental activities. The result is presented in Table 3.2.

Table 3.2 Study population

Category of Respondent	Sampled School	Respondent per School	Population Size	Percent
Teacher	23	30	690	33.3
Student	23	60	1380	66.7
Total	**-**	**90**	**2070**	**100**

The sample size was then determined from the study population using Krejcie and Morgan (1970) formula which is suitable for generalisation and representability. The result is presented as follows.

$$n = \frac{X^2 Np(1-p)}{e^2(N-1) + X^2 p(1-p)}$$

Where,

n = sample size

N = population size (2070)

e = acceptable sampling error which is 5% in this study

X^2 = chi-square of the degree of freedom 1 and confidence 95%= 3.841

p = the population proportion (assumed to be 0.50 since this would provide the maximum sample size.

The sample size was calculated as follows,

$$n = \frac{3.841 * 2070 * 0.5 * 0.5}{0.05^2(2070-1) + 3.841 * 0.5 * 0.5}$$

***n* = 324**

Hence, the sample size for this study was made up of 324 respondents.

Table 3.3 Sample Size

Category of Respondent	**Frequency**	**Percent**
Teacher	108	33.3
Student	216	66.7
Total	**324**	**100.0**

3.5.2 Sampling Procedure

A purposive sampling method was used to select twenty-three (23) schools with tree enclosures. Thereafter, the study population was determined and a simple random sampling technique was applied in order to draw the sample. Consequently, an exhaustive list (sampling frame) of all participants (study population), to which was assigned a sequential number, was prepared during data collection. From that list, the sample size of 324 respondents was drawn using a table of random numbers. Friedrichs (2008) supports that procedure by suggesting the use of either a random number generator or a random number table in random sampling processes so that each person remaining in the population has the same probability to be selected and form the sample.

3.6 Data Collection

3.6.1 Data Collection Instrument

A semi-structured questionnaire along with an empirical data sheet were used to collect data relevant to this study. Sackman (2006) recommends the use of questionnaires because self-administered surveys typically cost less than personal interviews and sample accessibility is easy. The questionnaire was used for gathering primary data from sampled respondents. Secondary data were sourced from Kajiado County Integrated Development Plans. Observations and measurements recorded in the data collection sheet were used to get empirical evidence on the number of trees per school enclosure, species diversity, and size of enclosures among others.

3.6.2 Pilot Testing

A pilot study was carried out using the questionnaire and empirical datasheet to pretest and validate research instruments. This helped the researcher know to what extent data could be collected in order for them to be accurate. Ten (10) teachers and students from five (5) schools owning tree enclosures were selected for that purpose in Nairobi County before starting the actual data collection exercise. A pilot test is useful for testing the reliability of data collection instruments. A pilot study conducted on a group of 5 to 10 respondents is sufficient for establishing whether research tools are valid and dependable (Mugenda and Mugenda, 2003).

3.6.3 Instrument Reliability

Research instruments, on one hand, can be described as measurement devices such as surveys and questionnaires. Reliability, on the other hand, is about the usability of the instruments. The research instruments of this study which are the questionnaire and empirical datasheet were deemed reliable as they helped the research achieve his target. In this case, research instruments were useful for recording data relevant to show the influence of school management, water availability, collective action, and climatic factors on the density of trees in school enclosures within Kajiado County.

3.6.4 Data Collection Procedures

Data were collected from respondents found in surveyed schools with tree enclosures after obtaining a research permit from the National Commission of Science, Technology, and Innovation (NACOSTI) in addition to subsequent clearance from the university to carry out the study. Research authorization letters from Kajiado County commissioner and county director of education were acquired as well. Thereafter was conducted a visit to the schools in order to first make appointments with the board of management and agree on when research instruments were going to be used. Primary data were obtained from sampled teachers and students while county's statistics were consulted for gathering secondary ones. Observations and measurements were carried out without interfering with the regular performance of the schools' activities.

3.7 Data Processing and Analysis

The goal of this section was to provide information and conclusions relevant to improving tree density in school enclosures. Descriptive statistical methods were used for analysing data collected through the questionnaire, observations and measurements. The variables of this study were analysed through means, modes, medians, and frequencies among others. Inferential statistical analyses were performed through regression and ANOVA in order to assess the influence of independent variables on the dependent one and whether that was significant. Besides, Chi-square tests were performed to determine existing significant differences between categories of frequencies of the study variables. All of these analyses were conducted using the Statistical Package for the Social Sciences (SPSS 25) software. The geographic information system software ArcGIS version 10.7 was used to draw the research site map. The results of the study were then presented through tables and figures. Data analysis was conducted at 95% level of confidence.

3.8 Legal and Ethical Considerations

In this study, the researcher made sure that the answers of the respondents were kept secret. Before filling the questionnaire, the respondents were requested to participate in the study and its purpose was thoroughly explained to them. Only those who consented were included in the actual data collection. There was a cover letter that accompanied the questionnaire requesting cooperation from respondents and a statement of confidentiality assured them that the study was purely for academic purposes. Data obtained from observations and measurements were faithfully recorded on the empirical datasheet and all legal and ethical practices were respected.

Table 3.4 Summary of Data Analysis

Objectives	Variables	Indicators	Statistical Test
To determine the influence of school management on the density of trees in school enclosures in Kajiado County	**Independent** School Management **Dependent** Tree Density	School board of management awareness, participation, commitment (funds and time)	**Descriptive statistics** Frequencies, means, median, mode **Inferential statistics** Levene's test, chi-square test, regression, ANOVA
To assess the influence of the availability of water on the density of trees within school enclosures in Kajiado County	**Independent** Water Availability **Dependent** Tree Density	Water quantity, quality, seasonality	**Descriptive statistics** Frequencies, means, median, mode **Inferential statistics** Chi-square test, regression, ANOVA
To identify the influence of collective action on the density of trees inside school enclosures in Kajiado County	**Independent** Collective Action **Dependent** Tree Density	Environmental club activities, group activities	**Descriptive statistics** Frequencies, means, median, mode **Inferential statistics** Chi-square test, regression, ANOVA
To explain the influence of climatic factors on the density of tree school enclosures within Kajiado county	**Independent** Climatic factors **Dependent** Tree Density	Drying of trees, Water availability, selection of species, climate change	**Descriptive statistics** Frequencies, means, median, mode **Inferential statistics** Chi-square test, regression, ANOVA

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter presents results and their interpretation of the factors influencing the density of trees in tree enclosures owned by schools in Kajiado County. The chapter is divided into the following sections: (i) the response rate (ii) characteristics of the respondents, (iii) characteristics of the surveyed schools, (iv) density of trees in tree enclosures Owned by Schools in Kajiado County, (v) influence of school management on tree density in school enclosures, (vi) influence of water availability on tree density, (vii) influence of collective action on tree density. (viii) influence of climatic factors on tree density. The analysis were conducted using both descriptive and inferential statistics at 95% level of confidence.

4.2 The Response Rate

A total number of 324 questionnaires were administered to the respondents sampled from 23 primary and secondary schools with trees enclosures in Kajiado County. The response rate is presented in Table 4.1.

Table 4.1: Response Rate

	Response	**% Response**
Successful	321	99.1
Unsuccessful	3	0.9
Total	**324**	**100.0**

As shown in Table 4.1, there was a 99% response rate, which the researcher found sufficient to proceed with data analysis. The high response rate of the questionnaires was attributed to the fact that the researcher personally administered the question to the respondents. Follow-ups were done by the researcher and his two assistants.

4.3 Characteristics of the Respondents

The results of the respondents' characteristics in this study have been organised into four categories namely; composition of the respondents, formal education level of the respondents, number of respondents per school surveyed and number of years lived within the area of study.

4.3.1 Composition of the Respondents in Schools

The study respondents were composed of teachers and students as shown in Table 4.2.

Table 4.2: Composition of the Study Respondents

	Frequency	Percent
Teachers	107	33.3
Students	214	66.7
Total	**321**	**100.0**

The majority (66.7 %) of respondents was made up of students in secondary and primary schools that were selected for this study. The teacher sample formed 33.3 %. Of the respondents.

4.3.2 Formal Level of Education Attained by the Respondents

The respondents were asked to state the highest academic level they had attained, and the data were summarised and presented in Table 4.3.

Table 4.3: Highest Education Level Attained by the Respondents

Formal Education Level	Frequency	Percent
No education	2	0.6
Primary Level	162	50.5
Secondary Level	71	22.1
Tertiary Level	86	26.8
Total	**321**	**100.0**

The majority (50.5 %) of respondents reached a primary level of education while 26.8 % of them had attained tertiary level. Respondents with secondary education levels were 22.1 % whereas 0.6 % represented gardeners that were included in the teacher sample. The early introduction of good environmental practices has the advantage of making students aware of challenges concerning their immediate environment.

4.3.3 Schools Surveyed and Number of Respondents per School

Twenty three (23) schools with tree enclosures were selected in Kajiado County. The number of respondents in each school varied as shown in Table 4.4.

