

UNIVERSITY OF RWANDA
COLLEGE OF ARTS AND SOCIAL SCIENCES
CENTER FOR CONFLICT MANAGEMENT
MASTERS OF ARTS IN SECURITY STUDIES

**FIREWOOD UTILIZATION AND ENVIRONMENTAL DEGRADATION: A CASE
STUDY OF MUSANZE DISTRICT OF RWANDA**

**A dissertation submitted to the center for conflict management in partial
fulfillment of the Requirement for the degree of master of security studies of
university of Rwanda**

By: Safari RUBABAZA

Supervisor: Professor Francois MASABO

Nyakinama, April 2019

DECLARATION

This work is unique and has not been submitted to any institution of higher learning for the award of master degree in security studies.

Safari RUBABAZA

Signature: Date:

This work of Safari RUBABAZA has done under my supervision as supervisor of university of Rwanda.

Professor Francois MASABO

Signature : Date :
.....

ACKNOWLEDGEMENT

A lots of appreciations, acknowledgements and thanks should go to my family, lecturers, colleagues and my research supervisor for the encouragement and guidance given to me while my studies and compilation of this study.

DEDICATION

This work is dedicated to my family, my wife and kids for all kind of supports provided to me while studying and compiling this research report.

ABSTRACT

The main purpose of this study is to examine the impact of firewood utilization has on environmental degradation, and it has also four specific objectives including to assess the effects of firewood utilization on environmental degradation in Musanze District of Rwanda for the last 5 years (March, 2014 – March, 2019); to show the connection between firewood utilization and environmental degradation in Musanze District of Rwanda; to find out the emergency response needed to mitigate the impact of firewood utilization on environmental degradation; to formulate recommended intervening strategies for halting firewood utilization and environmental degradation in Musanze District of Rwanda; literature reviewed showed that researchers stipulated that firewood utilization destroys the environment on high rate, the findings of the study proved that residents of Musanze District mostly in rural areas prefer to use firewood to warm house in seasons of coldness.

The findings indicate that 94 (94.0%) of respondents have agreed that government put much efforts in encouraging other sources of energy while cooking rather than firewood. The results also proved that there is correlation between destruction of species in system and rapid industrialization ($p=0.917$ with $\text{sig}=0.00$ at 0.01 level of significance), it means there is strong positive significant relationship between destruction of species in system and rapid industrialization. The study finding proved that sociocultural factor (conservative behavior) is the highest rated factor to influence emergency response in cutting back negative effects brought by firewood utilization. The findings also prove that LP Gas is very cheap compared to other sources of energy considered in this study.

In conclusion, the results prove that sensitization, mobilization and reinforcing environment protection regulations and policies can help to mitigate and prevent the effects of environment degradation; recommendations on sensitizing the members of local community to utilize gas cookers as a smarter, affordable and cheaper source of energy compared to others, increase safety awareness to gas cooker utilizers, enhancing the reinforcement and regulatory measures concerning environmental protection and further studies were recommended to be done on mining activities and environmental security, to analyze the impact of deforestation on environmental degradation, fire incidents and Liquefied Petroleum Gas utilization, other researches should be carried on analyzing the effect of biomass on environmental protection to mention but few.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iv
ABSTRACT	v
LIST OF TABLES	x
LIST OF ACRONYMS AND ABBREVIATIONS	xi
CHAPTER ONE: GENERAL INTRODUCTION	1
1.1. Background of the study	1
1.2. Problem Statement	1
1.3. Objective of The Study	3
1.3.1. General Objective	3
1.3.2. Specific Objectives	3
1.4. Research Questions	3
1.5. Significance of The Study	4
1.6. Limitations and Delimitations of the Study	4
1.7. scope of study	4
1.7.1. Geographical Scope	4
1.7.2. Time Scope	5
1.7.3. Content Scope.....	5
1.8. Conclusion	5
CHAPTER TWO: LITERATURE REVIEW	6
1.1. clarifications and definitions of key terms.....	6
1.1.1. Firewood utilization	6
2.1.2. The environmental degradation	6

2.2. Theoretical review	7
2.2.1 Environment and social theory	7
2.3. Review of Empirical Data	8
2.3.3. The emergency response needed to mitigate the impact of firewood utilization on environmental degradation.....	9
2.4. Conceptual Framework.....	12
CHAPTER THREE: RESEARCH METHODOLOGY	14
3.1. Research Design.....	14
3.2. Study Population.....	14
Table 3. 1: Musanze District Inhabitants Per Sectors	15
3.3. Sample Design.....	15
3.3.1. Sample Size	15
3.3.2. Sampling Techniques	15
3.4. Data Collection Instrument and Methods	17
3.4.1. Questionnaire	17
3.4.2. Interview Guide.....	17
3.4.3. Observation.....	17
3.7. Reliability and validity	18
3.8. Ethical Issues	18
CHAPTER FOUR: PRESENTATION, ANALYSIS AND INTERPRETATION OF FINDINGS	20
4.1. Socio demographic Characteristics of Respondents.....	20
4.2. Presentation of Research Findings.....	22
4.2.1. The effects of firewood utilization on environmental degradation	22
4.2.2. The relationship between firewood utilization and environmental degradation in Musanze District of Rwanda	28

4.2.3. The emergency response needed to mitigate the impact of firewood utilization on environmental degradation.....	31
4.2.4. The recommended intervening strategies for mitigating and preventing firewood utilization effects and environmental degradation in Musanze District of Rwanda	32
4.3. Summary	33
CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION	34
5.1. Summary of findings	34
5.3. Conclusion.....	38
5.4. Recommendation.....	39
5.4.1. Recommendation to Government.....	39
5.4.2. Recommendation to Individuals	39
5.4.3. Recommendation to Actors in Environmental Protection.....	39
5.4.4. Recommendation to Local Leaders.....	39
5.5. Suggestion for further studies	39
REFERENCE.....	41
APPENDIX ONE: RESEARCH OPERATIONALIZATION	46
APPENDIX TWO: QUESTIONNAIRE	48
APPENDIX THREE: INTERVIEW GUIDE FOR GAS AND CHACOAL RETAILERS	52

FIGURE

Figure 2.1 conceptual framework.....13

LIST OF TABLES

Table 4. 1: Descriptive Statistics of Gender of Respondents.....	20
Table 4. 2: Descriptive Statistics of Marital Status of Respondents	20
Table 4. 3: Descriptive Statistics of Educational Level of Respondents	21
Table 4. 4: Descriptive Statistics about being a Resident of Musanze District	21
Table 4. 5: Descriptive Statistics of Profession of Respondents.....	22
Table 4. 6: Descriptive Statistics about time spent in Musanze District.....	22
Table 4. 7: Descriptive Statistics about views of respondents on firewood as a primary source of energy while cooking and heating in Musanze District.....	23
Table 4. 8: Descriptive Statistics about views of respondents on primary source of energy while cooking at their households.....	23
Table 4. 9: Descriptive Statistics about views of respondents on whether firewood utilization can affected environmental degradation.....	24
Table 4. 10: Descriptive Statistics about views of respondents on whether firewood utilization increases the rate of tree cutting in Musanze District.....	24
Table4.11: Presenting economic impact of firewood utilisation on environmental degradation.....	25
Table 4. 12: Presenting views of respondents regarding the extent Musanze District encourages environmental protection related policies to cut back firewood utilization effects.....	26
Table 4. 13: Presenting information about Use of LP Gas while cooking can reduce the effect of firewood utilization and environmental degradation.....	26
Table 4. 14: Presenting the number of respondents who use LP Gas while cooking	27
Table 4. 15: Presenting views of respondents on the Civil Society and NGOs contributions to discourage firewood utilization and yield positive effects to environment.....	27
Table 4. 16: Presenting the information of respondents regarding government political will in encouraging other sources of energy while cooking	27
Table 4. 17: Forest coverage per hectare at sector level through use of secondary data collection approach	28
Table4.18: Estimated wood utilization in Musanze through use of secondary data collection approach...	29
Table 4. 19: Correlations analysis between firewood utilization and environmental degradation ...	30
Table 4. 20: Descriptive Statistic on factors influencing emergency response to mitigate the impact of firewood utilization on environmental degradation in Musanze District of Rwanda	31
Table 4. 21: Descriptive statistics about the views of respondents on affordability of firewood compare to other primary source of energy at home while cooking.....	32
Table4.22: Presenting views of respondents about intervening strategies to be applied to mitigate and prevent the negative effects of firewood utilisation and environment degradation.....	33

LIST OF ACRONYMS AND ABBREVIATIONS

HDR: Human Development Report

NEMA: National Emergency Management Agency

REMA: Rwanda Environment Management Authority

UN: United Nations

UNDP: United Nations Development Program

LPG: Liquefied Petroleum Gas

CHAPTER ONE: GENERAL INTRODUCTION

This chapter consists of the following content: study background, problem statement, study objectives, research questions, study scope, and study limitations.

1.1. Background of the study

Environmental degradation refers to the results of socio-economic, technological and institutional activities (Zhen et al 2011). The United Nations ranked environmental degradation among the ten threats that the World is currently facing (UN, 2016). Environmental degradation takes place when the natural resources are depleted and the most affected are water, air, soil, wildlife, animals, plants, and micro-organisms due human activities such as industrialization, rapid urbanization, massive agriculture expansion, population growth, and deforestation (Zaku, 2013). Researchers like (Repetto, 2016; Rowe et al.,2017) argued that fuelwood consumption is among the main factors that contribute to environmental degradation and deforestation.

Firewood consumption in Rwanda accounts (90%) of the total energy consumption (Opio, 2016) in order to survive. However, rural households have to depend on gathering branches of trees and destroying forests due to firewood scarcity (Twagiramungu, 2016). The current report of REMA (2018) indicates that the main environmental problems in Rwanda consist of soil degradation due to loss of vegetation cover, over – population, inappropriate agricultural systems, lack of anti-erosive measures, loss of biodiversity due to deforestation and wetland mismanagement, demographic pressure, migration and resettlements of population, pressure on wetland due to cleaning of marches and hydro agricultural development and uncontrolled production of domestic energy (firewood and charcoal).

1.2. Problem Statement

Firewood consumption is among the major root causes of environment degradation worldwide (Godfray et al 2010; Liu et al 2010; Zhen et al 2011). The demand for domestic energy is partly met by firewood which is the primary source of domestic energy in developing countries Rwanda inclusive (Khuman et al 2011; San et al 2012; Rehnus et al 2013). Researchers such as Wessels, 2013; Zaku, 2013; Twagiramungu, 2016; and many others who tried to done studies in the field of environmental degradation gave less attention the impact of fire wood utilization on environmental degradation. It is in the same context Wessels (2013) asserted that the demand of firewood as domestic source of energy is highly utilized in mountainous regions because of altitude, humidity, coldness, precipitation, and limited infrastructures which lead to high pressure

on scarce sources and environmental degradation at large. According to Opio (2016) Rwanda's firewood accounts 90% for total energy consumption. Households in rural areas depends much on firewood, fuel biomass, charcoals and have to adapt several mechanisms for obtaining energy mainly for cooking and heating (Zaku, 2013). Most of households in rural areas collect, gather, or buy loads of firewood (Mphinyane et al., 2016).

Sheram (2014) argued that environmental degradation in hilly areas are caused by many complex and interrelated factors such as scarcity of resources, accelerated soil erosion, landslides, droughts, floods, decline of forest cover, decline in agricultural yields, siltation problem, and shrinking of bio-diversity. Kumar (2014) argued that deforestation in less developed countries Rwanda inclusive is mainly caused by demographic pressure and production of domestic energy like firewood and charcoals for cooking at household level. Firewood utilization is a major challenge to environmental degradation and deforestation (Twagiramungu, 2016). According to Theuri (2017) and Vanderplas (2014) firewood consumption in rural areas and urban areas in Rwanda are different, for instance in 2013 in rural areas consumption of firewood accounted 3,076,623 tons per year compared to urban areas consumption of firewood accounted 97, 564 tons per year whereas in 2015 in rural areas it has increased up to 3,146,761 tons per year compared to 109,622 in urban areas. The number of fire wood consumption continues to increase, in 2018 in rural area consumption of fire accounted 3,621,413 tons per year compared to 121,789 in urban areas (REG, 2018).

In fact, the government of Rwanda has formulated so many policies to ensure affordable energy for all through cutting taxes on imported gas, family planning to reduce population pressure on demand of firewood while cooking, but the rate of urbanization and industrialization in Rwanda remains high, demand for firewood is still higher compared to tree planting (World Bank, 2016). In this world bank report on penetration of universal use of LPG, Rwanda is targeting to have 25% users of LPG in 2030 when countries like Angola, on current status 80% of population use LPG and it is targeting 100% by 2025.

