Södra's climate effect

SÖDRA

2019

LEAD AUTHOR: PETER HOLMGREN
CO-AUTHORS: EVA GUSTAFSSON, GÖRAN ÖRLANDER

Södra's climate effect

Lead author: Peter Holmgren
Co-authors: Eva Gustafsson, Göran Örlander
Växjö 2019-11-29

Contents

Summary

The report analyses the effect of Södra's operations on the global climate. Södra is a forest owners' association which also operates jointly-owned, integrated forest industry processing units. Södra is a major forestry sector enterprise, drawing from sustainable management of 2.6 million hectares of members' combined forest holdings and processing 13.7 million m^3sub harvested wood (2018) into construction materials, pulp for wood fibre products, bioenergy and onward timber delivery.

Innovation and improvements in industry processes have considerably reduced fossil energy use and enhanced resource efficiency. Further, a long history of investments in enhanced forest management have, over the long-term, increased forest growth, sustainable harvesting as well as the carbon sink effect of Södra members' forests. Following this trajectory, Södra has an ambitious goal to be a climate-positive enterprise with fossil-free production and fossil-free transportation.

The overall effect of Södra's operations on the global climate was estimated as the sum of three parameters:

1. Net sink of carbon in the forest (normally a positive climate effect)
2. Fossil emissions of carbon dioxide in the value chain (a negative climate effect)
3. Fossil emission reductions through substitution when forest products replace products with a higher climate footprint (a positive climate effect)

For the analyses, two subsystems were considered – Södra Members to account for forest management and timber delivery, and Södra Group to account for industry processes and marketed products. This corresponds to the overall governance of Södra with 52,000 independent forest owners delivering timber to their jointly-owned forest industry group.

The forest was estimated to sink 2.1 $MtCO_2e$ (million tons of carbon dioxide equivalent) in 2018. This is the net sink resulting from a forest growth of 13.1 Mm^3sub (million cubic meters of stem volume under bark) and a harvest of 11.9 Mm^3sub on members' land holdings, plus management of a smaller corporately-owned forest estate.

Fossil emissions of carbon dioxide were 0.6 $MtCO_2e$ in 2018, mainly transportation (0.20 $MtCO_2e$) and input goods (0.25 $MtCO_2e$). Industrial processes use mainly bioenergy and are almost fossil-free.

Fossil emission displacement through substitution was estimated at 7.7 $MtCO_2e$ for the year 2018. While the substitution effect is not part of official climate reporting methodologies, research now provides data that allow quantification of this significant factor when wood-based products replace fossil-based ones such as cement, steel, plastics or fossil energy.

Following this trajectory, Södra has an ambitious goal to be a climate-positive enterprise with fossil-free production and fossil-free transportation

Taken together, the overall climate effect of Södra's operations is positive at a level of 9.2 $MtCO_2e/yr$. This corresponds to about 20 % of Sweden's reported total fossil emissions.

In conclusion, a high contribution to mitigating global climate change is combined with long term investments in, and financial returns from, forestry and forest industries that benefit Södra's members and society at large.

The positive climate effect is created in the forest through commitments to sustainable forest management. This results in both increased carbon sink and storage, as well as laying a foundation for significant reductions of fossil emissions through substitution with forest products.

> ”
> *Unfortunately, climate agreements and policy have not fully incorporated the climate benefits of integrated forestry and the forest industry or the synergies with sustainable development*

At the other end of the value chain, consumers realise the positive climate effect when they choose forest products. This relates both to the physical storage of carbon in buildings and wood products, but also, more significantly, by leaving fossil energy underground.

Unfortunately, climate agreements and policy have not fully incorporated the climate benefits of integrated forestry and the forest industry or the synergies with sustainable development. Results of this study may help Södra further advance their climate efforts, and also stimulate a discourse that better establishes the forestry sector as a major part of the solution.

Introduction

Södra combines financial returns from its members' forestry operations with profits from forest industries owned jointly by the members (Box 1). The financial performance is achieved in parallel with a corporate goal to become fossil-free and climate-positive, contributing to Sweden's overall climate ambition and targets. Fossil-free value chains are expected to build competitiveness in an increasingly bio-based economy (Södra, 2019). Further, investments in enhanced forest management have, over the long term, increased forest growth, leading to a higher sustainable harvest and an increasing carbon sink in Södra members' forests. The Swedish forestry sector presents a similar perspective in its roadmap within the Government-led initiative "Fossil-free Sweden" (Skogsindustrierna, 2018).

There is a high level of integration and interdependency between products in the value chain. The timber market and return on forestry operations are primarily determined by high-value wood assortments that are sawn and eventually become solid wood products. This is where most of value is generated for the forest owners. In addition, other parts of the tree – including residual materials from sawmills – represent high economic values. Smaller wood dimensions are used for pulp production, whereas bark, wood chips, branches and sawdust are largely used for bioenergy. In all, the entire tree can be used for a variety of purposes, which means both the economic value and climate benefits can be maximized.

The main business process is subject to fulfilling a range of other sustainability goals. For example sustainable harvesting, considerations in regeneration harvesting, nature conservation measures, health and safety, and evaluation of suppliers (Södra, 2019).

Box 1. Extract from Södra Annual Report 2018 (Södra, 2019 p. 2)

Södra's business is built on value-generating relationships and a long-term approach. The overall assignment from our owners is to secure markets for our members' forest products, to promote the profitability of their forest estates by providing advice and support for responsible and sustainable forestry, and to contribute to a market-based return on their forest products. The wood is processed in Södra's mills and becomes sawn and planed timber, biofuel and market pulp.

Södra has one of the largest sawmill operations in Europe and is one of the biggest European suppliers of softwood sulphate pulp to the pulp market (market pulp). Södra also produces dissolving pulp from hardwood. Södra's three pulp mills have almost fossil-free production and generate large volumes of surplus energy. This bio-based energy is sold as both green electricity and district heating. Södra also owns the house-manufacturing company, Trivselhus.

Södra purposefully focuses on innovation to develop new products based on renewable raw materials from the forest. Södra's sales amounted to SEK 24 billion and the number of employees was just over 3,100.

