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# The Roadmap to Achieving Climate Neutrality in Türkiye: A Comprehensive Analysis of Long-Term Forestry Strategies

***Yusuf Serengil***✉

*İstanbul University-Cerrahpaşa, İstanbul/TÜRKİYE*

✉***Correspondence:*** serengil@iuc.edu.tr

**Abstract:** In 2021, Türkiye ratified the Paris Agreement and committed to achieving climate neutrality by 2053. As mandated by the agreement, Türkiye submitted its first Nationally Determined Contribution (NDC) and has been conducting simulations to identify alternatives to establish its Long-Term Strategy (LTS). Our study focused on the LULUCF (Land Use, Land Use Change, and Forestry) sector of Türkiye, mainly focusing on forestry. Our analysis shows that the forests in Türkiye offset approximately 8-10% of the country's total greenhouse gas emissions in 2021, down from over 20% in 2014. This reduction in offset percentage is due to a drop in the removal rate of forests over the last ten years. To achieve climate neutrality, this trend of reduction must be reversed. Recent inventory data shows that forest management is the central activity, with afforestation and other land use activities contributing less than 1%. However, when analyzing their effectiveness, it is important to consider the co-benefits of mitigation policies and measures. Our study concluded that Türkiye should prioritize forest management, including wildfire prevention and improved use of wood products, by investing in research and innovation. The forest products industry should also enhance the added value of wood products and embrace circularity to reduce raw material demand. By reducing the harvest rate, the carbon stock and increment of forests can be enhanced. Acceleration is needed towards achieving sectoral targets to achieve a climate-smart forestry perspective.

**Keywords:** Climate neutrality, Long term forestry strategy, Climate smart forestry.

## 1. INTRODUCTION

The Paris Agreement (PA) has a goal to limit global warming to well below 2, preferably to 1.5°C, compared to pre-industrial levels by the end of the century, according to the latest Intergovernmental Panel on Climate Change (IPCC) Working Group 1 report, the world is on track to exceed the 1.5 °C global warming level before 2040[1]. To limit the warming to 1.5 °C, only 400-500 GtCO2 of the carbon budget is available from 2020, while current annual emissions are around 40 GtCO2. As the carbon budget for 1.5°C is rapidly shrinking, developing countries may urge developed countries to work towards achieving net-negative emissions (Mohan et al., 2021).

The PA also underlines that to achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate-neutral world by mid-century. To this end, Article 4.19 of the Paris Agreement points out that countries must prepare and submit long-term climate strategies (LTSs or LT-LEDs) that carry through to mid-century or 2050 to the Secretariat of the UNFCCC[2].

According to United Nations Framework Convention on Climate Change (UNFCCC), net zero emissions are achieved when anthropogenic removals balance anthropogenic emissions of GHG to the atmosphere over a specified period. The IPCC (2021) defines carbon neutrality as the condition in which anthropogenic $CO_2$ emissions associated with a subject are balanced by anthropogenic $CO_2$ removals (Place et al., 2022). Therefore, becoming 'climate neutral' means reducing greenhouse gas emissions as much as possible but compensating for any remaining emissions. This is how a net-zero emissions balance can be achieved (Figure 1).

[1] https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/
[2] https://unfccc.int/process-and-meetings/the-paris-agreement

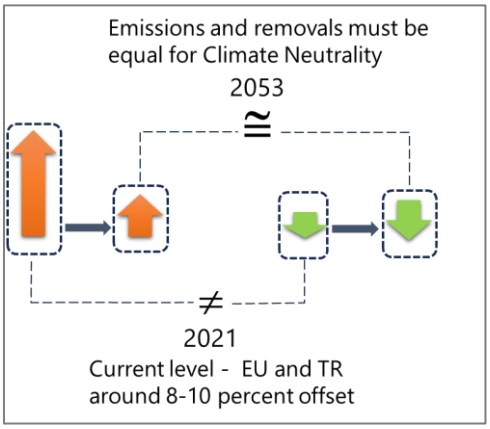


**Figure 1.** The schematic representation of climate neutrality. The green arrows represent removals (C sequestration by ecosystems). The emissions must equal removals for climate neutrality (net zero) at the target year. According to the most recent GHG inventory (2023) the removals offset around 8 percent of the emissions.