Kristin and Eva (2017) stated that firewood consumption is a big threat to environmental protection due to high rate fuelwood consumption in both rural and urban areas. Though, government of Rwanda and Rwanda Energy Group encourage people to use Liquefied Petroleum Gas (LPG) as primary domestic source of energy while cooking rather than using fire wood and charcoal (REG, 2018). It is against this regard the researcher wants to prove that there is any emergency to achieving the target goal of the sustainable development of ensuring affordable,

smart and sustainable energy for all through finding out the impacts of firewood utilization on environmental degradation in Musanze District of Rwanda. The increasing number of firewood utilization in the five consecutive years shows the noncompliance to laws and regulation of environmental protection which need serious measures and emergency response on this issue.

1.3. Objective of The Study

1.3.1. General Objective

To find out the impact of firewood utilization on environmental degradation with special consideration of Musanze District as case study.

1.3.2. Specific Objectives

- (i) To assess the effects of firewood utilization on environmental degradation in Musanze District of Rwanda for the last 5 years (March 2013 – March 2018).
- (ii) To find out the relationship between firewood utilization and environmental degradation in Musanze District of Rwanda.
- (iii) To find out the emergency response needed to mitigated the impact of firewood utilization on environmental degradation.
- (iv) To formulate recommended intervening strategies for halting firewood utilization and environmental degradation in Musanze District of Rwanda.

1.4. Research Questions

- (i) What are the effects of firewood utilization while cooking and heating to environmental degradation in the last 5 years (March 2013 – March 2018)?
- (ii) How is the relationship between firewood utilization and environmental degradation in Musanze District of Rwanda?
- (iii) What are emergency response needed to mitigate the impact of firewood utilization on environmental degradation?
- (iv) What are recommended intervening strategies for halting firewood utilization and environmental degradation in Musanze District of Rwanda?

1.5. Significance of The Study

The findings of the study are useful information source for researchers, environmentalists, policy formulators, UR students and other high learning institutions to have relevant information about firewood use and environmental degradation.

The study findings from this study help the community to know how to use LP Gas while cooking, the contribution of rural electrification to reducing firewood used in household lightening, boiling water, and conservative stove use.

1.6. Limitations and Delimitations of the Study

The constraint of language was identified in the study of this research. Most of the people were familiar with Kinyarwanda and it required translation in the whole process of research. when responding to the questionnaires, language barrier became a key issue because the target community is more familiar with Kinyarwanda and French, at the point of distributing and collecting data from the field, there was a need for translation.

In general, geographical coverage was another limitation because Musanze District is a mountainous area where it was necessary to climb hill to search for information, the diversity of data in cases where it is not well coded and controlled, and finally the insufficiency of literature on this study in the case of Rwanda because Rwandans do not have a culture of writing and reading books That may be another limitation.

1.7. scope of study

1.7.1. Geographical Scope

The study was conducted in Muhoza Sector of Musanze District, Northern province of Rwanda. The area was selected because of its easy accessibility and the fact that it is the area that has high altitude where people may need heating, lighting and cooking using firewood compared to other areas as asserted by Hable et al ..., (2014) that firewood is a major energy source, especially in many high mountainous regions in developing countries where other energy sources are limited and Sekhwela (2012) stated that fuelwood continues to play a significant role as an energy source for many rural households in Africa and particularly in the rural areas of Botswana where it is used across a very wide spectrum of activities including domestic cooking and house insulation.

1.7.2. Time Scope

This study took period of 5 years that is from March, 2013 - March, 2018 and it should study how to find out the impact of firewood utilization and environmental degradation in Musanze District of Rwanda.

1.7.3. Content Scope

The study confined on the impact of firewood utilization on environmental degradation, the research established the influencing factors of environmental degradation, relationship between utilization of firewood and environmental degradation, and later establish strategies to health environmental degradation and firewood utilization in Musanze District of Rwanda.

1.8. Conclusion

The study was organized into five chapters, with the introduction of chapter one presenting the introduction, background of the study, problem statement, study goals, research questions, study scope, study meaning and limitations. Chapter two discussed literature reviews in relation to the study's variables and goals. Chapter three highlighted the study design, target population, sample size and study sampling techniques, data gathering tools and data source, validity and reliability and ethical consideration. Chapter four dealt with findings presentation and interpretation and then chapter five dealing with summary, recommendations and suggestions for further studies.

CHAPTER TWO: LITERATURE REVIEW

This chapter consists of the following content: theoretical literature reviews and empirical literature reviews on both general and specific goals, critical review and research gap identification, as well as theoretical framework respectfully and finally give conceptual framework with its interpretation.

1.1.clarifications and definitions of key terms

1.1.1. Firewood utilization

Firewood can be defined as any wooden material collected by locals and used for fuel (Liu et al 2016). Researchers specified that wood consumption can be one of cause of environmental degradation (Tilman et al 2011; Arrow et al 2014; Imhoff et al 2014; Godfray et al 2016; Liu et al 2016; Zhen et al 2017). Others stipulated that places where features are characterized by mountain are known of high consumption energy using firewood. Mountainous areas are on high demand of wood because of limited source of energy and the high rate of utilization put pressure on natural resources. In Africa, mostly in rural areas firewood is the main source of energy because other energy sources are expensive and many people can't afford them while heating and cooking at household level (Boudreau et al. 2005, Shackleton et al. 2017). Though, firewood is a renewable source of energy and its over - utilization challenges the sustainability of firewood resources and gears environmental degradation (Gaugris & Van Rooyen 2010, Shackleton, 2008).

2.1.2. The environmental degradation

Environment refers to a combination of non-living components that give favorable habitation for biological development and its elements are always active to protect these biological lives to sustain the process in close coordination (Godfray et al, 2016). The illogical anthropogenic activities put these elements of environment on high risk of degradation in case of deforestation, and over-utilization of natural resources which endanger the elements of environment to become unsupportive and human beings' activities are very responsible for environmental degradation (Sheram, 2013)

According to (Panayotou, 2016) The environmental degradation in mountainous areas is highly caused by interrelated factors including scarcity of resources, soil erosion, droughts, land and mudslides, floods, loss of vegetation cover, and biodiversity disturbance whereby the core

influencing factor is the over – utilization of firewood which will remain even our focus in this study.

The environmental degradation is one among other largest threats in today's world. Deterioration environment goes hand in hand with depleting resources, air pollution, soil degradation, destruction of biodiversity and ecosystems as United Nations notified it among 10 threatening issue (Zhen et al, 2017). Human activities such as industrialization, expansion of agriculture and urbanization are responsible for the rapid environment degradation, global warming and desertification where on one hand or another firewood over-utilization has played its part on environmental degradation. It also leads to poor health, loss of life and infirmities of the millions in every year in less developed countries while the developed world has resources to halt and combat against the uncertainties caused by environmental degradation and global warming as well as desertification (Barbier et al, 2004).

2.2. Theoretical review

The study was beneficial from environment and social theory based on speech act philosophy of environment and social theory outlining the complex interconnection of environment, nature and social theory from ancient and pre-modern thinking to contemporary social theorization.

2.2.1 Environment and social theory

This study has been tracked in environmental and social theory that outlines the complex interconnection between environment, nature and social theory (Panayotou, 2010). It discovers the character of the environment and nature within social theory, which draws attention to how major religions have and continue to conceptualize the environment and analyze how non-human environment plays a very important role in Western thinkers like Rousseau, Malthus, Marx, Mill to Freud, Horkheimer and the school of thought in Frankfurt.

This theory also discusses contemporary thinkers such as Hebermas, Giddens, and Dawkins along with the skeptical environmentalist Lomborg's controversy. This theory continues to explode in contemporary social theorizing about the environment the correlation between gender and environment, postmodernism, and the dominance of orthodox economic thinking. This theory reflects the argument of an explicitly interdisciplinary green social approach that embraces both natural sciences and evolutionary biology and ecology with social science that emphasizes social, political and ethical theories and ideas (Sheram, 2013). It concludes with an argument for an explicitly interdisciplinary green social theoretical approach that combines

natural science insights such as evolutionary biology, physics and ecology with social science knowledge derived from social, political and ethical theories and ideas.

According to Barry (2007), the current environmental concerns are completely different from the previous generation because this generation has the capacity to destroy the planet, human activities are the main concerns for environmental sustainability, the natural environment cannot be taken for granted because the environment is as old as humanity and helps human and other creatures around it.

2.3. Review of Empirical Data

2.2.1. The effects of firewood utilization while cooking and heating to environmental degradation

The development process of economic and technological activities of man depends much on energy consumption firewood utilization inclusive and it causes several forms of pollution in air, water, and noise, depletion of natural resources which enhances environmental degradation. The quick increase of human population and industrialization development are the principle cause of environmental crisis (Shukla, 2010). The population activities added the rate of scientific and technological advancement.

Myers (2012) stated that the effort to safeguard the environment and other forests is a worldwide concern. It is therefore important to be aware of the cause of destruction to protect the environment. To understand the major determinants of environmental degradation, it is very important to distinguish between the agents of environmental degradation and their causes. Environmental degradation agents are those who cut down the forests, slash and burn farmers, commercial farmers, ranchers, loggers, firewood collectors and users, developers of infrastructure, and others. Deforestation causes are the forces that motivate the forest clearing agents. Most of the current literature, however, typically differentiates between two levels of specific factors: direct and indirect causes of deforestation. Direct agents and causes of deforestation, also commonly referred to as sources of deforestation, first-level or proximate causes (Panayotou, 2016; Barbier et al., 2014; Caviglia, 2009) are relatively easy to identify, but the indirect causes that are usually the main drivers of deforestation are those that cause the most disagreement and those that are most difficult to quantify (Bhatnagar, 2011; Mathematics, 2011).

2.3.2. The relationship between firewood utilization and environmental degradation

Firewood and biogas are Rwanda's main heating fuels at a rate of 86.3% of the total population and 3,687 domestic biogas digesters (REG, 2018); in fact, it is very easy to obtain firewood because it is extracted from private gardens and private forests and then cow households have biogas dung available. Consumption of firewood in the villages is positively influenced by elevation, private garden size and rainy season heating hours, and is negatively influenced by the level of education and electricity received (Surendra et al, 2014). The elevation correlates positively with heating hours per month and firewood consumption, as winter tends to be colder and lasts longer at high elevations. Education tended to play a role in consumption of firewood and the level of education correlated positively with lower consumption of firewood. Use of firewood also seemed to increase with garden size. The concentration of fuelwood in tropical dry forests and degraded forest areas is often concentrated (Repetto, 2016; 2018; Rowe et al., 2012; Anon., 2014). Fuelwood is usually not the major cause of deforestation in humid tropics, although it may occur in some populated areas with reduced forest areas such as the Philippines, Thailand and parts of Central America. Fuelwood gathering in Less Developed Countries was considered to be the main cause of deforestation and forest degradation (Repetto 2016).

2.3.3. The emergency response needed to mitigate the impact of firewood utilization on environmental degradation

The intensity of environmental emergency responses can originate from the effect it has on the community or settlement and determined by a combination of human and environmental factors. It includes also the size of the population, immigrants from neighboring communities, population growth and dependence on natural resources, environment-related factors such as the degree of habitat fragility, local levels of biological diversity and climate and weather condition, and socio-economic factors (Corina, 2001).

People use of fuel for cooking is generally the single biggest drain, and the biggest determinant of fuel consumption is food supply (Panayotou, 2010). Wood are used as the primary source of energy in most of the population in Africa mainly in Refugee camps and other settlements is wood, or wood-based products such as charcoal (UNCHR, 2002). Other sources, such as coal, kerosene, liquid propane, and electricity, are used less frequently, and usually in urban areas. The main cause is that the type and scale of impact involved are generally of less severe nature than those produced in rural areas. The main cooking system used by Rwandan is an open fire surrounded by three stones on which cooking materials rest (NISR, 2012). Simple, but inefficient

in terms of energy loss, the result, in some instances, has been an excessively high consumption of firewood which needs an urgent response to halt its consequent environmental damage (Myers, 2016).

People extract standing vegetation to meet their energy needs, implying in some cases the widespread cutting of trees. Even if biomass eventually recovers its original levels, it is possible that biodiversity can be permanently affected. The problem can be more serious where people are located in or adjacent to sensitive or protected areas (Repetto, 2010). Deforestation and land degradation carry with them an indirect economic cost for the local population, as does the reduced availability of fuel derived from nearby forests. The local poor are often affected adversely as migrants' demand forces up prices of fuel. Meanwhile some members of local communities may be able to benefit from trade in firewood, charcoal, and other products sold to migrants (Porter, 1994).