The purpose of this report is to establish a baseline of the climate effect from Södra's operations. The results will support continued analyses and decisions as to how Södra can achieve its strategic climate-related goals. In a broader sense, the report highlights the significant role of the forestry sector in achieving global climate change goals expressed in the Paris Agreement (UNFCCC, 2015). In particular, it illustrates how a member-led forest owner association can combine and develop synergies between financial results and sustainable development for the benefit of future generations.

The report focuses on Södra's climate effect in the year 2018. It is, however, important to acknowledge that the effect in 2018 is achieved as a result of many preceding years of proactive forestry by Södra's members and their shared investments in forest industry facilities. Further, it is a key characteristic of the long-term investments in forest management that wood removals are consistently lower than the forest growth so as to ensure an enhanced forest asset over time; and also that applied forest management includes the preservation of biological diversity and other ecosystem services.

The analysis is based on the model developed by SCA as presented in their annual report for year 2018 (SCA, 2019a). The approach is adapted to Södra's business model with member-owned forests and jointly-owned forest industry operations. The aim is to view Södra as an integrated enterprise, and at the same time make it possible to evaluate the performance of specific components or product categories.

Forestry and forest products as a circular business process

Forestry aims to manage forests for the very long term to ensure a stable or increasing supply of wood, non-wood products and other ecosystem services. The driving force is the natural photosynthesis process whereby trees and vegetation absorb CO_2 from the atmosphere and use solar energy to convert it to wood and other forms of biomass. Eventually almost all of this biomass is returned to the atmosphere, either slowly through biological decomposition processes, or quickly through fires, completing a natural carbon cycle between the atmosphere and the biosphere.

When we harvest trees for wood this natural carbon cycle is extended as the carbon will for some time be stored in forest products. Eventually wood-based products are also returned to the atmosphere as biogenic emissions of CO_2 – sooner in the case of bioenergy, later in the case of wooden buildings. Therefore, as long as we manage forests to reabsorb this CO_2, forest products can be considered carbon and climate neutral (Figure 1), which also reflects how biogenic carbon is accounted for in climate reporting (IPCC, 2006).

> ”
> *The climate effect from substitution is important as it means that the substituted fossil energy sources stay underground*

The long history of active forest management in Sweden, including the region where Södra operates, has led to a steady increase both in the growth of forests and of the growing stock. In climate terms this means that both the sink and the reservoir of carbon in forests have increased, which mitigates climate change. Furthermore, using forest products means that products based on higher use of fossil energy are replaced, or substituted. The climate effect from substitution is important as it means that the substituted fossil energy sources stay underground (Holmgren, 2019).

Conclusively, the business processes in forestry and forest industry are circular and potentially climate positive. This is well recognised in climate change reports and negotiations, where the role of forests, sustainable forestry, wood products and bioenergy are consistently promoted as important parts of the climate solution (IPCC, 2019, 2018, 1990). At the same time, unsustainable use or depletion of forests have been raised as a negative factor (UNFCCC, 2015), which has also strongly influenced the political discourse around forests and climate (e.g. Government of Norway, 2019).

This report demonstrates, through the case of Södra, how forestry and forest industry can generate positive climate effects as a co-benefit to sustainable forest management and financial returns.

Figure 1. Forestry and forest products are part of a green carbon cycle between biosphere and atmosphere. The figure illustrates the Swedish forestry sector. From Holmgren (2019).

Model overview

The base model is documented by Holmgren and Kolar (2019). The climate effect of a forestry enterprise, expressed in carbon dioxide equivalents (CO_2e), is defined as the sum of three factors:

1. Net sink of carbon in the forest (normally a positive climate effect)
2. Fossil emissions (CO_2) in the value chain (a negative climate effect)
3. Fossil emission reductions through substitution when forest products replace products with a higher climate footprint (a positive climate effect)

The model does not explicitly include biogenic CO_2 emissions in the value chain. The forest industry processes make use of large quantities of residual biomass for energy, thereby avoiding using fossil energy. These biogenic emissions are part of the biological carbon cycle as described in the previous section and therefore do not add to anthropogenic climate change. This corresponds to internationally agreed principles and reporting standards for greenhouse gas emissions (IPCC, 2006). Furthermore, efficiency gains and enhanced utilization of biomass in the industrial processes are continuously sought, which means that biogenic emissions in the value chain may be reduced, leading to larger volumes of marketed products, especially energy, that can generate climate benefits through substitution.

Given the structure of Södra, the model was divided into two subsystems, one for the climate effect of forestry on members' land holdings ("Södra Members") and one for Södra Skogsägarna Ekonomisk Förening ("Södra Group") – the industry group jointly owned by the members (Figure 2). These subsystems are not formally joined as one corporation. However, the business model implies that most of Södra Members' wood sales are procured by Södra Group, and vice versa most of Södra Group's procured wood is supplied by Södra Members. It is therefore relevant to analyse the climate effect of the two subsystems together.

SÖDRA MEMBERS

52,000 members own and manage 2.6 million hectares of forest

Timber data 2018 in million m^3sub:
- Forest growtht: 13.1
- Harvest: 11.9

Harvested volume is divided in million m^3sub:
- Supply to Södra group: 9.8
- Own use: 1.2
- Supply to others: 0.9

Members also jointly own Södra group

→

SÖDRA GROUP

Corporate forest holdings of 0.12 Mha, 0.4 Mm^3sub growth, 0.3 Mm^3sub harvest

Wood supply (Mm^3sub): 9.8 from members, 0.1 from corporate forests, 3.8 from other sources

Industry units produce and market 1.7 Mm^3 sawn wood, 1.7 Mt pulp of which 0.14 Mt for textiles, 5 TWh bioenergy, and other products

2.3 Mm^3sub roundwood and wood chips are sold onwards to other forest industry entities

Significant logistics including forestry operations and transportation of wood and products

Figure 2. Overview of the two Södra subsystems defined for this study, with key production data.

