THE IMPACT OF POST-CONSUMER PLASTIC BAGS ON ENVIRONMENT

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Abstract:

Environmental problems are huge issues to mankind and to living creatures everywhere on Earth. Some of these environmental hazards include phenomena that are long-standing, difficult to dealt with, and create largely negative impacts to generations after generations. This thesis wants to address plastic bags as an environmental problem, finds out why this specific item of everyday use had become the issue of the century. The study will also analyze thoroughly the impact of plastic bags on the environment, the people, and the planet. Finally, the thesis aims to discover some useful alternatives to this material in order to serve the same function but would not cause global damage.

The introduction chapter of the thesis introduces reader to some background information of the chosen topic, its purpose and limitations. Next, theories are written surrounding the history of plastic bags, different types and functionality of the material, and the latest con-junction with COVID-19 pandemic. The method used for research is literature review where secondary sources are gathered from electrical databases. Findings are then written in subcategories according to the plastic bags' impacts, their alternatives, and how plausible the solutions are based on users' behavior and awareness. Within the discussion chapter, the study findings are analyzed and the author gives her own opinion on the matter. The thesis is concluded that plastic bags need to be replaced due to its negative effect on the environment and everything living in that environment, and that replacing materials are

making their way into our lives. The people just need to be rational when choosing their product in order to have a better planet.

Keywords:	”plastic bags”, ”plastic”, ”impact of plastic bag”, ”the alternatives of plastic bag”.
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ABBREVIATION

BCP	Polychlorinated Biphenyls
HDPE	High-Density Polyethylene
LDPE	Low-Density Polyethylene
LLDPE	Linear Low-Density Polyethylene
NRDC	Natural Resources Defense Council
PE	Polyethylene
UAS	University of Applied Sciences
US	United States

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1 INTRODUCTION

1.1 Background

In today's modern life, using plastic bags has become extremely popular all over the world. Plastic bags, with their outstanding features such as convenience, durability, and low price, make the demand for using them instead of other containers with different materials increase rapidly. It leads to a result is that the use of plastic bags is overconsumption. However, besides the benefits mentioned above, plastic bags have their invisible disadvantages, which the users are not exactly aware of. About 500 years is the amount of time in which a plastic bag can degrade in a landfill; however, it does not stop there; later, it turns into microplastics, that its toxins can cause critical impacts on the environment [1]. More than that, littering indiscriminately due to consumers' lack of awareness made many sewers get clogged, which led to polluting the water environment seriously.

Realizing the seriousness of this problem, many environmental campaigns are run by different organizations all over the world to save our environment. One of the most popular programs is Earth Day, held on 22 April every year with different themes. This event was run for the first time in 1970; until now, this event has participated in more than 190 countries and 1 million members for every Earth Day. The theme of this year is Restore Our Earth which gets more meaningful in the Covid-19 situation [2] [3].

Therefore, the author decided to choose the topic *"The environmental impact of plastic bags and their alternatives"* to clarify the current state of this waste on the environment as well as effective alternatives to reduce its impacts.

1.2 Aim of study

This thesis aims to point out the harmful effects of plastic bags on the environment and list a few optimal replacements that are using the most popular in the current market.

1.3 Research questions

1. What are the harmful impacts of plastic bags on the environment?
2. What are the possible solutions to limit the impacts of plastic bags?
3. What are the possible solutions for raising users' awareness on the alternatives of plastic bags?

1.4 Limitation

Plastic appears in almost all aspects of today's life, in which plastic bags are consumed quite commonly. Most plastic bags are used only once. Twelve minutes is the average time of existing plastic bags, but the amount of time to decompose a plastic bag is enormous [1]. They greatly contribute to environmental pollution in general. Therefore, understanding more about plastic bags is extremely necessary. Because of that, the author chose only plastic bags as a research topic of this thesis. The thesis does not focus on any other different kinds of plastic wastes but plastic bags.

2 THEORETICAL FRAMEWORK

2.1 History of plastic bags

The process of formation and development of plastic bags is long and not easy. It took many decades from the time when the first material for plastic shopping bags was invented until plastic bags dominated other ones on the market.

In 1933, a new material that is stronger than paper called polyethylene was created by Eric Fawcett and Reginal Gibson. Twenty years later, in 1953, Karl Ziegler and Erhard Holzkamp fabricated high-density polyethylene (HDPE), another new material with outstanding advantages over the old one, such as being light, moldable, and durable. The advent of HDPE marked an important turning point in the manufacturing of plastic bags. HDPE is the most common material for creating modern plastic bags.

In 1965, the first plastic bag was designed and introduced by Celloplast, a company in Sweden, but Sweden was not the place that made plastic bags popular worldwide.

Figure 1:The first design of plastic bag by Sten Gustaf Thulin [4]

Until 1976, one company in America known as Mobil Chemical started to manufacture and then distributed plastic bags for the US stores with a small quantity. Since then, plastic bags are officially produced on a larger scale. Because of its conveniences, in 1982, paper bags are replaced with plastic ones in grocery chains Kroger and Safety. In 1985, plastic bags were presented in 75% of supermarkets as a choice for grocery bags for customers. Although the original purpose of making plastic bags was to save the environment, due to overuse and poor handling, plastic bags became the main cause of negative impact on the environment. Therefore, in 2002, the first ban on plastic bags was issued in Bangladesh. In 2007, single-use plastic bags were banned in some cities in America started from San Francisco.

Figure 2:The Minister of Environment began a mass awareness campaign for the plastic bags ban in Bangladesh [5]

Figure 3:San Francisso bans plastic grocery bags – the first city in the US [6]

In 2018, in order to reduce the use of plastic bags, alternative products began to be used in some stores. The alternative is compostable versions that can be disintegrated in land-fills to limit the harmful impacts on the environment.

However, in 2020, the unexpected revival of plastic bags took place because of Covid-19 to reduce the spread of the virus in the community [7] [8].

2.2 Common types of plastic bags

Based on the material of plastic bags, they can be classified into several different categories. However, in this thesis, the author mainly focused on the most common types that are made from PE (Polyethylene).

Polyethylene

Polyethylene (PE) is the most common raw material for making most of the plastic bags around us. Polyethylene, also known as polythene, with the chemical formula $(C_2H_{4)n}$ is a commonly used thermoplastic in the world [9]. PE products are widely used every day, from familiar utensils such as children's toys, garbage bags, or water bottles to industrial items such as reusable pallets, artificial turf, or storage tanks. Due to the outstanding properties that PE possesses, including durability, flexibility, and transparency, it can be used to produce a wide variety of objects with various purposes. Besides the advantages of physical properties, PE also has other eminent properties such as low cost and ease to use, so the demand for PE has increased over the decades. High-density polyethylene (HDPE), Low-density polyethylene (LDPE), and Linear low-density polyethylene (LLDPE) are the three main types of polyethylene that are known and manufactured the most [10].

