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Climate Change and Biodiversity Loss: Interconnected Challenges and Priority Measures

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ABSTRACT

Climate change refers to long-term variations in temperature and weather patterns, primarily caused by human activities since the 19th century, although natural changes in the solar cycle also play a role. The key indicators of climate change include rising atmosphere and sea temperatures, heat waves, storms, melting glaciers, rising sea levels, altered wind and rainfall patterns, changes in plant and animal life cycles and migration, and coral damage. These changes are largely attributed to the emissions of greenhouse gases (GHGs) into the atmosphere, which contribute to global warming by increasing the absorption of infrared radiation. Biodiversity, on the other hand, encompasses the genetic and phenotypic variation at various levels, from molecular to ecosystem. It represents Earth's wealth and provides essential goods and services, including resource provisioning, supporting services for protection and regulation of ecosystems, and cultural services that satisfy human appreciation of nature. Biodiversity is organized within ecosystems, where plants (producers), animals (consumers), and microorganisms (decomposers) coexist and interact with each other and the environment through food chains, biomass dynamics, and energy flows. Priority measures to address climate change and biodiversity loss include achieving the temperature target of 1.5°C recommended by the Paris Agreement, reducing GHG emissions, preserving and restoring ecosystems, promoting sustainable agriculture, adopting healthy and sustainable diets, improving forestry and agroforestry practices, reducing food waste, and enhancing carbon capture and storage. The post-2020 global biodiversity framework aims to achieve the 2030 biodiversity targets and the 2050 United Nations vision, which outlines long-term plans to minimize the impacts of climate change on biodiversity through effective and equitable climate action that mitigates further loss and damage.

Keywords: Biodiversity; Climate change; Conservation; Interconnectedness; Mitigation.

INTRODUCTION

Climate change is a significant global issue that is now widely acknowledged to be primarily caused by human activities. According to the United Nations Climate Action website (source: https://www.un.org/en/climatechange/what-is-climate-change), climate change refers to long-term variations in temperature and weather patterns resulting from natural changes in the solar cycle. However, since the 19th century, human activities have emerged as the main driver of climate change. The recognition of the concern surrounding recent climate changes led to the establishment of the World Climate Program (WCP) after the 1979 World Climate Conference, organized by the World Meteorological Organization, the United Nations Environment Program, and the International Council of Scientific Unions. These organizations signaled their determination to pursue investigations on climate change by the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC immediately formed three Working Groups WG1 to assess available scientific information on climate change, WG2 to assess environmental and Socio-economic impacts of climate change, WG3 to formulate response strategies to combat the impacts of climate change.The IPCC laid down guidelines for National Greenhouse Gas Inventories in 2006, which provided methods for managing human-caused emissions of gas inventories in each country. The IPCC released the 2019 refinement to the 2006 guidelines in a Special Report titled “Climate Change and Land”, which focused on the connections among climate change, food security, and sustainable land management. A report was also issued by the IPCC, (2019) on the impacts of climate change on coastal regions, oceans, polar and mountain ecosystems, as well as its impacts on the human communities that depend on these ecosystems for their life. The IPCC had also adopted the “COP21” Paris Agreement, which is a universal agreement that calls for driving efforts to limit the temperature rise to 1.5ºC above the pre- industrial levels. Several studies have confirmed the relationship between global warming and temperature rise, which imposed an impact on many physical and biological systems. The concentration of carbon dioxide and methane far exceed the values recorded over the ages since the Ice Age (about 650,000 years ago). Carbon dioxide (CO_2) has been regarded as the main reason for the so-called increase in greenhouse gas (GHG) concentrations since the industrial revolution in the 18th century. The sources are the CO_2 are the use of fossil fuels, in addition to agriculture and changes in land use, as well as human intervention in natural resources. This article deals with climate change aspects including definitions, indicators, and causes particularly GHGs and global warming (Moustafa and Ghowail, 2022). The article also deals with biodiversity including biodiversity definition levels, ecosystem structure, and function and

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how these aspects of biodiversity would be impacted by climate change, and how biodiversity conservation and restoration can contribute to minimizing the impacts of climate change on life on Earth.

Climate changes definition and indicators

Several indicators of the occurrence of climate change on Earth have been identified, in several IPCC reports, the most well-known and most reported are rising temperatures, less arctic sea ice, melting of glaciers, rising ocean heat content, decreasing snow, changing wind and precipitation patterns, changes in animal migration and life cycle, changes in the plants and animals life cycle and damaged corals Figure (1).

Figure (1) Arctic sea ice is vanishing during the course of the year https://sigmaearth.com/the-melting-of-the-arctic-sea-ice-alarming-crises-explained (2023).

