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# Forest cover and climate change

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**Abstract**

The loss of forest covers is a result of bad land use management and climate change alterations increased drastically in the last decades and observed in all over the world. Climate change mitigation is a vital task nowadays and many strategies are developed in terms of politics, limit to pollution factors, and implementations of new technologies in order to mitigate the negative trends. Forest recovery and reforestation are one of the best in long term approaches to reduce global warming and climate amendments. Remote sensing helps to assess the results of those actions. The goal of this review paper is to describe the state of forest cover damages and to give some trends and models that are being apply for monitoring and management in that area of study.

**Keywords:** Forest Transition Model, climate change, net forest lost, reforestation.

## The importance of forest cover for mitigating climate change

The forest is a national resource with a great social profit (Chand 2022). Forestcover is one of the most important factors connecting to the sustainable development of thehumanity and ecosystems on the planet.The forests are supplying benefits, such as clean air and water, placesfor restoration, wildlife habitats, carbon storage, climate improvements, and forest products (CCSP 2008). Forests are the best natural solution for removing the carbon dioxide from the atmosphere and retention of climate change.Forestsand oceans are considered as "carbon sinks" (Morrisand Chapman 2022). The Global Forest Watch project (GFW) deduces that between 2001 and 2020, global forests emitted 8.80Gt$CO_2$e/year, and removed -16.3Gt$CO_2$e/year.This represents a net carbon flux of -7.53Gt$CO_2$e/year.The researchers also point that increasing and recovering the forest lost can provide up to 30% of the solution of keeping global warming below 2° C (GFW 2022).

The commercial use of forests has reached such an extent that it has became a threat to the environment (Chand 2022)due to following major impacts:

- Increase in temperature;
- Lesser precipitation;
- Increased rate of soil erosion;
- Increase in frequency and volume of floods;
- Loss of soil productivity;
- Extinction of several species;
- Non-availability of several essential forest products;
- Imbalance in ecosystem.

Forests are a cost-effective solution for mitigating climate change.Climate change directly and indirectly affects the productivity and distribution of forests by changes in temperature, precipitation, increasing the frequency and intensity of wildfires, storms, insect outbreaks, and the occurrence of invasive species (EPA 2017).The anthropogenic pollution and inadequate politics can accelerate the climate change, frequency and severity of extreme events, which cause widespread adverse impacts and damages to nature and people (IPCC 2022).Forest cover mitigates the worst climate conditions, decrease high temperatures, decreased wind speed and drying of land, stabilize rain precipitations locally, improve soil quality and prevent from erosion, stabilize ecosystems and biodiversity.

The article aims to evaluate the research opinions about the current environmental state and the supposed adequate ways to protect Earth's ecosystem in equilibrium.

## Net forest lost in the world over the last decades

The net change in forest cover measures any gains through natural forest expansion or afforestation through tree-planting – minus deforestation (Ritchie and Roser 2021). According to the Global forest watch (GFW) for the 20 years period of time (from 2002 to 2021), 16% of forest resources were lost, that is approximately 68.4Mha forest lost globally.According to Crowther et al., (2015), every yearabout 15 billion trees are cutting down, so it decreased forest total area by 6.7% worldwide. Using satellite imagery, The Global Forest Watch project, estimates that global tree loss in 2019 was 24 million hectares, area in size of the United Kingdom (Ritchie and Roser2021).The two common reasons for forest lost are deforestation and wildfires.

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**Deforestation**

Deforestation is a human action applied throughout history and into modern times. Forests have been planted and cut to use the land for agriculture or animal grazing, to obtain timber or for urban activities. Deforestation altered landscapes and climate. Before 2,000 years approximately 80% of Western Europe was forest; today is about 34%. In North America, half of the forests in the eastern part of the continent were cut down from the 1600s to the 1870s for timber and agriculture. China has lost great expanses of its forests over the past 4,000 years and now just 20% of it is forested. Forest cover and vegetation loss cause climate change, desertification, soil erosion, decreasing crops variability, increasing flooding, and greenhouse gases in the atmosphere (Stanley 2022; figure 1).

In the last ten years (2012-2022), droughts, tropical storms, heat waves and fire weather are increasing in harshness and frequency, because of climate change. The worst effects of climate changes will continue to result in expansion of forest losses that contribute to more and more carbon dioxide being released into the atmosphere (Dean, 2021; figure.1).