Depending on the molecular density, polyethylene can be divided into one of the three main groups mentioned above. LDPE and LLDPE have a density range of 0,910 – 0,930 g/cm^3, HDPE possesses a higher amount of density than the two types above is 0,945 – 0,965 g/cm^3 [11]. Polyethylene in numerous of its different versions provides consumers a broad range of properties that can be suitable for a variety of aims. Most of the plastic bags that exist on the market today are mainly made from these three types of polyethylene.

HDPE is often used to make plastic bags in grocery stores or supermarkets because of its durability and strength. In addition, HDPE has good chemical resistance, so it is considered safe to contain foods and beverages. There is another reason that HDPE is so popular because its plastic number is #2, which means it can be easier to recycle than the other types [12].

Figure 4: Plastic number of HDPE [12]

LDPE has a lower density than HDPE, so it is more flexible but has less tensile strength. However, it still possesses similar characteristics to HDPE; therefore, it is also used for many purposes such as frozen food storage, cling crap, or grocery packaging. 4 is the plastic number of LDPE, which means that LDPE is easy to recycle. [13]

Figure 5: Plastic number of LDPE [13]

The same plastic number identifies LLDPE as LDPE. However, it has higher tensile strength and durability than LDPE. Commonly used for storing clothes and wrapping newspaper [14] [15].

2.3 Advantages and disadvantages of plastic bags

Advantages:

Hardly anybody uses plastic bags, but few people pay attention to their advantages because there are notions that plastic bags are not environmentally friendly. Plastic bags play an extremely important role in modern life.

Temporarily ignore the impacts of plastic bags on the environment; in this part, the author will focus on the benefits of plastic bags.

For consumers, plastic bags provide two main advantages that are durability and user-friendliness. The first reason consumers tend to prefer to use plastic bags over other types

of bags is because it is tough, resilient, and difficult to tear so that it can carry heavy objects. Moreover, because of its lightweight, it can be easy to carry everywhere. Besides that, it is impossible not to mention a remarkable benefit of plastic bags over paper bags which is reusability. Even when wet or dirty, it can be washed and repurposed [16]. According to NRDC Urban Program co-director Eric A.Goldstein, an American family uses almost 1500 plastic bags every year, thereby showing consumers favor for plastic bags. [17]

For retailers, low cost and marketing edge are reasons for preferring plastic bags. When produced in bulk, plastic bags have a price advantage over paper bags. When produced in bulk, a plastic bag costs 1 cent while a paper bag costs 4 to 5 cents [18]. Besides that, companies and stores also use plastic bags as a way to promote their brands. They often print all the information of the company or shop, usually the name, on plastic bags so that people can see and know more about their brand in detail. This form of advertising is widely used all over the world, especially in Asian countries.

Figure 6: Printed plastic bags [19]

For the ecological environment, according to the son of the inventor of the plastic bag, plastic bags were created with the original purpose of saving the planet [20], but due to improper use by humans, it has been counterproductive. In fact, plastic bags are very beneficial for the natural environment. For example, up to 40-70% of the energy can be saved by producing plastic bags instead of paper bags. Moreover, plastic bag production can also save nearly 96% of the amount of water because to produce the same quantity, producing plastic bags uses only 4% of the volume of water to manufacture paper bags. In terms of recycling, plastic recycling is about 91% less energy than paper one as well. [16]

Disadvantages:

In this section, the author has not discussed the impacts of plastic bags on the environment; this part will only briefly cover a few of the common disadvantages of plastic bags.

Firstly, plastic bag decomposition takes a long time depending on the type, 10 to 20 years for conventional plastic bags, and some take 500 to 1000 years to decompose. Secondly, plastic bags are the main reason that causes environmental pollution, especially the marine environment, thereby leading to economic losses. Moreover, recycling plastic bags is not needed to be cleaned before going to the recycling stage. [21] Another extremely dangerous harm of plastic bags is that the chemicals from them can affect human health. This effect occurs when people eat animals that have ingested plastic bags, usually marine animals such as fish, shrimp, etc.

Figure 7: Plastic affects human health [22]

2.4 Plastic bags and pandemic

The Covid-19 pandemic is an infectious pandemic caused by a virus called Sar-CoV-2, which is occurring worldwide. The pandemic took place first in December 2019 in Wuhan, China, originates in a group of people with unexplained pneumonia. By mid-January 2020, the pandemic continues to spread rapidly to other countries, and it is also confirmed that it is infectious from person to person [23]. On 11 March 2020, the World Health Organization officially declares that "Covid-19" is a global pandemic [24]. Up to the present time (06 April 2021), the total number of coronavirus cases is 132,597,727, and that of deaths is 2,876,699. The United States is the country with the highest number of active cases and deaths in the world, with the second and the third place being Brazil and India, respectively. The number of infected people increases every day and shows no sign of stopping. [25]

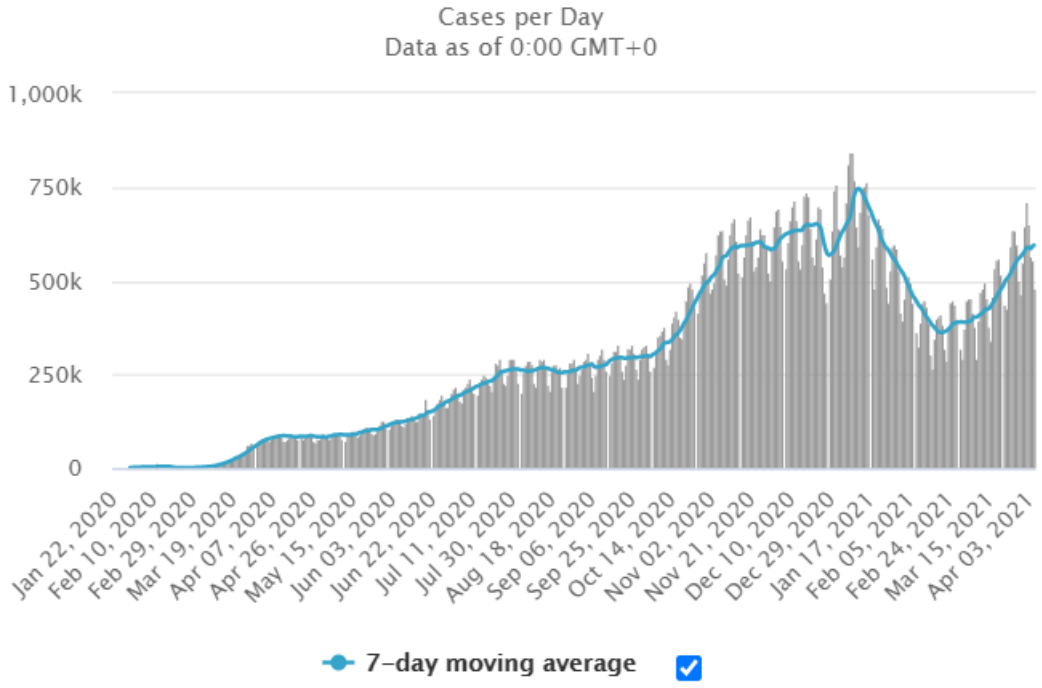

Figure 8: Daily New Cases [25]

To reduce the environmental impact of plastic in which plastic bags are a major contributor, various nations around the world have implemented a ban on plastic bags in stores, and Bangladesh was the first one to enforce this ban, then spread to other countries such as Rwanda, Kenya, China, etc.