Global warming

Global warming is a rise in the Earth's temperature to its natural rates due to an increase in the rate of emission and concentrations in the atmosphere of the GHGs because of an increase in the rate of their absorption by infrared radiation. The names of these gases are given in Figure (2), although the relative proportions of these gases vary in different estimates (Morice *et al.*, 2012), CO_2 is the major GHG followed by methane, nitrous acid, and fluorocarbon gases Figure (2)

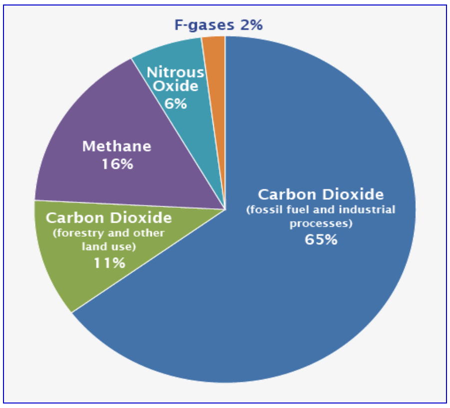

Figure (2) Graphs showing the major Globel Green Gas emission by gas (GHGs) and their emissions percentage. Source: IPCC (2014).

Sources and contributors of greenhouse gas emissions

The use of fossil fuel gases in industry, transportation, and buildings results in the production of CO_2 and NO_2. Additionally, fluorinated gases emitted from equipment has a significantly stronger warming effect, up to 23,000 times greater than CO_2. Furthermore, the expansion of livestock farming leads to substantial methane emissions, while the use of nitrogen-based fertilizers contributes to nitrous oxide emissions. Deforestation, over-extraction of natural resources, excessive energy consumption, and pollution also contribute to greenhouse gas (GHG) emissions. It is worth noting that natural sources of GHGs, such as black carbon produced by forest and savanna fires, as well as volcanic activities, also contribute to the overall emissions.

A curve illustrating the land surface air temperature increases in the 150 years (1850-2000) Figure (3) shows that the Earth's average surface air temperature has increased by about 1°C since 1900, with over half of the increase occurring since the mid-1970s. However, alarming increases have been reported in recent years. According to the 5th synthesis report issued by the IPCC, in 2021, the years 2011-2019 were the warmest recorded decade on Earth, with a global average temperature rise of 1.1°C above pre-industrial levels, which is much higher than the current human-induced global warming of 0.2°C per decade. The NOAA (National Centers for Environmental Information) records indicate that the years since 2005 are the warmest every year since global records began in 1880 with the years 2014–2022 ranking as the nine warmest years on record. More recently, the NOAA reported the highest monthly temperature ever for June 2023 (NOAA, 2023).

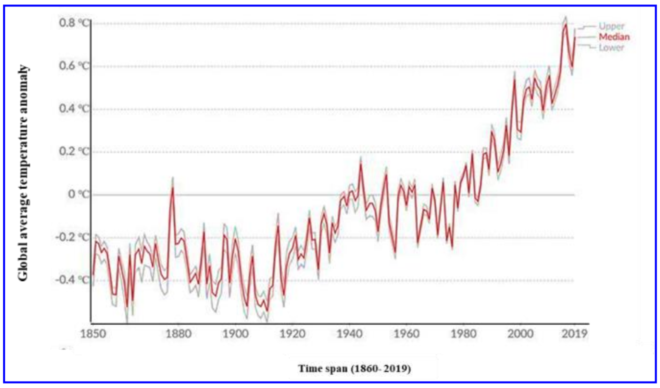

Figure (3) A curve illustrating the average temperature increases during the time period of since 1860 (Mcmaster, 2021).

Relation between rising temperature and concentration of CO_2

The rise in temperature is closely linked to the increasing global average concentrations of CO_2, as depicted in Figure (4). This relationship between global temperatures and greenhouse gas (GHG) concentrations, particularly CO_2, has remained consistent throughout Earth's history (Lacis *et al.*, 2010). Over the past century, there has been a rapid increase in CO_2 levels, preceding the recent temperature rise and the ongoing warming trend (Bezdek *et al.*, 2019). This implies that achieving stabilization in global and regional atmospheric CO_2 concentrations can potentially delay the temperature response following emission mitigation efforts (Mitchell et al., 2010; Samset *et al.*, 2020).

Consequences of climate change

The IPCC assessment reports addressing the physical

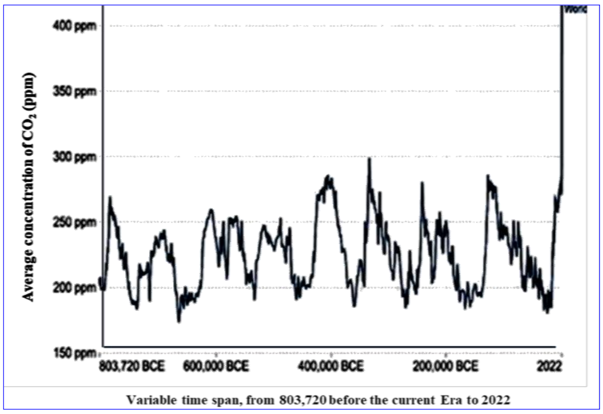

Figure (4) A curve illustrating the changes in global average concentrations of CO_2 in the atmosphere over a variable time span. Data published by National Oceanic and Atmospheric Administration (NOAA). https://gml.noaa.gov/ccgg/trends/global.html.

understanding of the climate system and climate change showed that problems associated with climate change have several consequences including temperature rise, drought, sea level rise and oceans acidifications, and threats to safe access to water sources and to biodiversity.

