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CLIMATE CHANGE DYNAMICS: PROTECTION AND SUSTAINABILITY OF BIORESOURCES AND WATER RESOURCES MANAGEMENT IN THE TROPICS.

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Abstract: Ecosystem management and restoration play an important role in climate change mitigation, responses, and adaptation. The gory incidence of the climate change is apparent in the continuous drift in ecological structures, compositions, species variations, migrations, extinctions and inherent effects on socio-economic recessions all over the globe. This, however, is not only complex but has continue to raise the dynamic bars that requires intensive scholastic discourse and evaluation to alleviate and possibly control the impacts. The knowledge of the principles and dynamics of climate change and its impact on biodiversity, speciation, variability, and sustainability and water resources is very critical. This suggests an empirical appraisal and approach and in-depth scholarly debate to unravel the mechanism and possibly proffer panaceas for healthy resilience and restoration of ecosystem equilibrium and sustainability. This study was carried out to unravel the principles and dynamics of climate change with reference to the protection and sustainability of diverse tropical bioresources. During the study, a web-based systematic review search with reference to the ROSES protocol was employed to source 156 articles that studied principles of climate change and their impacts on bioresources protection and sustainability. Seventy-two (72) peer-reviewed articles that met the inclusion criteria were retained and critically reviewed after a thorough screening. The review identified automobile emissions (14%), industries (21%), and agriculture, forestry, and other land uses (AFOLU) (24%) as the major contributors to the increase in global warming. This study recommends green energy, afforestation, ranching, and sustainable agricultural practices as panaceas that will stem the tide of ravaging drift in climate.

Keywords: Sustainability, Global Warming, Impacts, Green Energy, Emission

Introduction

Climate change is a global danger to biodiversity and ecosystems; it impacts species and their interactions with organisms, habitats, and niches; and it fundamentally alters ecosystem structures and functioning (Diaz *et al*. 2019). Though the effects of climate change are widespread and diverse, accumulating evidence suggests that reactions to climate change vary according to vulnerability, which is linked to differences in sensitivity, exposure, and adaptability (Beever *et al*., 2016 and Kovach *et al*., 2019). In terms of responses, higher trophic levels are expected to be more vulnerable to climate change due to changes in vulturine need, exploration, and encounter frequency. Functional responses, on the other hand, differ and are influenced by species structure, abiotic circumstances, and predator-prey relationships (Davis *et al*., 2017 and Van Zuiden *et al*., 2016). These alterations cause species metamorphosis, environmental changes, and altered interspecific relationships (Hobbs *et al*., 2009). Climate change refers to a change in the statistical features of the climate system over time. Climate change refers to long-term changes in a region's weather patterns. The shift is mainly natural, due to variations in the sun's activity, but it could also be anthropological (land use patterns such as urbanization, agricultural activities, etc.). Climate change has an unparalleled impact on ecosystems, biological species (morphological and phenological changes), productivity shifts, and species interactions (Sarah *et al.* 2020).

Global warming appeared to be a wonderful idea, particularly for those in northern climates. Focus was initially on sea-level rise and a threat to food supply, and this gradually expanded to include new items such as ecosystem deterioration and hazards to human health. Experts in sectors ranging from forestry to economics, as well as national security experts, contributed to an assessment of the potential repercussions. Knowledge of the complexity of the global system, the variances between regions, and the pattern adaptation by the vulnerable populations to the changes is vital to unearth the impacts of climate change on bioresources and water resources in the tropics. Suggesting that the average global temperature may rise by a few degrees Celsius before the end of the twenty-first century (Fig. 1). Study hypothetically poised that the greenhouse effect might exert a violent effect on the earth's climate in the 21st century (Min *et al*., 2011). The theory assumed that the greenhouse effect will have a severe impact on the earth's climate in the twenty-first century. A closer look in 1960 proved that CO_2 levels had risen rapidly. In 1963, the private "Conservation Foundation" conducted a groundbreaking discussion on the "implications of rising carbon dioxide content of the atmosphere." Carbon dioxide in the atmosphere functions as a greenhouse gas; its rise is primarily due to fossil fuel burning and deforestation of plants which act as carbon sink. This, according to Awosika et al. (2011), increase astronomically and has resulted in an average global temperature increase, as well as other climate system alterations. The change in climate system due irreversible variations in the quantity of meteorological variables such as temperature, precipitation, air pressure, heat, etc., has continued to impact negatively on agriculture, health, quantity and quality of water resources, soil nutrient, plants and animal diversity and adaptations. The aim of this study was to appraise the impacts of climate change on bioresources and water resources and protection and sustainability.

