Journal of the Faculty of Forestry Istanbul University 2016, 66(1): 295-302

JOURNAL OF THE FACULTY OF FORESTRY ISTANBUL UNIVERSITY
İSTANBUL ÜNİVERSİTESİ ORMAN FAKÜLTESİ DERGİSİ
ISSN: 0535-8418 e-ISSN: 1309-6257

Online available at / Çevrimiçi erişim
http://dergipark.ulakbim.gov.tr/jffiu - http://dx.doi.org/10.17099/jffiu.48603

Short Note / Kısa Not

Carbon stored in harvested wood products in Turkey and projections for 2020

Olivier Bouyer [1], Yusuf Serengil [2*]

[1] SalvaTerra, 6 rue de Panama, 75018, Paris, France
[2*] Istanbul University, Faculty of Forestry, 34473, Sariyer, Istanbul, Turkey

Corresponding author e-mail (İletişim yazarı e-posta): serengil@istanbul.edu.tr

Received (Geliş tarihi): 23.03.2015 - **Revised (Düzeltme tarihi):** 12.04.2015 - **Accepted (Kabul tarihi):** 13.04.2015

Abstract: Turkey is an Annex-I country under the United Nations Framework Convention on Climate Change (UNFCCC) and therefore submits its Greenhouse gases (GHG) emissions and removals from anthropogenic sources to the UNFCCC secretariat on an annual basis, through a National GHG Inventory Report (NIR). GHG emissions and removals from Land Use, Land Use and Forestry (LULUCF) constitute one of the main sectors in this report. One of the major land use categories in this sector is Forestland, and harvests in this category must be considered as a direct GHG emission to the atmosphere, unless the fate of the Harvested Wood Products (HWP) is reported. In this study, we estimated the carbon sequestration in the HWP category of the Turkish NIR, according to the 2006 Guidelines for GHG inventory in the Agriculture, Forestry and Other Land Use (AFOLU) sector, from the International Panel of Experts on Climate Change (IPCC). This is the first time such an estimate of carbon stocks and carbon stock changes in the HWP pool has been carried out in Turkey. The calculation has been done in Tier 2. We used United Nations Economic Commission for Europe (UNECE) Timber database disaggregated figures for HWP produced in Turkey from 1964 to 2013. We focused on the two main HWP categories, which are sawnwood and wood-based panels. Comparing UNECE data series with Orman Genel Müdürlügü (OGM, the Republic of Turkey, General Directorate of Forestry) data series for industrial roundwood over 1976-2013 (starting date for OGM data series), we noticed some anomalies (with UNECE data series as a basis: max: +47%, min = -23%, mean = +16%). Thus, the UNECE data on sawnwood and wood based panels were corrected based on OGM data. These anomalies could be due to: (i) use of volume over bark for UNECE and volume under bark for OGM (+15% for volume over bark), and (ii) integration of industrial roundwood coming from the private sector for UNECE. In order to ensure coherence, we then corrected the 1976-2013 UNECE data series for sawnwood and wood-based panels production taking into account for each year the percentage of anomaly. However, from 1976 to 1982, the anomalies are much reduced (-1% in average), which allow using the UNECE data series from 1964 to 1975. We estimated the average share of each HWP over the last ten years: 48% for sawnwood and 38% for wood-based panels. The 14% of other HWP are not considered in the analysis, either because they are short-lived products or marginal or difficult to estimate. A projection of HWP has been done until 2020 based on 2 alternative scenarios based on OGM strategy documents: intensive harvesting and extensive harvesting. For each scenario, intensive vs extensive, we disaggregated the 2013-2020 volume of industrial roundwood into the two HWPs, using the calculated percentages. The results of our analysis revealed that the HWP pool can add 3.14 Gg CO2 eq yr^{-1} additional removal to LULUCF sector in the GHG inventory of Turkey for 2013 compared to 1990. The amount of contribution is estimated to rise up to 13.70 Mt CO_2 eq yr^{-1}, and 10.99 Mt CO2 eq yr^{-1} for intensive and extensive scenarios that are developed based on OGM strategic plans in 2020.