Extraction of firewood, for example, may deprive a government of royalty payments and may also lead directly to more seriously degrading activities such as illegal lumbering or poaching, both of which are likely to result in loss of official revenue (Rowe & Bowder, 1992). The environmental impact of a sudden influx of migrants may create hostility between local communities and migrants. Where natural resources such as firewood or water are scarce, people compete for access to these resources. In addition, newly arrived migrants are often unaware of local traditions or laws to protect wildlife resources or sacred sites – a common source of conflict. Behaviors regarding firewood collection and improved stoves is dominated by social customs. While it is often assumed that men have little impact on cooking methods, husbands rank high as a social reference for advice. There are known linkages between health and long-term exposure to cooking fuel pollutants, particularly among women and children.

Biomass which is not properly dried may cause acute respiratory infections, lung disease, heart disease, destruction of red blood cells, eye disorders, and a variety of infant ailments; coal produces a lot of smoke and a variety of pollutants, including Sulphur dioxide and heavy metals. Kerosene presents the risk of starting a fire as it is usually stored in containers inside shelters. It is a poison, with special risk for children. It is important to note that biomass can be burned with no releases other than the products of complete combustion: carbon dioxide and water. This demands that the fuel be dried properly and fully burned in a well-ventilated area. Charcoal use is reported to produce little smoke. Gas stoves release less than one-fiftieth of the pollution that is emitted by burning firewood (Theuri, 2017). The association between exposure to raw biomass

smoke, acute respiratory illness, and the death of malnourished children has received very little attention by humanitarian assistance providers. Improving the efficiency of the stove and efficiency in wood use do not eliminate the negative health effects of exposure to raw biomass smoke.

2.3.4. Recommended intervening strategies for halting firewood utilization and environmental degradation

According to Vanderlpas (2014) the measure and strategies to halt environmental degradation and deforestation goes hand in hand with decreasing and looking for another source of domestic energy rather than fuelwood. These strategies require goodwill and cooperation because the affordability of another source of domestic energy for local poor people seem to be another challenge, though much of Less Developed countries has adapted the policy of universal penetration of liquefied petroleum gas but its affordability is still costly to poor people (BAMG, 2016). Effective implementation counter firewood utilization is very essential and it needs participation of both public sector, private and individuals to manage plans, monitoring and reinforcing the policy through provision of alternative source of energy such as gas, electricity and biogas on affordable prices in order to control firewood consumption (Theuri, 2017)

According to Khuman et al (2011) reducing the population growth is another pivotal recommendation to reduce environment degradation because the human activities are the major causes of environment degradation. He added that the increased incomes and literacy rates would also reduce pressure on deforestation and firewood consumption would change. Chomitz et al., (2017) argued that there is need for intervention of international organization such as World Bank and United Nations in controlling and mitigating this issue of environmental degradation as ranked among the ten threats of sustainable development of the World. There must be more sensitization on environmental protection, use of other source of energy at household level to control firewood consumption (Kristin & Eva, 2017).

Another strategy would be provision of restricted areas as fundamental in any attempt to conserve biodiversity (Myers, 1994; Myers and Mittermeier, 2000; Nepstad et al., 2006). In order to promote sustainable forest management and sustainable environment, it should be sustainable ecologically, economically and socially. However, management for environmental services alone is not economically and socially sustainable (Sheram,2013). The developed world should meet all the cost of environmental protection because are the ones with industries that produce more pollute air and cause global warming (Chomitz et al., 2017; Anon., 2015; 2017).

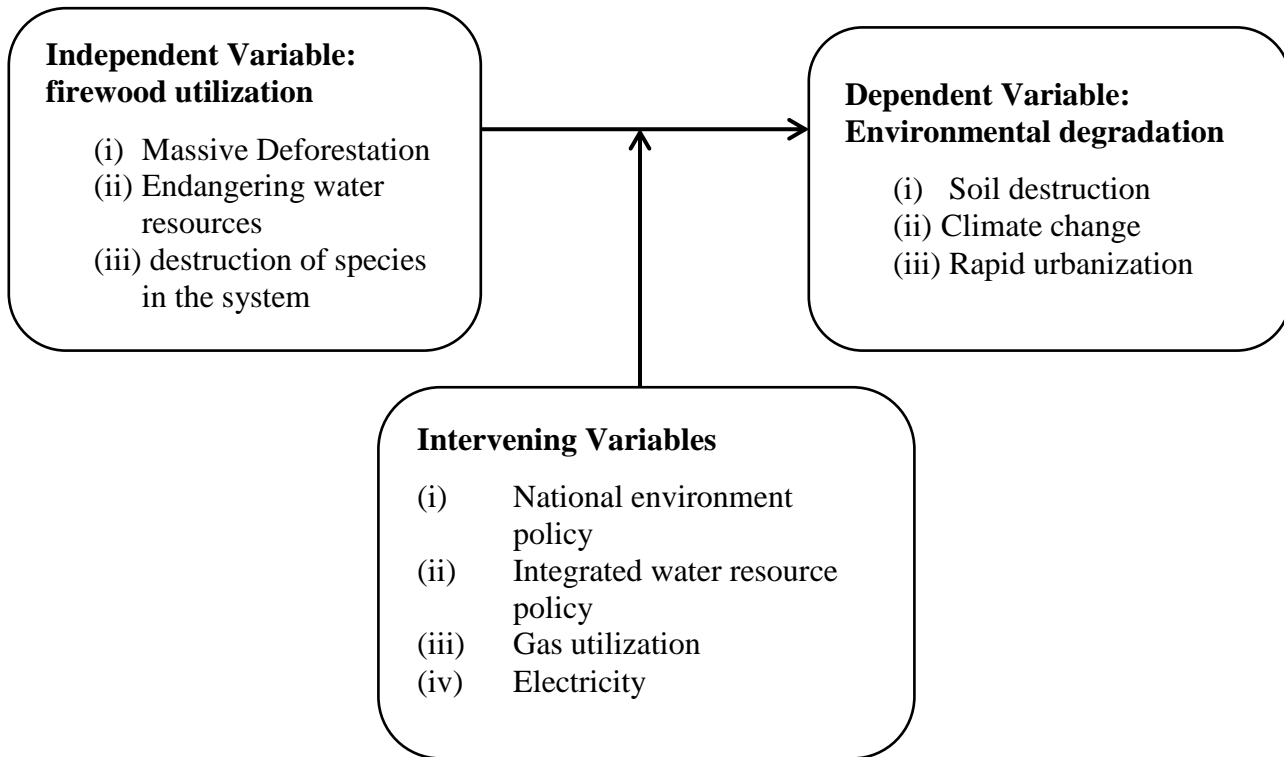
Budya and Yari (2011) suggested that there is need to increase areas of forest plantations by using vacant or unused lands and waste and marginal lands especially as road side, along railway tracts, on contours, avenues, boundaries and on land not suited for agricultural production should have a net positive benefit. Planting trees outside forest areas will reduce pressure on forests for timber, fodder and fuelwood demands. Moreover, the deforested areas need to be reforested and strengthen government and non-government institutions policies to protect environment.

There has been a wide range of policy statements and legislative and regulatory measures to protect the environment and mitigate fuelwood consumption, but they need to be enforced effectively. Laws, policies and legislation should be such that they encourage local people and institutional involvement in environmental management and conservation, as well as reducing the fuelwood utilization rate among poor local people. There is a need for many formal and informal enforcement / compliance mechanisms to prevent human activities from environmental degradation and environmental issues (Shukla, 2010)

2.4. Conceptual Framework

In this study, the conceptual framework was based on three variables, including the independent variable shown as the use of firewood, another dependent variable shown as environmental degradation, and finally the intermediate variables that can falsify the findings of the study, including national environmental policy, climate and weather change, integrated water resources policy, gas use. Mile & Huberman (1994) defined a conceptual framework as a visual or written product which explains the main things to be studied, either graphically or narratively, such as key factors, concepts or variable and presumed relationships between them.

As shown in figure 2.1



Source: Researcher, 2018

Figure 2.1. Conceptual Framework

The figure 2.1. Shows the independent variable as firewood utilization and dependent variable as environmental degradation. It further shows that firewood utilization is measured in terms of massive deforestation, endangering water resources, destruction of species in the system while environmental degradation is measured in terms of soil destruction, climate change and destruction of ecosystems. The figure also reveals that apart from firewood utilization, other factors such as national environment policy, climate and weather change, integrated water resources policy, gas utilization, electricity may also affect environmental degradation.

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter highlights the various methods and techniques for data collection and analysis to be used. Methodology of research is scientific techniques used to collect data either from field (primary data) or from other resources (secondary data) and how these data were analyzed.

3.1. Research Design

The researcher used descriptive research design that made it easy to include qualitative and quantitative data to facilitate the study's ability to capture diverse perspectives, facilitate planned minimum statistical analysis to enable quantitative summary of findings to add breath to the study and work to make it more representative (Mugenda, 2011). The study was based on the case study of Musanze District as it accurately portrayed the characteristics of the situation in other districts of Rwanda in terms of use of firewood, consumption of firewood energy during cooking and heating, thus reducing criteria bias and maximizing the reliability of evidence because Amin (2005) supports the use of case studies.

3.2. Study Population

This study was conducted in Musanze of Rwanda and the study population comprised 368,267 inhabitants of Musanze District (NISR, 2012) which was chosen randomly from each sector. The researcher preferred to use the recent population census data because the information got from the office was given different number on the current population of Musanze District.

Table 3. 1: Musanze District Inhabitants Per Sectors

Sectors	Inhabitants	Male	Female
Busogo	21512	10203	11309
Cyuve	39091	18358	20733
Gacaca	23609	11208	12397
Gashaki	13648	6509	7139
Gataraga	22710	10820	11890
Kimonyi	15589	7225	8364
Kinigi	27221	12818	14403
Mukoza	51878	25377	26501
Muko	18937	8959	9978
Musanze	31864	14833	17031
Nkotsi	13546	6204	7342
Nyange	27466	12794	14672
Remera	19112	9202	9910
Rwaza	20926	9967	10959
Shingiro	21162	9922	11240
Total	368 267	174 399	193 868

Source: NISR, 2012

3.3. Sample Design

3.3.1. Sample Size

The size of sample was drawn from 368,267 inhabitants of Musanze District. A sampling procedure was applied to select sample size through use of Yamane (1967)

$$n = \frac{N}{(1 + Ne^2)}$$

n = 100 respondents

N stands for population size

n stands for sample size

e stands for margin of error * desired (0.1)

3.3.2. Sampling Techniques

The sampling technique was stratified random sampling because the population to be used was not homogeneous, so it was necessary to combine stratified and simple methods of random sampling. The rationale for using stratified random sampling techniques was therefore used to reduce sampling errors because the respondents from each stratum were homogeneous and this technique facilitated the researcher's work in the collection, analysis and interpretation of the data.

Table 3. 2: Determination of Sample Size / Respondents Per Sectors

Sectors	Inhabitants	Male	Female	Respondents	Male	Female
Busogo	21 512	10 203	11 309	6	3	3
Cyuve	39 091	18358	20 733	11	5	6
Gacaca	23 609	11 208	12 397	6	3	3
Gashaki	13 648	6 509	7 139	4	2	2
Gataraga	22 710	10 820	11 890	6	3	3
Kimonyi	15 589	7 225	8 364	4	2	2
Kinigi	27 221	12 818	14 403	7	3	4
Mukoza	51 878	25 377	26 501	14	7	7
Muko	18 937	8 959	9 978	5	2	3
Musanze	31 864	14 833	17 031	9	4	5
Nkotsi	13 546	6 204	7 342	4	2	2
Nyange	27 466	12 794	14 672	7	3	4
Remera	19 112	9 202	9 910	5	2	3
Rwaza	20 926	9 967	10 959	6	3	3
Shingiro	21 162	9 922	11 240	6	3	3
Total	368 267	174 399	193 868	100	47	53

Source: Researcher, 2019

This study about utilization of firewood and environmental degradation used 6 respondents from Busogo Sector where 3 of them were females and other 3 were male, 11 respondents from Cyuve Sector where 5 of them were male and other 6 were females, 6 respondents from Gacaca Sector where 3 of them were male and other 3 were females, 4 respondents from gashaki sector where 2 of them were males and other 2 were females, 6 respondents from Gataraga Sector where 3 of them were male and other 3 were females, 4 respondents from Kimonyi Sector where 2 of them were males and other 2 were females, 7 respondents from Kinigi Sector where 3 of them were males and 4 of them were females, 14 respondents of Mukoza Sector where 7 of them were males and other 7 were females, 5 respondents from Muko Sector where 2 of them were males and other 3 were females, 9 respondents from Musanze Sector where 4 of them were males and 5 of them were females, 4 respondents from Nkotsi Sector where 2 of them are males and 2 others are females, 7 respondents from Nyange Sector where 2 of them are males and other 3 are females, 5 respondents from Remera Sector where 2 of them are males and other 3 are females, 6 respondents from Rwaza Sector where 3 of them are males and other 3 are females and the last but not the least Sector is Shingiro with 6 respondents where 3 are males and other 3 are females. The total number of respondent are 100 as per Yamane (1967) the number of females participated in the study are 53 whereas the number of males are 47 respondents.

