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NAVIGATING CLIMATE CHANGE: EFFECTS AND SOLUTIONS

S.RAMASWAMY [1], V.KAVERI [2], SRUTHI MOHAN [3], R.KAVITHA [4]

[1] Advisor-cum-Adjunct Professor (Economics),[2] Research Scholar, [3] Chief Administrative Officer, [4] Associate Professor
[1 & 3] GTN Arts College (Autonomous), Dindigul, Tamil Nadu, INDIA
[2] Department of Economics, School of Management Studies, The Gandhigram Rural Institute (DU), Gandhigram, Tamil Nadu, INDIA.
[4] Department of Economics, Sri Sevugan Annamalai College, Devakottai, Sivagangai District, Tamil Nadu, INDIA.

Abstract

Climate change impacts our environment, natural resources, and way of life in various ways. For instance, higher temperatures lead to more frequent, intense, and prolonged heat waves, posing health risks, especially to vulnerable groups like young children and the elderly. It also worsens air and water quality, spreads diseases, and alters the occurrence of extreme weather events. Rising sea levels endanger coastal communities and ecosystems. Changes in rainfall patterns and stream flow affect water supplies, quality, and hydroelectricity production. Ecosystem shifts alter the geographic ranges and lifecycle events of plant and animal species. Furthermore, increased frequency and intensity of extreme weather events like heat waves, droughts, and floods result in property damage, societal disruptions, and insurance unavailability and affordability issues.

Keywords: Climate crisis, Sustainable solutions

I. Introduction

Climate is the average daily weather for an extended period at a certain location. Weather can change from minute to minute, hour to hour, day to day, season to season. Climate is the average of weather over time and space. Climate has spatial and temporal components. It consists of many kinds of weather events, their periodicities and the nature of dynamism. In other words, a general prevailing weather condition of a region i.e. temperature, air pressure, humidity, sunshine, cloudiness, winds, etc., through the year, averaged over a series of years. Climate change is a term that refers to major changes in temperature, rainfall, snow or wind patterns lasting for decades or longer. Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period (i.e.) decades to millions of years. Climate change may refer to a change in average weather conditions. In other words, A gradual change in the weather conditions over a period, short or long time. This is majorly due to changes in natural habitats caused by manmade or natural reasons. Climate change is a multifaceted global issue with scientific, economic, social, political, and ethical dimensions, and its effects will persist for millennia. It will raise global temperatures, alter rainfall patterns, and lead to more frequent and severe floods and droughts, affecting all nations. Developing countries are particularly vulnerable, as climate change exacerbates challenges like population growth, poverty, and rapid urbanization. Without significant adaptation efforts, millions could be pushed deeper into poverty, hindering sustainable development opportunities. Urgent adaptation measures are needed, with estimated costs reaching billions of dollars annually. Increased efforts by developed countries to reduce emissions could encourage participation in mitigation efforts by developing nations.

II. Key Definitions for Climate Change

According to **NASA (National Aeronautics and Space Administration)** Climate change refers to significant, long-term changes in the Earth's climate patterns, including temperature, precipitation, and other atmospheric conditions, resulting from human activities such as burning fossil fuels and deforestation, as well as natural factors. In the words of **IPCC (Intergovernmental Panel on Climate Change)** Climate change is defined as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer, arising from natural processes and human activities. In the opinion of **UNFCCC (United Nations Framework Convention on Climate Change)** Climate change refers to a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable periods. According to the **World Meteorological Organization (WMO),** Climate change encompasses variations in temperature, precipitation, humidity, atmospheric pressure, and other atmospheric conditions occurring over time scales ranging from decades to millions of years. These changes can be natural or human-induced and can have significant impacts on ecosystems, societies, and economies. **EPA (Environmental Protection Agency)** defines Climate change as significant and lasting changes in the Earth's climate patterns, including variations in temperature, precipitation, sea level, and other indicators, resulting from human activities such as burning fossil fuels, deforestation, and industrial processes, as well as natural factors. According to **NOAA (National Oceanic and Atmospheric Administration),** Climate change is defined as long-term shifts in temperature, precipitation, and other atmospheric conditions that occur over decades or longer periods, resulting from natural variability and human activities such as burning fossil fuels, deforestation, and land use changes.