Keywords: Climate change mitigation, national GHG inventory, harvested wood products

Türkiye'de hasat edilmiş orman ürünlerinde tutulan karbon ve 2020 projeksiyonları

Özet: Türkiye Birleşmiş Milletler İklim Değişikliği Çerçeve Sözleşmesinde (BMİDÇS) Ek-1 ülkesi olarak yer almaktadır. Dolayısıyla diğer ülkelerle beraber insan kaynaklı sera gazı salım ve tutumlarını BMİDÇS sekreteryasına Ulusal Sera Gazı Envanteri (USGE) ile her yıl raporlamaktadır. Bu rapor içerisinde Arazi Kullanımı, Arazi Kullanım Değişikliği ve Ormancılık (AKAKDO) önemli bir sektör olarak yer almaktadır. Bu sektörde en önemli kategorilerden biri Orman alanlarıdır ve bu alanlarda gerçekleştirilen kesimler (hasat) eğer kesilen ürünlerin kullanım alanları belli değilse atmosfere doğrudan salım olarak raporlanır. Bu çalışmada Hükümetlerarası İklim Değişikliği Paneli tarafından geliştirilen Tarım, Orman ve Diğer Arazi Kullanımları Klavuzuna göre USGE'deki Hasat Edilmiş Orman Ürünleri (HOÜ) kategorisinde tutulan karbon miktarı tahmin

To cite this article (Atıf): Bouyer, O., Serengil, Y., 2016. Carbon stored in harvested wood products in Turkey and projections for 2020. *Journal of the Faculty of Forestry Istanbul University* 66(1): 295-302. DOI: 10.17099/jffiu.48603

edilmiştir. Bu hesaplama HOÜ yer alan karbon stoklarının hesaplanması konusunda ülkemizde yapılan ilk çalışmadır. Hesaplama Seviye-2 düzeyinde gerçekleştirilmiştir. Hesaplamada Birleşmiş Milletler Avrupa Ekonomik Komisyonu (BMAEK) tarafından verilen ve alt gruplara ayrılan 1964-2013 dönemi kereste üretim verilerinden yararlanılmıştır. Çalışmada 2 HOÜ kategorisine ağırlık verilmiştir; kereste odunu ve ahşap panel. Fakat veri kullanımında bazı tutarsızlıklara rastlanmıştır. Örneğin 1976-2013 döneminde BMAEK ile Orman Genel Müdürlüğü endüstriyel yuvarlak odun üretim değerlari arasında ciddi farklılıklar göze çarpmaktadır (BMAEK verileri +%47 ile -%23 arasında, ortalamada da +%16 yüksek bulunmuştur). Tutarsızlığın sebepleri şunlar olabilir: (i) BMAEK verileri kabuklu, OGM verileri kabuksuz hacmi göstermektedir (kabuklu hacim yaklaşık %15 fazladır, ve (ii) BMAEK verilerinde özel sektör üretim rakamları da yer almaktadır. Verilerin tutarlılığını sağlamak için 1976-2013 BMAEK kereste ve ahşap panel verileri fark yüzdesi ile orantılı olarak düzeltilmiştir. Öte yandan 1976-1982 döneminde fark çok düşük olduğundan (-%1) 1964-1975 BMAEK verileri kullanılabilmiştir. Her HOÜ kategorisinin son on yıldaki payını tahmin edilmiştir. Buna göre %48 kereste, %38 ahşap paneldir. Geriye kalan %14 kısa ömürlü veya daha az önemli ürünler olup hesaba katılmamıştır. OGM strateji belgelerine dayalı olarak 2020 yılına kadar uzanan iki alternatif senaryo için HOÜ projeksiyonu yapılmıştır: şiddetli kesim ve mutedil kesim. Her iki senaryo için 2013-2020 endüstriyel odun hacmi hesaplanan yüzdeler baz alınarak iki HOÜ kategorisine oranlanmıştır. Yapılan çalışma 1990 yılıyla karşılaştırıldığında HOÜ havuzunun Türkiye'nin sera gazı envanterine AKAKDO sektörü ile 3.14 Gg CO2 eq yr^{-1} fazladan tutum sağlayabileceğini ortaya koymuştur. Dahası katkı miktarı şiddetli ve mutedil kesim senaryolarına göre 2020 yılında sırasıyla 13.70 Mt CO2 eq yr^{-1} ve 10.99 Mt CO2 eq yr^{-1} a çıkabilir.

