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Climate Change: The Role of Engineers

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1. Introduction

Climate change is a long-term change in the average weather patterns that have come to define earth's local, regional and global climate. There are two causes of climate change: natural processes and human activities. Natural processes that contribute to climate change are: volcanic eruptions, ocean currents, the earth's orbital changes, solar variation and internal variability. Human activities have been estimated to have contributed 95% to the global warming the world is currently facing. This is by releasing harmful emissions of carbon dioxide and other greenhouse gases into the air. Human activities that produce greenhouse gases include: burning fossil fuels, deforestation and agriculture.

Climate Change has led to an increase in devastating climatic disasters. Some of the disasters include more frequent and intense drought, storms, heat waves, rising sea levels, melting glacier and warming oceans. These disasters have a direct negative impact on the environment, death of people and loss of biodiversity

Engineers can contribute towards the fight against climate change by helping reduce carbon dioxide (CO_2) emissions. This can be done by identifying major emission sources and coming up with policies, strategies and measures to help combat the issue. Engineers are involved in offering solutions to minimise climate change in the energy sector, agriculture, waste management, redesigning cities and inventions and innovations to assist people in adapting to climate change

DEAR READER

Welcome to KeSEBAE Newsletter

A fortnightly Newsletter touching on topical issues affecting our environment.

KeSEBAE NEWS is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE).

WHAT'S INSIDE

2. Energy Sector

Fossil fuel supply 84% percent of the world's energy. The fossil fuels are a form of non-renewable energy and include coal, oil and natural gas. They provide energy for electricity, industries, transport and other energy requiring sectors of the economy.

Increase in the economic development leads to the increase in the demand for energy. This results in more greenhouse gas emission from the fossil fuels combustion. Engineers have therefore provided solutions that try to meet the energy demand, while protecting the environment. They have proposed possible solutions in the transport sector, manufacturing sector and provided alternative sources of renewable energy that are clean, sustainable and environmentally friendly.

3. Transport Sector

The transport sector is vastly dependent on the combustion of fossil fuel as the primary source of energy. Transport represents 23% of global energy-related CO_2 and other greenhouse gases. Reducing transportation's dependence on petroleum is a step further in the fight against climate change. Combustion of petroleum fuels lead to emissions of particulate matter such as sulphur dioxide; which forms sulphate aerosols forming acid rain. Engineers have found alternative fuel sources for powering vehicles. The alternative ways of powering vehicles currently in practical use are: Electricity (Using lithium-ion batteries), Hydrogen, Biodiesel, Ethanol, Natural gas and Propane

The challenge of alternative energy sources used in transport are: high capital costs, slow response to the new energy technology and minimal awareness on how the new technology works.

3.1. Case example: Tesla cars

Tesla cars are electric vehicles created by Tesla Inc. a clean energy company based in Palo Alto, California. They are powered by batteries comprising of thousands of lithium-ion cells. The cars are equipped with a heating system that warms the battery in cool temperatures. Tesla cars run solely on battery power hence have to be charged. The energy is generated and stored in the battery and then used to drive a small motor that powers the vehicle. The major advantage of the batteries of the car can be charged using renewable energy such as solar, making it more environmentally friendly.[1]

Figure 3.1: *Tesla Lithium batteries.* ***Source****: Tesla*

Figure 3.2*: Electric car charging* ***Source****: Bloomberg*

3.2. Shift Modes of Transport

In an attempt to reduce fossil fuel dependence, this can be applied by inducing people to substitute some of their driving with public transportation services such as bicycles and walking. Transporting goods contributes heavily to

[1] My energy Ltd, 2021. How does a Tesla battery work https://myenergi.com/guides/how-does-a-tesla-battery-work/

pollution; to minimize these effects, transport of resources and manufactured goods efficiently should be via pipeline, rivers, railways, roads, ships and airplanes using technologies e.g., electric train that exert minimal impacts on the surrounding land use while serving the needs of consumers with little waste

4. Manufacturing sector

The high heat needed to process industrial materials — such as concrete, iron, steel, and petrochemicals — is responsible for about 10% of global CO_2 emissions, according to a report from the Centre on Global Energy Policy.

