AN INVESTIGATION ON EFFECTS OF COMBUSTION OF FOSSIL FUELS ON THE ENVIRONMENT IN KOGERO DIVISION, KISUMU CITY, KENYA.

BY

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A RESEARCH REPORT SUBMITTED TO THE FACULTY OF EDUCATION IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF AWARD OF A DIPLOMA OF SCIENCE WITH EDUCATION

AUGUST 2009

DECLARATION

I **Asango W. Edwin, DSE/12410/61/DF**, declare that this research report is from my own findings and has never been produced by anyone else for the award of a Diploma in this or any other institution.

SIGN.....

DATE..... 04/08/09

APPROVAL

This Research Proposal has been submitted for examination with my approval as the University Supervisor

Signature: ..... Date: 04/08/09

MR. KIRYA ROBERT KENT

DEDICATION

This research report is dedicated to my beloved wife **Jacquilyne Nanjala Cheloti** for her moral support.

ACKNOWLEDGEMENT

My special thanks go to the Almighty for the good health throughout the research period.

I also wish to acknowledge the effort of my family members; My Father, **Mr. Carl Asango**, My Mother **Mrs. Hellen Asango**, My brothers and sister for their moral and financial support throughout my research period.

I also take the opportunity to acknowledge the professional efforts of my supervisor. **Mr. Kirya Robert Kent** who guided me doing the research and finally, I owe thanks to all my friends for their constant and unfailing support.

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ABSTRACT

The study was conducted to investigate the effect of combustion of fossil fuels on the environment a case study of Kisumu City. The objective of the study were to find out the end products of automobile and industrial combustion of fuels, to device ways of reducing amount of pollutant emissions fuel sources with low pollutant emissions.

The study used both the qualitative and quantitative approaches using the deliberate sampling method since only specific categories of people were conducted. The sampling procedure of the sample was random. The research instruments used to collect data were questionnaires, observation and interviews. The data was analyzed through coding by tallying frequencies, calculating percentages and representing the information using thematic approach on tables, pie chart and bar graphs.

`The study established that poor maintenance of motor vehicle and industries caused air pollution, use of fuels with low pollutant emissions was away of controlling smoke pollution and use of leaded fuels was an alternative source of fuel with low pollutant emissions. From the findings of the study the following recommendations were made; amendment of both traffic and industrial law to minimize on amount of pollutant emissions; use of fuel with additives and sensitization of people on effects of environmental degradation.

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Since the industrial revolution, 1750, human activities had substantially added to the amount of heat trapping green house gases in the atmosphere. Greenhouse gas concentrations in the atmosphere had historically varied as a result of many natural processes for example volcanic activity, changes in temperature. However, since the industrial revolution human beings had added significant amount of green house gases in the atmosphere by burning fossil fuels, cutting down forests and other activities. Because greenhouse gases absorbed and emitted heat, increasing their concentration in the atmosphere would tend to have a warming effect.

According to the National Oceanic and Atmospheric Administrations (NOAA) concentrations of carbon dioxide, CO_2 in the atmosphere had increased from approximately 280 parts per million (ppm) in pre-industrial times to 382 parts per million in 2006, a 36% increase. Almost all of the increase was due to human activities (IPCC, 2007). The current rate of increase in carbon dioxide concentrations is about 1.9ppm/year. Present carbon dioxide concentrations are higher than any time in at least the last 6500000 years (IPCC, 2007).

According to Hesser (2004), Focus on Earth Science, Scientists believed that the increase of carbon dioxide was due to burning fossil fuels such as coal, oil and natural gas. These fuels were called "fossil fuels" because they were composed of remains of plants and animals. When fossil fuels were burnt, stored carbon was given off as carbon dioxide. People had been using fossil fuels for many years. However, the effects of additional carbon dioxide in atmosphere were just being realized.

It was not until 1977 that a meeting of industrialized nations was convened to tackle the problem of global warming, the Kyoto Climate change conference agreed to a 6% to 8% reduction below 1990 levels in emission of carbon dioxide and green house gases by

2012. To accomplish that, a cut in use of fossil fuels by industries and consumers alike was to take place. It was hoped that new energy saving technologies would be available to developing countries as well.

Despite of all these, Kenya as a country had put and was putting a lot of efforts in realizing the 2030 vision of industrialization which could only be realized through automobiles and coming up of industries. Kisumu had become a fast growing City due to the coming up of industries and the increase in number of automobiles on the streets. Therefore, the burning of fossils (natural gas, petroleum, and coal) would increase the amount of carbon dioxide in the atmosphere, a source of environmental pollutant.

1.2 STATEMENT OF PROBLEM

Although automobile and industrial plants had been given restrictions as pertains pollution of the environment, much damage was done. Some activities that pollute the environment had wide reaching effects. Therefore, pollution was an international issue of concern; hence the government had to look for ways to solve the problem.

1.3 PURPOSE OF THE STUDY

The purpose of this study was to examine the effects of burning fossil fuels as a source of environmental pollutant in Kisumu city, Kogero division.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study were as follows;

i) To find out the end products of automobile and industrial combustion of fuels.

ii) To device ways of reducing amount of pollutant emissions to the environment.

iii) To find out alternative fuel sources with low pollutant emissions.

1.5 RESEARCH QUESTIONS

The study was guided by the following research questions:

i) What are the end products of automobile and industrial combustion of fuels?

ii) What ways can be devised to reduce amount of pollutant emissions to the environment?

iii) What alternative fuel sources can be used that have low pollutant emissions?