Table 3. 3. Stratification of Respondents

Respondents	Respondents	Male	Female
Agronomy at Sector Level	15	7	8
Charcoal Retailer	17	8	9
LP Gas Wholesaler	8	4	4
Firewood Retailer	26	12	14
Member of Local Community	34	16	18
Total	100	47	53

Source: Researcher, 2019

This study about firewood utilization and environmental degradation focused on the respondents whose activities and profession can affect the utilization of firewood and environmental degradation such as Agronomist of sectors, charcoal retailers, LP Gas wholesalers, Firewood retailers and members of local community.

3.4. Data Collection Instrument and Methods**3.4.1. Questionnaire**

The questionnaire was used as a tool for collecting data from the targeted population. And this technique helped research access to primary data through semi-administered structured questionnaires with predominantly closed and some final questions

3.4.2. Interview Guide

In order to obtain the primary data from the respondents about firewood utilization and environmental degradation in Musanze District, the researcher used interview guide to record the information given by the respondents and to keep the conversation on the topic and other relevant information required by the researcher to be able to interpret the data as Kennedy (2006) suggest use of interview guide to direct the conversation towards the information needed.

3.4.3. Observation

The unstructured method of observation has been used as it enables the researcher to find out even beyond the specific issues. This method helped to research to relate the information give on questionnaire to the real situation at the field.

3.5. Data Source

To drive the research findings to their meaningful interpretation, the researcher collected data and information from both primary (from the field with the help of informants and respondents

of the study) and secondary sources (from reviewing of both qualitative and quantitative data from annual reports about firewood utilization and environmental degradation, text books, and journals).

3.5.1 Primary Data

As the population were informed on the objective of the research, the primary data were collected from respondents who asked to participate in this study on the use of firewood and environmental degradation were from Musanze District in Rwanda's northern province. The researcher used various tools to effectively collect primary data, including observation, questionnaires, and interview guide.

3.5.2. Secondary Data

The secondary data were gathered from textbooks, national documentaries, newspapers, internet and annual reports. Qualitative and quantitative data were included in the data collected.

3.6. Data Processing

Field data was edited, coded, and tabulated based on topics emanating from research goals and questions. In this study, data analysis was performed using SPSS to facilitate the analysis of the significant variables relationship. For the editing and coding process, tables were used. This made it easy for the researcher to analyze and summarize the findings according to the study's goals. Analysis of correlation was used to identify the relationship between the variable dependent and the independent variables.

3.7. Reliability and validity

Research validity is a very important measurement psychometric property. It is therefore important that before using the research tools to establish it. The appropriateness and generalization of questions to the topic were thus validated with the assistance of the supervisor. The supervisor gave various objective advices on the content to secure his expertise and experiences and assessed the suitability and relevance of the tools for this study. Before the final distribution and use of the pilot study questionnaire (Saunders, et. al. 2007), his observations, amendments and recommendations were considered. The reliability analysis was used to establish both the consistency and stability of the research instrument.

3.8. Ethical Issues

During research it is advisable to request for permission from the competent authority before collecting the required data. First, each study respondent should be first informed about the

purpose of the study, and then the questionnaires be administered. Researcher should also respect the degree of confidentiality in the information collected from the field for security purposes. A high degree of confidentiality has been maintained to ensure that no unauthorized persons have disclosed the information obtained in the study and that the study results are for academic purposes only.

CHAPTER FOUR: PRESENTATION, ANALYSIS AND INTERPRETATION OF FINDINGS

Chapter four includes research findings about socio demographic characteristics of respondents; effects of firewood utilization on environmental degradation in Musanze District of Rwanda for the last 5 years (March 2013 – March 2018); the relationship between firewood utilization and environmental degradation in Musanze District of Rwanda; the emergency response needed to mitigated the impact of firewood utilization on environmental degradation; and recommended **intervening** strategies for halting firewood utilization and environmental degradation in Musanze District of Rwanda basing on views and perceptions of the respondents.

4.1. Socio demographic Characteristics of Respondents

The researcher used questionnaire and interview guide to collected the data presented in Table 4.1. to Table 4.6 concerning gender, marital status, educational level, residence, profession and time spent in Musanze by the respondent. Sociodemographic characteristics help the researcher to analyze, discuss and interpret the respondents' perceptions and views basing on their characteristics and level of understandings hence the use of sociodemographic elements in this study.

Table 4. 1: Descriptive Statistics of Gender of Respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	47	47.0	47.0	47.0
Female	53	53.0	53.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The results of this study indicates that more women participated in this study at rate 53 (53.0%) of the total percent of respondents, compare to counterpart male who are at 47 (47.0%) of respondents. This means that this study is gender sensitive hence relevancy of information.

Table 4. 2: Descriptive Statistics of Marital Status of Respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Single	23	23.0	23.0	23.0
Married	69	69.0	69.0	92.0
Divorced	6	6.0	6.0	98.0
Separated	2	2.0	2.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings of this study indicates that this study involved the married at rate of 69 (69.0%), single at rate of 23 (23.0%), divorce at 6 (6.0%) and 2 (2.0%) of respondents are separated. Marital status influences the understanding and perception of an individual since the big number of respondents are married, it means that the respondents of this study have knowledge, experience and skills about firewood utilization and environmental degradation hence accurate and relevant information.

Table 4. 3: Descriptive Statistics of Educational Level of Respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Primary	31	31.0	31.0	31.0
Secondary	30	30.0	30.0	61.0
University	36	36.0	36.0	97.0
Non - formal	3	3.0	3.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The results indicate that 36 (36.0%) of respondents holds university degree, 31 (31.0%) have finished only primary education, 30 (30.0%) of respondents have completed their secondary education whereas only 3 (3.0%) have no formal education. The findings prove that more than 66 (66.0%) of respondents are well educated, this gives assurance of their perceptions and views that are more reliable because they have education, and education influences understandings and views but normally making people to have common views.

Table 4. 4: Descriptive Statistics about being a Resident of Musanze District

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	100	100.0	100.0	100.0
No	0	0.0	0.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings of this study indicates that all 100 (100.0%) of the respondents are residents of Musanze District, this means that this research is relevant and covers the whole characteristics of the case study as Musanze Districts, and sample size where taken from each sector of Musanze District.

Table 4. 5: Descriptive Statistics of Profession of Respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Agronomy at sector level	15	15.0	15.0	15.0
Charcoal Retailer	17	17.0	17.0	32.0
LP Gas wholesaler	8	8.0	8.0	40.0
Firewood retailer	26	26.0	26.0	66.0
Members of Local Community	34	34.0	34.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings of this study indicates that 34 (34.0%) of respondents are members of local community, 26 (26.0%) of respondents are firewood retailers, 17 (17.0%) of respondents are charcoal retailers, 15 (15.0%) of respondents are agronomies at sector level and 8 (8.0%) are LP Gas wholesaler. This result proves that the relevant participants of the study on firewood utilization and environmental degradation were involved in this study to come up with relevant information.

Table 4. 6: Descriptive Statistics about time spent in Musanze District

	Frequency	Percent	Valid Percent	Cumulative Percent
below 5 years	3	3.0	3.0	3.0
5 - 9 Years	1	1.0	1.0	4.0
10 -14 Years	3	3.0	3.0	7.0
15 Years & above	93	93.0	93.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings of this study indicates that 93 (93.0%) have spent 15 years and above in Musanze District, 3 (3.0%) have been in Musanze since the last 10 – 14 years in Musanze, 1 (1.0%) of respondent has spent 5 – 9 years, and 3 (3.0%) of respondents have spent below 5 years. This means that at 7 and some other few were newly immigrants in Musanze District and Corina (2001) argued new immigrants participate and increase environmental degradation because most of them have little capital and depends on natural resources where use of firewood.

4.2. Presentation of Research Findings

The researcher presented research findings basing on the specific objectives of the study, the views and perceptions of the participants was collected, tabulated and analyzed in the following findings.

4.2.1. The effects of firewood utilization on environmental degradation

The findings of this subsection part of our study concentrated on the views of respondents talking firewood as primary source of energy in Rwanda, other sources of energy while cooking

at home, views on whether firewood utilization can affect environmental degradation to mention but few.

Table 4. 7: Descriptive Statistics about views of respondents on firewood as a primary source of energy while cooking and heating in Musanze District

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	97	97.0	97.0	97.0
Neutral	1	1.0	1.0	98.0
Disagree	2	2.0	2.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings in table 4.7 indicates that 97 (97.0%) of respondents have accepted that firewood utilization as a primary source of energy while cooking and heating can affect environmental degradation, 1 (1.0%) of respondents remained neutral while 2 (2.0%) of respondents disagreed with the above statement. This means that most of the population in Musanze District know the impact of firewood on environmental degradation. In an interview with one agronomy stipulated that though Musanze has a very nice climate and weather but sometimes in rainy season they experienced floods and river overflows because of lack of plantation cover in some parts of Musanze due to deforestation and firewood utilization, he added that in Musanze Vegetable Market firewood and charcoal retailers have a very big market and clientele in Musanze compare to other smaller business which shows the rate of tree cutting in Musanze District.

Table 4. 8: Descriptive Statistics about views of respondents on primary source of energy while cooking at their households

	Frequency	Percent	Valid Percent	Cumulative Percent
Firewood	83	83.0	83.0	83.0
LP Gas	14	14.0	14.0	97.0
Biogas	3	3.0	3.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings of table 4.8 reveals that 83 (83.0%) of respondents utilize firewood while cooking, 14 (14.0%) of respondents use Liquefied Petroleum Gas while cooking whereas only 3 (3.0%) of respondents use biogas while cooking. This means that are very big number of Musanze population which is around 83.0 % utilize firewood while on 17.0% of the population can use other sources of energy to favor environmental protection, this reveals that the rate of environmental degradation and tree cutting in Musanze is still high. In interview with one member of local community, people in Musanze District mostly in rural areas they prefer to use firewood to warm up the house and to keep the heat in the house because of coldness but they

normally use roots of completely demolished trees, she added that most of the old people they cannot leave in a building without fire which is kept warming the building.

Table 4. 9: Descriptive Statistics about views of respondents on whether firewood utilization can affected environmental degradation

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	70	70.0	70.0	70.0
Neutral	24	24.0	24.0	94.0
Disagree	6	6.0	6.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings in table 4.9 indicates that 70 (70,0%) of respondents agreed that firewood utilization affects environmental degradation, while 24 (24.0%) of respondents remained neutral about the statement, and only 6 (6.0%) of respondents disagreed that firewood utilization cannot affect environmental degradation. The results here show that some people want to remain so conservative and keeping their behavior of using woods while cooking and heating because a big numbers of neutrality of 24.0 % of respondents show that people don't want to show whether they can leave using firewood and adopt LP Gas utilization while cooking or any other primary source of energy which doesn't affect the environment. In an interview with one of the LP Gas retailers asserted that gas is very cheap, smartest, faster and affordable compared to any other primary source of energy while cooking at household, she argued that Government of Rwanda has put so much efforts in cutting the taxes attached to gas so that the price of gas may keep decrease, she added that its price it is not like the one of charcoal or woods that can change any time because gas price is government regulated to favor the wholesaler and the buyer.

Table 4. 10: Descriptive Statistics about views of respondents on whether firewood utilization increases the rate of tree cutting in Musanze District

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	96	96.0	96.0	96.0
No	4	4.0	4.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The results in table 4.10. indicates that a big number of respondents have accepted that firewood utilization affects the rate of tree cutting in Musanze District at rate of 96 (96.0%) while 4 (4.0%) of respondents rejected that the statement. This proves that since the same respondents had agreed that firewood utilization affect environmental degradation at rate of 70.0% in table 4.9. it directly reveals that there are other factors that affect environmental degradation in Musanze District that are different from the researcher's study today which can be suggested for further

studies. In personal observation while collected the questionnaires and interviewing the respondents, the researcher himself saw some plantation of trees which were being cutting and other whether making charcoals in traditional method, fortunately, I went to the factory which makes small ships from woods remaining and make them like charcoals and they use them in a conservative charcoal stoves hence lesser use of woods and less severity of cutting trees.

