Time to dispel
The forest carbon debt illusion

Summary | May 2021

This summary and the report it refers to, The forest carbon debt illusion, were commissioned by the Swedish Forest Industries Federation in 2021. Both papers are available at www.forestindustries.se
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It is sometimes suggested that harvesting wood leads to a carbon debt that takes long to pay back by new trees. This statement goes diametrically against the understanding that the forest bioeconomy is a significant part of the climate solutions we need. This brief explains that reduced or halted forest harvesting is an invalid climate action – also in the short term – where sustainable forest management and efficient value chains are in place.

SUMMARY

There is no time to waste. We need real and reliable climate actions, and we need them now. Managed forests and renewable forest products are a big part of the solution. Their combined positive effects on the global climate are large, immediate and a co-benefit of financial returns in the forest-based sector.

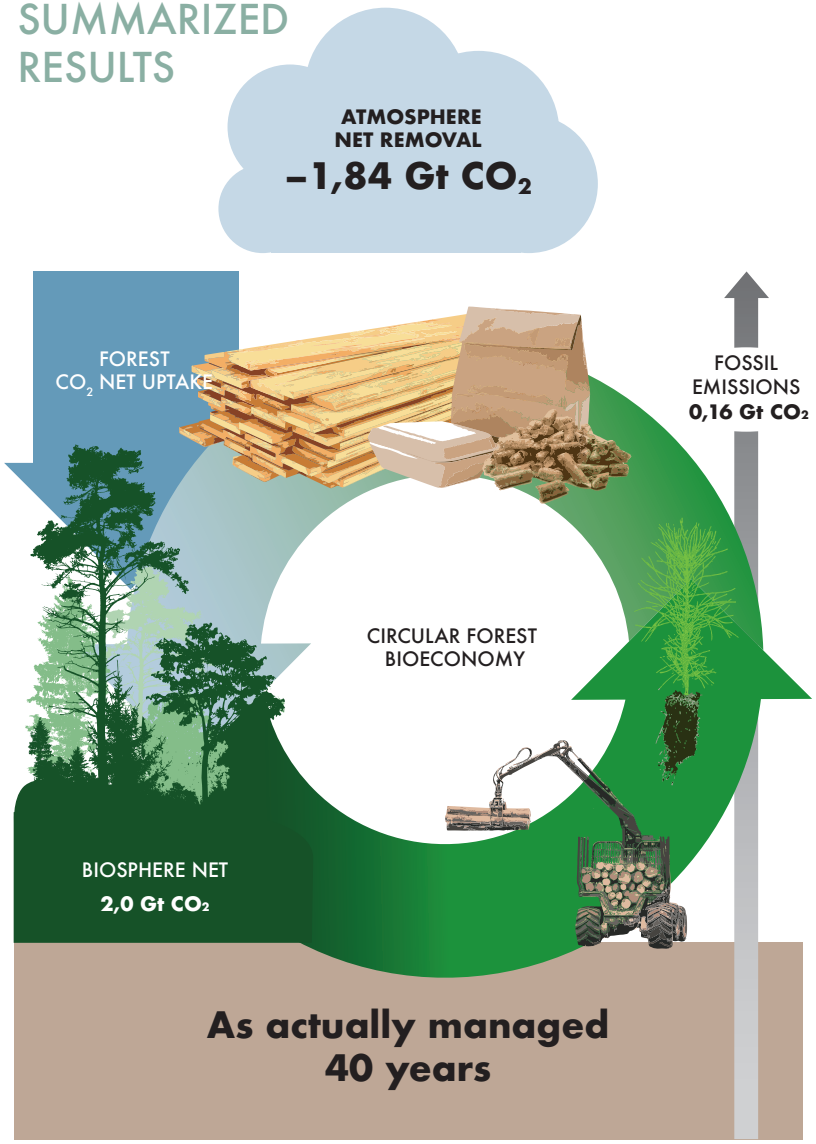
In the intensive debate around forests and climate it is sometimes suggested that carbon should be kept in the forest instead of harvesting wood, as we don't have time to wait for the forest to grow back. Based on the analysis presented here, the proposition of such a "forest carbon debt" after harvesting is not valid. Given long-term investments in forest management and efficient, integrated value chains, the suggestion to reduce or halt forest harvesting for global climate reasons is counterproductive as much less carbon dioxide would then be removed from the atmosphere. Such inaction would both damage sustainable development aspirations and also seriously decrease our opportunities for avoiding dangerous climate change.

Structures in climate reporting and negotiations tend to separate the forest from wood value chains. This makes the integrated benefits of the sector difficult to appreciate in political processes. As a consequence, isolated and potentially harmful policies are constructed.