The manufacturing sector can lower the carbon emissions. This can be achieved by: eco-design engineering, material substitution, remanufacturing plans, additive manufacturing and reducing yield losses.

Eco-design engineering involves manufacturers minimising the environmental impact of a product across its entire lifecycle, from material extraction to end of life. Design engineers follow this principle by considering factors such as the amount of energy and materials consumed in production and how the product and its by-product may affect biodiversity. Design engineers thereby come up with solutions that avail alternative processes, systems or materials to minimise the impact.

Rusal developed its own ALLOW range of low-carbon aluminium alloys. This replaces the aluminium which emits 11.5 tons of CO_2 per ton of aluminium during smelting.

Material substitution involves switching to a lower carbon version of the same material or finding alternative materials for convectional designs. For example, the bamboo toothbrush that substitutes plastic.

Manufacturers use materials such as steel in ***remanufacturing***, thereby reducing carbon emissions in the production chain. It involves reclamation of used durable material. This is common in the automotive industry where mechanical parts such as engines and transmissions are often manufactured.

Unlike traditional manufacturing techniques such as moulding and foaming which are subtractive, in ***additive manufacturing*** no waste is incurred. All the material required is used. This reduces waste and energy used in production.

The concept of overall equipment effectiveness (OEE) experiences six big losses which are: equipment failure, planned stops, idling, reduced speed, production defects and ***reduced yields***. Each of these losses impact of the energy amount used and the carbon footprint. Manufacturers can consider implementing data driven strategies, to introducing automation to production lines in turn reducing losses.

5. Promoting Renewable Energy

Global energy demand increases as per economic development and improvement of standard of living. Engineers should facilitate the holistic system for promoting sustainable energy use by policy and programs.

Sustainable energy is the form of energy that meets today's demand without putting them in danger of getting expired or depleted. Engineers can contribute towards sustainable development through advancing forms of sustainable energy.

Figure 5.1*: Renewable energy* ***Source****; Istock*

All renewable energy sources like wind, solar, geothermal, hydropower and ocean energy are sustainable as they are stable and available in plenty. Sustainable energy does not include any source derived from fossil fuels or waste products. Renewable energy reduces dependence on fossil fuels, as fossil fuels in many countries are imported.

5.1. Futuristic Solar Panels

Solar panels are traditionally installed on rooftops or in large fields to gather sunlight without obstruction. Recently developed solar panels in China harvest energy from raindrops, solar panel roads are being tested out, and a team of researchers at Michigan State University believe that all windows and cell phone screen can be used as solar panels.

6. Stratospheric aerosol injection

The past four years have been the hottest ever recorded, a recent report by US government agencies and predicted that temperatures could rise by about as much as 4.8 degrees Celsius by the end of the century. If current trends continue, it would cause catastrophic environmental changes. Researchers at Harvard are proposing to send sun-blocking particles (same particles released by cars and factories) to form an artificial cloud.

This artificial cloud could be a sulfuric acid cloud in the upper atmosphere that's similar to what volcanic eruptions produce. They could be formed after spraying sulphur dioxide. The artificial clouds reflect away sunlight thereby cooling the earth.

Intentional strategy to block the sun, could help to buy some more time for countries to reduce their emissions. This is maybe the most reasonable way to avert climate change.

Figure 6.1*: Stratospheric aerosol injection* ***Source:*** *Spice SRM.*

7. Carbon Capture

Scientists say that we will not meet targets to limit global warming to 1.5 degrees Celsius without removing some of the CO_2 already emitted from the earth's atmosphere. The **Intergovernmental Panel on Climate Change (IPCC)** projects between 100 billion and 1 trillion tons of CO_2 would need to be removed this century.

Carbon capture and storage (CCS) technology is capable of capturing up to 90% of the CO_2 emissions produced by the burning of fossil fuels for power generation and used in industrial processes. CCS captures CO_2before it is released and stores it underground, in rock formations, or beneath the seabed.