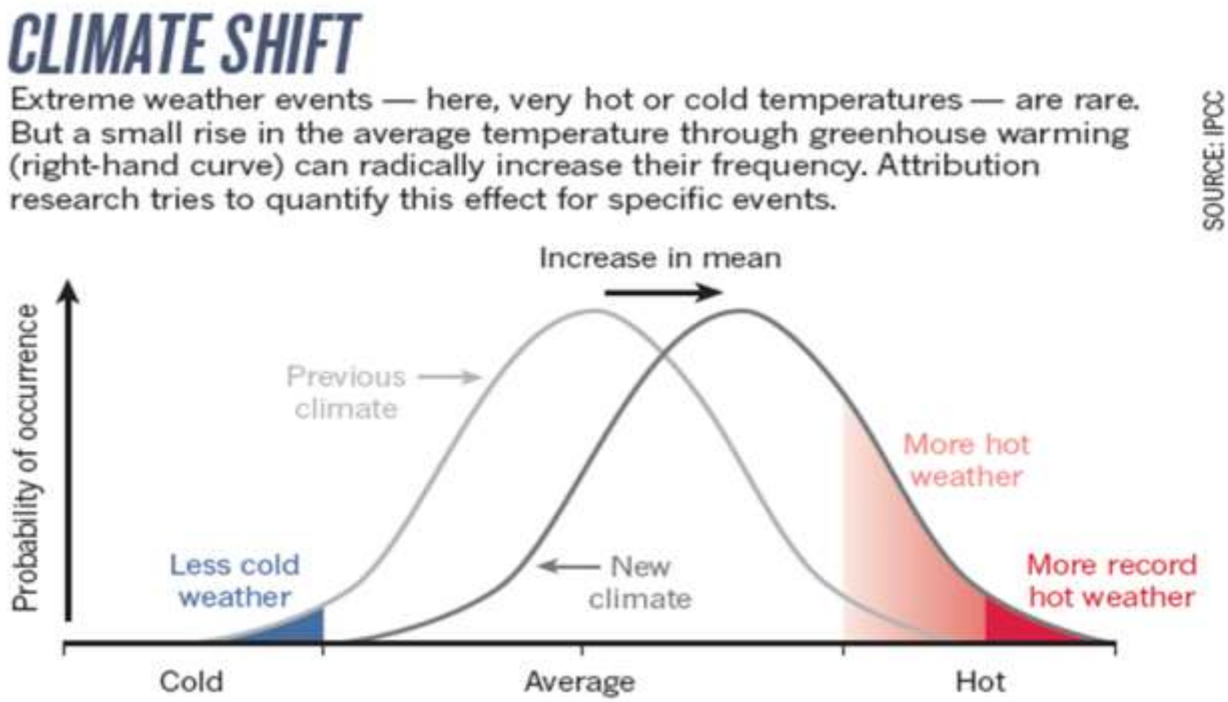

Fig. 1: Climate Shift (IPCC, 2007)

Methods of Literature Search

A web-based systematic review search with reference to the ROSES protocol was employed to source articles that studied principles of climate change and their impacts on water resources, bioresources protection and sustainability. Internet searches using search engines such as Chrome, Explorer, Google, and Mozilla Firefox were used to search terms and words related to the subject. To identify related literature, words, technical terms, and keywords such as climate change, global warming, biodiversity, bioresources, greenhouse gases, and impacts were combined or used independently to mine data and articles used for the study. One hundred and fifty-six (156) articles that studied climate change dynamics, bioresources, biodiversity, impacts, protection, sustainability, and tropics were sourced from the internet. Forty-one (41) articles written outside the scope of the title and 32 articles that were not written in the English language were excluded, while 11 articles that were not retrieved were not used for this study. After the thorough search, the study retained and critically reviewed 72 articles that met the inclusion criteria. The articles retrieved were not only written in English language but also captured the titles and area of the study.

Climate Change Dynamics

Climate change is a long-term change in the climatic conditions of a place. This, however, is driven by climate forcing, which usually regulates the external and internal heat and energy of the earth. Climate forcing is a force that works on the earth's climate, causing a change in how energy flows through it (such as long-lasting, heat-trapping gases, often known as greenhouse gases). These gases delay outgoing heat in the atmosphere, causing the globe to warm. Factors influencing climate forcing include solar radiation, earth's orbit inclination, albedo, thermohaline circulation in the oceans, mountain ranges, continental drift, and changes in greenhouse concentrations. Total solar irradiance (TSI) is a method that measures the changes in energy the earth receives from the sun, and this encompasses the 11-year solar cycle, as indicated in Figure 2, and solar flares/storms from the sun's surface. The figure shows that the increase in sun radiation may not be attributed to the increase in global warming; instead, the amount of carbon dioxide (Co_2,) chlorofluorocarbons (CFCs,) and other automobile emissions, which tend to trap heat at the earth surface, may be attributed to global warming. A study found that fluctuations in solar energy may not explain direct link to increase global temperature. For example, Lockwood and Ball (2020), who investigated limiting long-term fluctuations in quiet-sun irradiance and their contribution to total solar irradiance and solar radiative forcing of climate, found that the average amount of energy from the sun is relatively constant. If the warming was driven by a more active sun, the study would predict higher temperatures throughout the atmosphere. Instead, the study found that the high atmosphere cooled while the surface and lower atmosphere warmed. This provides evidence that greenhouse gases are reducing heat loss from the lower atmosphere. Climate models that include variations in solar irradiance may be unable to reproduce the known temperature trend over the last century or more without accounting for an increase in greenhouse gases.