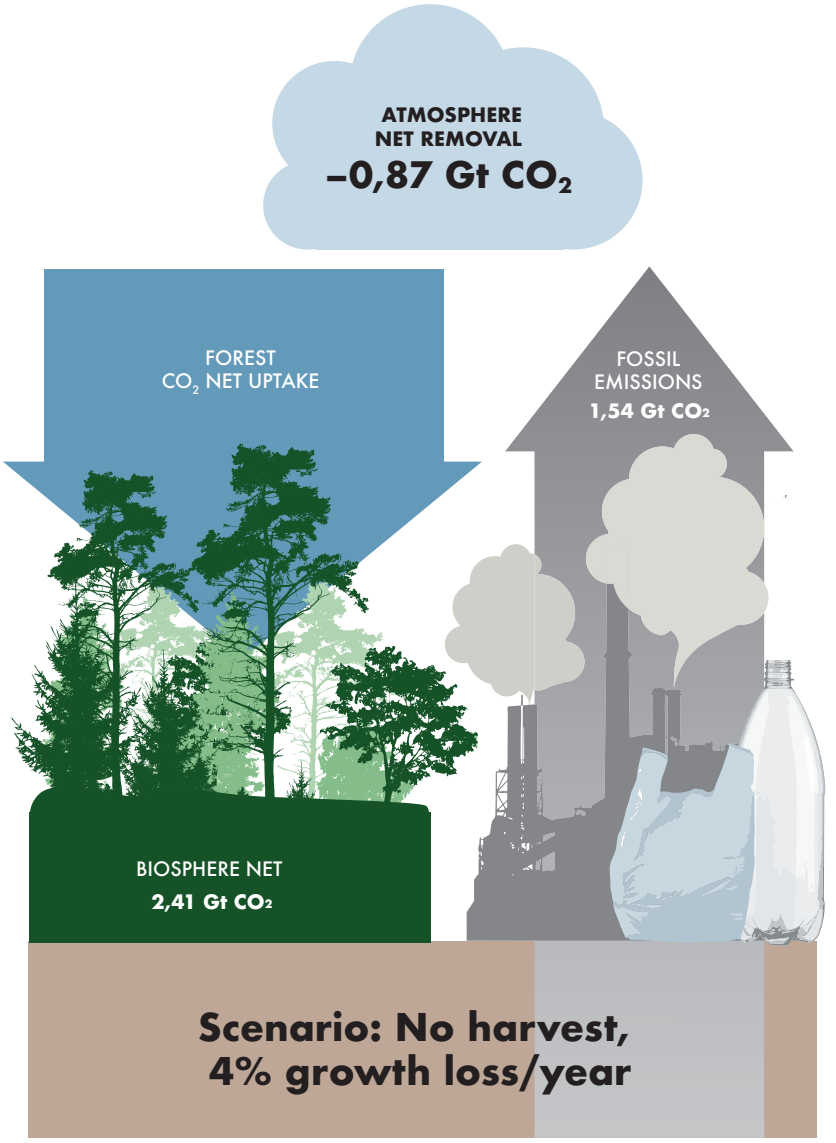
This summary presents how major climate solutions are generated in Sweden both in the short and longer term[1]. The circular forest bioeconomy concept provides a holistic perspective that should guide forest-related policies towards the future we want.

[1]This summary is based on "The forest carbon debt illusion"
– a report from the Swedish Forest Industries published in May 2021.

SUMMARIZED RESULTS



For Swedish forests and forest-based sector, the as-actually-managed case (the circular forest bioeconomy) results in considerably more removal of CO2 from the atmosphere over 40 years compared with a no-harvest scenario. Also in a shorter time frame (10 years) the as-actually-managed case removed more.



CO2 from the atmosphere (see results section). The higher fossil emissions in the no-harvest scenario are due to forgone displacement effects from forest-based products.

The forest carbon goes around and around

It is obvious and intuitive. Forests provide us with wood, which we turn into renewable products that can replace fossil-based ones. Meanwhile the forests continue to grow, continue sequestering carbon dioxide and keep delivering more wood.

But it's also complicated. The forest needs to be well managed for the long term, avoiding over-harvesting and maintaining a high growth rate. Long and diverse value chains need to be integrated and deliver a variety of wood-based products. Recycling of forest products, often several times, is a fundamental part of the circular economy that reduces demand for new raw material. Bioenergy from residues and waste from forest and forest industry as well as from end-use of products, should be used efficiently. Finally, the carbon is recycled through the atmosphere back to the growing forest. This is how the Swedish forest-based sector works. It is a circular forest bioeconomy[2].