1.6 SCOPE OF THE STUDY

Geographically the study covered Kisumu City, Kogero Division neighbouring the Central Division and the Industrial Area zone. Contextually the study covered Finding out the end products of automobile and industrial combustion of fuels, device ways of reducing amount of pollutant emissions and finding out alternative fuel sources with low pollutant emissions.

1.7 SIGNIFICANCE OF THE STUDY

This study was useful in the following ways;

i) Personally beneficial since it was a partial requirement for the award in my academic studies.

ii) It was read and be of help to my colleagues while writing their research report.

iii) Create general awareness on pollution of environment to the society.

iv) If published the government would formulate policies, legislate laws for automobile and industries to use fuels with low pollutant emissions.

CHAPTER TWO
LITERATURE REVIEW

2.1 CHAPTER OVERVIEW

This chapter contained the conceptual and theoretical aspects of the study and reviewing the literature according to the following themes of study; Theoretical framework, End products of fuel combustion, Reduction in amount of pollutant emission and Alternative fuel sources.

2.2 Theoretical Framework

According to Hesser (2004), Focus on Earth Sciences, fossil fuels are hydrocarbons formed during plant and animal decay millions of years ago. They were considered non renewable natural resources. Each person must take active part in the conservation of these valuable energy resources.

Scientists believed that the increase of carbon dioxide in the atmosphere was due to burning of fossil fuels as coal, oil and natural gas. When the fossil fuels were burned, stored carbon was given out as carbon dioxide. People had been using fossil fuel for a long time. However, the effects of additional carbon dioxide in the atmosphere were just now being realized. This had greatly contributed to global warming.

2.3 End Products of Fuel Combustion

According the Ebbing and Gammon (1999), General Chemistry, the burning of fossil fuels; natural gas, petroleum, coal was a source of environmental pollution. Acid rain which had been shown to be injurious to the environment was believed to be partially as a result of burning of coal and petroleum. It appeared that carbon dioxide, a main product in burning of fossil fuels may also be a major pollutant. The percentage of carbon dioxide in the atmosphere had risen steadily since the large scale burning of fossil fuels begun in the late nineteenth century. Carbon dioxide in the atmosphere acted like the glass on green house, retaining the earth's heat like the glass on green house, retaining the earth's heat energy. Climatologists believed that this green house effect was at least partly

responsible for the recent increase in the average temperature of the earth and that thus global warming may increase because of the increasing concentration of the carbon dioxide.

However, intergovernmental panel on climate change IPCC (2007) disagreed with him. According to the panel greenhouse gas concentrations in the atmosphere had historically varied as a result of many natural processes for example volcanic activity. However, the panel also resolved that since the industrial Revolution of humans had added a significant amount of greenhouse gases in atmosphere by burning fossils fuels, cutting down forests and other activities. According to Patti Hutchison (2009), edHelper.com, life could not exist on earth without greenhouse effect since our planet would be cold. However, he agreed with other scientists that can increase in greenhouse effect would make the earth too hot.

According to Atkins, Loretta (1997), Chemistry Molecules, Matter and Change: In 1989, scientists in Netherlands noticed that the great tit, a forest songbird, was producing eggs with thin porous shells. Scientists therefore investigated the birds' supply of calcium, which is needed for strong shells. Great tits normally get their calcium from the snails that make up most of their diet. However, the snails had virtually vanished from forests. According to his book, dry forest soils normally contained 5-10 grams of calcium per kilogram; but the calcium content of the soil had fallen to 0.3 g Kg^{-1}, too low for snails to survive. The fall in calcium content had been traced to acid rain, in particular to rain containing sulfuric acid. The serious pollutants in acid rain were strong acids in comparison with rain unaffected by human activity which contained mostly weak acids and had a pH of 5.7. The primary acid present is carbonic acid, H_2CO_3, which resulted from the dissolving of atmospheric carbon dioxide on acidic oxide in water.

Atkins and Loretta (1997) suggested that sulfur dioxide was produced as a by-product of burning fossil fuels. It combined with water directly to form sulfurous acid, a weak acid.

$SO_{2\,(g)} + 2\,H_2O_{(1)} \longrightarrow H_3O^+_{(aq)} + HSO_3^-{}_{(aq)}$

Alternatively, in presence of particulate matter and aerosols, sulfur dioxide reacted with atmospheric oxygen to form sulfur trioxide, which forms sulfuric acid with water

$2\,SO_{2\,(g)} + O_{2\,(g)} \longrightarrow 2\,SO_{3\,(g)}$

$SO_{3\,(g)} + H_2O_{(1)} \longrightarrow H^+_{(aq)} + HSO_4^-{}_{(aq)}$

Sulfuric acid was a strong acid that was especially damaging to soil because it caused the leaching of calcium ions. Most soils contained clay particles, which were surrounded by layers of ions, including calcium ions, ca^{2+}. However, calcium ions in the clay particles could be replaced by hydrogen ions, H^+ from sulfuric acid. Because calcium sulfate was insoluble in water, it could no longer circulate through the soil or be taken up by plants. If calcium leached from the soils was not replaced, plants suffered and entire forest could be affected.

According to Alexander Miller, Assistant Director of the UN's Food and Agriculture Organization, he wrote in the Standard Sunday, December 7, 2008 headline; "Take Climate Change Seriously or Prepare for a Worse Food Crisis". He wrote that agriculture was the sector most likely to be affected by climate change and would be increasingly vulnerable to these effects in future.