Figure 9: Plastic bags ban in Thailand [26]

Since August 2014, the United States has begun to enforce bans on plastic bags in some states, initially in California. By the beginning of 2021, the United States had a total of 8 states and some cities that had banned the use of plastic bags. [27]

The information mentioned above shows that governments of numerous countries and territories worldwide have recognized the harmful influence of plastic bags on the ecological environment and other aspects of daily life; therefore, they are working together to limit those damages. But until the covid-19 pandemic happened, there was a strong revival of plastic products in general and plastic bags in particular. A portion of plastic waste is generated from items intended to prevent the spread of the virus from protecting healthcare workers, volunteers, and other people, such as masks, saliva shields, protective clothing, etc. Another part comes from the packaging of the product ordered online, most notably the food. The reason for this is that because of the rapid spread of the pandemic, many areas are locked down, people are lock up in the house, and as a result, they have to buy food and other product online. They do not even notice how many plastic bags they used through those purchases, but the amount of plastic waste has increased significantly since that. Moreover, because of safety, people have stopped using reusable bags, the ban on plastic bags is temporarily dumped in some places.

Figure 10: Plastic bags are used more often during the Covid-19 pandemic [28]

3 METHOD

In this section, the author will present the main method selected and how to proceed with the method to complete this thesis. Unfortunately, this section has some limitations because of a few reasons that will be covered later. However, to ensure accuracy, the information and data will be updated within the author's possibility.

3.1 Literature review

Depending on the research purpose and the desired results, the researcher can use one or several different methods to increase the accuracy and comprehensiveness of the thesis. Because each method has its own advantages and restrictions, it is necessary to set the criteria for selection as well as being skillful in combining them. However, the first thing to do before making selection criteria is that the researcher has to clearly understand about the purpose of the research and the research questions, which is important in choosing the method.

There are some criteria that the author can rely on to decide to choose research methods for this thesis. Firstly, information and data must be specific, clear, and up to date. Secondly, research data must be collected and aggregated from reputable sources such as scientific reports, academic papers, or articles on trustworthy websites. Finally, the document has to help narrow the scope of the content, to focus on solving the questions mentioned above, and then expand to new questions if possible. This is also an important criterion as well as a challenge for the literature review and the research methodology. [29]

From the above criteria, the author chooses to use the research method to read, synthesize, and analyze related documents. Applying this method requires the author to read as many documents relevant to the topic both directly and indirectly as possible. An important part of the search process is choosing a quality keyword, leading to achieving the most results. The next step is selecting useful facts and figures to analyze. Then, through what has been obtained from the previous step, proposing possible solutions to solving the initial problem.

The author decides on this methodology because it is suitable for expanding the knowledge related to the topic and providing the readers with enough information to be aware of the urgency of the problem.

3.2 Article research

To carry out this step, the first thing to do is to plan specifically for the information search, including effective keywords and reliable sources. This planning is really necessary as it determines the accuracy as well as the reliability of the final results. To find suitable keywords, the topic should be broken down into several parts. From these small parts, create the corresponding keywords. If the number of newly generated keywords is abundant, limit them to a searchable size. Based on keywords, identify valid sources to conduct the work of searching and collecting information. Trusted sources should be textbooks, scientific research, newspapers, journals, or published information on government sites or reputable organizations. The benefit of obtaining information and data from reputable

sources is primarily to avoid subjective and negative opinions from a small number of individuals. During the search process, it is possible to use alternative or synonym words to increase the comprehensiveness and multidimensionality of the research. [29] Common untrustworthy sources can be mentioned as sales websites or personal blogs. The author has to pay great attention to avoid such pages.

The electronic databases that the author used mainly in this thesis are collected from the library site of Arcada University of Applied Sciences (UAS), such as Finna, Libguide, Theseus. Also, utilize some free databases available from Google scholar or luanvan.vn. These databases are selected based on the criteria of being free, academic, easy to access, and fully article readable. The author has chosen keywords that match the research questions, such as "plastic bags," "grocery bags," "plastic bags impact," or "alternatives of plastic bags." After entering the keywords into the database, a series of different results will appear, from which the author has to select the necessary information for research.

3.3 Article analysis

In this step, the data and information gathering process will be proceeded according to what are basically presented in the Article-Research part. Still, a few sub-steps are added with the purpose of double refining to get the best articles. After keywords have been selected and entered into the database, numerous results will be output, both related and unrelated. The number of results can be enormous. Then uses a higher-level filtering tool called inclusion and exclusion criteria which are composed by the author.

Table 1: Inclusion and Exclusion criteria

Inclusion	Exclusion
Research is related to the thesis topic or research questions.	Research is unrelated to the thesis topic or research questions.
Research in English or Vietnamese.	Research in other languages.
Research provides information and data with reliable evidence and references.	Research provides information and data with subjective opinions with unreliable evidence and references.
Research can be accessed with full text.	Research cannot be accessed with full text.
Research is published within the past 10 years.	Research is published more than 10 years.

In the following step, in order to minimize the number of results received to become a number of readable resources, the author has used an additional filtering tool that is filtering by titles because titles can be easily seen without taking a long time to access. Finally, the author will read all the filtered documents thoroughly and highlight the information and data that is necessary for the work. During the process of writing, if other difficulties about sources appear, they will be supplemented later.

3.4 Validity

Reliability is not enough to judge the quality of a thesis. Another factor needed to increase accuracy is validity. These two factors are very important and essential to measure the accuracy and transparency of research results. [30]

In this thesis, the author has tried to use the recourses provided by the library site of Arcada UAS together with a careful reading of the obtained materials, compared with other relevant sources to select the most accurate information and data to avoid subjective

opinions or unclear data. Most of the information and data in this research has been collected from sources with the latest publication dates to increase the reliability of the work. Besides that, to minimize the effects of uncontrollable reasons, information and data will be regularly updated during the writing process.

4 FINDINGS

In this section, the author will show all information and data collected from the selected documents in the method section. The final results are presented logically into three main parts, namely 4.1 The impacts of plastic bags on the environment, 4.2 The alternatives, and 4.3 Users awareness for the alternatives.