Table 4.4: Schools Surveyed and Number of Respondents Interviewed

Name of School	Frequency	Percent
Olekasasi Primary	28	8.7
Kiserian Secondary	22	6.9
Rockfield Senior School	19	5.9
Arap Moi Primary	18	5.6
Kiserian Primary School	16	5.0
Olekasasi Secondary	16	5.0
Narumoru Primary	16	5.0
AIC Girls Primary	16	5.0
Olkejuado High School	15	4.7
Nareel Boys Secondary	15	4.7
Ngong Township	14	4.4
Nkaimurunya Mixed Day Secondary	14	4.4
Ongata Ronagai Primary School	14	4.4
Moi Girls Isinya Secondary	14	4.4
Oloolua Primary	13	4.0
Naserian Osupuko Primary	13	4.0
Isinya Boys Secondary	13	4.0
Olooltepes Secondary	11	3.4
Kimuka Girls Secondary	9	2.8
Ongata Rongai Education Complex	9	2.8
Dawamu Secondary School	9	2.8
Ereteti Primary	5	1.6
Kiserian Mixed Day Secondary	2	.6
Total	**321**	**100.0**

Table 4.4 shows that the majority (8.7 %) of respondents were from Olekasasi primary school while Kiserian Mixed Day Secondary schools provided the least respondents (0.6 %).

4.3.4 Years Spent by Respondents Studying or Working within the Area of Research

The respondents were asked how long they have been living or working in the area of study. Results are presented in frequency Table 4.5.

Table 4.5: Frequency Distribution of Number of Years Respondents Have Lived in Area of Study

Number of Years	Frequency	Percent
1	36	11.2
2	48	15.0
3	53	16.5
4	27	8.4
5	37	11.5
6	47	14.6
7	34	10.6
8	15	4.7
9	4	1.2
10	8	2.5
11	2	0.6
12	2	0.6
13	1	0.3
15	3	0.9
17	1	0.3
19	1	0.3
20	2	0.6
Total	**321**	**100.0**

The number of years spent by the respondents within the study area varied from 1 to 20 years. The majority (16.5 %) of them had lived for about 3 years in Kajiado County. This is relevant as time spent by the respondents may have exposed them to environmental concerns in the study area.

4.4 Characteristics of Surveyed Schools in Kajiado County

Surveyed schools were selected on the basis of ownership of a well-maintained tree enclosure within the school compound. Data was collected on the type and distribution of the schools sampled, the type of ownership and the level of the schools surveyed as well as the level of fencing of the enclosures of the schools. This form of categorisation gives a general view of the schools found within the study area in Kajiado County.

4.4.1 Type and Distribution of Surveyed Schools

Schools owning tree enclosures were the ones selected to form the target population for this study, the distribution of the schools is shown in Table 4.6.

Table 4.6: Type of School Category and their Distribution in the Study Area

	School Category					
Sub- County	**Primary**	**%**	**Secondary**	**%**	**Total**	**%**
Kajiado North	105	32.7	77	24.0	182	56.7
Kajiado West	27	8.4	10	3.1	37	11.5
Kajiado East	5	1.6	66	20.6	71	22.1
Kajiado Central	16	5.0	15	4.7	31	9.7
Total	**153**	**47.7**	**168**	**52.3**	**321**	**100.0**

The majority (56.7 %) of schools was found in Kajiado North with 24 % of them being secondary ones. Although Kajiado Central provided for the least (9.7 %) schools, it was noted that there were more primary schools than secondary ones in Kajiado North (32.7%), West (8.4%), and Central (5%). In general, most (52.3%) of the schools surveyed were secondary ones. Primary schools represented the remaining 47.7%. Kajiado North had most schools with enclosures since the area is wetter than the others.

4.4.2 Type of Ownership and Level of Schools Surveyed

The categories of schools sampled included primary and secondary schools as depicted in Table 4.7.

Table 4.7: Type of Ownership and Level of School

School Category	Type of Ownership					
	Public		Private		Total	
	No	%	No	%	No	%
Primary	153	47.7	0	0.0	153	47.7
Secondary	134	41.7	34	10.6	168	52.3
Total	**287**	**89.4**	**34**	**10.6**	**321**	**100.0**

The majority (52.3%) of schools was composed of secondary ones with 41.7 % of them being public and 10.6 % private. Primary schools (47.7%) were all public as there were no private ones found with tree enclosure in the study area.

4.4.3 Source of Tree Seedlings

The sources through which the schools got their seedlings are presented in Table 4.8.

Table 4.8: Source of Tree seedling

Source of Seedlings	Frequency	Percent
Donors	172	53.6
Own nursery	27	8.4
Purchase	100	31.2
Well wishers	22	6.9
Total	**321**	**100.0**

The majority (53. 6%) of schools obtained seedlings from donors supporting tree planting campaigns. 31.2 % purchased tree seedlings and only 8.4% had their nurseries. The low number of tree nurseries could have been a limiting factor to the availability of seedlings in tree enclosures. It was concluded that the school board of management did not encourage much the implementation of tree nurseries.

4.4.4 Fencing of Tree Enclosures in Schools

Table 4.9 shows whether the school tree enclosures were fenced or not.

Table 4.9: Fencing of Enclosures

Enclosure type	Frequency	Percent
Fenced	297	92.5
Not Fenced	24	7.5
Total	**321**	**100.0**

The majority (92.5%) of school enclosures were fenced. This indicates, for example, a certain level of protection against animal grazing and other kinds of threats that could be faced by the trees inside enclosures.

4.5 Density of Trees in Tree Enclosures Owned by Schools in Kajiado County

The density of trees within tree enclosures owned by schools was the dependent variable used in this study. The variable was operationalised as the number of trees per unit area of the enclosure. The number of the trees within the enclosure was counted and the species identified. As for the size of the tree enclosure area, it was estimated and the density was then calculated.

4.5.1 Names of Trees Kept in Tree Enclosures

Botanical and common names of the main trees planted within school enclosures were noted after observation. Data were summarised in multiple response Table 4.10.

Table 4.10: Names and Frequency of Trees Kept in Tree Enclosures (Multiple Response Table)

Botanical Names of Tree species	Common Names	Frequency	Percent
Acacia Xanthophloea	Fever tree	288	89.7
Eucalyptus Fusifolius	Blue gum	140	43.6
Casuarina Equisitifolia	She-oak	95	29.6
Fruit trees	Mango	47	14.6
	Avocado	40	12.5
Grevillea Robusta	Silvery oak	81	25.2
Croton Megalocarpus	Croton	73	22.7

n=321

The results in Table 4.10 show that *Acacia Xanthophloea* (fever tree) represented the main (89.7%) tree specie grown and maintained inside school enclosures. Avocado fruit trees were the least (12.5 %) one. It was noted that there was quite a variety of tree species including blue gums, mango fruit trees, and croton to name a few. This is important as diversifying tree species planted in a given area can improve soil quality. The dominance of fever trees in enclosures was attributed to their numerous environmental benefits.

4.5.2 Number of Trees Growing in School Enclosures

The number of trees per school enclosure was counted. Table 4.11 displays the results.

Table 4.11: Number of Trees Existing in Tree Enclosures of schools surveyed

Number of Trees	Frequency	Percent
1-50	101	31.5
51-100	115	35.8
101-150	10	3.1
151-200	76	23.7
Above 201	19	5.9
Total	**321**	**100.0**

Mean 107, Median 74, Mode 188, Std. dev 95, min 10, and max 400

From the results in Table 4.11, it was noted that on average, there were 107 trees per enclosures. The majority (35.8%) of schools had between 51-100 trees growing in their compounds. The maximum number of trees identified inside enclosures was estimated at 400 while 10 was the minimum. These results indicate a decent tree cover.

4.5.3 Size of Tree Enclosures Owned by Schools

The size of the tree enclosure areas was measured. Results are shown in Table 4.12.

Table 4.12: Area of Tree Enclosures in Schools within Kajiado County

Area of Tree Enclosure (Ha)	Frequency	Percent
0.20	16	5.0
0.28	4	1.2
0.32	24	7.5
0.36	2	0.6
0.40	148	46.1
0.42	3	0.9
0.81	14	4.4
1.21	9	2.8
1.62	42	13.1
1.82	27	8.4
2.02	13	4.0
4.05	19	5.9
Total	**321**	**100.0**

Mean 0.98, Median 0.40, Mode .40, Std. dev 0.972, min 0.20, and max 4.05

Results in Table 4.12 indicate that the size of enclosures varied from 0.20 to 4.05 hectares (ha) with an average of 0.98 ha per school tree enclosure. The majority (46.1%) of enclosures ranged at 0.40 ha. These results illustrate that there was enough space for trees to be planted and grown inside enclosures.

4.5.4 Density of Tree within Enclosures

The density of trees in enclosures was estimated. The results are shown in Table 4.13.