High temperatures

International conventions on climate change and environmental affairs have reached a consensus that limiting the temperature rise to no more than 1.5°C is crucial to mitigate the most severe impacts of climate change and ensure the habitability of our planet. A preliminary assessment conducted by the Network of Experts on Climate and Environmental Change in the Mediterranean region in 2019 revealed that without decisive action, the region is projected to experience an annual temperature increase exceeding the global average by approximately 0.3°C. Furthermore, it is anticipated that the rise in temperature will be more pronounced during the summer months compared to winter (Brook and Fordham, 2015). It is widely acknowledged that urban areas tend to be warmer than the surrounding rural areas due to human activities (Cramer and Guiot, 2019). However, achieving the goal of limiting global warming to 1.5°C may prove challenging unless there are substantial reductions in global greenhouse gas emissions (Samset *et al*., 2020).

Drought

An increase of 1^{o}C in the global temperature would result in a decrease in precipitation by about 4%, in most parts of Europe and the Mediterranean region and an increase of 1.5 C^{0} would lead to an increase in dry periods by 7% in the same region (Kuglitsch *et al*., 2010; Vautard *et al*., 2014). Moreover, a global increase in atmospheric temperature at 2C^{0} will be accompanied by a reduction in the amount of rain in many places. Scenarios that predict a rise in temperatures between 2C^{0} to 4C^{0} in southern Europe during the eighties of this century indicate a significant decrease in rainfall by up to 30%, as well as the disappearance of the frost season in the Balkans (Toreti *et al*., 2013; Toreti and Naveau, 2015; WWF Report, 2018). Balting *et al*. (2021) showed that the severity of drought in dry regions depends on the GHGs emission and development pathways. Drought hotspots in the sub-tropical regions in today's climate are expected to become a new normal by the end of the 21st century under the warmest scenario. Under the warmest future scenario, the drought occurrence rate may be 100% higher than that of the low-emission scenario. In regions less affected by long-lasting droughts like Europe, drought occurrence is probable in the warmest future. Under these conditions, the ecosystem functions will be diminished or damaged Balting *et al.* (2021). Drought is likely to accelerate the hydrological processes with many consequences, which increased the possibility of wildfire risk (Mukherjee *et al.*, 2018).

Sea-level rise and coastal areas' soil salinization

Climate change may cause ice melting at the North Pole leading to acceleration of the melting of the ice sheet in Greenland and Antarctica poses a significant risk to further sea- level rise, with the potential for a rise of several meters even under the assumption that global warming does not exceed the 1.5°C limit (Schleussner *et al*. 2016). Regional climate predictions related to the relative change in sea level are less accurate than global predictions due to the limitations of global simulation models and the interactions between the Atlantic and the Mediterranean Sea. Regional changes in the runoff of rivers relative to the Mediterranean coasts may lead to changes in soil salinity, which should also be considered as soil movement in the eastern part of the Mediterranean Basin. The Mediterranean Sea level recorded an annual rise of 0.7 mm between 1945 and 2000 and this increase reached 1.1 mm between 1970 and 2006) and an annual increase of about 3 mm per year has been observed from 2000 to 2020 (Calafat and Gomis, 2009). The future rise in the global average sea level is serious and future projections about sea level rise range from 52 to 190 cm by 2100, depending on the methodology (Meyssignac *et al*, 2010). This will greatly affect the rise in the level of the Mediterranean Sea due to its connection to the Atlantic Ocean through the Strait of Gibraltar. Rising sea level may rise to about 19 to 58 cm at the end of the 21st century and may also increase groundwater aquifers in 12 out of 19 countries in the Middle East and North Africa. The sea level rise in this way is likely to cost Egypt great losses in the Nile Delta region, as it may be one of the main countries that will be affected by a rise in the Mediterranean surface (Magnan *et al*., 2016).

Ocean acidification

The world's oceans absorb up to 30% of the CO_2 emitted by human activities, and absorbed by the water produces a dilute acid that separates and contributes to ocean acidification. At the global level, it is expected that by the year 2100, the absorption of CO_2 from the oceans will lead to an increase in acidity (pH) by 0.15 - 0.41 units compared to its levels for the period between 1870 and 1899. In the Mediterranean region, where the current rise in sea acidity is estimated at 0.018 to 0.028 units per decade. (Kapsenberg *et. al*., 2017) representing about a 30% increase in sea acidity.