4.1 The impact of post-consumer plastic bags on environment

Nowadays, plastic bags appear everywhere, and almost no one does not use plastic bags every day. The main source of plastic bags is from shopping activities that have become indispensable in modern life. As mentioned above, the average life cycle of plastic bags is 12 minutes [1], therefore, the phrase "single-use plastic shopping bags" has become extremely popular, but it is also a danger. Why call "single-use plastic shopping bags" a danger? That is because it also comes with enormous negative effects on the environment along with the convenience it brings to humans. Below are the negative effects of disposable grocery bags on our habitat that the author has summarized. In addition to a few articles and research papers used as the main source for the synthesis of results, the author also takes statistics from reputable organizations to reinforce the results.

4.1.1 Aesthetic degradation

According to the Journal produced by Ritchie and Roser, they found that in 2010, 270 million tons of plastic were produced around the world. Of the total, 99.5 million tons of plastic waste generated was deposited 50 kilometers from the shoreline of oceans and sea. The amount of plastic waste mismanaged but leaked into the ocean from the environment was 31.9 million tons in 2010. They found out that 8 million tons of the total produced

plastic materials entered the ocean from rivers and other outlets. When plastics bags enter the oceans and seas, some plastics float on the water's surface while others get submerged. It is estimated that around 100000 tons of plastic have been disposed of on the water's surface. [31]

The chart below shows the general growth of the number of plastics produced globally from 1950 to 2015.

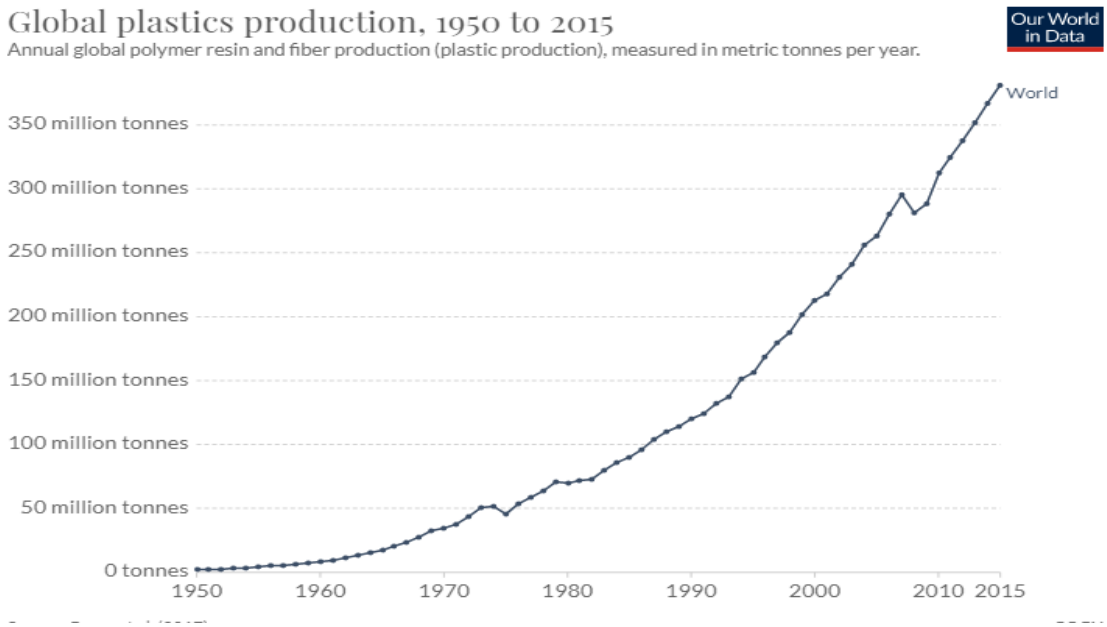

Figure 11: The figure of global plastic production from 1950-2015 [31]

From the figure above, the curve shows an exponential growth of the number of plastics produced per year. In 1950, there were no plastics produced since producing the plastics had not been developed. Between 1970 and 1980, the annual production of plastic was around 50 million tons per year. The production has been rising continuously to more than 100 million tons per year at around 1990. From the year 2000 onwards, the growth of amount of plastic produced grew to above 200 million tons per year. By the year 2015, the amount of plastic produced has surpassed 350 million tons of plastic products produced globally. The curve shows that the plastic materials will continue being produced exponentially.

When the data was analyzed from the chart, it showed that the total amount of plastic materials produced worldwide was around 7.8 billion tons. The figure shows that the number of plastics that has ever been produced is high and they get degraded after a very long time. All types of plastics that are produced are either recycled, discarded, or incinerated. The process of incineration and recycling is negligible, below 10% of the total plastics produced. The rest of the materials is left in the environment (discarded).

The process of dumping plastic wastes is changing over time from 1980 to 2015. Around 1980, all the plastic waste was discarded in the environment. There was no sensitization on proper methods of dumping plastic products. By the start of 1990, the methods of dumping plastic waste had changed, and recycling and incineration had started to be used. The image below shows methods of the processes of plastic waste disposal over the years.

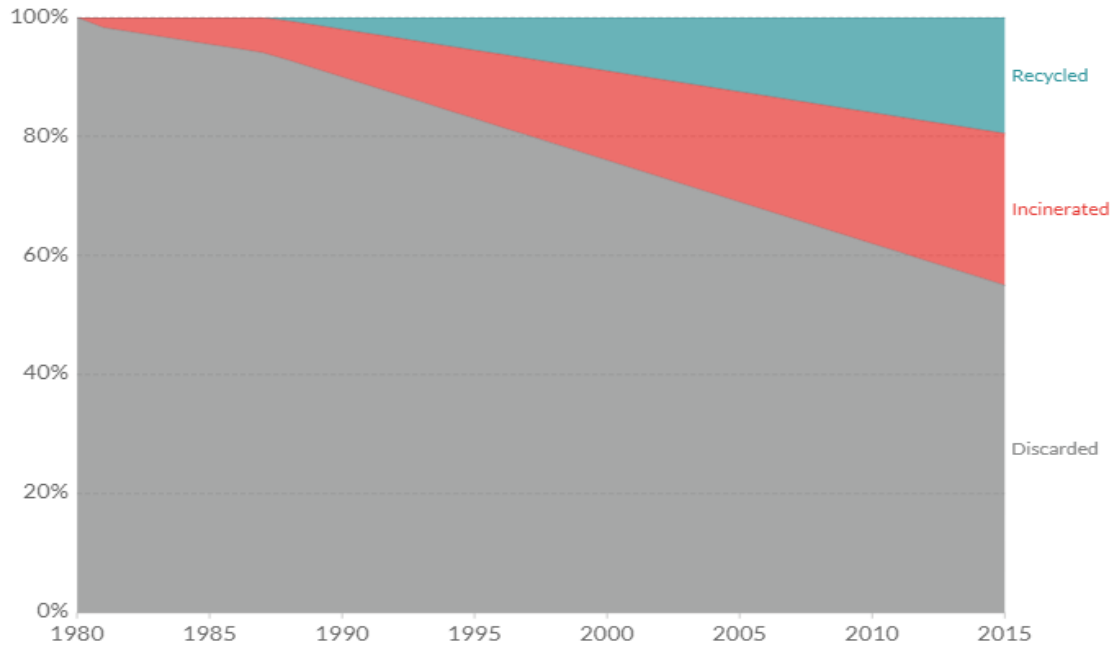

Figure 12: The plastic disposal methods from 1980-2015 [31]

It was estimated that by 2015, less than 60% of the global plastic waste would be discarded into the environment, 20% being recycled, while the remaining 25% be incinerated. Further estimates showed that the incineration process would grow to 50 percent,

the rate of recycling grew to 44% while discarding plastic to the environment would reduce to 6 percent. These were mere projections that were being made, but the figures are different when the data was analyzed around 2015.