Table 4.13: Number of Trees per Hectare (Density) in Tree Enclosures

Tree Density	Frequency	Percent
1-50	29	9.0
51-100	130	40.5
101-150	58	18.1
151-200	39	12.1
201-250	50	15.6
251-300	15	4.7
Total	**321**	**100.0**

Mean 127, Median 103, Mode 82, Std. dev 68, min 25, and max 277

The density of trees ranged from 25 to 277 with an average of 127 trees per hectare (ha) of school enclosure. The majority (40.5 %) of schools had tree densities ranging between 51 and 100 trees per ha of enclosure. These results show that the schools' tree densities are decent and can be attributed to the use of enclosures. The chi-square test of tree density categories is shown in Table 4.14.

Table 4.14: Chi-square Test for Equality of the Categories of Tree Densities within the school Enclosures in Kajiado County

Categories of Tree Density	Observed N	Expected N	Residual	Statistics
1-50	29	53.5	-24.5	χ^2= 152.850
51-100	130	53.5	76.5	df= 5
101-150	58	53.5	4.5	*p*= .001
151-200	39	53.5	-14.5	
201-250	50	53.5	-3.5	
251-300	15	53.5	-38.5	
Total	**321**			

The chi-square test revealed a statistical (p = .001) significant difference among the categories of tree density. The category of tree density with 51-100 trees per ha of enclosure was significantly (χ^2= 152.9, df= 5, p = .001) higher than the others, thereby indicating that the majority of schools had tree densities ranging between 51 to 100 trees per hectare of enclosures.

4.6 Influence of School Management on the Density of Trees in Enclosures

The first specific objective of the study was: to assess how school management activities influence the density of trees in tree enclosures owned by schools in Kajiado County. The independent variable was the level of the school management board, and the dependent variable was the density of trees within the tree enclosures owned by schools in Kajiado County.

4.6.1 School Management Activities Related to Tree Enclosure Management

School management of activities related to the growing of trees within the school enclosures was an independent variable in this study. The variable was operationalised as an index comprising of six statements that related to the management of the enclosures by the board, as follows: (i) the importance of tree planting and management activities within the tree enclosures, (ii) sensitisation of the students to the benefits of a clean school environment, (iii) organisation of environmental awareness activities within the school, (iv) the board actively participates in tree planting and management activities performed within the tree enclosures, (v) the management of the school positively affects the density of the trees in the enclosures, (vi) the board is aware of the problems of climate change. Respondents were required to indicate their level of agreement with the statements using a rating scale of 1 to 5, where the 1 was to correspond to a strong disagreement with the statement and 5 a to strong agreement with the statement. The different ratings by each respondent for the six statements were then summed up to form an index of the level of school board management of the tree enclosures within their school. The mean scores for the individual statements making the six statements, their means and standard deviations are shown in Table 4.15.

Table 4.15: Mean Scores of Respondents' Responses to the School Management Statements

No	Statement	Mean	SD
1	The importance of tree planting and management activities within the tree enclosures by the board	3.57	0.507
2	Sensitisation of the students to the benefits of trees and a clean school environment	3.92	0.687
3	Organisation of environmental awareness activities in the school.	3.23	0.156
4	The board actively participates in tree planting and management activities performed within the tree enclosures	3.26	0.935
5	The management of the school positively affects the density of the trees in the enclosures	3.98	0.689
6	The board is aware of the problems of climate change	3.18	0.877
	Mean score for the index of School Management of tree enclosures	**3.19**	**0.207**

From Table 4.15 the mean score to the statements regarding school management in tree enclosures is 3.19. This indicates that the majority of respondents recognised the influence of the school board of management on the density of trees is within their school compounds. The standard deviation score of 0.207 shows that the different answers did not vary much from each other. The frequency Table 4.16 presents the distribution of the answers.

Table 4.16: Frequency Distribution of the School Management Categories

Rating scale	Frequency	Percent
1.00	28	8.7
2.00	53	16.5
3.00	73	22.7
4.00	78	24.3
5.00	89	27.7
Total	321	100.0

Mean 3.19, Median 4, Mode 5, Std. dev 1.288, min 1, and max 5.

Most of the responses range from the rating scale of 3 to 5 with the majority (27.7%) showing a high level of school management towards tree enclosures. This was understood through a high level of sensitisation, participation, and funding of environmental activities by the school board of management. The chi-square test of the categories of frequency is presented in Table 4.17.

Table 4.17: Chi-square Test for Equality of the Categories of School Board Management of Tree Enclosures in Kajiado County

Scale	**Description**	**Observed N**	**Expected N**	**Residual**	**Statistics**
Below 1	Very Low	28	64.2	-36.2	χ^2= 36.118
1.1-2.0	Low	53	64.2	-11.2	df= 4
2.1-3.0	Moderate	73	64.2	8.8	*p*= .001
3.1-4	High	78	64.2	13.8	
4.1-5	Very High	89	64.2	24.8	
Total		321			

The chi-square test was conducted to determine the significant differences existing between the categories of school management. The results show that the category with a very high level of school board management within enclosures was significantly (χ^2= 36.1, df= 4, *p*= .001) higher than the other categories observed. This category could represent private school management.

4.6.2 Comparison of School Management Levels between Private and Public schools

The data was analysed to determine the means of two groups (private school management and public school management). The results are given in Table 4.18.

Table 4.18: Means of the Private and Public Schools Management

Groups	*n*	Mean	Std. Deviation	Std. Error Mean
Public Management	287	3.160	1.256	.074
Private Management	34	3.521	.580	.099

The level of enclosure management for private-owned schools was higher (3.521) than the level for the public ones (3.160) on a scale of 1 to 5. The *t* test for the distribution of the respondents is provided in Table 4.19.

Table 4.19: Mean Comparison between the Private and Public School Management Levels

	T	*df*	*p*
Equal variances assumed	-1.651	319	.004
Equal variances not assumed	-2.907	77.1	.001

Levene's Test for Equality of Variances (F 21.540, p 001)

The level of enclosure management for private schools was significantly higher statistically (*t* -2.907, *df* 77, *p* .001).

This meant that private school activities as far as the management of tree enclosures was concerned, was significantly higher than those of public schools. This can be attributed to funding (money spent on enclosures), hiring of manpower, desire to have beautiful and clean compounds.

4.6.3 Determining the Influence of School Board of management Activities on Density of Trees in Tree Enclosures within Schools in Kajiado County

The first research question of this study sought to answer whether the school board management activities significantly influenced the density of trees in tree enclosures owned by schools in Kajiado County. The research question was stated as:

How does school management activities influence the density of trees in tree enclosures owned by schools in Kajiado County?

The study question was answered testing the relationship between the school management activities and the density of trees using a simple linear regression model. The dependent variable was the density of trees within tree enclosures owned by schools in Kajiado County and the independent variable was the school board of management activities within tree enclosures. The results of the regression model are presented in Table 4.20.

Table 4.20: Regression Model Summary for School Management Activities and Tree Density in Tree Enclosures

R	R Square	Adjusted R square	Std. Error of the Estimate
.899[a]	.808	.807	.611

a. Predictors: (Constant), School Management Activities
b. Dependent: Density of trees in enclosures

The model indicates an adjusted R^2 value of 0.807; this means that the independent variable School Management Activities explains approximately 81 % of the variation in the dependent variable Density of Trees in enclosures. The ***F*** test for the regression model is shown in the ANOVA Table 4.21.

Table 4.21: ANOVA Table for the Regression Testing the Fit of the Model

Model	**Sum of Squares**	***df***	**Mean Square**	***F***	***p***
Regression	500.644	1	500.644	1338.624	.001
Residual	119.306	319	.374		
Total	**619.950**	**320**			

The overall regression equation was found to be significant (F (1, 319) = 1338.6, p=.001). The regression coefficients of the model showing the *beta*, *t* statistics, and the tolerance levels are shown in Table 4.22.

Table 4.22: Regression Coefficients for School Management and Density of Trees

	Unstandardized Coefficients		**Standardized Coefficients**			**Collinearity Statistics**
	B	**Std. Error**	**Beta**	***t***	***p.***	**VIF**
(Constant)	-.325	.097		-3.358	.001	
School Management Activities	1.035	.028	.899	36.587	.000	1.000

The regression analysis shows that school management has a positive and significant influence (β=.899, p=.001) on tree density within school enclosures in Kajiado County. It was concluded that the increased participation and commitment of the school board of management in addressing environmental concerns through tree planting and management activities significantly improved the density of trees inside enclosures.

4.7 Influence of Water Availability on Density of Trees within School Enclosures

The second objective of the study was to assess the influence of the availability of water on the density of trees in school tree enclosures within Kajiado County. The independent variable was water availability, and tree density was the dependent one.

4.7.1 Sources of water for Tree Enclosures in Kajiado County

Six water sources were identified in enclosures. Table 4.23 displays the result.

Table 4.23: Source of Water for Tree Enclosures (Multiple Response Table)

Source of Water	Frequency	Percent
Shallow Wells	141	43.9
Storage tanks	119	37.1
Water pipeline	88	24.7
Borehole	50	15.6
Water Vendors	32	10
Rain (natural)	31	9.7

n=321

Shallow wells (43.9%) were the main water sources in school enclosures. The least (9.7%) source of water used in enclosures was natural rain. This is another indication of unreliable rainfall in Kajiado County. Besides, only a few schools used more than two sources of water in their compounds despite the wide range of water sources observed in Kajiado County.