He further stated that there's increasing evidence that declining ground water levels and rising sea levels that lead to acidity of the soil and increasing levels of salinity were linked to climate change.

2.4 Reduction in Amount of Pollutant Emissions

In February 2007, EPA finalized a rule to reduce hazardous air pollutants from mobile sources (Control of Hazardous Air Pollutants from Mobile Sources, February 9, 2007).The rule would limit the benzene content of gasoline and reduced toxic emissions from passenger vehicles and cars. EPA estimated that in 2030 this rule would reduce total emissions of mobile source air toxics by 330000 tons and precursors to Ozone by over 1 million tons.

By 2010, EPA's existing programs would reduce mobile source air toxics by over 1 million tons from 1999 levels. In addition to controlling pollutants such as hydro carbons, particulate matter and nitrogen oxides. EPA's recent regulations controlled emissions from highway vehicles and non road equipment also resulted in large air toxic reductions. Further more, EPA had programs under development that would provide additional benefits from further controls for small non road gasoline engines, diesel locomotive in marine engines. Finally, EPA had developed a variety of programs to reduce risk in communities, such as Clean School Bus USA, the Voluntary Diesel Retrofit Program and National Clean Diesel Campaign.

According to Clean School Bus USA, EPA's national partnership to minimize pollution from school buses. Leaders from corporate America children's health, environmental and governmental organizations gathered to plan to reduce children's exposure to diesel exhaust by eliminating unnecessary school bus idling, installing effective emissions control systems on newer buses and replacing the old buses in the fleet with newer ones. EPA's Voluntaries Diesel Retrofit Program worked to reduce pollutions through installation of pollution-reducing devices on the vehicles and to use cleaner – burning diesel fuels.

According to Best Work Places for Commuters was a voluntary program, for reducing vehicle miles traveled is an effective way to reduce air toxic risk in communities. According to Atkins and Loretta (1997) Chemistry molecules, matter and change, it stated that atmospheric nitrogen and oxygen could react to form nitrogen oxide, NO at high temperatures of automobile internal combustion engines and electrical power stations;

$$N_2 + O_{2\,(g)} \longrightarrow 2\,NO_{(g)}$$

The nitric oxide, NO, was not very soluble in water but could be oxidized further in air to form nitrogen dioxide.

$2\,NO_{(g)} + O_{2(g)} \longrightarrow 2\,NO_{2(g)}$

The nitrogen dioxide reacted with water forming nitric acid and nitric oxide:

$3NO_{2(g)} + 3\,H_2O_{(l)} \longrightarrow 2\,H_3O_{(aq)} + 2\,NO_3^-{}_{(aq)} + NO_{(g)}$

However, catalytic converters in automobile reduced the nitrogen monoxide, NO to N_2 and were required for all new cars and trucks.

According to Laura G. Smith; Human Health Web Site; driving less was one of the best ways to save energy and avoid polluting air. He further commented that we could help by sharing rides to school or work. Purchase cars that used less fuel such as the new "hybrid" cars.

2.5 Alternative Fuel Sources

According to Ebbing and Gammon (1999), controlling carbon dioxide emissions into the answer lied in the conversion to a hydrogen energy economy where hydrogen would become a major energy carrier. Automobiles, for example would be modified to burn hydrogen, which would be obtained from other energy sources. In steam reforming process, steam and hydrogen from natural gas reacted at high temperatures and pressure in presence of nickel catalyst to form carbon monoxide and hydrogen;

$C_3H_{8(g)} + 3\,H_2O_{(g)} \xrightarrow{Ni} 3\,CO_{(g)} + 7\,H_2(g)$

The hydrocarbon, in effect, provided the energy for production of hydrogen.

He further wrote that hydrogen could also be produced from coal by water – gas reaction, which was no longer used commercially but became important again as natural gas and petroleum became more expensive.

In this reaction, steam was passed over red-hot coke and coal.

$C_{(s)} + H_2O_{(g)} \longrightarrow CO_{(g)} + H_{2(g)}$

To obtain pure hydrogen, carbon monoxide was to be removed by reacting carbon monoxide with steam in presence of a catalyst to give more hydrogen and carbon dioxide;

$CO_{(g)} + H_2O_{(g)} \xrightarrow{Catalyst} CO_{2(g)} + H_{2(g)}$

The primary fuel, however, was liquid methanol, wood alcohol, CH_3OH, which reacted with water vapor in steam – reforming unit to produce hydrogen and carbon monoxide which was catalytically oxidized to carbon dioxide.

In principle, the steam reforming unit could use fuels other than methanol, such as gasoline. The result was an automobile with very low pollutant emissions.

According to Environmental Protection Agency, EPA (2007), Fuel additives improved fuel quality and significantly prolonged engine life. In addition, their use reduced carbon dioxide and nitrogen oxide emissions to air and cut fuel consumption by up to two percent.

According to Dr. Andreas Kreimeyer, Board member, one of the leading World's producers of fuel additives. The company marketed products with more efficient fuel combustion, thus reducing consumptions and emissions. In China drivers added Keropur@ a gasoline additive to their tanks. China now aimed to develop additives to be added to fuels in standardized amount at refinery.

According to Hesser (2006), Focus on Earth Science, solar power was an example of an alternative energy source that was clean and efficient, though was not used more because solar cells were very expensive to produce. Nuclear power was also an alternative source of fuel though very controversial subject. Nuclear accidents had occurred in the past, causing many people to oppose the development and use of nuclear power plants.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

This study used both qualitative and quantitative approaches using deliberate sampling method. Only specific people in each category were conducted. They included drivers, officials from motor inspection and license body, industrial workers, ministry of environment and natural resources staff, and the locals.

