Commentary



# What can the Glasgow Declaration on Forests bring to global emission reduction?

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The Glasgow Declaration on Forests signed at the recent UN Climate Change Conference (COP 26) committed to halting forest loss by 2030. 141 countries and regions, collectively covering over 90% of global forest, endorsed this declaration. Avoiding forest loss can generally contribute to climate change mitigation; however, the impacts of the declaration on global carbon dioxide ($CO_2$) emission reduction are still unclear. Here we show that the Glasgow Declaration, if implemented fully and in a timely fashion, could reduce 123 Gt $CO_2$ of emission from 2021 to 2050. This study also highlights that any delays in implementing the declaration would decrease the avoided emission. Although the Glasgow Declaration is a milestone for mitigating climate change, the more ambitious afforestation plan is urgently needed to keep the global temperature rise to below 1.5°C relative to pre-industrial levels.

## THE GLASGOW DECLARATION ON FORESTS

At the recent COP 26, the "Glasgow leaders' declaration on forests and land use" was released, with the goal of "halting and reversing forest loss and land degradation by 2030" (https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use). So far, 141 countries and regions endorsed the declaration that collectively covers about 3,700 Mha of land, that is, more than 90% of global forest area. While it has long been recognized that forests contribute significantly to climate change mitigation,[1] it is critical to understand the impact of the Glasgow Declaration on global emission reduction toward carbon neutrality, as well as its implications for global climate action.

This Glasgow Declaration is a continuation and extension of many previous declarations. For example, the New York Declaration on Forests, endorsed at the United Nations Climate Summit in September 2014, proposed a timeline to cut natural forest loss in half by 2020, and strives to end it by 2030. However, over the past 4 decades, global forest area continues to decrease, at a rate of 0.03% $yr^{-1}$ globally, and especially, the overall primary forest area degraded and deforested has increased by about 17% since the 1980s. During 2000–20, more than 23.8 Mha forests were converted to croplands or pastures annually, resulting in a transition from a net carbon sink to a net carbon source, particularly in the tropics.[2] Lack of, or delays in, implementation fails to bring reductions in $CO_2$ emission, largely undermining the Glasgow Declaration's goals. Only by acting immediately and decisively can the declaration help deliver climate mitigation and sustainable development goals.[3] Here we evaluate the potential implications of the Glasgow Declaration for mitigating climate change. In particular, we quantify the impacts of delayed actions of forest protection and restoration on emission reduction. Our emission calculation follows the bookkeeping modeling approach,[2] considering various future forest loss scenarios, with and without delayed impacts.[3]

## POTENTIAL CONTRIBUTIONS TO CLIMATE CHANGE MITIGATION

Relative to the business-as-usual (BAU) scenario where forest loss is assumed to continue at the same average rate (23.8 Mha $yr^{-1}$) as in 2000–20 (Figure 1A), halting forest loss by gradually reducing forest clearance by 2030 can largely reduce $CO_2$ emission (Figure 1B). Excluding legacy emission from pre-2021 deforestation activities (data not shown), the global $CO_2$ emission under BAU caused by forest biomass loss and soil carbon loss reaches an average of 4.91Gt $CO_2$ annually in the period 2021–50. Starting from 2021, the rate of emission increases with the accumulated extent of forest clearance and reaches a stable value of 5.34 Gt $CO_2$ $yr^{-1}$ by 2035 (Figure 1B, dark solid). Following the Glasgow Declaration to gradually prevent forest loss, we assumed that the overall forest area loss rate is likely to decrease substantially to zero by 2030 (Figure 1A, red solid). If immediate actions are taken to reduce forest loss and the deforestation rate drops to zero evenly by 2030, the $CO_2$ emission caused by forest loss will be much smaller, with an annual rate of emission of 0.77 Gt $CO_2$ (2021–50) (Figure 1B, red solid). Furthermore, the earlier that forest loss is halted,