Wood-based products and energy are fundamentally different from those based on fossil deposits like coal, oil or natural gas. This is because CO_2 is not added to what we already have in the atmosphere and biosphere. Wood-based products are instead manufactured from

[2].Swedish Forest Industries 2019. Contribution of the Swedish forestry sector to global climate efforts

FIGURE 1. The Swedish circular forest bioeconomy includes long-term forest management, integrated value chains and recycling of carbon back to the growing forest.

recycled carbon that has been captured by trees. When we use fossils, on the other hand, additional CO2 is pumped into the atmosphere speeding up global warming.

We want the forest bioeconomy to continue to develop for many, many years. This requires investments in long-term sustainable forest management for healthy and stable forests that grow well. It also requires investments in efficient value-chains to maximize the use of all raw material, as well as investments for research and innovation towards new climate-smart forest-based products. We need a sound market economy that manage risk and bring reasonable returns on these investments. Over time a healthy forest-based sector can then lead to even more impressive climate benefits.

How does the positive climate effect work?

There are three key interactions between the forest-based sector and the global climate challenge. We need to add these together to see the full picture:

1 **Net carbon sink in forest and harvested wood products.**
Photosynthesis captures carbon from the atmosphere and stores it in trees. Active forest management ensures that the carbon storage is secure and increase over time. After harvesting, wood products continue to store carbon, often for a long period of time.

2 **Displacement (or substitution) of fossil emissions.**
Using wood-based products and energy means that we use less products that depend on fossils. This way, large quantities of fossils stay underground and do not add to the climate change problem.

3 **Remaining fossil emissions.**
The forest industry uses its own bioenergy, but some fossil emissions remain in the value chain, for example in transportation. This needs to be deducted from the above positive contributions.

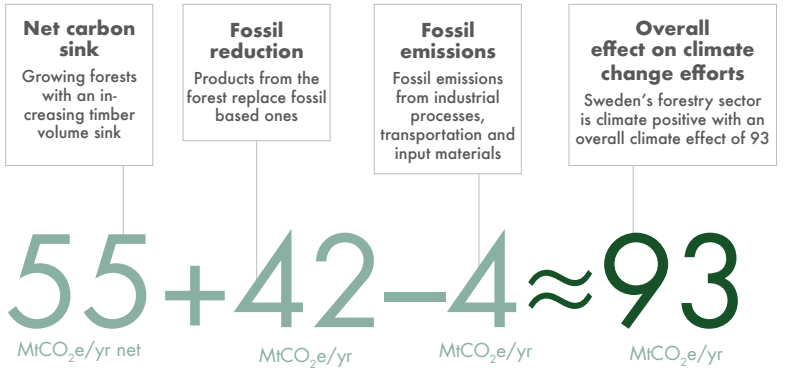


FIGURE 2. The annual positive climate effect of the Swedish forest-based sector was estimated in 2017 at almost twice the territorial emission of the country as a whole[3].

On a yearly basis, the contributions can be very significant. An analysis of the forest-based sector in the European Union showed that the positive climate effect corresponded to 20% of all EU fossil emissions[3]. For Sweden, the positive effect has been estimated at almost twice the reported fossil emissions of the country[4] (Figure 2). These examples reflect real-world situations where wood harvest is well below forest growth and where value-chains overall are resource-efficient.

Despite these positive results, forest-related political processes risk being misguided. In part, this is rooted in sector structures established for climate change negotiations. As a consequence, calls for urgent climate actions may lead to missed opportunities in the forest-based sector, which is further discussed below. These policy issues must be resolved to help guide climate policy and the transformation to a fossil-free welfare society.

3. CEPI 2020: Climate effects of the forest-based sector in the European Union.
4. Swedish Forest Industries 2019: Contribution of the Swedish forestry sector to global climate efforts.

Structures that separate

The sector structure in climate research, reporting, assessments and negotiations separates the forest from wood-based value chains. The forest forms part of a land use segment with its own policy focus, for example in the EU LULUCF regulation or through separate guidelines within the EU Taxonomy for Sustainable Investments. Building on the same logic, the EU Green Deal aims for climate neutrality in 2050 including an anticipated increase of carbon storage in forests to offset fossil emissions in other sectors.

IPCCs global models, which underpin high level assessments, take this one step further by counting the forest sink mainly as "natural response", leaving emissions caused by harvesting within the concept of "forestry"[5]. As a result, "forestry" is attributed with 11% of total anthropogenic emissions, i.e., a very big part of the problem. An adjustment of this misrepresentation is underway, supported by an important new publication in Nature[6].