III. What Causes Climate Change?

Carbon dioxide (CO2), methane (CH4), and water vapour (H2O) are considered to be greenhouse gases that exist in the Earth's atmosphere. These gases can trap heat and contribute to the greenhouse effect. The Sun emits energy in the form of shortwave radiation, which reaches the Earth's surface without significant interaction with greenhouse gas molecules. This radiation is not greatly affected by the presence of greenhouse gases. However, the Earth's surface emits long wavelength radiation, which interacts with greenhouse gases and leads to the absorption of some energy. This absorbed energy is then retained in the atmosphere. This process, known as the greenhouse effect, is crucial for maintaining the warmth necessary for life on Earth. When the proportion of greenhouse gases in the atmosphere increases, there is a corresponding increase in the absorption of radiation. This leads to a rise in Earth's temperature, which is commonly referred to as climate change. Climate change can occur gradually through natural processes, such as changes in the Earth's orbit or volcanic activity. It can also occur abruptly due to significant events like meteorite impacts or volcanic eruptions. However, the current rapid climate change that is being observed is primarily a result of human activities. Three main human activities contribute significantly to climate change. The first is the combustion of fossil fuels for various purposes, such as heating, electricity generation, and transportation. When fossil fuels are burned, carbon dioxide is released into the atmosphere. This additional carbon dioxide adds to the overall greenhouse gas concentration. The second activity that contributes to climate change is deforestation. When forests are cleared, the carbon stored in trees is released into the atmosphere as carbon dioxide. Additionally, the loss of trees reduces the Earth's capacity to absorb and sequester carbon dioxide from the atmosphere. This further contributes to the greenhouse effect and global warming. The third human activity that impacts climate change is the reduction in biodiversity. When ecosystems lose their biodiversity, they become less effective at capturing and storing atmospheric carbon. This means that less carbon dioxide is removed from the atmosphere, leading to increased greenhouse gas concentrations and higher temperatures. Furthermore, less diverse ecosystems are also less resilient to the impacts of climate change, such as rising temperatures. It is important to note that while the 50 least developed countries are estimated to have contributed only 1% of greenhouse gas emissions causing global warming, the United States, the European Union, and China collectively account for approximately 60% of these emissions. This highlights the significant role that these countries play in the current climate crisis. Over time, the impacts of climate change will be universally felt, yet presently, certain individuals bear a disproportionate burden. Typically, the affluence of prosperous nations has arisen from endeavours that emit greenhouse gases. This prosperity affords these nations greater resilience against climate change effects. Conversely, poorer nations encounter greater challenges in adapting to climate change and consequently endure its brunt. Moreover, their limited capacity to address climate-related challenges impedes their developmental progress, diverting resources away from broader development efforts.

