RESTORATION OF GLOBAL FORESTS AND BIODIVERSITY THROUGH GREEN ENERGY

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Abstract: During the exploration, loss of global forest and biodiversity, climate changes and emissions were evaluated and determined the best ways to restore the world's ecosystem using green energy. The suggested primary land use data were collected and collated forest resources were assessed. Ways of biodiversity conservation strategies and status were evaluated. The GHG emission was inventoried and calculated. Author inferred that primary forest loss in the tropics increased by 10% in 2022, with the Amazon destroyed in 2020. The world's forest cover is decreasing, with significant losses in sub-Saharan Africa and Latin America. The world's total growing stock of trees fell slightly from 560 billion m^3 in 1990 to 557 billion m^3 in 2020, with 606 Gt of living biomass and 59 Gt of dead wood. However, biomass per unit area has increased. During the period of incidence of COVID, reduced emissions by 5.2% was noticed. With a mean temperature of 1.11°C, 2021 was one of the seven warmest years on record. The main source of worldwide total GHG emissions from exclusive land use are CO_2, CH_4, and N_2, which account for 72%, 19%, and 6% of emissions respectively while F gases from other sources contribute only 3%. The forest ecosystems absorb 2 billion tons of CO_2 per year, and emissions can be reduced through natural synergies between climate preservation and development, such as increased energy demand and renewable energy.

Keywords: Biodiversity, Climate change, Forests, GHG, Renewable energy, Restoration.

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INTRODUCTION

Forests are the most important ecosystems on the planet because they support a diverse range of plant and animal species including micro-organisms. Forests cover 31% of the world's land surface, store an estimated 296 Gt of carbon and support the vast majority of terrestrial biodiversity (FAO, 2022). More than half of this green cover is found in Russia and Canada's boreal forests, South America's Amazon and China's coniferous and broad leaved forests. These carbon capture and storage forests clean the air, filter water, prevent soil erosion and serve as an important buffer against change in climate. In 2022, the tropics lost 4.1 Mha (10.1 million acres) of primary forest, a 10% increase over

2021. Over 104 Mha of pristine and intact forest landscapes have been lost since 2000. Over 10,000 Sq km of the Amazon were destroyed for road development alone in 2020 (Symington, 2023). A variety of human development related and anthropogenic activities including pollution, pesticides etc. contribute to deforestation, fragmentation and threats to biodiversity (Chaudhary *et al.,* 2021; Prakash and Verma, 2022; Singh *et al.,* 2023). However, change in climate is exacerbating the problem with more forest fires, hurricanes, droughts and other extreme weather events as well as invasive species and insect outbreaks and disrupting forest ecosystems.

The variability of life on Earth that may be conserved through *in-situ* and *ex-situ* conservation, which consists of the protection of plant, animal, microbial and genetic resources for food production, agriculture and ecosystem functions. Biodiversity is being lost due to habitat loss, resource overexploitation, and changes in climatic conditions, pollution, invasive exotic species, diseases, hunting and other factors (Kumar and Verma, 2017). It is important to conserve biodiversity because it provides numerous economic and ethical benefits as well as aesthetic value. The threats to biodiversity include habitat fragmentation, which stresses already scarce natural resources, deforestation, and annexation by invasive species and climate change (Khan, 2019).

Biodiversity is an important resource on the earth but a number of flora, fauna and microbes are slowly degrading and disappearing due to indiscriminate human activities. Global terrestrial forests account for 75% of terrestrial gross primary output and 80% of Earth's total plant biomass, encompassing 4.03 Bha or 30 % of the planet's total land area (Pan Yude *et al.*, 2013). During the year 2000, 2 Bha of forests have lost. The statistical profile of the world's forest assessment in 2015 showed 3999 Mha of forest area in 234 countries and territories, with an annual changing rate of 0.13% and a declining ratio of 31.6% from 4128 Mha since 1990 (Macdicken, 2015). Global Forest Watch estimated that the world had 3.92 Gha of tree cover in 2010 which covered more than 30% of its land area. It lost 22.8 m^2 of tree cover in 2022.

Forest biological diversity encompasses all life forms found in forested areas as well as the ecological roles they play. It can be viewed at various levels such as ecosystem, landscape, species, population and genetic. In fact genetic diversity acts as buffer for biodiversity (Ashok, 2017). This complexity enables organisms to adapt to changing environmental conditions while maintaining ecosystem functions. Many forests have more biodiversity than other ecosystems; hence forest ecosystems are an important component of the world's biodiversity. Forests cover 31% of the world's land area and provide critical habitat for millions of species. They are vital sources of clean air and water as well as crucial fighting against climate change.