4.7.2 Availability of Water for Tree Enclosure Management

The availability of water for the management of trees within the school enclosures was an independent variable in this study. The variable was operationalised as an index comprising of seven statements related to the availability of water for tree management within the enclosures, as follows: (i) water is important in tree planting, growing and management within the tree enclosures, (ii) use good quality water without excess salts and pollution for trees in the enclosure, (iii) water in the tree enclosure is enough for watering trees and use in the tree nursery at all times, (iv) trees are watered at regular intervals in the tree enclosure, (v) the amount of water in the tree enclosure is enough for trees during the dry season, (vi) water storage tank capacity is enough to supply the tree enclosure throughout the year, (vii) water availability positively affects the density of trees in your tree enclosure. Respondents were required to indicate their level of agreement with the statements using a rating scale of 1 to 5, where the 1 was to correspond to a strong disagreement with the statement and 5 to a strong agreement to the statement. The different ratings by each respondent for the seven statements were then summed up to form an index of the level of water available for use in tree enclosures within the school. The mean scores for the individual statements making the seven statements, their means and standard deviations are shown in Table 4.24.

Table 4.24: Mean Scores of Respondents' Responses to the Availability of Water Statements

No	Statement	Mean	SD
1	Water is vital in tree planting, growing and management within the tree enclosures	2.57	0.607
2	Use good quality water without excess salts and pollution for trees in the tree enclosure	3.12	0. 877
3	Water in the tree enclosure is enough for watering trees and use in the tree nursery at all times	3.33	0.561
4	Watering of trees is done at regular intervals within the tree enclosures	2.26	0.135
5	The amount of water in the tree enclosure is enough for trees during the dry season	2.88	0.489
6	water storage tank capacity is enough to supply the tree enclosure throughout the year	2.78	0.587
7	Water availability positively affects the density of trees in your tree enclosure.	3.20	0.777
	Mean score for the index of water availability for trees within the tree enclosures	**2.84**	**0.707**

Table 4.24 shows a mean score of 2.84 out of a rating scale of 1 to 5. This indicates that not many respondents agreed with all statements regarding the availability of water in enclosures. Although the answers did not vary much considering the standard deviation of 0.707, tree watering activities were performed at irregular intervals. Again water storage tank capacities were not enough. Table 4.25 summarises the results.

Table 4.25: Frequency Distribution for the Categories of Water Availability in School Enclosures

Rating Scale	Frequency	Percent
1.00	56	17.4
2.00	84	26.2
3.00	58	18.1
4.00	55	17.1
5.00	68	21.2
Total	321	100.0

Mean 2.84, Median 3, Mode 2, Std. dev 0.707, min 1, and max 5.

The results in Table 4.25 show that the majority (26.2%) of respondents indicated a low rating regarding the availability of water in school enclosures. This was understood through poor regularity regarding the watering of trees in addition to limited water storage facilities. The chi-square test indicating the significant differences among the categories of water availability is shown in Table 4.26.

Table 4.26: Chi-square Test for the Categories of Water Availability in School Enclosures

Scale	Description	Observed N	Expected N	Residual	Statistics
Below 1	Very Low	56	64.2	-8.2	χ^2= 9.296
1.1-2.0	Low	84	64.2	19.8	*df*=4
2.1-3.0	Moderate	58	64.2	-6.2	*p*=0.34
3.1-4	High	55	64.2	-9.2	
4.1-5	Very High	68	64.2	3.8	
Total		321			

The chi-square test indicates significant differences between the categories of water availability frequencies. The results show that the category with low availability of water is significantly (χ^2= 9.296, *df* = 4, *p* = 0.34) higher than the others. It was concluded that water is not regularly available in school enclosures within Kajiado County, especially in dry spells when water supplies decrease.

4.7.3 Determining the Influence of Water Availability on Tree Densities in Enclosures for Trees in Kajiado County

The second research question of this study sought to answer whether the availability of water significantly influenced the density of trees in enclosures owned by schools in Kajiado County. The research question was stated as:

To what extent does the availability of water influence the density of trees in enclosures owned by schools in Kajiado County?

The study question was answered testing the relationship between the availability of water and the density of trees using a simple linear regression model. The dependent variable was the density of trees within tree enclosures owned by schools in Kajiado County while the independent variable was the availability of water within tree enclosures. The results of the regression model are presented in Table 4.27.

Table 4.27: Regression Model Summary for Availability of Water and Tree Density in Tree Enclosures

R	R Square	Adjusted R Square	Std. Error of the Estimate
.946[a]	.895	.895	21.94004

a. Predictors: (Constant), water availability in tree enclosures mean

b. Dependent: Density of trees in enclosures

The model indicates an adjusted R^2 value of 0.895; this means that the independent variable Water Availability explains 89.5 % of the variation in dependent variable

Density of trees in enclosures. The ***F*** test for the regression model is shown in the ANOVA Table 4.28.

Table 4.28: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	*df*	Mean Square	*F*	*p*.
Regression	1311318.83	1	1311318.83	2724.16	.001[b]
Residual	153555.60	319	481.366		
Total	1464874.44	320			

The overall regression equation was found to be significant (*F* (1, 319) = 2724.164, *p*=.001). The regression coefficients of the model showing the *beta*, *t* statistics, and the tolerance levels are shown in Table 4.29.

Table 4.29: **Regression Coefficients for Water Availability and Density of Trees**

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	**Std. Error**	***Beta***	***t***	***p***	***VIF***
(Constant)	-6.433	2.831		-2.272	.024	
Water Availability	46.815	.897	.946	52.194	.001	1.000

The regression analysis indicates that the availability of water and the density of trees are positively and significantly (β=.946, *p*=.001) related within school enclosures in Kajiado County. It was concluded that the less watering exercises were carried out, the less the density of trees increased. This was observed especially during dry seasons where water supplies declined. The situation was compounded by the schools' low capacities of storing water inside their compounds.

4.8 Influence of Collective Action on Tree Density in Tree Enclosures within Schools in Kajiado County

The third objective of the study was to assess how collective action, through environmental clubs and group activities, influences the density of trees in tree enclosures owned by schools in Kajiado County. The independent variable was collective action, and the dependent variable was the density of trees within tree enclosures owned by schools in Kajiado County.

4.8.1 Collective Action and its Influences on Trees within the Tree Enclosures

Collective action through environmental clubs and other group members and its influences on trees within the school enclosures was an independent variable in this study. The variable was operationalised as an index comprising of six statements related to the collective action for tree management and planting within the enclosures, as follows: (i) collective action through environmental clubs and other groups is important in enhancing tree planting activities in enclosures, (ii) collective action through environmental clubs and other groups is important in enhancing tree management activities in enclosures, (iii) collective action through environmental clubs and other groups positively influences tree density in your enclosures, (iv) collective action through environmental clubs and other groups are aware of the problems of climate change on trees, (v) collective action through environmental clubs and other groups creates awareness on the planting of tree enclosures, (vi) collective action through environmental clubs and other groups creates awareness on the management of tree enclosures. Respondents were required to indicate their level of agreement with the statements using a rating scale of 1 to 5, where the 1 was to correspond to a strong disagreement to the statement and 5 to a strong agreement with the statement. The different ratings by each respondent for the 6 statements were then summed up to form an index of level of collective action through environmental clubs and other groups' influences on trees within the school enclosures. The mean scores for the individual statements making the six statements, their means and standard deviations are shown in Table 4.30.

Table 4.30: Mean Scores of Respondents' Responses to the Collective Action Influences on Trees within the Enclosures Statements

No	Statement	Mean	SD
1	collective action through environmental clubs and group activities is essential in enhancing tree planting activities in enclosures	2.57	0.507
2	collective action through environmental clubs and group activities is essential in enhancing tree management activities in enclosures	2.92	0.687
3	collective action through environmental clubs and group activities positively influences tree density in enclosures	3.23	0.156
4	collective action through environmental clubs and group activities raise awareness on the impact of climate change on trees	2.26	0.935
5	collective action through environmental clubs and group activities raise awareness on tree planting in enclosures,	2.98	0.689
6	collective action through environmental clubs and group activities raise awareness on the management of tree in enclosures	2.18	0.877
	Mean score for the index of collective action Influences on trees within the tree enclosures	**2.74**	**1.398**

The results in Table 4.30 show that the mean score is 2.74 out of a rating scale of 1 to 5, meaning that collective action playing a role influencing the density of trees in school enclosures was recognised by several respondents. The frequency Table 4.31 shows the distribution of the categories of collective action

Table 4.31: Frequency Distribution for the Category of Collective Action

Rating Scale	Frequency	Percent
1.00	85	26.5
2.00	72	22.4
3.00	23	7.2
4.00	88	27.4
5.00	53	16.5
Total	**321**	**100.0**

Mean 2.74±.078, Median 3, Mode 1, Std. dev 1.39, min 1, max 5.