IV. The main Greenhouse Gases

The primary Greenhouse Gases originating from human activities encompass carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), among others. Below are elaborations on the origins and recent patterns of these emissions. ***Carbon dioxide:*** Carbon dioxide stands as the foremost greenhouse gas driving contemporary climate alterations. Naturally, CO2 is absorbed and released as part of the carbon cycle, involving processes like plant and animal respiration, volcanic eruptions, and exchanges between the ocean and atmosphere. However, human endeavours, like fossil fuel combustion and alterations in land use, discharge substantial quantities of CO2, leading to an elevation in atmospheric concentrations. ***Methane:*** Methane arises from a combination of natural occurrences and human interventions. This includes emissions from natural wetlands, agricultural practices, as well as processes related to fossil fuel extraction and transportation, all contributing to the release of CH4. Presently, methane levels in Earth's atmosphere exceed those of any period in the last 800,000 years. The surge in CH4 concentrations throughout much of the 20th century, largely attributable to human actions, has resulted in levels now surpassing two-and-a-half times those of the pre-industrial era. However, in recent decades, the pace of this increase has notably decelerated. ***Nitrous oxide:*** Nitrous oxide results from a blend of natural processes and human interventions, predominantly stemming from agricultural practices and natural biological activities. Additionally, N2O is generated through fuel combustion and various other industrial processes. Since the onset of the Industrial Revolution, N2O concentrations have surged by around 20%, experiencing a notably rapid escalation towards the conclusion of the 20th century. Notably, over the past century, the augmentation in N2O concentrations has outpaced any recorded period in the past 22,000 years. **Other greenhouse gases:** Water vapour, despite its brief atmospheric lifespan, reigns as the most prevalent greenhouse gas and holds paramount importance in driving the natural greenhouse effect. Certain human activities can impact localized water vapour levels. **Tropospheric Ozone (O3),** despite its brief atmospheric persistence, stands as a potent greenhouse gas. It forms through chemical reactions involving emissions of nitrogen oxides and volatile organic compounds, primarily stemming from vehicles, power plants, and various industrial and commercial activities, under the influence of sunlight. Besides its heat-trapping properties, ground-level ozone serves as a pollutant, capable of inducing respiratory issues and adversely affecting agricultural produce and ecosystems. **F-gases,** a group comprising Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6), are commonly employed in various applications such as coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants. Unlike water vapour and ozone, these F-gases exhibit extended atmospheric lifetimes, and emissions of some of these compounds will continue to impact the climate over several decades or even centuries. **Black Carbon (BC)** contributes significantly to atmospheric warming by directly absorbing sunlight and infrared radiation. It can also darken snow and ice, accelerating melting. Conversely, other aerosols like sulphates can cause cooling by reflecting sunlight. Aerosols, including BC, interact with clouds, influencing their formation, reflectivity, and precipitation. Clouds themselves can have both cooling and warming effects on climate. Natural variations in solar activity and Earth's orbital parameters significantly influence the climate by altering the amount of solar energy reaching Earth. Solar changes, such as fluctuations in solar intensity due to the sun's 11-year cycle, can lead to periods of either warming or cooling, although their impact on climate is generally modest. Additionally, alterations in Earth's orbit shape, tilt, and axial position can further modulate solar energy receipt at the planet's surface. Volcanic eruptions can temporarily cool the Earth by reflecting sunlight with particles in the upper atmosphere. This effect, caused by cooling aerosols, lasts for a few years but doesn't create long-term changes like greenhouse gases do because the particles don't stay in the atmosphere as long.

V. Effects of Climate Change

Climate change has profound global impacts, affecting various groups. The World Economic Forum outlines six ways it's already influencing our lives, including health, economic, and environmental concerns. The World Health Organization warns it's the most significant health threat, estimating it could lead to an additional quarter of a million deaths annually by 2030-2050, mainly due to malnutrition, malaria, diarrhoea, and heat-related illnesses. Climate change has broad societal impacts, particularly affecting vulnerable groups and cities. It threatens livelihoods and challenges our adaptation to historical climate norms. Impacts span health, infrastructure, transportation, energy, food, and water supplies. Vulnerable populations and specific professions face heightened risks. Weather-sensitive professions like outdoor tourism, commerce, and agriculture are particularly susceptible to climate impacts. According to the National Oceanic and Atmospheric Administration, climate change affects various sectors of society in interconnected ways. Droughts can disrupt food production and pose health risks. Flooding can spread disease and cause damage to ecosystems and infrastructure. Health problems can lead to higher mortality rates, affect food supplies, and reduce worker productivity.

Geographic Location: Residential locations shape vulnerability to climate change. Coastal areas, experiencing rapid population growth, face risks from storms, droughts, and heat waves. Mountain regions may encounter water scarcity and increased wildfires. Arctic communities confront issues like thawing permafrost and reduced sea ice. Both coastal and western U.S. populations strain infrastructure due to climate-related changes and population growth.

Indigenous Peoples: Indigenous communities and tribes, though diverse, often face common challenges in adapting to climate change. These include residing in rural or climate-affected regions like coastal areas, depending on local environments for sustenance and income, dealing with heightened health risks, such as lack of insurance and limited healthcare access, and living in isolated or low-income areas.