Anahtar Kelimeler: İklim değişikliğine karşı azaltım, ulusal sera gazı envanteri, hasat edilmiş orman ürünleri

1.INTRODUCTION

Climate change is a serious global problem, and reductions in greenhouse gasses is an integral part of it (Serengil et al., 2011; IPCC, 2014). Measures to mitigate climate change are becoming more pronounced worldwide as the UNFCCC talks advance towards creating a new agreement beyond 2020 (Serengil and Erden, 2012). Turkey has been a part of this convention since 2004 and thus has been reporting GHG emissions and removals in the LULUCF sector, together with GHG emissions from other sectors, to the UNFCCC secretariat since 2006.

The latest inventory (2012) shows that the LULUCF sink (mainly forest) is estimated to offset 16% of the total GHG emissions of Turkey (NIR, 2014). However, the percentage decreases due to faster increasing emissions in other sectors (i.e. energy, solvents and products use, waste). An impressive improvement of the Turkish forests in terms of area and standing volume can be observed for the past decades: massive efforts in terms of rehabilitation of degraded forests and afforestation, conversion of coppices to high forest, strong improvement of the forest fire fighting and forest health measures, etc. All this has resulted in an increase in forest biomass stock, allowing for an increase of harvesting since the 2000's. This is clearly seen in the GHG reports of Turkey.Based on latest inventory assessments (ENVANIS), there is around 21.9 M ha of forest in Turkey (27% of the country), 54% considered "productive" (above 10% of forest cover) and 46% considered "degraded" (between 1% and 10% of forest cover).

Turkey is an Annex 1 Party in the convention with "specific circumstances": because of its fastest population growth rate among all Organisation for Economic Co-operation and Development (OECD) countries and its lowest energy related CO_2 emissions per capita among International Energy Agency (IEA) countries. The name of Turkey was deleted from the Annex 2 of the UNFCCC and was not included in the Annex B of the both terms of Kyoto Protocol. This means that Turkey has no legally binding emission reduction objective but is expected to take action after 2020 with the new agreement that is supposed to be accepted in Paris this year (2015). In the context of the preparation of a 2015 multilateral treaty on climate change, which would enter into force in 2020, differentiation among Annex 1 and non-Annex 1 Parties may be revisited and this may end up with positive consequences for Turkey. Thus, mitigation efforts can be rewarded.

There are several options to mitigate climate change. The most obvious one is to avoid deforestation and forest degradation (Buizer et al., 2014). Often considered for tropical developing countries (deforestation and forest degradation due to the large scale agroindustry, slash-and-burn cropping, illegal logging, etc.), policies and measures for avoiding deforestation and forest degradation (Carrasco and Papworth, 2014) can also be implemented in developed countries: improving the fire-fighting system, increasing resilience of forests stands to extreme events such as storms, promoting reduced impact logging, etc. In temperate forests, gains can vary from few tCO_2eq (avoiding forest degradation) to hundreds of tCO_2eq/ha (avoiding deforestation) each year.

In addition to this, carbon removals in existing forests can be improved via sustainable forest management practices (Makkonen et al., 2015): by using selected species, lengthening rotations, rejuvenating old forest stands, etc. In temperate forest, gains are in the order of few tCO_2 eq/ha/year. Afforestation/Reforestation (A/R) is another significant option. It covers different modalities of conversion of non-forest land into forest land (planting, seeding, assisted natural regeneration, etc.).

Biomass resources like wood (firewood, wood pellets, granulated wood, etc.) can be used for energy production (heat and/or electricity) which adds up to mitigation capacity (Haus et al., 2014; Muench, 2014). Forest biomass resources are carbon neutral over the medium to long- term if (an only if) the forest is sustainably managed. One Ton of Oil Equivalent (toe) can be substituted by four cubic meter of fresh wood and, consequently, avoids the emission of three tCO_2eq. Finally, a large portion of carbon can be stored in long-life HWP (wood frame, wardrobe, etc.) or medium to short-life wood products (wooden crates, cardboard, etc.). If the storage is longer than 100 years (average lifetime of the CO_2 in the atmosphere), then one cubic meter of wood equals to one tCO_2eq avoided (Donlan, 2012; Sikkema et al., 2013).