The initial part of the process involves separation of CO_2 from the gases emitted during power generation and industrial processes such as manufacturing cement or steel. This is done by pre-combustion capture, post-combustion capture or oxy-fuel combustion.

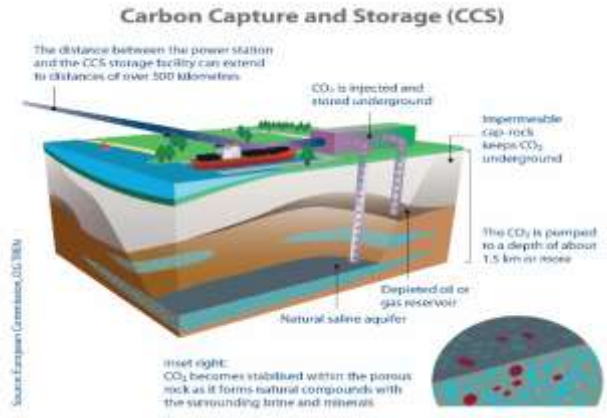

Figure 7.1: *Carbon Capture and Storage (CCS)*

Negative emission technologies (NETs)

Unlike carbon-capture methods that reduce emissions from power plants and industrial facilities, NETs remove carbon dioxide in the atmosphere and sequester it in the ground or other forms of long-term storage. Examples of NETs include reacting CO_2 with various minerals, cultivating forest and croplands that take up carbon dioxide, and practices to enhance carbon storage in coastal and marine ecosystems.

8. Redesigning cities

In most cities, natural vegetation has been cleared to make room for the construction of tall buildings. The tall buildings

block out the free flow of air throughout the cities due to congestion. This has to increased temperatures in the cities and the rise in the need for air conditioning systems.

The construction materials in buildings used such as asphalt and concrete absorb and reemit more heat. The heat-absorbing materials can make the cities hotter than their surroundings; an effect called the "heat-island effect".

In order to solve this problem, engineers help in redesigning cities by increasing green spaces and adaptation measures to climate change.

Green spaces can be by planting trees on rooftops, interspacing green spaces and parks and planting trees on sidewalks. These vegetation help absorb CO_2 emitted. A single tree can absorb up to 26 pounds of CO_2 in a single year.

Figure 8.1: *Sustainable green building* ***Source:*** *PlanRadar*

Trees can help fight against the heat-island effect by providing shade and cooling through the water vapour released from their leaf surface through evaporation.

In China, Sponge Cities Project is piloting eco-engineering solutions to absorb and reuse rainwater in over 30 metropolises to reduce risk of flooding. This is by planting trees or vegetation around buildings. The roots of the plant act as sponges to recharge groundwater during heavy rains.

9. Adaptation to climate change

Adaptative mitigations are a good strategy towards the fight of climate change. Climate change causes distortions in the weather and climate pattern. It stimulates increase in the number of climatic disasters. This is a predicament that we may have to cope with. The fight is to slow down the rate at which the earth's climate changes with the hope of reducing its effects. Engineers can therefore assist by providing strategies such as:

9.1 Helping communities adapt

The most basic method engineers implement is making buildings climate resilient. The most frequently experienced disasters due to climate change are catastrophic fires, floods, cyclones and hurricanes.

Structural designs can help reduce heat inside buildings. In Vietnam, traditional housing designs are constructed with optimum orientation, high rise rooms and large openings.

Figure 9.1*: Resettllement village, Nakai Plateau, Khammoune Province, Lao.* ***Source****: World Bank*

Rainwater harvesting and recharge systems that capture water and store it in tanks help in times of drought. This is also important reducing flood risks due to heavy rains.

Due to the rise in coastal flooding and sea level, coastal communities are likely to be severely affected in case of flooding. Building flood resistant houses is key to this challenge. In Kerala, India, flood-resistant houses are constructed on pillars to allow floodwater to flow underneath.

Figure 9.2*: Proposal for the Shelter of Kindness a buoyant multipurpose building in Bangladesh.* ***Source****: Giant Gras*

In Malaysia, buildings are elevated 2 metres above the ground allowing waterflow and wetland vegetation to grow underneath. Public areas are also connected through elevated passages.