Urban Populations: Urban areas and their infrastructure are uniquely sensitive to climate change. Cities absorb and retain heat, exacerbating heat waves. With dense populations, especially in coastal megacities, they're more susceptible to climate-induced events, affecting a larger number of people. Elevated temperatures and extreme weather events impact energy costs, air and water quality, and human health. Ageing infrastructure poses additional challenges, such as drainage and transportation systems, during peak demand periods like summer heat waves.

Effects on Economic Activities and Services: Climate change endangers regions in the United States reliant on local natural resources, such as farming, tourism, and insurance industries, jeopardizing their economic stability and the livelihoods of those dependent on them. Communities tied to crops like corn, wheat, or cotton depend on specific climates. Climate change may shift these ideal climates northward, impacting these communities' way of life. Climate change will also likely affect tourism and recreational activities. A warming climate and changes in precipitation patterns will likely decrease the number of days when recreational snow activities such as skiing and snowmobiling can take place. Climate change could make insurance more difficult and expensive for many in risk-prone areas, or even unavailable. Insurance is vital for protecting investments in real estate, agriculture, transportation, and utilities, spreading costs across society and building resilience. With climate change, extreme weather events like heat waves, droughts, and floods are expected to become more frequent and intense, leading to increased property and crop losses and costly disruptions. This has already impacted insurance availability and affordability in vulnerable regions.

Climate Effects on Agriculture and Food Supply: Climate greatly impacts agriculture and fisheries. While higher temperatures and CO2 levels may initially benefit crop yields, other factors like nutrients and water availability are crucial. Changes in droughts and floods pose challenges, impacting food safety and farmers' livelihoods. Warmer waters may disrupt fish habitats. Overall, climate change could alter traditional practices, affecting crop yields and nutrition. Extreme weather events can harm crops, worsened by reduced water supplies. Rising CO2 levels may increase weeds and pests, further threatening crops and human health.

Effects on Livestock: Climate change directly threatens animals like livestock through heat waves and indirectly through impacts on pasture and feed supplies. Drought reduces quality forage, while changes in crop production affect grain availability. Climate change may also increase livestock diseases, leading to changes in veterinary practices that could affect food safety. Elevated carbon dioxide levels may boost pasture productivity but decrease forage quality, requiring adjustments in animal diets.

Effects on Fisheries: Climate change worsens existing fisheries stresses, like overfishing and pollution, with temperature shifts having significant impacts. Species may relocate, leading to resource competition. Warmer temperatures and salinity changes cause marine disease outbreaks, disrupting ecosystems. Temperature and seasonal alterations affect reproduction and migration patterns. These factors, along with other climate impacts, lead to declining salmon populations and challenge aquatic ecosystems. Ocean acidification, driven by increasing atmospheric CO2, weakens shellfish shells by depleting seawater calcium. This process also threatens vital ecosystems for fish and shellfish. Reduced shellfish size and abundance lead to lower harvests and potential consumer price changes.

Climate Effects on Coastal Areas: The densely populated U.S. coastline, home to about 25 million people vulnerable to flooding, is vital for the nation's economy and hosts diverse ecosystems. Climate change, through sea level rise, storm intensity, and ocean acidity, worsens existing challenges like shoreline erosion and water pollution, impacting coastal infrastructure and ecosystems.

Sea Level Rise: Since 1901, global sea levels have risen around eight inches. However, observed changes at specific locations are influenced by both global sea level increases and local land movements, caused by factors like coastal subsidence and ice melt. Climate models suggest sea level rise will accelerate, with estimates of 1 to 3 feet by the century's end. Rising sea levels also raise groundwater salinity, threatening drinking water sources and harming aquatic ecosystems.

Climate Effects on Ecosystems: Climate strongly impacts ecosystems, prompting species to migrate and disrupting food chains. Rising sea levels and warming temperatures force species to relocate or perish, while development and logging activities exacerbate these effects. Climate change interacts with human stressors like coastal development, increasing strain on fragile areas, and intensifying erosion risks in logged forests.