Applying the climate effect model (Holmgren and Kolar, 2019) to a set of two subsystems requires clarity in the interactions between the two subsystems as well as how the total climate effect can be estimated without double counting. The relationship between the two subsystems is described in Figure 3, together with production flows and climate effect origins.

As a simplification it is assumed that all fossil emissions of carbon dioxide in the value chain, including forest operations, are made within the Södra Group subsystem and as a consequence no fossil emissions of carbon dioxide are assigned to Södra Members. Given that almost all forest operations actually are performed under the auspices of Södra Group, this assumption has very minor implications.

Södra Members generate climate benefits through increased carbon stock (a net sink in vegetation and soil) in their combined forest holdings of 2.6 million hectares. The delivered wood will eventually reduce fossil energy use through substitution. The total climate effect is calculated for this subsystem separately as well as in combination with Södra Group.

Also for Södra Group there is a climate effect from the relatively small corporate forest holdings, most of it in the Baltic countries. Fossil emissions occur throughout the value chain, from forestry operations, through transport and industrial processes, to customers. The substitution effect initiated in Södra members' forests (as well as in other forests where wood is sourced) is carried through the value chain and onto customers of Södra Group.

An exchange of wood material occurs between the two subsystems. Södra Members sell some of their produce to other forest industries, and also consume a part of the harvest themselves for example as bioenergy for heating. Further, Södra Group procures wood from sources that are not members of Södra. These exchanges affect the overall climate performance and have been considered.

The results from the two subsystems can be added for a complete estimate of Södra's climate effect. One must then avoid double counting of the substitution effect and take into account the exchanges of wood between the subsystems.

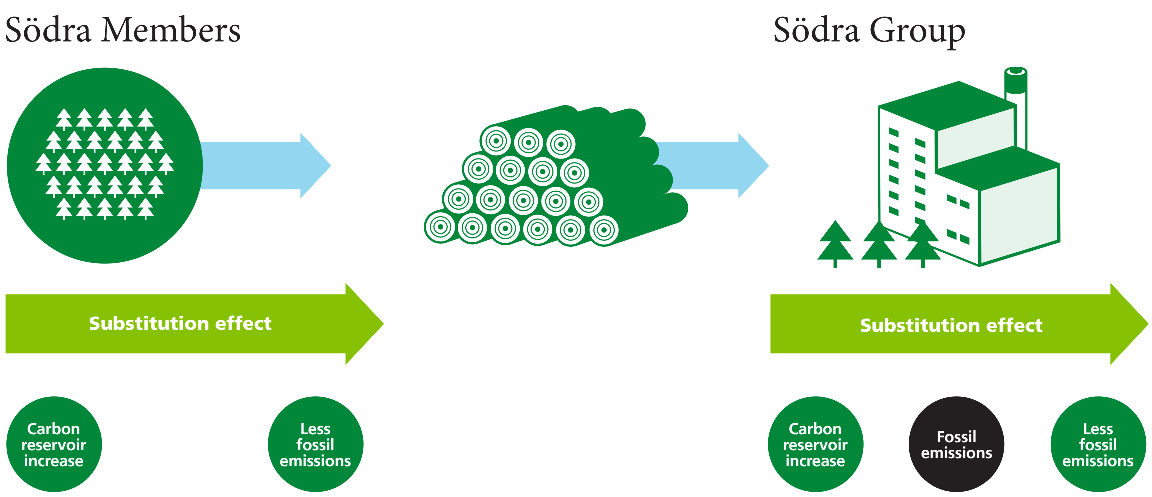

Figure 3. Overview of production flows (arrows) and climate effects (circles) of the two subsystems of Södra's operations. Note that substitution effects are created through sustainably managed forests in combination with efficient value chains of forest products.

Reduction of fossil emissions through substitution

When consumers or downstream businesses choose forest products over products that cause more fossil emissions, they help mitigate climate change. Building a house with a wooden structure, using clothes made from wood fibre-based textiles, or heating your home with residual bioenergy are all examples where consumption includes a climate dimension.
Making the effect of these choices visible and quantifiable for consumers, corporations and politicians can stimulate positive climate actions.

> *The reduction of fossil emissions through substitution (substitution effect) is a key element in estimating the overall climate effect of forestry and forest industries*

The reduction of fossil emissions through substitution (substitution effect) is a key element in estimating the overall climate effect of forestry and forest industries. It is also a less visible effect compared with the forest carbon sink and fossil emissions in the value chain, which both refer to specific items in formal reporting to the intergovernmental climate arrangements (IPCC, 2006; Naturvårdsverket, 2018; UNFCCC, 2015) and are *de facto* included in most large corporations' legally required sustainability disclosures (Årsredovisningslag, 2019).

By contrast, the effects of substitution are not explicit in official climate change reports. Implicitly, the effect is included in the overall reports, as emissions in other sectors would have been higher, should forest products not have been available. However, a lower-than-otherwise emission in, say, the housing sector, is not easily attributed to sustainably-managed forests and wood delivery.

The IPCC categorizes "Forestry and other land uses" (FOLU) as a distinct sector for which the carbon stock and fluxes are reported separately. For the wider forestry sector, including value chains and products, this creates a problem as the forest growth (sink) and carbon storage are separated from downstream substitution effects from forest products. This hinders an integrated perspective on climate change effects for the sector as a whole. Instead, perverse incentives are created that counteract active forestry and increased wood supply due to the proprietary logic of international climate reporting that focuses on the forest carbon reservoir in isolation. Consequently, the political focus becomes to "conserve and enhance" the forest carbon stock as such over time (Holmgren, 2019).

While the substitution effect of forest products is not an explicit part of formal climate reporting or climate agreements, it has long been acknowledged as an important factor for achieving climate change mitigation targets (IPCC, 2018, 1990). Recent years have seen an increasing attention in research for quantifying the substitution effect by establishing "substitution factors" that estimate the quantity of fossil emissions substituted (displaced) by different categories of forest products (Holmgren and Kolar, 2019; Leskinen et al., 2018; Sathre and O'Connor, 2010). The substitution factor is usually expressed as the amount of fossil carbon emissions that is displaced per unit of carbon present in the forest products, i.e. tons of fossil carbon per ton of biogenic carbon (equivalents), or tC/tC.