From a policy perspective, this structure breaks the forest bioeconomy cycle. Instead of building on the opportunities of biologically based production, the link from forest to wood value chains becomes invisible. Further, the link from value chains back to investment in forest management is ignored. It is imperative to restore these links so that the full contribution of the forest-based sector can be accounted for in climate policy.

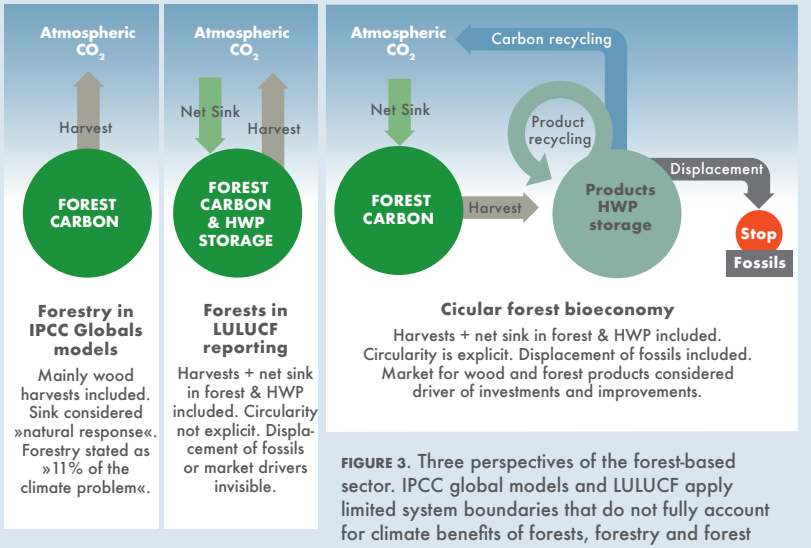


FIGURE 3. Three perspectives of the forest-based sector. IPCC global models and LULUCF apply limited system boundaries that do not fully account for climate benefits of forests, forestry and forest products. The circular forest bioeconomy concept includes a more complete set of climate effects.

For this reason, the concept of a circular forest bioeconomy should instead help guide forest-related climate policy. This builds on carbon circularity from forests to products to atmosphere and back to the forest. Market incentives, that drive investments in long-term forest management as well as innovation and value chain improvements, are seen as necessary functions. Importantly, the role of forest products in displacing fossil emissions, as a major contribution to climate solutions, is made explicit. Existing biophysical models, such as those applied by IPCC and the EU LULUCF regulation, need to be complemented by a more complete system perspective of a circular forest bioeconomy.

[5] IPCC 2019: Special Report on Climate Change and Land
[6] Grassi, G., et al. 2021: Critical adjustment of land mitigation pathways for assessing countries' climate progress. Nature Climate Change. DOI: 10.1038/s41558-021-01033-6

Urgency that can mislead

The Paris Agreement highlights the urgency for effective climate action. Related IPCC analyses set out scenarios that indicate the pace by which greenhouse gas emissions need to be reduced to stay on track with the Paris ambition[7]. From these calculations it is deduced that global emissions need to be halved in the next decade or so, which is both a staunch vision and a tremendous challenge for society.

Unfortunately, the urgency is sometimes used to argue for reduced or halted harvesting of wood with the thinking that it is better in the short term to keep carbon stored in the forest. Otherwise, it is argued, a "carbon debt" would accrue and it would take too long before the carbon is again captured by new trees. This goes diametrically against the understanding that a circular forest bioeconomy generates very large climate benefits.

Clearly, such a major difference in perspective must be resolved to avoid counterproductive policies and actions. This brief explains that reduced or halted forest harvesting is an invalid approach – also in the short term – where sustainable forest management and efficient value chains are in place. This is illustrated below with real-world data from the development of the Swedish forest-based sector.

[7] IPCC 2018. Global warming of 1.5°C.

What does available science tell us about forest carbon debt?

A debt usually represents an initial cost that is to be paid back. A forest carbon debt assumes an action where forest carbon storage is reduced, causing greenhouse gas emissions, as a transformation to producing climate-smart products from the land. These products can displace fossil emissions and at the same time the forest may grow back. Gradually, these developments pay back on the initial debt so that we eventually reach a break-even point with respect to climate impact. Beyond the break-even point, the idea is that continued displacements and forest growth will return positive climate effects.

This model was first introduced to predict the effects of bioenergy projects, for example when rainforests are deforested for oil palm plantations which creates a large initial debt. In such cases the payback time can be very long – up to hundreds of years. Clearly, from a climate change perspective this is not compatible with stipulated time frames for reducing emissions.