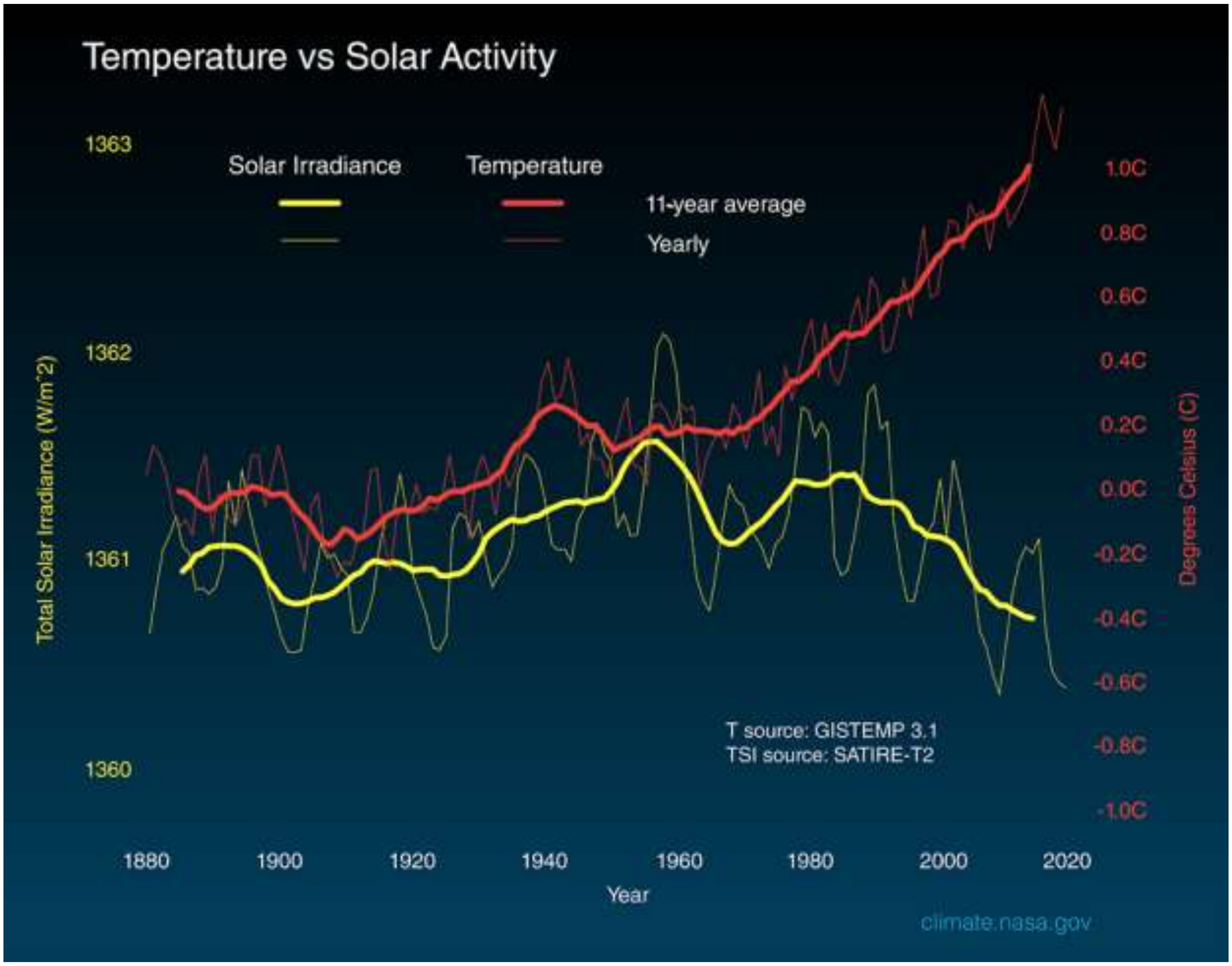

Figure 2: Solar Radiation and Temperature

The graph above compares and contrast temperature changes to the sun's energy received by earth. The quantity of solar energy received by earth followed the sun's regular 11-year cycle with no net increase over the years. Global temperatures have risen significantly, as a result, it is exceedingly unlikely that the sun is directly responsible for the observed global temperature rise during the last half-century. The increase in temperature is due to concentration Co_2 that tend to blankets the escape of the radiation into the upper atmosphere. The greenhouse effect occurs when gases such as water vapor, carbon dioxide, nitrous oxide, and methane capture energy from the sun, causing an increase in temperature on earth. The greenhouse effect occurs when gases in the earth's atmosphere absorb and emit infrared radiation, warming the lower atmosphere and surface. Without these gases, heat would escape into space, and the earth's average temperature would be lower. Greenhouse gases on earth have a warming effect of approximately 33 °C. Without the earth's atmosphere, the average temperature would be significantly lower than the freezing point of water.