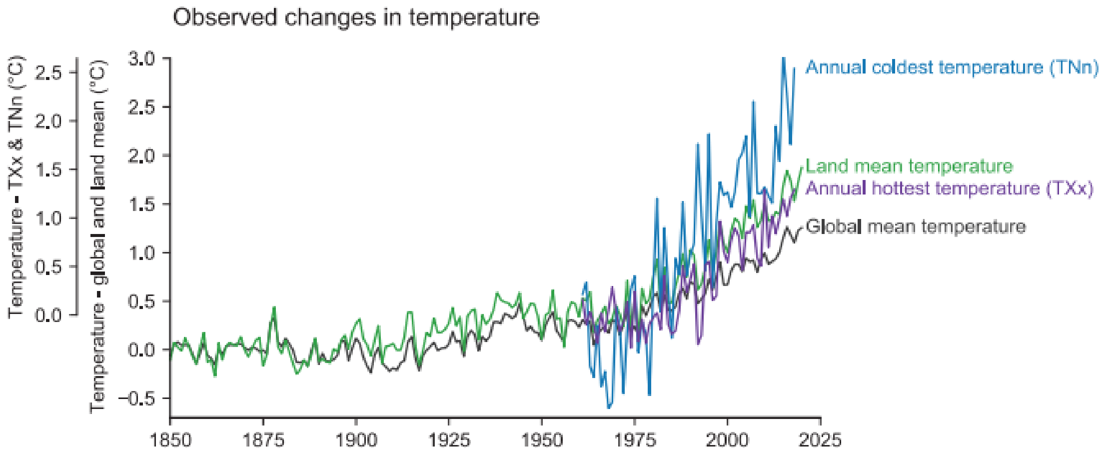


**Figure1**.Time series of observed temperature anomalies for global average annual mean temperature (black), land average annual mean temperature (green), land average annual hottest daily maximum temperature (TXx, purple), and land average annual coldest daily minimum temperature (TNn, blue) (Seneviratne et al., 2021).

As an example , India today (Yadav,2022), is in the grip of burning heat waves with the maximum temperatures crawling towards 50 degrees Celsius in the major parts of the country(table 1).

**Table 1.**

| **Localities/Indian cities** | **Temperatures $^0$C** |
|---|---|
| Mungeshpur, Delhi | 49.2 |
| Najafgarh, Delhi | 49.1 |
| Banda, Uttar Pradesh | 49.0 |
| Gurugram, Haryana | 48.1 |
| Churu, Rajasthan | 47.9 |
| Pilani, Rajasthan | 47.7 |
| Jhansi, Uttar Pradesh | 47.6 |
| Ganganagar, Rajasthan | 47.6 |
| Narnaul, Haryana | 47.5 |
| Khajuraho, Madhya Pradesh | 47.4 |

India suffered its hottest March in more than 100 years; and April recording unusually high temperatures in excess of $45^0$Celsius on most days (Yadav 2022).

The UN's Intergovernmental Panel on Climate Change (IPCC)caring our assessment of planet's future, 234 scientists from 66 countries highpoints that human impact warmed the temperatures of planet at a rate that is unprecedented in at least the last 2,000 years. In 2019, atmospheric $CO_2$ concentrations were higher than at any time in at least 2 million years, and concentrations of methane and nitrous oxide were higher than at any time in the last 800,000 years (https://news.un.org/en/story/2021/08/1097362).

The IPCC made sixth assessment cycle and releasedthe Sixth Assessment report(AR6),enclosing \three Special Reports, a Synthesis Report, and latest Methodology Report:

- *Climate Change 2021:* The Physical Science Basis - 9 August 2021 - Working Group I;
- *Climate Change 2022:* Impacts, Adaptation and Vulnerability- 28 February 2022 - Working Group II;
- *Climate Change 2022:* Mitigation of Climate Change- 4 April 2022 - Working Group III;
- *Synthesis Report*- scheduled to be released in September 2022.