Range Shifts: Rising temperatures are prompting North American species to migrate northward and to higher elevations. Over recent decades, both terrestrial and aquatic plants and animals have shifted to higher elevations at a median rate of 36 feet (0.011 kilometres) per decade and to higher latitudes at a median rate of 10.5 miles (16.9 kilometres) per decade.

Food Web Disruptions: Climate change can have far-reaching effects on ecosystems, as changes in one species can cascade through food webs, impacting numerous other organisms. For instance, declines in ice algae, a key food source for seals, can lead to decreases in seal populations, ultimately affecting polar bear populations that rely on seals as prey. **(CCSP, 2008; USGCRP, 2014; ACIA. 2004)**.

Buffer and Threshold Effects: Ecosystems act as buffers against wildfires, flooding, and droughts, but climate change and human activities may weaken this ability, heightening vulnerability. Examples include coastal reefs and wetlands protecting against storm surges, and cyclical wildfires reducing forest fire risks. **(USGCRP, 2009)**.

Pathogens, Parasites, and Disease: Climate change and ecological shifts may facilitate the spread of pathogens, parasites, and diseases, posing significant risks to human health, agriculture, and fisheries.

Extinction Risks: Climate change, along with habitat destruction and pollution, is a major driver of species extinction. The IPCC estimates that 20-30% of studied plant and animal species could face extinction if temperatures rise as projected by the end of the century. This could exceed natural extinction rates. Species like the pika, ringed seals, polar bears, and Pacific Northwest salmon are particularly vulnerable. **(IPCC, 2014)**

Climate Effects on Energy: Climate change is likely to increase summer electricity demand for cooling while decreasing winter demand for heating fuels. This may require new infrastructure investments, especially to manage peak demand during heat waves **(CCSP, 2008)**. Climate change may alter water availability for electricity generation and fuel extraction, increasing competition for scarce water resources. Sea level rise and intense storms could damage energy infrastructure, impacting production and delivery **(USGCRP, 2009).**

Climate Effects on Forests: Forests offer numerous benefits to society, such as clean water and air, recreational opportunities, wildlife habitats, carbon storage, climate regulation, and a diverse range of forest products **(CCSP, 2008)**. Climate shapes forest ecosystems and is vital for their health. Changing climate can worsen threats like pest outbreaks, wildfires, human development, and drought to forests. Climate changes, both direct and indirect, impact forest growth and productivity by altering temperature, rainfall, weather patterns, and other factors. Elevated carbon dioxide levels also affect plant growth. These changes have diverse effects on complex forest ecosystems. Climate change is likely to change the frequency and severity of forest disturbances, including wildfires, storms, insect outbreaks, and invasive species occurrences **(CCSP, 2008)**. Changes in temperature, precipitation, and carbon dioxide levels could impact forest productivity and distribution **(USGCRP, 2009)**. Climate change is expected to exacerbate existing challenges for forests, including those stemming from land development and air pollution **(USGCRP, 2014).**

Climate Effects on Human Health: Climate change leads to warming temperatures, altered precipitation, more extreme weather events, and rising sea levels, posing health risks worldwide. Vulnerable populations, including children, pregnant women, older adults, and those with low incomes, face increased dangers. Warmer temperatures will result in more frequent and prolonged heat waves **(USGCRP, 2016)**. These changes will lead to an increase in heat-related deaths. Extreme heat exposure can cause heat stroke, dehydration, and various health issues like cardiovascular, respiratory, and cerebrovascular diseases **(USGCRP, 2009; CCSP, 2008)**. Northern latitudes face increased vulnerability to excessive heat, impacting outdoor workers, student-athletes, homeless individuals, and those lacking access to air conditioning, such as low-income households and older adults. Vulnerable groups include young children, pregnant women, older adults, and individuals with certain medical conditions. Urban areas are warmer than rural ones, and climate change is expected to heighten heat-related health risks for urban populations. Heat waves often coincide with stagnant air, exacerbating air pollution and its health impacts. Climate changes impact both indoor and outdoor air quality. Warmer temperatures and altered weather patterns can deteriorate air quality, exacerbating respiratory and cardiovascular health issues, including asthma attacks. Increasing wildfires, a consequence of climate change, produce harmful smoke and air pollutants. Additionally, rising carbon dioxide levels and warmer temperatures influence airborne allergens. **(USGCRP, 2016)**. It's crucial to recognize that the impacts of climate change extend beyond the mentioned regions. Climate change is a multifaceted challenge necessitating a comprehensive approach. Governments, businesses, and individuals each hold responsibilities in both mitigating its effects and adapting to its impacts.