The knowledge base around substitution factors is emerging and needs further attention in research. The current report is based on substitution factors compiled from a review of available research by Holmgren and Kolar (2019) (Table 1). The substitution effects are estimated for forest products delivered from forest industries, i.e. conventional forest industry product categories such as sawn wood, pulp, paper and bioenergy. This corresponds with approaches in research that have studied the substitution effect of forest products and the forestry sector (Leskinen et al., 2018). It means that the point of reference for the substitution effect is at delivery from industries. In all more than 50 scientific publications have studied substitution factors of forest products over the past ten years, as reviewed separately by Holmgren and Kolar (2019) and Leskinen et al. (2018). Methodologies are still evolving, however, which makes results somewhat difficult to compare. The substitution factors used in this study (Table 1) should be considered estimations that will need adjustment as research advances.

Table 1. Substitution factors for displacement of fossil emissions applied in this report.

Product category	Substitution factor tC/tC
Roundwood	0.57
Wood chips	0.9
Sawn wood	1.5
Textile pulp	1
Other pulp	0.7
Other (tall oil, turpentine)	0.7

In addition to substitution factors used by Holmgren and Kolar (2019) a substitution factor of 0.9 tC/tC is applied for forwarded wood chips, based on the consideration that wood chips are used partly for bioenergy and partly for board products for which it is assumed that the substitution factor is close to that of sawn wood. Further, for textile pulp, a substitution factor of 1 tC/tC is applied. While this factor has been estimated at as high as 2.8 tC/tC (Leskinen et al., 2018), it is not yet well researched, which justifies a more conservative assumption for this study.

Understanding the substitution effect is relevant at all stages in the long value chain from the forest to consumer, construction or energy products. The actual substitution effect is not realised until ultimate (consumer) products are chosen over fossil-based ones (which may happen at several subsequent uses of recycled wood or fibre). For all stages before this point, the substitution factor is an estimate of downstream effects.

Evaluating policy and management options throughout the value chain therefore requires that downstream substitution effects can be estimated at different points along the value chain. For example, it is important to understand downstream climate effects of improved forest management with increased sustainable harvest levels and wood delivery, so as to help incentivize long-term investments in forest land (Lundmark et al., 2014).

”The substitution factors (...) should be considered estimations that will need adjustment as research advances

For this reason, the current report acknowledges that substitution effects are initiated in the managed growing forest, passed on through harvested wood, maintained through value chains, passed on to customers who refine the products further mainly into consumer and construction products, where the substitution effect is finally realised each time recyclable forest products are chosen over fossil-based ones. (Figure 3).

Following this approach, the substitution factor at the stage of roundwood supply from the forest has been retrospectively calculated based on substitution factors considered for sawn wood, fibre products and bioenergy (Table 1). Drawing from below results, the substitution factor for roundwood in the Södra context was calculated as follows:

- The net use of roundwood is 12.0 Mm^3sub (gross input of 13.7 Mm^3sub wood less onward sales of roundwood of 1.7 Mm^3sub). The carbon content of this is 3.0 MtC.
- The estimated total substitution effect (see below) of products derived from this volume is 6.3 $MtCO_2e$ (again excluding forwarded roundwood), equivalent to 1.7 MtC, from the supplied roundwood.
- The substitution factor for roundwood in the Södra context is then 1.7 MtC / 3.0 MtC = 0.57 tC/tC

Note that the roundwood substitution factor refers to the wood material as such and does not consider fossil emissions caused later in the value chain, as these are accounted for separately in the model.

Subsystem 1: Climate effect of forestry by Södra Members

This section summarizes calculation of climate effects for the Södra Member subsystem.

Net sink in the forest

The climate effect of the forest is calculated as the net change of carbon stock, resulting from biological biomass growth, removals of biomass by harvesting of trees and losses (oxidation) of carbon in biological processes or fires. For the forest holdings of Södra Members (2.6 million hectares), an extract of data from the Swedish National Forest Inventory (SLU, 2018) was used for the calculation of net change. By using sample plots falling within Södra Member's properties, a precise and statistically valid estimate of the changes in carbon stock over time can be obtained. For 2018 the biological growth (including losses in the forest) was 13.1 Mm^3sub (stem volume under bark) and wood harvests 11.9 Mm^3sub (Södra, 2018). The resulting net increase of growing stock corresponds to an overall net sink of 1.9 million tonnes CO_2e in vegetation and soil (Södra, 2019).

Fossil emissions of carbon dioxide in the value chain

As noted above, no fossil emissions of carbon dioxide are attributed to the Södra Member subsystem. These are all reported under the Södra Group subsystem.

Fossil emissions displacement through substitution

Total wood harvests by Södra Members were 11.9 Mm^3sub (Södra, 2018). Out of this, 9.8 Mm^3sub was supplied to Södra Group's industries, 1.2 Mm^3sub maintained for own use and 0.9 Mm^3sub sold to other forest industry entities.

The harvested wood will eventually result in reduced fossil emissions as forest products replace products with a fossil climate footprint. At the stage of roundwood, the substitution factor in the Södra context was estimated at 0.57 tC/tC (see above section).

The substitution effect of wood delivered from Södra Members can then be calculated as:

- Carbon content of 11.9 Mm^3sub delivered wood = 3.0 MtC
- Fossil displacement through substitution = 3.0 MtC * 0.57 tC/tC = 1.7 MtC, corresponding to 6.3 $MtCO_2e$

Total climate effect of Södra Member subsystem

Based on the above, the total climate effect of Södra Members is 8.2 $MtCO_2e$ for the year 2018 as the sum of:

- Net sink in the forest: 1.9 $MtCO_2e$
- Fossil emissions of carbon dioxide: 0 $MtCO_2e$ (all fossil emissions of carbon dioxide, including for forestry operations, are accounted for in the Södra Group subsystem)
- Fossil emission displacement through substitution: 6.3 $MtCO_2e$

Subsystem 2: Climate effect of Södra Group

This section summarises calculation of climate effects for the Södra Group subsystem.