A study connects the global warming trend observed since the mid-twentieth century to the human expansion of the "greenhouse effect" (IPCC, 2007), which occurs when the atmosphere traps heat emanating from the earth into space. About 90% of this heat is subsequently absorbed by greenhouse gases and re-radiated into the atmosphere as infrared heat, which slows heat escape to space (Fig. 3). Carbon dioxide, nitrous oxide, methane, chlorofluorocarbons, and water vapor are five major greenhouse gases. Since 1750, the industrial activities that underpin our modern civilization have increased atmospheric CO_2 levels by about 50% (Friedlingstein *et al*., 2022). This increase is attributed to human activity, as scientists can detect a specific isotopic fingerprint in the atmosphere. In its sixth assessment report, the Intergovernmental Panel on Climate Change (IPCC, 2007), which is made up of scientific experts from all over the world, concluded unequivocally that the increase in CO_2, methane, and nitrous oxide in the atmosphere over the industrial era was caused by human activities and that human influence is the primary driver of many changes observed across the atmosphere, ocean, cryosphere, and biosphere.

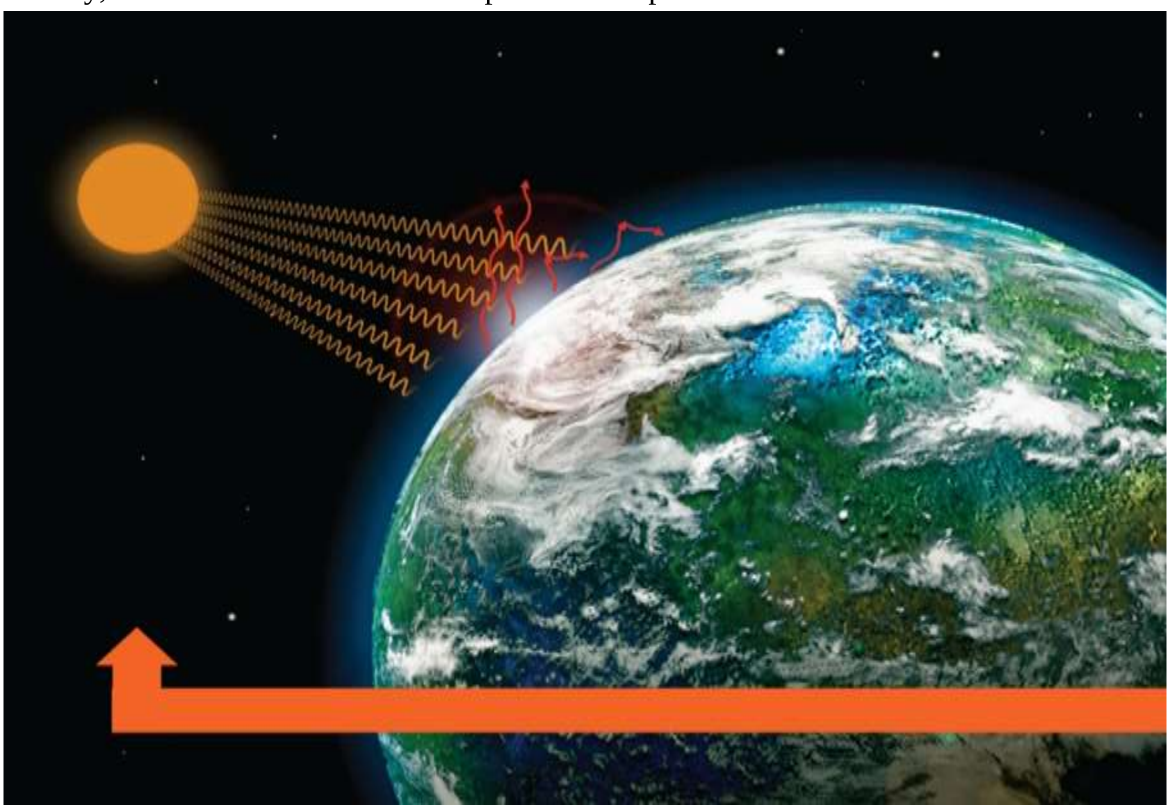

Figure 3: The Process of Global Warming (Dole, 2011)

The major greenhouse gases are water vapor, CO_2, methane (CH_4), ozone. Clouds, like greenhouse gases, alter the radiation balance. The term “greenhouse gases” is used to denote its ability to warm our planet just like glass panes in a greenhouse, which allow light but prevent heat from leaving, leading to increased temperature (Fig. 3). As the sunlight enters the earth's atmosphere and passes through a layer of greenhouse gases and reaches the earth's surface, land and water absorb its energy; the energy is absorbed and returned to the atmosphere. Greenhouse gases trap much of the energy, leading to global warming. Figure 4 illustrates the direct and indirect emission of Co_2 into the atmosphere. The figure reveals that electricity and heat (25%), agriculture, forestry, and other land use (AFOLU) (24%) and industry (21%) accounted for 70% of direct emissions.