The carbon debt model has been applied also to forest management, that is, situations where the forest remains but harvesting of wood may still create a carbon debt (Figure 4). A literature review[8] reveals that available science on forest carbon debt[9] have often applied nar-

[8] For details, see Swedish Forest Industries 2021: The Forest Carbon Debt Illusion.
[9] Forest carbon debt is here used in relation to a reference scenario that applies less or no management interventions. That is, there is a debt relative to the reference until the break-even point. Sometimes a narrower interpretation is used to only refer to recovery of the initial reduction of carbon stock.

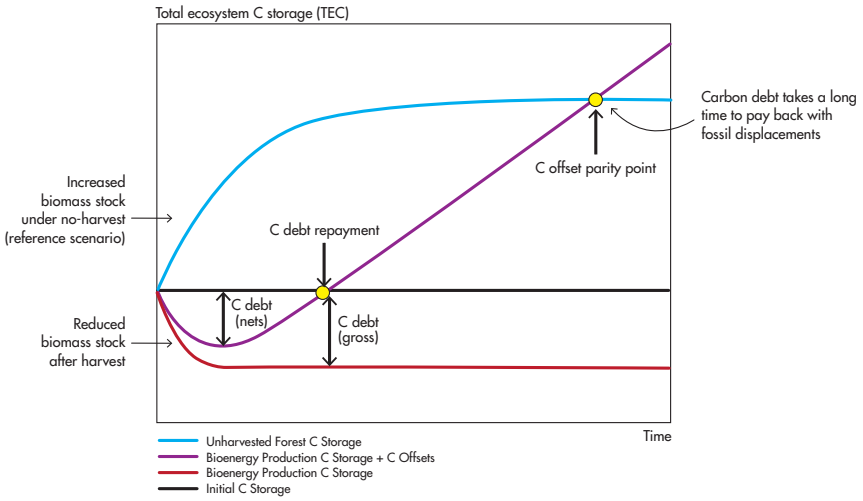
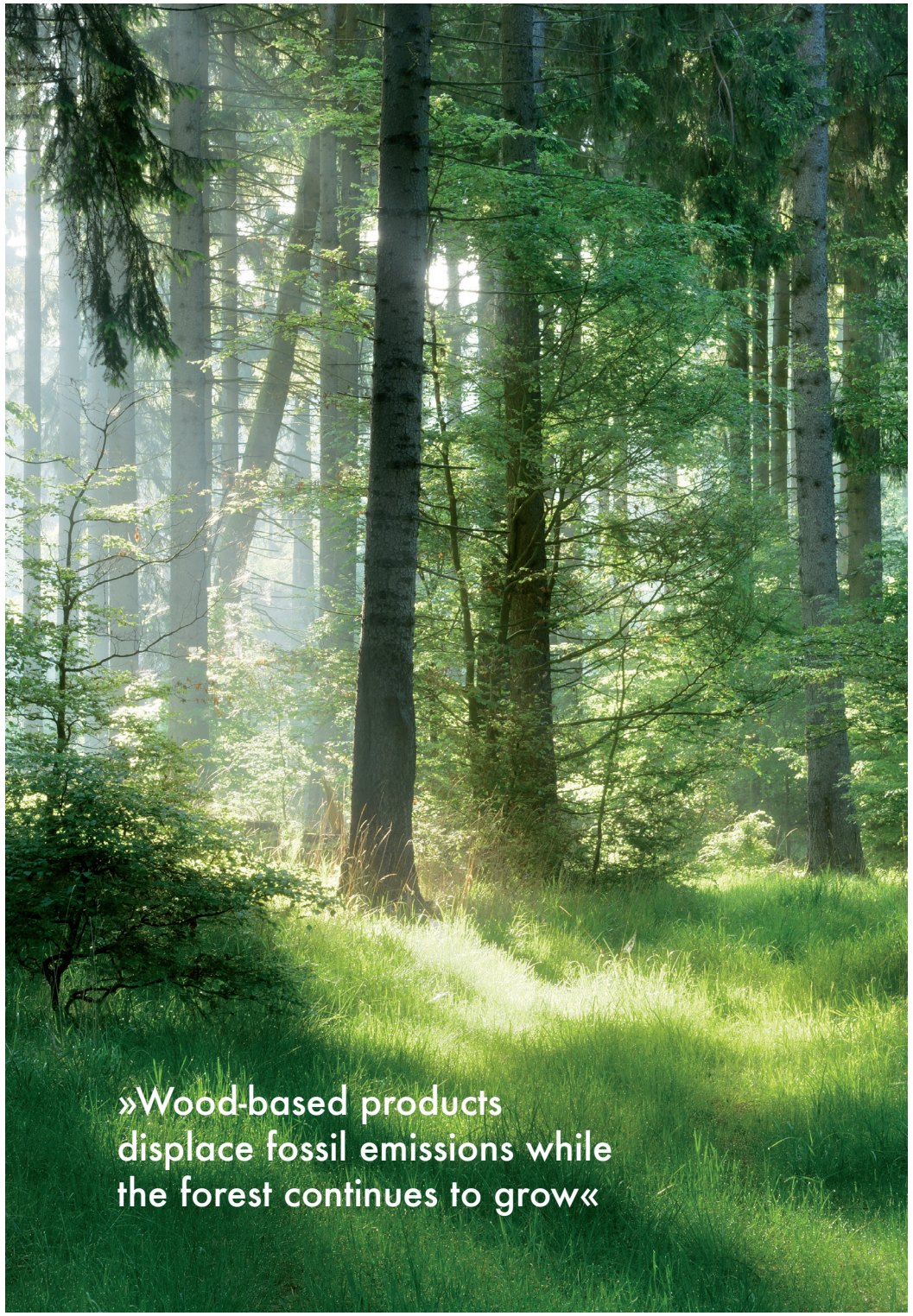