Table4.11: Presenting economic impact of firewood utilisation on environmental degradation

Variable		Frequency	Percent
Firewood utilization has led to loss of biodiversity	Agree	94	94.0
	Neutral	4	4.0
	Disagree	2	2.0
Firewood utilization has led to decrease of tourism industry	Agree	65	65.0
	Neutral	26	26.0
	Disagree	9	9.0
Firewood utilization has led to destructions of infrastructure	Agree	74	74.0
	Neutral	25	25.0
	Disagree	1	1.0
Firewood utilization has led to increment of poverty	Agree	5	5.0
	Neutral	81	81.0
	Disagree	14	14.0
Firewood utilization has led to loss of economic growth and fishery development	Agree	78	78.0
	Neutral	21	21.0
	Disagree	1	1.0
Firewood utilization has led to reduction of farm produce	Agree	52	52.0
	Neutral	45	45.0
	Disagree	3	3.0
Firewood utilization has led to reduction of livestock products	Agree	48	48.0
	Neutral	47	47.0
	Disagree	5	5.0

Source: Primary Data, 2019

Table 4.11. reveals that 94 (94.0%) of respondents have agreed that firewood utilization has led to loss of biodiversity, 78 (78.0) have agreed that firewood utilization has led to loss of economic growth and fishery development, 74 (74.0%) of respondents have agreed that firewood utilization has led to destruction of infrastructure, 65 (65.0%) of respondents have agreed that firewood utilization has led to decrease of tourism industry while the lowest level of agreement is at rate of 5 (5.0%) stating that firewood utilization has led to poverty increment with high level of neutrality of 81 (81.0%) of respondents and the highest level of disagreement of 14 (14.0%) of respondents. This means that the respondents of study agreed at rate of 65 (65.0%) that tourism industry is being affected by firewood utilization which is the largest foreign exchange earner business in Rwanda (RBD, 2018). Hence there is emergency need to control the effect of

firewood utilization on environmental degradation vis a vis tourism industry because Musanze District is at the core of tourism industry in Rwanda.

Table 4. 12: Presenting views of respondents regarding the extent Musanze District encourages environmental protection related policies to cut back firewood utilization effects

	Frequency	Percent	Valid Percent	Cumulative Percent
Great Extent	70	70.0	70.0	70.0
Neutral	28	28.0	28.0	98.0
No extent	2	2.0	2.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The table 4.12 indicates that 70 (70.0%) of respondents asserted that Musanze District encourages environmental protection related policy to a great extent, while 28 (28.0%) of respondents remained neutral on this statement while 2 (2.0%) of respondents disagreed with the statement saying that Musanze District encourages environmental degradation related policies to cut back fire utilization effects in Musanze District. This means that Musanze District does it possibility to ensure the protection of environment but there still a need to maximize the application of policies and measures to protect environment and cut back the effects of firewood utilization on environmental degradation.

Table 4. 13: Presenting information about Use of LP Gas while cooking can reduce the effect of firewood utilization and environmental degradation

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	92	92.0	92.0	92.0
No	8	8.0	8.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The results in table 4.13 indicates that 92 (92.0%) of respondents accepted that use of LP Gas while cooking can reduce the effect of firewood utilization and environmental degradation, whereas 8 (8.0%) of respondents rejected the statement. This reveals that almost the whole population of Musanze district know that use of LP Gas while cooking can reduce the effects of firewood utilization on environmental degradation hence. In interview with one of the agronomy asserted that Government should facilitate the local member of the community to afford the price of gas cooker to cut back the effect of firewood utilization on environment.

Table 4. 14: Presenting the number of respondents who use LP Gas while cooking

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	14	14.0	14.0	14.0
No	86	86.0	86.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The results in table 4.14 indicates that a big number of respondents do not use LP gas while cooking at rate of 86 (86.0) of respondents, while a number of respondents who use LP Gas while cooling is 14 (14.0%) of respondents. This means that a big number of Musanze residents do not use gas hence, the emergency response to control the effects of firewood utilization on environmental degradation to facilitate the residents to possess gas cookers and access to loans to buy them and pay in installments.

Table 4. 15: Presenting views of respondents on the Civil Society and NGOs contributions to discourage firewood utilization and yield positive effects to environment

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	64	64.0	64.0	64.0
Disagree	21	21.0	21.0	85.0
Neutral	15	15.0	15.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings in table 4.15 prove Civil society and NGOs in Musanze District contribution to discouragement of firewood utilization and yield positive effects to environment at rate of 64 (64.0%) of respondents, while 21 (21.0%) of respondents disagreed with the statement and 15 (15.0%) remained neutral about the statement. This means that civil society and NGOs have taken their part in environmental protection initiative to ensure that firewood utilization effects are cut backed.

Table 4. 16: Presenting the information of respondents regarding government political will in encouraging other sources of energy while cooking

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	94	94.0	94.0	94.0
Neutral	6	6.0	6.0	100.0
Total	100	100.0	100.0	

Source: Primary Data, 2019

The findings in table 4.16 indicates that 94 (94.0%) of respondents have agreed that government put much effort in encouraging other sources of energy while cooking rather than firewood, 6 (6.0%) of respondents remained neutral about the statement. This proves that Musanze District and Government of Rwanda at large have put much effort in encouraging use of gas cooker while cooking.

4.2.2. The relationship between firewood utilization and environmental degradation in Musanze District of Rwanda

In this subsection the researcher presents the secondary data collected from annual report about deforestation and afforestation rate to capture the relation between firewood utilization and environmental degradation and need for emergency intervention, data from the field were also presented basing on the relationship between firewood utilization and environmental degradation. Where firewood utilization is measured by massive destruction, endangering water resources and destruction of species in system while environmental degradation was measured in climate change, rapid industrialization and soil degradation.

Table 4. 17: Forest coverage per hectare at sector level through use of secondary data collection approach

Sectors	Central Forest	District Forests	Private Forests	Afforestation
Busogo	41,50	6,10	168,96	747,51
Cyuve	-	4,91	230,08	161,01
Gacaca	63,81	-	21,56	938
Gashaki	135,97	-	26,24	730,08
Gataraga	25,37	-	225,87	965,28
Kimonyi	6,15	64,59	78,94	744,86
Kinigi	-	-	229,55	1934,9
Mukoza	60,92	-	147,65	673,71
Muko	7,98	-	129,05	684,08
Musanze	23,66	10,72	111,82	1158,9
Nkotsi	59,89	-	9,14	697,86
Nyange	-	8,71	179,54	947,286
Remera	65,45	-	50,02	492
Rwaza	62,14	7,6	111,78	613
Shingiro	-	18,10	11 240	1153,5
Total	552,84	109,47	1748,41	13641,7

Source: Forest office of Musanze District, 2019

Musanze district has 552, 84 ha of central forest, 109,47 ha of district forest, 1748,41 of private forest and the areas afforested since the last 5 years is 13641,7 ha. Some of these forests are natural forests that cover 18410,72 ha including the volcano national park that has 16000 ha of natural forest.

Table4.18: Estimated wood utilization in Musanze through use of secondary data collection approach

Utilizer / destination	Estimated annual wood products utilized in stere, sacs and poles	Estimated annual Wood products utilized in m³
Smaller factories	74 990 st	37 495
Public institutions	101 774 st	50 887
Households	902 490 st	451 245
Restaurants	66 292 st	33 146
Charcoal	127 970 sacs	42 230
Timber	831 760 st	24 493
Construction	42686 poles	426
Total		639 922

Source: Musanze District office of forest, 2019

The formula got from the office of forest in Musanze district converts $1\text{m}^3 = 2 \text{ stere} = 100 \text{ poles} = 700\text{kg} = 2.5 \text{ adults tress}$. The results reveals that Musanze district utilize $639\,922 \text{ m}^3$ quantity of wood per year which is equal to $447\,945\,400 \text{ kgs}$ of wood products or $1\,599\,805$ adult trees which shows that there is high rate of deforestation compared to the number of hectares afforested in the last five years which is equal to 13641.7 ha . According to FAO (1989) guide for field technicians in forestry 1.111 trees are required per hectare and $1\,599\,805$ adult trees are cut per year in Musanze, it means $1\,439\,968.4968 \text{ ha}$ of trees are utilized per year, since the rate of afforestation is at $13\,641.7 \text{ ha}$ in the last 5 years and rate of deforestation is at $1\,439\,968 \text{ ha}$ in one year, proves that 105.5% is the rate of deforestation, meaning the planted trees in years cannot be even utilized in one years.

Table 4. 19: Correlations analysis between firewood utilization and environmental degradation

		Massive Destruction	Endangering Water Resources	Destruction of Species in System	climate change	rapid industrialization	Soil degradation
Massive Destruction	P Correlation	1	.441**	-.139	.087	.215*	.444**
	Sig. (2-tailed)		.000	.167	.009	.032	.000
	N	100	100	100	100	100	100
Endangering Water Resources	P Correlation	.441**	1	-.253*	.105	.105	.440**
	Sig. (2-tailed)	.000		.011	.297	.297	.000
	N	100	100	100	100	100	100
Destruction of Species in System	P Correlation	-.139	-.253*	1	.391**	.342**	-.265**
	Sig. (2-tailed)	.167	.011		.000	.000	.008
	N	100	100	100	100	100	100
climate change	P Correlation	.087	.105	.391**	1	.917**	-.484**
	Sig. (2-tailed)	.389	.297	.000		.000	.000
	N	100	100	100	100	100	100
rapid industrialization	P Correlation	.215*	.105	.342**	.917**	1	-.418**
	Sig. (2-tailed)	.032	.297	.000	.000		.000
	N	100	100	100	100	100	100
Soil degradation	P Correlation	.444**	.440**	-.265**	-.484**	-.418**	1
	Sig. (2-tailed)	.000	.000	.008	.000	.000	
	N	100	100	100	100	100	100

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

P Correlation is Pearson Correlation.

Source: Primary Data, 2019

The findings of table 4.19 indicated that almost all the factors or measures have significant positive relationship with positive Pearson correlation at level of significance which is under 0.01 level of significance which implies that if one factor increases another one may increase. For instance, correlation between massive destruction and water resources (p=.441 with sig=.000 which is lesser than 0.01 level of significance) hence positive relationship, correlation between massive destruction and climate change (p=.087 with sig=.008 which is lesser than 0.01 level of significance), correlation between destruction of species in system and rapid industrialization (p=.917with sig= 0.00 at 0.01 level of significance). There is also significant negative relationship with negative Pearson correlation at 0.01 level of significance which implies that once one factor decreases another on can decrease, for instance correlation between endangering water resources and massive destruction (p=-.139 with sig= .000 which is lesser than 0.01 level of significance), soil degradation and climate change (p=-.418 with sig= .000 which is lesser than 0.01 level of significance), destruction of species on system and soil degradation (p=-.484 with sig = .000 which is lesser than 0.01 level of significance). Most of the results with Table 4.19

revealed that there is significant and positive relationship between firewood utilization and environmental degradation.

4.2.3. The emergency response needed to mitigate the impact of firewood utilization on environmental degradation

In this subsection of this study the researcher is much concerned about the emergency response needed to mitigate the impact of firewood utilization on environmental degradation in Musanze District with special consideration on population growth and size, sociocultural factor (conservative behavior), immigrants from neighboring communities, dependence on natural resources (cutting trees) and high rate of deforestation. The researcher looked also at affordability of firewood compare to other primary source of energy at home while cooking.

Table 4. 20: Descriptive Statistic on factors influencing emergency response to mitigate the impact of firewood utilization on environmental degradation in Musanze District of Rwanda

Variable		Frequency	Percent
Population growth & Size	Agree	78	78.0
	Neutral	18	18.0
	Disagree	4	4.0
Sociocultural factor (i.e. conservative behavior)	Agree	96	96.0
	Neutral	3	3.0
	Disagree	1	1.0
Immigrants from Neighboring communities	Agree	92	92.0
	Neutral	7	7.0
	Disagree	1	1.0
Dependence on natural resources (cutting trees)	Agree	85	85.0
	Neutral	13	13.0
	Disagree	2	2.0
Economic factors (tourism & better infrastructure development)	Agree	70	70.0
	Neutral	19	19.0
	Disagree	9	9.0

Source: Primary Data, 2019

The results in table 4.20. indicates the highest need for emergency response to mitigate the impact of firewood utilization on environmental degradation is sociocultural factor (conservative behavior) rating at 96 (96.0%) of respondents, immigrants from neighboring communities at rate of 92 (92.0%) of respondents, dependence on natural resources (forests and plantations) at rate of 85 (85.0%), population growth and size at rate of 78 (78.0) of respondents, and economic factors (tourism and development of good infrastructures) at rate of 70 (70.0%). This study finding proved that sociocultural factor (conservative behavior) is the highest rated factor to influence emergency response in cutting back negative effects brought by firewood utilization, this imply

that government and other actors in environmental protection should sensitize the citizens about the use of gas cooker, or other sources of energy rather than firewood which fuels deforestation and impact climate change and then cause global warming.