Threats to freshwater resources

Freshwater resources are expected to witness a percentage reduction of 2% and 15% at a temperature of 2.0°C, which is considered one of the largest rates of decline worldwide. On the other hand, freshwater resources may be more frequent and could also lead to a decrease in the current water resources due to the damage to supply networks, insufficient drinking water, and impact on distribution infrastructure. Some arid regions are highly dependent on the water resources provided by melting snow in mountainous regions. For the snow- dominated communities – such as the Atlas Mountains in Morocco or the Alps in Italy and France – climate change may lead to a decrease in spring runoff associated with snowmelt, leading to a decreased available water resource (Meier, *et al*., 2014). North Africa and the Middle East are the most vulnerable parts of the World to the effects of climate change because these countries are undoubtedly among the countries that suffer severely from water shortage globally, as the per capita because water resources are less than the normal rate. In addition, these countries suffer from a critical situation regarding low rainfall and severe variation in their spatial and temporal situations. Moreover, rising sea levels may negatively affect the quality of groundwater in Egypt through the intrusion of salt water into it. In addition, sea level rise affects the water cycle under the surface of the coastal areas, and this causes a reduction in the flow of fresh water and a decrease in the proportion of freshwater areas (Marchane *et. al*., 2017).

Biodiversity definition, levels, and organization

Biodiversity (biological diversity) covers all levels of genetic and phenotypic natural variation at the molecular, individual, population, species, and ecosystem levels. In the Convention on Biodiversity (1992), biodiversity was defined as the variability among all forms of living organisms including terrestrial and aquatic ecosystems. Biodiversity is divided into three major levels: Ecological Levels-from populations to ecosystems and biomes, Taxonomic levels-from clones to kingdoms, Genetic levels-from genes to genomes and phenotypes The current Earth's biodiversity is the result of the long evolution of life forms. Until approximately 600 million years ago, all life consisted of single-celled organisms like bacteria. Other life forms such as protests and fungi, have been evolved and compose of simple structures, but most species of plants and animals are composed of organs and organ systems composed of tissues and cells Figure (5).

The living organisms on Earth and their complex interactions, with the abiotic (non-living) components in the biospheres are formed of ecosystems each comprised of communities (DeSalle *et al*., 2002). Evidence based on DNA sequences or the proteins they encode are used to estimate relatedness among species and their evolutionary pathways. The species live in communities of populations of interbreeding individuals of one species. Species that have accumulated greater differences in their DNA sequences diverged from their common ancestor in the past when mutations accumulate through time for a given sequence of DNA. Biodiversity is often measured as the number of species or higher taxonomic diversity such as genera and higher ranks including families, orders, classes, divisions and kingdoms of living organisms.

Ecosystems

Ecosystem is the coexistence of biotic components such as plants, animals, and microorganisms together and their interaction with each other and with the abiotic components such as soil and water resources, and environmental factors in any area on the globe. The effect of the environment on plants and the effect of plants on animals and microorganisms and the types of animals and micro-organisms that live in the ecosystem are closely related to human life. It is also obvious that there are reciprocal relationships among organisms and between them and the non-living resources.

Biotic components and trophic levels in the ecosystem

Biotic components of the ecosystem are comprised of several trophic and functional levels. The organization of a terrestrial ecosystem showing its components, trophic levels and energy flow, represented by a desert ecosystem, is illustrated in Figure (6). The first and most essential component is the producers of food and energy for other components, the second 10 level is called consumers and the third level comprises the decomposers; these levels are mainly made of plants, animals, and microbes (bacteria/fungi) respectively.

The producers

The producers are self-feeding organisms (autotrophs), which derive their energy from sunlight to make food from simple inorganic materials, and produce food which is complex organic compounds such as carbohydrates, fats, and proteins. The synthesis of organic food by the producers is initiated by through the process of photosynthesis which is a complex process that can be simplified by the conversion of 12 H_2O+6 CO_2 in the presence of light and chlorophyll to form sugars with the release of oxygen.

The consumers

Consumers are mostly animals that get their food from material produced by the producers and digest it in their digestive systems. Consumers benefit from the digested materials to build other compounds or create new cells, and to produce energy through respiration which is the opposite process of photosynthesis. Consumers use the energy in various vital activities such as growth, movement, and reproduction, while CO_2 and water are excreted by the body. Consuming organisms are classified into three levels, depending on the nature of the food they eat; these are herbivores including animals that consume plants, and are known as primary consumers, omnivores including animals that include herbivores and meat-consuming animals and are regarded as consumers of the second level and carnivorous which are animals that eat live or dead animals and are known as predators, and are regarded as third-level consumers.

The decomposers

These are microorganisms known to be analyst heterotrophic fungi and bacteria that may be parasitic