FIGURE 4. The original illustration of the carbon debt model in managed forests with added comments. The figure indicates a reduction of biomass after harvest, which is not the case in sustainably managed forest landscapes. Source: Mitchell et al. 2012[10].

row system boundaries and assumptions, which makes it difficult to find well-informed support for strategic decisions. Still, these results are frequently used in the forest-climate debate to argue for reduced or halted harvesting of wood in the short term. Limitations in several available studies include:

- Assumption that bioenergy is the only product from the forest;
- Geographic limitation to individual stands instead of managed landscapes;
- Real-world data over time about actual forest development and harvesting are not used;
- Scenarios instead use simplified parameters to model far into the future;
- Economic externalities to applied scenarios are not considered.

[10] Mitchell et al. 2012. Carbon debt and carbon sequestration parity in forest bioenergy production. DOI: 10.1111/j.1757-1707.2012.01173.x



Applying real-world data for Sweden 1980-2019

To complement perspectives available in scientific publications, real-world data from the Swedish forest-based sector was applied to illustrate how climate benefits have accrued over the past 40 years. This was compared with alternative scenarios where wood harvesting would have been reduced or eliminated during the same time period.

Swedish forestry and forest industry has a long history. Over the past 100 years, restoration of forests has been a political and economic priority. Forest growth and standing volume have doubled and at the same time wood harvesting has doubled. This has created opportunities for a successful forest industry that today generates 10% of world trade in forest products.

Because of the importance of the forest-based sector, the Swedish national forest inventory has kept track of forest resources[11], which means that we have reliable and detailed data for the current analysis that looks at the period 1980-2019 (Figure 5). We also have reliable statistics of the full set of forest product categories – solid wood products, fibre products and bioenergy – and a good understanding of the combined fossil displacement effect from these.

The real-world development was compared with scenarios where the forest would not have been harvested, and one where the harvest was reduced by 10%. Abandoning the forest completely is of course a rather extreme scenario, but it does occur as an alternative in the debate. More realistic arguments are made for reducing the harvest so as to park more carbon in the forest in the short term.

[11] SLU 2020. Skogsdata 2020.

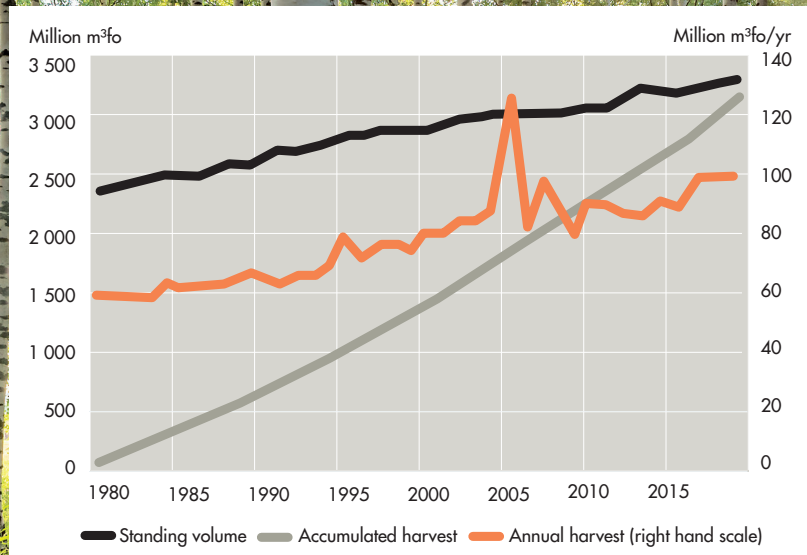


FIGURE 5. Measured development of and harvest from Swedish forests1980-2019 – the time period used in the current analysis. Both the standing volume and annual harvest have increased significantly. About three billion m³ of wood was harvested over these 40 years.