Table 4. 21: Descriptive statistics about the views of respondents on affordability of firewood compare to other primary source of energy at home while cooking

Variable		Frequency	Percent
Firewood consumption per month (Kgs)	Below 100 Kgs	1	1.0
	100-199 Kgs	13	13.0
	200 Kgs & above	86	86.0
Charcoal consumption per month (Kgs)	Below 50 Kgs	1	96.0
	50- 99 Kgs	3	3.0
	100 Kgs & above	96	96.0
LP Gas consumption per month (Kgs)	Below 10 Kgs	1	1.0
	10 – 19 Kgs	93	93.0
	20 Kgs & above	6	6.0

Source: Primary Data, 2019

The findings in table 4.21 shows that 86 (86.0%) of respondents asserted that their households had to use or use 200 Kgs and above of firewood per month, while 96 (96.0%) of respondents agreed to have used or use 100 Kgs per month, and 93 (93.0%) of respondents asserted that they can use 10-19 Kgs of LP Gas per month. According to REG (2019) the price of charcoal is 150 Rwf per Kg, LP Gas is 1150 Rwf per kg, and firewood is 100 Rwf per kg. Basing, on these prices it seems that 100 kg of charcoal per month can cost 15,000 Rwf, 10kgs of LP Gas per month can cost only 11,500 Rwf and 200 kgs of fire woods per month can cost 30,000. The findings prove that LP Gas is very cheap compared to other sources of energy considered in this study, in addition the results revealed that firewood utiliziers consume the amounts of money to be used in two months in a single month. Hence, sensitization about the use of LP Gas is need by not only government, it would be an assignment of different actors and individuals to educate their neighbors to cut back its negative effect to environment and neighbor's finance.

4.2.4. The recommended intervening strategies for mitigating and preventing firewood utilization effects and environmental degradation in Musanze District of Rwanda

In this subsection, this research looked at the recommended intervening strategies to mitigate and prevent utilization of firewood effects and environmental degradation with special consideration on cutting down taxes attached to LP Gas, Use of conservative stoves, sensitizing residents about the use of other affordable and safer sources of energy rather that fire woods while cooking, and reinforcing measures that protect environment and ecosystem.

Table4.22: Presenting views of respondents about intervening strategies to be applied to mitigate and prevent the negative effects of firewood utilisation and environment degradation

Variable		Frequency	Percent
Continuing to cut down taxes attached to LP Gas	Agree	81	81.0
	Neutral	17	17.0
	Disagree	2	2.0
Use of conservative stoves	Agree	65	65.0
	Neutral	26	26.0
	Disagree	9	9.0
Sensitizing residents about the use of other affordable and safer sources of energy rather than fire woods while cooking	Agree	85	85.0
	Neutral	14	14.0
	Disagree	1	1.0
Reinforcing measures that protect environment and ecosystem	Agree	71	71.0
	Neutral	24	24.0
	Disagree	5	5.0

Source: Primary Data, 2019

The findings in table 4.20 indicates that the best intervening strategy to mitigate and prevent the negative effects of firewood utilization and environmental degradation is sensitizing the residents about the use of other affordable and safer sources of energy rather than firewood while cooking at rate of 85 (85.0%) of respondents, the second is continuing to cut down taxes attached to LP Gas at rate of 81 (81.0%) of respondents, reinforcing measures that protect environment and ecosystems is the third at rate of 71 (71.0%) of respondents and use of conservative stoves at 65 (65.0%) of respondents. These results prove that sensitization, mobilization and reinforcing environment protection regulations and policies can be the working strategies to mitigate and prevent the effects of environment degradation.

4.3. Summary

This chapter presented the data collected and analyzed basing on four specific objectives of the study, but most of the results revealed that firewood is the primary sources of energy using in Musanze while cooking at rate of 83% of the population because within this study of 100 respondents only 14% owns LP Gas and 3% of the respondents use biomass, the study revealed that to prevent and limit the negative effects of firewood utilization and environmental degradation, there is a need to sensitize, mobilize and reinforce environment protection measures because this study proved that LP Gas is the most affordable energy for cooking compared to firewood and charcoals.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION

This study chapter involves summary of findings, conclusion, and recommendations to the government, individuals, actors in environmental protection, and local leaders and suggestions for further studies.

5.1. Summary of findings

This study was about firewood utilization and environmental degradation in Musanze District and it was broadened into its specific objective to compile a very comprehensive research.

5.1.1. Socio demographic Characteristics

The results of this study indicates that more women participated in this study at rate 53 (53.0%) of the total percent of respondents, compare to counterpart male who are at 47 (47.0%) of respondents. This means that this study is gender sensitive hence relevancy of information.

The results indicate that 36 (36.0%) of respondents holds university degree, 31 (31.0%) have finished only primary education, 30 (30.0%) of respondents have completed their secondary education whereas only 3 (3.0%) have no formal education. The findings prove that more than 66 (66.0%) of respondents are well educated, this gives assurance of their perceptions and views that are more reliable because they have education, and education influences understandings and views but normally making people to have common views.

5.2.1. The effects of firewood utilization on environmental degradation

The findings indicated that 97 (97.0%) of respondents have accepted that firewood utilization as a primary source of energy while cooking and heating can affect environmental degradation, the findings of table 4.8 reveals that 83 (83.0%) of respondents utilize firewood while cooking, 14 (14.0%) of respondents use Liquefied Petroleum Gas, this reveals that the rate of environmental degradation and tree cutting in Musanze is still high. In interview with one member of local community, people in Musanze District mostly in rural areas they prefer to use firewood to warm up the house and to keep the heat in the house because of coldness but they normally use roots of completely demolished trees, she added that most of the old people they cannot leave in a building without fire which is kept warming the building.

The findings indicate that 70 (70,0%) of respondents agreed that firewood utilization affects environmental degradation, the results indicate that a big number of respondents have accepted that firewood utilization affects the rate of tree cutting in Musanze District at rate of 96 (96.0%).

In personal observation while collecting the questionnaires and interviewing the respondents, the researcher himself saw some plantation of trees which were being cutting and other whether making charcoals in traditional method, fortunately, researcher went to the factory which makes small ships from woods remaining and make them like charcoals and they use them in a conservative charcoal stoves hence lesser use of woods and less severity of cutting trees.

The findings revealed that 70 (70.0%) of respondents asserted that Musanze District encourages environmental protection related policy to a great extent, whereas the results indicate that 92 (92.0%) of respondents accepted that use of LP Gas while cooking can reduce the effect of firewood utilization and environmental degradation. The results also indicate that a big number of respondents do not use LP gas while cooking at rate of 86 (86.0) of respondents, while a number of respondents who use LP Gas while cooling is 14 (14.0%) of respondents. The findings proved that Civil society and NGOs in Musanze District contribution to discouragement of firewood utilization and yield positive effects to environment at rate of 64 (64.0%) of respondents, the findings have also indicated that 94 (94.0%) of respondents have agreed that government put much effort in encouraging other sources of energy while cooking rather than firewood, 6 (6.0%) of respondents remained neutral about the statement. This proves that Musanze District and Government of Rwanda at large have put much effort in encouraging use of gas cooker while cooking.

5.2.2. The relationship between firewood utilization and environmental degradation

The research findings are summarized, presented and analyzed basing on the relationship between firewood utilization and environmental degradation. Where firewood utilization is measured by massive destruction, endangering water resources and destruction of species in system while environmental degradation was measured in climate change, rapid industrialization and soil degradation. Hence, the researcher looked at the correlation of firewood utilization measures with the ones of environmental degradation to prove the relationship between firewood utilization and environmental degradation. The findings indicated that almost all the factors or measures have significant positive relationship with positive Pearson correlation at level of significance which is under 0.01 level of significance which implies that if one factor increases another one may increase. For instance, correlation between destruction of species in system and rapid industrialization ($p=.917$ with $\text{sig}= 0.00$ at 0.01 level of significance). There is also significant negative relationship with negative Pearson correlation at 0.01 level of significance which implies that once one factor decreases another one can decrease, for instance correlation

between destruction of species on system and soil degradation ($p = .000$ with $\text{sig} = .000$ which is lesser than 0.01 level of significance).

5.2.3. The emergency response needed to mitigate the impact of firewood utilization on environmental degradation in Musanze District of Rwanda

The results indicate the highest need for emergency response to mitigate the impact of firewood utilization on environmental degradation is sociocultural factor (conservative behavior) rating at 96 (96.0%) of respondents, immigrants from neighboring communities at rate of 92 (92.0%) of respondents, dependence on natural resources (forests and plantations) at rate of 85 (85.0%), population growth and size at rate of 78 (78.0) of respondents, and economic factors (tourism and development of good infrastructures) at rate of 70 (70.0%). This study finding proved that sociocultural factor (conservative behavior) is the highest rated factor to influence emergency response in cutting back negative effects brought by firewood utilization, this implies that government and other actors in environmental protection should sensitize the citizens about the use of gas cooker, or other sources of energy rather than firewood which fuels deforestation and impact climate change and then cause global warming.

The findings show that 86 (86.0%) of respondents asserted that their households had to use or use 200 Kgs and above of firewood per month, while 96 (96.0%) of respondents agreed to have used or use 100 Kgs per month, and 93 (93.0%) of respondents asserted that they can use 10-19 Kgs of LP Gas per month. According to REG (2019) the price of charcoal is 150 Rwf per Kg, LP Gas is 1150 Rwf per kg, and firewood is 100 Rwf per kg. Basing, on these prices it seems that 100 kg of charcoal per month can cost 15,000 Rwf, 10kgs of LP Gas per month can cost only 11,500 Rwf and 200 kgs of fire woods per month can cost 30,000. The findings prove that LP Gas is very cheap compared to other sources of energy considered in this study, in addition the results revealed that firewood utilizers consume the amounts of money to be used in two months in a single month. Hence, sensitization about the use of LP Gas is needed by not only government, it would be an assignment of different actors and individuals to educate their neighbors to cut back its negative effect to environment and neighbor's finance.

5.2.4. The recommended intervening strategies for mitigating and preventing firewood utilization effects and environmental degradation in Musanze District of Rwanda

In this subsection, this research looked at the recommended intervening strategies to mitigate and prevent utilization of firewood effects and environmental degradation with special consideration on cutting down taxes attached to LP Gas, Use of conservative stoves, sensitizing residents about

the use of other affordable and safer sources of energy rather than fire woods while cooking, and reinforcing measures that protect environment and ecosystem.

The findings indicates that the best intervening strategy to mitigate and prevent the negative effects of firewood utilization and environmental degradation is sensitizing the residents about the use of other affordable and safer sources of energy rather than firewood while cooking at rate of 85 (85.0%) of respondents, the second is continuing to cut down taxes attached to LP Gas at rate of 81 (81.0%) of respondents, reinforcing measures that protect environment and ecosystems is the third at rate of 71 (71.0%) of respondents and use of conservative stoves at 65 (65.0%) of respondents. These results prove that sensitization, mobilization and reinforcing environment protection regulations and policies can be the working strategies to mitigate and prevent the effects of environment degradation.