Forests play an important role in reducing the likelihood of natural disasters such as floods, droughts, landslides and other extreme events. They also help to reduce climate change by storing carbon and protecting watersheds. However, every year, 13 Mha of forest are destroyed, and the continued deterioration of dry lands has resulted in the desertification of 3.6 Bha. Every year, the world's forests absorb 2.4 BMT of CO_2 accounting for one-third of the CO_2 emitted by the combustion of fossil fuels. Forest deterioration releases more carbon into the atmosphere, generating 4.3-5.5 $GtCO_2$ eq/yr annually. Protecting and repairing this massive carbon sink is critical for climate change mitigation (Yude, 2011). In 2018, energy related CO_2 emissions reached an all time high of 33.1Gt. According to the IPCC study, renewables are expected to supply 70-80 % of electricity in 2050 under 1.5°C global warming scenario (UN, 2019). Thus, it is crucial to take urgent action to combat climate change and its impacts on the protection of natural ecosystems and biodiversity because it has an effect on biodiversity and sustainable development (Verma, 2021).

Since 1900, the average surface air temperature has risen by about 1°C (1.8°F), with more than half of the rise occurring since the mid1970s. Global temperature could rise by more than 1.5°C (2.7°F) by 2030 as compared to pre-industrial levels (NAS and Royal Society, 2020). Climate change has a significant impact on biodiversity

by increasing the intensity and frequency of fires, storms, and droughts. This adds to the already existing threat to biodiversity posed by other human activities. Rising global temperature has the potential to change ecosystems over time by altering what may grow and live in them. Mangroves are significant carbon sinks and the Amazon is a massive carbon store. Protecting these natural carbon sinks from further damage is a critical component of limiting climate change. According to the US National Oceanic and Atmospheric Administration, carbon dioxide emissions from energy use, industrial processes, flaring and methane (in carbon dioxide equivalent) increased 5.7% in 2021 to 39.0 $GtCO_2e$, close to 2019 levels and CO_2 peaked at 421 ppm in May 2022 (NOAA, 2022).

Forests that are sustainably managed provide an important, renewable and carbon-neutral source of biomass for energy. Wood-based bioenergy plantations in comparison to other renewables such as solar, hydro and wind, require comparatively little capital or technological development and could be an especially efficient use of abandoned agricultural land and soils too poor to sustain annual crops. Agriculture, forestry and other land uses can reduce emissions while also removing and storing carbon dioxide on a huge scale. Thus, this study focuses on assessing human impacts on forests and biodiversity and determining how change in climate, GHG emissions can be reduced by using green energy and maintaining forest cover. However, the global environmental problems remain the same and are challenging to cope with due to climate change issues and the degradation of forests and biodiversity at an alarming rate.

Forest and land area: The FAO defines forest as 'land spanning more than 0.5 ha with trees higher than 5m and a canopy cover of more than 10%, or trees capable of reaching these thresholds *in situ* (FAO, 2015a). The FAO questionnaire on land use, irrigation and agricultural practices is used to collect data on land area. Data gaps can be filled by using national statistical yearbooks and other official government data portals. National and international sector reports filled in the gaps with additional information. Data with updated time series including the year 2020 for forest areas and forest land data from 2022 were used.

Biodiversity Conservation: Rewilding efforts were explored from a long-term perspective to ensure positive effects on biodiversity and resilient ecosystems for future generations. Ecological balance is necessary for rich biodiversity and human survival (Kumar, 2017; Verma, 2018). The study identified protection and management of biodiversity in order to obtain resources for long-term development in terms of preserving genetic and species diversity, maintaining life-supporting systems and important ecological processes and ensuring the sustainable use of species and ecosystems. Both *in-situ* and *ex-situ* biodiversity conservation were identified as contributing to the variability of life on earth. The important strategies for biodiversity conservation applied worldwide were reviewed and documented. A case study approach was chosen to address the research problem and ensure its comprehensive exploration with a variety of data collection and analysis procedures. It employed a combination of complementary methods including archival reviews and expert interviews, quantitative methods for the analysis of meteorological data and qualitative vulnerability assessment.

Greenhouse Gas Emission and Reduction: The COP-26 Summit in Glasgow was acknowledged as the world's last chance to keep 1.5 °C alive and academic research is critical to attaining this global aim. Countries, communities and businesses are increasingly pledging to achieve net zero emissions by 2050, eliminating as much CO_2 as they produce to limit global warming. Short and medium-term emission reduction targets are being set all over the world in accordance with the Paris Agreement in order to eliminate the worst effects of climate change. For this study, the information contained in GHG emission inventories submitted to the United Nations Framework Convention on Climate Change (UNFCCC), data from the World Bank and serving as the official statistics for international climate policies were evaluated.