According to the IPCC Sixth Assessment Report, Chapter 11 with the climate change signs of weather-related disasters will become more intensive and frequent as: *Temperature Extremes; Heavy Precipitation and Pluvial Floods; River Floods; Droughts; Extreme Storms, Including Tropical Cyclones; Compound Events, Including Dry/Hot Events, Fire Weather, Compound Flooding, and Concurrent Extremes*(Seneviratne et al., 2021).

The best natural tool supposed for mitigation and retarding the drastic amendments on the ecosystems and weather related disasters is reforestations and slowing down the speed of deforestation (figure 2).

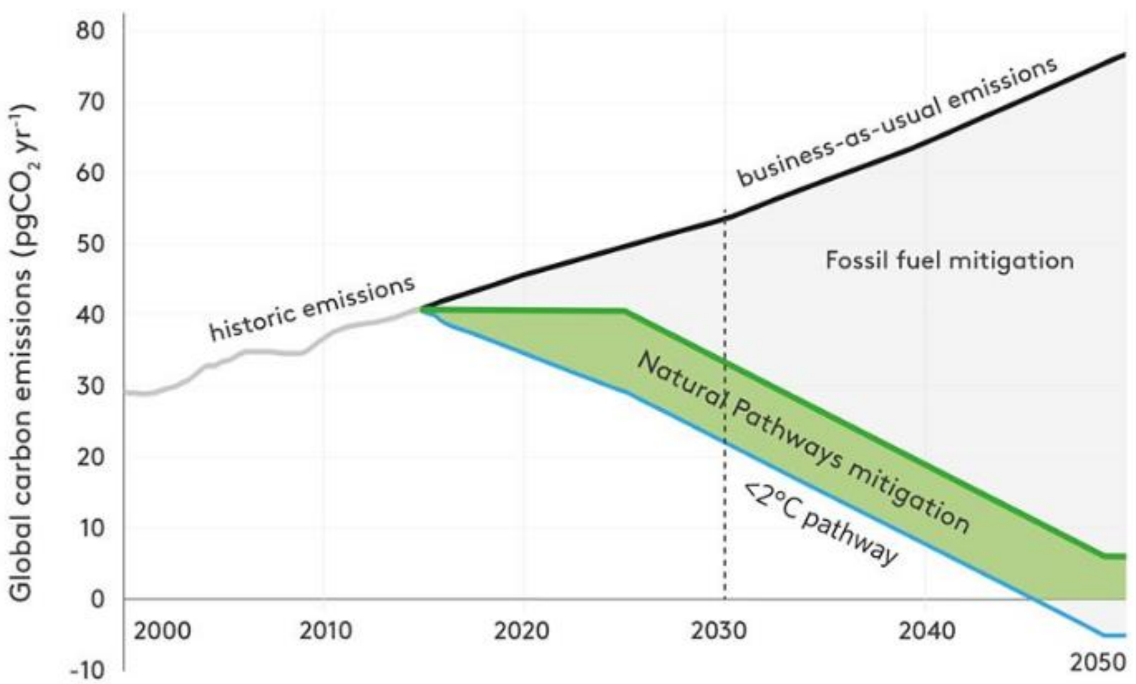


**Figure 2.** Contribution of natural climate solutions (NCS) to stabilizing warming below 2°C. According to the Copernicus Climate Change Service, the humanity will reach a warming of 1.5°C on January 2034 (figure 3)