The figure showed that by 2015, the total plastic produced from 1950-2015 amounted to 8300 million tons. The process of incineration had used 700 million tons of global plastic waste, which is 8 percent. 55 percent of the plastic produced was discarded or fall on the land, which was about 4600 million tons. In 2015, 2500 million tons of plastic produced were being used, accounting for 30 percent of total waste. The remaining 500 million tons of plastic produced went through the recycling process. Therefore, there is a very high number of waste materials that have been discarded into the environment.

The aesthetic is the first aspect affected by the indiscriminate disposal of plastic bags because it is so obvious. In developing countries where consumer awareness is low, used plastic bags can be found everywhere, for example, on the road, in the river, in the canals, even on the tree. Thus, plastic materials become omnipresent, polluting the environment. When the wind blows over the environment, the plastic bags are always carried by the wind since they are very light and disposed of in areas where they were not dumped. Plastic bags destroy the appearance of any areas where it exists, from urban to rural, from the forests to the oceans.

Most people tend to disregard these landscape influences because they think they are not so important. However, a few studies show that the natural landscape has huge benefits for humans. The natural environment offers medical benefits; it helps patients to feel relaxed and reduce stress. As a result, the recovery time is reduced [32]. Besides, the natural landscape also gives people other great benefits such as:

Table 2: Benefits of Urban Landscape [33]

Benefit	Author of study
• Reduce noise	
• Reduce crime rates	The U.S Forest Service
• Improve attention and memory	Marc Berman of the University of Michigan
• Improve the quality of life	Housley and Wolf

Not only that, but the natural landscape also brings countless advantages in other aspects. All these things mentioned above proved that living in an environment with a highly aesthetic natural landscape will enhance feelings of happiness; in other words, the quality of life will be improved. Unfortunately, the widespread appearance of single-use plastic bags is losing these benefits to humans. The environment has been degraded due to the plastic materials that get disposed of by the surrounding.

The landscape has lost its natural beauty due to the high number of plastics disposed of in the environment. According to the study conducted by Jacobsen, he illustrated that in each year, around 500 billion plastic bags are normally used and get disposed of to the environment. The number is too high, indicating that the number of plastics disposed to the environment could distort the surrounding. He pointed that every man in the universe, including children, ladies, and men, uses an average of 83 plastic bags annually.

These plastic bags end up getting disposed of on the soil, rivers, oceans, and seas, and even on the plants since recycling is difficult. When they get into the environment, they can even take more than 300 years to degrade. The study shows that in the United States, around 100 billion of the total plastic bags are produced. When plastic bags get degraded, they release very toxic compounds into the environment, contaminating the soil, water, and air. [34]

4.1.2 The harm of plastic bags to the water

When the plastics are disposed to the environment, running water from rainfall and sewage lines carries the bags to the rivers since they are very light [35]. Once in the river, they are eventually drained off to the lakes, ocean, and seas. Once they get disposed of in such water bodies, they pose a serious threat to the animals which live in water habitats. The sea, lakes, and oceans animals might be entangled by the plastic bags, which endangers their lives. Fish and other aquatic animals might confuse plastic bags with their foods, making them ingest the bags. Once they get into their digestive system, they block the digestive system, which threatens the life of an aquatic animal. When the materials block the digestive process, the animal might experience starvation, infection, choking, and later may lead to mortality. When the analysis was conducted, a large tortoise had been mistakenly swallowed in a plastic bag and seaweed, which caused it to die.

The presence of plastic bags in water bodies has become a huge problem since the plastic bags get brittle into small particles, which can be later be consumed by the human's freshwaters. The issue of plastic in clean waters poses a serious threat to human health. Therefore, the governments and scientists are trying to reduce plastic bags in the marine environment since the materials could lead to serious diseases such as cancer. [36]

Furthermore, the plastic bags disposed of in the oceans and seas have hindered economic development where they are moved along the ocean's shore. The plastic bags that get trapped on the coastline make the shore look littered and dirty, affecting tourism activities. When tourists find the area littered, they are discouraged and never turns back. Therefore, the reduction of tourist activities makes the government lose income which is generated by the industry. Also, the materials which are trapped along the shoreline have posed a serious threat to the shipping infrastructure, aquaculture, fishing, and energy production. The figure below shows plastic materials that are trapped on the shoreline of the sea.

Figure 13: An image showing a coastline that has been polluted with plastic materials [37]

The image above shows a coastline that has been polluted with plastic materials. The materials are first deposited in the sea, but later, the sea waves move the plastic bags on the shoreline. As a result, the shoreline looks dirty, which could be harmful. Anyone coming to the shoreline might need to take precautions since the dirt looks unpleasant. Therefore, the dirt on the shoreline has discouraged tourism, leading to loss of income in countries with shorelines invaded with plastic bags. [37]

Once the plastic bags are brittle into tiny particles and the last downgrade in the environment, the elements that make the plastics are trapped in food, water, and animals. Humans would then consume the materials from animals, plants, and water to contain carcinogenic materials. Inside the body, the materials interfere with reproduction, cause immune disorders, and develop problems for both wildlife and humans. Also, the materials get to the food chain; thus, affecting every organism which is involved.

Figure 14: Plastic bags littered along the beach [37]

The image above shows plastic waste that has been deposited along the beach. It contaminates the surrounding waters and blocks the sea entry, which discourages sea activities such as fishing and shipping and contaminates the water when the waste decomposes. [37]

4.1.3 The impact of plastic bags on the atmosphere

Whenever the plastic bags are discarded around the environment, some people see them littering the compound. Therefore, they collect plastic bags together and burn them in order to reduce their spread. Burning plastic bags (incineration) releases toxic gases such as furans, dioxins, polychlorinated biphenyls (BCPs), and mercury into the atmosphere. When these gases get into the atmosphere, they are a serious threat to the life of animals, humans, and vegetation.