3.2 RESEARCH POPULATION

The study population was Kisumu City, Kogero Division which had a population of six thousand people, industrial area which had a population of four thousand and central zone which had a population of about fifty thousand people.

3.3 SAMPLE AND SAMPLING PROCEDURE

The sample included top five officials of motor inspection and license body, at most five drivers, five middle class and three casual workers in industries, top five officials from the Ministry of environment and natural resources, and twenty-seven locals. The sampling procedure was random.

3.4 RESEARCH INSTRUMENTS

The instruments used in the data collection were questionnaires, observation and interviews. The researcher used questionnaires since they were relatively cheap if informants responded in time, using observation saved on time since the researcher observed and recorded data which respondents did not easily reveal, for interviews the data collected was accurate and supplementary information from informants personal characteristics and environment which was useful during interpretation of results was got.

3.5 RESEARCH PROCEDURE

On approval of the proposal by the university, letter was given from the Faculty of Education to carry out research in the field. Researcher seeked for permission from concerned authorities. Questionnaires were distributed to relevant people and authorities to be filled. Observation and interviews were conducted accordingly. The data collected was tallied and presented using tables and data was presented using pie charts, bar graphs, percentage was calculated. A rough copy on data collected was written and lastly a fair copy written and handed to the supervisor for approval.

3.6 DATA ANALYSIS

The analysis of data was through coding by tallying frequencies, calculating percentages and representing the information using thematic approach on tables, pie charts and bar graphs.

3.7 LIMITATIONS OF THE STUDY

The following constraints were expected during the study; limited time frame, illiteracy, lack of interest of respondents, lack of skills from researcher on data collection
Since it was the first time experience.

3.8 ETHICAL CONSIDERATIONS

The researcher seeked permission from the relevant authorities, introduced himself / herself to the respondents, ensured that there is no persuasion of respondents and assured respondents of confidentiality.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA FINDINGS

4.1 Chapter Overview

This chapter covers the analysis of data, interpretation and presentation. Using the generated frequency tables, bar graphs and pie charts through cross tabulations from all the questionnaires, analyses the effects of combustion of fossil fuels on the environment. They are presented under different sub-headings but all in line with the main objectives of the study.

4.2 End Products of Fuel Combustion

Research question one was revisited: What are the end products of automobile and industrial combustion of fuels.

From the questions asked to many people, views on the end products of automobile and industrial combustion of fuels were given.

The respondents were asked whether they know of human activities that cause air pollution to the environment.

Table 1: Opinion on human activities that cause air pollution to the environment.

Activities that cause air pollution	Burning of vegetation	Smoking Cigarettes	Motor Vehicles and Industries	No opinion	Total
Number of respondents, frequency	16	9	22	3	50
Percentage %	32	18	44	6	100

From the information given in the table above, it was found that 32% of the people believe that pollution was caused by burning vegetation, 18% of the respondents believed that it was caused by smoking cigarettes, 44% of the respondents were of the view that it was caused by motor vehicles and industrial emission of smoke. However, 6% of the respondents said they had no opinion on causes of air pollution.

The data was presented using a bar graph as shown below.

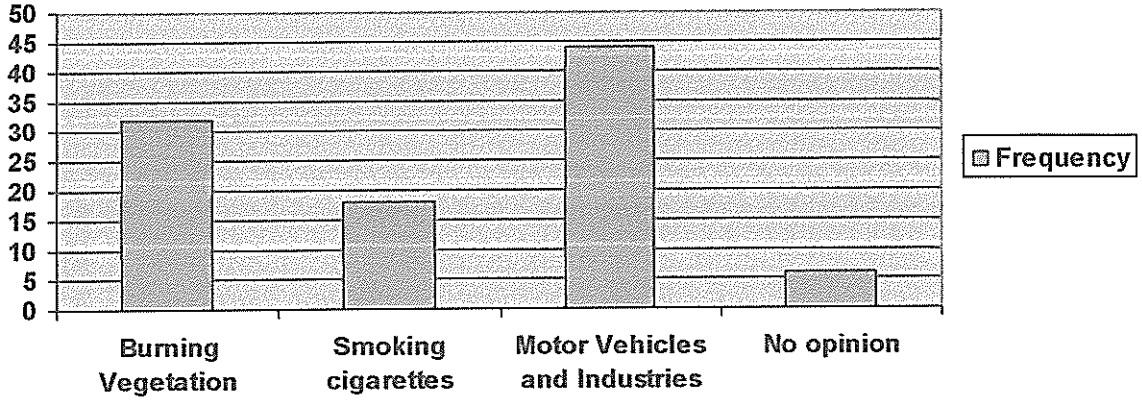

Figure 1: The bar graph showing people's opinion on causes of air pollution to the environment.

From the results , it appears that people attribute causes of air pollution to motor vehicle and industrial emission, as a result, people using motor vehicles as main means for transport and also due to the coming up of industries. It was also found that air pollution was caused by burning of vegetation due to burning of forests, as people clean land for cultivation.

Air pollution was also attributed to smoking as many of the smokers had become chain smokers. Thus, it can be said that most of the people were of the opinion that air pollution was caused by motor vehicle and industrial emission of smoke to the environment.

The respondents were also asked how motor vehicles and industries emit smoke.