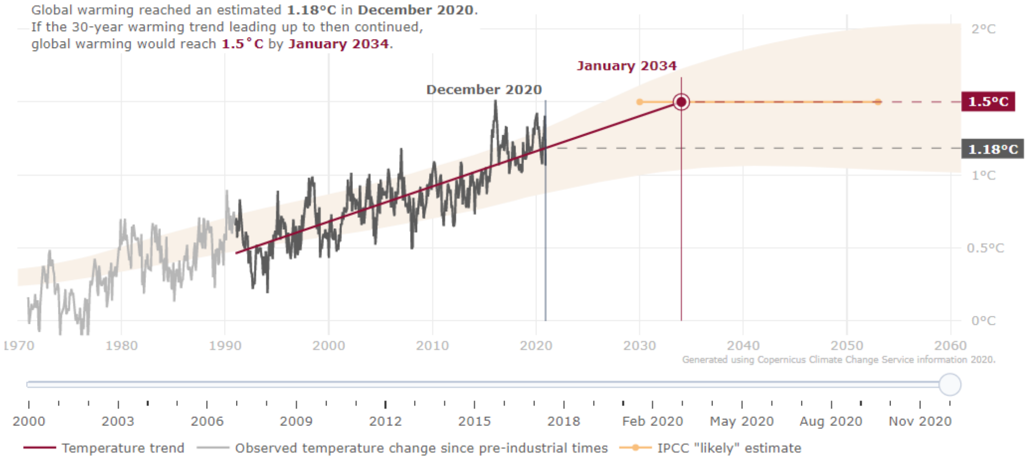


**Figure 3.** A screenshot from the application. The yellow shaded area represents the uncertainty of the estimated 30-year average associated with past climate data and future climate projections and the orange line shows the likely estimate of when we will reach a warming of 1.5°C. Both are from the IPCC report, 'Global warming of 1.5°C'. Credit: Copernicus Climate Change Service, ECMWF.

**Wildfires**

Global warming and improper land use pattern accelerates wildfire events in the last decades and will be major problems in the future. In 2011, wildfires consumed more than 8 million acres of forest in the U.S., causing 15 deaths and economic loss about \$1.9 (EPA 2017).Fires contribute to climate change; they released extremely large emissions of carbon dioxide and other different pollutants to the atmosphere (CCSP 2008; figure 4).There is a well-known worsening cycle: Climate change carries drought and higher temperatures, fires start and spread easy, emits more climate-changing carbon into the atmosphere and speeds the rising of temperatures (Brown 2022).

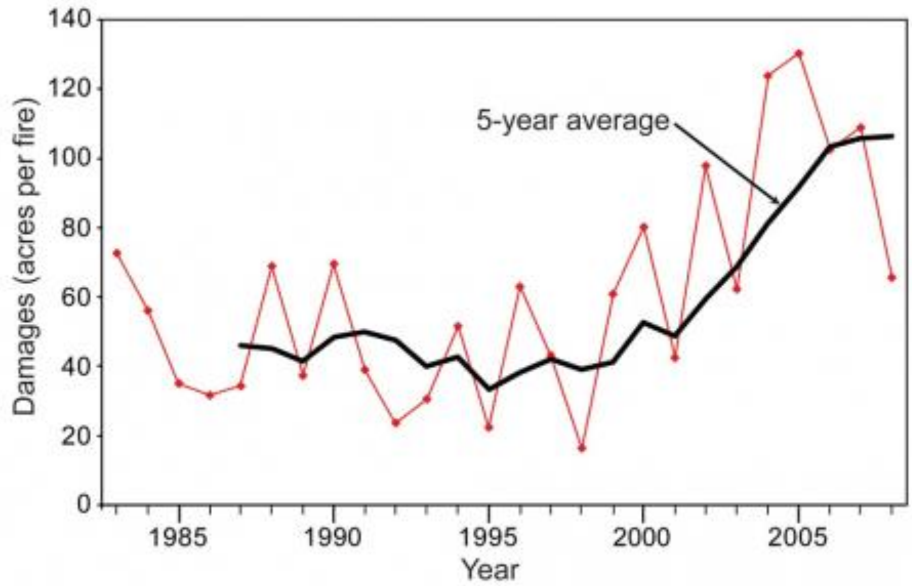


**Figure 4.**Annual wildfire-burned area (in millions of acres) from 1983 to 2015 (the two lines represent two different reporting systems, shown for comparison; CCSP 2008).

The impacts of climate change on vegetation and atmosphere, and for monitoring the fires, scientists use several low Earth-orbit satellites, including the Copernicus Sentinel-3. According to the Center for

Research on the Epidemiology of Disasters, at least 470 wildfire disasters – incidents that killed 10 or more people or affected more than 100 – have been reported globally since 1911, causing at least $120bn in damages (figure 5).During 2021 the registered temperatures in Europe were the highest in the history. On August 12, a monitoring station in Sicily reported of $48.8^{0}$C ($119.8^{0}$F). Several countries informed for their worst fires in decades – Algeria, Turkey, France, Greece, Italy, Spain and other. In Greece, more than 500 fires forced the evacuation of thousands of people as forests were scorched by wildfires in Evia, Peloponnese, and Attica, including around the capital Athens. In Italy the fires were more than 500 in Sicily and the southern Calabria region(HaddadHussein 2021).