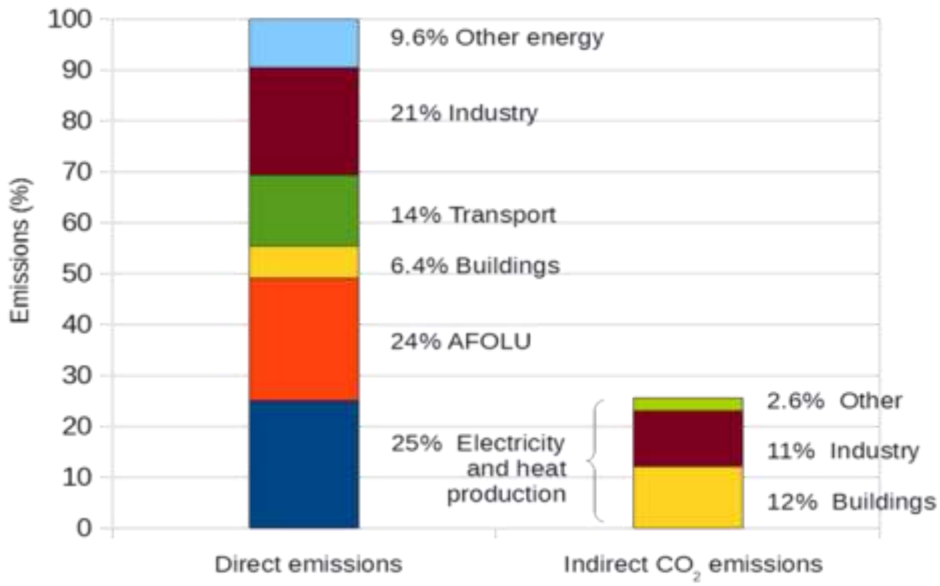

Fig. 4: Emission of Greenhouse Gas

In 2001, the IPCC's Third Assessment Report (TAR) predicted a warming trend of 0.6ºC over the preceding century and has since risen to 0.74ºC (IPCC, 2007). The temperature increase is global; however, it was first observed in the northern Polar Regions. The climate system has warmed on the earth's surface in the upper ocean, and in the high atmosphere, as well as in hundreds of meters of the upper ocean. Average Northern Hemisphere temperatures were greater than any other 50-year period in the last 500 years. According to the study, evidence of a warming globe includes shorter freezing seasons for lakes and rivers, as well as rising soil temperatures (Dole, 2011). Sea levels have increased globally at an average rate of 1.8 mm per year since 1961 and 3.1 mm per year since 1993, consistent with the warming tendency. The entire global rise in the twentieth century was 17 cm; contributing to the rise were the expansion of water as it warmed and the melting of glaciers, ice caps, and polar ice sheets. Figures 5 and 6 show that the global increase in temperature became noticeable from the year 2000.