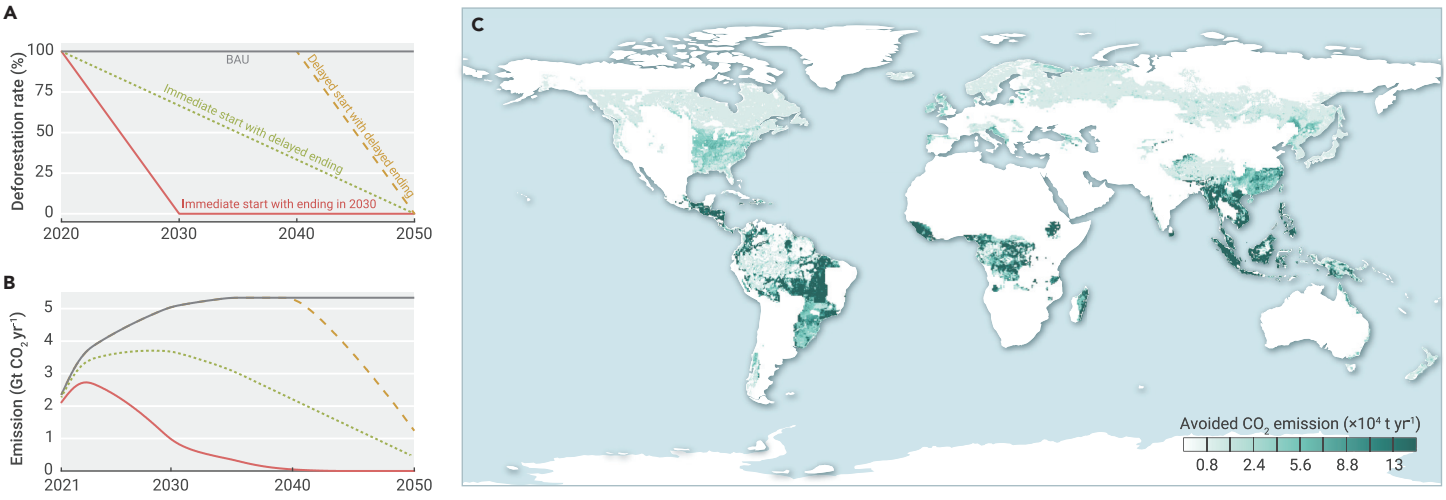


**Figure 1. Global $CO_2$ emission reduction due to reduced forest loss** (A) Different scenarios of forest loss, with BAU showing the loss at the historical rate (dark solid), and others showing reduced loss rate owing to the Glasgow Declaration with ending in 2030 (red solid), delayed ending (green dotted), or delayed timeline (orange dashed). (B) $CO_2$ emission caused by forest clearance under different scenarios in (A). (C) Spatial emission reduction owing to reduced forest loss with the deforestation rate dropping to zero evenly by 2030.

the lower the emission, and therefore the higher overall emission reduction. Compared with BAU, halting forest loss by 2030 can reduce 76%–91% of deforestation $CO_2$ emission from 2021 to 2050, depending on the intensity of actions taken to stop forest loss globally (data not shown). Note that the legacy emission from historical forest loss (0.45 Gt $CO_2$ $yr^{-1}$) would occur during 2021–50 regardless of the declaration, so it was not included as part of the emission in BAU and other scenarios.