Türkiye ratified the Paris Agreement in the fall of 2021 and submitted its first Nationally Determined Contribution (NDC) target in 2022 during the 27th Conference of Parties (COP27). In 2023, Türkiye presented its detailed NDC document. The NDC aims to increase the capacity of forests to absorb carbon dioxide by implementing sustainable forest management practices, afforestation and reforestation, restoration, and long-term planning by rejuvenating existing forest areas. The initiative also encourages nature and technology-based solutions that enhance sink capacity, such as afforestation, rural agricultural land protection, and grassland improvement. Additionally, the Plan focuses on preventing, controlling, and reducing desertification and land degradation. For adaptation, the Ecosystem-Based Adaptation (EBA) Strategy seeks to promote agro-forestry[3].

To tackle the urgent issue of climate change, countries are presently submitting long-term climate strategies to the UNFCCC process. These strategies incorporate the potential use of 'negative emissions technologies' (NETs) in the future. NETs encompass various interventions that remove carbon from the atmosphere, such as large-scale terrestrial sequestration in forests, wetlands, and soils and using carbon capture and storage technologies (Jacobs et al., 2023).

Türkiye will launch its 2030 Climate Change Action Plan in 2023 and submit its LTS to the UNFCCC secretariat in 2024. The LTS will put forward Türkiye's policy decisions in forestry and land use for the coming decades.

Our paper focused on the land use sector, specifically forestry, and the various mitigation options available to Türkiye. We presented and discussed these options in detail, highlighting their potential impact and feasibility.

## 2. THE INTERNATIONAL LTS CONTEXT

United Nations Strategic Plan for Forests 2030[4] is one of the documents to highlight the mid-term global strategies. The Plan mentions the following goals and priorities:

i. *Reverse the loss of forest cover worldwide through sustainable forest management,*

ii. *Enhance forest-based economic, social, and environmental benefits, including by improving the livelihoods of forest-dependent people,*

iii. *Increase the area of protected forests significantly worldwide and other areas of sustainably managed forests, as well as the proportion of forest products from sustainably managed forests,*

[3] https://unfccc.int/documents/627743
[4] https://www.un.org/esa/forests/documents/un-strategic-plan-for-forests-2030/index.html

iv. *Mobilize significantly increased new and additional financial resources from all sources for the implementation of sustainable forest management and strengthen scientific and technical cooperation and partnerships,*

v. *Promote governance frameworks to implement sustainable forest management, including through the United Nations Forest instrument, and enhance the contribution of forests to the 2030 Agenda for Sustainable Development.*

vi. *Enhance cooperation, coordination, coherence and synergies on forest-related issues at all levels, including within the United Nations system and across member organizations of the Collaborative Partnership on Forests, as well as across sectors and relevant stakeholders.*

On the other hand, the EU forest strategy for 2030 aims to *set a vision and concrete actions to improve the quantity and quality of EU forests and strengthen their protection, restoration and resilience. The strategy aims to adapt Europe's forests to the new conditions, weather extremes and high uncertainty brought about by climate change. This is a precondition for forests to continue delivering their socio-economic functions, and to ensure vibrant rural areas with thriving populations.*

These global and regional strategies toward 2030 focus on two main pillars:

- Protection, restoration, and resilience - achieve Zero Net Deforestation from national and global perspectives, improve the quantity and quality of forests, and adapt to new conditions, weather extremes and high uncertainty that climate change brings.
- Circularity, efficiency, and sustainability of the forestry sector - developing skills and empowering people for sustainable forest-based bioeconomy (Green jobs)

When we get back to Türkiye, the CCDR[5] of World Bank published in 2022 was the first whole sectorial assessment of the Türkiye's long-term strategic mitigation options. The report highlighted the below findings:

*Türkiye is highly vulnerable to the impacts of climate change and other environmental hazards due to its geographic, climatic, and socioeconomic conditions. Therefore, it is crucial for Türkiye to prioritize adaptation and resilience. The recent war in Ukraine has led to energy supply disruptions and price increases, which pose significant risks for countries like Türkiye that heavily rely on fossil fuel imports. This highlights the urgent need for climate action to ensure energy security and affordability.*

*To achieve its development and climate goals, Türkiye needs to adopt a resilient and net-zero development pathway (RNZP). However, this requires significant deviation from current trends and major policy changes.*

The report also emphasized the need for investment in adequate sectors and activities. With these investments, Türkiye's economy will get the lowest negative impacts and gain momentum.