5.3. Conclusion

In conclusion, people in Musanze District mostly in rural areas prefer to use firewood to warm up the house and to keep the heat in the house because of coldness but they normally use roots of completely demolished trees, most of the old people they cannot leave in a building without fire which is kept warming the building. civil society and NGOs have taken their part in environmental protection initiative to ensure that firewood utilization effects are cut backed. The findings indicate that 94 (94.0%) of respondents have agreed that government put much effort in encouraging other sources of energy while cooking rather than firewood. This proved that firewood utilization and environmental degradation have significant positive relationship with positive Pearson correlation at level of significance which is under 0.01 level of significance which implies that if one factor increases another one may increase which that means there is a strong positive significance between destruction of species in systems and rapid industrialization. The study finding proved that sociocultural factor (conservative behavior) is the highest rated factor to influence emergency response in cutting back negative effects brought by firewood utilization, this imply that government and other actors in environmental protection should sensitize the citizens about the use of gas cooker, or other sources of energy rather than firewood which fuels deforestation and impact climate change and then cause global warming. The findings also prove that LP Gas is very cheap compared to other sources of energy considered in this study, in addition the results revealed that firewood utilizers consume the amounts of money to be used in two months in a single month. Hence, sensitization about the use of LP Gas is need by not only government, it would be an assignment of different actors and individuals to educate their neighbors to cut back its negative effect to environment and neighbor's finance. This research looked at the recommended intervening strategies to mitigate and prevent utilization of firewood effects and environmental degradation with special consideration on cutting down taxes attached to LP Gas, Use of conservative stoves, sensitizing residents about the use of other affordable and safer sources of energy rather that fire woods while cooking, and reinforcing measures that protect environment and ecosystem. These results prove that sensitization, mobilization and reinforcing environment protection regulations and policies can be the working strategies to mitigate and prevent the effects of environment degradation.

5.4. Recommendation

The researcher preferred to recommend to the government, individuals, actors in environmental protection, and local leaders

5.4.1. Recommendation to Government

The researcher would like to recommend to government to certify the firewood and charcoal retailers in order to reduce fraudulent activities in tradition methods of charcoal making and transporting, it should also sensitize the members of local community to utilize gas cookers because they are very smarter, affordable and cheaper compared to other source of energy in Rwanda. The government should also increase safety awareness to gas cooker utilizers in order to keep its citizens and their properties safer. The government should also enhance the reinforcement and regulatory measures concerning environmental protection.

5.4.2. Recommendation to Individuals

The researcher would like to recommend to individuals to mobilize resources to buy gas cookers those in urban areas, while those in rural areas should use biomass while heating. To those who cannot afford to buy gas cookers should buy conservative stoves to reduce the rate of amount of charcoal or woods to be used while cooking.

5.4.3. Recommendation to Actors in Environmental Protection

The researcher would also like to recommend to actors in environmental protection and environmentalist to organize clubs of sensitizing the local community about the good use of Liquefied Petroleum Gas in order to prevent the negative effects of firewood utilization.

5.4.4. Recommendation to Local Leaders

The researcher would like to recommend to local leaders to be part and partial of environment protection through reinforcing the policies governing environmental protection and posing charges to those who break that pattern of rules. The local leaders should sensitize all local meetings about the use and affordability of Gas.

5.5. Suggestion for further studies

The researcher would like to suggest further studies to carry out in this field to fill up the gap left out by this research because it was limited on time, cost and its variables mainly on firewood

utilization and environmental degradation and even specifically in Musanze District, hence further study should be about mining activities and environmental security, to analyze the impact of deforestation on environmental degradation, fire incidents and Liquefied Petroleum Gas utilization, other researches should be carried on analyzing the effect of biomass on environmental protection to mention but few. This research is alerting the government on the increase of firewood utilization from 2013- 2018 regardless laws and policies the government has put in place and will help to take serious measures and even further study should put more emphasis on how this need emergency response, taking into account on how the increase vary every year.

REFERENCE

- Angelsen, A. 1995. Shifting cultivation and deforestation: a study from Indonesia. *World Development* 23: 1713-1729.
- Angelsen, A. 1999. Agricultural expansion and deforestation: modeling the impact of population, market forces and property rights. *Journal of Development Economics* 58: 185-218.
- Angelsen, A. 2006. A stylized model of incentives to convert, maintain or establish forest. Background Paper for World Bank Policy Research Report entitled “At Loggerheads: Agricultural Expansion, Poverty reduction and Environment in the tropical forests-2007”.
- Angelsen, A. and Kaimowitz, D. 2001. *Agricultural technologies and tropical deforestation*. CABI Publishing, Wallingford, United Kingdom.
- Anonymous, 2011a. State of the World’s Forest. FAO, Rome. 163p. Anonymous. 2011b. Mining, deforestation cause severe drought. March 5 *The Asian Age*, New Delhi.
- Anonymous. 1990b. Situation and outlook of the Forestry Sector in Indonesia, Vol. 1: Issues, findings and opportunities. Ministry of Forestry, Government of Indonesia; FAO, Jakarta.
- Anonymous. 1990c. Indonesia: sustainable development of forests, land and water. The World Bank, Washington DC.
- Anonymous. 1990d. Rainforest destruction: causes, effects and false solutions. World Rainforest Movement, Penang Malaysia.
- Anonymous. 1994a. Deforestation Technical Support Package. Third International Conference on Environment Enforcement, Oaxaca Mexico April 25-28, 1994. World Wildlife Fund; U. S. Environmental Protection Agency and U. S. Agency for International Development.
- Anonymous. 2012. Forest certification and biodiversity: opposites or complements? Discussion paper prepared for the GEF, International Tropical Timber Organization, Yokohama Japan
- Anonymous. 2015. Ecosystems and Human well-being: synthesis. Millennium ecosystem Assessment. Island Press, Washington DC.
- Anonymous. 2017. Three Essential Strategies for Reducing Deforestation. Mexico, Michoacan. WRM's bulletin N° 136, November 2008.
- Ascher, W. 2013. Political economy and problematic forestry policies in Indonesia: obstacles to incorporating sound economics and science. The Center for Tropical Conservation, Duke University.

- Balakrishnan K., S. Sambandam, S. Ghosh, K. Mukhopadhyay, M. Vaswani, N. K. Arora, D. Jack, A. Pillariseti, M. N. Bates, and K. R. Smith. 2015. "Household Air Pollution Exposures of Pregnant Women Receiving Advanced Combustion Cookstoves in India: Implications for Intervention." *Annals of Global Health* 81 (3): 375-85.
- Bangalore. Sunderlin, W. D.; Resosudarmo, I. A. P.; Rianto, E. and Angelsen, A. 2000. The effect of Indonesia's economic crisis on small farmers and natural forest cover in the outer islands. CIFOR Occasional Paper No. 28 (E). CIFOR, Bogor Indonesia.
- Barbier, E. B.; Burgess, J. C. and Folke, C. 1994. *Paradise lost? The ecological economics of biodiversity*.
- Berkeley Air Monitoring Group. 2015. *Field Performance of a Modified Philips Stove in Gisenyi, Rwanda*. Berkeley, CA. Bruce, Nigel G.,
- Bhatnagar, P. 2011. *The Problem of Afforestation in India*. International Book Distributors, Dehra Dun.
- Bruijnzeel, L. A.; Bonell, M.; Gilmour, D. A. and Lamb, D. 2015. Forest, water and people in the humid tropics: an emerging view. In: *Forest, Water and People in the humid tropics*, eds.
- Budya, Hanung, and Muhammad Yasi Arofat. 2011. "Providing Cleaner Energy Access in Indonesia through the Megaproject of Kerosene Conversion to LPG." *Energy Policy* 39 (12): 7575–86.
- Coelho, Suani T., and José Goldemberg. 2013. "Energy Access: Lessons Learned in Brazil and Perspectives for Replication in Other Developing Countries." *Energy Policy* 61 (1): 1088–96.
- Forouzanfar, M. H., et al. 2016. "Global, Regional, and National Comparative Risk Assessment of 79 Behavioral, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990–2015: A Systematic Analysis for the Global Burden of Disease Study 2015." *The Lancet* 388 (1): 659–724.
- Grieshop, Andrew P., Julian D. Marshall, and Milind Kandlika. 2011. "Health and Climate Benefits of Cookstove Replacement Options." *Energy Policy* 12 (12): 7530–42. CEEAC-CEMAC (Communauté Economique des Etats de l'Afrique Centrale and Communauté Economique et Monetaire de l'Afrique Centrale). 2014.
- Kristin Aunan, and Eva A. Rehfuss. 2017. "Liquefied Petroleum Gas as a Clean Cooking Fuel for Developing Countries: Implications for Climate, Forests, and Affordability."

- Materials on Development Financing no. 7, KfW Development Bank, Frankfurt.
https://drive.google.com/file/d/0B_799OzSu-p8WTB3YW1wZII4SXM/view.
- Levang, P. 2012. People's dependencies on forests. In Technical Report, Phase I 1997-2012. ITTO Project PD 12/97 Rev. 1 (F) - Forest, Science and Sustainability: The Bulungan model forest, pp 109-130. CIFOR, Bogor Indonesia.
- Mahar, D. 2008. Government policies and Deforestation in Brazil's Amazon region. World Bank, Washington DC.
- Mullick, B. and Griffiths, T. 2017. India: Indigenous movement in Jharkhand challenge plans for industrial development that threatens to destroy Adivasi forests, farmlands and way of life. WRM's bulletin N° 116, March 2017.
- UNHCR 2002 "Guidelines for Environmental Management," online: UNHCR (date accessed: 22 March 2019).
- UNHCR 2002 "Evaluation of Energy-Saving Options for Refugees," online: UNHCR (date accessed: 22 March 2019).
- Ibid., 6.
- UNCHR 2006 Adoption Barriers for Efficient Domestic Energy in Refugee Sites, online: (date accessed: 13 May 2019). 1
- Corinna Kreidler, 2001 "The Provision of Household Energy: Coping Mechanisms of Internally Displaced People in Benguela Province, Angola," Boiling Point 46.
- Myers, N. 2016. Tropical deforestation: rates and patterns. In: The Causes of Tropical of Tropical Deforestation. The economic and statistical analysis of factors giving rise to the loss of the tropical forest, eds. Brown, K. and Pearce, D. pp 27-40. UCL Press.
- Myers, N. and Mittermeier, R. A. 2010. Biodiversity hotspots for conservation priorities. Nature 403: 853-854.
- Nepstad, D. C.; Carvalho, G.; Barros, A. C.; Alencar, A.; Capobianco, J. P.; Bishop, J.; Moutinho, P.; Lefebvre, P.; Lopes Silva, Jr. U. and Prins, E. 2011. Road paving, fire regime and the future of Amazon forests. Forest Ecology and Management 154: 395-407.
- Nepstad, D. C.; Schwartzmann, S.; Bamberger, B.; Santilli, M.; Ray, D.; Schlesinger, P.; Lefebvre, P.; Alencar, A.; Prinz, E.; Fiske, G. and Rolla, A. 2016. Inhibition of Amazon deforestation and fire by parks and indigenous lands. Conservation Biology 20: 65-73.
- Panayotou, T. 2010. The economics of environmental degradation: problems, causes and responses, HIID Development discussion papers 335. Harvard University.

- Pearce, D. and Brown, K. 2014. Saving the world's tropical forests. In: *The Causes of Tropical of Tropical Deforestation. The economic and statistical analysis of factors giving rise to the loss of the tropical forest*, eds. Brown, K. and Pearce, D. pp 2-26. UCL Press.
- Porter, G. 1994. The environmental hazards of Asia Pacific development: The Southeast Asian Rainforests. *Current History* 93: 430-434.
- Purnamasari, R. S. 2010. Dynamics of small-scale deforestation in Indonesia: examining the effects of poverty and socio-economic development.
- Repetto, R. 2010. Deforestation in the Tropics. *Scientific American* April, p. 37
- Repetto, R. 2014. The forest for the trees? Government policies and the misuse of forest resources. World Resource Institute, Washington DC.
- Ross, 1996. Conditionality and logging reform in the tropics. In: *Institutions for Environmental Aid: Problems and Prospects*, eds. Keohane, R. O. and Leve, M A. Pp 167-197. MIT Press, Cambridge Massachusetts.
- Rowe, R.; Sharma, N. P. and Bowder, J. 1992. Deforestation: problems, causes and concern. In: *Managing the world's forest: looking for balance between conservation and development*, ed. Sharma, N. P. Pp 33-46. Kendall/Hunt Publishing Company, Iowa.
- Rowntree, P. R. 1988. Review of General Circulation Models as a basis for predicting the effects of vegetation change on climate. In: *Forests, climate and hydrology, regional impacts*, eds.
- Schneider, R. R. 2015. Government and economy on the Amazon frontier. Environment Paper 11. World Bank, Washington DC.
- Scrieciu, S. S. 2003. Economic causes of tropical deforestation- a global empirical application. Development Economics and Public Policy Working Paper 4. Institute of Development Policy and Management, University of Manchester.
- Sheram, K. 2013. *The Environmental Data Book*. The World Bank, Washington DC.
- Shukla, G. 2010. Biomass production and vegetation analysis of Chilapatta Reserve Forest Ecosystem of West Bengal. Uttar Banga
- Southgate, D. 1994. Tropical deforestation and agricultural development in Latin America. In: *The Causes of Tropical of Tropical Deforestation. The economic and statistical analysis of factors giving rise to the loss of the tropical forest*, eds. Brown, K. and Pearce, D. pp 134-43. UCL Press.