The most visible and felt effect of cyclones and storms is that they blow off roofs and damage structures. To mitigate this, communities can build round-shaped houses

Figure 9.3*: Typhoon-proof dome houses in the Philipines* ***Source:*** *rappler.com*

9.2 Construction of dykes in coastal areas

A sea dyke is a manmade structure designed to protect low-lying coastal areas from flooding from the sea and ocean. They are designed with several components including a sand core. A watertight outer protective layer, toe protection and a drainage channel. Sea dykes are made to withstand and resist water and wave action. Majorly used in countries such as Vietnam, Bangladesh, Thailand, the Netherlands and parts of the United States. They provide a high degree of protection against flooding.

Smart dykes are dikes equipped with sensors that give continuous feedback on the actual state of the dike.

9.3 Storm detecting sensors

Sensors are a highly efficient detection technology heavily applied in our generation. In the event of a storm or high-water event, water can compromise bridges and other transportation infrastructure

Figure 9.4: *Storm-tide sensor installed on a bridge* ***Source:*** *USGS*

Roads and bridges fitted with sensors enable engineering teams to inspect before declaring safe to use sensors tell officials which bridges need to be inspected so we can focus inspectors and get roads opened more quickly. This improves road safety and reduces the risk of accidents due to weaken or cracked roads from the storms.

10. Agriculture

10.1 Sustainable intensification

Intensification means producing more with less. It is the result of using input more efficiently or adding new inputs that minimise limiting factors of production.

Conventional intensification practices are based on changes or increase in the use of direct inputs such as improved varieties/breeds, agrochemicals, water and mechanization. Additionally, a variety of agronomic practices available, aim at optimized density, rotations and precision of farming methods.

Intensification typically reduces the emissions intensity of agriculture. Agricultural output can be increased either by expansion or by intensification.

Unlike expansion, intensification does not cause conversion of land with high carbon stocks such as forests, thereby lowering agricultural carbon emission.

10.2 Sequestering carbon in agricultural systems

Soils hold an enormous amount of carbon and acts as a carbon sink. Sequestering carbon is a process whereby carbon is left stored or injected into the soils. In agriculture, the carbon stocks can be built through three major practices which are:

- ***Management of carbon in cropping systems*** **–** The two main ways of increasing carbon stocks in cropland soils are protecting existing carbon in the system and increasing the amount of carbon in the system. The existing carbon in the system can be protected by putting organic matter in the soil and reducing erosion through practices such as terracing, contour strips and planting cover crops. The organic matter slowly decomposes releasing carbon back into the soil.
- ***Agroforestry*** **–** This is an intensive land management that combines above ground biomass e.g., trees and shrubs with crop/livestock production.
- ***Improve carbon storage in grazing land*** **- C**arbon stores in grazing land can be protected and increased through a measure that promote productivity of grasses. It can be achieved by improving pasture management practices such as rotational livestock grazing, introducing grass species of higher quality, application of biochar and compost among many others.

11. Waste management

Waste management impacts climate change through landfill methane emissions, energy wasted in industries during production and energy used in transportation of waste.

Environmental engineers have come up with methods of waste management, such as resource recovery and efficient waste treatment.

11.1 Recovering and Reusing Resources

Resource recovery is the process of recovering materials or energy from solid waste for reuse. The objective of this is to make the best use of the economic, environmental and social costs of the material before being permanently laid to rest in a landfill. This results in reduction of industrial energy use and emissions because of recycling and re-use of products.

Figure 11*: Resource Recovery cycle.* ***Source****: Vans Chemistry*

11.2 Efficient Waste Management

Designing systems for effective municipal waste management. For example, introduction of biological, physical and chemical treatment of solid municipal waste.

A team of researchers in Japan inadvertently developed an enzyme that can break down plastic in a matter of days — far faster than the hundreds of years that plastic usually takes to decompose

11.3 Restoring the Natural Ecosystem

Engineers can achieve this through; treating and restoring old industrial waste sites, reclaiming old mine properties, treating polluted ground water, lakes and streams, renewing aging urban areas in large cities, reclaiming and restoring eroded or damaged farmlands

12. The Big Controversy

In the 21st century, 2020 is recorded to be the warmest year having tied with 2016, according to the data provided by National Aeronautics and Space Administration (NASA). In 2020, the average global temperatures were 14.9 degrees Celsius about 1.2 degrees Celsius above the 1850-1900 preindustrial levels.