The following methodology was used to determine annual greenhouse gas emissions per

mile. The carbon dioxide emissions per gallon of gasoline were divided by the average fuel economy of vehicles to determine the carbon dioxide emitted per mile traveled by a typical passenger vehicle. The carbon dioxide emissions were then divided by the ratio of CO_2 emissions to total vehicle greenhouse gas emissions to account for vehicle methane and nitrous oxide emissions.

Using the following formula, the CO_2 emissions were computed and confirmed from published literature. But because of rounding off, the computations provided in the equations might not provide the precise outcomes displayed. The heat content of the fuel per gallon is multiplied by the kg CO_2 per heat content of the fuel to determine the amount of CO_2 released per gallon of gasoline that burns. The carbon dioxide emissions per gallon of motor gasoline burned are 8.89×10^{-3} metric tons, as per the 'Gallons of gasoline' calculation. The carbon dioxide emissions per gallon of motor gasoline can be calculated using a methodology of dividing vehicle miles traveled by average gas mileage, multiplying gasoline consumption by carbon dioxide per gallon, and dividing emissions by the ratio of carbon dioxide emissions to total vehicle greenhouse gas emissions. The calculation is as follows:

8.89×10^{-3} metric tons CO_2/gallon gasoline $\times$ 1/22.2 miles per gallon car/truck average $\times$ 1 CO_2, CH_4 and N_2O/0.994 CO_2 = 4.03 x 10^{-4} metric tons CO_2e/mile (EPA, 2021).

Clean Energy and Forest Cover
The global data for clean energy was obtained from a statistical review of world energy. The problems and uncertainties confronting the global energy system are at their peak in nearly 50 years. According to BP's statistics in the Review of World Energy 2022, worsening shortages and rising prices underscore the need for energy 'security' and 'affordability' with 'reduced carbon' when solving the energy trilemma.

Primary energy consumption figures for non-fossil-based electricity (nuclear, hydro, wind, solar, geothermal, biomass power and other renewable sources) were calculated on an 'input-equivalent' basis that is based on the amount of fossil fuel required to generate that amount of electricity in a standard thermal power plant. According to the assessment, primary energy included economically traded fuels such as modern renewables used to generate electricity. On an input-equivalent basis, energy from all non-fossil power-producing sources was accounted (BP, 2022).

Global Forest Resource Assessment (GFRAs) was comparatively used for a comprehensive view of the world's forests. Indicators of Sustainable Development Goals (SDGs) were assessed in relation to the world's forests and the ways in which resources are changing, including the ways in which they are used.

Impacts and Implications: The impact of climate change on species and ecosystems in the study area was examined. Novel uses of two complimentary ecological modeling tools that each provide a wide measure of the ecological importance of future environmental change yield quantitative information about the scale of environmental change across the countries. To provide a measure of the potential for future environmental change to drive ecological change, indexes were used. Scaling is difficult because local surroundings are highly multidimensional and respond to changes in the environment in complex ways. Two methodologies were used in the study to quantify and project an ecological index of environmental change.

Neural networks were used to analyze patterns of species composition and vegetation classification across the European continent. GDM (Generalized Dissimilarity Modeling) was used to investigate biodiversity patterns across broad taxonomic groups. The methods are essentially similar, but they differ in that they employ a single index to compare contemporary ecosystems across locales. The description of the current level of the methodology applied for measuring the current level at the global level is based on assessments of the WMO (World Meteorological Organization) provided data for the year 2021. Both the current level and trend assessments made at the world level only are assessed for this study (WMO, 2019).

RESULTS AND DISCUSSION

Forests and Land area

The world's forest area is 4.06 billion hectares, accounting for 31% of the total land area. The tropical domain has the most (45%), followed by the boreal (27%), temperate (16%), and subtropical (11%). More than half is concentrated in five countries: the Russian Federation (815 Mha), Brazil (497 Mha), Canada (347 Mha), the United States of America (310 Mha), China (220 Mha), and the rest of the world (1870 Mha).

Forest cover decreased from 31.9% of the total land area in 2000 to 31.2% in 2020, representing a net loss of nearly 100 Mha. The global forest cover is continuing to decline, with significant losses occurring in Latin America and Sub-Saharan Africa. The data in Fig. 1 depict the annual net change rate in forest area from 2000 to 2010 and 2010 to 2020. The annual net change in forested area as a percentage of total forest area is measured by the forest area net change rate. Negative values represent a net loss of forest while positive values represent a net gain (UN, 2022a).

Fig. 1: In Sub-Saharan Africa, forest cover shrank at a faster rate between 2010 and 2020 than between 2000 and 2010.