It is worth noting that, in addition to the storage effect of HWP, there is also a substitution effect: indeed, a portion of HWP can also be used as building and housing materials instead of “fossil” materials (iron, concrete, glass, etc.), therefore avoiding GHG emissions due to the processing of such “fossil” materials. In France, for instance, one cubic meter of wood used as building or housing material avoids 0.8 tCO_2eq in average (*Institut technologique Forêt-Cellulose-Bois-construction-Ameublement* – FCBA, 2011).

In this study, we estimated the carbon sequestration in the HWP category of the Turkish NIR, according to IPPC (2006) Guidelines. In other words we calculated the carbon balance of HWP in Turkey. This is the first time such an estimate of carbon stocks and carbon stock changes in the HWP pool has been carried out in Turkey.

2. MATERIAL AND METHODS

In order to estimate annual changes in HWP, we used the general method explained in Equ. 12.1 of the IPCC (2006) guidelines:

$$C(i+1) = \exp(-k) \times C(i) \times [(1-\exp(-k))/k] \times \text{inflow}(i),$$

Where, k = decay constant of first order decay (/yr) = log(2)/HL, with HL = half-life (yr)
C(i) = carbon stock of HWP in the beginning of the year I (GgC)
$\Delta C(i) = C(i+1) - C(i)$ (GgC/yr), with C(i) = 0 in 1990
Inflow (i) = inflow to the HWP pool during the year I (GgC/yr)

We used the following default values for our calculations (Table / Tablo 1):

Table 1. Default values used to estimate carbon stock changes in HWP pool (IPCC, 2006)
Tablo 1. HOÜ havuzundaki karbon stok değişiminin hesaplanmasında kullanılan geçerli (default) değerler (IPCC, 2006).

Default value for rate of increase from 1900 to 1964, based on Table 12.3 from AFOLU 2006	
	0,015
Defaut value for "HL", half-life (yr), from FCCC/KP/AWG/2010/CRP.4/Rev.4 (para 7, page 31)	
Sawnwood (yr)	35
Wood-based panels (yr)	25
Estimate of "k", decay constant of 1st order decay (/yr), based on Equ. 12.1 from AFOLU 2006	
Sawnwood (yr)	0,020
Wood-based panels (yr)	0,028

We did the calculations in four steps:

- Corrected 1900-2013 data series: the UNECE Timber database gives disaggregated figures for HWP produced in Turkey from 1964 to 2011. We focused on the two main HWP categories, which are sawnwood (UNECE code: 5) and wood-based panels (UNECE code: 6).

Comparing UNECE data series with OGM data series for industrial roundwood over 1976-2013 (starting date for OGM data series), we noticed some anomalies (with UNECE data series as a basis: max: +47%, min = -23%; mean = +16%). These anomalies could be due to two things: (i) use of volume over bark for UNECE and volume under bark for OGM (+15% for volume over bark), (ii) integration of industrial roundwood coming from the private sector for UNECE.

In order to ensure coherence, we then corrected the 1976-2011 UNECE data series for sawnwood and wood-based panels taking into account for each year the % of anomaly. Luckily, from 1976 to 1982, the anomalies are very reduced (-1% in average), which allow using the UNECE data series from 1964 to 1975. After that, we used the corrected 1964-2013 data series and we extrapolated the 1900-1963 data series (starting in 1964) using the default value for rate of increase of HWP in Europe, based on Table 12.3 from AFOLU 2006. We estimated complete 1900-2013 data series for all the categories;

- Share of HWP categories over 2012-2020: We estimated the average share of each HWP over the last ten years: 48% for sawnwood and 38% for wood-based panels (the 14% of others HWP were not considered in the analysis, either because they were short-lived products or marginal or difficult to estimate). Then we used strategy documents of the OGM to analyse the harvest scenarios until 2020. We found out that there are 2 possible scenarios to close the gap between wood demand and supply; extensive and intensive. For each scenarios, we disaggregated the 2013-2020 volume of industrial roundwood into the two HWPs, using the calculated %. Assuming OGM harvests 90 Mm3 of industrial roundwood from 2013 to 2017, the increase of OGM production of industrial roundwood is estimated to increase gradually: 14.7 Mm^3 in 2013, 16 Mm^3 in 2014, 18 Mm3 in 2015, 20 Mm^3 in 2016, 21.3 Mm^3 in 2017 (90 Mm3 in total). After that, we assume the same trend will continue up to 26.4 Mm^3 by 2020. Only considering the effective thinning of forests, according to the management plans prescriptions, an increase of total roundwood production of 25 Mm^3 by OGM would be possible by 2020. It would imply an intermediate objective of 21 Mm^3 by 2017. This later situation represents the extensive scenario.

