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# Harvested wood products (HWP) in the Swiss National Inventory Report 2020 (GHG inventory 1990-2018)

Description of time series, modelling methodology and results used for accounting HWP under the Kyoto Protocol.

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## History

Date	Major changes	By
up to NIR 2018	FOEN 2018h documentation established	Paolo Camin and Nele Rogiers
NIR 2019	FOEN 2019e: Corrections of Figures (units)	Dominik Eggli and Beat Rihm
NIR 2020	FOEN 2020e: Recalculations wood density, recycling paper	Dominik Eggli and Beat Rihm

## 1. Executive summary

CO<sub>2</sub> emissions and removals from Harvested wood products (HWP) must be reported under the UNFCCC and accounted for by Parties to the Kyoto Protocol in the second commitment period (2013-2020). This report explains the data sets and methods applied by Switzerland to calculate yearly carbon stock changes in HWP and shows detailed results used for accounting under the Kyoto Protocol in the Swiss Greenhouse Gas Inventory (FOEN 2020).

Carbon stock changes in the HWP pool were calculated for three semi-finished wood product categories: i) sawnwood, ii) wood-based panels and iii) paper and paperboard. Activity data were collected from international database (FAOSTAT) as well as from surveying the Swiss wood industry (Tier 2 and 3 methodologies).

For calculating carbon stock changes in HWP, Switzerland applied the default first order decay model using the corresponding default half-lives (35 years for sawnwood, 25 years for wood-based panels and 2 years for paper and paperboard; Tier 2 methodology). Following the provisions of the Kyoto Protocol, HWP originating from imported wood were excluded from the accounting and HWP originating from deforestation activities were accounted for on the basis of instantaneous oxidation.

The total inflow of carbon to the HWP pool in 2018 amounted to 436 kt C (51% from sawnwood, 39% from wood-based panels, 10% paper and paperboard). The outflow from the pool was reported to amount to 415 kt C in 2018 (56% from sawnwood, 33% from wood-based panels, 11% paper and paperboard). Thus, there was a net carbon gain in HWP of 21 kt C or -78 kt CO<sub>2</sub> in 2018.

## 2. Introduction

Forests have a significant impact on the global carbon cycle and therefore on the climate. On the one hand, they help improve local climates by moderating temperature and humidity, while on the other hand, they absorb atmospheric carbon (CO<sub>2</sub>) through photosynthesis, forest growth and forest expansion and store it on the long term (sequestration). When wood is used in furniture or construction, for example, the sequestered carbon remains stored in the wood product.

The role of HWP in mitigating greenhouse gas (GHG) emissions has been recognized by the Kyoto Protocol (KP). For accounting in the first KP commitment period (2008–2012), it was assumed that the annual amount of carbon leaving the HWP pool equals the annual carbon inflow to the pool. This means that all carbon in harvested biomass was oxidized at the time of harvest. In reality, wood-based materials may store carbon over a long-time frame. Depending on the balance between carbon inflow and outflow and the corresponding carbon stock change, the HWP pool may indeed act as a sink or as a source of CO<sub>2</sub>. For this reason, for the second KP commitment period (2013–2020) accounting rules were changed. At the 17<sup>th</sup> Conference of the Parties (COP17) to the UNFCCC and the 7<sup>th</sup> Session of the Conference of the Parties (CMP7) to the Kyoto Protocol in Durban it was decided that CO<sub>2</sub> emissions and removals from HWP should be accounted for under the Kyoto Protocol from 2013 (Decision 2/CMP.7).

The following accounting rules were agreed upon through Decision 2/CMP.7, are described and explained in detail in IPCC (2014) and were implemented for the calculation of HWP in the Swiss GHG inventory:

- Imported HWP and exported round wood shall not be accounted for.
- Definition of default half-lives for the HWP categories: sawnwood, wood-based panels and paper. Exported HWPs should be accounted for using default half-lives.
- HWP originating from deforestation shall be accounted for on the basis of instantaneous oxidation.
- Rejected HWP in solid waste disposals and HWP used for energy production shall be accounted for on the basis of instantaneous oxidation.
- Each country using a projected Forest management reference level (FMRL) can decide whether or not to include HWP produced prior to the start of the second commitment period.
- Accounting for HWP originating from Afforestation and Reforestation under KP Article 3.3 and from Forest management under KP Article 3.4 should be treated separately.

In climate reporting, the effects of substitution are recorded as CO<sub>2</sub> reductions within the industry and energy sectors and are, therefore, not recognized as a contribution of the forestry and wood products industries. To fully assess the forestry and wood products industries' impact to climate, an integrated study of the forestry and wood products industries which accounts for all storage and substitution effects would be needed.

## 3. Definition of HWP pool

HWP are defined as wood-based materials that, following harvest, are transformed into commodities such as furniture, plywood, paper and paper-based products, or used for energy. After a period (lifetime of the product), which can vary considerably depending on the product itself, the wood product might be recycled (especially in the case of paper), used for wood energy, or be disposed of in a landfill.

For the climate reporting, Switzerland does not account the amount of recovered wood pulp for paper production. Products disposed of in landfills are not included in the HWP pool.

In order to estimate the changes in the HWP pool the inflow and outflow from the pool must be quantified. The inflow can be estimated directly from data on the production of HWP.