Net sink in the forest

The climate effect (net sink) in corporately owned forests (118 000 hectares) was estimated at 0.2 $MtCO_2e$ for 2018 based on corporate inventory of the forests (Södra, 2018). Note that the estimate is made for the full year, even though parts of the estate came under Södra's ownership during the year.

Fossil emissions of carbon dioxide in the value chain

Fossil emissions in the value chain are regularly reported within the annual sustainability reports (Södra, 2019). For this report, the calculations were amended to include all fossil emissions of carbon dioxide through the value chain.

For forest operations, estimated emissions for all wood supply were included, i.e. emissions of forest operations caused by Södra's own activities as well as emissions by other operators. In addition, emissions related to wood supplied to other industry entities have been included. This corresponds with the simplification (see above) that the minor emissions within the Södra Member subsystem are attributed to Södra Group.

One significant addition to the 2018 annual sustainability report is that input goods have been included.

Table 2. Fossil emissions of carbon dioxide in Södra Group by category in 2018.

Area	Fossil emissions of carbon dioxide $MtCO_2e$
Forest operations	0.07
Transportation	0.20
Industry processes	0.06
Input goods	0,25
Total	**0.58**

The total fossil emissions of carbon dioxide were estimated at 0.6 Mt CO_2e (Table 2).

Fossil emissions displacement through substitution

The products and quantities delivered by Södra Group in 2018 are listed in Table 3. Carbon content in the solid products was calculated based on standard conversion factors. For bioenergy products, a carbon equivalent was calculated as the carbon content of the amount of fossil fuel required to produce the same quantity of energy. Applying the substitution factors established above (Table 1) gives the fossil emission displacement through substitution for each product category (Table 3). The total substitution effect for Södra Group in 2018 is estimated at 7.2 Mt CO_2e.

Total climate effect of Södra Group subsystem

Based on the above, the total climate effect of Södra Group is 6.8 $MtCO_2e$ for year 2018 as the sum of:

- Net sink in the forest: 0.2 $MtCO_2e$
- Fossil emissions of carbon dioxide: -0.6 $MtCO_2e$
- Fossil emission displacement through substitution: 7.2 $MtCO_2e$

Table 3. Products and quantities marketed by Södra Group in 2018 and associated fossil emission displacement through substitution

Product category	Marketed quantity		Carbon content/ equivalents	Substitution factor	Fossil emission displacement
	quantity	unit	Mt C	tC/tC	$MtCO_2e$
Wood products					
Roundwood	1.71	Mm³sub	0.43	0.57	0.9
Wood chips	0.59	Mm³sub	0.15	0.9	0.5
Sawn wood	1.75	Mm³sw	0.44	1.5	2.4
Fibre products					
Textile pulp	0.14	Mt	0.05	1	0.2
Other pulp	1.64	Mt	0.61	0.7	1.6
Bioenergy					
Biofuels	3.87	TWh	0.46	0.7	1.2
Heat	0.43	TWh	0.05	0.7	0.1
Electricity	0.57	TWh	0.07	0.7	0.2
Other					
House bodies	441	pcs			not included
Peat	0.25	Mm³			not included
Crude tall oil	0.44	TWh	0.05	0.7	0.1
Turpentine	0.02	TWh	0.002	0.7	0.0
Total			**2.3**		**7.2**

Overall climate effect of Södra

Adding the two subsystems described in the previous section provides an estimate of the overall climate effect of Södra. For the forest and value chain components, this is straightforward. The substitution effect requires some attention with respect to the system boundary.

Net sink in the forest

The net sink in the forest is calculated by adding the effects of the subsystems:

- Södra Members: 1.9 $MtCO_2e$
- Södra Group: 0.2 $MtCO_2e$

for a total of 2.1 $MtCO_2e$

Fossil emissions of carbon dioxide in the value chain

Emissions in the value chain were only accounted for the Södra Group system, at a level of 0.6 $MtCO_2e$.

Fossil emissions displacement through substitution

The substitution effect that Södra as a whole passes on to customers and eventually to consumers must consider a system boundary that includes the two Södra subsystems and the total volume of marketed products that leave the overall system. This means that roundwood from Södra Members that is sold to other forest industries accrues a substitution effect that should be added to the products marketed by Södra Group (Figure 4).

Note that the harvested wood for own use by Södra Members (1.2 Mm^3sub in 2018) has been considered as internal consumption and is therefore not included in the overall substitution effect of Södra. One may argue, however, that some substitution accrues from these volumes as they are used for construction or energy purposes.

The fossil emissions displacement through substitution for Södra as a whole is therefore:

- 0.5 $MtCO_2e$ from roundwood marketed by Södra Members to other forest industry, (0.9 Mm^3sub * 0.57 tC/tC)
- 7.2 $MtCO_2e$ from products marketed by Södra Group

for a total of 7.7 $MtCO_2e$.

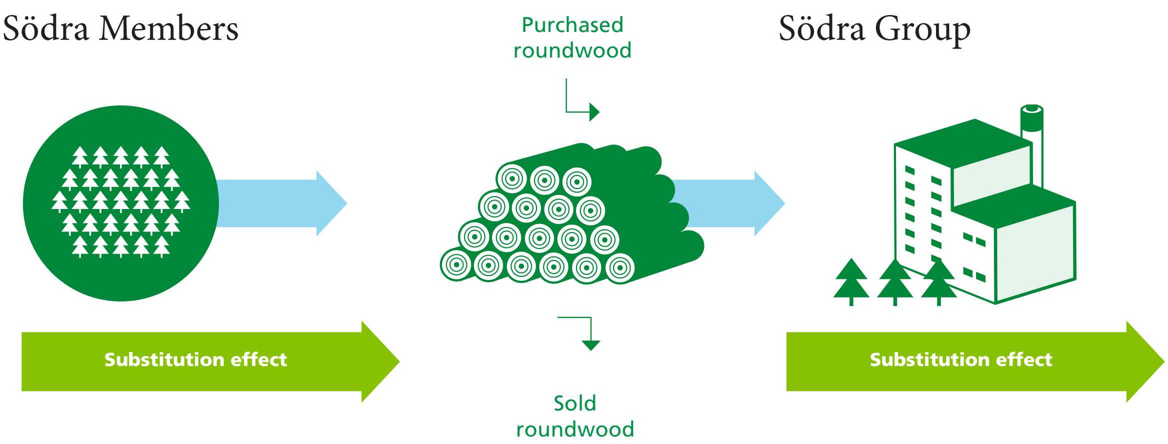

Figure 4. For the Södra system as a whole, fossil emissions displacement through substitution is enabled both by marketed products from Södra Group and by roundwood marketed by Södra Members to other forest industry entities.