Effects on Businesses: Businesses are confronted with a range of challenges stemming from the impacts of global warming and climate change, particularly in logistics and transportation. Damaged transport infrastructure and the necessity for extensive route adaptations due to climate-related events are anticipated to double direct transportation carbon emissions by 2050. In air transport, more frequent storms could lead to delays and cancellations, while intense heat and rainfall may affect airport runways and reduce aircraft take-off weight. Similarly, road transport faces issues such as reduced fuel efficiency and increased energy consumption for refrigerating perishable goods. Water transport is vulnerable to frequent droughts and floods, resulting in increased shipping costs due to longer routes caused by storms and higher maintenance requirements for vessels. Rail transport may experience challenges like decreased visibility and infrastructure issues due to increased rainfall and rising temperatures. Furthermore, changing climates significantly influence tourist comfort and travel decisions, potentially leading to a significant reduction in tourist arrivals, thereby impacting employment and exacerbating poverty in developing countries. Lastly, while global warming may drive the development of new inventions and increased investment in the renewable energy sector, sustaining new technologies requires substantial investment and rapid adaptability, leading to shifts in funding habits concerning existing technologies.

VI. What can be done?

Adaptation is commonly contrasted with coping, which refers to short-term strategies for dealing with immediate shocks. Coping typically involves households mobilizing resources to address crises, such as responding to food shortages during abnormal seasons or years. The ability to make adjustments in practices or systems to anticipated or actual climate changes depends largely on the resilience of the community or system. This resilience influences farmers' capacity to successfully respond and adapt to climate change. Adaptation also encompasses the ***potential*** of a system, region, or community to withstand and adjust to the impacts of stressors, with variations observed between developed and developing countries, within countries (such as low and high-favored areas), and communities (among different socio-economic groups). Factors influencing adaptation include ***human capital***, including knowledge of climate (both scientific and local), technical and political capabilities, education levels, perceptions, health status,

access to information and technology, communication networks, freedom of expression, technology transfer, innovative systems, capacity building, and early warning systems. **(UNFCCC, 2002; Reid & Vogel, 2006)**

Mitigation reduces disaster impacts and tackles climate change by cutting greenhouse gas emissions. This involves shifting to low-carbon energy sources like wind, solar, and nuclear power, while also protecting and enhancing natural carbon sinks such as forests and oceans.

Sustainable Development Goals: In the same year as the Paris Agreement, all UN Member States adopted 17 Sustainable Development Goals (SDGs). These goals encompass everything needed to protect the planet and ensure global peace and prosperity. The SDGs are interconnected, requiring collective achievement to secure a future where everyone enjoys a healthy life. Sustainable development means achieving this without compromising the needs of future generations, sustaining actions indefinitely without resource depletion or irreversible damage. ***(Figure 1)***

Figure 1 - SDGs

VII. Solutions to Climate Change?

Ending Our Reliance on Fossil Fuels: To combat climate change, we must drastically reduce fossil fuel consumption, which accounts for over 75% of warming emissions. Transitioning to renewable energy sources like wind and solar is essential, with these sources playing an increasingly significant role in electricity generation.

Greater Energy Efficiency: Energy efficiency, dubbed "the first fuel," is essential because it reduces the need for actual fuel consumption, whether it's for solar or gas power. This strategy can be applied across sectors like power plants, factories, vehicles, and buildings. Measures such as weatherproofing, cool roofs, efficient heat pumps, and LED light bulbs all contribute significantly to cutting energy usage.