However, a direct quantification of the outflow from the pool can only be based on successive inventories of products in use – this is quite resource-demanding and requires extensive data. In Switzerland no such inventories were made. An alternative way for the quantification of the outflow is the calculation with a model using a “First Order Decay”, as stipulated in Decision 2/CMP.7 and described in IPCC (2014). This model estimates the outflow from the pool based on the size of the pool and the product life expectancies (half-lives).

Only semi-finished wood products (SFWP), i.e. sawnwood, wood-based panels and paper and paperboard, can be accounted for (see Figure 2.8.2 in IPCC 2014). Finished products (e.g. furniture, floors, beams, books etc.) do not enter the estimations.

#### 4. Reporting HWP

Presently, two sets of guidelines for estimating the carbon stock in the HWP pool exist:

- The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines; IPCC 2006) and
- The 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (2013 KP Supplement; IPCC 2014).

In the latter it is specifically stated that it is “...consistent with the 2006 IPCC Guidelines but does not revise or replace the 2006 IPCC Guidelines” (IPCC 2014). Theoretically, the 2006 IPCC Guidelines can be used for reporting under the UNFCCC. However, for accounting under the Kyoto Protocol, the 2013 KP Supplement must be used, because it was developed in accordance with Decision 2/CMP.7 and 2/CMP.8. Since the 2013 KP Supplement (IPCC 2014) also encourages parties to harmonize UNFCCC and KP calculation in order to increase transparency, accuracy and consistency, the Swiss HWP reporting has been prepared on the basis of the 2013 KP Supplement. Thus, methods used for reporting under the UNFCCC and accounting under the Kyoto Protocol are the same.

##### 4.1. Choice of the approach

The 2013 KP Supplement (IPCC 2014) provides three tiers to calculate the carbon stock changes in the HWP pool from domestic harvest (i.e., the trees harvested in the reporting countries) in the second commitment period:

- Instantaneous oxidation (Tier 1): This approach does not quantify the changes in HWP stock under the assumption that harvested wood is instantaneously oxidized. This method was used by default in the first commitment period.
- Default method (Tier 2): This method applies a first order decay function based on default half-lives differentiated between the main semi-finished wood products (i.e. sawnwood, wood panels, paper and paperboard) as defined by the international classification system of forestry products. All countries using the accounting method with a “reference level” for forest management in the second commitment period (i.e., all EU member states) must use at least the Tier 2 approach.
- Country-specific methods (Tier 3): If more detailed data and methodologies are available, a country-specific method can be used.

Switzerland applied a combination of a Tier 2 and Tier 3 approach for the product categories sawnwood and wood-based panels. The IPCC default method for estimating the HWP carbon stock was used in combination with country-specific activity data as well as data from FAOSTAT.

For the product category paper and paperboard, Switzerland applied the Tier 2 approach; activity data are derived from FAOSTAT.

It is assumed that HWPs disposed of in solid waste disposal sites are instantly oxidised. I.e. the wood in solid waste disposal sites is not a part of the HWP pool.

The 2013 KP Supplement Tier 2 method is basically a flux data method where estimates of net emissions are derived from a stock change calculation applied to products derived from domestic harvest, excluding imported HWP. To implement this method, it is necessary to estimate:

- 1) the annual fraction of the industrial roundwood (sawn wood and wood-based panels) and wood pulp commodities (paper and paperboard) from domestic harvest;
- 2) the share of HWP originating from Afforestation/Reforestation and Deforestation under Article 3.3 and Forest management lands under Article 3.4 of the Kyoto Protocol.

In accordance with the IPCC guidelines, the carbon stock included in fuelwood is immediately released into the atmosphere.

#### 4.2. Method for calculating carbon stocks in HWP

Changes in carbon stocks in year  $i$  were estimated on the basis of information on the inflow of wood products into the stock and of assumed lifetimes and decay factors of these products. In accordance with the 2013 KP Supplement a first order decay (i.e. exponential decay) function (equation 2.8.5 in IPCC 2014) was used to estimate the carbon stock and the annual changes for each of the SFWP categories.

$$C_{i+1} = e^{-k} \cdot C_i + \left[ \frac{(1 - e^{-k})}{k} \right] \cdot Inflow_i$$

$$\Delta C_i = C_{i+1} - C_i$$

Where:

$C_i$  is the carbon stock for the given HWP category at the beginning of year  $i$  (variables are written with index  $i$ , as the equation is used in the discrete form); in Gg C

$k$  is the decay constant of first-order decay depending on the HWP category ( $k = \ln(2)/HL$  where  $HL$  is the half-life of the HWP pool in years.)

$Inflow_i$  is the inflow to the given HWP category during year  $i$ ; in Gg C yr<sup>-1</sup>

$\Delta C_i$  is the carbon stock change during year  $i$ ; in Gg C yr<sup>-1</sup>

The starting year used to estimate the delayed emissions from the existing pools (inherit emissions) was 1900. In accordance with the 2013 KP Supplement and IPCC 2014, the calculations started in 1900 with a carbon stock  $C_{(1900)}$  equal to 0.

The choice of expected lifetimes and thus of the half-lives for the HWP influences the size of the stock and thus the stock changes. However, the influence on the stock changes may be relatively small (depending on the pool characteristics), as the applied lifetimes influence both the size of the stock and the size of the outflow. Since these two are opposing effects, they partially cancel each other out.

#### 4.3. Allocation of HWP to activities

The calculation and accounting of HWP depends on its activity of origin.