## 3. MATERIALS AND METHODS

To evaluate the forestry sector for the mitigation capacity we looked at the details of the categories and subcategories (Figure 2).

We used the same methodology as the Land Use Land Use Change and Forestry (LULUCF) sector GHG inventory of Türkiye based on the IPCC (2006) Guidelines. We also used the most recent data from the Activity Reports of the General Directorate of Forestry. The data sources we used were:

- National Inventory Report (NIR) of Türkiye 2023,
- General Directorate of Forestry, 2022 Action Plan,
- LULUCF section of the Country Climate and Development Report (CCDR) of Türkiye by the World Bank, 2022,
- FAO Forest Products Database (https://www.fao.org/faostat/en/#data/FO)

[5] https://www.worldbank.org/en/country/turkey/brief/key-highlights-country-climate-and-development-report-for-turkiye

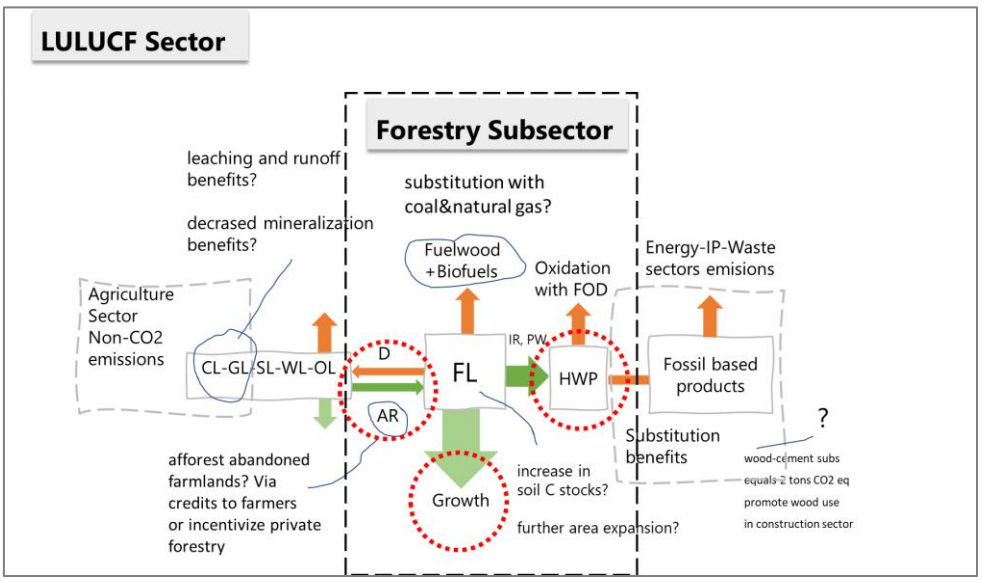


**Figure 2.** The forestry sector as part of the LULUCF sector. The potential mitigation categories are given in red dotted circles.

## 4. RESULTS AND DISCUSSION

### 4.1. Results

According to the latest GHG inventory report, Türkiye's emissions have increased to 564.39 MtCO2e, while removals have decreased to 47.15 MtCO2e. This reduction in the land sector is due to two main factors: the large mega-fires in 2021 and an increased harvest rate in forestlands. Compared to the 1990 figures, the removals have decreased by 29.12 percent, from 66.51 MtCO2e to 47.15 MtCO2e, while emissions have increased by 61.10 percent during the same period (Figure 3). The GHG inventory indicates that Türkiye is not on track to achieve the peak of emissions and removals during the 2030s.