Source: SLU 2020. Skogsdata 2020.

Results

The results are illustrated in Figure 6.
All scenarios lead to considerable increase of the forest living biomass, that is, an increase of the carbon storage. The as-actually-managed case resulted in an increase of 44%, while the no-harvest scenarios added 91% and 64% respectively. The 10 per cent harvest reduction scenario led to an increase of 54% to the quantity of living biomass.

In the no-harvest scenarios there are no forest products, so fossil-based alternatives are brought in instead, resulting in large increases of fossil emissions. The alternative to import forest products was not considered as this represents a shift of harvesting elsewhere and would be considered a leakage. Stopping the flow of forest products will also turn the normally increasing net sink in harvested wood products into an emission source as already existing products are gradually phased out.

In the scenarios with harvesting, stumps, roots and branches (about 1/3 of the tree biomass) remain as carbon storage in the forest and gradually decay. Similar to carbon storage in harvested wood products, this continued storage of dead biomass keeps substantial quantities of carbon away from the atmosphere for an extended period of time.

Reducing the harvest by 10% will indeed increase the carbon stock in the forest. But this will be counteracted by higher fossil emissions because of foregone displacement by forest products as well as a slower increase of carbon storage in harvested wood products. Overall, there is no significant net difference for the global climate between these scenarios. But reduced harvesting will cause (a) higher fossil emissions and (b) higher risk for calamities in the forest.

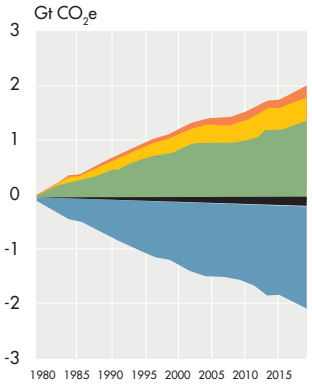
Over the 40-year period, the no-harvest scenarios perform worst, by a good margin. The as-actually-managed and the reduced-harvest scenarios both removed 1,8 – 1,9 Gt carbon dioxide from the atmosphere. For the no-harvest scenarios, past investments in forest restoration would mean that the forest continues to grow well with a positive, but declining contribution even after 40 years. At the same time, Sweden would nearly have doubled its fossil emissions throughout the period. Overall, no-harvest scenarios lead to 1,0 resp. 1,8 Gt more carbon dioxide in the atmosphere compared with the scenarios with continued harvesting.

Also in the shorter term (10 years), the no-harvest scenarios perform worse than both scenarios with continued harvesting. The difference is 10-20 Mt carbon dioxide emissions per year, corresponding to 20-40 per cent of Sweden's total fossil emissions. So, also in the shorter term, active forestry with forest-based products is the better alternative.

The above results based on historical data were cross-checked with predicted developments in the coming 40 years, using officially produced scenarios from the Swedish Forest Agency[12]. This confirmed that the development over the past 40 years is expected to continue for decades to come. One difference is that the initial forest carbon stock is now considerably higher than 40 years ago, which on one hand means even higher risks for the carbon storage if the forests are not actively managed, but on the other offers higher levels of fossil displacement from forest products.

12. Swedish Forest Agency 2015: Skogliga konsekvensanalyser 2015 – SKA15

Scenario: **As-actually-managed**

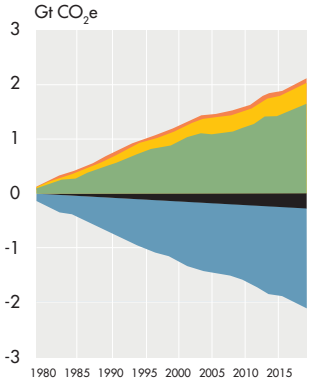


KEY DEVELOPMENTS

- More living biomass
- Small fossil emissions
- Major removal of atmospheric CO_2

ACCUMULATED CHANGE	
Carbon pool	Gt Co_2e
Over 40 years	
Living biomass	+1,38
Dead biomass	+0,62
Fossil deposits	–0,16
Atmosphere	–1,84
First 10 years	
Atmosphere	–0,55

Scenario: **10% Harvest reduction**



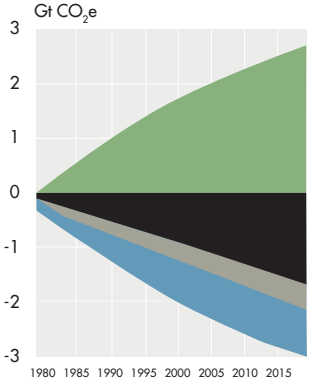
KEY DEVELOPMENTS

- More living biomass
- Some fossil emissions
- Major removal of atmospheric CO_2