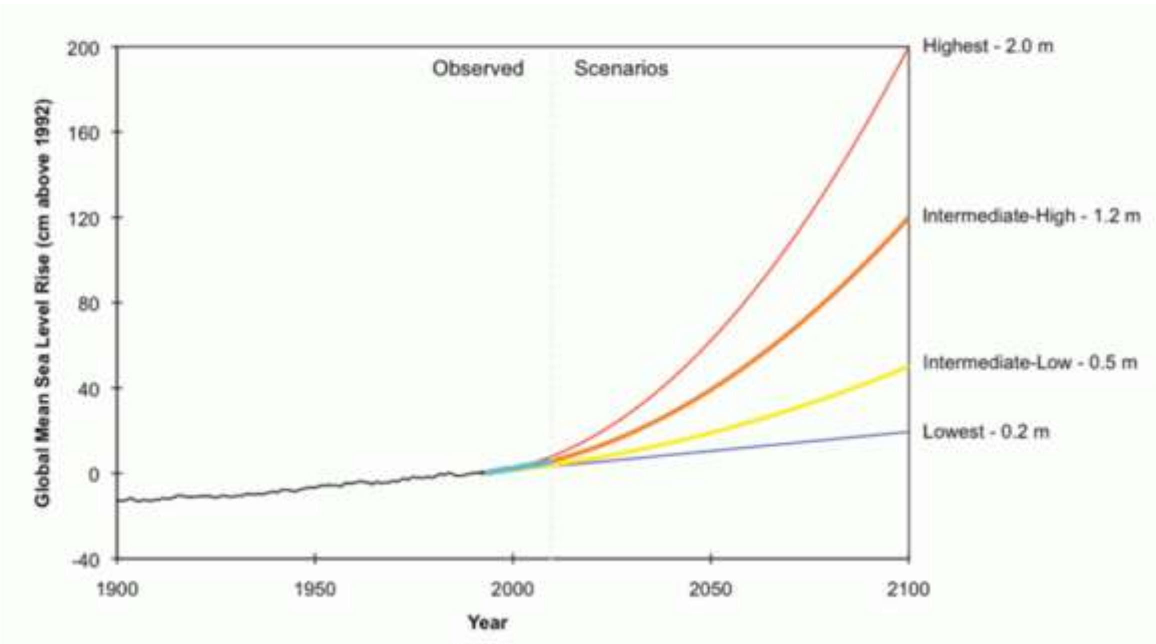

Fig. 5: Rise in Sea Level (Min *et al.*, 2011)

Figure 1
Variations in the Earth´s Surface Temperature, 1000–2100.
Source: IPCC 2001 a.

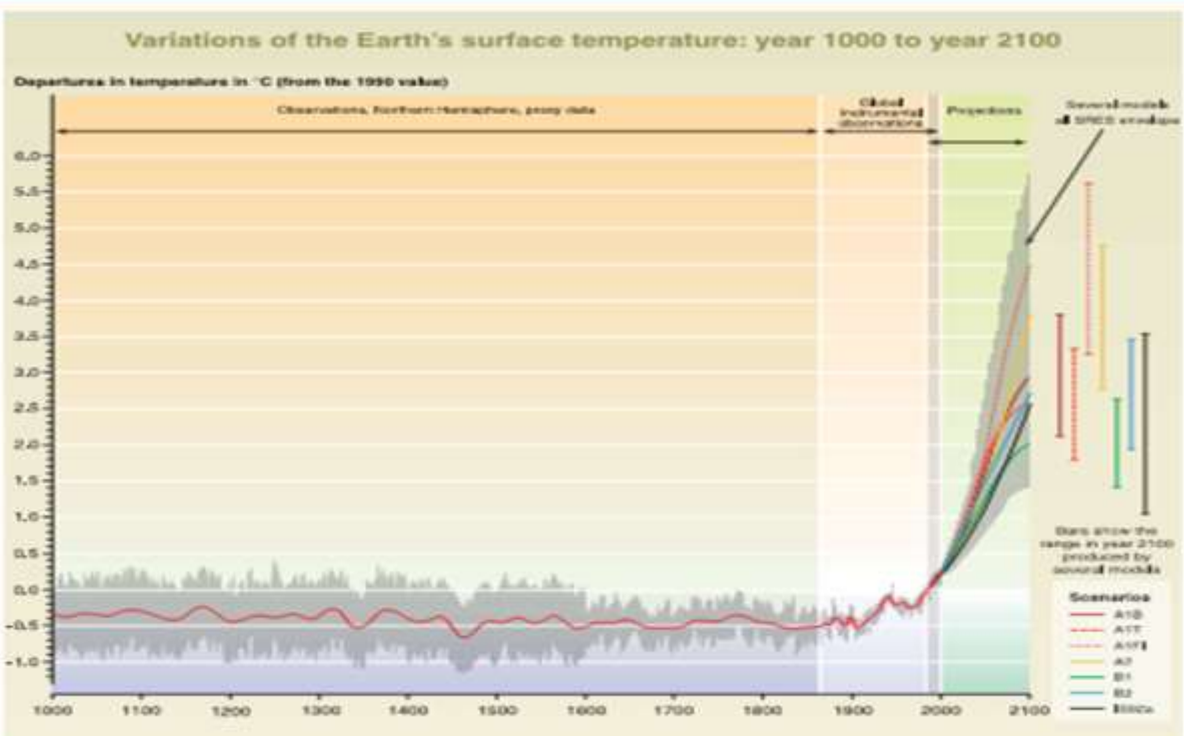

Figure 6: Variations in Earth Surface Temperature

Over the past century, average temperatures in the Arctic region have grown at nearly twice the global average rate, while sea ice extent has decreased and temperatures at the top of the permafrost layer have risen (IPCC, 2007). Major alterations have already been observed: Global mean warming is 0.8°C higher than pre-industrial levels. The oceans have warmed by 0.09°C since the 1950s (IPCC, 2001). Sea levels have risen by 20 cm from pre-industrial times and are currently increasing at 3.2 cm/decade. A study of strategic forecasts up to 2010–2015 on the effect of expected climate changes on the economy of Russia by Vuglinsky and Gronskaya (2005) reported that an increase in winter temperature significantly alters the ice regime of water bodies in northern regions. This, however, buttresses the impacts of the increase in temperature on the incessant thinning and evolving glaciation in previously glaciated regions of the world (Figures 7 and 8).