Table 2: Views on how motor vehicles and industries emit smoke

Ways into how smoke is emitted	Low Speed	Poor maintenance	Low quality fuels	No opinion	Total
Number of respondents, frequency	8	27	11	4	50
Percentage %	16	54	22	8	100

From the study, the results depicted that 54% of the people attribute emission of smoke to poor maintenance of motor vehicle and industrial engines, 22% of the people attribute to low quality fuels, 16% of the people attributed it to low running speed of motor vehicle and industrial engines. However, 8% of the people had no idea on how motor vehicle and industries emit smoke. The data was presented using a pie chart as shown below;

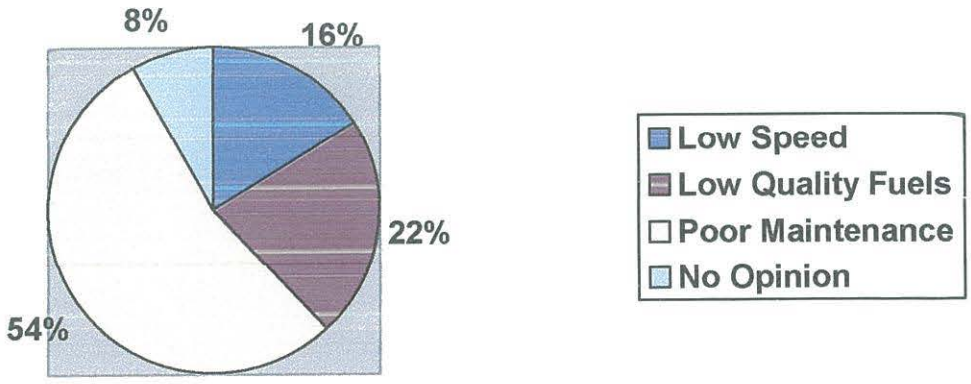

Figure 2: Pie chart showing opinions on how motor vehicles and industries emit smoke

The results showed divergent views on how motor vehicles and industries emit smoke. There were more people, 54%, who opted for poor maintenance of engines which as a result brought about incomplete combustion, thus more carbon emission to environment; 22% of the people were of the view that it was due to low quality fuels which were considered to be cheap by many more especially those in the public service vehicles for carrying passengers and 16% was attributed to low speed of motor vehicles and running machines in industries, that is during idling that more smoke is given out. Therefore, it was concluded that more people attributes emission of smoke to poor maintenance of motor vehicles and industries.

The respondents were also asked how smoke affects vegetation and human beings.

Table 3: Opinions on impact of smoke pollution to human beings and vegetation

Effect of smoke pollution to human beings and vegetation	Inadequate Rainfall	Change in Temperature	Cause disease	Total
Number of Respondents, frequency	31	05	14	50
Percentage %	62	10	28	100

From the results above, it was found out that 62% of the people attributed inadequate rainfall to smoke pollution; 28% of the people were of the view that smoke pollution caused a number of diseases and 10% of the people were of the view that smoke pollution caused change in climate due to temperature rise.

The data was presented using a pie chart as shown below;

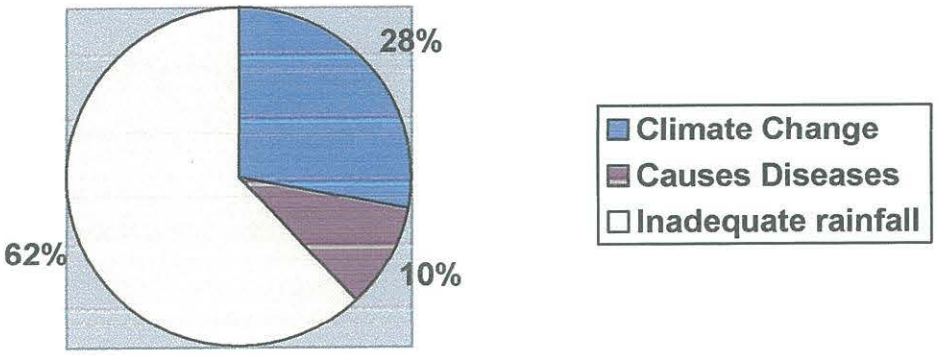

Figure 3: The pie chart showing opinion on impact of smoke pollution to human beings and vegetation.

The findings showed that majority of the people, 62%, were of the view that inadequate rainfall was caused by smoke pollution. They were of the idea that accumulation of smoke in the atmosphere interfered with the hydrological cycle, hence interferes with the rainfall. The results also showed that 28% of the people attributed smoke pollution to cause most respiratory diseases like cancer, tuberculosis which had claimed many lives as a result of people smoking heavily. Also, 10% of the people were of the view that smoke pollution brought about climate change due to rise in temperatures as a result of accumulation of a lot of gases in the atmosphere which causes destruction of the ozone layer which shields away heat from the sun.

4.3 Reduction in Amount of Pollutant Emissions

Research question two was revisited: What ways can be devised to reduce the amount of pollutant emissions to the environment.

From the questions asked to many people. Views on how to reduce amount of pollutant emissions to the environment were given. The respondents were asked whether they know of any human activity that can control smoke pollution.

Table 4: Opinions on human activity that can control smoke pollution

	Yes	No	Total
Frequency	46	04	50
Percentage	92	8	100

From the information given in the table above, it was found that 92% of people had an idea of human activity that can control smoke pollution in different ways. However, 8% of the people had no idea on human activity that can be used to control smoke pollution.

The data was presented using a pie chart as shown below.