The results in Table 4.31 show that collective action influenced tree density in the majority (27.4 %) of schools, especially those having active environmental clubs. The 26.5 % of respondents opting for a very low rating regarding the influence of collective action on the density of trees can be attributed to a lack of environmental clubs, if not, rather a lack of involvement, participation and action plan from existing clubs in addressing tree planting and management within the school enclosures. The chi-square test for the categories of collective action is shown in Table 4.32.

Table 4.32: Chi-square Test for Equality of the Categories of Collective Action in Tree Enclosures in Kajiado County

Scale	Description	Observed N	Expected N	Residual	Statistics
Below 1	Very Low	85	64.2	20.8	χ^2= 44.903
1.1-2.0	Low	72	64.2	7.8	df= 4
2.1-3.0	Moderate	23	64.2	-41.2	*p*= .001
3.1-4	High	88	64.2	23.8	
4.1-5	Very High	53	64.2	-11.2	
Total		**321**			

The chi-square analysis was performed to determine the significant differences between the categories of collective action. The results in Table 4.32 show that the category with a high level of collective action within school enclosures is significantly higher (χ^2=

44.903, df= 4, *p*= .001) than the others but the one with very low influence. This is explained by the fact that the importance of collective action was highly recognised by the schools that experienced improved tree densities due to the active involvement of their environmental clubs. Those assisted in bringing together the school community towards planting and managing trees. The clubs also raised environmental awareness, sensitised on climate change, and carried out many other group activities to address environmental concerns in the enclosures. On the contrary, the low rating on collective active action can be attributed to a lack of the aforementioned endeavours.

4.8.2 Determining the Influence of Collective Action on Tree Densities in Enclosures for Trees in Kajiado County

The third research question of this study sought to answer whether collective action significantly influenced the density of trees in school tree enclosures in Kajiado County. The research question was stated as: How does collective action influence the density of trees in school tree enclosures within Kajiado County?

The study question was answered testing the relationship between collective action and the density of trees using a simple linear regression model. The dependent variable was the density of trees within school tree enclosures in Kajiado County and the independent variable was collective action. The results of the regression model are presented in Table 4.33.

Table 4.33: Regression Model Summary for Collective Action and Tree Density in Tree Enclosures

R	R Square	Adjusted R Square	Std. Error of the Estimate
.869[a]	.756	.755	33.50524

a. Predictors: (Constant), collective action mean

b. Dependent: Density of trees in enclosures

The model indicates an adjusted R^2 value of 0.755, meaning that the independent variable Collective Action explains 75.5 % of the variation in dependent variable Density of trees in enclosures. The ***F*** test for the regression model is shown in the ANOVA Table 4.34.

Table 4.34: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	**df**	**Mean Square**	**F**	**p**
Regression	1106764.595	1	1106764.595	985.893	.001[b]
Residual	358109.846	319	1122.601		
Total	**1464874.441**	**320**			

The overall regression equation was found to be significant (*F* (1, 319) = 985.9, *p*=.001). The regression coefficients of the model showing the *beta*, *t* statistics, and the tolerance levels are shown in Table 4.35.

Table 4.35: Regression Coefficients for Collective Action and Density of Trees

	Unstandardized Coefficients		**Standardized Coefficients**			**Collinearity Statistics**
	B	**Std. Error**	***Beta***	***t***	***p***	***VIF***
(Constant)	11.444	4.123		2.776	.006	
Collective Action	42.040	1.339	.869	31.399	.001	1.000

The regression model indicates that collective action significantly and positively influenced (β = .869, *p*=.001) tree densities in school enclosures within Kajiado County. It was concluded that the schools that encouraged the participation of their community, through active environmental clubs and group activities focused on tree planting and management, were likely to see tree densities improve within their compounds.

4.9 Influence of Climatic Factors on Density of Trees in Enclosures within Schools in Kajiado County

The fourth objective of the study was to assess how climatic factors influence tree density inside enclosures in Kajiado County. The independent variable was climatic factors and the dependent variable was the density of trees in tree enclosures in Kajiado County.

4.9.1 Climatic Factors and their Influences on Tree Densities within the Tree Enclosures

Climate and its influences on trees within the school enclosures was an independent variable in this study. The variable was operationalised as an index comprising of seven statements related to the influence of climates on tree density in the schools' compound, as follows: (i) amount of rains in the area is low and affects tree and seedling growth, (ii) prolonged periods of absence of rains (drought) cause trees and seedlings in the enclosures to dry out, (iii) climate affects the selection of tree species to grow in the enclosures, (iv) climate causes trees and seedlings in the enclosure to grow slowly (slow growth rate), (v) temperatures are very high they dry the soil moisture in the enclosure very quickly, (vi) temperatures are very high they cause high rates of evaporation from the water tanks and transpiration from the trees, (vii) climate changes have a negative effect on the trees within the tree enclosures. Respondents were required to indicate their level of agreement with the statements using a rating scale of 1 to 5, where the 1 was to correspond to a strong disagreement to the statement and 5 to a strong agreement to the statement. The different ratings by each respondent for the seven statements were then summed up to form an index of the climatic influences on trees within the school enclosures. The mean scores for the individual statements making the six statements their means, and standard deviations are shown in Table 4.36.

Table 4.36: Mean Scores of Respondents' Responses to the Climatic Influences on Trees within the Enclosures Statements

No	Statement	Mean	SD
1	Amount of rains in the area is low and affects tree and seedling growth	2.57	0.51
2	Prolonged periods of absence of rains (drought) cause trees and seedlings in the enclosures to dry out	2.92	0.69
3	Climate affects the selection of tree species to grow in the enclosures	2.23	0.16
4	Climate causes trees and seedlings in the enclosure to grow slowly (slow growth rate)	2.26	0.94
5	Temperatures are very high they dry the soil moisture in the enclosure very quickly	2.98	0.69
6	Temperatures are very high they cause high rates of evaporation from the water tanks and transpiration from the trees	3.18	0.88
7	Climate changes have a negative effect on the trees within the tree enclosures	2.54	0.78
	Mean score for the index of climatic Influences on trees within the tree enclosures	**2.97**	**1.41**

The mean score was 2.97 out of a scale of 1 to 5. This indicates that the influence of climatic factors on tree density was recognised by many respondents. The responses were varied though. This is due to the standard deviation of 1.41. Table 4.37 presents the results of the categories of frequencies related to the influence of climatic factors on tree density.

Table 4.37: Frequency Distribution for the Category of Climatic Influence on Tree Density

Rating Scale	Frequency	Percent
1.00	37	11.5
2.00	75	23.4
3.00	71	22.1
4.00	29	9.0
5.00	109	34.0
Total	321	100.0

Mean 2.97, Median 3, Mode 5, Std. dev 1.405, min 1, and max 5.

The majority of respondents (34%) considered the influence of climate on tree density to be very high within the school enclosures. This can be attributed to the fact that high temperatures caused high rates of evapotranspiration which affected trees in the enclosures. The chi-square test showing significant differences in the categories of frequencies is displayed in Table 4.38.

Table 4.38: Chi-square Test for the Categories of Climatic Influence for Tree Enclosures in Kajiado County

Scale	Description	Observed N	Expected N	Residual	Statistics
Below 1	Very Low	37	64.2	-27.2	χ^2= 64.623
1.1-2.0	Low	75	64.2	10.8	df= 4
2.1-3.0	Moderate	71	64.2	6.8	*p*= .001
3.1-4	High	29	64.2	-35.2	
4.1-5	Very High	109	64.2	44.8	
Total		321			

The chi-square test was performed to determine the significant differences between the categories of climatic factors' influence. The results in Table 4.38 showed that the category with very high climatic influence on tree density is significantly higher (χ^2= 64.623, df= 4, *p*= .001) than the others. The high level of climatic influence on tree density in school enclosures was due to the fact that high temperatures dried soil moisture very quickly reducing the survival and growth rate of seedlings in the school compounds. High temperatures also affected surface water sources used for tree watering. Besides, Climate change can be another factor influencing tree density through longer droughts and unreliable rainfalls in the area of study.

4.9.2 Determining the Influence of Climatic Factors on Tree Densities inside Enclosures in Kajiado County

The forth research question of this study, sought to answer whether climatic factors significantly influenced the density of trees in school tree enclosures within Kajiado County. The research question was stated as:

To what extent do climatic factors influence the density of trees in enclosures owned by schools in Kajiado County?

The study question was answered testing the relationship between climatic factors and the density of trees using a simple linear regression model. The dependent variable was the density of trees within tree enclosures owned by schools in Kajiado County and the independent variable was climatic factors. The results of the regression model are presented in Table 4.39.

Table 4.39: Regression Model Summary for Climatic Factors and they Influence on Tree Density in School Enclosure

R	R Square	Adjusted R Square	Std. Error of the Estimate
.907[a]	.822	.822	28.58148

a. Predictors: (Constant), climatic factor mean

b. Dependent: Density of trees in enclosures

The model indicates an adjusted R^2 value of 0.822. This means that the independent variable Climatic Factor explains 82 % of the variation in the dependent variable Tree Density in enclosures. The ***F*** test for the regression model is shown in Table 4.40.