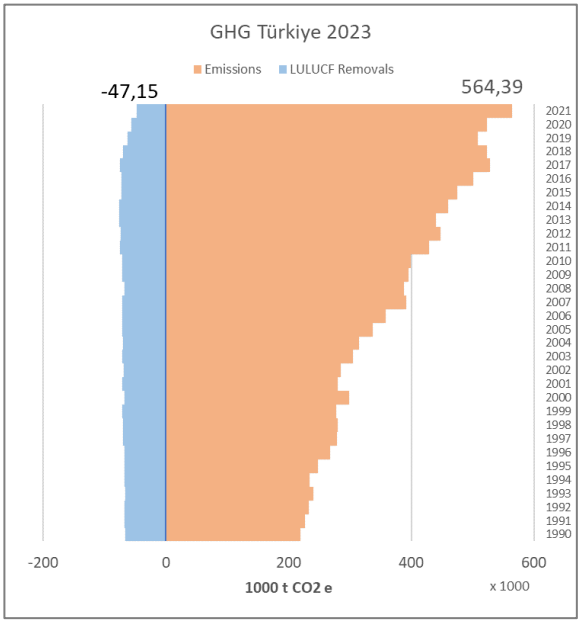


**Figure 3.** The emission and removal series of Türkiye for the 1990-2021 period according to the latest GHG inventory (2023) submitted to the UNFCCC.

Türkiye's LULUCF sector saw most of its removals in 2021 fall under the Forestland (FL) category. A total of 33.94 MtCO2e removals (44.066 FL-FL + 340 L-FL = 44.41 MtCO2e total removals) was accounted for in 2021. These figures show that the overwhelmingly major category of the LULUCF sector is forestlands remaining forestlands (FL-FL). The share of afforestation/reforestation adds less than 1 percent to the total removals.

It's worth mentioning that while the Harvested Wood Products (HWP) category is considered a removal category, it represents delayed emissions since it involves a transition from forestland to the atmosphere Figure 4).

The inventory also reveals that land uses (croplands, grasslands, wetlands, settlement, otherland) other than FL are all emissions.

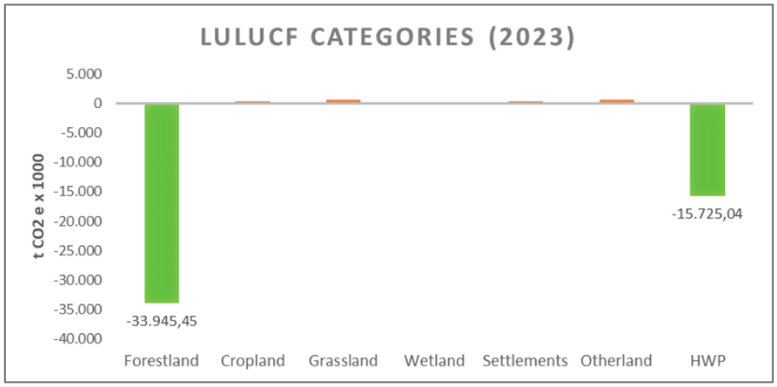


**Figure 4.** The share of LULUCF sector emission and removal categories according to the latest GHG inventory (2023) submitted to the UNFCCC. Green represents negative emissions (removals), while orange represents emissions.

The reduction of LULUCF sector removals as compared to 1990 occurred during the 2015-2021 period, as seen in Figure 5. The increase in the HWP during the same period indicates that the reduced removals are related to the harvest rate.