According to the Chief Economist of the World Bank, Zhang Shuai, the world has failed to halt, protect and prevent the extinction of threatened species by 2020. A study assessing 71,000 animal species revealed a significant difference in conservation status with 48% declining, 49% stable, and 3% increasing, primarily in the tropics (Fig. 2).
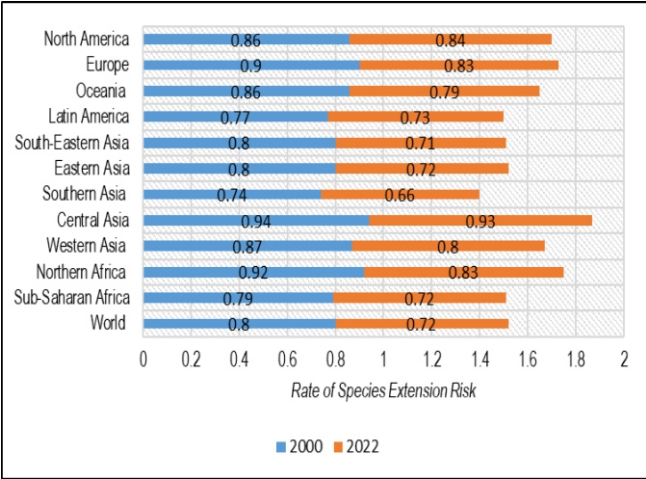

Fig. 2: Red list index shows that risk of species extinction is on the rise.

The integrated ground and Earth observation data used to map annual forest-related greenhouse gas emissions and removals globally at a spatial resolution of 30 m over the years 2001–2019 showed that global forests absorbed 7.6 49 Gt CO_2e yr1, reflecting balance between gross carbon removals (15.6 49 $GtCO_2$e yr1) and gross emissions from deforestation and other disturbances (8.1 2.5 Gt CO_2e yr1) (Harris, 2021).

According to the United Nations and World Bank, the rate of net forest loss in the world's countries has decreased from 7.8 Mha/year in the decade 1990 to 2000 to 5.2 Mha in 2000 to 2010 and 4.7 million ha per year in 2010 to 2020. According to the United Nations, the annual rate of deforestation in the world's forests has dropped to 10 Mha down from 12 Mha in 2010 to 2015. Since 1990, an estimated 420 million ha of forest have been lost worldwide, but the rate of loss has significantly decreased. Between 2010 and 2020, the global forest area decreased by 1.2%, with declines concentrated in Africa and South America. Asia, Europe, and Oceania have all seen net increases in forest area since 1990. Between 1990 and 2020, the rate of net forest loss decreased significantly (United Nations, 2021).

Food driven deforestation accounts for 27% of global forest loss with Southeast Asia experiencing a significant increase. Forestry, which contributes to 26% of global loss is vulnerable to poor management despite sustainable certifications. Slash and burns or agriculture accounts for 24% of global forest loss

with small clearings replaced with crops and abandoned over time. Wildfires which are a natural part of forest growth account for 23% of global forest loss with the majority occurring in northern latitudes as a result of lightning strikes and climate change. While urbanization is often focused on low-impact development, it accounts for less than 1% of forest loss, with urban deforestation being the least concerning category (Clay and Curtis, 2023).

The world lost 3.3 Mha of forest between 2010 and 2015. Poor rural women rely on a common pool of resources and are particularly vulnerable to their depletion. Pollinator loss threatens between $235 billion and $577 billion in annual global crop output. The loss of arable land is estimated to be 30 to 35 times the historical rate, with 12 Mha lost each year (23 Ha/minute). 20 million tons of grain could have been grown in a year. Globally, 74% of the poor are directly affected by land degradation. Of the 8,300 known animal breeds, out of which 8% have extinct and 22% are on the verge of extinction. Less than 1% of the over 80,000 tree species have been studied for potential use. Microorganisms and invertebrates play an important role in ecosystem services, but their contributions are rarely recognized (Díaz, 2019).

Between 1990 and 2015, the global forest area shrank from 31.7% to 30.7%. This loss was primarily the result of forest conversion to other uses, such as agriculture and infrastructure development. Planting, landscape restoration, and natural expansion returned other areas to forest. Protected areas covered 15.2% of the world's terrestrial and freshwater environments in 2014. Key biodiversity areas (KBAs) are places that make a significant contribution to the preservation of global biodiversity. Protecting KBAs around the world is critical for preserving genetic, species and ecosystem diversity. As of 2015, over 23,000 plant, fungus, and animal species were known to be on the verge of extinction as a result of forest conversion to other uses, such as agriculture and infrastructure development. Amphibian populations are rapidly declining in Latin America and the Caribbean. Southeast Asia has seen the greatest

increases in the risk of extinction for birds and mammals. Poaching and wildlife trafficking are sabotaging conservation efforts. At least 7,000 animal and plant species have been reported in illegal trade since 1999, affecting 120 countries. Wildlife trafficking affects all parts of the world, whether as a source, transit point or destination (UNstats, 2016).