Renewable Energy: Transitioning from fossil fuels to clean energy is the key to winning the fight against climate change.

Solar energy: Solar energy is generated by photovoltaic cells, converting sunlight directly into electricity. Paired with this growth is an increase in battery storage, vital for managing energy demand and preventing power failures, especially during peak times like hot days.

Wind energy: Unlike solar panels, which convert sunlight into electricity, wind turbines generate power when the wind spins their blades, turning a generator. Offshore wind, especially, can supplement energy needs during peak times like evenings and when solar energy is limited. Effective planning and protective measures are necessary to harness offshore wind's potential while minimizing impacts on wildlife.

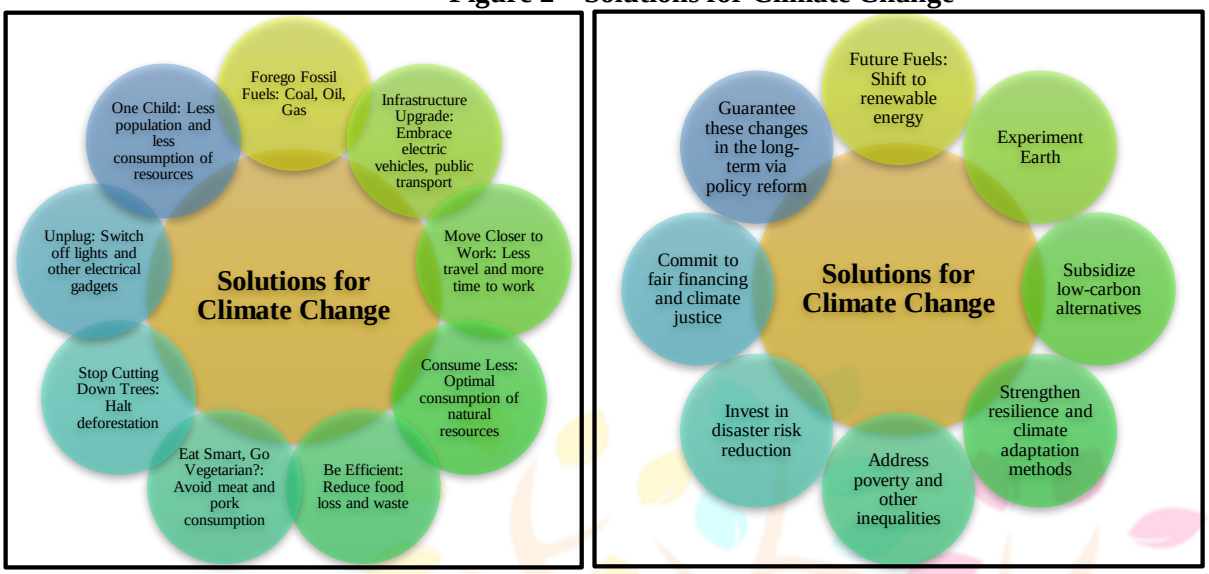
Geothermal and hydroelectric energy: Water, under certain conditions, can be a renewable energy source. Geothermal energy involves drilling deep underground to extract hot water, which is then converted into steam to generate electricity. Hydroelectric energy uses gravity to power generators with the force of moving water. Proper management is vital for both geothermal and small-scale hydroelectric plants to ensure sustainability. However, large-scale mega-dams can disrupt ecosystems and river systems, posing significant challenges.

Biomass energy: Burning organic materials such as wood, agricultural products, or animal waste for electricity generation, known as biomass, generally fails to reduce carbon emissions. Instead, it often causes more environmental harm than benefit, with only rare exceptions.