- Inflow of HWP over 1900-2020: We multiplied the four data series (two scenarios x two HWPs) expressed in '000 m^3/yr by the "weighted" Basic Wood Density factor (D, tdm/m^3) calculated for mixed forest in Turkey. The default CF value was used to convert dm into C and 44/12 into CO_2 equivalent.

- Carbon stock and carbon stock changes in HWP: For each data series, we applied the Equ. 12.1 (IPCC, 2006), using the ad hoc default values presented.

3. RESULTS AND DISCUSSIONS

3.1 Carbon Stock Changes (CSC) in HWP

The major tree species in Turkey are given in Table / Tablo 2. The wood density (D) values compiled by Tolunay (2011) have been calculated as the aerial cover weighted mean for the top ten coniferous (0.458 ton/m^3) and deciduous species (0.549 ton/m^3) and their total as the mixed coefficient (0.489 ton/m^3).

Table 2. The major tree species in Turkey in 2014 (ENVANIS, 2014) and their wood density values based on country specific data (Tolunay, 2011).
Tablo 2. Türkiye'de 2014 yılı için ana ağaç türleri (ENVANIS, 2014) ve ülkeye özgü verilere dayalı odun yoğunluğu değerleri (Tolunay, 2011).

Main species	**Area (ha)**	**Area (%)**	**D (wood density) Tonnes dm/ m^3 moist volume)**
Calabrian pine	3,202,343	27.7	0.478
Larch	2,564,720	22.2	0.470
Oak	2,137,486	18.5	0.570
Beech	1,621,257	14.0	0.530
Scots pine	738,495	6.4	0.426
Fir	406,498	3.5	0.350
Spruce	228,786	2.0	0.358
Cedar	220,328	1.9	0.430
Alder	99,984	0.9	0.407
Juniper	89,474	0.8	0.460

The CSC have been calculated by using an excel spreadsheet (Table / Tablo 3) using the calculated (country specific) D values and a default CF value of 0.5 given in IPCC (2006).

The harvest rate was high in the 70's (above 20 Mm^3, made of firewood for roughly 75%). From there, it decreased to its lowest level at the beginning of the 2000's (12.5 Mm^3/yr in 2001), before rising again till now. It is worth noting that the harvest of firewood constantly decreased while the harvest of industrial roundwood, that stayed stable from the 70's to the 2000's (around 7 Mm^3/yr), started to increase strongly after (Figure 1).