Threats to Forests and Biodiversity
The variety and number of living species found in certain areas and across the globe consist of genetic variability, species diversity and ecosystem diversity (UNEP, 2022a). An ecosystem is a collection of living things that live in a certain environment (Kumar, 2016). There are many distinct species in the same habitat and there are many different ecosystems on the planet. Of the 8,300 animal breed recorded, part of which 8% have extinct and 22% are on the verge of becoming extinct. Less than 1% of the over 80,000 tree species have been examined for their potential uses. Drought and desertification cause the loss of 12Mha (23 hectares every minute) per year which might have produced 20 Mt of grain. Land degradation directly affects 74% of the world's poor. Agriculture supports 2.6 billion people yet soil deterioration affects 52% of agricultural land. Forests provide a living for around 1.6 billion people. More than 80% of all terrestrial animal, plant, and insect species can be found in forests. Forests cover 31% of the Earth's land an area of over 4 Bha encompassing 93% of natural and 7% of planted forests, and in addition to supplying food and shelter, forest resources are precarious in preventing climate change, safeguarding biodiversity and providing homes for indigenous people (UN, 2022b).

The FAO Questionnaire on Land Use, Irrigation and Agricultural Practices which is sent annually to 205 countries and territories, collects data on land area. Despite improved access to remote sensing data, forest re-growth or forests with low canopy cover density cannot always be detected. Over the period 1990 to 2020, the Forest and Rainforests Report (FRA) examines the status and trends of more than 60 forest related variables in 236 countries and territories. Data for FRA 2020 were collected in a transparent, traceable

reporting process using commonly agreed upon terms and definitions. More than half (54%) of the world's forests are concentrated in just five countries viz Russia, Brazil, Canada, China, and the United States of America. This equates to 0.52 ha per person, despite the fact that forests are not distributed equally among people or geographically. Since 1990, the world has lost 178 Mha of forest, an area roughly the size of Libya. Net forest loss has decreased from 7.8 Mha/year in the 1990s to 4.7 Mha/year between 2010 and 2020.

According to the UNEP (2021), Africa had the highest annual rate of net forest loss from 2010 to 2020 followed by South America. Oceania had the greatest net gain in forest area, but Europe and Asia had much lower net gain rates. The global forest area proportion fell from 31.9% of total land area in 2000 to 31.2 % in 2020, representing a net loss of nearly 100Mha (Table 1). Land conversion to agriculture has resulted in a decrease in forest area in Latin America, sub-Saharan Africa and south-eastern Asia (FAO, 2020).

Table 1: Forest area as a percentage of total land area.

Regions	2015 (%)	2020 (%)	Remarks
World	31.3	31.2	Decrease
Sub-Saharan Africa	28.5	27.6	Decrease
Northern Africa and Western Asia	4.6	4.6	No change
Northern Africa	3.6	3.5	Decrease
Western Asia	6.2	6.3	Increase
Central and Southern Asia	10.8	11.0	Increase
Central Asia	3.2	3.3	Increase
Southern Asia	15.5	15.7	Increase
Eastern and South-Eastern Asia	29.7	30.0	Increase
Eastern Asia	22.6	23.5	Increase
South-Eastern Asia	48.2	47.1	Decrease
Latin America and the Caribbean	46.7	47.4	Increase
Oceania	21.7	21.8	Increase
Australia and New Zealand	18.0	18.1	Increase
Oceania (exc. Australia and New Zealand)	76.7	76.5	Decrease
Europe and Northern America	41.1	41.2	Increase
Europe	45.9	46.0	Increase
Northern America	35.5	35.5	No change
Landlocked developing countries	17.0	16.6	Decrease
Least Developed Countries	27.2	26.3	Decrease
Small island developing States	73.4	73.3	Decrease

Source: Global Forest Resources Assessment and FAO STAT Database, Food and Agriculture Organization of the United Nations (FAO).

Greenhouse Gas Emissions and Reduction

In 2020, the top seven emitters (China, EU27, India, Indonesia, Brazil, Russian Federation and United States) together with international transport accounted for 55% of global GHG emissions. The least developed countries emit an average of 2.3 GtCO$_2$e per capita. High emitting households exist in all major economies and there are significant inequalities both within and between countries. Emissions from consumption

are also highly unequal between and within countries. The bottom 50% of households emits 1.6 $GtCO_2e$/capita on average and contributes 12% to global GHG emissions.

Global greenhouse gas concentrations reached new highs in 2020 and real time data indicate that this trend will continue. During the period of incidence of COVID, global carbon dioxide (CO_2) emissions were decreased by 5.2 % in 2020, totaling nearly 2 Bmt. The global mean temperature in 2021 was about $1.11^{\circ}C$ above pre-industrial levels (from 1850 to 1900) making it one of the seven warmest years on record (UNSD, 2022).