Table 4.40: ANOVA Table for the Influence of Climatic Factors on Tree Density in School Enclosures

	Sum of Squares	***df***	**Mean Square**	***F***	***p***
Regression	1204283.094	1	1204283.094	1474.210	.001[b]
Residual	260591.346	319	816.901		
Total	**1464874.441**	**320**			

The overall regression equation was found to be significant (*F* (1, 319) = 1474.210, *p*=.001). The regression coefficients of the model showing the *beta*, *t* statistics, and the tolerance levels are shown in Table 4.41.

Table 4.41: Regression Coefficient for the Climatic Influence on Tree Density

	Unstandardized Coefficients		**Standardized Coefficients**			**Collinearity Statistics**
	B	**Std. Error**	***Beta***	***t***	***p***	***VIF***
(Constant)	-2.996	3.738		-.802	.423	
Climatic Influences	43.634	1.136	-.907	38.395	.001	1.000

The regression analysis indicates that climatic factors have a significant and negative influence (*β*= -.907, *p*=.001) on the density of trees inside school tree enclosures in Kajiado County. It was observed that the planting and management of selected tree species to grow within school enclosures was affected by variations of climatic conditions such as temperature and rainfalls. The more temperature increased, the more soil was dried and the less the density of trees improved in enclosures. The more rainfalls were unreliable the less tree density increased. Longer dry seasons also affected trees by slowing their growth rate. Climate change played a significant role by disrupting and exacerbating the aforementioned climatic conditions as well. In conclusion, the more climatic factors were disturbed, the less the density of tree was expected to improve.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMANDATIONS

5.1 Introduction

This Chapter provides a discussion on the research findings, summary, conclusions, recommendations, and areas of further research.

5.2 Discussions

This section discusses the results of the study based on the stated objectives

5.2.1 Tree Density in Kajiado County

The study revealed that the majority of schools had tree densities higher than 50 trees per hectare (ha) of school tree enclosure ranging between 0.2 to 4.05 hectares. *Acacia xanthophloea* (fever tree) was the dominant tree species in most school compounds. This revealed the fact that many trees were planted and/or managed in small areas (enclosures), thereby indicating that a decent tree cover can be achieved through the use of enclosures. The results are mainly attributed to the role that enclosures played in tree planting and management activities as most of them (92.5%) were fenced. Fences were critical for protecting trees inside enclosures (WOCAT, 2013) as those were effective in preventing, for instance, animal activities such as grazing (Verdoodt *et al*., 2010; Angassa and Oba, 2010) from affecting them. The results agree with Angassa (2016) and Yayneshet *et al*. (2009) who concluded that the use of enclosures can contribute to increased biomass production of trees. Enclosures can improve plant biodiversity and natural regeneration of trees (Angassa, 2014; Etafa and Raj, 2013; Hailu, 2016) as they are well-known management tools for environmental rehabilitation (Aerts *et al*., 2009). Fenced tree enclosures should be promoted across degraded areas such as Kajiado County in order to improve tree cover and fight environmental issues due to erosion, grazing, and extraction of fuel woods among other things.

Despite the fact that this study supports the implementation of tree enclosures as a mean of rehabilitating areas that have lost most of their vegetation, its findings were not supported by Flintan *et al*. (2011) and Fekadu (2009) who considered the effectiveness of enclosures controversial for restoring specific woody vegetation attributes; instead their argument is that enclosures are rangeland privatisation strategies that threaten their own long-term sustainability. This study however establishes enclosures as a sustainable way of increasing the density of trees in areas affected by drought, deforestation, and land degradation among other environmental issues.

The dominance of *Acacia xanthophloea* (fever trees) in enclosures was attributed to their numerous environmental benefits. This is in line with Orwa *et al*., (2009) and Okello *et al.*, (2001) who discussed the various benefits of *Acacia xanthophloea* saying that they can be used for shade and shelter, timber, ornamental purposes, and act as live fences. This is important as the tree species can contribute to reducing costs related to installing physical fences in enclosures as they can serve as natural fencing systems. Moreover, *Acacia xanthophloea* can be used for rehabilitation purposes. Kahuthia-Gathu *et al.* (2018) support that arguing that fever trees have been used, for instance, to rehabilitate quarries in Athi River, in Kenya and can contribute to the increase and preservation of plant biodiversity as well as nature restoration.

The abovementioned characteristics of *Acacia xanthophloea* must be taken into account when initiating projects aimed at increasing tree densities in degraded areas. Those projects should be looking at similar criteria when selecting tree species to use as such tree species can help cut down costs related, for example, to the purchase and installation of fences while being efficient in restoring vegetation attributes in areas of concern.

5.2.2 Influence of School Management on the Density of Trees in Enclosures

The study revealed that the more the board of the school was involved in environmental activities and committed to providing more funds for example, the more the density of trees was increasing within the school enclosure. This was observed in private schools management as those allocated more resources to the environment (funds, manpower, desire to have a cleaner environment) than public ones. These results are consistent with the findings of Wango (2009) arguing that the school management through its internal management structure ensures that the necessary planning and implementation is undertaken in order to achieve the school goal, which is, in this case, to increase the number of trees inside the compound. In addition, the school board of management was aware of the benefits of trees and climate change, hence participated in tree planting and management activities while promoting environmental awareness within the school education system. Agarwal and Nangia (2005) support that in considering the school education system a decent medium for raising environmental awareness and sharpening environmental skills. Furthermore, there was a conspicuous lack of tree nurseries in most school enclosures. This was due to the fact that those were not promoted through the school environmental management despite the recognition of their critical role in bringing environmental awareness (UNEP, 2011) and providing seedlings for tree planting projects as, in this case, those using school compounds. With regard to that, the limited implementation of tree nurseries as means of providing planting material such as seedling did not contribute much to improving the density of trees inside enclosures. The results agree with Broad Hurst *et al.* (2016) considering the provision of planting material for any plant-based ecological restoration project to be crucial for them to be successful. This is also in line with UNEP (2011) recognising that tree nurseries can be used for addressing the global diminishing forests. Projects aimed at increasing tree densities through the use of enclosures should consider implementing tree nurseries at their early stage. Tree nurseries can be easily manageable in small areas (enclosures) and provide planting resources that can help accelerate the restoration process of degraded areas.

5.3.3 Influence of the Availability of Water on Tree Density in school tree Enclosures

The availability of water was low in the majority of school enclosures. This confirmed the fact that water is a scarce resource in Kajiado County as recognised by the County Government of Kajiado (2018). It was concluded that the schools which did not encourage frequent watering activities in addition to not diversifying enough their water supply by using, for instance, more than 2 water sources were likely to see the number of trees decrease within their enclosures. These results agree with Zhang *et al.* (2015) who stated that water deficits combined with altered water availability patterns can cause drought stress, hence influence the overall vulnerability of forest ecosystems. Further, the limited number of water storage facilities also contributed to reduced water supply, which proved detrimental to trees particularly during dry seasons when overall water supplies decrease in the region.

In that regard, the school board of management should consider implementing water conservation practices to increase the supply of water in tree enclosures. The use of techniques such as Rainwater Harvesting (RWH) can be effective as it can bring significant water conservation benefits (GhaffarianHoseini *et al.*, 2016). The application of micro-catchment water harvesting systems using for example the roofs of available buildings in the school compounds can increase the amount of rainwater available for the trees, especially during dry spells. Carmona and Velasco (1988) support that by stating that the survival rate of planted trees can be improved through the application of micro-catchment water-harvesting systems. RWH is also beneficial to the schools as it requires minimal maintenance and storage costs while bringing water to the place of need (Efe, 2006; Opare, 2012), particularly in remote areas where piped water and reliance on wells is no longer an option (Opare, 2012) as it is the case in several schools within Kajiado County.

The rainwater collected can then be kept in storage tanks, which should be properly maintained for better performance (Mwami, 1995). Improved water supply through the use of well-maintained storage tanks can contribute to increasing the density of trees within enclosures.

At last, the overall low level of water supply also affected soil moisture. This negatively influenced the growth of seedlings during dry seasons as agreed by Valdecantos *et al*. (2006) stating that reduced water availability in soils during drought strongly affects seedlings survival. The density of trees was therefore affected through the reduced number of seedlings growing to maturity in school compounds. The situation could be mitigated using Soil and Water Conservation (SWC) techniques within school compounds.

5.3.4 Influence of Collective Action on Tree Density in Tree Enclosures within Schools in Kajiado County

The findings of this study showed that schools with active environmental clubs experienced improved tree densities inside their compounds. This was attributed to environmental clubs carrying out group activities involving the school community in tree planting and management activities. Such undertakings contributed to raising awareness on the importance of trees and climate change as well. These results are in line with Mamvibela (2002) and Ndaruga (2004) who concluded that environmental issues can be addressed by school clubs through tree planting activities. Results also agree with Kaur and Kaur (2013) stating that awareness is essential for action to be taken. This shows that knowing and understanding the role of trees along with the impact of climate change on the environment was critical for the school community to be able to participate actively in the enhancement of their tree enclosures. This helped them undertake proper actions in order to improve the density of trees in school compounds.