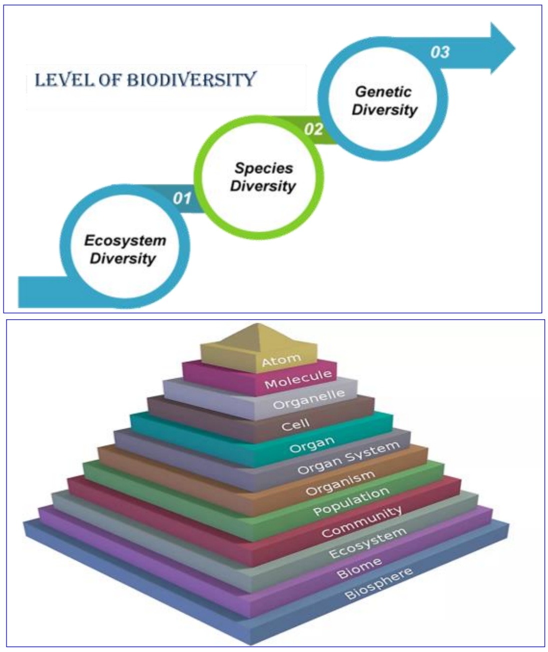

Figure (5) The Hierarchical Structure of Life. A, showing the level of biodiversity. B, the organization of biodiversity from the biosphere to the atom (modified from Bailey, 2019, https://www.thoug-htco.com/the-pyramid-of-life-373403).

or saprophytic. The decomposers analyze dead bodies of plants and animals and degrade compounds using digestive enzymes outside their bodies and suck particles of decaying food across the cell membrane. Detritivores are worms and snails living in the soil and consume the decomposed organic material and are consumed by carnivores.

Biomass and energy and flow in the ecosystems

The plants as the producers in the ecosystem, fix carbon at similar rates across ecosystems (Cebrian (1999) and part of the energy in the synthesized biomass as organic compounds in the green leaves of plants is consumed by the plants in respiration, growth, survival, and reproduction. Some of the manufactured energy is transferred to the primary consumers or herbivores which consume energy obtained from the producers in the growth 11 and formation of tissues, heating the body, movement as well as reproduction to produce offspring, and the bulk of this energy is used in tissue repair and traffic and other activities carried out by these animals. The dead bodies, secretion, and wastes of the producers and consumers are used by decomposers to produce energy for the producers in lands and seas. The efficiency of energy transfer as biomass in one trophic level such as primary producers is stored as biomass in the next trophic level such as primary consumers (La Pierre and Hanley, 2015). The energy flow in a desert ecosystem is illustrated in Figure (6).

Ecosystems goods and services

Reid *et al.* (2005) classified the ecosystem's goods and services into provisioning, supporting, regulating, and cultural. The provisioning services include food and fodder production, medicinal, cosmetic, and pharmaceutical products, fibbers such as wood products, and textiles, and firewood and genetic resources harboring diversity in genes, and species, for the future. The supporting services provide protection of water resources, soil formation and protection, food storage and recycling, environment clean up through recycles of substances, nutrients, and water, and maintaining the balance of gases in the atmosphere and pollination of flowers. Regulating services are important for human societies and provide maintaining and sustaining ecosystems through carbon sequestration, contributing to climate and water stability and protection from diseases and natural hazards. Finally, cultural services satisfy human spiritual and aesthetic appreciation components such as education and scientific 12 research, recreational services such as sports, fine and applied arts and tourism, and other aesthetic aspects such as cultural values and spiritual enrichment.

Ecosystem types

Natural ecosystems arose because of natural environmental changes, and are classified into terrestrial systems, such as deserts, grasslands, pastures, and forests, including tropical forests, deciduous forests, tundra and savannah, and aquatic water systems such as seas, oceans, rivers, fresh lakes, salt lakes, and swamps. The systems that live in wetlands or shallow waters are regulated by a special agreement in 1971 in Ramsar, Iran before the famous Convention on Biological Diversity was approved in Rio de Janeiro, Brazil (1992). The Ramsar Convention is of international importance as the wetland habitat is the home of migrating birds. Ecosystems are divided into two main types; aquatic and terrestrial, but there are integrated and effective systems in any area of the globe. The aquatic systems vary in the components and interrelationships among their components compared to the terrestrial systems on land. Differences also exist between ecosystems of freshwater environment and the marine environment, in different areas of oceans, seas, Lakes Rivers etc. Land ecosystems vary in deserts, forests, agricultural lands, and others.

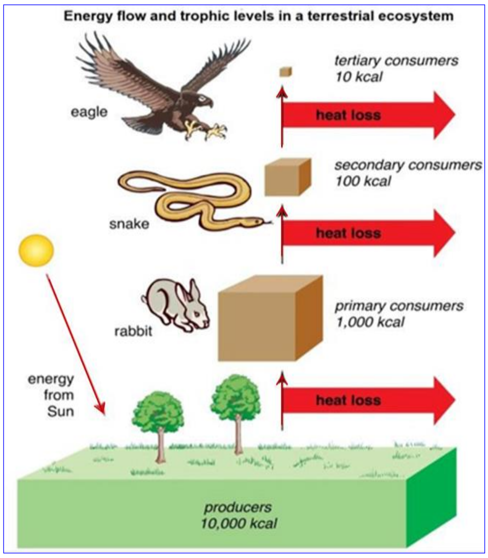

Figure (6) The organization of a terrestrial ecosystem in trophic levels and energy flow. https://www.britannica.com/science/t-rophic-level.