Sustainable Transportation: Transportation is a major source of greenhouse gas emissions, requiring the elimination of vehicle pollution to achieve net-zero global emissions by 2050, as outlined in the Paris Climate Agreement. While electric vehicles (EVs) accounted for less than 8% of global vehicle sales in 2021, they're projected to surpass half of all new sales by 2035. Governments worldwide are actively phasing out gas-powered vehicles and promoting public transportation and congestion pricing to reduce car trips and emissions. Encouraging zero-emission modes like walking and biking is also crucial, requiring significant funding, planning, and infrastructure development by leaders at all levels.

Sustainable Buildings: Energy usage in buildings, covering lighting, appliances, heating, cooling, cooking, and water heating, often represents the largest source of carbon pollution in cities. Improving building energy efficiency with upgrades like better windows and insulation can reduce emissions significantly. Raising public awareness about cost-effective solutions such as heat pumps, Energy Star appliances, and building decarbonization is crucial for creating sustainable buildings for the future. Ecologist Stephen Pacala (1959) and Psychist Robert Socolow (1942) both at Princeton University came up with the so called "wedges" to reduce the greenhouse emission to safer levels **(Figure 2)**

Figure 2 – Solutions for Climate Change



***Source**: Compiled by the Authors from different sources*

Better Forestry Management and Sustainable Agriculture: Some of our strongest allies in the fight against climate change are the trees, plants, and soil that store massive amounts of carbon at ground level or underground. Without the aid of these carbon sinks, life on Earth would be impossible, as atmospheric temperatures would rise to levels more like those found on Venus. Forests like the Canadian boreal or the Amazon rainforest are to be managed sustainably. Society should put an end to deforestation practices. The culture of Indigenous communities is to be protected. Adopting practices associated with organic and regenerative agriculture are to be encouraged.

Conservation-Based Solutions: Intact ecosystems, like coastal wetlands and forests, store vast amounts of carbon, helping to mitigate climate change. To preserve biodiversity and combat climate change, experts advocate for global leaders to protect and restore at least 30% of land, inland waters, and oceans by 2030, as endorsed by the Intergovernmental Panel on Climate Change.

Industrial Solutions: Heavy industry, responsible for 40% of global greenhouse gas emissions, primarily from carbon-intensive products like chemicals, steel, cement, and others, must sharply reduce emissions and address local pollution. Adopting cleaner processes can allow growth without increasing emissions, while also promoting job creation in manufacturing.

Technological Solutions: Technology is vital for tackling climate change, but it requires substantial research and funding. Efforts like developing longer-lasting EV batteries, non-polluting hydrogen solutions, and effective carbon capture methods are crucial. Governments must prioritize clean energy technology investment by offering grants, subsidies, tax incentives, and other support to spur innovation.

Our Choices: Individual action is crucial in addressing the climate crisis. By advocating, making sustainable choices in daily life, and supporting eco-friendly businesses, individuals can make a significant impact. Leaders must prioritize frontline communities in crafting climate policies to ensure their inclusion and benefit from cleaner air and better job opportunities. To combat climate change, governments and businesses must: Keep fossil fuels underground, Invest in renewables, Transition to sustainable transport, Improve home insulation, Promote plant-based diets and sustainable farming, Restore ecosystems for carbon absorption, Protect forests and oceans, Encourage reduced consumption, and Minimize plastic use.

VIII. Conclusion

Climate change has emerged as a leading cause of poverty and hunger, placing 45 million people worldwide, including nearly 21 million children, at extreme risk of famine. Communities worldwide report increasing instances of unreliable seasons, droughts, and floods. Despite being the least responsible for climate change, vulnerable communities bear the brunt of its impacts. Addressing climate change requires a two-pronged approach: mitigating emissions to stabilize heat-trapping greenhouse gases in the atmosphere and adapting to existing climate change effects. The Secretary-General of the United Nations outlines five critical actions necessary to transform our energy system and accelerate the transition to renewable energy. These actions include making renewable energy technology a global public good, improving global access to components and raw materials, establishing a level playing field for renewable energy technologies through global cooperation and coordination, shifting energy subsidies from fossil fuels to renewables, and tripling investments in renewables. These statements from the Secretary-General are particularly relevant in light of the energy and environmental crises faced by many countries, prompting significant investments in the renewable energy market.

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