Dioxins are a very poisonous gas released when plastic bags or materials are burnt down. It mixes with the air in the atmosphere, and when it rains, it is washed away by the raindrops and ends up settling on the surface of plant leaves. When people consume food

where the gas had settled, they consume the dioxin gas, which eventually settles in our bodies. Inside the body, the gas pollutes the cells and can lead to cancerous diseases and disrupt respiratory and thyroid systems. Therefore, the dioxin gas can lead to serious health conditions to the human and animals. Also, when the gas settles on plant leaves, it blocks gas carbon dioxide intake for photosynthesis, thus causing the plants to produce less production, which is an abnormality. The image below shows heavy concentrated smoke which leaves into the air when plastic materials are being burnt.

Figure 15: The image showing smoke rising into the sky when plastic bags were burnt [38]

The image above was taken in Dandora Area dumpsite in Nairobi, Kenya. It was taken before the Kenyan Government had not banned plastic bags in the country [38]. A cloud of dense smoke is seen from the image, which pollutes the air from the image. Also, when the plastic bags are burnt, they release choking gas, which is unpleasant. When the produced gas from the burning of plastic gets into the body, they increase the chance of getting heart diseases, respiratory conditions such as emphysema and asthma. The said

conditions make a person have the following symptoms: nausea, rashes, headaches, and general tiredness.

When the phthalates compound that is used to give plastic products their softness and flexibility gets into the body, it disrupts the endocrine system, leading to many health problems. The commons problems associated with the phthalates are that it inhibits a neonatal's growth, causes fertility issues, and increases the chances of developing asthma and allergies.

Burning plastic bags releases soot (black carbon) into the atmosphere due to incomplete combustion. The soot contributes to air pollution, which eventually causes climate change and global warming. In addition, the produced gas from plastic bags burning raises to the sky and affects the ozone layer. The ozone layer is responsible for regulating the number of ultraviolent radiations that reach the earth's surface. When more ultraviolent radiations reach the earth, the effect of global warming is experienced. Therefore, the earth experience increases drought, heat, and insect outbreaks due to global warming and climate change.

Climate change is associated with landslides, flooding, salinization, erosion, desertification, among others. These conditions are affected by atmospheric conditions change due to the amount of gas released into the atmosphere [39]. Therefore, there are increased temperatures, which makes more water evaporate from the soil. When the water vapor rises to the atmosphere, they cause a heavy downpour which results in floods. These pose a risk to animal survival due to intense and more frequent weather storms, rising sea levels, drought, warming oceans, and melting glaciers.

The national geographic has reported that the sea level is continuing to rise due to global warming. The earth's average temperatures increase, making the north pole and south poles ice sheets and glaciers melt, which eventually add water into the oceans and the seas. There is also an increasing amount of water that is leaving the land to the sea due to ground pumping [40]. The waters from lakes, aquifers, soil moisture, rivers are continuing

to move from the land to the sea due to human activities. The image below shows the Pedersen Glacier in Alaska.

Figure 16: on the left is the image of Pedersen Glacier in Alaska taken in 1917, while on the right is the Pedersen Glacier take in 2005 [41]

The above images show that the glacier melted water formed an iceberg of a marginal lake near the bay of the Pedersen Glacier. After one century, the glacier had melted, and the iceberg had become a grassland. The images show the increased rate of ice melting in the north and south poles affected by human activities.

There is a heavy process of melting glaciers due to the increased heat. The World Glacier Monitoring Service postulated that the Greenland Ice Sheet lost about 34 billion tons of ice between 1992 and 2001. The loss has rapidly increased to 247 billion tons per year for a period of 14 years between 2002 and 2016. In the Antarctic, ice loss increased four times from 51 billion tons per year from 1992-2001 to 199 billion tons per year from 2002-2016. The huge decrease in ice is attributed to the gases released by the incineration of plastic bags.

According to Lindsey, she had pointed out that the sea level is continuing to rise due to increased atmospheric heat. She postulated that the sea level had risen by about 8-9 inches from the year 1880. The rising sea level is caused by melting glaciers and ice. When satellite measures were analyzed, it was observed that the global mean sea level had risen by 3.4 inches in 2019, which is above the recorded measurement in 1993. She depicted that the global sea level had risen by 0.24 inches between 2018 and 2019. [41]

The graph below shows the increase in sea level from 1880 to 2020.

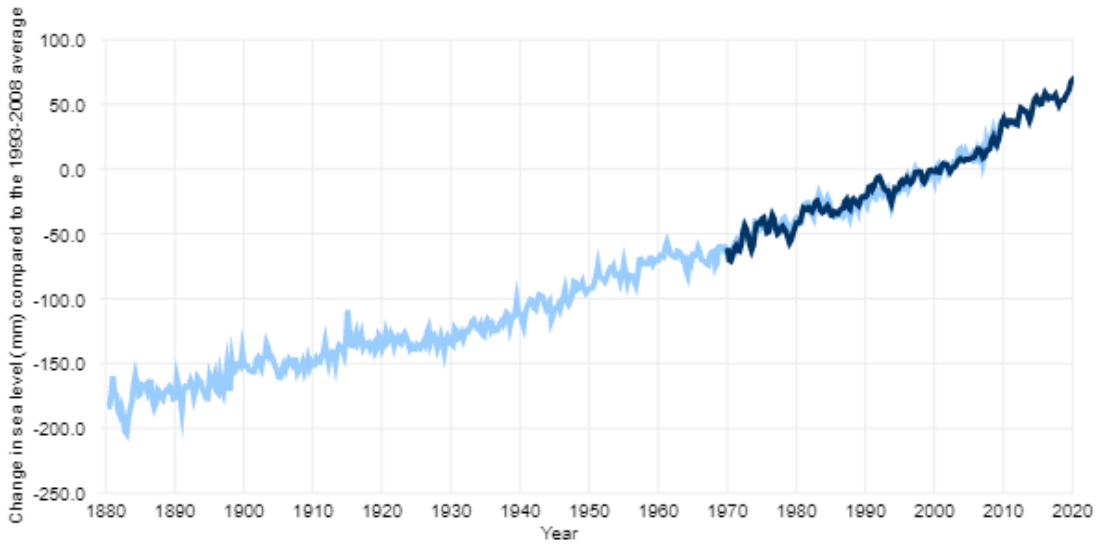

Figure 17: The graph of change in sea level against year [42]

The y-axis shows an increase in sea level while the x-axis shows the year. From 1880 to 1970, the increase in sea level is below zero, meaning that there was not much climate change. However, the rise of sea level from 1970 to 2020 is exponential since million tons of plastic bags are produced daily, and the incineration process is continuing. [42] From the graph above, the ocean rose with a rate of 0.06 inches from 2006 to 2015, which was more than 2.5 times the rate of ocean rises from 1880 to 1990. In the event that the 21st century ends, it is estimated that the oceans and seas would rise by 0.3 meters even if harmful gases would be stopped from being produced. In several oceans, the sea level had

risen by 6-8 inches from 1880. The variations in sea level rise are attributed to the direction of wind, strength, and ocean currents.