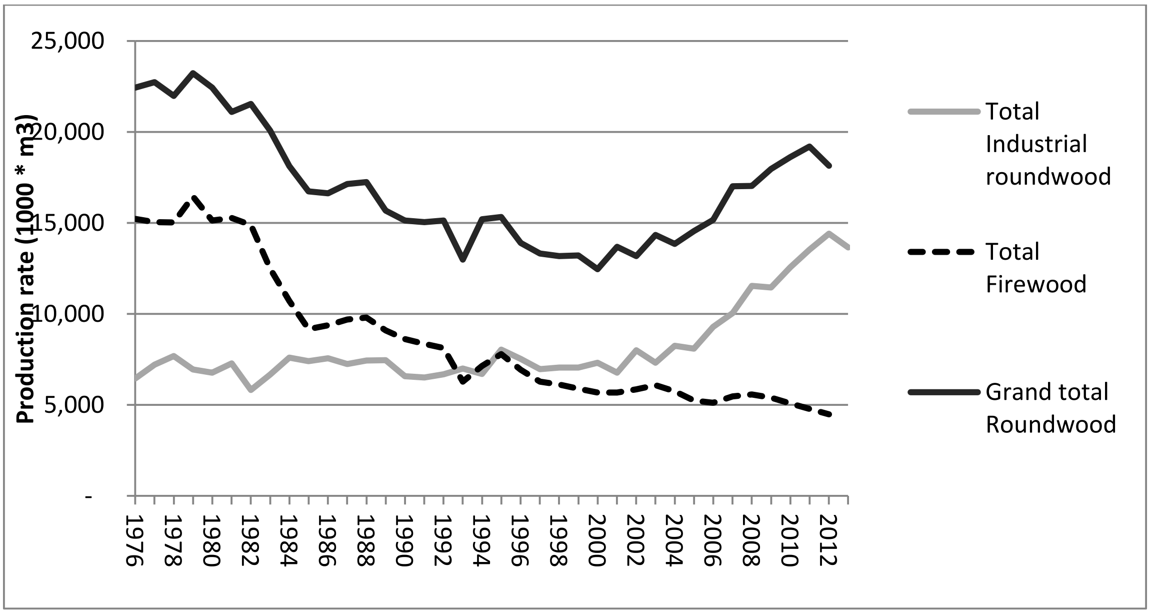

Figure 1. Annual harvest (ind. roundwood and firewood) in '000 m3 from 1976 to 2013 (OGM, 2014).
Şekil 1. 1976 yılından 2013'e yıllık kesim miktarları (x1000 m3 cinsinden endüstriyel yuvarlak odun ve yakacak odun).

Table 3. The calculation procedure for HWP for extensive (ext.) and intensive (int.) scenarios.
Tablo 3. Şiddetli ve mutedil kesim senaryoları için HOÜ hesaplama prosedürü.

	Production (in '000 m^3, otherwise precised)	**1978**	**2020**	**Explanations**
IR-UN	Industrial Roundwood (UNECE, overbark)	7.863		
SW-UN	Sawnwood (UNECE)	4.650		
	% Sawnwood (UNECE)	59%	48%	SW/IR*100
WP-UN	Wood-based panels (UNECE)	541		
	% Wood-based panels (UNECE)	7%	38%	WP/IR*100
IR-OGM	Industrial roundwood (OGM only, underbark)	7.694		
	Diff UNECE vs OGM (1977-2011)	2%	32%	(IR-UN)-(IR-OGM)/(IR-OGM)*100
SW-C	Sawnwood (UNECE, corrected)	4.548		
WP-C	Wood-based panels (UNECE, corrected)	529		
IR-OGMint	Industrial roundwood (OGM only, Int. Scen)	7.694	26.359	
IR-OGMext	industrial roundwood (OGM only, Ext. Scen)	7.694	22.378	
=SW-C	P° Sawnwood Production (Int Scen)	4.548	12.627	
=WP-C	P° Wood-based panels Production (Int Scen)	529	9.908	
=SW-C	P° Sawnwood Production (Ext Scen)	4.548	10.720	
=WP-C	P° Wood-based panels Production (Ext Scen)	529	8.412	
I-SWint	Inflox sawnwood (Int Scen) in '000 tC/yr	1.075	3.087	=(SW-C)*D*CF
I-WPint	Inflow wood-based panels (Int Scen) in '000 tC/yr	125	2.422	=(WP-C)*D*CF
I-SWext	Inflow sawnwood (Ext Scen) in '000 tC/yr	1.075	2.621	=(SW-C)*D*CF
I-WPext	Inflow wood-based panels (Ext Scen) in '000 tC/yr	125	2.056	=(WP-C)*D*CF
CS-SWint	Carbon stock sawnwood (Int Scen) in '000 tC/yr	12.698	44.232	Eq.12.1.(IPCC, 2006)
CS-WPint	Carbon stock wood-based panels (Int Scen) in '000 tC/yr	786	21.382	Eq.12.1.(IPCC, 2006)
CSC-Int	Changes in HWP C stocks in '000 tC/yr (Int Scen)	590	3.734	((CS-SWint (i)+ CS-Wpint) (i)) / ((CS-SWint (i-1)+ CS-Wpint) (i-1))
CSC-Int	Net removals in $MtCO_2eq/yr$ (Int Scen)	-2,16	-13,69	CSC-Int*-44/12/1000
CS-SWext	Carbon stock sawnwood (Ext Scen) in '000 tC/yr	12.698	42.530	Eq.12.1.(IPCC, 2006)
CS-WPext	Carbon stock wood-based panels (Ext Scen) in '000 tC/yr	786	20.068	Eq.12.1.(IPCC, 2006)
CSC-ext	Change in HWP C stocks in '000 tC/yr (Ext Scen)	590	2.992	((CS-SWext (i)+ CS-WPext) (i)) / ((CS-SWext (i-1)+ CS-WPext) (i-1))
CSC-ext	Net removals in $MtCO_2eq/yr$ (Int Scen)	-2,16	-10,97	CSC-Int*-44/12/1000