- Decision 2/CMP.7 stipulates that HWP originating from Deforestation activities must be accounted for on the basis of instantaneous oxidation.

- HWP originating from Forest management (FM) and Afforestation shall be included in the HWP pool. HWP from Forest management is accounted for using a FMRL, HWP from Afforestation is accounted with a gross-net approach.

In Switzerland, HWP originating from Deforestation was excluded from the pool by determining the fraction of the feedstock (roundwood for production of HWP) originating from deforestation following equation 2.8.3 in IPCC (2014):

$$f_j(i) = \frac{harvest_j(i)}{harvest_{total}(i)}$$

Where:

$f_j(i)$  is the share of the harvest originating from activity j in year i

$harvest_j(i)$  is the harvest originating from activity j in year i

$harvest_{total}(i)$  is the total harvest from all activities in year i

However, there are no specific harvesting data for deforestation areas. Therefore,  $f_j(i)$  was calculated as ratio of "losses of above ground living biomass from Deforestation" to "losses of above ground living biomass from FM". Losses of living biomass correspond to cut and mortality. The resulting ratios are between 0.005 and 0.011.

No specific data on harvest originating from Afforestation activities were available. It was assumed, in accordance with IPCC (2014) that all wood entering the accounting framework originated from Forest management. This is a realistic assumption because, taking into account age, species composition and growth rates of Afforestations since 1990 in Switzerland, the wood originating from thinnings of Afforestations is likely to be used as energy wood whereas harvesting of industrial roundwood on afforested areas is expected to be negligible.

#### 4.4. Estimation of annual fraction of HWP from domestic harvest

Decision 2/CMP.7 stipulates that only HWP produced domestically may be included in the HWP pool of the reporting country, i.e. the HWP must originate from trees harvested and processed in the reporting country. This means that the domestic production must be split in one part produced from domestically harvested wood, and another part produced from imported roundwood.

##### 4.4.1. Categories sawnwood and wood-based panels

In order to estimate the annual fraction of HWP originating from domestic harvest equation 2.8.1 in IPCC (2014) was used for the categories sawnwood and wood-based panels:

$$f_{IRW}(i) = \frac{IRW_p(i) - IRW_{EX}(i)}{IRW_p(i) + IRW_{IM}(i) - IRW_{EX}(i)}$$

Where:

$f_{IRW}(i)$  is the share of domestically harvested and consumed industrial roundwood (feedstock) to the total domestic consumption of industrial roundwood in year i

$IRW_p(i)$  is the production of roundwood in year i; in Gg C yr<sup>-1</sup>

$IRW_{IM}(i)$  is the import of roundwood in year i; in Gg C yr<sup>-1</sup>

$IRW_{EX}(i)$  is the export of roundwood in year i; in Gg C yr<sup>-1</sup>

$f_{IRW}(i)$  was estimated separately for sawnwood coniferous and non-coniferous. For wood-based panels an average share of domestic feedstock based on the determined roundwood consumption was used. The share was calculated for the period after 1961; for previous years (1900-1960) an average of the first 10 years (1961-1970) was applied.

Using equation 2.8.4 in IPCC (2014), the produced amount of HWP of each category ( $HWP_p(i)$ ) was multiplied with this ratio in order to obtain the part of HWP produced from domestic harvest ( $HWP_j(i)$ ).

$$HWP_j(i) = HWP_p(i) \times f_{DP}(i) \times f_j(i)$$

Where:

$HWP_p(i)$  is the HWP amount produced from domestic harvest associated with activity j in year i; in kt C yr<sup>-1</sup>

$f_{DP}(i)$  is the share of domestic feedstock for the production of the particular HWP category originating from domestic forests in year i. For sawnwood and panels,  $f_{DP}(i)$  is equal to  $f_{IRW}(i)$

$HWP_p(i)$  is the production of the particular HWP commodities (i.e. sawnwood, wood-based panels, and paper and paperboard) in year i; in kt C yr<sup>-1</sup>

#### 4.4.2. Category paper and paperboard

In order to estimate the annual fraction of paper and paperboard originating from domestic harvest equation 2.8.2 in IPCC (2014) was used:

$$f_{PULP}(i) = \frac{PULP_p(i) - PULP_{EX}(i)}{PULP_p(i) + PULP_{IM}(i) - PULP_{EX}(i)}$$

Where:

$f_{PULP}(i)$  is the share of domestically produced pulp for the domestic production of paper and paperboard in year i

$PULP_p(i)$  is the production of wood pulp in year i; in Gg C yr<sup>-1</sup>

$PULP_{IM}(i)$  is the import of wood pulp in year i; in Gg C yr<sup>-1</sup>

$PULP_{EX}(i)$  is the export of wood pulp in year i; in Gg C yr<sup>-1</sup>

The share of wood pulp produced from recovered paper is not explicitly mentioned in equation 2.8.4 in IPCC (2014). Therefore, equation 2.8.4 was extended for paper and paperboard as follows:

$$HWP_j(i) = HWP_p(i) \times f_{DP}(i) \times f_j(i) \times (1 - f_{RECPULP}(i))$$

Where:

$f_{DP}(i)$  is equal to  $f_{IRW}(i) \times f_{PULP}(i)$  for paper and paperboards

$f_{RECPULP}(i)$  is the share of recovered fibre pulp used for the production of paper and paperboard.