Total climate effect of Södra

Based on the above, the total and positive climate effect of Södra as a whole is 9.2 MtCO_2e for year 2018 (Figure 5) as the sum of:

- Net sink in the forest: 2.1 MtCO_2e
- Fossil emissions of carbon dioxide: -0.6 MtCO_2e
- Fossil emission displacement through substitution: 7.7 MtCO_2e

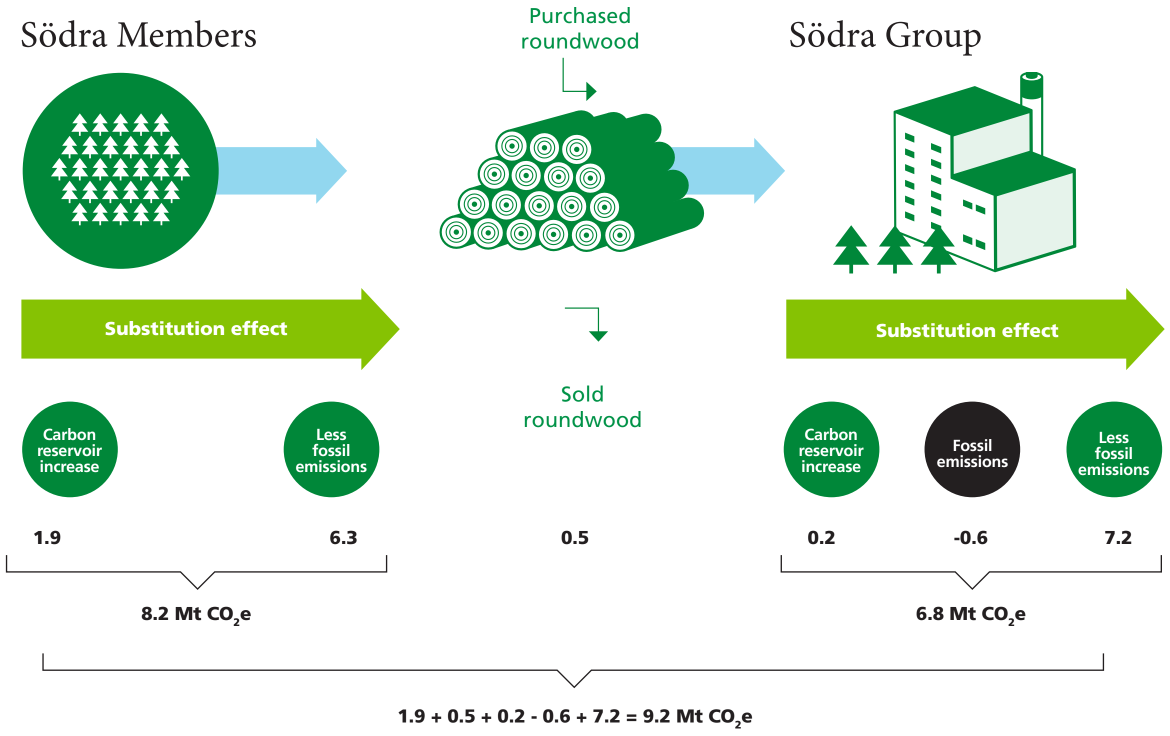

Figure 5. Climate effect for Södra as a whole is estimated to be 9.2 MtCO2e for 2018. The figure illustrates the contribution of each of the two subsystems.

Discussion

Significance of results

The positive climate effect of 9.2 $MtCO_2e$/yr by Södra is a very strong contribution to the global climate solutions we need. It is considerably larger than fossil emissions from the entire Swedish steel industry at 6 $MtCO_2e$/yr (Jernkontoret, 2018), and corresponds to almost 20% of reported territorial emissions in Sweden (Naturvårdsverket, 2018). The results are in line with analyses of the large contribution by the Swedish forestry sector as a whole, estimated at 93 $MtCO_2e$/yr by (Holmgren, 2019), the reported net sink in Swedish forests (Naturvårdsverket, 2018), as well as earlier estimates of substitution effects of Swedish forest products (Lundmark et al., 2014).

At the same time, remaining fossil emissions of carbon dioxide in the value chain are significant at 0.6 $MtCO_2e$/yr, or about 1% of Sweden's total territorial emissions. Södra has a strong ambition to reduce these emissions further, which would appear to be positive not only as a necessary climate action as such, but also to accentuate the fossil-free profile of forest products. The main challenges relate to removing emissions associated with input materials, forestry operations, transportation of roundwood to industry and transportation of products to customers.

> *The positive climate effect of 9.2 $MtCO_2e$/yr (...) corresponds to almost 20 % of reported territorial emissions in Sweden*

Model

The model chosen to calculate the climate effect of Södra is intentionally simplified. Interactions between forests, forest industry, product substitution and the climate are extremely complex. While the model provides valid results, these are approximations. It was considered of limited added value to detail the model and calculations further, corresponding to conclusions from a roundtable evaluation of the model (SCA, 2019b). Instead, enabling communication and a broad understanding of the contributions of forestry, forest industries and forest products has been prioritized.

As discussed above, the displacement of fossil emissions through substitution requires further research. This is an essential factor for understanding the benefits of the forestry sector with respect to climate change. Due to their absence in formally established official climate change reporting, there has been less attention on substitution effects and the knowledge base is still emerging.