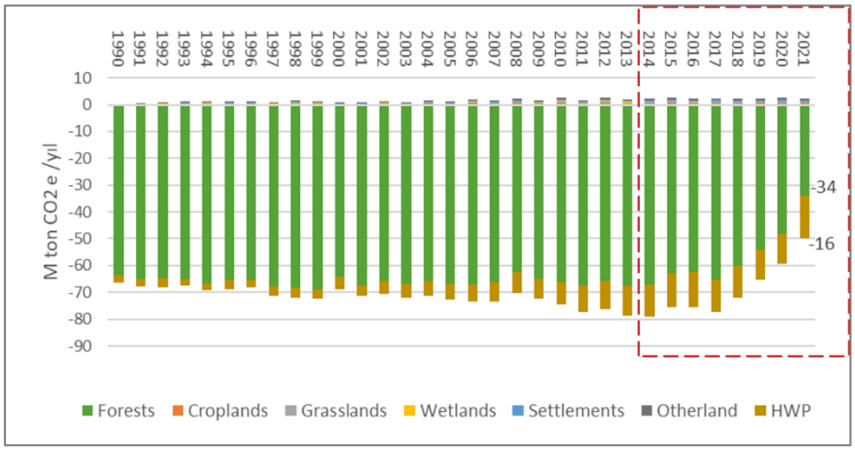


**Figure 5.** The time series of LULUCF sector removals for the 1990-2021 period. The percentage of other land uses has witnessed a notable increase, while the removal of forestland category has experienced a significant decline in recent years.

### 4.2. Discussion

Climate neutrality requires the reduction of emissions as well as the increase in removals. The latest GHG inventory figures show that Türkiye is performing the opposite at the current state. To enhance the removals, Türkiye must leave its current forestry policies and move towards a new tract that prioritizes ecosystem services, particularly carbon. EU has launched new forestry approaches as part of the 2030 Forest Strategy under the Green Deal. The Union forestry specialists are also seeking ways to enhance biogenic removals (Aggestam & Giurca, 2021; Lier et al., 2021; Lovrić et al., 2023;

Winkel et al., 2022). Climate-smart forestry (Weatherall et al., 2022) and closer-to-nature forestry[6] are the recent approaches the EU forestry policy is trying to move on.

On the other hand, the use of wood material is expanding in all sectors, and more raw wood material is needed to boost wood's substitution benefits towards fossil-based products (Jonsson et al., 2021; Schulte et al., 2023). The forest ecosystems can grow fast to accumulate carbon in biomass and soil but can also provide wood material to enhance substitution benefits. However, this requires very sophisticated forest management.

The latest figures in the GHG inventory of Türkiye indicate that:

- Türkiye must invest in forest management to increase its removals.
- The land categories other than FL should become emission-negative. They are all emitting at the current state.
- Investing in HWP may enable delayed emissions if the fuelwood use ratio drops further,
- Afforestation/reforestation, grassland rehabilitation, improved cropland management, wetland restoration, and greened settlements do not have large mitigation potentials but should be supported to enhance the sector. These categories are also significant for their co-benefits, such as increased productivity and resilience. There may be a good potential for afforestation of unstocked lands and also potential of afforestation of abandoned croplands.
- Disturbances, especially forest fires, must be appropriately managed to reduce emissions. Particularly, the disastrous wildfires must be disabled by using new technologies and prevention measures.
- Controlling urban expansion (sprawl) towards croplands, unstocked forestlands, and grasslands can reduce emissions caused by land use changes.

Among these mitigation measures and strategies, the focus must be on the forest management category. To increase the FL category removals, the average net increment of the forests should get into an increasing trend. According to the latest figures extracted from the action plans of the General Directorate of Forestry, the per-hectare stock and increment values are in decline while harvesting is increasing. The productive forests' weighted average stock and increment were 121.70 m3/ha and 3.35 m3/ha in 2022, respectively. The production has increased to 2.36 m3/ha in 2021 and then reduced to 2.19 m3/ha in 2022 (Figure 6). The harvest rate has been 65.37 percent of the increment by 2022. However, it should be noted that more than 10 percent of the forests are protected, and increment is not distributed evenly throughout the country. Thus, the utilization rate could be considerably high in some regions of the country, which might be suppressing the increment rate.