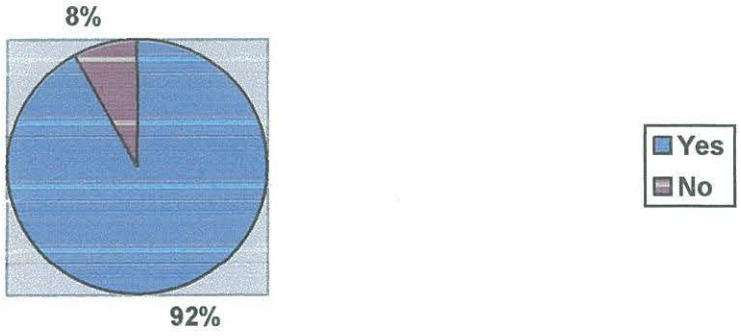

Figure 4: The pie chart showing opinion on human activity that can control smoke pollution

From the data collected, 92% of the people had an idea on how human activity could control smoke pollution. They were of the idea that it could be controlled by discouraging people from burning vegetation for example forests, some were of the view that it could be controlled through use of clean fuels with little carbon wastes. Frequent servicing of engines and change of engine oil was also sited as a way of controlling smoke pollution. Of those 8% who had no idea about human activity that can control smoke pollution were very ignorant about smoke pollution due to illiteracy.

The respondents were also asked about ways to control smoke pollution by motor vehicles and industries.

Table 5: Opinion on ways to control smoke pollution by motor vehicles and industries.

Ways of controlling smoke pollution by motor vehicles and industries	Use of fuels with low pollutant emissions	Use of less fuel consuming engines	No opinion	Total
Number of respondents, frequency	29	18	3	50
Percentage %	58	36	6	100

From the table above, findings showed that 58% of the people were of the view that use of fuels with low pollutant emissions was a way of controlling smoke pollution, they were of the view that leaded fuels should be used which ensures complete combustion resulting into less waste emissions into the atmosphere. Of the total sample of study, 36% of the respondents were of the view that use of less fuel consuming engines was one way of controlling smoke pollution. They were of the idea that the less fuel burned will reduce on the amount of emission to the atmosphere.

However, of the total sample, 6% of the people had no idea on how motor vehicles and industries could control smoke pollution.

The above information from the table was presented using the bar graph as shown below.

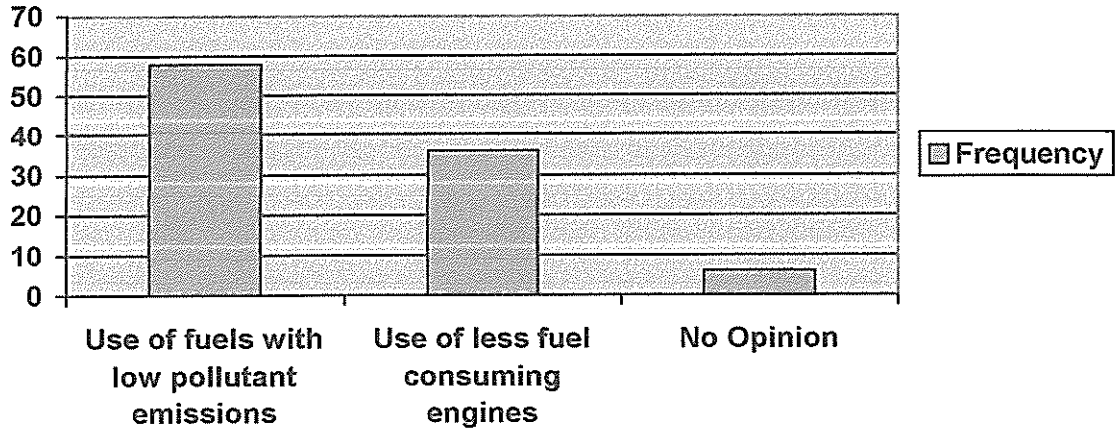

Figure 5: A bar graph showing ways on how motor vehicle and industries could control smoke pollution

The respondents were also asked whether aforestation was a way of checking effects of smoke pollution.

Table 6: Views on whether aforestation is a way of checking effects of smoke pollution.

	True	False	Total
Frequency	47	03	50
Percentage	94	6	100

From the information given in the table above, it was found that 94% of the people were of the view that aforestation was a way of checking effects of smoke pollution. However, 6% of the people said that aforestation could not help in checking effects of smoke pollution. Of those who said that it was true aforestation could help in checking the

effects of smoke pollution said that this was made possible through the process of photosynthesis whereby trees use carbon dioxide in the atmosphere keeping its concentration at minimal amounts. They were also of the idea that trees play a role in the cooling of the environment through the process of transpiration where plants lose water vapor in the atmosphere which cools in the clouds and falls back as rain. Among those who were of the idea that aforestation could not check the effects of smoke pollution was due to ignorance; simply because 100% of them were illiterate.

4.4 Alternative Fuel Sources

Research question three was revisited; what alternative fuel sources can be used that have low pollutant emissions.

From the questions asked to many people, views on alternative fuel sources with low pollutant emissions were given.

The respondents were asked whether they know of any alternative fuel with low pollutant emissions.

Table 7: Views on alternative fuel with low pollutant emission.

Alternative fuel with low pollutant emission	Use of leaded fuel	Steam driven engines	No opinion	Total
Number of respondents, frequency	30	15	05	50
Percentage %	60	30	10	100

As can be seen in the table above, 60% of the people were of the view that leaded fuels can be used as alternative source of fuel. They were of the view that lead should be added

during refining of crude fuel which improves combustion of the fuels and as a result leads to low pollutant emission. Of the total sample, 30% of the people were of the view that use of steam to drive engines which was a source of energy in the early times. They were of the opinion that steam driven engines would emit low amount of waste gases into the atmosphere. However, 10% of the people had no opinion on any alternative fuel source that could be used to power engines.