The share of recovered fibre pulp is calculated based on FAO-data on production, import and export of wood pulp and recovered fibre pulp. It was defined as the ratio of net consumption of recovered pulp to net consumption of total pulp:

$$f_{RECPULP}(i) = \frac{RECPULP_p(i) + RECPULP_{IM}(i) - RECPULP_{EX}(i)}{PULP_p(i) + PULP_{IM}(i) - PULP_{EX}(i)}$$

Where:

$RECPULP_p(i)$  is the production of recovered fibre pulp in year i; in Gg C yr<sup>-1</sup>

$RECPULP_{IM}(i)$  is the import of recovered fibre pulp in year i; in Gg C yr<sup>-1</sup>

$RECPULP_{EX}(i)$  is the export of recovered fibre pulp in year i; in Gg C yr<sup>-1</sup>

## 5. Data

### 5.1. Model parameters

#### 5.1.1. Emissions factors – half-life

In accordance with the Tier 2 approach default values on half-lives are used (Table 2.8.2 in IPCC 2014):

- Sawnwood 35 years
- Wood-based panels 25 years
- Paper and Paperboard 2 years

#### 5.1.2. Carbon conversion factors

For converting product volume of panels or weight of paper/paperboard into carbon, the following default conversion factors (Table 2.8.1 in IPCC 2014) are used:

- Fibreboard compressed 0.315 t C/m<sup>3</sup>
- Hardboard 0.335 t C/m<sup>3</sup>
- Insulating Board 0.075 t C/m<sup>3</sup>
- Medium density fibreboard MDF 0.295 t C/m<sup>3</sup>
- Particle Board 0.269 t C/m<sup>3</sup>
- Plywood 0.267 t C/m<sup>3</sup>
- Veneer Sheets 0.253 t C/m<sup>3</sup>
- Paper and paperboard 0.386 t C/t

For sawnwood, country-specific values measured by the wood industry and checked with the values in the National Forest Inventory (NFI) are used (Werner 2019):

- Sawnwood coniferous 0.205 t C/m<sup>3</sup>
- Sawnwood non-coniferous 0.295 t C/m<sup>3</sup>

### 5.2. Activity data

Historical data on production, import and export of roundwood and SFWP were available from two sources:

- FAO forest product statistics (FAOSTAT) for the period 1961-2018, that cover data on production, import and export of roundwood, SFWP and paper/paperboard as well as recovered fiber pulp;
- National statistics: sawmill statistics (production of sawnwood), surveys of the wood processing industries (production of wood panels), felling statistics (production of roundwood), foreign trade statistics (share of industrial roundwood and wood products).

The activity data (production and trade of sawnwood, wood-based panels and paper and paperboard) were derived principally from FAOSTAT. This data set, including also outliers, was verified and corroborated with data from the national statistics. To estimate the HWP contribution for the period 1900 to 1960, historical production data and data from national statistics were used. For recovered fiber pulp, there are no reliable data in FAOSTAT until 2000; for this period, the 10-year average 2001-2010 was used instead.

#### 5.2.1. FAOSTAT

FAOSTAT is the statistical office of the FAO. Its database includes statistical data on production, import and export of roundwood and SFWP as reported by member states. Swiss data in the FAOSTAT database is based on primary statistical data as well as national historical research data. The Swiss Federal Statistical Office (SFSO) manages the database (FAOSTAT 2019).

## 5.2.2. National statistics

The Federal Statistical Office produces primary statistics both in monetary value and physical units. Relevant for HWP estimates were the statistics on wood harvest in the forest (SFSO 2019d), on the sawnwood production, and statistics on international trade of roundwood and SFWP. The statistics on the production of wood-based panels are collected and managed by the Federal Office for the Environment and fed into FAOSTAT.

### 5.2.2.1. Felling statistics – production of roundwood

The statistics on the annual harvest in the forest is based on a questionnaire sent out by the Federal Statistical Office (SFSO) to all forest owners (FOEN 2020b). Since there is a methodological discrepancy between the SFSO felling statistics and the NFI wood harvest estimates, the harvest level reported in the NFI was considerably higher than the one reported by the felling statistics. A study was carried out in order to correct and improve the statistical data (Altwegg et. al. 2010). Consequently, the results produced by the Federal Statistical Office were corrected, resulting in an increase of about 20% in the reported annual harvest figures.

### 5.2.2.2. Wood processing statistics – production of sawnwood

The wood processing survey covers all production data of sawmills over the marketing year (SFSO 2020c). Annual sawnwood production is reported in m<sup>3</sup>. Also, the utilization of the residual wood as energy wood (in own enterprise or by third parties), as paper, pulp and panels is calculated on the basis of these statistics and fed into FAOSTAT. The wood processing statistics are not calculated on an annual basis, rather a full survey of sawmill production data is carried out every 5 years. The data quality is considered as good, and data are available since 1951.

### 5.2.2.3. The production of wood-based panels

The production of wood-based panels in Switzerland is shared by only two companies, one of which produces particleboard and the other various forms of fibreboard (FOEN 2017a). The Federal Office for the Environment sends a form to the companies annually in order to collect data on production and share. Since 2010, export figures are no longer published for data protection reasons and have to be estimated.

## 6. Results: HWP originating from Forest management

### 6.1. Carbon stock, inflow and outflow

In this section the development of the carbon stock in HWP originating from Forest management is described.