Throughout the history of the earth, there have been several abrupt climate changes which had negative effects such as loss of biodiversity, extreme temperature conditions, low or high, glacial recession and severe mass extinction.

An abrupt climate change is defined as a transition of the climate system into a different mode on a time scale faster than the responsible forcing. Younger Dryas event took place about 12,900 to 11,600 years ago, is an example of an abrupt climate change. It occurred during the last deglaciation, a period of global warming when the earth system was in transition from a glacial mode to an interglacial mode. It was characterized by a sharp drop in temperature in the northern Atlantic region of estimated 4 to 8 degrees Celsius. This resulted in cooling of northern Europe and North America.

At the end of the Younger Dryas, as measured by ice cores, imply a sudden warming of +10 degree within a time scale of a few years. Another abrupt change is the +4 degrees on Greenland 11,270 years ago and the + 6 degrees warming 22000 years ago on the Antarctica.

From the above given data, we perceive that global warming has not been a strange occurrence in the earth's surface. The earth has gone through time periods of alternative warming and cooling.

12.1 Milankovitch Cycle

A Milankovitch cycle is a cyclical movement related to the earth's orbit around the sun. the three cycles are, eccentricity, axial tilt and precession. These three cycles combine to affect the amount of solar heat that's incident on the earth's surface and hereafter, influences climatic patterns.

Eccentricity is the measure of the shape's deviation (of the path of the earth around the sun) from being a circle. The path of the earth's orbit around the sun is not a perfect circle but an ellipse. The elliptical shape changes from less elliptical to more elliptical and back.

The earth spines around its own axis, tilting at an angle between 22.1 degrees and 24.5 degrees and back. A complete cycle for the axial tilt lasts about 41,000years.

Greater tilts mean that the hemispheres closer to the sun such as during summer, will experience a larger amount of heat than when the tilt is less[2].

Precession is described as the tilt axis also wobbles like a top caused by tidal forces from the Sun and Moon. A complete cycle is more or less 26000years.

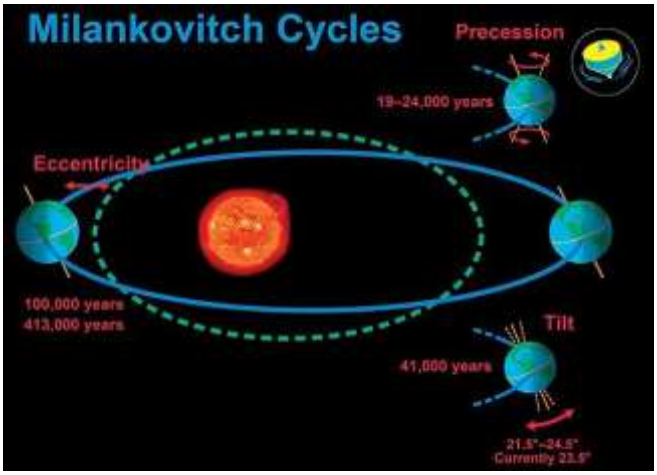

Figure 12.1: *Milankovitch cycle showing eccentricity, precision and axial tilt.* ***Source:*** *Universe today*

The Milankovitch Cycles show that the earth global average temperatures move up and down between glacial and inter-glacial phases of ice ages, which makes temperatures to go up and down between 16 degrees Celsius and 6 degrees Celsius over the past 400, 000 years.