Ecosystems Productivity

Ecosystems are valued by their productivity which varies among ecosystems and is measured as mass or energy and depends on many factors particularly the resources such as solar energy input, temperature, moisture levels, carbon dioxide levels, nutrient availability, and interactions among ecosystem components. The productivity of the ecosystems may be units of either energy or biomass and is of two basic types: gross productivity and net productivity. Gross primary productivity (GPP) is the rate at which solar energy is captured in sugar molecules during photosynthesis (energy captured per unit area per unit time) and the net primary productivity (NPP) is the GPP minus the rate of energy loss to metabolism and maintenance. In other words, it is the rate at which energy is stored as biomass by plants or other primary producers and made available to the consumers in the ecosystem. The variation in average net primary productivity across different terrestrial and aquatic ecosystems is depicted in Figure (7). Terrestrial ecosystems exhibit higher primary productivity in tropical rainforests and other forest biomes compared to savannas and cultivated lands, while desert ecosystems tend to have the lowest productivity. Conversely, aquatic ecosystems demonstrate higher productivity in swamps, marshes, coral reefs, and salt marshes, as opposed to the upwelling zone, lakes, and streams. In extremely arid deserts, net primary productivity fluctuates on shorter time scales and can be as low as a few tens of grams C/m^2/yr.

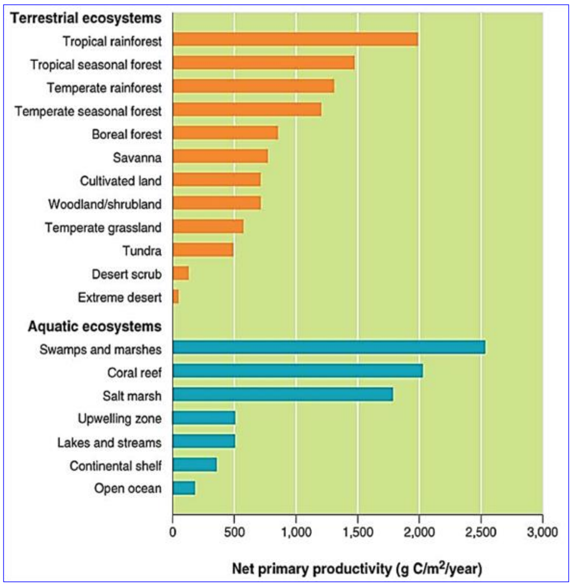

Figure (7) Diagram illustrating the variation of average net primary productivity (g/Cm^2/year) in different types of terrestrial and aquatic ecosystems (Source. Ap Environmental https://mhsapes.weebly.co-m/18-reading.html)

Global threats to biodiversity

The alarming report of the World-Wide Fund in 2018 (WWF, 2018) titled "Living Planet Report" estimated a 60% reduction in global populations of mammals, fish, birds, reptiles, and amphibians in the last 50 years. This potential loss puts many species and whole ecosystems on the brink of extinction. The WWF's 2018 report identified several threats as indicators of biodiversity loss:

Global environmental changes

This includes escalating drought, storms, hurricanes, volcanic activity, and more frequent waves of violent earthquakes. These environmental changes can have a significant impact on biodiversity.

Emission of greenhouse gases

The report highlights the emission of gases that cause the greenhouse effect, leading to the rise in Earth's temperature. This is a crucial factor contributing to climate change, which in turn affects biodiversity.

Irrational use of plant and animal resources

This refers to practices such as overgrazing, deforestation, illegal hunting of birds and animals, and unregulated eco-tourism. These activities can lead to the depletion of plant and animal populations, thus negatively impacting biodiversity (Moustafa and Mansour, 2020). In addition, the increasing demand for food crops for the ever-increasing human population leads to the transformation of natural ecosystems such as forests that produce oxygen into industrial systems that produce carbon dioxide and methane.

Based on the Global Assessment on Biodiversity and Ecosystem Services, the extinction rate in the 20th century was indeed significantly higher than the average rate during the preceding 65 million years. This alarming finding highlights the urgent need to address threats to biodiversity. Threats to biodiversity are extensively documented in the Red List, published by the International Union for the Conservation of Nature (IUCN). The most recent list reveals that over 42,100 species, representing approximately 28% of all assessed species, are currently threatened with extinction.

By acknowledging these alarming statistics and taking appropriate actions, we can actively work towards preserving and protecting biodiversity. This includes implementing measures to mitigate the causes of species decline, conserving critical habitats, promoting sustainable practices, and fostering international collaboration for effective conservation efforts. Through these collective actions, we can strive to safeguard the rich tapestry of life on our planet.

Climate change impacts on biodiversity

Insect rearing

The Working Group II contribution to the 6th IPCC assessment report on the impacts of climate change, at ecosystems, biodiversity, and human societies (IPCC, 2022) reviewed vulnerabilities, capacities, and limits of the natural world and human societies to climate change adaptation. Two other global biodiversity organizations, the IIPBES, and the WWF ranked climate change as the largest global driver of biodiversity loss. However, the climate crisis is increasing and is the major contributor to species extinctions in three ways: Disturbing habitats due to fires, floods, droughts, melting ice caps, and rising sea levels (Ibrahim, 2021). High temperature is a factor that disturb physiological processes and endanger the survival of some vulnerable species of plants and animals. Threaten keystone species in a knockout action on keystone species such as polar bear and other rare key species in other ecosystems.