The major contributors to climate change are emissions of CO_2 and other GHGs like methane and nitrous oxide emitted by humans which are the world's most persuasive problems (IPCC, 2013). This relationship between global temperature and greenhouse gas concentrations particularly CO_2 has existed throughout Earth's history (Lacis, 2010). Carbon dioxide (CO_2) builds up in the atmosphere as a result of fossil fuel combustion and large-scale deforestation. Methane (CH_4) and nitrous oxide (NO_x) are gases produced by agriculture and animal husbandry (laughing gas, N_2O). These are among the gases with a high potential for global warming. The CO_2, CH_4, and N_2O, are the primary contributors to global total GHG emissions from exclusive land use, which contribute 72%, 19% and 6% respectively while F gases from other sources contribute 3%only (Jahw, 2018).

Global GHG emissions recovered from the COVID-19 pandemic in 2021, with emissions of six Kyoto greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) rising from 47.3 Gt in 2020 to 49.5 Gt in 2021, a 4.6% increase over 2020 levels. This rebound was caused in part by an increase in the carbon intensity of the economy. From 2019 to 2021, methane and nitrous oxide emissions remained stable while fluorinated gases increased. Global GHG emissions have increased over the last decade but at a slower rate than in the previous decade. Human activities have an impact on terrestrial sinks through land use, land-use change, and forestry (LULUCF), altering the CO_2 exchange (carbon cycle) between the terrestrial biosphere and the atmosphere. In 2020, the LULUCF sector was a net sink in 17 G20 member countries including China, United States of America, India and the EU27. Emissions per capita vary greatly across countries. In 2020, the global average per capita GHG emissions were 6.3 tones of CO_2 equivalent (tCO_2e). The United States continues to be far above this level, with 14 tCO_2e, followed by Russia with 13 tCO_2e, China with 9.7 tCO_2e, Brazil and Indonesia with around 7.5 tCO_2e, and the European Union with 7.2 tCO_2e (UNEP, 2022b).

For each group of greenhouse gases, average annual emission levels in the last decade (2010 to 1910) were higher than in any previous decade (high confidence). The magnitude and rate of these increase varied by gas when compared to 1990. CO_2 emissions from fossil fuels and industry (FFI) increased by 15 $GtCO_2$-eq yr-1, while CO_2 emissions from LULUCF increased by 1.6 $GtCO_2$-eq yr-1 depicted in table 2.

Table 2: Global net anthropogenic GHG emissions (GtCO2-eq yr–1) 1990–2019.

Drivers	2019 emissions (GtCO$_2$-eq)	1990–2019 increase (GtCO$_2$-eq)	Emissions in 2019, relative to 1990 (%)
CO$_2$-FFI	38 ± 3	15	167
CO$_2$-LULUCF	6.6 ± 4.6	1.6	133
CH$_4$	11 ± 3.2	2.4	129
N$_2$O	2.7 ± 1.6	0.65	133
F-gases	1.4 ± 0.41	0.97	354
Total	59 ± 6.6	21	154

Greenhouse gases include Carbon dioxide, Methane, Nitrous oxide and Fluorinated gases. The Carbon dioxide (CO_2) enters the atmosphere

through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products and is also emitted as a result of other

chemical reactions (e.g. the manufacture of cement). Methane (CH_4) emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Nitrous Oxide (N_2O) emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. The fluorinated gases i.e. hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6) are synthetic chemical compounds with high global warming potential (much higher than CO_2, CH_4, and N_2O) that are used and released in a wide variety of commercial products and industrial processes (such as refrigerants, solvents, aerosol propellants,

insulating foams, fire suppression agents, and heat transfer agents).

In 2018, global carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions all reached new highs. The CO_2 increase from 2017 to 2018 was very similar to that observed from 2016 to 2017 and was nearly equal to the average annual increase over the previous decade (Table 3). The table 3 shows the global annual surface mean abundances and trends of key greenhouse gases as measured by the GAW global GHG monitoring network in 2018. Uncertainties are within 68% confidence limits and units are dry-air mole fractions (Conway *et al.,* 1994). GAW Report No. 184 describes the averaging method (WMO, 2009). The analyses are carried out at 129 stations for CO_2, 127 for CH_4, and 96 for N_2O.

Table 3: Global annual surface mean abundances and trends of key greenhouse gases.