Figure 7. Effects of Climate Change on Glacier (Glaciations in Progress)

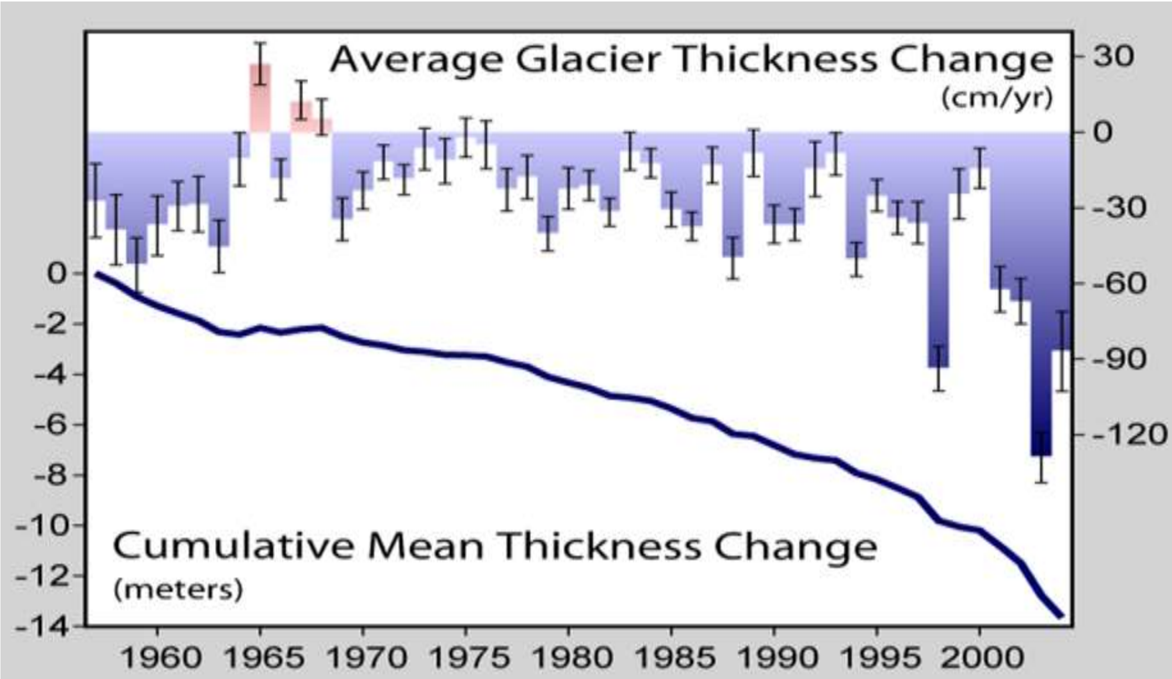

Fig. 8: Thickness Change in Glacier (Dole, 2011)

Climate Change and Biodiversity

Climate change, according to Amitav (2019), has a direct impact on the lives of approximately 1.2 billion people, particularly agricultural activities, which are the most susceptible sector. This shows that substantial effort is required to mitigate the apparent effects of climate change on biotic and abiotic environments in order to conserve the innocuous bioresources of flora and wildlife. The loss of a species from an ecosystem has an impact not just on the species that is lost, but also on the interactions with other species and the general ecological functions that are expected to result from these interactions. Some countries, such as India, have established targets to significantly cut greenhouse gas emissions by 2050 (Amitav, 2019). Climate change affects biodiversity in a variety of ways, including diminishing the amount and availability of suitable habitats and eliminating species that are critical to the species' survival (Doak and Morris, 2010 and Dawson *et al*., 2011). As a consequence of ecosystem service, biological resources directly benefit the world's economy, and most especially, the economies of less-industrialized countries (Travis, 2003). Reductions in biodiversity to the point where it can no longer contribute to ecosystem servicing can have a negative influence on the value of ecosystem services and the abundance of bioresources for biotechnology research, socioeconomic activity, and ecosystem functions and balance. The loss of any of the species or trophic levels, or both, may accidentally lead to ecosystem dysfunctions and extraordinary loss of biomass, as well as intrinsic permanent alterations in ecosystem patterns, structures, and compositions.

Climate change's various components, together with anthropogenic stressors, are expected to be the primary drivers of biodiversity at all levels (Parmesan 2006). The loss of biodiversity due to climate change has altered the pattern and dynamics of energy flow and material circulation (Zhong and Wang 2017), which has a significant influence on the ecosystem and ecosystem services. For example, the ability of ecosystems to provide climate regulation services is dependent on the richness of species they now support (Bellard *et al.* 2012). Climate change is also caused by the conversion of biological resources into useful commodities and services, particularly when grasslands and forests are turned into croplands (Lambin and Meyfroidt 2011). The production of biological resources for food, fuel, and fiber, as well as the conversion of forests and grasslands to farmland, have a direct impact on greenhouse gas (GHG) emissions (Burnham and Ma, 2015). According to Dejen (2018), one of the most important supporting services offered by forests is the removal of carbon from the atmosphere (carbon sequestration) and its long-term storage in biomass, dead organic matter, and soil carbon pools. According to Pan *et al.* (2011), tropical forests contain an estimated 55% of global forest carbon reserves, with biomass accounting for more than half. Forests play an important role in carbon sequestration since they absorb 57% of the carbon emitted annually from worldwide fossil fuel consumption and land-use change, reducing the rate of growth in atmospheric CO_2 concentrations by half (Le Quéré et al. 2009). Species can influence the long-term balance of carbon gains and losses in ecosystems via several components of the carbon cycle, including the volume, turnover, and longevity of carbon stores in soils and vegetation (Maestre *et al.* 2012). The interconnectedness of climate change and abundant water and bioresources, however, confirmed the negative correlation between drift in climate change and biodiversity (Figure 9).