Climate action and biodiversity conservation

Mass reforestation and habitat restoration are the most effective ways to capture sufficient CO_2 from the atmosphere via photosynthesis (Williamson, 2016; and Griscom *et al.,* 2017). However, conserving and restoring natural habitats and climate change mitigation and adaptation policies have been pursued separately by different countries. The social and economic dimensions have been added through shared socio-economic pathways as ways and means of nature conservation (Rogelj *et al.,* 2018). However, the major concern is whether it is possible to halt projected trends in biodiversity loss and that nature is on the road to recovery by 2050. While ensuring that other global goals, such as ensuring food security, are also central targets to achieve for the increasing human population. Roberts *et al.* (2020) called
for combining the targets of success in biodiversity conservation with the habitat protection and restoration necessary to bring down greenhouse gas concentrations and promote natural and societal adaptation to climate change. Maxwell *et al.* (2020) criticized the expansion of protected areas by national governments since 2010 which limited success in increasing the coverage across eco-regions in key biodiversity areas and wilderness areas as well as limiting the ecosystem services such 16 as productive fisheries, and carbon services on land and sea.

The UNEP-WCMC and IUCN reports from 2019 revealed that protected areas have expanded, covering 15.3% of on-land and freshwater environments, an increase from the previous coverage of 14.1%. Additionally, protected areas in the marine environment have expanded from 2.9% to 7.5%. This expansion is an encouraging step towards conserving and safeguarding biodiversity. The carbon sequestration and storage capacity of terrestrial ecosystems play a crucial role in mitigating human-induced climate change, as highlighted by Griscom *et al*. (2017). This underscores the importance of preserving and restoring healthy ecosystems as a means to combat climate change. Maxwell *et al*. (2020) propose that area-based conservation efforts can contribute more effectively to achieving global biodiversity goals. By focusing on specific areas and implementing targeted conservation strategies, we can enhance the effectiveness of biodiversity conservation initiatives.

To ensure the success of biodiversity conservation, it is essential to retain and protect healthy ecosystems. This can be achieved through collaboration with local communities and private initiatives, as they play a vital role in stewarding and managing natural resources. However, the long-term success of these conservation approaches relies on securing adequate financial resources and implementing strong management policies for land, water, and sea. Adequate funding and effective policies are critical for supporting conservation efforts and ensuring the sustainable management of our natural resources. By addressing these factors and working collaboratively, we can strive towards successful biodiversity conservation and the preservation of our planet's invaluable ecosystems.

Nature-based solution to biodiversity loss by climate change

Biodiversity ecosystems and habitats are regarded as a nature-based solution for biodiversity resilience to climate change. Species and genetic diversity in these systems have an important role in the mitigation and adaptation to climate change impacts. In particular, the diversity of forest trees enhances productivity and carbon storage by terrestrial ecosystems. Animals also provide essential contributions to carbon sequestration in the ecosystem through seed dispersal and trophic levels balance. In the marine ecosystem, whales play a key role in supporting phytoplankton through fertilization and in carbon sequestration. Genetic diversity of both plant and animal species is important for ecosystem dynamics and makes major contributions to climate strategies for the conservation and restoration of genetic and species diversity in crops, livestock, and trees (Moustafa and Mansour, 2020).

The UN 2050 vision for biodiversity

The Global CBD Outlook, published in 2020, provides valuable insights into biodiversity and ecosystem services. Additionally, national reports submitted by countries on their implementation of CBD goals (CBD Outlook 5) offer further information on global efforts towards biodiversity conservation, sustainable use, and fair and equitable benefit sharing. The strategic plan for biodiversity from 2011 to 2020, which included the Aichi Biodiversity Targets, was adopted during the 10th meeting of the parties to the CBD in Nagoya, Japan. At the CBD 14th conference held in Sharm El-Sheikh, Egypt in 2018, a vision for biodiversity in 2050 was outlined. Furthermore, the CBD 15th meeting in Kunming, China (2020) saw the adoption of the post-2020 framework for biodiversity.

Global Biodiversity Framework as a mandate for the process and guidance on the principles, characteristics, key activities and information sources for how biodiversity is valued, conserved, restored, and wisely used to maintain ecosystem services, sustaining a healthy planet, and delivering benefits essential for all people by 2050 taking into consideration climate change impacts on biodiversity. The 6th Assessment Synthesis Report by the IPCC WG III in 2022 called for available multiple, feasible, and effective options to reduce GHG emissions and adapt to human-caused climate change to save nature and people. The post-2020 global biodiversity framework provides context for discussions on the 2030 possible biodiversity targets and the 2050 UN vision and has long-term goal plans to minimize the impacts of climate changes on biodiversity. Mainstreaming effective and equitable climate action now will reduce more losses and damages to biodiversity. The UN 2050 biodiversity vision's ultimate achievements would be an abundance of wildlife and natural ecosystems, reduced risk of extinction for all species, and more long-term biodiversity benefits for the people in their daily lives.