GHGs	2018 global mean abundance	2018 abundance relative to year 1750*	2017–2018 absolute increase	2017–2018 relative increase	Mean annual absolute increase over the last 10 yrs.
Co$_2$	407.8±0.1 ppm	147%	2.3 ppm	0.57%	2.26 ppm yr–1
CH$_4$	1869±2 ppb	259%	10 ppb	0.54%	7.1 ppb yr–1
N$_2$O	331.1±0.1 ppb	123%	1.2 ppb	0.36%	0.95 ppb yr–1

*Assuming a pre-industrial mole fraction of 278 ppm for CO_2, 722 ppb for CH_4 and 270 ppb for N_2O.

Science suggests that global emissions should be cut by 45% by 2030 as compared to 2010 levels in order to limit global warming to 1.5°C. Emissions from developed countries fell by about 4% in 2018 as compared to 2010, while emissions from developing countries increased by 14.4% in 2014. As a result, all communities must step up their efforts to meet the Paris Agreement's goals.

Projected global emissions from NDCs announced prior to COP 26 would increase the likelihood of warming exceeding 1.5°C and make it more difficult to limit warming to less than 2°C after 2030 (IPCC, 2022a). The report concludes that for some scenarios, returning to below 0.85°C in 2100 is impossible and that mitigation after 2030 can no longer establish pathway that limits global warming to 1.0°C. Although the EPA defines toxic and hazardous material reduction as the elimination of toxic or hazardous material generation in the process including inputs, byproducts, wastes, releases and discharges and

reducing the use of raw materials such as energy, water or other resources.

According to the IPCC's sixth Assessment Report realized carbon dioxide removal (CDR) may play three complementary roles globally or at the country level lowering net CO_2 or net GHG emissions in the short term, offsetting difficult to abate residual emissions to achieve net zero emissions in the mid-term and achieving net negative emissions in the long term if deployed at levels greater than annual residual emissions (IPCC, 2022b).

Unless significant emission reductions are achieved quickly, the remaining carbon budget for limiting global warming to 1.5°C will be depleted by the end of this decade. In this context, there is growing interest in the potential contributions made by reducing short reducing methane emissions from fossil fuels and other sources by at least 30% is a critical component of

Paris compatible mitigation strategies. The fossil fuel sector has the greatest potential for reducing methane emissions followed by the waste and agriculture sectors (UNEP, 2021). According to the Intergovernmental Panel on Climate Change, human activities must be carbon neutral by 2050, with significant mitigation coming from land-based options. Stopping deforestation could reduce direct emissions while also preserving forests' carbon absorbing capacity. Globally threatened ecosystems contain 260 Gt of irreversible carbon, with an estimated 289 Mha deforested between 2016 and 2050. Agriculture is responsible for 90% of global deforestation which is fueled by poverty and unsustainable practices. Stopping deforestation could prevent emissions at a low cost equivalent to 14% of the additional mitigation required by 2030.

Clean Energy and Forest Cover
The use of renewable and other ecologically friendly energy sources to generate electricity on-site may reduce greenhouse gas emissions. Exemplifications include rooftop solar panels, solar water heating, small-scale wind generation, natural gas or renewable hydrogen energy cells and geothermal energy. Transportation is the largest source of hothouse gas emigrations. Greenhouse gas exoduses come from industries including from making iron and sword, cement as well as aluminum. Exoduses come from crop husbandry, similar to rice or sludge, and from the beast. Further, greenhouse gas emigrations in soil and shops than it might emit. Climate change will continue and accelerate in the times ahead with significant impacts on the health of our abysses, timbers, freshwater and our municipalities and metropolises. While must reduce hothouse gas emigrations to avoid the worst impacts of climate change also have to prepare for impacts like the ocean position rise and further frequent and violent extreme rainfall that can't avoid.

To combat climate change, it's crucial to limit greenhouse gas emissions like carbon dioxide, and multiple solutions are needed rather than a single solution. Individual action and collective efforts can significantly reduce greenhouse gas emissions, as electricity usage accounts for 25% of global emissions. Renewable energy sources like solar, wind and biomass can reduce carbon

dioxide emissions. Consuming a plant-based diet and reducing food waste can save about 90Gt of CO_2 over 30 years. Fossil fuels emit harmful pollutants, and emissions must be regulated or traded.

Most of the ways from place to place currently rely on fossil fuels. Burning fossil fuels for transportation adds up to 14% of global greenhouse gas emissions worldwide. Public transportation, carpooling, biking and walking reduce the amount of carbon dioxide that is added to the air but also increase the amount that is removed. The places where carbon dioxide is pulled out of the air are called carbon sinks. Conserving forests, grasslands, peat lands, and wetlands are important carbon sink areas. The earth heats up faster and achieves a greater temperature in deforested areas resulting in localized upward motions that boost cloud formation and eventually create more rainfall.