4.1.4 The impact of plastic bags on the animals

When plastic bags are dumped carelessly on the environment, cattle tend to swallow them since they taste salty. Once they are swallowed, they affect the cattle's health, where the animal may eventually die. The indiscriminate habit of feeding is accounted for by the body's lack of minerals, making the animal susceptible to different foreign materials. According to Ramaswamy & Sharma, they found that the ingestion of plastic bags accelerated several pathological problems. The plastic in the stomach became impacted, and tympany. The cattle showed some signs of bloating, which was observed from an abnormal bulging of the abdomen. During the study, 711 animals were operated on to observe whether they contained foreign materials in their stomach. The following table indicates the quantities of foreign materials that were found in the stomach of the animals. [43]

Table 3: Quantities of foreign materials that were found in the stomach of the animals [43]

Sl. No	Quantities of FB's recovered (Kg)	No of animals	%
1.	0.75 - 2.0	28	3.94
2.	2.0 - 5.0	116	16.31
3.	5.0 - 9.0	217	30.52
4.	> 9.0	350	49.23
Total		711	100

The materials that were found in the stomach included clothes, plastic bags, and leather pieces. The materials caused occlusion and ruminal obstruction in the stomach of the animal. The mass of foreign materials found in the animal's body ranged in sizes from 0.75 kg to more than 9 kg. The animals with the materials exhibited signs of depression, grunting, and arched back, accompanied by pain. The animals with a high amount of foreign materials had reduced milk yields by 75%, making the farmer incur high costs due to

fewer yields. In addition, some animals died due to bloating of the stomach, making the farmers suffer severe losses. Other losses were attributed to the amount of money spent treating the animal that had swallowed foreign material such as plastic bags.

4.2 The alternatives

There are other alternatives to plastic bags that can be used to pack foodstuffs and other items. Several countries in the world have put restrictions on plastic bags, such as China, Rwanda, and Kenya, among others. For example, the Rwandan government has put restrictions on the use of plastic materials for packaging by 2020. The restriction was put in place to stop using plastic materials apart from the plastic need to package the hospital drugs and vaccines—plastics like straws, water, soda bottles, plastic food packaging, and coffee stirrers.

Rwanda is one of the 34 countries that have set restrictions on plastics to use to make the environment clean and reduce pollution. In Rwanda, it is illegal to sell plastics bags, use, produce, or import. A person found using plastic bags faces imprisonment or a fine.

The Rwandan government advised its people to use alternatives packaging materials that are biodegradable. People have turned to non-woven bags in the market. Other packaging materials alternative to plastic include the packaging net, woven suit bags, box bottom-ngunia, and gift bags. Some are made up of khaki papers in their makings, and they are very beautiful. People in Rwanda are reusing the carrier bags that are produced. [44]

When the government banned plastic bags in Kenya, people turned to cultural baskets for carrying their products [45]. The following image shows ngunia used for holding products in Kenya.

Figure 18: A ngunia used for holding contents [45]

The image above shows a ngunia used for holding product and packaging contents in Kenya. It replaced the plastic bags which were being used to hold products.

The image below shows the packaging nets used for packaging products.

Figure 19: Packaging nets for holding contents [46]

The packaging bags are made up of biodegradable materials, which means they can decompose when left in the environment [46]. The materials cannot be blown by air like plastic bags, making them less pollutant in the environment. Also, the packaging bags are normally recycled, thus reduces the rate of disposal in the environment.

4.3 Users' awareness of the alternatives

To reduce the use of plastic bags and turn to new packaging materials in the market, governments should educate people on the harmful effects of plastic bags on the environment, marine life, plants, and animal health. The governments should also promote the use of reusable bags such as ngunia's to reduce plastic materials used. When people are sensitized, they would carry the reusable materials to their homes and start using them as the mean of packaging. [47]

The sellers at the local market should be forced to stop selling the people who buy goods and products without reusable carrier bags. When such rules are put in place, people will start carrying their shopping baskets and reusable bags whenever they go shopping. The idea of forcing people to use reusable bags would ensure that carrier bags promote food stores. Also, people who make cultural baskets such as 'kiondo' in Kenya would be promoted. [48]

To reduce the use of plastic bags in the environment, the government should sign petitions that discourage plastic bags. Putting such measures would ensure that people would no longer use plastic bags in the future. For example, in Rwanda, the government banned any importation, manufacture, or use of plastic materials in the country. In addition, the plastic bag manufacturing companies were banned from operating in Rwanda, thus ensuring that plastic bags no longer pollute the country.

Also, governments should let people look for alternatives to use after banning the use of plastic bags and materials. People should always be reminded to bring their reusable bags when shopping. The plastic bags used to wrap gifts should be banned from the market. Anyone thinking that he/she should be given bags for wrapping gifts should be encouraged to carry their own.

In order to eliminate the use of plastic bags, the states should put measures to stop the use of all plastic materials to make sure that people turn to another method of carrying their shopping and grocery products. Straws used to drink sodas should be banned, and the government informs their people to drink sodas from the bottle or use a metal straw. The balloons should also be banned if they would be used outdoors. They are known to have traveled long distances when the wind blows them, thus littering a very wide area. The balloons are made up of rubber and plastic, which makes them takes a lot of time to break down when in the environment.

In parties, the government should place strict measures to reduce the use of plastic cups and plates. All the paper plates and cups have a plastic lining on top, which is a pollutant to the environment. Furthermore, the government should encourage its people to be guided by the following values whenever they use plastic bags; reuse, reduce and recycle.

5 DISCUSSION

Plastic bags have been found that they are a pollutant to the environment. The advent of HDPE marked an important turning point in the manufacturing of plastic bags. HDPE has been the most common material for creating stylish plastic bags. Its invention marked the

new era of manufacturing plastic bags since it created very soft plastics. In 1965, a company in Sweden referred to as Celloplast first designed plastic bags, but the company did not market its products [4].

The people who introduced plastic bags aimed to save the world's environment from wood and other materials used to manufacture shopping bags. Their objective was let down by the people who started using plastic bags. They overused the plastic bags and handled them poorly. They did not recycle the plastic bags making their demand grow exponentially from 1980 onwards. It was discovered that by 1980, the total number of plastic bags which were ever manufactured was about 50 million tons. Since the world population was still increasing, the demand for plastic bags for holding contents increased. By the year 2000, the total number of plastic materials manufactured was around 200 million tons. The production of plastic bags continued, and by the year 2015, more than 350 plastic bags had been manufactured.