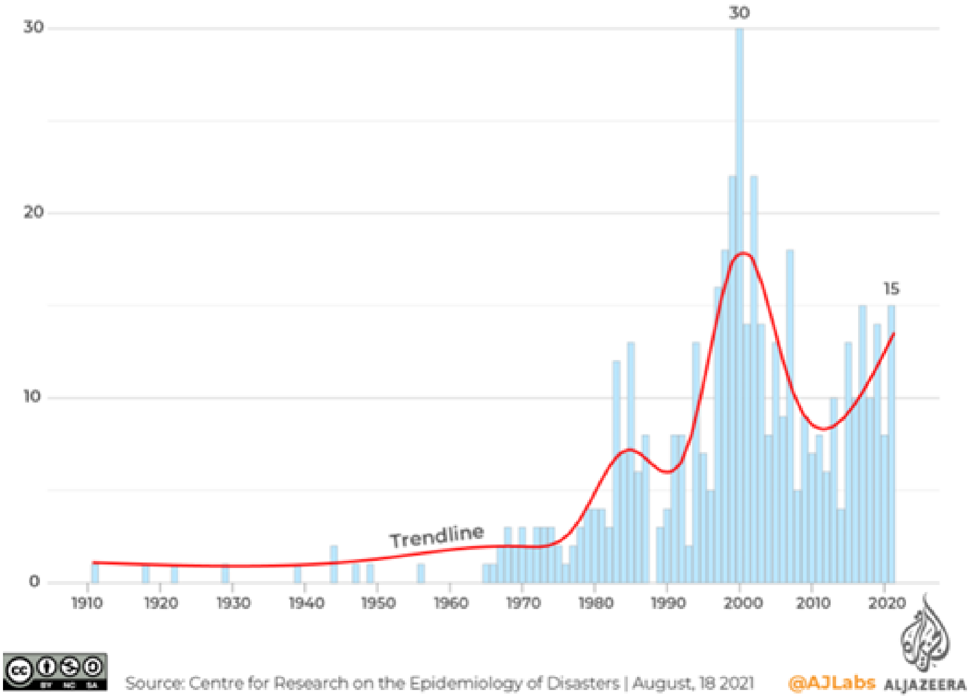


**Figure 5.**U.S. Wildfire statistics and trends (Haddad Hussein 2021).

## Sustainable Forest Management and Forest Transition Model

### Sustainable Forest Management

The Sustainable Forest Management has broad social, economic and environmental goals; Mondal(2022)suggested inclusion of following points for forest conservation:

- *Conservation of forest is a national problem so it must be tackled with perfect coordination between forest department and other departments;*
- *People's participation in the conservation of forests is of vital importance. So, we must get them involved in this national task;*
- *The cutting of trees in the forests must be stopped at all costs;*
- *Celebrations of all functions, festivals should proceed with tree- plantation;*
- *Cutting of timber and other forest produce should be restricted;*
- *Grasslands should be regenerated;*
- *Forest Conservation Act, 1980 should be strictly implemented to check deforestation;*
- *Joint Forest Management (JFM);*
- *Agro-forestry;*
- *Social Forestry.*

New programs, projects and methods are developed and applying for keeping the forest resources and ecological balance.

### Forest Transition Model

The turnaround in long-run land-use trends from net deforestation to net reforestation is defined as a forest transition (Mather, 2008 and Barbier et al., 2017). Forest transition describes the status of forest dynamic between forest net loss to net gain ona given region (Mather, 1992), linking deforestation to the demographic and economic growth of the country, and market (Robbins 2011and Hecht et al., 2014). One of the common reasons of deforestation is felling of trees for trade (Chand, 2022). The forest transition model claims that as a society advances to later stages of demographic and economic transitions, reforestation begins to outpace deforestation (Timms et al., 2012). The theory explained that population growing cause deforestation and after realization of economic status starts activities for forest recovery (Mather, 1992; Mather, 2008; Robbins, 2011; Hecht et al., 2014 and Chand 2022).