ACCUMULATED CHANGE	
Carbon pool	Gt Co_2e
Over 40 years	
Living biomass	+1,70
Dead biomass	+0,47
Fossil deposits	–0,29
Atmosphere	–1,88
First 10 years	
Atmosphere	–0,52

FIGURE 6. Accumulation of carbon storage changes for the four scenarios 1980-2019. All scenarios indicate increasing living biomass over time. The no-harvest scenarios lead to very high fossil emissions due to forgone displacement effects, and also losses of carbon storage in harvested wood products. The as-actually-managed and reduced-harvest scenarios provide most reduction of atmospheric carbon both in the short term (10 years) and the long term (40 years). The effects are of a very high magnitude with atmospheric removal in the range 1,8-1,9 Gt CO2 over 40 years for the top two scenarios. As a reference, the accumulated fossil emissions for Sweden were 2,1 Gt CO2e for the same 40-year period.

Scenario: **No-harvest, 4% annual net growth loss**

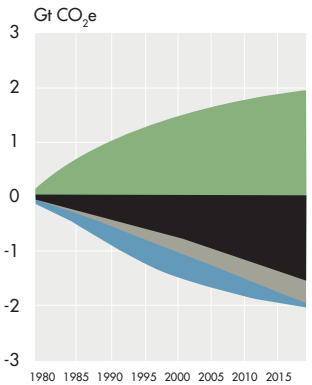


KEY DEVELOPMENTS

- Much more living biomass
- Large fossil emissions
- Some removal of atmospheric CO_2

ACCUMULATED CHANGE	
Carbon pool	Gt Co_2e
Over 40 years	
Dead biomass	–0,44
Living biomass	+2,85
Fossil deposits	–1,54
Atmosphere	–0,87
First 10 years	
Atmosphere	–0,44

Scenario: **No-harvest, 6% annual net growth loss**



KEY DEVELOPMENTS

- More living biomass
- Large fossil emissions
- No removal of atmospheric CO_2

ACCUMULATED CHANGE	
Carbon pool	Gt Co_2e
Over 40 years	
Living biomass	+2,00
Dead biomass	–0,44
Fossil deposits	–1,54
Atmosphere	–0,02
First 10 years	
Atmosphere	–0,34

- Harvested wood products increase
- Stumps/roots/bransches increase
- Living biomass increase
- Harvested wood products decrease
- Fossil deposits decrease
- Atmospheric CO2 decrease

[a]Dead biomass refers to change of: stumps/roots/ branches and harvested wood products.

Conclusions

The results show that no forest carbon debt accrues – even in the short term – as the forest is managed to increase both standing volume and wood supply, and as forest products displace large quantities of fossil emissions.

The 10% reduction of harvests had a similar effect on the atmosphere as the as-actually managed case, but with higher fossil emissions due to forgone fossil displacement and reduced increase of harvested wood products storage.

Halting wood harvesting for climate reasons is shown to be a highly counterproductive measure, mainly because of much higher fossil emissions, but also because the overall carbon uptake in the biosphere does not increase to compensate for the forgone fossil displacement.

»The solutions provided by an efficient forest-based sector are a critical contribution«

In addition, reductions of the forest-based sector would have very large negative implications on the economy, including reduced employment, rural development losses, forgone export revenues, devaluation of forest land and forest industry and more difficult access to forests for other economic activities. Forest-based products are also important for sustainable development more broadly, including for food security, hygiene/health, gender equality, avoiding pollution by plastics, and facilitating trade in other sectors.

Conclusively, there is no support for reducing harvests from Swedish forests for climate reasons in the short or longer term. On the contrary, because the transformation to a fossil-free welfare society is such a major challenge, the solutions provided by an efficient forest-based sector are a critical contribution. Ill-informed argumentation against forestry and forest industry does not help us mitigate climate change. Rather, it is a threat that enhance the climate crisis.

The climate benefits from the circular forest bioeconomy are co-benefits from a well-functioning market for forest-based products. Over a very long time period, investments in improved forest management as well as innovation and resource efficiency have gradually improved the financial performance of the sector. At the same time, environmental impacts have decreased, emphasis on biodiversity conservation improved, and contributions to climate solutions increased.

A key point for the policy debate is the apparent synergy between financial and climate performance in the forest-based sector in the context of sustainable development. Looking at the forest-based sector with a holistic perspective is, therefore, fundamental for our common future.

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