When plastic bags were produced and used, people mishandled them since they were discarded in the environment. Other people viewed them as pollutants in the environment and decided to incinerate them, while others recycled the plastic bags. When plastic bags have been discarded in the environment, they pollute the surroundings. Plastic bags end up being dumped in the soil, lakes, rivers, seas, and oceans. When they are left in the environment, plastic bags take a very long time to biodegrade. They can take even more than 300 thousand years to decompose [49]. Thus, plastic bags should be handled with a lot of care and never left in the environment. On the soil, the plastic inhibits plant growth since roots cannot be able to penetrate the plastic bags. Most of the plants grow weakly, and during the dry season, they wither due to a lack of water since the root cannot go down deeply. Therefore, the plant ends up wilting, making the plastic bag become extremely pollutant.

When the plastic bags get into the water bodies, the marine animals confuse them with their food and swallow them. In the stomach, they are not digested, making the marine animals' digestive system bloat and eventually dying. Therefore, marine life is threatened by the high number of papers found in the oceans and sea. Also, the plastic bags are

pushed to the shoreline by waves, where they pollute the beaches and shoreline. The plastic bags that get trapped on the coastline making the shore look littered and dirty, affecting tourism activities. When tourists find the area littered, they are discouraged and never turns back. Therefore, tourism activities reduce in the area. Due to the reduction of tourist activities, the government loses income which is generated by the industry. Also, the materials which are trapped along the shoreline have posed a serious threat to the shipping infrastructure, aquaculture, fishing, and energy production.

The process of incinerating plastic bags is harmful to the environment. When the plastic bags are burnt, they release choking gas, which is unpleasant. When the produced gas from the burning of plastic gets into the body, they increase the chance of getting heart diseases, respiratory conditions such as emphysema and asthma. The said conditions make a person have the following symptoms: nausea, rashes, headaches, and general tiredness. When the phthalates compound that is used to give plastic products their softness and flexibility gets into the body, it disrupts the endocrine system, leading to many health problems. The commons problems associated with the phthalates are that it inhibits a neonatal's growth, causes fertility issues, and increases the chances of developing asthma and allergies.

Burning plastic bags releases soot (black carbon) into the atmosphere due to incomplete combustion. The soot contributes to air pollution, which eventually causes climate change and global warming. In addition, the produced gas from plastic bags burning raises to the sky and affects the ozone layer. The ozone layer is responsible for regulating the number of ultraviolent radiations that reach the earth's surface. When more ultraviolent radiations reach the earth, the effect of global warming is experienced. Therefore, the earth experience increases drought, heat, and insect outbreaks due to global warming and climate change.

Climate change is associated with landslides, flooding, salinization, erosion, desertification, among others. These conditions are affected by atmospheric conditions change due to the amount of gas released into the atmosphere. Therefore, there are increased temperatures, which makes more water evaporate from the soil. When the water vapor rises to

the atmosphere, they cause a heavy downpour which results in floods. These pose a risk to animal survival due to intense and more frequent weather storms, rising sea levels, drought, warming oceans, and melting glaciers.

The national geographic has reported that the sea level is continuing to rise due to global warming. The earth's average temperatures increase, making the north pole and south poles ice sheets and glaciers melt, which eventually add water into the oceans and the seas. There is also an increasing amount of water that is leaving the land to the sea due to ground pumping. The waters from lakes, aquifers, soil moisture, rivers are continuing to move from the land to the sea due to human activities. Coastal waters have flooded the land of Kiribati in Oceania due to rising sea levels. Since plastic bags continue to be produced and incinerated (burned), they will continue producing harmful gas that will affect the ozone layer. Global warming and climate change will continue to affect the whole world. National Geographic has indicated that if the current human activities continue, sea level would continue to rise to cause greater harm to coastal people. [50] The temperature of the oceans would also rise to make the oceans unsuitable for marine life.

The rate of melting of the Antarctica ice sheets and Greenland Glaciers is devastating. The melted water ends up in the seas and oceans, thus increasing the amount of seawater. Therefore, the sea will move more inland, causing devastating destructions on aquifers, agriculture activities, flooding, and erosion. With typhoons and hurricanes, more rain will be experienced in the inland, which will cause flooding.

Moreover, disposing of plastic bags indiscriminately has been identified to be a threat to animal's health. Animals such as cattle pick the disposed of plastic bags and consume them when they lack proper minerals. Plastic bags have a salty taste which is good for the animals. When the cattle swallow these plastic bags, they settle in the stomach since they cannot be digested. After accumulating in the stomach of the cattle for a long time, the animal starts showing signs of general tiredness, and their stomach bulges up. Later, bloating would be observed, and the animals generate body weaknesses. The animals with the plastic bags exhibited signs of depression, grunting, and arched back, accompanied by pain. The animals with plastic bags in the stomach also reduce milk yields by 75%,

making the farmer incur high costs due to fewer yields. In addition, some animals end up dying due to bloating of the stomach, making the farmers suffer severe losses. Other losses to the farmer are attributed to the amount of money spent treating the animal that had swallowed plastic bags. [43]

6 CONCLUSION

The research of this thesis aimed to point out the harmful effects of plastic bags on the environment and list a few optimal replacements which were being used the most popular in the current market. It was found that plastic bags are extremely pollutant when they are left in the environment. First, they are produced in large numbers every day, which makes them readily available. Once they are used, people discard the plastic bags anyhow on the environment, making them get into the soil, water bodies such as seas, oceans, rivers, and lakes.

When they are in the soil, they inhibit plant growth since roots cannot penetrate the plastic bags. The plants get a very small area for getting water, and when the dry season comes, they with and dries up. When plastic bags get on the land and in the waters, the animals confuse them with their foods and end up swallowing, which later blocks the animal's stomach. The animal may eventually die due to bloating, which later occurs.

The process of incinerating plastic bags produces very toxic gas, which interferes with the ozone layer. As a result, more ultraviolet radiations from the sun reach the earth's surface causing global warming and climate change. Global warming has caused the earth's temperature to increase, which has led to the melting of ice in the southern and northern hemispheres. The melted water ends up in the sea and oceans, which has been attributed to the rise of sea level. Therefore, due to the harmful effects of plastic bags on the environment, several measures are put in place to reduce the harm.

People have been advised to use biodegradable materials when wrapping up the products and when shopping. These materials include khaki papers, woven baskets, woven nets, and traditional baskets like 'kiondo' and ngunia. In Rwanda, Kenya, and China, rules have

been set up to ban the use of plastic bags. As a result, people have turned to biodegradable carrier bags, which do not affect the environment. The carrier bags that are used are very presentable, and recycling is key. For the states where no measures have been put to regulate the use of plastic bags, the government should encourage and promote industries that recycle plastic bags to reduce the harm.

Reducing plastic bags would make the world regain its natural beauty, be less contaminated, and be attractive. People, animals, and plants would get good health since they would live in a great environment. Rivers, land, oceans, and the sea would regain their natural status and be good for animal life. The governments should place strict measures to reduce the use of plastic bags and plastic materials. All the paper plates and cups have a plastic lining on top, which is a pollutant to the environment. Furthermore, the government should encourage its people to be guided by the following values whenever they use plastic bags; reuse, reduce and recycle.

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