#### 6.1.1. Production and share of roundwood from domestic harvest

Figure 1 shows the production and share of roundwood for Switzerland, 1990-2018. In 1990 (storm Vivian) and in 2000 (storm Lothar), storms ravaged Swiss forest. In 2000, the winter storm Lothar doubled total harvesting amount due to salvage logging. Since 2007, wood harvest is decreasing. The quantities of exported roundwood were closely correlated with those of production, as on average 30% of roundwood produced was exported. The import of roundwood in Switzerland played a marginal role, contributing approximately 8% of total roundwood production.



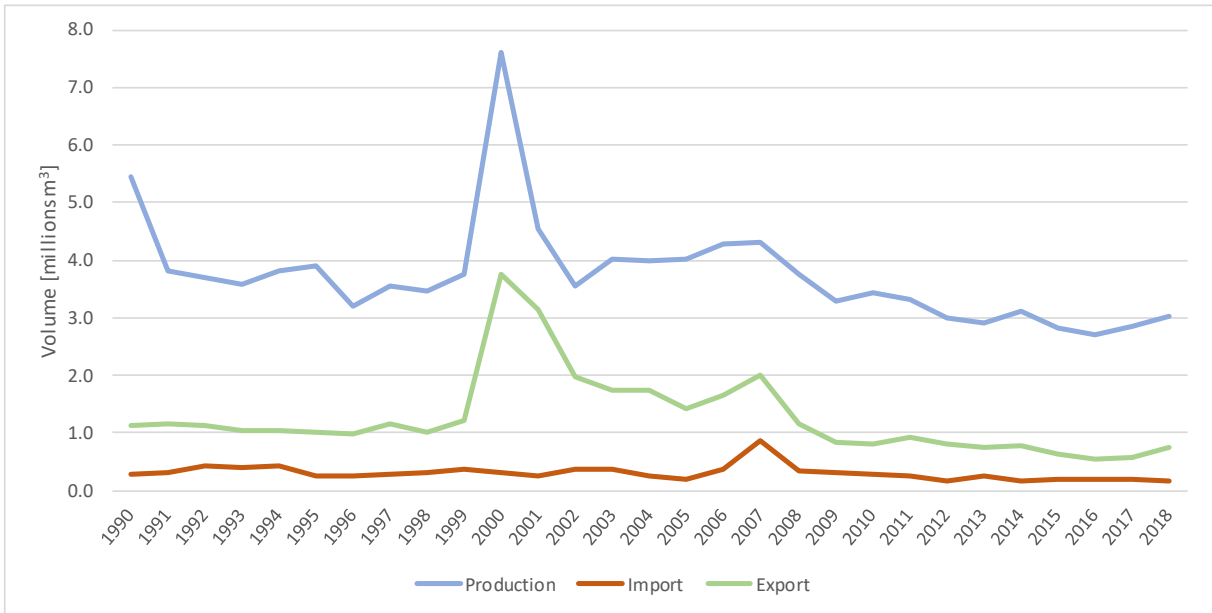


Figure 1: Production, export and import of roundwood; 1990-2018.

The development of the fraction of the roundwood feedstock originating from domestic harvest for producing HWP from 1990 to 2018 is given in Figure 2. For coniferous roundwood the fraction was steady between 90 and 95%, for non-coniferous roundwood it was lower; however, since 2009 the fraction came close to 90%.

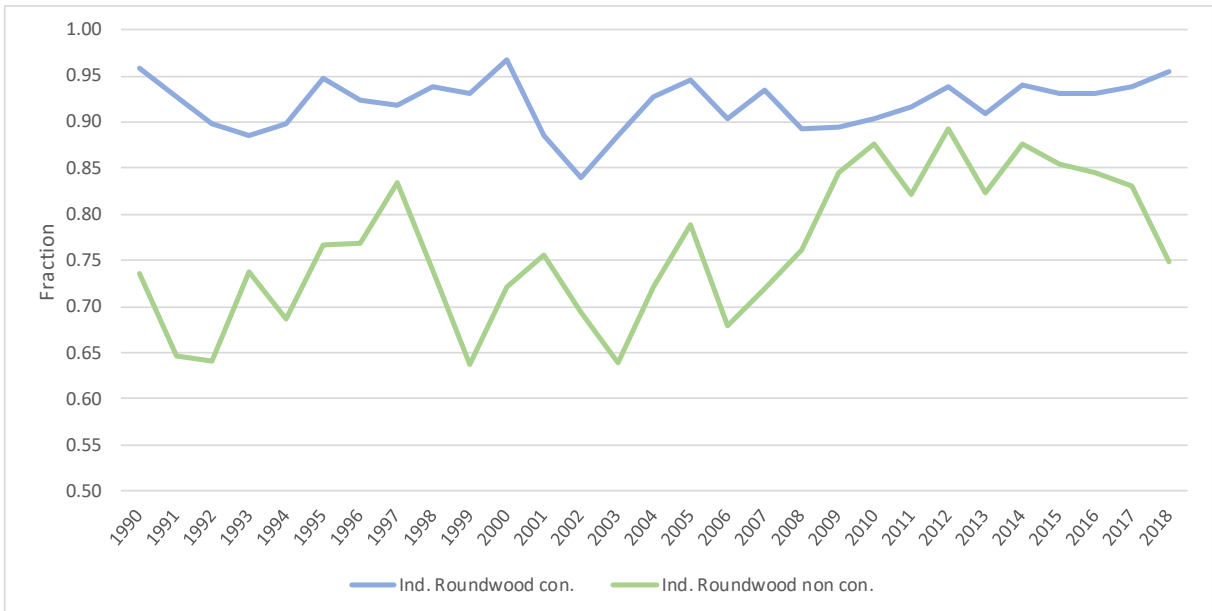


Figure 2: Fraction of the feedstock for production of HWP coming from domestic harvest; 1990-2018, specified for coniferous (industrial roundwood coniferous) and non-coniferous (industrial roundwood non coniferous).