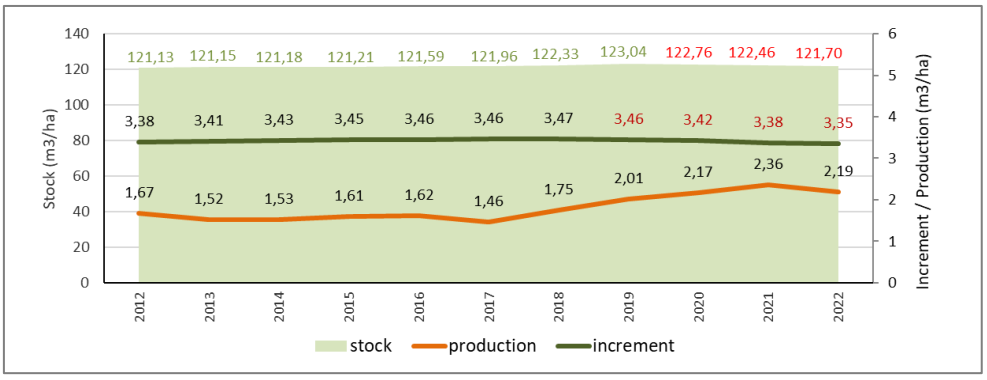


**Figure 6.** The time series of increment rates, stock, and harvest in productive forests. The decline in the increment rate parallels the decline in the LULUCF sector removals in recent years.

[6] https://efi.int/publications-bank/closer-nature-forest-management

To achieve increases in FL removals, Türkiye must turn the declining trend of increment to the opposite direction (Figure 7) to reach an average net increment rate somewhere around 3.6-4.0 to reach a removal rate of around 80-120 MtCO2 e by 2050.

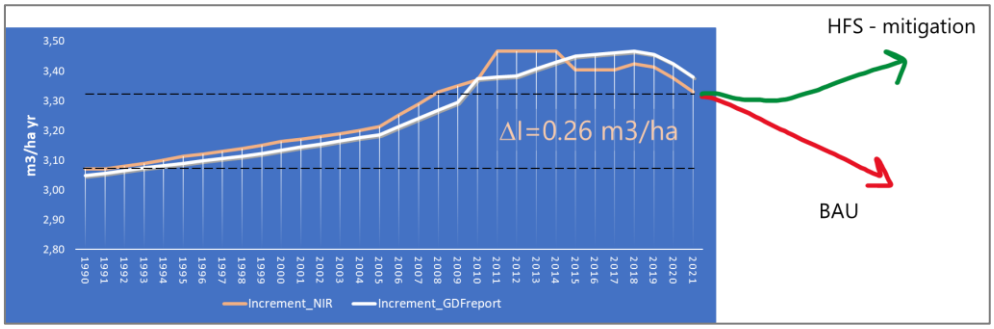


**Figure 7.** Time series of increment rates according to GDF activity reports and GHG inventory reports. The difference is caused by the slight difference in calculating the average. Türkiye must enhance the increment rate in a High Forest Scenario (HFS) as compared to Business as Usual (BAU).

## 5. CONCLUSION

Türkiye is on the eve of its green transformation by submitting its first NDC document, Climate Change Action Plan for 2030, and LTS. A roadmap in forestry and the Land Sector is needed in this preparation period. The roadmap with a set of strategies will guide the land sector decisions in the coming decades.

According to the results above, a 0.5 $m^3$/ha yr increase in the average net increment rate for productive forests supported by afforestation/restoration and wildfire prevention would move Türkiye on track for climate neutrality at a year beyond 2050. However, enhancing removals is only a part of the LTS. The emissions must reach the peak point and start declining around early 2030 to reach the target in the 2050s. Türkiye's Climate Neutrality target year, 2053, is only three years later than the EU. To align with the target, the removals will reach somewhere near one hundred million tons of $CO_2$ equivalent by the 2050s. Türkiye must start investing in biogenic removals since the growth of the forests is taking time. The biogenic mitigation options must be fully implemented for their cost effectiveness and co-benefits before other costly options, such as Carbon Capture and Storage (CCS).

Funding restoration (afforestation, rehabilitation etc.), circularity, innovation/technology, and high added value is necessary for the whole land sector. Good practices, including NBSs in all land uses, especially in urban areas, have limited mitigation potential but are critical to enhancing climate adaptation.

In conclusion, increasing the productivity (stock and increment) of forests as part of climate-smart forestry is the key to climate mitigation.

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