The above information was presented using a pie chart as shown below

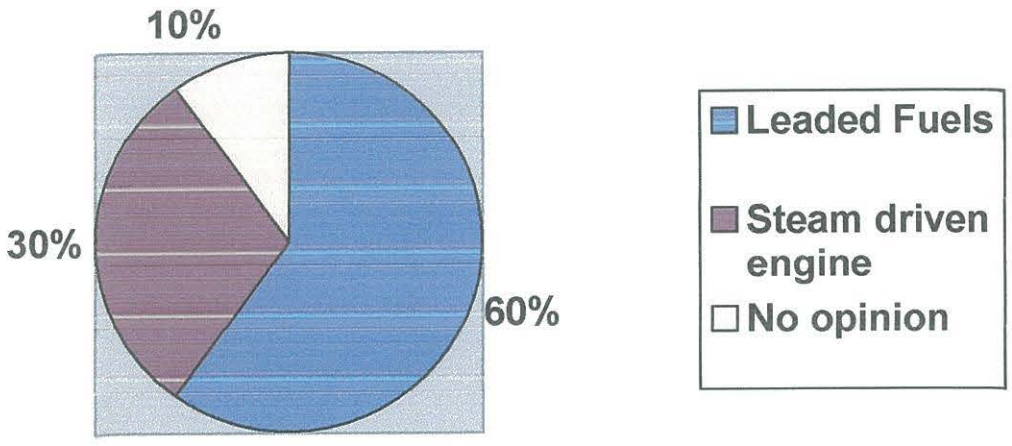

Figure 6: A pie chart showing alternative fuel sources

The respondents were also asked about measures the government should take to control environmental degradation in Kisumu City.

Table 8: Responses on measures the government should take to control environmental degradation in Kisumu City

Measures government should take to control environmental degradation	Sensitization of people about control of environmental degradation	Amendment of traffic laws & industry laws	No opinion	Total
Number of respondents, frequency	15	32	03	50
Percentage %	30	64	6	100

It was clear from the table that the vast majority of the respondents, 64%, believed that amendment of the traffic law was the only way forward for the government to curb environmental degradation on our roads. They were of the view that the traffic act should be made tight through ensuring that there was zero tolerance to corruption and as a result, the traffic officers should only allow road worth vehicles on the roads which were well serviced. This would help to reduce on amount of pollutant emission to the atmosphere. Industrial laws should also be amended to put restrictions to industries to minimize pollutant emissions by ensuring that clean fuels with additives are used.

Of the total sample, 30% of the respondents were of the idea that the government should sensitize people on the effects on pollutant emission. Among the effects mentioned by the respondents were the rise in temperature, acid precipitation. However, 6% of the respondents had no opinion simply because they were ignorant about pollution which was as a result of illiteracy.

The above information was presented on a bar graph as shown below.

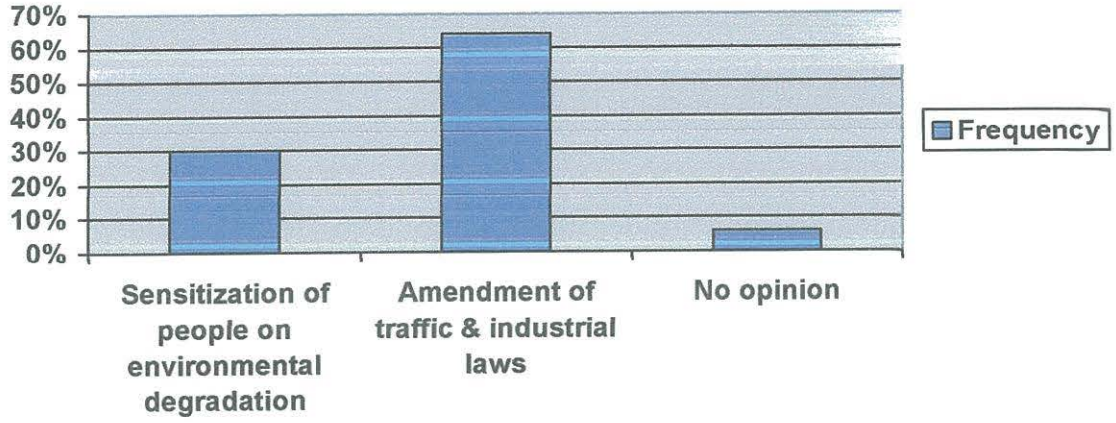

Figure 7: A bar graph showing responses on measures the government should use to control environmental degradation.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 DISCUSSION

The findings of the study suggested that combustion of fossil fuels caused pollutant emissions to the environment which had a wide reaching effect.

Discussion on research question one, what are the end products of automobile and industrial combustion of fuels

The findings of the study showed that many people attributed air pollution to motor vehicle and industrial emissions. This was as a result of people using automobiles as the main means of transport and also due to the coming up of industries which use fuel as a source of energy.

This was in agreement with Ebbing and Grammon (1999), General Chemistry, who found out that the burning of fossil fuels, was a source of environmental pollution. According to them, carbon dioxide, a main product in burning fossil fuels was a major pollutant, its increase in concentration in the atmosphere acts like glass on greenhouse retaining earth's heat leading to increase in the average temperature of the earth and thus global warming.