Tropical deforestation accounts for roughly 20% of global greenhouse gas emissions. Deforestation may also result in the release of carbon stored in the soil. Land use mitigation projects that attempt to reduce emissions and improve greenhouse gas removal also aim to improve income, livelihoods and ecosystem services. Ecosystem services, including climate change mitigation, water, carbon, and nutrient cycle maintenance, weather regulation, and marine life protection, are crucial for socio-economic development and enhancing human and environmental resilience. Surface water runoff which moves quicker than subterranean flows becomes a problem in deforested areas. This may cause flash flooding and more localized flooding. In 2015, the United Nations established Sustainable Development Goal 15 to combat deforestation, desertification, land restoration, biodiversity protection and poaching and wildlife trafficking. It employs four indicators to ensure long-term livelihoods for future generations. Agriculture is a valuable economic resource because it accounts for 80% of the human diet (UNDP, 2020). Forests cover 30% of the Earth's surface provide vital habitat for millions of species are important sources of clean air and water and are critical while fighting against the climate change.

Achieving SDG 15 will necessitate resolving causes and trade-offs in order to improve land life and accommodate broader community ideals (UNFCC, 2022). Climate change may reduce food production in certain areas while creating new opportunities in others (Lobell *et al.,* 2011; 2013). Between 1990 and 2015, worldwide forest cover fell by 3.1% to 30.6% of global land area. Deforestation in the tropics remained higher with 5 to 6Mha lost annually during the same period. Since 2010, the rate of forest loss has reduced but there remain substantial regional variances (FAO, 2015b).

Commercial agriculture has surpassed subsistence farming as the primary driver of change in the tropics and subtropics. In recent years, commercial agriculture has been responsible for 70% of deforestation in Latin America compared to 30 to 35 % in tropical Asia and Africa (Kissinger, 2012). In many regions of the world, forest land has risen with most of this due to the spread of industrial tree plantations. Except for Europe and North America, the volume of wood collected is increasing in every location. Addressing rising wood demand in the tropics may eventually necessitate more intensive forest management.

Similarly, climate action is another focus of Sustainable Development Goal 13 (SDG 13 or Global Goal 13), one of 17 Sustainable Development Goals established by the United Nations in 2015. SDG 13 has five targets that must be met by 2030. This goal's official mission statement is to take immediate action to combat climate change. In 2021, the global average temperature was approximately 1.1°C higher than pre-industrial levels (from 1850 to 1900). The seven warmest years on record occurred between 2015 and 2021 with the top three being 2016, 2019 and 2020 (UN, 2021; Martin, 2022). Switching to renewable energy and improving end use energy efficiency are two of the most important sources of greenhouse gas savings that countries must prioritize (UN, 2022c). Greenhouse gas emissions from developed countries and transition economies fell by 6.5% between 2000 and 2018. To meet the Paris Agreement's maximum target of 1.5°C or even 2°C, greenhouse gas emissions must begin to fall by 7.6% per year beginning in 2020 (UN, 2020).

Forest ecosystems are the most significant terrestrial carbon sinks, absorbing approximately 2 Bmt of CO_2 per year. There are numerous approaches to reducing carbon emissions but the most promising are those that leverage natural synergies between climate preservation and development. Many of these are related to energy demand (e.g. efficiency and conservation, education and awareness) whereas others are related to energy supply (i.e. renewable options).

Renewable energy sources such as bioenergy, solar energy, geothermal energy, hydropower and wind energy have the potential to mitigate climate change. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) concludes that the majority of the observed increase in global average temperature since the mid-20th century is very likely due to anthropogenic greenhouse gas (GHG) emissions. Greenhouse gas emissions from the provision of energy services have significantly contributed to the historic increase in atmospheric GHG concentrations.

CONCLUSION
The world's forest area, which accounts for 4.06 Bha (31%) of the total land area and stores 296 Gt of carbon, is rapidly being deforested and degraded, resulting in biodiversity loss. Despite a decline in deforestation and net forest loss rates over the last three decades, land-use changes have reduced 178 Mha since 1990. Since 1990, primary forests have declined by more than 80Mha, owing primarily to factors such as forest fires, pests, diseases, invasive species, droughts, and extreme weather events. Biodiversity or the variety of life on Earth is diminishing as a result of habitat loss, resource overexploitation, and changes in climatic condition, pollution, diseases and hunting. Forests play an important role in mitigating natural disasters and climate change by storing carbon and protecting watersheds. Conserving forests and biodiversity by promoting sustainable forest management benefits both people and the environment by supporting livelihoods, providing clean air and water, conserving biodiversity, and responding to

climate change. Emissions and the processes that cause them must be quantified as part of management and accountability mechanisms. Renewable energy sources and improved energy efficiency are crucial for reducing greenhouse gas emissions. Countries must prioritize these sources to prevent climate change.

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