As expected, because they have the highest deforestation rate and the largest carbon stores, tropical forests have the greatest potential for emission reduction (Figure 1C). These forests (23°S–23°N) suffer 80% of global deforestation activity (2021–30) and can contribute 85% of the global emission reduction if the deforestation rate falls to zero by 2030. For reference, the annual fossil-fuel related emission in Brazil (0.44Gt $CO_2$ $yr^{-1}$ during 2000–20) is only half of the size of its emission reduction.[2]

## DELAYED IMPACTS OF GLASGOW DECLARATION

2030 is now less than 8 years away, and the practical timeline to accomplish the Glasgow Declaration could be pushed back, largely because of delayed actions. By constructing scenarios that simulate possible delays in the ending and/or starting of actions, we show that any such delays in halting forest loss would bring much less emission reduction over time (Figure 1A). Even with actions started immediately (starting at 2021 with a delayed ending, Figure 1A, green dotted), with every 1 year of delay in ending time, the emission would increase by 88 Mt $CO_2$ $yr^{-1}$ compared with the scenario that mimics the Glasgow Declaration (i.e., halting forest loss during 2021–30) (Figure 1B). The overall emission reduction (2021–50) relative to BAU would be 58%–98% lower than that under the expected Glasgow scenario without delay. To halt forest loss in 10 years as indicated by the declaration, postponing the start of actions would push back the timeline (Figure 1A, orange dashed), which could substantially narrow the emission gap between BAU and scenarios with delayed actions to preserve forests (Figure 1B). For each year of delayed timeline, an additional 176 Mt $CO_2$ $yr^{-1}$ of emission would be added relative to the expected Glasgow scenario, and the total 30-yr (2021–50) emission reduction can diminish to 17%–96% depending on the timeline for stopping forest loss.

In general, following the Glasgow timeline to halt forest loss immediately and reach zero area loss by 2030, 123 Gt $CO_2$ of emission can be avoided from 2021 to 2050. For comparison, the remaining carbon budget to limit global warming to 1.5°C (50% likelihood) is 420 Gt $CO_2$.[2] Therefore, successful and rapid implementation of the Glasgow Declaration can make a big difference for meeting the Paris Agreement climate target. However, with a delayed timeline, regardless of the type of delay, the size of avoided emission shrinks, until the deadline to meet the emission reduction targets is totally missed (e.g., 2030, 2050).[3] It should be noted that non-$CO_2$ greenhouse gas emissions and biophysical impacts may also change as a result of the implementation of the Glasgow Declaration, so they should be examined for future assessment of net climate impacts.

## WHAT SHOULD BE THE GLASGOW DECLARATION'S SUCCESSOR?

The Glasgow Declaration is ambitious, and never before have so many countries (i.e., 141 countries) reached an agreement to protect the Earth's forests. However, this declaration is still not sufficient to keep the global average temperature rise to well below 1.5°C relative to pre-industrial levels, even with full implementation by all participant countries. The latest special report by the Intergovernmental Panel on Climate Change suggested that it would be necessary to achieve a 200 Mha reduction of deforestation and a 950 Mha increase in forests by 2050 relative to 2010.[4] Fortunately, there is still potential for reforestation. Recent studies show that there is room for extra canopy cover excluding existing trees and agricultural and urban areas.[3] However, among 170 countries, there are only 13% countries (27) with larger net forest area change (actual mean annual increase of forest area from 2001 to 2020)[5] than potential afforestation rate (mean annual increase of forest area since 2011 to reach the maximum forest area by 2050), with China topping the list of net forest gain. About 58 countries show increasing forest area during the past 20 years, but the increase rates are far less than the potential afforestation rates. Another 85 countries have to halt forest loss before any meaningful net gain.[5] There is urgent need to hasten the successor of Glasgow Declaration for forest restoration, it remains among the most effective strategies for climate change mitigation. Also note that biophysical (e.g., water), environmental (e.g., land, biodiversity), and social-economic issues (e.g., cost, human wellbeing) should be scrutinized for forest restoration.[3]

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## AUTHOR CONTRIBUTIONS

Z. Q. and W. Y. conceived the original idea and designed the overall study. Y. Z. and D. W collected the data and conducted modeling, P. S., P. C. and S. P. helped with data analysis and interpretation of the results. W. Y. and Z. Q. wrote the manuscript, and all authors reviewed and edited the manuscript.

## DECLARATION OF INTERESTS

The authors declare no competing interests.