Forest Transition Model gives information about the state of forest cover on a planet, and separated four different trends:*pre-transition*, *early transition*, *late transition* and *post-transition*(Hosonuma et al., 2012; figure.6).

- *Pre-transition countries* - have high forest cover and low deforestation rates;
- *Early-transition countries* - loss of forest cover has a high speed;
- *Late-transition countries* - the deforestation rate start to lower and small fraction of remaining forests exist;
- *Post-transition phase*– the change rate of forest area becomes positive and forest cover increases through reforestation.

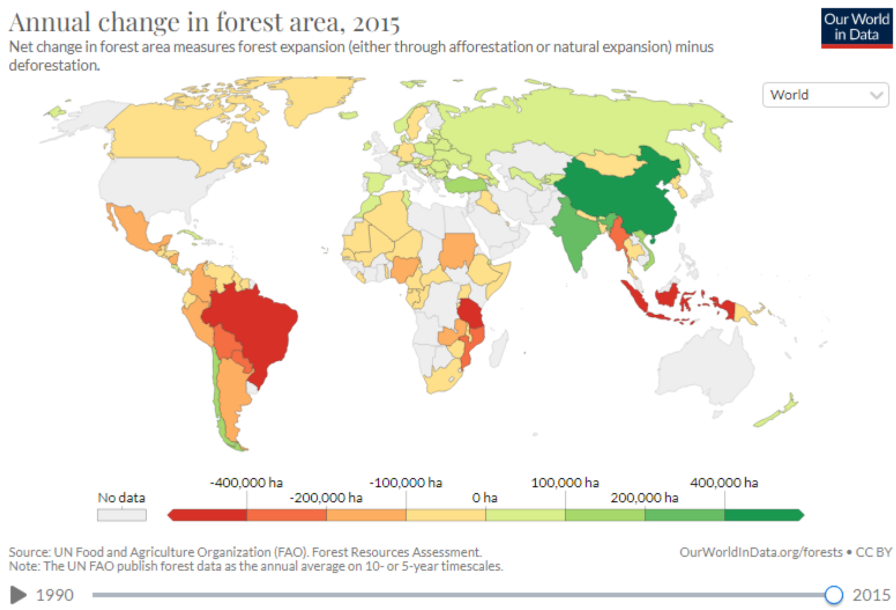


**Figure 6.**Forest transition model – transition phase (Pendrill et al., 2021;Ritchie Hannah and Max Roser, 2021).

In the last decades remote sensing has become an incredible tool for global forest monitoring, but like all tools has limitations.Countries with low deforestation rates can be classified as pre- or post-transition depending on forest cover percent, or if net reforestation is occurring. Countries with high deforestation rates can be classified as early-transition, or late-transition if gross deforestation is increasing and remaining forest cover is not too low(Pendrill et al., 2021). Sometimes false positive or negative rate around 12-13% at a global scale can be produced. Refining the automated algorithms, applying higher resolution imagery to calibrate and validate monitoring outputs of algorithms, the comparison of different time series will allow more accurate detection and determination of the regrowth patterns, differentiation between crops, grasslands, plantations, and natural tree/shrub recovery dynamics and distinguishing between early regrowth, mature regrowth, crops, and other states (Hansen et al., 2013).

Forest transition theory also has limitations in its concept of forests, explanation for forest transitions, and its generalizability (Perz, 2005).According to Chand (2022), the conservation management of forests, included:

- *Regulating and Planning Cutting of Trees;*
- *Control over Forest Fire;*
- *Reforestation and Afforestation;*
- *Check over Forest Clearance for Agricultural and Flabitation Purposes;*
- *Protection of Forest;*
- *Proper Utilisation of Forest Products and Forests.*

## Conclusions

The sustainable development related to the eco-balance and forest recovery. Slowing down the speed of deforestation and increasing reforestations is the best naturalin long-time tool proper for mitigation the worst effects of climate change and retarding the amendments of ecosystems. The researchers believe that increasing and recovering the forest cover lost can provide up to 30% of the solution of keeping global warming below 2° C.Recovering the forest cover is a profitable solution for mitigating global warming negative effects and stabilizing the climate and that is important for the sustainable development. Monitoring, precise assessment, global collaboration and adequate politic can prevent fromfuture worsening of the climate change, andweather-related extreme events.

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