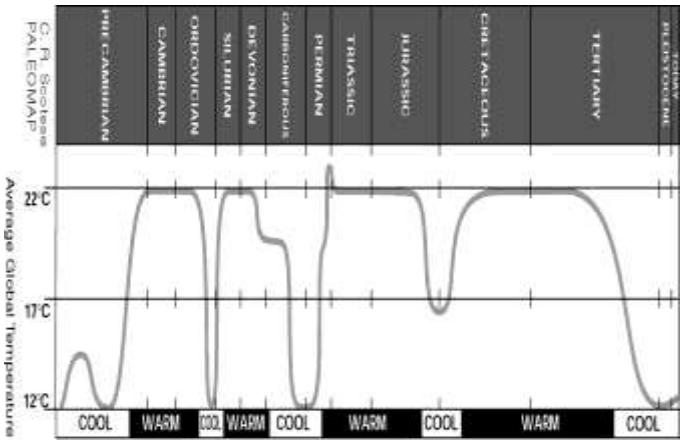

Figure 12.2: *Milankovitch cycle showing variations in temperature of different ages.* ***Source****: Universe today*

[2]Alan Buis, 2020. Milankovitch (Orbital) Cycles and Their Role in Earth's Climate. https://climate.nasa.gov/news/2948/milankovitch-orbital-cycles-and-their-role-in-earths-climate/

This argument is held in high value by detractors of the Global Warming concept, who claim that the earth's current warming is just part of a series of cyclical events that take thousands of years to complete and hence cannot be prevented.

12.2 Why are Human Activities as a Great Contributor to Global Warming a Main Concern?

The natural maximum average global temperature of between 15 and 16 degrees Celsius was reached in the most recent Milankovitch cycle, some 7000 years ago. This implies that, from the recorded average global temperature in 1966 of 14 degrees Celsius, the temperature of the earth should have gone lower. Quite the contrary is depicted, as the earth's average temperature continue to rise continually. The rise in temperature, in itself is not of great concern. But the fact that the rise is experienced in a very short period of time. The accelerated global warming is catapulted by the harmful emissions of greenhouse gases from human activities

In the previous, abrupt climate changes, it took long periods of time for the temperatures to escalate as shown the figure. From the predictions being given by IPCC and other bodies, an abrupt climate change on the earth may occur, purportedly due to human activities.

12.3 What is the IPCC?

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

It was created to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options.

12.4 Criticisms on IPCC Assessment Report

The IPCC suggested that climate change in the last decade was caused by increased human activities that caused the latest disasters experienced globally. While that in itself is not wrong, the fact that it used extreme weather conditions to model and come up with this conclusion was not warranted. Climatic disasters such as flooding, droughts, extreme temperatures, heat waves may have been seen but from the earth's history, they have existed since time immemorial. As a matter of fact, People on earth have never been safer from climate disasters than they currently are. The risk of death by climate-related disasters has fallen by more than half now within the last 100 years. Floods, storms, droughts, wildfires and extreme temperatures are still present as always been. But have become far less deadly and disruptive than they would. This is due to the scientific inventions and innovations that have been put to use that buffer the adverse effects.

The IPCC may have blatantly exaggerated the current climatic situation of the world. Judging on statistics from the past, the earth's climate has always experienced variations in its climatic conditions. Ups and downs in temperature, rainfall intensity etc. the fact astutely remains that emissions from human activities could be a contribution to such, but it is also senseless to bestow the entire blame on human activities.

A good example is the heat waves experienced in the UK in 2020. It was suggested that due to climate change, the UK would experience disruptive climatic changes such as heat waves. The 2020 heatwaves claimed the old and infirm who were already near the end of their lives 2,244 were over the age of 65 while 1,173 were more than 85 years old. This by far cannot be compared to the heat waves of the past, such as the 1911 July-September heatwave in Britain that killed thousands[3]

[3] Ben Pile, 2021. Is the climate really getting more disruptive? https://www.spiked-online.com/2021/08/03/is-the-climate-really-getting-more-disruptive/

12.5 Errors of The IPCC Data Analysis

The IPCC has a history of errors and making unfounded claim. The 2007 fourth assessment report stated that Netherlands is prone to both river flooding and rise in sea levels because 55 per cent of its territory is below sea level. The actual fact is that only 26 per cent of the Netherlands is below sea level. There was an unproved allegation in the 2007 report that global warming could cut north African crop production by up to 50 per cent by 2020. It also stated that in just 13 years rain-fed crop production was about to drop by half. The IPCC in 2010, withdrew this claim since there was no proof.