Theuri, D., (2017). Energy Sector Costing to meet Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS) and the East Africa Community Regional Access to Modern Energy Services Strategy. United Nations Development Programme (UNDP)/United Nations Environment Programme (UNEP), Nairobi.

Unasylva 61: 14-20. Putz, F. E.; Blate, G. M.; Redford, K. H.; Fimbel, R. and Robinson, J. 2011. Tropical forest management and conservation of biodiversity: An overview. Conservation Biology 15: 7-20.

Vanderplas (2014). Biomass Energy in Rwanda-An Update. Prepared for the PRSC. World Bank, Washington D.C.

APPENDICES

APPENDIX ONE: RESEARCH OPERATIONALIZATION

Research Question	Independent Variable	Dependent Variable	Dimension of the IV	Dimension of the DV	Indicator of Dimension
To assess the effects of firewood utilization on environmental degradation in Musanze District of Rwanda for the last 5 years (March 2013 – March 2018).	Firewood utilisation	Environmental degradation	<p>Economic factors: Massive destruction of environment, endangering water resources and destruction of ecosystem.</p> <p>Political factors: Tax attached to LPG, inefficient rural electrification, poverty, lack of biomass, lack of sensitization about use gas and environmental protection, population growth and size, immigrants from rural neighbouring communities,</p> <p>Sociocultural factors: conservative behaviour, cooking for big cultural ceremonials</p>	<p>Economic factors: Soil degradation, deforestation, rapid industrialisation, illegal mining, infrastructure destruction,</p> <p>Political factors: Lack of regular reinforcement of environmental protection policies, controlling illegal mining and mining related policies, inadequate measures of controlling population growth, high fertility rate,</p> <p>Sociocultural factors: use of firewood in cooking for ceremonies and other household parties.</p>	<p>Cutting trees, flooding, Soil Erosion, Deforestation, Toxic air/pollution, Reduction of crop production, Climate change and temperature, Weather modification.</p> <p>Loss of biodiversity, decrease of tourism industry, Poverty increment, Infrastructure destruction, Loss of Economic growth in agriculture and fisheries, Reduction of farm produce and livestock products</p>

<p>How is the relationship between firewood utilization and environmental degradation in Musanze District of Rwanda?</p>	<p>Firewood utilisation</p>	<p>Environmental degradation</p>	<p>Economic: water resources, Ecosystem, tourism, conservatives stove Political factors: Planting trees after cutting one, environmental policy and sensitizing population Sociocultural factors: Influencing attitudes and behaviours of locals</p>	<p>Economic factors: massive destruction, deforestation Political factors: government regulation of tree cutting, plantation of trees on public roads, and a long rivers and lakes. Sociocultural: collective work while planting trees, and controlling environmental degradation</p>	<p>Planting trees, environmental sustainability, affordable sources of energy while cooking, heating and lighting Monitoring and Evaluation of programs to guarantee environmental sustainability, controlling the use of wood products,</p>
<p>What are recommended intervening strategies for halting firewood utilization and environmental degradation in Musanze District of Rwanda?</p>	<p>Recommended intervening strategies to halt Firewood utilisation</p>	<p>Environmental degradation</p>	<p>Economic factors: cutting down taxes attached to gas, use of conservatives stoves, use of biomass to people who has cows in the village. Political factors: reinforcing environmental protection policy and awareness, mobilising and sensitization about use of gas, favouring the access of</p>	<p>Economic factors: National and international economic impact in terms of restoring green cover and protection of endangered species. Political factors: Government intervention in setting environmental protection related policies, organising Umuganga in every month</p>	<p>Planting trees and protecting the existing forest, restoring green cover, regulating Climate and temperature and flesh air, Weather modification. protecting biodiversity, economic growth in agriculture and fisheries, increase of farm produce and livestock products environmental protection related policies, use of gas while cooking and heating to avoid environmental</p>

			loans from the bank to buy gas cooker. Sociocultural: Breaking conservative behaviour of the locals, exposure, education and public awareness	specified for environmental protection, Sociocultural: engaging locals in protecting the environment, planting more trees, increase clubs for environmental protection in both sectors and schools.	degradation, certifying allowed dealers in firewood and charcoal retailers
--	--	--	---	---	--

Source: Researcher, 2019

APPENDIX TWO: QUESTIONNAIRE

FOR MEMBERS OF LOCAL COMMUNITY AND FIREWOOD RETAILERS

FIREWOOD UTILIZATION AND ENVIRONMENTAL DEGRADATION

All information provided in this study will be treated as confidential and your anonymity is assured

Part I: Demographic Characteristics of Respondents

1. Gender: 1= female [] 2= male []
2. Marital status: 1=Single [] 2=Married [] 3=Divorced [] 4=Separated [] 5= Widowed []
3. Educational level: 1=No schooling 2=Primary education 3=Secondary education 4=Tertiary
4. Are you a resident of Musanze District? 1= Yes [] 2= No []
5. How long have you lived here in Musanze District?
 - a. 0 – 3 []
 - b. 4 – 7 []
 - c. 8 – 11 []
 - d. 12 years + []

Respondents' Views on Firewood Utilization and Environmental Degradation

PART II: The contribution of firewood utilization while cooking and heating to environmental degradation

6. Firewood is the primary source of energy while cooking and heating in rural areas
Agree [] Neutral [] Disagree []
7. What is your primary source of energy while cooking at your household?
Firewood [] Gas [] Electricity [] other, specify
8. In your own understanding, do you think firewood utilisation can contribute to environmental degradation?

Agree [] Neutral [] Disagree []

8. Does firewood utilisation increase the rate of tree cutting in Musanze District?

Yes [] No

9. If yes, how many kilos of firewood a household can use in a month

Below 30 kg [] 30 – 59 kg [] 60 -89 [] 90 and above []

10. The following environmental degradation indicators are related to the effects of firewood utilisation in Musanze District. Please record your level of agreement using the scale of 1-3 where 1 - Agree, 2 – Disagree, 3 – Neutral

	1	2	3
Cutting trees			
Flooding			
Soil erosion			
Deforestation			
Toxic air/ pollution			
Weather modification			
Climate change and temperature			

8. The following indicators are related to the economic impact of firewood utilisation on environmental degradation in Musanze District. Please record your level of agreement to the statement using the scale of 1-3 where 1 – Agree, 2 – Disagree, 3 – Neutral

	1	2	3
Firewood utilisation has led to loss of biodiversity			
Firewood utilisation has led to decrease of tourism industry			
Firewood utilisation contributes to increment of poverty			
Firewood utilisation contributes to infrastructure destruction			
Firewood utilisation contributes to loss of economic growth in agriculture and fisheries			
Firewood utilisation leads to reduction of			

farm produce			
Firewood utilisation leads to loss of livestock products			

9. To what extent does the Musanze District encourage environmental protection related policies to discourage firewood utilisation

Great extent [] Neutral [] No extent[]

10. In your own opinion, do you think use of gas while cooking and heating can discourage the utilisation of firewood and encourage environmental sustainability, Yes [] No []

11. if yes, do you use gas while cooking and heating? Yes [] No []

12. If no, do you plant trees after cutting one for cooking and heating? Yes [] No []

13. If yes, how many trees (specify)

14. In your own opinion, do you think electricity has contributed to reducing the rate of environmental degradation, more specifically reducing the firewood utilised to lighting, Yes [] No []

15. if yes, do you have electricity? Yes [] No []

16. If yes, do you think does it have impact on environmental degradation? Yes [] No []

17. To what extent civil society and NGOs get involved in environment sustainability through discouraging the utilisation of firewood in Musanze District? Have these partnerships yielded any positive effects to environmental degradation in the people of Musanze District?

Great extent [] Neutral [] No extent[]

18. In your own opinion, do you think the government has shown political will to encourage other sources of energy while cooking?

PART III: The relationship between firewood utilization and environmental degradation

19. To what Extent Do you think the factors of firewood utilisation are related to the factors of environmental degradation. Please record your level of agreement to the statement using the scale of 1-3 where 2 –Little Extent, 3 – Neutral, 1 – Great Extent

	1	2	3
Cooking			

Heating			
Lighting			
Climate change and weather modification			
Destruction of ecosystems			
Water resources			
Mineral exploitation			
Massive destruction			
Soil destruction			

PART IV: The recommended intervening strategies for halting firewood utilization and environmental degradation

20. In your own opinion, what are intervening strategies do you think can be applied to halt firewood utilisation and environment degradation in Musanze District? Among the following

	1	2	3
Continuing the policy of cutting down tax attached to LPG gas			
Using conservative/cyanarumwe stoves			
Sensitizing the residents about the better use of firewood			
Outreach programs planting more trees			
Measures to protect ecosystems			

APPENDIX THREE: INTERVIEW GUIDE FOR GAS AND CHACOAL RETAILERS

Part I: Demographic Characteristics of Respondents

1. Gender: 1= Male [] 2= Female []
2. Marital status: 1=Single [] 2=Married [] 3=Divorced [] 4=Separated [] 5= Widowed []
3. Educational level: 1=No schooling 2=Primary education 3=Secondary education 4=Tertiary
4. Are you a resident of Musanze District? 1= Yes [] 2= No []
5. How long have you lived here in Musanze District?
 - a. Below 5 years []
 - b. 5 – 9 []
 - c. 10 – 14 []
 - d. 15 & years + []

PART II: The contribution of firewood utilization while cooking and heating to environmental degradation

6. Firewood is the primary source of energy while cooking and heating in rural areas
Agree [] Neutral [] Disagree []
7. What is your primary source of energy while cooking at your household?
Firewood [] Gas [] biomass [] other, specify
8. In your own understanding, do you think firewood utilisation can contribute to environmental degradation?
Agree [] Neutral [] Disagree []
8. Does firewood utilisation increase the rate of tree cutting in Musanze District?
Yes [] No
9. If yes, how many kilos of firewood a household can use in a month
Below 30 kg [] 30 – 59 kg [] 60 -89 [] 90 and above []
10. The following indicators are related to the economic impact of firewood utilisation on environmental degradation in Musanze District. Please record your level of agreement to the statement using the scale of 1-3 where 1 – Agree, 2 – Disagree, 3 – Neutral

	1	2	3
Firewood utilisation has led to loss of biodiversity			
Firewood utilisation has led to decrease of tourism industry			
Firewood utilisation contributes to increment			

of poverty			
Firewood utilisation contributes to infrastructure destruction			
Firewood utilisation contributes to loss of economic growth in agriculture and fisheries			
Firewood utilisation leads to reduction of farm produce			
Firewood utilisation leads to loss of livestock products			

8. To what extent does the Musanze District encourage environmental protection related policies to discourage firewood utilisation

Great extent [] Neutral [] No extent[]

9. In your own opinion, do you think use of gas while cooking and heating can discourage the utilisation of firewood and encourage environmental sustainability, Yes [] No []

10. if yes, do you use gas while cooking and heating? Yes [] No []

11. If no, do you plant trees after cutting one for cooking and heating? Yes [] No []

12. If yes, how many trees (specify)

13. In your own opinion, do you think electricity has contributed to reducing the rate of environmental degradation, more specifically reducing the firewood utilised to lighting, Yes [] No []

14. if yes, do you have electricity? Yes [] No []

15. If yes, do you think does it have impact on environmental degradation? Yes [] No []

16. To what extent civil society and NGOs get involved in environment sustainability through discouraging the utilisation of firewood in Musanze District? Have these partnerships yielded any positive effects to environmental degradation in the people of Musanze District?

Great extent [] Neutral [] No extent[]

17. In your own opinion, do you think the government has shown political will to encourage other sources of energy while cooking?

PART III: The relationship between firewood utilization and environmental degradation

18. To what Extent Do you think the factors of firewood utilisation are related to the factors of environmental degradation. Please record your level of agreement to the statement using the scale of 1-3 where 2 –Little Extent, 3 – Neutral, 1 – Great Extent

	1	2	3
Cooking			
Heating			
Lighting			
Climate change and weather modification			
Destruction of ecosystems			
Water resources			
Mineral exploitation			
Massive destruction			
Soil destruction			

PART IV: The recommended intervening strategies for halting firewood utilization and environmental degradation

19. In your own opinion, what are intervening strategies do you think can be applied to halt firewood utilisation and environment degradation in Musanze District? Among the following

	1	2	3
Continuing the policy of cutting down tax attached to LPG gas			
Using conservative/cyanarumwe stoves			
Sensitizing the residents about the better use of firewood			
Outreach programs planting more trees			
Measures to protect ecosystems			