### 6.1.2. Inflow and outflow

Figure 3 shows the production of sawnwood, panels and paper and paperboard from Swiss wood industries for the years 1900 to 2018. The production of sawnwood increased until 1990. Since then, an inverse trend of decreasing production started and remains until today. The two product categories sawnwood and panels had opposing trends over the last 27 years: while panel production continued increasing over this period by about 2.8%, the production of sawnwood registered a decreasing trend of about 2.2%. The production of paper and paperboard remained more or less stable over this period. The average total production modelled since 1990 is about 1'277'000 m<sup>3</sup> yr<sup>-1</sup> for sawnwood, about 772'000 m<sup>3</sup> yr<sup>-1</sup> for panels, and respectively for paper and paperboard about 442'000 tonnes yr<sup>-1</sup>.

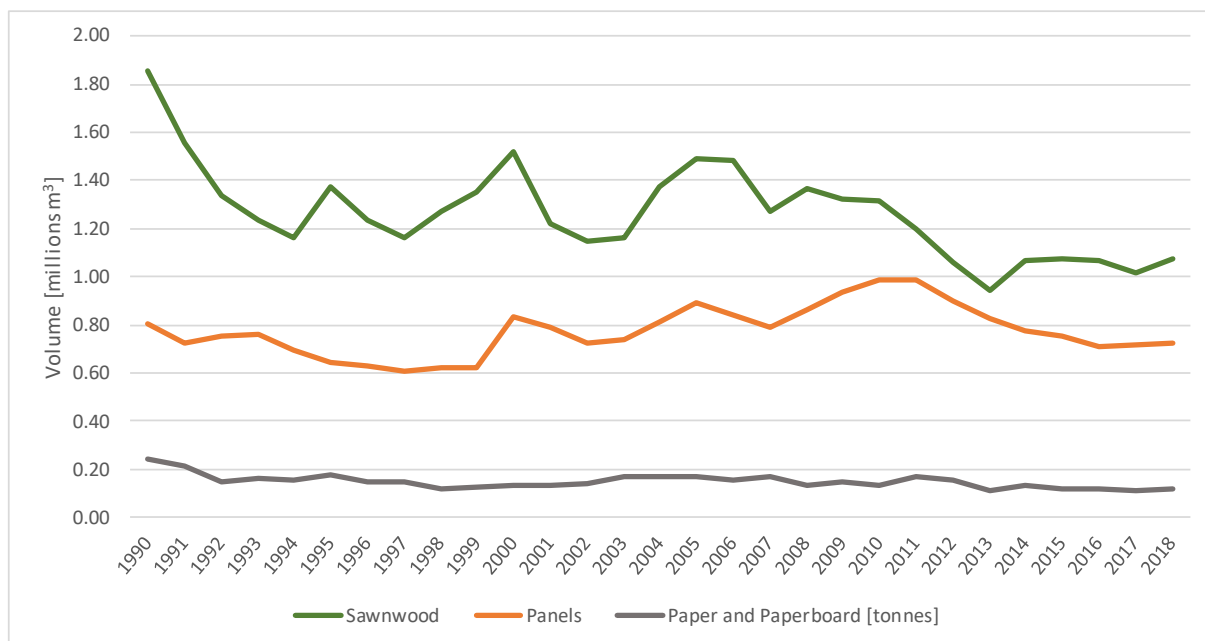


Figure 3: Production of HWP from domestic harvesting (sawnwood, panels and paper and paperboard); 1990-2018. The share of recovered fibre pulp in paper production is excluded.

The inflow to and the outflow from the HWP pool for the categories sawnwood, panels and paper and paperboard are shown in Figure 4. Similar to the trend in production, the inflow to the sawnwood pool was decreasing after 2005. Also the effects of the storms Vivian (1990) and Lothar (2000) can be distinguished. In 2012 the sawnwood inflow dropped below the estimated outflow and remained lower until 2017.

The inflow rate for panels was slightly increasing from 1990 to 2010 and afterward there was a gradually decreasing trend but always higher than outflow. If the trend observed between 2011 and 2017 will continue the inflow rate for panels is expected to drop below outflow in the near future.

For Paper and Paperboard there was a slightly decreasing trend for both inflow and outflow from 1990 to 1998. Since then, there is hardly any trend. For paper and paperboard, the inflow and the outflow over the whole period are almost the same which can be explained by the short lifetime of only two years.