Note, however, that official climate change reporting methodology (IPCC, 2006) does include carbon sink in "Harvested Wood Products" (HWP). This is to account for the temporary physical carbon storage in forest products. HWP accounting must not be confused with the substitution effect, which is the additional benefit of not using fossil-based products. The present study does not account for the sink in HWP, which is reported at about 7 $MtCO_2e$/yr for Sweden as a whole (Naturvårdsverket, 2018). In theory, about 10% of this could be attributed as an additional positive climate effect of Södra's products.

Drivers and tradeoffs of positive climate effects

The positive climate effects in the forest and through substitution are both co-benefits of long-term investments in sustainable forest management – leading to enhanced growth and higher standing timber volumes, and development of logistical systems and the forest industry. These investments have resulted in increasing financial returns over time, that are expected to continue to accrue over the long term.

A long-term, sustainable and profitable forestry sector thus has a cooling effect on the global climate. Conditions for these achievements include stable politics over the long term, reliable institutions including land tenure arrangements, and well-functioning markets and trade for forest products.

However, a wider set of goals is attributed to forests and forestry. Besides the financial and climate ones, there are social and other environmental considerations. Conservation of biological diversity, in particular, is a matter of priority and ambition for forest owners, as well as a legal requirement. Current approaches to biodiversity conservation are dominated by excluding forest land from wood production so as to promote natural regeneration and the prevalence of rare species. Consequences of tradeoffs between climate and biodiversity benefits appear to need further analyses. With larger areas set aside, less growth enhancement and substitution effects are to be expected. Further, protection against pests and diseases may be less efficient if, for example, untreated reserves in the landscape provide breeding grounds for insects such as the bark beetle.

The main counter-argument to these statements is that forestry is to be considered part of the carbon cycle

Bioenergy and biogenic emissions sometimes receive critique from researchers and media who argue that active forestry is a false climate solution as it results in large biogenic CO_2 emissions which have the same climate effect as CO_2 as fossil emissions. Some of the critique is founded in the use of wood pellets instead of coal to produce electricity at low efficiency rates, as a means to meet EU directives on renewable energy (Brack, 2017). A related argument is that CO_2 in the atmosphere needs to be quickly (in the next decade or so) reduced and that stopping forest harvesting would be a way to help achieve this as trees would in the short term absorb large amounts of carbon.

The main counterargument to these statements is that forestry is to be considered part of the carbon cycle, as described in the introductory section to this report. That is, biogenic emissions return to the growing forest and no additional carbon is added to the atmosphere. This is also how emissions are handled in international reporting (IPCC, 2006). Regarding the time argument, it is necessary to analyse the effects with a broader perspective as to forest development, impacts on the forestry sector and society, as well as the overall effect on the climate over the short and long term.

Efficiency in the value chains is, however, an important consideration. While Swedish forest industries have long worked to maximize efficiency, including combined heat and power plants working at 99% efficiency rates, this is not the case in many other countries. High utility of wood requires long-term investments, including bioenergy infrastructure. The climate effect of such investments is potentially high in many regions, which illustrates that climate benefits from the forest can be enhanced through investments in the value chain.

How is forestry considered in international climate reports?

As noted above in the section on substitution factors and further discussed in Holmgren (2019), the current structure of climate change reporting and the formulation of climate agreements (UNFCCC, 2015) may result in perverse incentives for forest management. Instead of stimulating a higher climate effect through active forestry and forest products that substitute fossil-based material, the established norm is to view the forest as a carbon reservoir that should be "conserved and enhanced." While "Harvested Wood Products" are included in the accounting methodology, this is merely an extension of the carbon storage logic and does not refer to the more significant substitution effect. Consequently, the integration between forests, forestry and forest industry is not acknowledged and the circular, fossil-free and bio-based forest economy is not highlighted as a major part of the solution. On the contrary "forestry" is posed as part of the problem, for example in the IPCCs latest assessment report where "forestry and other land use" account for 11% of global emissions. (IPCC, 2014).

> *Instead of stimulating a higher climate effect through active forestry and forest products that substitute fossil-based material, the established norm is to view the forest as a carbon reservoir that should be "conserved and enhanced"*

In addition, the IPCC 1.5 degree report (IPCC, 2018) introduces suggested timelines for emissions reductions so as to halt the anthropogenic warming at 1.5 degrees Celsius above pre-industrial levels. The proposed pace is dramatic and to make it less strenuous on fossil-based sectors, considerable contributions from forests and trees in the coming few decades are built into the scenarios. Again, the models refer only to sinking carbon into the forest and not substitution effects. Further, the positive feedback loop that functioning markets for wood stimulate improved management and therefore an enhanced sink is not part of the IPCC analyses. Neither are synergies with other development objectives. Consequently, incentives and agendas are created to abandon forests, as the current framing by climate science assumes this is the best course of action for the climate.

In August 2019, the Intergovernmental Panel on Climate Change (IPCC) released a special report on Climate Change and Land (IPCC, 2019). The report received considerable attention worldwide as it addresses land use as one of the largest contributing factors to climate change, and at the same time the sector that will be affected the most by climate change. The biggest focus of the report is food production and the food value chains, including diets. Considerable reduction of emissions is proposed though changes in agricultural production, reduced loss and waste of food, and reduced consumption of meat.

Forests and forestry receive relatively less attention, and mainly in relation to deforestation and forest degradation, as major sources of emissions. In this regard, it is striking that global models applied by the IPCC restrict "forestry" to areas where trees are removed, thus excluding all other land where the forest is managed for increased sustained yield, and enhanced sinks. This creates a skewed perspective of the forestry opportunities.

Active, sustainable forestry as a climate-positive action receives relatively little attention in the Climate Change and Land report. While "reforestation, forest restoration and afforestation" is considered to have a global potential in the order of 10Gt CO_2e/yr removals (25% of current global emissions), this is offset against the perceived risk of food insecurity as forests would expand. Further, while issues with food value chains are a major part of the analyses in the report, the opportunities offered by forest product value chains in reducing fossil emissions are not. This follows the abovementioned IPCC proprietary logic that separates sectors. Conclusively, the IPCC Land report appears to be a lost opportunity for promoting the climate benefits of forestry and forest products and may well instead, and ironically, cause obstacles in climate policy discussions.