The main explanations for these trends are the following: (i) Industrial roundwood: "*Demand for industrial wood in Turkey is steadily increasing, mainly to meet the needs of the construction industry […] Imports of forest products (excluding wood furniture) was about 1 200 MUS$ in 2007 and by far exceed exports (US$ 455 MUS$)*" (HAASE – FAO, 2011), (ii) Firewood: numerous reports point out the massive rural exodus, that explains the decrease in demand.

For 2007-2011, the average harvest was 17.2 Mm^3 (45% of the volume increment, according to ENVANIS data, 2014), made of 77% coniferous and 23% deciduous, and divided into industrial roundwood for 69% and firewood for 31%. After firewood, logs (third quality for 98% of the volume) are the main products (29% of the total harvest, 18.5% of coniferous and 5.5% of deciduous), followed by fiber chips (23.8%), and pulp wood (12%). The remaining products (electric poles, mining poles, small logs, etc.) are marginal (8.2%) (Wood Marketing Division of OGM, 2014).

The influence of harvest rates and shift in product types for the last 2 decades added further carbon storage in the wood products circulating in the country. The amount of carbon in HWP was 4368.2 Mg CO2 eq in 1990. It decreased to 546.06 Mg CO2 eq in 1999 and started to increase again steadily until 2013 (Figure / Şekil 2). The amount of carbon in HWP in 2013 reached to 7509.27 Mg CO2 eq which reflects an increase of 3141.07 Mg CO2 eq since 1990 with an average increase of 130.88 CO2 eq per year.

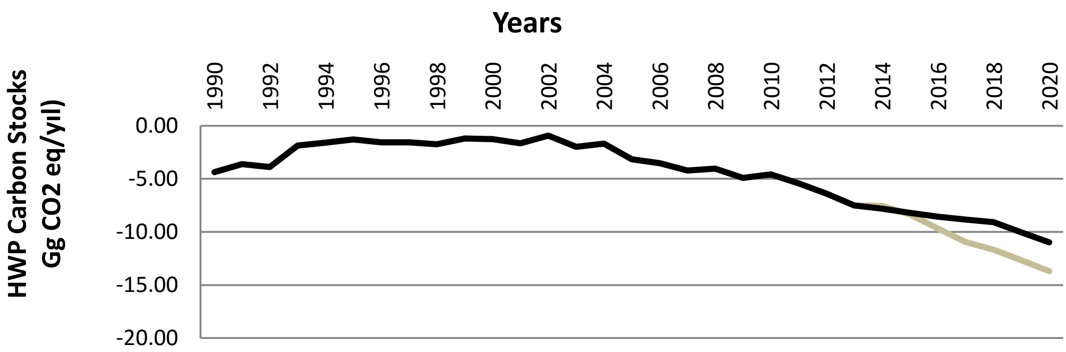

Figure 2. Estimate of carbon stock changes of the HWP pool in Turkey, from 1990 to 2020 (Bouyer et al., 2014). The grey line represents intensive, black line represents extensive scenarios.
Şekil 2. HOÜ havuzundaki 1990'dan 2020'ye kadarki karbon stok değişim tahmini (Bouyer ve ark., 2014). Gri çizgi şiddetli, siyah çizgi ise mutedil kesim senaryolarını ifade etmektedir.

The total 7509.27 Mg CO2 eq in 2013 represents a significant amount of removal which is more than 10 percent of the LULUCF sector total. It is also good news for Turkey as the amount is expected to increase in both scenarios (intensive and extensive). In extensive scenario the removals in HWP reaches 1099.14 Mg CO2 eq while it reaches 1370.79 Mg CO2 eq according to intensive scenario.