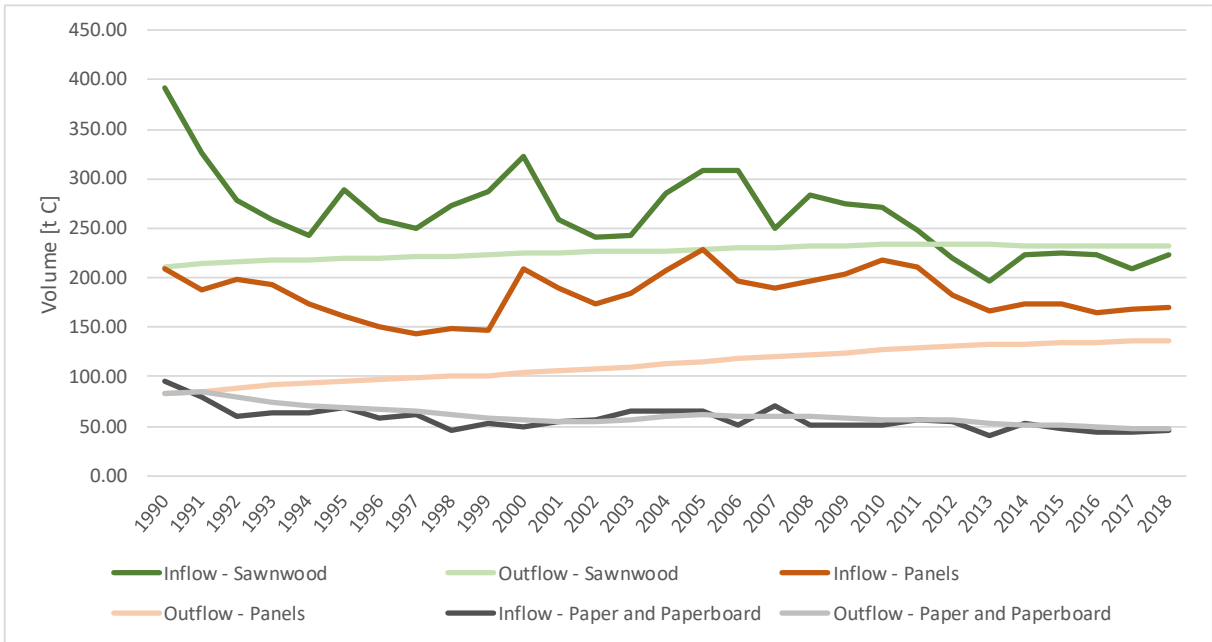


Figure 4: Inflow and outflow from the HWP pool for the categories sawnwood and panels; 1990-2018.

Figure 5 and table 1 show the development of the carbon stock changes for the categories sawnwood, panels and paper and paperboard between 1990 and 2018. Until 1991, sawnwood was the dominant category for the HWP pool. However, wood-based panels gained in importance. Since 2001 the contribution by panels is higher than that from sawnwood. The value for paper and paperboard fluctuates and represents about 5% of the total HWP emissions/removals.