5.3.5 Influence of Climatic Factors on Density of Trees inside School Enclosures in Kajiado County

This study revealed that changes in climate negatively affected trees through longer droughts, higher temperatures, and unreliable precipitations causing some trees and seedlings to grow slowly and others to dry within enclosures. Same results were observed by Levesque *et al.* (2014) who concluded that forests growing in arid and semi-arid locations and at their dry limits are particularly vulnerable to climate change which can cause a combination of warming and altered rainfall patterns that can lead to feedback effects on remaining vegetation, reduced biomass accumulation, drought, and die-off (Brienen *et al*., 2015). More authors such as Desai *et al*. (2008) and Zhu *et al*. (2011) established that the increase in global temperature affects biodiversity at different scales and ways; bringing longer growing seasons for trees (Bonan, 2008). In addition, the results brought up the fact that high temperatures affected the growth of trees by drying soil moisture as supported by Padilla and Pugnaire (2007) recognising the existence of highly positive relationships between soil moisture and seedling survival. High temperatures also caused high rates of evaporation that lowered surface water supply in the area of study. The results agree with Bada *et al*. (2017) saying that water availability is affected in the arid and semi-arid areas by global warming and climatic changes that increase the rate of evaporation in surface water sources. Reduced water supplies due to climatic factors did not contribute to the improvement of tree densities in school enclosures as water shortages were exacerbated by climate change (Kelley *et al*., 2015) in the region. Less water supply meant reduced water quantities for plants.

Furthermore, the density of trees, with regard to species diversity, was affected by climatic factors through the selection of species planted and managed in enclosures. For instance, it was noted that the dominance of *Acacia xanthophloea* (fever trees) was mostly due to their numerous environmental benefits. Those include but are not limited to the ability of the tree species to adapt to environmental changes (Ludwig *et al*., 2004) and drought stress (Oba *et al*., 2001). Thomas *et al*. (2014) support the results by concluding that the selection of forest resource materials depends on their capacity to survive and thrive under degraded land conditions as well as their potential to adapt to changing environments. This resulted in increased preference of fever trees over blue gum, croton, and other tree species planted and grown in school compounds, hence their dominance inside enclosures. This is relevant as future tree planting campaigns should consider using tree species that are climate resilient depending on the region where the project will be carried out.

5.3 Summary of the Main Findings

This study highlighted the fact that the density of trees was significantly influenced by the school management, availability of water, collective action, and climatic factors in school tree enclosures. School boards of management were aware of the benefits of having a clean and healthy environment. They also knew about climate change and the importance of trees within school compounds. Therefore, they participated in tree planting and management activities while sensitising the school community on the relevance of the matter. These endeavours were recognised for positively affecting tree densities within enclosures, especially those owned by private schools. Although many water sources including shallow wells, boreholes, and water storage tanks among others were identified inside school compounds, only a few schools had more than two of those at their disposal. Low availability of water supplies coupled with irregular watering intervals played a significant role in reducing the number of trees grown in the area of concern, particularly during dry seasons. Collective action played a significant role through school environmental clubs and group activities pertaining to the plating and management of trees and contributed to raising environmental awareness despite the poor implementation of tree nurseries in most enclosures. The limited number of tree nurseries contributed to reducing the density of trees through the reduced provision of seedlings. Climatic factors negatively affected tree densities in school enclosures. This occurred through longer droughts, unreliable rainfalls, and higher temperatures. The selection of tree species was affected by the climate as well.

5.4 Conclusions

The following conclusions were made from the study.

(i) School management significantly influences the density of trees in school enclosures within Kajiado County,

(ii) Water availability significantly influences the density of trees in school enclosures within Kajiado County,

(iii) Collective action significantly influences the density of trees in school enclosures within Kajiado County,

(iv) Climatic factors significantly influence the density of trees in school enclosures within Kajiado County.

5.5 Recommendations

This study has demonstrated that the density of trees was affected by the school management, water availability, collective action, and climatic factors in tree enclosures within Kajiado County. Therefore, future tree planting and management campaigns using school compounds can be improved by considering the following recommendations:

(i) The use of enclosures should be strongly promoted in tree planting and management activities involving schools. This is a sustainable way of restoring degraded lands. The school board of management of schools with no tree enclosure can implement one by setting aside a small piece of land within the compound of their school to grow trees. They should also put a fence around it to protect the trees against external treats such animals. They should select climate-resilient tree species such as *Acacia Xanthophloea* (fever tree) which are drought resistant and can easily adapt to a changing environment. This can lead to improved tree densities within school compounds. *Acacia Xanthophloea* tree species can also be used as natural fences, which can help in reducing costs related to purchasing and installing physical fences that may discourage the implementation of the enclosure.

(ii) To address water scarcity issues, Soil and Water Conservation (SWC) techniques should be used in school compounds. For example, the school board of management can plan for the digging of channels that can carry runoffs to pits lined with plastic to keep water for further use. The pits should be dug near the enclosures to facilitate tree watering exercises. The width and depth of the pits should depend on the water supply need of the school with regard to the tree enclosure. Water from building rooftops available in the school compound can also be channelled, through the use of hoses, to pits. If there is more money, the school board of management should purchase more water storage tanks as they can keep water collected from rooftops as well. They should use proper lids to cover the storage tanks in order to mitigate the impact of high temperatures on water supplies through evaporation. This can increase water supply available for trees during dry seasons. The school board of management should also design watering activities schedules that can assist in planning for tree watering activities organised by classes of students which can perform it either early in the morning as well as in the evening. Tree watering should be done 3 to 4 times a weeks, especially in dry seasons. Environmental clubs can help to devise the tree-planting schedule. Applying all these measures requires money, so the school board of management of public schools should demand for more funds to be allocated to environmental concerns and include it in the school budget. They should keep advocating for more efforts to be done to address environmental issues from their schools' board of governance.

(iii) The school administration should promote the use of tree nurseries. This can be done through training organised by the school environmental club as to the implementation of tree nurseries. The school administration should set aside a small space in the school compound where the tree nursery can be developed.

(iv) The government of Kenya should make more land available for tree planting and management activities. This can be done by lending unused lands to schools to allow them to implement and manage tree enclosures.

(v) International, national, and local environmental stakeholders involved in tree planting campaigns using school compounds should continue supporting such undertakings by proving more funds. They should also build people's capacities through training sessions on how to implement efficient tree enclosures and nurseries to support tree planting and management projects in the long run. This can contribute to achieving SDG 15, life on land, which supports afforestation and reforestation efforts globally.

5.6 Area of Further Research

This study recommends the following area of further research:

(i) The Influence of water conservation practices on the density of trees in school tree enclosures.

(ii) The effects of soil conservation techniques on the density of trees within school tree enclosures.

(iii) The impacts of community participation on the implementation of tree enclosures in arid areas.

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APPENDICES

Appendix A: Letter of Introduction

Vuna Chris Ndukula

0743795022

Nairobi

Dear respondents,

My name is Vuna Chris Ndukula and I am a master's degree student at Africa Nazarene University. I would like to collect data on factors that influence the density of trees in school tree enclosures within Kajiado County, Kenya. Your school has been selected to provide desired information.

I would be grateful for your kindly participation in answering the enclosed questionnaire. The information you will provide will be treated with utmost good faith and confidentiality and your response will be highly appreciated.

Your faithfully,

Vuna Chris Ndukula

Appendix B: Questionnaire

The purpose of this questionnaire is to collect data that will be used in a study to assess the factors influencing the density of trees in school tree enclosures owned by schools in Kajiado County, Kenya. When answering the questions, please give an honest opinion. I appreciate your contribution to this study. All your responses will be treated confidentially. If you have any questions, please do not hesitate to contact me. Mark with a tick (√) where applicable or write your response in the space provided.

Section A: Demographic Information

1. What is your title? ………………………………………………………………

2. What is your level of education?

No education [ ] Primary level [ ] Secondary level [ ] Tertiary level [ ]

3. How long have you been working at your current position? ………………………

4. What is the category of your school? Primary [ ] Secondary [ ]

5. Is your school a public or a private one? ....

6. How long have you been studying or working in your school?

……………………………………………………………………………………

Section B: School Management

Indicate your level of agreement with the following statement ‘relating to the school management of trees in the enclosure of your school, by putting a tick [√] to the level you require. This uses a scale of 1 to 5, where; where; 1 corresponds to Strongly Disagree (SD), 2 correspond to Disagree (D), 3 correspond to Undecided (U), 4 correspond to Agree (A), and, 5 correspond to Strongly Agree (SA).