CONCLUSION

Climate change and biodiversity loss are urgent interconnected global challenges. Human activities primarily drive climate change, resulting in rising temperatures, extreme weather events, melting glaciers, and ecosystem changes. These changes are largely due to greenhouse gas emissions. Biodiversity encompasses the diverse life on Earth and provides crucial services to humanity. It is organized within ecosystems, where species interact with one another and the environment. Preserving and restoring ecosystems is vital for maintaining biodiversity and ensuring the continued provision of ecosystem services. Addressing climate change and biodiversity loss necessitates a comprehensive approach. Key measures include meeting the temperature target outlined in the Paris Agreement, reducing greenhouse gas emissions, promoting sustainable agriculture, adopting healthy and sustainable diets, improving forestry practices, reducing food waste, and enhancing carbon capture and storage. Additionally, the post-2020 global biodiversity framework aims to achieve biodiversity targets by 2030 and mitigate the impacts of climate change on biodiversity. This framework emphasizes the importance of effective and equitable climate action to minimize further loss and damage. By taking immediate and collective action, we can work towards a sustainable future. This future involves mitigating climate change, conserving biodiversity, and safeguarding the well-being of both humanity and the natural world.

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تغير المناخ و إنْدِثار التنوع البيولوجي: التحديات المترابطة والتدابير ذات الأولوية

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الملخص العربـــي

التغيرات المناخية هى تغيرات طويلة المدى في درجات الحرارة وأنماط الطقس بسبب التغيرات الطبيعية في الدورة الشمسية. ومع ذلك، فمنذ القرن التاسع عشر، أصبحت الانشطة البشرية هى السبب الرئيسي لتغير المناخ. ومن أهم مؤشرات التغيرات المناخية ارتفاع درجات حرارة الغالف الجوة ومياة البحر، وزبادة حدوث موجات الحر والعواصف، وذوبان األنهار الجليدية، وارتفاع منسوب مياة البحار والمحيطات، وكذلك التغيرات في أنماط الرياح وهطول األمطار، بما يسفر عن تغيرات في دورة حياة النباتات والحيوانات وهجرتها فضال عن تضرر الشعاب المرجانية وتناقصها. وتعزى المناخية بشكل عام إلى زيادة معدل انبعاثات ما يسمى بالغازات الدفيئة التى تسبب االحتباس الحرارى نتيجة امتصاص األشعة الكونية وخاصة تحت الحمراء. ومن ناحية أخرى، يغطي التنوع البيولوجي جميع مستويات التباين الطبيعى لألحياء من المستوى الجزيئي المتمثل فى الجينات إلى مستوى األفراد والجماعات واألنواع والنظام البيئية. والتنوع البيولوجى هو ثروة الحياة على األرض ويوفر السلع والخدمات األساسية لسكان األرض. وتصنف تلك الخدمات إلى أربعة أنواع تشمل خدمات توفير الموارد (Provisioning services) التى توفر الموارد الرئيسية للحياة على األرض، والخدمات الداعمة(services Supporting) ، وخدمات التنظيم (Regulation services) للحفاظ على النظم البيئية والحماية من المخاطر الطبيعية والمخاطر التي يسببها اإلنسان، والخدمات الثقافية (Cultural services) التي تلبى الجوانب الروحية للبشر. وينتظم التنوع البيولوجي على األرض أنظمة بيئية تتكون من تعايش المنتجات (النباتات) و المستهلكات (الحيوانات والكائنات الحية الدقيقة) المحللات وتفاعلها مع بعضها البعض ومع البيئة في سالسل غذائية من الكتلة الحيوية والطاقة فى مسارات تنتقل عبر المستويات الغذائية للنظم البيئية. وتتمثل التدابير ذات األلوية في تحقيق خفض ارتفاع درجة الحرارة بمقدار 1.5 درجة مئوية كما أوصى اتفاق باريس للمناخ (2021) بالحد من انبعاثات الغازات الدفيئة، والسيطرة على فقدان وتدهور النظم البيئية وصون األنواع، والحفاظ على الزراعة المستدامة، وتحقيق نظم غذائية صحية ومستدامة، وتحسين حالة الغابات والحراجة الزراعية، والحد من هدر الغذاء، وزيادة احتجاز الكربون وتخزينه فى األرض لوقف انبعاثه فى الفضاء. ويدعو اإلطار العالمي للتنوع البيولوجي لما بعد عام 2020 إلى تحقيق أهداف التنوع البيولوجي عام 2030، وتشتمل رؤية األمم المتحدة لعام 2050 على خطط طويلة األجل لتقليل آثار تغيرات المناخ على التنوع البيولوجي من خلال اقتراح إجراءات مناخية فعالة وعادلة من شأنها أن تقلل من المزيد من الخسائر واألضرار للتنوع البيولوجى