However, Intergovernmental Panel on Climate Change (2007), disagreed with them. According to the Panel, greenhouse gases concentrations in the atmosphere had historically varied as a result of many natural processes for example volcanic activity and cutting down forests.

The findings of the study also showed that poor maintenance of motor vehicle and industrial engines increased the amount of smoke emission as a result of incomplete combustion of the fuels leading to more carbon emission to the environment. The findings also showed that use of low quality fuels and low speed of automobiles and running of machines in industries contributed to emission of more smoke. This was in

agreement with Hesser (2004), Focus on Earth Science, who found out that when fossil fuels are burned, stored carbon is given out as carbon dioxide.

Discussion on research question two, what ways can be devised to reduce amount of pollutant emission to the environment.

The findings of the study showed that use of fuels with low pollutant emissions was one way of controlling smoke pollution by motor vehicles and industries.

This was in agreement with Clean School Bus USA; according to EPA's voluntary Diesel Retrofit Program, worked to reduce pollution through installation of pollution reducing devices on the vehicles and use of cleaner burning diesel fuel.

It was also found out from the study that use of less fuel consuming engines was another way of controlling smoke pollution. This was in agreement with Laura G. Smith; Human Web Site; driving less was one of the best ways to save energy and avoid polluting air. He further commented that we could help by sharing rides to school or work and purchase of cars that use less fuel such as the new "hybrid" cars.

However, according to Atkins and Loretta (1997), disagree with Laura G. Smith. According to them, nitrogen monoxide, NO, a waste product of fuel combustion could be converted by catalytic converters to nitrogen N_2 which is not a pollutant.

Discussions on research question three; what alternative fuel sources can be used that have low pollutant emissions.

The results of the study showed that use of leaded fuel was an alternative source of fuel. This was in agreement with Environmental Protection Agency, EPA (2007), fuel additives improve fuel quality and significantly prolonged engine life. In addition, their use reduced carbon dioxide and nitrogen oxides emissions to air and cuts fuel consumption by up to two percent.

This is also in agreement with Dr. Andrew Kreimeyer, Board member, one of the leading world producers of fuel additives. The company marketed products with more efficient fuel combustion, thus reducing consumptions and emissions. In China, drivers must add keropur @ a gasoline additive to their tanks. China now aims to develop additives to be added to fuels in standardized amounts at refinery.

However, Hesser (2004), Focus on Earth Science, disagreed; according to him, solar power was an example of alternative energy that was an example of alternative energy that was clean and efficient, though not used more because solar cells are very expensive is produced. He further wrote that nuclear power was also an alternative source of fuel though a very controversial subject.

It was also found out that use of steam driven engines could be used as alternative fuel with low pollutant emission. This was in agreement with Ebbing and Gammon (1999), general Chemistry, according to the writer, controlling carbon dioxide emission into the atmosphere was a difficult challenge, but the answer lied in the conversion to a hydrogen energy economy where hydrogen would become a major energy carrier. Automobiles, for example would be modified to burn hydrogen, which would be obtained from other energy sources. In steam reforming process, steam and hydrogen from natural gas reacted at high temperatures and pressure in presence of nickel catalyst to form carbon monoxide and hydrogen.

5.2 CONCLUSION

This study has examined the end products of automobile and industrial combustion of fuels, devised ways to reduce amount of pollutant emissions to the environment and alternative fuel sources with low pollutant emissions. The findings showed that air pollution was as a result of combustion of fuels in automobiles and industries which brought about accumulation of waste gases of combustion of fuels like sulfur dioxide, carbon dioxide, nitrogen dioxide. It was found out that poor maintenance of motor vehicles and industries increased the amount of smoke emission as a result of incomplete combustion of the fuels leading to more carbon emission.

The findings of the study showed that use of fuels with low pollutant emission was one way of controlling smoke pollution by motor vehicles and industries. It was also found out that use of less fuel consuming engines was another way of controlling smoke pollution. Lastly, the findings of the study showed that use of leaded fuels and use of steam driven was an alternative fuel source with low pollutant emissions.

5.3 RECOMMENDATIONS

From the findings of the study I made the following suggestions:

(i) The traffic laws should be amended to ensure that the police ensure that automobile owners carry out servicing and maintenance of engines frequently which should be monitored through certificate issuance.

(ii) The industrial laws should also be amended to ensure that industries are restricted to minimize on amount of pollutant emission to the environment through use of clean fuels.

(iii) The government should ensure that automobiles and industries use fuels with additives.

(iv) Sensitization of people on the effects of environmental degradation.

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APPENDICES

Appendix I: RESEARCH QUESTIONS

Dear Respondent,

I am a student of Kampala International University pursuing a diploma of Science with Education. Kindly assist me to fill this questionnaire, which seeks your opinion concerning effects of combustion of fossil fuels on the environment. Your contribution will enhance strategies to alleviate the problem.

I assure you that your opinion will be treated with confidentiality.

Topic: An investigation on Effects of combustion of fossil fuels on the environment.

INSTRUCTIONS

i) Do not write your name

ii) Write in spaces provided and tick the box of your choice where applicable

iii) Feel free to ask a question for clarity.

Questions 1-4; Gives Background Information of the Respondent.

1. Personal Details

   a) Age 18-24 ☐ 25-30 ☐ 31-34 ☐ 35 and above ☐

   b) Gender Male ☐ Female ☐

2. Level of Education

   a) Secondary ☐

   b) Tertiary ☐

   c) Others (Specify) .....

3. Occupation.....

4. Residence.....