Conclusions

- Södra, like the Swedish forestry sector at large, contributes strongly to climate solutions. The overall and positive climate effect of Södra is estimated at 9.2 MtCO_2e/yr, corresponding to 20% of reported fossil emissions for Sweden as a whole;

- The climate benefits should be seen as an integrated co-benefit of active forestry with associated forest industry. That is, forestry and forest industry generate financial returns with societal and climate/environment co-benefits. In addition, the financial returns stimulate a positive feedback loop that further improves forest management over time.

- As for Sweden as a whole, the positive development of forestry among Södra's members is a result of stable politics, well-established land tenure rights, a market economy, as well as very long-term perspectives and policies for forest management. Continued climate and sustainable development benefits from forestry depend on these factors.

- International climate agreements and reporting regulate forestry in ways that may create perverse incentives. In particular, the perspective of forests as a carbon reservoir may hinder development of forest product value chains that deliver higher climate benefits, positive feedback loops for forest management, as well as other sustainable development contributions. Political processes and decisions regarding the forest/climate nexus should take this broader perspective into account, for the benefit of future generations.

References

Årsredovisningslag, 2019. Årsredovisningslag (1995:1554) [WWW Document]. URL https://lagen.nu/1995:1554 (accessed 7.17.19).

Brack, D., 2017. The Impacts of the Demand for Woody Biomass for Power and Heat on Climate and Forests [WWW Document]. Chatham House. URL https://www.chathamhouse.org/sites/default/files/publications/research/2017-02-23-impacts-demand-woody-biomass-climate-forests-brack-final.pdf (accessed 11.22.18).

Government of Norway, 2019. Norway's International Climate and Forest Initiative (NICFI) [WWW Document]. Government.no. URL https://www.regjeringen.no/en/topics/climate-and-environment/climate/climate-and-forest-initiative/id2000712/ (accessed 8.27.19).

Holmgren, P., 2019. Så stort är skogsnäringens bidrag i klimatarbetet – Skogsindustrierna [WWW Document]. URL https://www.skogsindustrierna.se/siteassets/dokument/nyheter/rapport-skogsnaringens-klimatbidrag.pdf

Holmgren, P., Kolar, K., 2019. Reporting the overall climate impact of a forestry corporation – the case of SCA [WWW Document]. URL https://mb.cision.com/Main/600/2752801/999695.pdf

IPCC, 2019. Climate Change and Land [WWW Document]. URL https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf (accessed 8.8.19).

IPCC, 2018. Global warming of 1.5°C [WWW Document]. URL http://www.ipcc.ch/report/sr15/

IPCC, 2014. Climate Change 2014 Synthesis Report [WWW Document]. URL http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories [WWW Document]. URL https://www.ipcc-nggip.iges.or.jp/public/2006gl/

IPCC, 1990. Assessment Report 1: The IPCC Response Strategies [WWW Document]. URL https://www.ipcc.ch/report/ar1/wg3/

Jernkontoret, 2018. Klimatfärdplan: för en fossilfri och konkurrenskraftig stålindustri i Sverige. [WWW Document]. URL http://fossilfritt-sverige.se/wp-content/uploads/2018/04/ffs_stalindustrin.pdf

Leskinen, P., Cardellini, G., González-García, S., Hurmekoski, E., Sathre, R., Seppälä, J., Smyth, C., Stern, T., Verkerk, P.J., 2018. Substitution effects of wood-based products in climate change mitigation [WWW Document]. URL https://www.efi.int/sites/default/files/files/publication-bank/2018/efi_fstp_7_2018.pdf

Lundmark, T., Bergh, J., Hofer, P., Lundström, A., Nordin, A., Poudel, B.C., Sathre, R., Taverna, R., Werner, F., 2014. Potential Roles of Swedish Forestry in the Context of Climate Change Mitigation. Forests 5, 557–578. https://doi.org/10.3390/f5040557

Naturvårdsverket, 2018. National Inventory Report 2018 [WWW Document]. URL https://www.naturvardsverket.se/upload/miljoarbete-i-samhallet/internationellt-miljoarbete/miljokonventioner/FN/national-inventory-report-2018.pdf (accessed 6.16.19).

Sathre, R., O'Connor, J., 2010. Meta-analysis of greenhouse gas displacement factors of wood product substitution. Environ. Sci. Policy 13, 104–114. https://doi.org/10.1016/j.envsci.2009.12.005

SCA, 2019a. Annual report 2018 [WWW Document]. URL https://www.sca.com/globalassets/sca-engelska/investors/annual-reports/sca_annual-report-2018_eng2.pdf

SCA, 2019b. Climate benefits from forests, forestry and forest industry – how can we clarify, calculate and communicate them? Report from a roundtable discussion. [WWW Document]. URL https://www.sca.com/globalassets/sca/hallbarhet/klimatnytta/roundtable-discussion-on-climate-benefits-from-forests-forestry-and-forest-industry-march-2019.pdf

Skogsindustrierna, 2018. Färdplan för fossilfri konkurrenskraft – Skogsnäringen [WWW Document]. URL http://fossilfritt-sverige.se/wp-content/uploads/2018/04/ffs_skogsnaringen.pdf (accessed 6.13.19).

SLU, 2018. Skogsdata 2018 - Aktuella uppgifter om de svenska skogarna från Riksskogstaxeringen [WWW Document]. URL https://www.slu.se/globalassets/ew/org/centrb/rt/dokument/skogsdata/skogsdata_2018_webb.pdf (accessed 11.20.18).

Södra, 2019. Årsredovisning och hållbarhetsredovisning 2018 [WWW Document]. URL https://www.sodra.com/sv/om-sodra/detta-ar-sodra/finansiell-information/

Södra, 2018. Internal document.

UNFCCC, 2015. Paris Agreement [WWW Document]. URL https://unfccc.int/sites/default/files/english_paris_agreement.pdf (accessed 6.13.19).