The impact of climate change on biodiversity varies from (i) changes in main vegetation zones or biomes; (ii) alterations in ranges of individual species and composition assemblages; (iii) interconnections between the consequences of climate change and habitat fragmentation; (iv) changes in ecological function; and (v) expansion, contraction, and "migration" of habitat (Daly and Brodeur, 2015). Increased incidence of disease and invasive species; variations in temperature, precipitation, and other environmental circumstances; and alterations in food availability are all inherent effects of climate change. Deaths in ecological connections due to climate change may be a precursor to the extinction of vital pollinators or mutualistic nutrient fixers. Migration in response to adverse effects of climate change dynamics may not be feasible due to fragmentations, alterations, and destruction of habitats and migration corridors.

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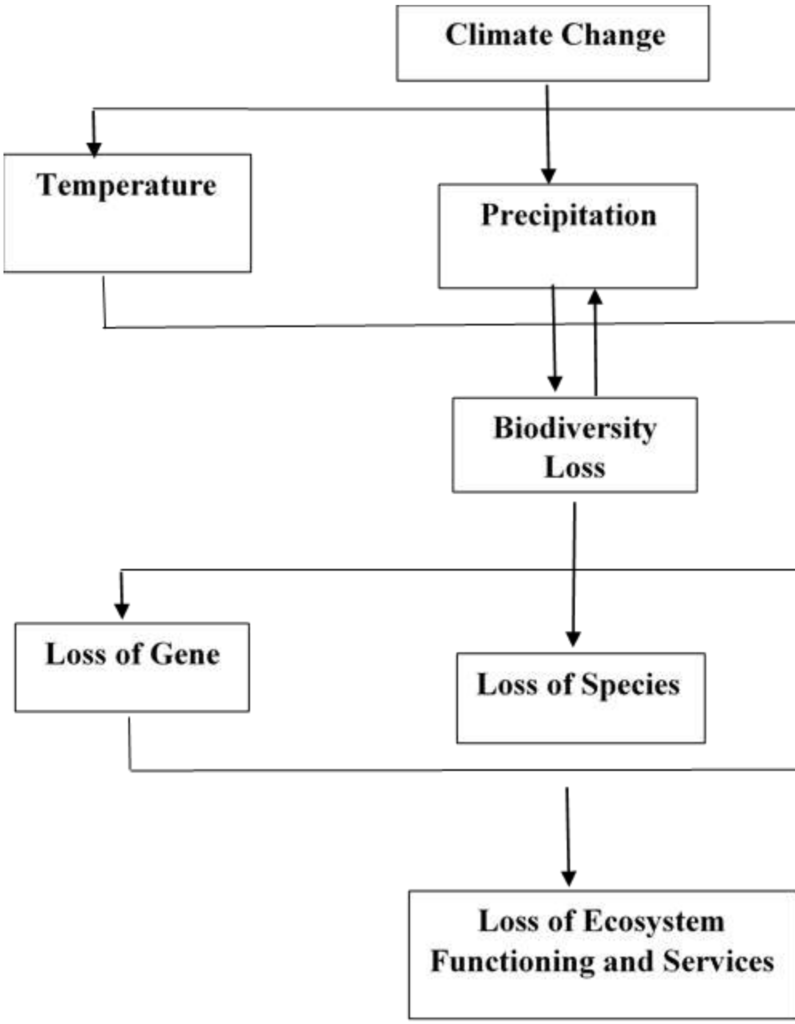

Figure 9: Climate Change and Biodiversity: A Nexus (Dejen, 2018)

Conclusion

Climate change is occurring, and within the next few decades, people and ecosystems will have either committed to a significantly warmer world or taken big steps to reduce warming. Extensive and interconnected ecosystems, species and genetic diversity, trophic integrity, and habitat variability can all help to mitigate the effects of climate change. Ecosystem management and restoration can play a key role in climate change mitigation and social adaptation, but they will only be beneficial if combined with a reduction in fossil fuel emissions. This recommends afforestation, de-grazing, enhanced ranching of livestock, green urbanization, sustainable agriculture practices and improved in crop production will not enthrone ecosystem equilibrium but will bolster aquifer recharge for increased availability, quantity and quality of water resources for socio-economic activities and bioeconomy for nation building.

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