The most famous erroneous claim was that Glaciers in the Himalaya are receding faster than in any other part of the world. The 2007 report also said that, there was a likelihood of them disappearing by the year 2035 or sooner as the earth's global warming increases. Its total area was said to likely shrink from the present 500,000 square kilometres to 100,000 square kilometres by the year 2035.Three years later, The IPCC admitted that the claim was an unconfounded claim. Its source was not research, peer-reviewed or otherwise but rather an obscure media interview with a scientist from 1999.

About 10 years ago, ahead of the *Fifth Assessment Report*, researchers came up with four scenarios statistically modelled to show how carbon emissions might alter during the 21st century. One of these scenarios was identified as the business-as-usual scenario, and that predicted a catastrophic five-degree Celsius rise in global temperatures by 2100.

The problem was that this was a worst-case scenario that the researchers themselves estimated had only a three per cent chance of happening.

Since the IPCC assessment reports are written by scientists and researchers who are human, nothing in it is infallible. Mistakes and errors are to be expected. Therefore, every scientist has a right to question the variability of the assessment on reports given and come up with a conclusion that is scientifically justifiable.

12.6 What Breakthrough National Centre for Climate Restoration said about climate change

Another institution, called the Breakthrough National Centre for Climate Restoration in Australia, argues that the IPCC gave an optimistic model of climate change and understated the harm it will do.

Breakthrough institute suggested that severely adverse changes due to climate change are to be expected. That the earth will be largely inhabitable and the world may come to the end of human civilisation. This will result in widespread droughts and famines, the earth heating up to temperatures leading to 20 days a year of lethal heat, reduction in crop yields by a fifth, sea levels rising by 0.5 metres and the earth becoming uninhabitable for humans. This may lead to extinction of mankind off the earth surface. The breakthrough report displays a pessimistic model.

The Breakthrough institute has a clear history as always writing contrary information that criticizes environmental groups. This poses a huge challenge, since such sources cause people to question the credibility of environmental groups. While yet, maybe main intention is politicising such information for their own gain.

12.7 The Role of Social Media

Several articles and papers written online suggesting the end of the world by 2050. It is merely a speculation and conclusion of one own's thoughts. This is a likely projection instead of an exploration of facts.

12.8 Conclusion

Global warming and climate change is not entirely dependent on human activities. There are other factors such as natural processes that should be taken into account too.

The IPCC is an environmental group that puts its best foot forward to ensure global participation in the fight against climate change. This does not reserve the fact that we are open to scrutinize the reports they give and not accept anything as it comes. As the old scientific motto by the Royal Society "*Nullius in verba*" meaning, take nobody's word for it.

Human activities may be simply accelerating the process of climate change that could have happened anyway. The global effort is therefore to slow down the rate of climate change, in hope to reduce climatic disasters and protect the environment.

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Account No: **Your Full Name**

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SEBAE EXECUTIVE COMMITTEE

On 13 July 2021, KeSEBAE Executive Committee held a virtual meeting. The meeting discussed:

- KeSEBAE 2021 Annual Conference
- KeSEBAE Membership Recruitment
- KeSEBAE ongoing projects.

The next executive committee meeting is scheduled for 17 August 2021.

KeSEBAE 2021 CONFERENCE

KeSEBAE Annual Conference is scheduled for 24-26 November 2021.

ATTENDANCE: Mixed mode attendance: both virtual and in-person

Submit abstract for conference to *info@kesebae.or.ke*

Important Links		
KeSEBAE	:	https://www.kesebae.or.ke/
JEAE	:	https://www.kesebae.or.ke/journal/
EBK	:	https://ebk.or.ke/
IEK	:	https://www.iekenya.org/
PASAE	:	http://www.pasae.org.za/

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KeSEBAE NEWS EDITORIAL

The **KeSEBAE NEWS** is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers

Submit your articles to:

Contact: **Ezekiel Oranga**

Email: info@kesebae.or.ke

The **Kenya Society of Environmental, Biological and Agricultural Engineers**

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