No.	School management of tree related activities in the enclosures	Level of agreement with statement				
		SD	**D**	**U**	**A**	**SA**
		1	**2**	**3**	**4**	**5**
7	Tree planting and management activities are important for the board of your school					
8	Students are sensitised about the benefits of trees and a clean school environment					
9	Environmental awareness activities are organised in your school					
10	The board of management of your school participates in tree planting and management activities performed inside the enclosure					
11	The density of trees is positively affected by the management of your school					
12	The board of your school is aware of climate change					

13. What can be done to increase the number of trees in your school enclosure? ……………………………………………………………………………………………….

Section C: Water Availability

14. What is the source of the water you use?

Tanks [ ] Pipes [ ] Rain [ ] Vendors [ ] Wells [ ] Borehole [ ]

Indicate your level of agreement with the following statement ‘relating to the availability of water in your school, by putting a tick [√] to the level you require. This uses a scale of 1 to 5, where; where; 1 corresponds to Strongly Disagree (SD), 2 correspond to Disagree (D), 3 correspond to Undecided (U), 4 correspond to Agree (A), and, 5 correspond to Strongly Agree (SA).

No.	Water availability in school	Level of agreement with statement				
		SD	**D**	**U**	**A**	**SA**
		1	**2**	**3**	**4**	**5**
15	Water is important for the tree planting, growing and management in your school enclosure					
16	You use good quality of water without excess salts and pollution for trees in the enclosure					
17	You have enough water for watering trees and for the nursery at all times					
18	You water trees at regular intervals in the enclosures					
19	You have enough water for watering trees during dry season					
20	Your water storage tank(s) has enough capacity to supply the tree enclosure throughout the year					
21	Availability of water positively affects the density of trees in your tree enclosure					

Section D: Acquisition of Species

22. Where do you get tree species seedlings?

From donors [ ] Own nursery [ ] through purchases [ ] well-wishers [ ]

Section E: Collective Action

23. Does your school have an environmental club?

Yes [ ] No [ ]

Indicate your level of agreement with the following statement 'relating to environmental collective action in your school, by putting a tick [√] to the level you require. This uses a scale of 1 to 5, where; where; 1 corresponds to Strongly Disagree (SD), 2 correspond to Disagree (D), 3 correspond to Undecided (U), 4 correspond to Agree (A), and, 5 correspond to Strongly Agree (SA).

No.	**Collective action (environmental club)**	**Level of agreement with statement**				
		SD	**D**	**U**	**A**	**SA**
		1	**2**	**3**	**4**	**5**
24	Collective action is important for tree planting activities through environmental clubs and group activities in your school enclosures					
25	Collective action is important for tree management activities through environmental clubs and group activities in your school enclosures					
26	Collective action through environmental clubs and group activities positively influence the density of trees in your school enclosure					
27	Environmental clubs and Group activities contribute to raising awareness on climate change and its impact in enclosures					

28	Collective action through environmental clubs and group activities help to raise awareness on tree planting in the school enclosure					
29	Collective action through environmental clubs and group activities help to raise awareness on the management of trees in the school enclosure					

Section F: Climatic factors

Indicate your level of agreement with the following statement 'relating to climate, by putting a tick [√] to the level you require. This uses a scale of 1 to 5, where; where; 1 corresponds to Strongly Disagree (SD), 2 correspond to Disagree (D), 3 correspond to Undecided (U), 4 correspond to Agree (A), and, 5 correspond to Strongly Agree (SA).

No	**Climate**	**Level of agreement with statement**				
		S	**D**	**U**	**A**	**SA**
		1	**2**	**3**	**4**	**5**
30	The amount of rains in the area is low and affects tree and seedling growth					
31	Drought cause trees and seedlings in the enclosures to dry out					
32	Climate affect selection of trees to grow in the enclosure					
33	Climate cause tree and seedlings to grow slowly in your school enclosure					
34	Temperatures are very high and dry the soil moisture in the enclosure quickly					
35	Temperatures are very high and cause high rate of evaporation from water tanks and transpiration from the trees					
36	Climate changes has a negative effect on the trees within the enclosure					

THANK YOU

Appendix C: Data Collection Sheet

No	Date	Name of school	Sub-county	Location		Fencing of enclosure	Number of trees in area	Size of school enclosure	Type of water sources	Dominant species	Comments
				Lat.	Long.						
1											
2											
3											
4											
5											
6											
7											

Appendix D: Photographs Taken During Data Collection

1. A water storage tank used in a school

2. Fever trees in Kajiado County

A school enclosure planted with trees and grass species

Students watering trees in a school enclosure

5. Pupils planting seedlings in their school enclosure

6. Seedlings pending planting

7. Degraded land in Kajiado County

Appendix E: ANU Research Authorisation Letter

AFRICA NAZARENE
UNIVERSITY

12th June, 2018

RE: TO WHOM IT MAY CONCERN

Chris Vuna Ndikula 18J01DMEV003 is a bonafide student at Africa Nazarene University. He/She has finished his/her course work and has defended his/her thesis proposal ***entitled "An assessment of factors influencing tree density in forest tree enclosures owned by schools in Kajiado county Kenya***

Any assistance accorded to him/her to facilitate data collection and finish his/her thesis is highly welcomed.

Prof. Rodney Reed
Deputy Vice Chancellor, Academic Affairs

P.O Box 53067 - 00200 Nairobi, Kenya • Tel: 020 252 7170/1 - 5 • Fax: 020 201 2233 • Cell: 0733 874 111 • Email: registrar@anu.ac.ke • www.anu.ac.ke

Appendix F: NACOSTI Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/19/38557/30207**

Date: **18th June 2019**

Ndukula Chris Vuna
Africa Nazarene University
P.O. Box 53067-00200
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"An assessment of factors influencing tree density in forest tree enclosures owned by schools in Kajiado County, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Kajiado County** for the period ending **18th June, 2020.**

You are advised to report to **the County Commissioner, and the County Director of Education, Kajiado County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

DR MOSES RUGUT, PhD, OGW
DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kajiado County.

The County Director of Education
Kajiado County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

Appendix G: NACOSTI Research Permit

THIS IS TO CERTIFY THAT:
MR. NDUKULA CHRIS VUNA
of AFRICA NAZARENE UNIVERSITY,
49456-243 goma,has been permitted to
conduct research in *Kajiado County*

on the topic: *AN ASSESSMENT OF FACTORS INFLUENCING TREE DENSITY IN FOREST TREE ENCLOSURES OWNED BY SCHOOLS IN KAJIADO COUNTY, KENYA*

for the period ending:
18th June,2020

Permit No : NACOSTI/P/19/38557/30207
Date Of Issue : 18th June,2019
Fee Recieved :Ksh 2000

Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.

National Commission for Science, Technology and innovation
P.O. Box 30623 - 00100, Nairobi, Kenya
TEL: 020 400 7000, 0713 788787, 0735 404245
Email: dg@nacosti.go.ke, registry@nacosti.go.ke
Website: www.nacosti.go.ke

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH LICENSE

Serial No.A 25347

CONDITIONS: see back page

Appendix H: Research Authorisation Letter from Kajiado County Ministry of Interior and Co-Ordination of National Government County Commissioner

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT
COUNTY COMMISSIONER, KAJIADO

Telephone: 0203570295
Fax: 0202064416

Email: kajiadocc2012@gmail.com
When replying please quote

County Commissioner
Kajiado County
P.O. Box 1-01100
KAJIADO

Ref. KJD/CC/ADM/45 VOL. I1 (155)

25TH JUNE, 2019

NDUKULA CHRIS VUNA,
AFRICA NAZARENE UNIVERSITY,
P.O BOX 53067 – 00200,
NAIROBI

RE: RESEARCH AUTHORIZATION

Following the request made on your behalf by National Commission for Science, Technology and Innovation vide **letter Ref. No. NACOSTI/P/19/38557/30207 dated 18th June 2019**.

You are hereby granted authority to carry out research on ***"An assessment of factors influencing tree density in forest tree enclosures owned by schools in Kajiado county,*** *for a period ending 18th June 2020.*

It is expected that you adhere to research ethics in doing your study.

COUNTY COMMISSIONER
KAJIADO COUNTY
25 JUN 2019
P.O. Box 1-01100, KAJIADO

CHERONO RORIAN
FOR: COUNTY COMMISSIONER
KAJIADO COUNTY.

CC:

County Director of Education
KAJIADO COUNTY.

Deputy County Commissioners
KAJIADO COUNTY

Appendix I: Research Authorisation Letter from Kajiado County Ministry of Education

MINISTRY OF EDUCATION
State Department of Early Learning & Basic Education

Ref: KJD/C/R.3/VOL.II/120

Ndukula Chris Vuna
Africa Nazarene University
P.O. Box 53067-00200
NAIROBI

RE: RESEARCH AUTHORIZATION

Reference is made to a letter from National Commission for Science, Technology and Innovation ***Ref. NACOSTI/P/19/38557/30207*** dated 18th June, 2019.

Authority is hereby granted to you to conduct your research on **"An assessment of factors influencing tree density in forest tree enclosures owned by schools in Kajiado County"** for a period ending **18th June, *2020.***

On completion of the research, you are expected to submit ***a copy*** of the research report/thesis to our office.

COUNTY DIRECTOR OF EDUCATION
KAJIADO COUNTY

SAMMY N. NG'ANG'A
FOR: COUNTY DIRECTOR OF EDUCATION
KAJIADO COUNTY