4. CONCLUSION

In Turkey, the use of firewood has been decreasing, with the development of alternative sources of energy. This causes a shift in the use of wood from firewood to industrial roundwood. The demand to the industrial roundwood also increases with economic growth. The shift in use of the wood together with increased demand result in an increase in the volume of HWP with longer life cycle. We can anticipate this sectorial trend to go on as it is in the next decade.

Turkey has the largest increase in GHG fossil emissions among all other Annex-I countries. This means that increasing removal in the LULUCF sector is very important to counterbalance the emissions. Therefore we suggest estimating carbon stock changes in the HWP pool in the annual GHG inventory of Turkey. Turkey has plans to increase harvest rate until 2020 to match an increased demand. This means that the share of HWP will also increase if the harvests are used in long duration wood products. This will ultimately contribute a lot to the economy of the Turkish forest sector and the mitigation of climate change.

In addition to these; we anticipate that a more comprehensive assessment of the HWP in the country with a more disaggregated data might add more removal and help offset Annex-A emissions of the country. A database established under the OGM GHG inventory unit would fulfil this task.

REFERENCES (KAYNAKLAR)

Bouyer, O., Ulgen, H., Serengil, Y., Liagre, L., 2014. Cost and Benefit Assessment of Implementing LULUCF Accounting Rules in Turkey. 1st Carbon Summit. Istanbul, Turkey.

Bouyer, O., Serengil, Y., 2014. Cost and Benefit Assessment of Implementing LULUCF Accounting Rules in Turkey. OGM. Istanbul, Turkey. 84 p. (+ tables in annexes).

Buizer, M., Humphreys, D., De Jong, W., 2014. Climate change and deforestation: The evolution of an intersecting policy domain. *Environmental Science and Policy* 35: 1-11.

Carrasco, L.R., Papworth, S.K., 2014. A ranking of net national contributions to climate change mitigation through tropical forest conservation. *Journal of Environmental Management* 146: 575-581.

Donlan, J., Skog, K., Byrne, K.A., 2012. Carbon storage in harvested wood products for Ireland 1961–2009. *Biomass and Bioenergy* 46: 731-738

FCBA., 2011. Carbone Forêt-Bois: Des faits et des chiffres. 15p.

HAASE (FAO), 2011. Overview of the forestry sector in Turkey. 6p (Apr. 2011)

Haus, S., Gustavsson, L.,Sathre, R., 2014. Climate mitigation comparison of woody biomass systems with the inclusion of land-use in the reference fossil system. *Biomass and Bioenergy* 65: 136-144.

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Uses. 678 p.

IPCC, 2014. Summary for policymakers. Climate Change 2014: Mitigation of Climate Change. Cambridge University Press, Cambridge, United Kingdom and New york, USA (2014) (Contribution of working group III to the fifth assessment report of the intergovernmental panel on climate change).

Makkonen, M., Huttunen, S., Primmer, E., Repo, A., Hildén, M., 2015. Policy coherence in climate change mitigation: An ecosystem service approach to forests as carbon sinks and bioenergy sources. *Forest Policy and Economics* 50:153-162.

Muench, S., 2014. Greenhouse gas mitigation potential of electricity from biomass. *Journal of Cleaner Production*. In press. doi:10.1016/j.jclepro.2014.08.082

NIR,2014.http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories submissions/items/8108.php

Serengil, Y., Augustaitis, A., Bytnerowicz, A., Grulke, N., Kozovitz, A.R., Matyssek, R., Mueller-Starck, G., Schaub, M., Wieser, G., Coskun, A.A., Paoletti, E., 2011. Adaptation of forest ecosystems to air pollution and climate change: a global assessment on research priorities. *IForest Biogeosciences and Forestry* 4: 44-48.

Serengil, Y., Erden, H., 2012. Durban climate deal and LULUCF. *International Journal of Environmental Studies* 69(1): 169-171.

Sikkema, R., Junginger, M., McFarlane, P., Faaij, A., 2013. The GHG contribution of the cascaded use of harvested wood products in comparison with the use of wood for energy - A case study on available forest resources in Canada. *Environmental Science and Policy* 31: 96-108.

Tolunay, D., 2011. Total carbon stocks and carbon accumulation in living tree biomass in forest ecosystems of Turkey. *Turkish Journal of Agriculture and Forestry* 35: 265-279.