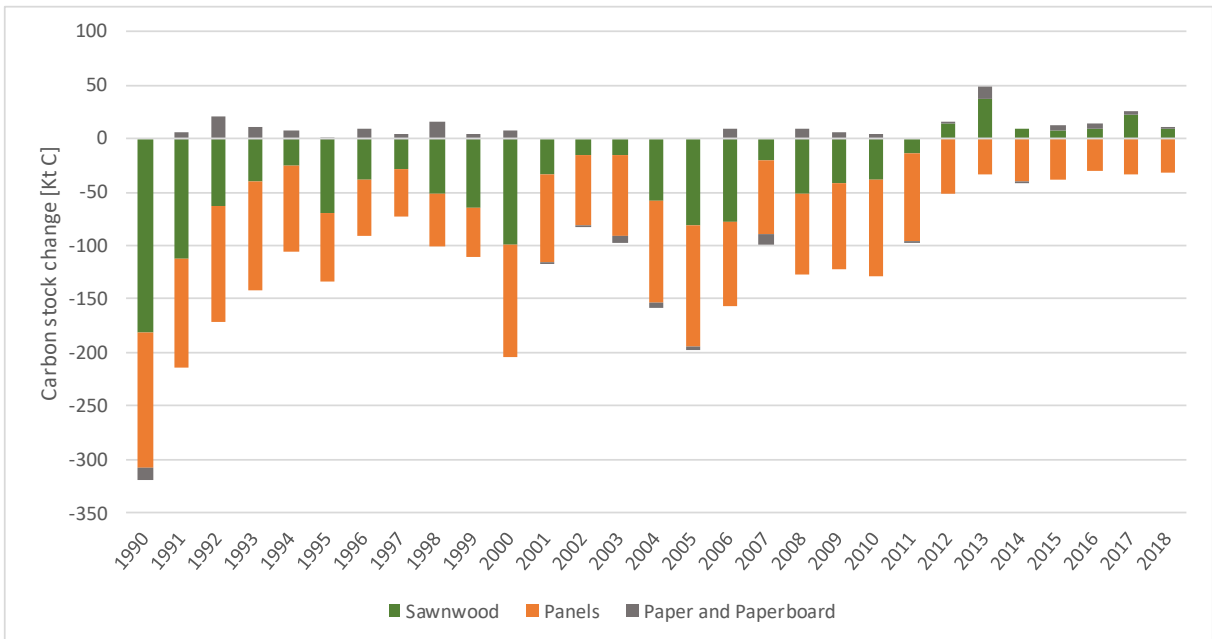


Figure 5: Carbon stock changes from HWP (positive values refer to emissions, negative values refer to removals) between 1990 and 2018 originating from land under Forest management.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	kt C									
Total	-318.8	-208.4	-151.7	-130.1	-97.8	-132.8	-82.4	-70.0	-84.3	-105.4
Sawnwood	-180.6	-111.7	-62.8	-40.6	-25.1	-69.9	-38.5	-28.4	-50.8	-65.2
Panels	-127.0	-102.6	-109.3	-101.0	-80.3	-64.6	-52.9	-45.2	-49.4	-45.2
Paper and Paperboard	-11.1	5.9	20.3	11.6	7.6	1.7	9.0	3.6	15.9	5.0
	kt C									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	kt C									
Total	-197.2	-116.5	-82.1	-97.9	-158.6	-198.5	-148.1	-99.8	-118.2	-115.3
Sawnwood	-99.2	-32.9	-14.9	-16.3	-58.4	-80.7	-77.8	-19.6	-52.1	-41.5
Panels	-105.6	-83.4	-65.7	-74.2	-94.7	-113.8	-79.3	-69.2	-75.4	-80.0
Paper and Paperboard	7.7	-0.2	-1.5	-7.5	-5.5	-4.0	8.9	-10.9	9.3	6.1
	kt C									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	
	kt C									
Total	-124.8	-97.0	-36.7	15.5	-31.6	-27.3	-15.6	-6.5	-21.4	
Sawnwood	-38.7	-14.3	13.4	37.2	9.8	7.7	9.2	22.7	9.3	
Panels	-90.5	-81.1	-51.3	-33.7	-40.1	-39.2	-30.3	-32.9	-32.5	
Paper and Paperboard	4.4	-1.5	1.2	12.1	-1.3	4.3	5.5	3.7	1.8	

Table 1: Carbon stock changes in HWP (positive values refer to emissions, negative values refer to removals) between 1990 and 2017 originating from land under Forest management. HWPs originating from Deforestation were calculated using instantaneous oxidation; there are no HWPs from Afforestation.

The total inflow in 2018 was 436 kt C, with shares of 222 kt C from the production of sawnwood, 169 kt C from the production of wood-based panels, and 45 kt C from the production of paper and paperboard. The outflow from the pool was 415 kt C with shares of 232 kt C from sawnwood, 137 kt C from wood-based panels, and 47 kt C from paper and paperboard. This means that the net carbon sequestration in HWP was about 21 kt C in 2018 divided into a net emission of 9 kt C from sawnwood, a net sequestration of 32 kt C from wood-based panels and a net emission of 2 kt C from paper and paperboard.

## 6.2. Uncertainty

This section provides an overview of the uncertainties related to the results of this reporting. The uncertainty related to the choice of SFWP to account for the HWP contribution to the overall carbon stock will not be discussed.

### 6.2.1. Uncertainty in methods

Uncertainty in methods relates to the choice of model to describe the development of the HWP pool over time. The Tier 2 method “first order decay” used is “assumed to be a good proxy for the decay of semi-finished wood products” (IPCC 2014 – page 2.132). However, the behaviour of the HWP pool may also possibly follow a different decay function.

#### 6.2.2. Uncertainty of conversion factors (emission factors)

The 2006 IPCC Guidelines indicate an uncertainty of about 50% on the default half-life parameter (IPCC 2006, Vol. 4, Table 12.6).

Regarding the default conversion factors, the 2006 IPCC Guidelines (IPCC 2006, Vol. 4, Table 12.4) indicate an uncertainty of about +/- 25% on the conversion from volume to biomass. For Switzerland, a somewhat lower value of 20% is used considering the county-specific measured wood densities for sawnwood.

The 2006 IPCC Guidelines propose a default uncertainty of +/- 10% on the conversion from biomass to carbon (carbon content).

The resulting uncertainty of the conversion factors is 54.8%.

### 6.2.3. Uncertainty of activity data

According to IPCC (2014, chp. 2.8.6) uncertainty on activity data is caused by: a lack of time series, definitional uncertainties, limited resources for data collection, reporting errors and missing subcategories. These points in general refer to different kinds of measurement uncertainty. In addition, statistical uncertainty may also be included if data acquisition is based on statistical sampling. According to the expert judgment of authors of the 2013 KP Supplement, uncertainty on the reported values on inflow may lie between -25% and + 5%. In other words, underreporting is likely.

Regarding data from national Statistics (FOEN 2020b, SFSO 2019c) and FAOSTAT, the relevant uncertainty refers to the reporting of roundwood and the following conversion to sawnwood. Errors on reporting and limitations on data collection are probably the most important factors, as well as statistical uncertainty on the estimation of the annual harvest. Regarding the “Survey by the Wood Panels Industry” (FOEN 2017a), uncertainty is related to the companies’ ability to report correct volumes and the overall coverage of the wood industry. This uncertainty can be limited by cross-validation on roundwood consumption and the results of the production.

On this basis, the mean uncertainty for the production data was estimated to 5% (expert judgement). The uncertainty of the share of domestic harvest in the wood products is higher as it is calculated with proxy data (import and export of industrial roundwood). It was set to 10% (expert judgement). The resulting total uncertainty of activity data is 11.2% for all product categories.

## 7. Planned improvements and considerations related to UNFCCC reviews

### 7.1. HWP from Paper and paperboard

In response to a recommendation (UNFCCC 2018, ID#KL.7), the available data from the FAOSTAT database was used to calculate the contribution of paper and paperboard to the HWP pool and reported in the submissions 2018 and 2019. In Submission 2020, also the domestic pulp in production of recycled paper was determined. Thus, all issues of KL.7 (UNFCCC 2018) are resolved.

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